IRICEN Journal of Civil Engineering

ज्ञान ज्योति से मार्गदर्शन

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Signing of MOU for M.Tech. (Rail Technology-Civil) between IRICEN and Savitribai Phule Pune University

Indian Railways Institute of Civil Engineering, Pune



To impart world class training in Rail technology and Railway specific civil engineering through competent faculty & personnel and state-of-art training infrastructure.

We shall ensure continuous improvement in both technical and managerial areas to play a significient role in finalization of prevailing practices and help in achieving overall vision of the Indian Railways.



OUR QUALITY POLICY

1. We will impart quality training in the fields of rail technology and railway specific civil engineering to develop competence amongst engineering fraternity of railways.
2. We will focus on customer satisfaction through identification, control and improvement of all key processes. For this, we will continuously endeavour to deliver quality services through constant interaction with RDSO, Railway Board and Zonal Railways.
3. For ensuring overall development of trainees, we will also emphasise on Improvement of their managerial skills.
4. For achieving above, we will deploy competent faculty & personnel and state-of- art infrastructure.
5. We will create conducive working environment where every employee is motivated to contribute his best.
6. Our motto is to “Beam as a beacon of knowledge”.
7. This Quality Policy shall be reviewed periodically for its continuing suitability and communicated to all employees.



From director's desk

Dear Readers,

The quarter gone-by will be always remembered for the reason that merger of Rail Budget with General Budget has taken place during this period. For IRICEN there is another pleasant reason to remember this quarter, for signing of a Memorandum of Understanding between IRICEN and Savitribai Phule Pune University for award of Masters degree to IRSE probationers.

In this edition of the journal, papers on wide ranging topics are included. The contribution of papers from retired officers and authors, to share their knowledge and wisdom, is laudable.

The papers relating to formation rehabilitation and strengthening using geo-grids are extremely relevant as Indian Railways is at threshold of raising speeds of passenger services and higher axle loads. Another interesting paper is on an innovation solution for improvement of bearing capacity for approaches by stone column.

I feel that the readers would find these papers and articles contained in this edition of the journal and expect that feedback and contribution for improvement and inclusion in subsequent editions.

I also extend greeting to all engineers on the occasion of IRSE day.

Pune

October - 2016.

(N. C. Sharda)
Director

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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.

World's Longest, Deepest Train Tunnel Opens in Switzerland

Stretching for 35 miles under the Swiss Alps, the Gotthard Base Tunnel has opened in Switzerland, nearly two decades after construction began, and will connect the cities of Bodio and Erstfeld, as part of an ambitious high-speed rail line that will eventually stretch from Rotterdam in the Netherlands to the Italian city of Genoa.

It is the world's longest and deepest train tunnel, longer than both the 33-mile Seikan rail tunnel in Japan and the 32-mile Channel Tunnel, which connects France and the UK, and reaches depths of upto 1.4 miles below the surface of the mountains. Several European heads of state were in attendance for the tunnels's inauguration. The completion of the $12.2 billion project was marked with an extravagant ceremony. About 500 people were selected from a lottery to participate in its first train ride.

Proposals for the base tunnel date back to 1947, but the project wasn't approved until 1992, following a voter referendum. Over the course of 17 years, workers excavated more than 28 million tons of rock from the site, which they repurposed as concrete for the tunnel. Full service is expected to begin in December, with passenger trains travelling at a maximum speed of 155 miles per hour. When the service begins, the travel time between Zurich and Milan will be reduced by an hour.

Ref: Civil Engineering & Construction Review, July 2016, Pg12

India's First Bullet Train to Run by 2023

Railway Minister Suresh Prabhu has announced that India's first bullet train will run in 2023 and is expected to cover 508 km between Mumbai and Ahmedabad in about two hours, running at a maximum speed of 350 kmph and operating speed of 320 kmph.

Passengers will get the thrill of riding under the sea while travelling between Mumbai and Ahmedabad on the first bullet train zof the country. The 508-Kilometre long Mumbai Ahmedabad high speed rail corridor will have a 21 km tunnel under the sea.

Estimated to cost about ₹₹97,636 crore, 81 percent of the funding for the project will come in the form of loan from Japan. The estimate includes possible cost escalation, interest during construction and import duties. It is a soft loan for 50 years at 0.1 percent annual interest with a 15 year moratorium.

According to the detailed project report proposed by the Japanese International Corporation Agency(JICA), while most part of the corridor is proposed to be on the elevated track, there will be a stretch after Thane creek towards Virar which will run under the sea.

Rolling Stock and other equipment like signalling and power system will be imported from Japan as per the loan agreement. An official said the loan agreement with Japan is slated to be signed by the end of the year and construction work is likely to begin by the end of theyear and construction work is likely to begin by the end of 2018.

Ref: Civil Engineering & Construction Review, July 2016, Pg12

Railways will Seek Cabinet Approval for 3 Freight Corridors

For expansion of the Dedicated Freight Corridor (DFC) network, the Indian Railways will seek the cabinet's approval for arranging funds and acquiring land for the three new dedicated corridors. The Railway Budget 2016-17 has proposed the total 5,769 km-long track comprising three more dedicated freight corridors in the country to ensure faster movement of googs. RITES has undertaken the preliminary engineering and traffic system study of the proposed three new routes to ascertain the traffic projection and the report has been submitted to railways. The proposed new routes are the 2,327 km-long east-west corridor connecting Kolkata to Mumbai; the 2,328 km-long north-south corridor linking Delhi with Chennai, and the 1,114 km-long east coast corridor from Kharagpur to Vijaywada. The market share of railways is expected to go up to 50% from the current 18% with the operation of DFC. While the railways will earn revenue from freight movement on the dedicated corridors, DFCC will earn access charge, which is about 35-40% of the revenue earnings.

The Master builder, June 2016

Railways to Seek $500mn Loan for Station Development

Indian Railway will seek USD 500 million with a moratorium of 7 years from World Bank for undertaking redevelopment of some major stations as part of its ambitious station development plan. Altogether 403 stations have been identified for redevelopment in a big way with improved passenger amenities including shopping malls, multiplexes, office complex, eateries and larger parking lots using vast land in possession of the public sector transporter. Station development is a focus area for the cash-strapped railways and concerted efforts are being made to firm up a roadmap

for it. Besides, railways is also in discussion with some foreign entities to benefit from their expertise in developing stations. While French Railway (SNCF) has been given Ambala and Ludhiana stations for redevelopment, the public transporter is also in talks with Germany and South Korea for some other stations. Railways is exploring the possibility of involving South Korea for redeveloping the New Delhi station as a world class station.



The Indian Railway Stations Development Corporation (IRSDC) has been tasked with redeveloping eight stations- Habibganj, Bijwasan, Anand Vihar, Chandigarh, Shivaji Nagar, Surat, Gandhinagar and Mohali. A cabinet note has been initiated to entrust three identified stations to National Building Construction Corporation (NBCC), a Public Sector Undertaking under Urban Development Ministry on nomination basis.

The Master builder, June 2016

CCEA Approves Broad Gauge Railway Line from Mau to Tarighat

The Cabinet Committee on Economic Affairs, chaired by the Prime Minister, Narendra Modi has given its approval for a new broad gauge line between Mau Station of North Eastern Railway and Tarighat Terminal station of East Central Railway. The total length of this new broad gauge line will be 51 kilometers. The estimated cost of the project is ₹1765.92 crore and expected completion cost is ₹2109.07 crore with 5 percent escalation per annum. The project is likely to be completed in the next six years during 12th and 13th Plan period. This project will provide alternative, shorter convenient and better transport infrastructure to the area separated by river Ganga so as to remove the transport difficulties in the area and to boost the socio economic development. The catchment area of project line will serve passenger requirement and will facilitate the people of the area for travelling to different parts of the country. In addition, this new line will provide an alternative route connecting Northern and East Central railway via NE Railway. This project line has huge potential in enhancing railway traffic and also gives opportunity to develop this area by providing more efficient transportation system.

The Master builder, June 2016

Pune-Nashik Rail Line Survey Finally Gains Momentum



The long-pending proposal of laying a railway track between Pune and Nashik has finally moved ahead with the Central Railway recently announcing a final location survey for the project. The survey will propose the alignment of the track and study in detail various other aspects like location of stations, loading-unloading places, possible freight and passenger quantum and requirement of land for infrastructure. The railway administration has invited tenders to appoint a firm to carry out the survey work, which is expected to be completed within six months. The new line will have a total length of 265 km and will connect the two fastest growing cities in the state. The Central Railway has earmarked Rs 1.98 crore for the survey. It is important to get details of the land where the track is to be laid. The survey will focus on land-holding pattern and study the villages along the proposed alignment. Physical inspection of surrounding areas will also be done. Nashik is the only city in the state, which is not directly connected to Pune with a rail link. At present, all trains between Pune and Nashik go via Kalyan or commuters have to travel to Manmad and then take a train to Nashik, spending more than six to seven hours in travelling time.

The Master builder, July 2016

Land Acquisition for Agartala-Akhaura Railway Route to Start Soon



Acquisition of land for rail link between Agartala and Akhaura in Bangladesh will start soon as funds have been released by DoNER ministry. Rs 97 crore were earmarked for land for Agartala- Akhaura rail project in the Indian side. Now, the ministry will start acquisition of land in five-kilometre area up to the border on Indian side. The process of laying the 15.054-km-long railway tracks to connect Agartala with Akhaura in Bangladesh will be completed by 2017. Of the total track, a stretch of five kilometre would be on the Indian side and the rest in Bangladesh. A flyover (viaduct) which will be 3.7 km long would be constructed on the Indian side to save cultivable lands. DoNER has already sanctioned Rs 580 crore for the project as New Delhi is keen to establish the rail link, which would connect West Bengal and Tripura through Bangladesh. The Agartala-Akhaura railway route would connect Indian Railways with Bangladesh Railways to improve connectivity and boost trade between the two countries. Also the 1,700 km distance between Agartala and Kolkata, which passes the 'chicken s neck' in Siliguri would be reduced to 350 km if passengers could move through Bangladesh. The entire project cost for laying down the track on Indian side and Bangladeshi side would be borne by India.

The Master builder, July 2016

International Geotech Engineers help Shore up Rail Links in NFR



The broad gauge lifeline of northeastern states is in danger and it is because of the loose soil beneath the railway track. So engineers from Austria and Germany are now working hard to find a solution even as the Northeast Frontier Railway has decided to divert parts of the track in Dima Hasao district of southern Assam. The track that traverses southern Assam, Mizoram, Manipur and Tripura was converted from metre gauge to broad gauge last year. However, within weeks train services had to be suspended — first because of rain and landslides, and then due to loose soil beneath the railway track. Northeast Frontier Railways has decided to divert about 200 metres of the track near Migrendisa.

The lone railway line from Guwahati passes through Lumding in Nagaon district in central Assam and southern Assam, connecting Agartala and parts of Manipur and Mizoram with the rest of India. The Guwahati-Silchar railway route is the lifeline for southern Assam comprising Cachar, Karimganj, Hailakandi, Dima Hasao districts, and the mountainous states of Tripura, Manipur and Mizoram. The region is dependent on this railway route for supply of food grain, fertiliser, petroleum products, construction materials and other commodities.

The Silchar-Jiribam (52 km) in Manipur and Silchar-Bhairabi (120 km) in Mizoram gauge conversion projects are part of the Lumding-Silchar line.

The Master builder, July 2016

Bullet Train Project from Mumbai-Ahmedabad Overcomes BKC Hurdles



The ₹98,000 crore project for a bullet train between Mumbai and Ahmedabad has found itself clear of a major hurdle. The Maharashtra government withdrew its objection to provide land at the Bandra Kurla Complex

(BKC) in Mumbai to build an underground station. Indian Railways requires 0.9 hectares of BKC land for access to underground station. However, the Maharashtra state government had earlier denied Railway ministry the land saying that giving it away would hamper the state's project – the Mumbai International Financial Services Centre, located in BKC complex and that there could be a loss in revenue of around Rs 10,000 crore. Although the land in not within the criteria of special economic zone (SEZ), state government is expecting the centre to relax norms.

The Master builder, July 2016

Indian Railways Expresses Interest in Magnetic Levitation



(Maglev train superconducting magnet bogie - MLX01)

The Indian Railways issued an Expression of Interest (EoI) for Magnetic Levitation (MagLev) train technology on 2nd August 2016. The EoI invites interested companies to design, build, operate and maintain MagLev systems for both passenger travel and cargo transportation. The deadline for submittal is 6 September. Technical and commercial bids would be called for at a later stage. The Indian Government would provide the land, while the company awarded the contract would design the train and build a 200 – 500 km long elevated track, after successfully demonstrating the technology over a test distance of 10 – 15 km. Once completed the MagLev system would be operated under a Public-Private-Partnership (PPP) model. The Indian Ministry of Railways has shortlisted four railway routes for the implementation of MagLev technology: (i) Bengaluru – Chennai (ii) Hyderabad – Chennai (iii) New Delhi – Chandigarh (iv) Nagpur – Mumbai. The expected average speed would be 350 km/h, with a top speed of 500 km/h. The world's fastest commercial MagLev train currently operates in Shanghai at a top speed of 430 km/h. The 30.5 km line connects Shanghai Pudong International Airport to the outskirts of central Pudong.

The Master builder, August 2016

NAIR, Baroda Varsity Ink Pact for MBA Programme for Rail



National Academy of Indian Railways (formerly Railway Staff College), Vadodara where the proposed Railway University is being planned to be set up by Centre

In a step towards setting up the country's first Railway university, an MoU signed between National Academy of Indian Railways (NAIR) here and Maharaja Sayajirao University to award MBA degrees to rail employees in various fields like accounts and personnel.

NAIR, the apex training institute for imparting training to railway officers, has been selected for upgradation as a full-fledged Railway University as part of efforts to enhance the skills of railway officers. The city-based National Academy of the Indian Railway (NAIR) and M S University of Baroda today inked an agreement which will offer MBA programme for railway officers.

It is envisioned that Railway University, when set up, would act as an affiliating University. Five other premier Central Training Institutes of the Railways at Pune, Nasik, Jamalpur, Secunderabad and Lucknow, which train officers of various specific disciplines in the Railways, would be affiliated as constituent colleges.

As a measure of enhancing professional management education in the railway field to the Probationary Officers, it was decided that NAIR shall tie-up with Maharaja Sayajirao University, Vadodara for awarding MBA degree in specific Railway fields to Indian Railway Accounts Service (IRAS), Indian Railway Personnel Service (IRPS) and Indian Railway Store Service (IRSS) officers, said a senior Railway Ministry official.

The MoU signed by Union Minister Suresh Prabhu and Gujarat Chief Minister Vijay Rupani here. This was ratified earlier by the academic council and Senate of MS University.

Railway probationary officers who are currently trained at NAIR, will study and obtain MBA degree from the University with specialisation in respective fields such as Finance, Human Resource Management, Production and Operations Management and Marketing Management.

The tie-up also enables MS University to select students at their end for MBA along with Railway officers. These students will also be awarded MBA degree in respective disciplines.

He said this will also serve the requirements of railway-related infrastructural construction contractors, suppliers, Metros and Port Railways.

They can also seek employment in Railways, by appearing in exam conducted by UPSC, he said.

The programme starts with the first batch of IRSS joining NAIR in August 2016.

Other initiatives for railway related education and research as a railway budget initiative, four Centres of Railway Research (CRR) were to be set up in premier educational institutions of India.

Source:http://www.railnews.co.in/

SAIL-BSP Inches Closer to Produce World's Longest Rail



The new Universal Rail Mill (URM) of state-run Steel Authority of India Limited (SAIL) in Bhilai Steel Plant (BSP) has achieved the milestone of successfully rolling out the first rail through its Tandem Mill.

The feat would pave way for the steel maker to roll out 130-meter rail from the mill located in Chhattisgarh's Durg district. The 130-meter rail would be World's largest rail in a single piece. The new URM is part of BSP's modernization programme that would scale up capacity to 7 million tonnes per annum (mtpa).

SAIL's Bhilai Steel Plant during April 2016 had initiated hot trials of its new state of the art 1.2 mtpa (million tonne per annum) Universal Rail Mill. The Reheating Furnace of the Universal Rail Mill was lit up on March 25, 2016, following which hot blooms were rolled from the new Mill's Rolling Stand No 1 on Thursday. The lighting up of Reheating Furnace and hot trials of Universal Rail Mill (URM) are important milestones towards commissioning of URM as also in Bhilai's seven million tonne (mt) Modex Programme.

A SAIL spokesperson said technology and equipment suppliers along with BSP team were working relentlessly for last one and half month to make the Tandem Mill ready for rolling. "With the trial rolling of more than 100-meter-long rails from Tandem mill, BSP is only inches away from the commercial production of world class and longest rails," he added.

The URM has a capacity of producing 1.2 million Tonnes of rails. It would help the company to meet the specific demand from the Indian Railways. The BSP is the sole supplier of rails to the Indian Railways that had been demanding 260-meter rails for the past two years.

According to company officials, the plant was fulfilling the demand by welding 65-meter rails that the plant was producing from the old set-up. The 130-meter rail that the plant's new URM would roll out, would require only one weld joint to meet the demand of Indian Railways' order.

Under the modernization programme, long rail welding complex had also been set in the BSP. With proven technology for world class rail welding, the 1.1 mtpa complex is equipped with fully automated flash butt welding machine to weld rails of 130-metre length and fully automated long rail handling facility. Welding of head hardened and micro alloyed rails can be carried out in the new complex.

The commuter enjoys a safe and bump less-ride and the railroad company saves on track life and maintenance. The BSP had in fact established long rail production facilities in 2004 at a cost of ₹400 crore to cater to the demand for long rails from Indian Railways.

Source:http://www.railnews.co.in/

Environmental Clearance must for Railway Projects, says NGT



The National Green Tribunal (NGT) has made it mandatory to obtain environmental clearances for Indian Railway projects before any work begins on the ground.

The NGT bench, headed by the tribunal's chairperson Justice Swatanter Kumar, delivered the order on Tuesday in response to a petition filed by environmentalist Vikrant Tongad.

In a petition filed on May 3, 2016, Tongad alleged that the Indian Railways project of laying 140km new track from Noida in UP to Rewari in Haryana will affect the ecology of the area because the Hindon River's 800-metre stretch in Noida is being averted without obtaining environmental clearance (EC).

Indian Railways argued before the tribunal that its projects are exempted from obtaining EC as they are big infrastructure projects of national importance.

"But NGT did not go by Indian Railways counsel's argument and made it clear that a railway project should obtain EC, like Delhi Metro projects," Rahul Chaudhary, advocate on behalf of the petitioner, said.

Tongad is all set to file another petition in the NGT demanding a stay order on the work at Hindon River in Noida.

Source:http://www.railnews.co.in/

Talgo Clocks 180 km per Hour on Mathura-Palwal Section in 38 Minutes

Talgo train outruns Gatiman clocking 180 km per hour, aims for 220 kmph



The Indian Railways has conducted the second trial run for high-speed Talgo trains of Spain on the Palwal-Mathura section of the North-Central Railway. Spanish-made Talgo has become the fastest train in the country by clocking a speed of 180 km/hr by covering 84 km in 38 minutes in the trial, surpassing the record of Gatimaan Express.

The train successfully completed its trial run on Wednesday by clocking 180 km/hr due to its light and advanced technology, Prabhash Kumar, Divisional Railway Manager, Agra, said.

Talgo is a Madrid-based Spanish leading manufacturer of semi-high speed (160-250 kmph) and high-speed (350 kmph) passenger trains, which are energy-efficient.

The trials were conducted with empty coaches. In the coming days, trials will take place with sand bags filling the passenger sitting spaces.

On the fifth day of the trial, the train covered 84 km in 38 minutes between Mathura and Palwal. The second phase of the trial run had resumed on July 9.

On the first day of the trial between Mathura and Palwal, the train had clocked 120 km/hr following which it was decided that its speed would be increased by 10 km/hr everyday.

Enthused by the successful trail runs, the speed of the train was increased to 170 km/hr on Tuesday.

Now the next trial run will be carried out by keeping sand bags to mimic passengers' weight to check the train's condition on turns.

The next trial will be carried out on the route of Mumbai-bound Rajdhani Express from Mathura.

Talgo aims to connect the national capital, New Delhi, with the financial capital, Mumbai.

The maximum speed of Gatimaan Express is 160 km/hr, Shatabdi Express 150 km/hr and Rajdhani Express is 130 km/hr.

Source:http://www.railnews.co.in/

Konkan Railway Partners Shapoorji Pallonji for New Chiplun-Karad Rail Line



Konkan Railway will sign an MoU with Shapoorji Pallonji & Co on August 14 for construction of new railway line between Chiplun and Karad railway stations.

The pact will be signed in the presence of Railway Minister Suresh Prabhu and Maharashtra Chief Minister Devendra Fadnavis, Konkan Railway Chairman and Managing Director, Sanjay Gupta said here today.

The project was conceived jointly by Railway Ministry and Government of Maharashtra to ensure better connectivity for the coastal Konkan region.

Gupta said the upcoming project is finally seeing light of the day with the identification of Shapoorji Pallonji Corporation Pvt Ltd (SPCPL) as the Public Private Partner with KRCL (Konkan Railway Corporation Limited).

Outlining the challenges, the recently-appointed full time CMD said, "We have enormous potential to expand ourselves and we are doing that. We are on the path of our capacity building and I hope that the biggest challenge is to arrange the financing modalities and funds which I am working hard to achieve to execute the various projects.

"In fiscal ended recently, we earned profit of Rs 129 crore. Our effort would be to maintain and raise the bar from this level," he said.

Last year, to mark its silver jubilee, the Konkan Railway had proposed to link Chiplun in coastal Ratnagiri district with Karad in Satara district across the Sahyadris, providing rail connectivity between the hinterland of Maharashtra and its Konkan coast. The linkage will provide a big boost to the industry, said Siddeshwar Telugu, CPRO, Konkan Railway, in a release here.

The route will be 103-km long. As the Maharashtra government is developing or expanding the ports of Rewas, Dighi, Jaigarh, Angre, Vijaydurg and Redi, the Karad-Chiplun line will facilitate easy transport of export/ import cargo. The detailed project report has already been prepared, Telugu said. The 'traffic projection' report has been prepared by Pricewaterhousecoopers while the financial viability study was conducted SBI Capital.

The major cargo that this line will transport is coal used for power generation. The estimated cost of construction is around Rs 2,500 crore. Maharashtra government would bear half the cost and the balance would be funded through the private participation.

The project is expected to be completed within five years. The special purpose vehicle for the project would be formed within a couple of months and the construction may start soon thereafter, the PRO added.

Source:http://www.railnews.co.in/

New Land Act to Raise Freight Corridor Land Costs from ₹16000 Cr to ₹20000 Cr

The cost of land acquisition for the ambitious dedicated freight corridor, is expected to go up from ₹16000 crores to a little over ₹20000 crores because the railways has now begun the process of acquiring land under the newer Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act 2013.

This act became law from January 1, 2014 and it has provisions which the government as well as the railways claim, is better than previous laws as far as compensation for land-owners is concerned.

The project, at a total cost of ₹81500 crores being built by the Dedicated Freight Corridor Corporation (DFCC), was previously acquiring land under the Railway Amendment Act, 2008, said officials. A total of 10548 hectares or 105.48 square kilometres of land is required for the high speed freight corridor than runs across nine states of India.

"The rise in land costs is not of significance when you consider the commitment of the DFCC to ensure that nobody whose land is acquired feels cheated or short-changed. It is a project that is going to change the way railways transport freight and there should be no compromise on such important issues as land acquisition," said an official. More than three lakh people are set to be affected by the twin legs of the project.

As of now the DFCC has disbursed a sum of ₹4959 crores for land acquisition and rehabilitation for the projects western leg between Jawaharlal Nehru Port near Mumbai and Dadri near Noida in Uttar Pradesh. Officials said that out of the ₹4959 crores disbursed, a sum of ₹4600 crore was for land compensation and the rest ₹359 crore under rehabilitation.

As per the 2016-17 Pink Book – the railways book on budgeted expenditure for a financial year- a sum of ₹3000 crores was allotted by the railways for land acquisition. This includes ₹1500 crores for the western leg of the freight corridor between Jawaharlal Nehru Port and Dadri and ₹1420 crores for the eastern leg

between Dankuni (West Bengal) and Ludhiana (Punjab).

Why the DFC is important for the railways: The share of the railways is steadily failing when it comes to transporting goods across the country. According to figures available from the Twelfth Five Year Plan, India, the railways share of goods transport stands at 36 percent compared to 48 percent in the United States and 47 percent in China, two of the world's largest economies. India transports nearly 57 percent of its goods by road while it is 22 percent in China and 37 percent in the United States. According to the railways, increasing freight share will not only boost its finances but also cut down on fuel emissions that road transport brings about.

Source:http://www.railnews.co.in/

Indian Railways Plans Drive against Encroachments

The Indian Railways has decided to construct new lines on the extreme sides of the existing tracks to prevent encroachers occupying its land, even as the road transport ministry dropped the idea after finding it impractical for safety reasons.

The decision is aimed at keeping land for captive use in future when the demand for additional infrastructure is required. It will also help the public sector entity get rid of hassles of land acquisition at higher cost.

"We have now decided that third line will be a line which will be on the side. What we will do is that it will be either extreme left or right and we will leave enough space in between so that when there is demand for fourth line it comes in-between and we do not have to go for land acquisition," Railway Board Chairman A.K. Mital said.

Speaking to RailNews, a senior civil engineer with the railways said that once a railway track is laid, the prices of land along it go up, making land acquisition in future a very expensive affair. "Besides, once land along the railway track is illegally encroached and people make permanent settlements there, removing them becomes big challenge," he said.

The idea to leave land in the middle of the project was first mooted by prime minister Narendra Modi in a meeting to review infrastructure development in the country. This was provided as solution to check the menace of encroachment along the rail and highway stretches. The idea, however, fell on technical parameters.

Source:http://www.railnews.co.in/

Railways to Float Global Tender for Procuring 300 Aluminium Coaches Shortly



Buoyed by the successful Talgo train trial, the railways is firming up an acquisition plan to procure 300 light-weight aluminium coaches from the market to be used for reducing inter-city travel time.

With the over-saturated main trunk routes posing a serious challenge for the railways' 'Raftaar' mission, the national transporter is looking towards light-weight aluminium coaches as an easy option to increase train speed on existing lines in shortest possible time.

Railways Minister Suresh Prabhu has launched the Raftaar Mission to increase the speed of passenger and freight services significantly.

"Instead of steel coaches, use of aluminium coaches seems to be the future now as the railways will gradually go for the light-weight material for faster journey on existing tracks," said a senior Railway Ministry official, adding, "A global tender will be floated shortly for this."

The light-weight aluminium coaches manufactured by Spanish Talgo and hauled by an Indian locomotive covered the 1,384km distance between Delhi and Mumbai in less than 12 hours as against the travel time of 16 hours taken by Mumbai Rajdhani, the fastest train at present between the two metropolises.

"We are proposing to acquire 300 aluminium coaches to begin with which means about 15 trains with 20 coaches each can be pressed on inter-city routes such as Delhi-Kanpur and Delhi-Lucknow," said the official.

Asked whether these coaches will be from Talgo, the official said the procurement will be made through open tendering process in which any company can participate.

The coaches of proposed high-speed train between Mumbai and Ahmedabad will also be made of aluminium as the light-weight train uses less energy and moves faster in comparison to steel coaches.

On if the railways would opt for tilting technology like Talgo train for not losing speed on curves, the official said, .

"We are examining every aspect. A decision will be taken before floating the global tender."

However, he said that Talgo—train design has to be changed as it cannot be pressed into service in the Indian rail system in its existing form. While the width has to be increased from the existing size, the footboard height has also to be increased to match our platform height.

The Talgo trial was conducted here without any cost to the railways as the Spanish company did bear the entire cost of shipment of coaches from Spain to India.

Source:http://www.railnews.co.in/

Budget Merger may Save Railways ₹10,000 Crore



As the merger of Rail Budget with the General Budget is expected from the next financial year (2017-18), the cash-strapped Indian Railways is expected to save up to Rs 10,000 crore on account of the fact that it will not be required to pay dividend to the government then on.

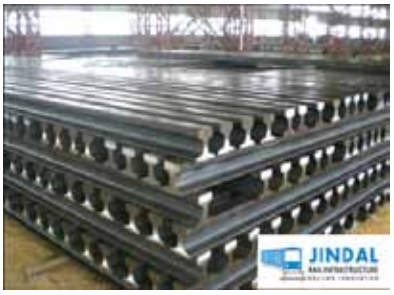
Recommending that the government should waive off payment of dividend by the Railways, the Joint Committee set up to finalise modalities for the merger of Rail Budget with the General Budget, which submitted its report to the Finance Ministry, however suggested the practice of getting gross budgetary support (GBS) from the exchequer should continue. The Railways pays out Rs 10,000 crore as dividend a year after getting a GBS of about Rs 40,000 crore, which the committee recommended various changes including waiving off of payment of dividend by railways.

The General Budget to be presented by the Finance Minister will also have a separate annexure with details of plan and non-plan expenditures to be incurred by the national transporter, according to the recommendations of the joint panel comprising senior officials from the ministries of railways and finance.

The recommendations will be placed before the Cabinet for a final decision, the sources said. The report on the merger of the Rail Budget and General Budget, was to be submitted by August 31 but was delayed and finally submitted on September 8, official sources in the Railways said.

Source:http://www.railnews.co.in/

Jindal Rail Infra Ltd to Start Supplying Head Hardened Rails in India



JSPL to become India's first maker of Head Hardened Rails with total rail making capacity of 60,000 tonnes per month, of which 30,000 tonnes is head hardened rails. JSPL eyes ₹3,500 Crore revenue from rail sector in next 3 years. The plant in Chhattisgarh, set up in technical collaboration with German SMS Meer Gmbh, has the capacity to deliver 30,000 tonnes of head-hardened rails per month.

Jindal Steel and Power Ltd said, the company is set to supply rails for the high-speed railway and metro rail projects with its ₹200-crore plant, set up in collaboration with SMS Meer, Germany, coming on stream.

The plant is capable of producing 30,000 tonnes of head hardened rails a month and it aims to substitute imports, which metro rail developers were forced to use till now.

"The declared metro rail projects itself give us a market of 0.5 million tonnes over the next two-three years. With this new line of products, we expect that our rail business will yield ₹200 crore of revenues a month from this fiscal (2016-17) as compared to ₹45 crore a month in the previous fiscal," said Ravi Uppal, Managing Director and Group Chief Executive Officer, Jindal Steel

and Power Ltd.

Uppal said currently, the landed price of imported head hardened rails is around ₹75,000 per tonne, while normal imported rails cost ₹50-55,000 per tonne.

"We would aim to bring down this cost difference. Apart from getting head hardened rails at a cheaper price, buyers can also benefit from shorter delivery times and would also be able to order as much as they need rather than bulk orders, which they need to place for imports," he added.

Jindal Steel and Power Ltd expects its entire rail business to contribute ₹1,800 crore to ₹2,000 crore to its revenues in the 2016-17 fiscal which would be scaled up to over ₹3,300 crore over the next two-three years.

Already, the company's order book for normal rails is 3 lakh tonnes, which would be delivered over the next few months.

Head hardened rails are typically used in metro rail projects as well as on high-speed freight corridors. Head hardening technology entails a special heat treatment process, which requires precise temperature control to achieve nearly 50 per cent higher hardness as compared to a normal rail.

On the remarkable achievement Mr. Naveen Jindal Chairman – JSPL said "In line with the Government's thrust on 'Make in India' JSPL has successfully completed trials of Head Hardened Rails and is all set for commercial production. JSPL being the only producer of Head Hardened Rails in the country is poised to play an important role in the growth of India's rail infrastructure."

"More than the boost to the infrastructure sector, I feel that the economy would benefit from the reduced import dependence and the improved investment demand due to domestic manufacturing of such rails," said Devendra Kumar Pant, chief economist, India Ratings.

Source:http://www.railnews.co.in/

India's First Medallist at the ongoing Rio Olympics, Wrestler Sakshi Malik Works for Indian Railways

Following her bronze medal win at the Rio Olympics, wrestler Sakshi Malik, who is a railway employee, will be awarded ₹60 lakh and also promoted as a gazetted officer.



According to the announcement made earlier by Railway Minister Suresh Prabhu before the commencement of the Olympics, Sakshi Malik will also be posted in the Zonal Railway of her choice.

"Entire Indian Railways fraternity is feeling proud today, as its employee has brought laurels for the nation," the Railways said in a statement.

Mr Prabhu along with both the Ministers of State Manoj Sinha and Rajen Gohain have congratulated her.

The gritty wrestler from Haryana won the Olympic Bronze medal in 58 kg category of women's freestyle wrestling. She also created history by becoming the first woman wrestler from India to bag an Olympic medal.

She is currently working in the commercial department of the Delhi Division of Northern Railway.

According to a senior Railway official, the national transporter facilitated grooming of Sakshi Malik as an ace wrestler by providing all kinds of facilities, environment and incentives. Wrestling coach of Railways Kuldeep Malik worked hard to prepare the women wrestlers for the mega event of the Olympics.

"It was the proactive approach of president Railways Sports Promotion Board (RSPB) Pradeep Kumar, who was instrumental in raising women's wrestling team and positive approach of the Ministry of Railways, who declared the awards not after Olympics as they usually do but prior so that there is an added motivation," RSPB secretary Rekha Yadav said.

"The Indian Railways is proud of both its wrestlers Sakshi Malik and Vinesh Phogat. Sakshi is currently a senior clerk with Northern Railways. She will be promoted to the rank of a gazetted officer," she added.

Source:http://www.railnews.co.in

Geogrids for Base Reinforcement for Railway Loading and their Properties

By
Rajeev Bhargava*

1.0 Introduction:

As a result of increasing railway traffic speed and axle loads, the ballast deteriorates due to breakage of the angular corners, which reduces the shear strength and the drainage characteristics of this important load bearing layer as the fines clog the pore space. A weakening of the ballast layer in turn causes greater stresses to the underlying subballast blanket and subgrade layer which can finally lead to detrimental deformations to the railway track. Geogrid reinforcement placed underneath the sub-ballast/ blanket layer can help reducing those stresses and additionally improves the bearing capacity of the underlying subgrade. This phenomenon can also be profitably used where rail height is constrained and new thicker concrete sleepers are to be installed to replace old, thinner timber or steel sleepers.

1.1 The mechanisms of geogrid reinforcement and the beneficial consequences for the performance of railway tracks are explained in the ensuing paragraphs.

Traffic loads applied to the railway track create a lateral spreading motion of the aggregate. Tensile lateral strains are created at the interface subgrade/geogrid as the aggregate moves down and the sideways due to the applied load. Through shear interaction (interlocking) of the base aggregate with the geogrid the aggregate is laterally restrained and the tensile forces are transmitted from the aggregate to the geogrid.

The reinforcement mechanisms and their resulting benefits associated with the interaction of the geogrid with the unbound aggregate are as follows:

- Confinement of the aggregate results in a reduction of lateral spreading.
- Confinement results in an increase in lateral stress within the aggregate thereby increasing its stiffness. This reduces the dynamic (recoverable) deformation for each load cycle.
- An increased stiffness of the aggregate results in an improved vertical stress distribution onto the underlying subgrade. This leads to reduced and more uniform surface deformation.
- A reduction in the shear stress within the subgrade is leading to lower vertical strain/settlement.

As the geogrid is much stiffer in tension as the aggregate, the lateral stress is reduced in the reduced base aggregate and less vertical deformation at the surface of the railway line can be expected. The interaction between geogrid and sub-ballast increases the shear strength and thus the load distribution capacity of the used aggregate material. This correlation enables the reduction of reinforced thickness in comparison to un-reinforced aggregate layers .

1.2 Parameters important to Clients

It is believed that Polypropylene is the most frequently used polymer for base reinforcement. The 'parameters important to Clients' for a geogrid manufactured from polypropylene, can be classified into TWO categories:

a. Parameters affecting durability

b. Parameters affecting Deformation and Load distribution

2.0 Geogrid Parameters Affecting Deformation and Load Distribution

A. Tensile Strength

Loads which are transferred to Geo-grid structure are distributed by the reinforcement via tensile elements and the junction. Depending on project

*Retired General Manager, Indian Railways

specific conditions and loads applied, the geo grid must have sufficient tensile strength to absorb tensile forces under typical serviceability conditions (0-2 %elongation) to limit deformations in base course. Hence, tensile strength at 2% strain is therefore the most important property signifying immediate stress absorption with low deformation on soil.

Good manufacturers are able to ensure 35% -40% of UTS at 2% strain.

A reasonably high value of Tensile strength at 2% makes sure both (a) TS @ 0.5 % strain (b) high stiffness within service range .

B. Radial Stiffness 0.5%

Traffic loads applied to the aggregate are dynamic in direction and intensity as well. Radial effectiveness is the ability of Geo grid to absorb the applied loads from all directions and transfer them effectively in all directions. Therefore, a geo grid with high radial stiffness in service load range, absorbs the load optimally, as it mobilises tensile forces in all directions (Multi axial) and transfers them safely.

The above becomes important for safety of construction because Geo grid with high radial stiffness leads to resistance against deformations.

C. Torsional Rigidity

Torsional rigidity defines the resistance of a geogrid against torsion /rotation. High torsional rigidity ensures that, the movements within the granular materials are reduced and thus minimises deformation. This thus optimises the interlocking. High torsional rigidity thus ensures better load distribution and creates rigid reinforcement. This is assessed by Aperture Stability test.

The very method of carrying out Aperture Stability test is by clamping the junction and giving torque, This test thus demonstrates availability of necessary rotational stiffness of junction for load transfer to the Geo-grid.

Incidentally, the necessary strength of junction not to get ripped off while withstanding anticipated construction conditions gets assessed by installation damage assessment tests conducted with simulated field trials.

Both these tests i.e. Aperture Stability test and installation damage assessment therefore put together ensure, required junction efficiency for junction not to get ripped off while achieving required strain in geo-grid as well as junction not getting ripped off, while withstanding anticipated harsh construction activities.

D. Elongation at UTS

Lower elongation at ultimate Tensile Strength is a reflection of high strength at low strains and is indicative of stiffer go-grid. This ensures Geogrids ability to mobilise tensile strength early resulting in low deformation. Normally the stiffness of geo-grid is preferred to be same in both Machine direction and cross direction.

Good manufacturers try to ensure elongation at UTS same in both the directions and try to restrict its value even less than 8%. Such stiffer geo-grids ensure high value of torsional rigidity /rotational stiffness.

3. Geogrid Properties for Durability

3.1 Parameters affecting durability in Service

A. Dynamic Fatigue.

When subjected to repeated loads, all materials suffer from dynamic fatigue.The guideline for determining dynamic fatigue is provided in EBGEO.

The Tensile strength of PP geogrid is reduced by a reduction factor (Factor A1) to arrive to Creep Reduced Tensile Strength. Dynamic loading Reduction factor A5 can be determined in a pulsating load test. The load cycle considers the frequency of occurrence for the entire design life of the structure. The frequency is taken at 10Hz for 107 load cycles. If there is no fall in tensile strength from creep reduced tensile strength, the geogrid is said to have a A5 factor of 1.0. Any geo grid having aligned molecular orientation would have high resistance to dynamic fatigue. Many of manufactures of stiff geogrids are able to achieve A5 factor as 1.0.

B. Ageing Test for determining the resistance to Oxidation.

Polypropylene degrades by oxidation, which is a reaction between the polymer and the molecular oxygen. This test is indicative of adequacy of additives such as anti-oxidants stabilizers to give good ageing life.

Life of a polypropylene geogrid can be predicted using a screening test as per EN ISO 13438.

Oven Testing: For screening lifetime > 25 years, specimens are exposed to heated air at 110 deg Celsius for 28 days for geogrids. After these exposures strength retained should be > 50% of original strength.

Autoclave Ageing is performed on samples dipped in slightly alkaline solution under pressure of 51 bars at 80 deg Celsius for 28 days. Strength retained should be > 50% of original strength.

From either of the tests, three stage Arrhenius diagrams can be set up. Life time from each stage is extrapolated and added together to give the full life of the geogrid.

The predicted life of Geogrids from many manufacturers is 100 years.

Autoclave Testing is a better of the two methods, as it is faster and simulates leaching of antioxidants.

C. Resistance to chemical aggressive environment in Geogrids for base reinforcement

As per EN 12960 geo-synthetics are subjected to Sulphuric acid and Calcium hydroxide to test their durability in highly acidic or alkaline environment. This situation does not normally happen in ordinary soils where Ph value is usually between 4 and 9.

The desirability for resistance to chemically aggressive environment exists in landfills, industrial areas, chemical factories, natural soils containing suphates or in areas where sub-grade has been improved by lime injection etc.

In railways, such environment can happen in case of accidental spillage from moving goods. In such an eventuality the geo-grid would get exposed to such environment for a very short time. Further, the geo grid is made from polypropylene which itself is highly resistant to chemicals. Hence this test is irrelevant when geogrid is made from Polypropylene, unless the geogrid is used in high chemically aggressive environment.

3.2 Geogrid properties for Survivability during Construction

A. Relevance of assessing resistance to UV and weathering for Base reinforcement

Energy is required to initiate the oxidation process, available from UV rays of the sun. Initiation of early oxidation can lead to shorter life of Polypropylene Geogrids.

Every manufacturer has their own manufacturing processes to meet UV resistance. It is immaterial whether manufacturers add Carbon black or any other UV stabilizer. This depends on their convenience of manufacturing.

Further, assessment of dosage of UV stabiliser may not be the correct reflection of UV resistance available because of likely improper dispersion of stabilizer throughout the molten polymer.

ASTM and EN tests for UV are index tests for guidance to determine maximum exposure duration / before installation, depending upon geographical locations.

A better way to control damage due to UV, is to specify the maximum exposure time of geosynthetic to sunlight. As a good practice, maximum exposure duration before / during installation for sufficient protection against UV without significant damage is as under:-

Retained Strength after testing EN 12224	Maximum exposure duration (uncovered) before / during installation
>80%	1 month
60% to 80%	2 weeks
Untested material	1 day

From the perusal of data sheets of various manufacturers, it is clear that all manufacturers are able to achieve the Retained strength > 80%. For base reinforcement applications, maximum exposure duration is always < 1 month hence reduction factor is 1.0 for UV is applied for all geogrids during design.

However, it is important to prescribe this value because some geosynthetic manufacturers do not provide UV resistance in their products and prescribe covering the geosynthetic within one day of installation.

B. Resistance to Installation Damage

Installation damage tests the structural integrity of Geogrid when subjected to mechanical loads of construction equipment and compaction of fill materials. The test serves to assess site damage with simulated field trial (e.g. granular material placed over geo grid and compacted with compaction equipment). The data sheets of manufactures in regard to installation damage test must mention the fill material to which the value corresponds to.

The fill aggregates used to cover the geogrid is the most important factor which governs the amount of installation damage. In case of railways the geogrid is supposed to be installed below coarse granular material. Hence strength retained after installation under coarse gravel needs to be checked. Most geogrid manufacturers have Tensile strength retained as >85% in coarse gravel.

4. Basic Identifying Parameters

4.1 Apart from the parameters affecting durability, following properties identify a Geo-grid:-

i) Tensile Strength @ low strain

ii) UTS

iii) Elongation at UTS

iv) Radial stiffness @ 0.5%

v) Rotational stiffness / Torsional stiffness measured by Aperture Stability Test

4.2 Depending upon the identifying properties mentioned by manufactures in their data sheets, Geogrids can be divided into 2 groups:-

a. 'Group a'- Data sheets of geo-grids which mention (i), (ii) & (iii) above i.e. Tensile strength at low strain, UTS, Elongation at UTS.

Such manufactures normally ensure Tensile strength @ low strain and UTS essentially same in both directions.

b. 'Group b'- Data sheets of geo-grids which mention (iv) & (v) above i.e. Radial Stiffness and Rotational Stiffness (Torsional Rigidity) measured by Aperture Stability Test.

4.3 Regardless of parameters picked by manufactures mentioned in their data sheets , the BASIC IDENTIFYING PARAMETERS for Geogrid are :-

(a) Tensile Strength at low strain indicative of capacity of absorbing load at small deformations apart from stiffness and

(b) Elongation at UTS indicative of stiffness .

Other parameters such as Radial Stiffness and Aperture stability test are the outcome of manufacturing practices. If we do not insist for basic identifying parameters of geo grid, we may end up in wrong geo-grid. It would be appreciated that load absorbed by Geo grid at small deformations facilitates a composite structure. Higher rotational stiffness and tensile strength at small deformations facilitates faster dissipation hence better interlocking.

4.4 Soil /Geo-grid Interaction Coefficient (Pull out Tests) judges quality of interaction between geo-grid and surrounding soil.

This test is not fully indicative of capacity of geo grid to absorb load from all directions of which the best indicator is Tensile strength /Radial stiffness . Pull out test does not fully simulate actual field conditions for base reinforcement. Hence this standalone test does not make us comfortable for adjudging its performance for base reinforcement. Any geo grid which has high stiff bars and steep stress strain relationship is bound to ensure 'a necessary minimum' pull out.

Conversely, manufacturing practice can also ensure higher pull out strength though stiffness may be less. Interlocking may still be enough not to cause slippage during pull out test but lesser stiffness and poor stress –strain relationship will have adverse effect on load absorption properties of geo-grid at low strain

4.5 It is therefore a considered opinion that geogrids satisfying the basic identifying parameters as above should 'only' be put to trial.

4.6 Aforesaid tends to dictate that it would be a desirable practice for clients , for 'a' minimum consignee-end inspections at the time of bulk procurement, to install their own Testing equipment for conducting tests for basic identifying parameters such as: tensile testing machine (to test Tensile Strength @2% and elongation at UTS) and ageing test.

Of course, manufacture testing certificate (MTC) has to be always ensured.

5.0 Manufactures' Specific Parameters should be Part of Quality Assurance Programme (QAP).

Every manufacture has its own manufacturing practices, consequently their own specific in-house tests & dimensions to achieve the performance parameters.

It has always been a standard practice to ask in the QAP from the manufacturers all such details pertaining to their manufacturing practices, their own in-house tests , dimensions, methodology adopted to accept raw material in their QAP. QAP is as such manufacturer specific. Manufactures are free to lay down their own parameters in QAP whatever considered necessary such as rib thickness, mass per unit Area, opening dimensions, junction efficiency, raw materials , additives , antioxidant etc, necessary to ensure the performance parameters for their geogrid. QAP parameters, being manufacturer specific, are bound to vary from manufacturer to manufacturer depending upon their manufacturing process. It is however important for every manufacture to submit QAP so as to check the reproducibility of these manufacture specific parameters. Manufacturer should submit compliance of important parameters for each lot.

However approach of client many a times , imprudently incorporating manufacturer' s QAP items as part of specifications, brand the specifications as 'manufacturer oriented' . Such an approach thereby unreasonably tends to debar other good and legitimate manufacturers of geo grid.

■■■

IR likely to commission Tejas Train sets by Feb-2017



Kapurthala: The first coach of the Railway's premium offering – the premium Tejas brand of trains – has been built at the Rail Coach Factory at Kapurthala and is expected to be put on trial soon. According to RCF officials, the coach will be sent to the Indian Railways to decide on which section the 130 kmph coach will be tested. According to the current schedule, officials said the train is likely to be commissioned by the Railways in February next year. The Railways plan to make three such rakes, said officials.

One of the biggest challenges, officials said, would be fitting television screens on the back of the seats, a unique initiative that has not been done on Indian trains previously. However, it is yet to be ascertained how these enhanced features will perform at top speeds. Officials, however, said the first coach built do not have TV screens fitted into the seats yet. The blue and yellow seats have an ergonomic design and provide a high level of comfort as compared to the seats fitted in the higher class coaches of trains currently.

The Tejas train is positioned for the business traveller who is willing to pay more for superior travelling comforts, said railway officials. The nine sectors identified by the Railways that will attract passengers for Tejas include Delhi-Agra, Delhi-Chandigarh, Delhi-Kanpur, Nagpur-Bilaspur, Mysuru-Bengaluru-Chennai, Mumbai-Goa, Mumbai-Ahmedabad, Chennai-Hyderabad and Nagpur-Secunderabad. Officials said no specific route has been chosen for the Tejas rake.

Tejas will operate at speeds of 130 kmph and above and offer onboard services such as entertainment, local cuisine, WiFi. Tejas coaches will be equipped with 22 new features, including entertainment screens for each passenger along with phone socket and LED boards for communicating safety instructions. There will be water level indicators in bio-vacuum toilets, sensorised taps and hand driers; will have CCTVs, and fire and smoke detection and suppression system.

Source : www.railnews.co.in

Improvement of Bearing Capacity for Approaches of 4 Lane ROB by "Stone Column"

By
M.K. Gupta*
S.M. Maheshwari**
H.S. Chaturvedi***

1.0 Introduction

4 lane ROB in lieu of LC No.6 in connection with DFCCIL is being constructed between Jasai - JNPT section in Mumbai Division. The entire work including approaches is being done by Central Railway (Construction) department.

The area is very near to the Jawaharlal Nehru Port and sea and has very poor bearing capacity of soil (3 to 5 t/m2). The marine clay at site was classified as Medium to High compressible soil with the high plasticity. The consolidation parameters indicated that the soil would undergo the heavy magnitude of settlements.

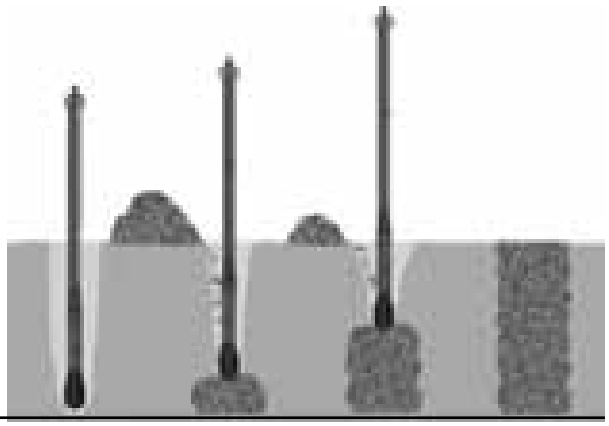
The main Road over bridge having 21 spans with PSC girders is on pile foundations. The approaches of ROB is having length of about 88 m and 66 m at Uran and JNPT end respectively, which have been provided with RE wall. The design requirement of RE wall was;

1. Minimum Bearing Capacity of 25.0 t/sqm.
2. The allowable post construction settlement less than 50mm.
3. Differential settlement after construction of reinforced earth wall less than 1in 100.

Extremely low bearing capacity of soil at approaches of ROB and significant differential settlement can cause distress to the facing RE wall panels leading to complete failure of approaches of ROB. Therefore, construction of RE Wall in highly compressible soil having very low bearing capacity was recommended only after proper treatment of ground.

2.0 Why Stone Columns ?

Based on the soil investigation, the highly compressible soil having very low bearing capacity when subjected to service loads undergo excessive settlement with the expulsion of pore water. Construction on sites underlain by thick strata of cohesive soft soils requires faster and effective ground improvement methods. In the situation involving soft cohesive skills, the primary consolidation subjected to the construction or temporary preloading require considerable time. In order to improve the mechanical behavior of soft foundation soil and to speed up construction, it is desired to accelerate the rate of consolidation. To improve these soil types, it is necessary to create stiff reinforcing elements in the soil mass. Among the various methods for improving in-situ ground conditions, stone columns was considered one of the most versatile and cost-effective ground improvement techniques to increase the load carrying capacity, reduce settlement of structural foundation and accelerate consolidation settlements due to reduction in flow path length. Use of PVD drain was time consuming.

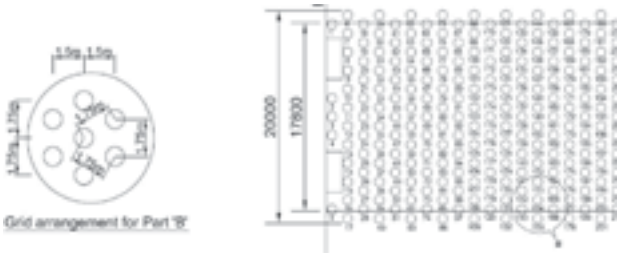


*CAO(C), Central Railway
** CE(C)MTP, Central Railway
*** Dy.CE(C)Juinagar, Central Railway

A widely used method of improvement of the mechanical behavior of soft foundation soils is the replacement of some of the soil with crushed rock or gravels to form and array of stone columns. There are two beneficial effects resulting from the presence of stone columns in foundation soil. First, the granule material is stiffer and has higher frictional strength than the soft soil, so that the columns act as piles to increase the bearing capacity of foundation soil. Second, the granular material has a high permeability compared to soft cohesive soils so that the columns also act as drains and accelerate the rate of consolidation process of the foundation soil. Also the aggregate fed into the bore exerts pressure on displaced soil. Hence, stone columns are very effective in increasing bearing capacities and reducing total and differential settlements of superstructures constructed on soft soils.

3.0 Design of the Stone Columns

Considering the project requirements and the existing soil stratification it was proposed to install the Vibro stone columns of finished diameter of 900mm at 1.75/1.90m spacing in Triangular Grid pattern. The depth of column was 16.0-18.0m from EGL (i.e. 14.4-16.4m below cut of level of stone column). Stone columns was designed by the consultant and proof checked by the IIT, Mumbai.



Uran End approach of ROB

At Uran end, the length of proposed RE Wall was 88m. Out of 88 m length, for 51m length stone columns in complete width of 17.5m was proposed in triangular grid pattern at 1.75 m c/c. In balance 37m, only two rows of stone columns at 1.9 m c/c in triangular grid pattern was proposed just below RE wall. The total 465 numbers of stone columns were proposed at Uran end approach.

JNPT end approach of ROB

At JNPT end, the length of RE Wall proposed was 66m. Out of 66 m length, for 51m length stone columns in complete width of 17.5m was proposed in triangular grid pattern at 1.75 m c/c. In balance 15m, only two rows of stone columns at 1.9 m c/c in triangular grid pattern was proposed just below RE wall. The total 433 numbers of stone columns proposed at JNPT end approach.

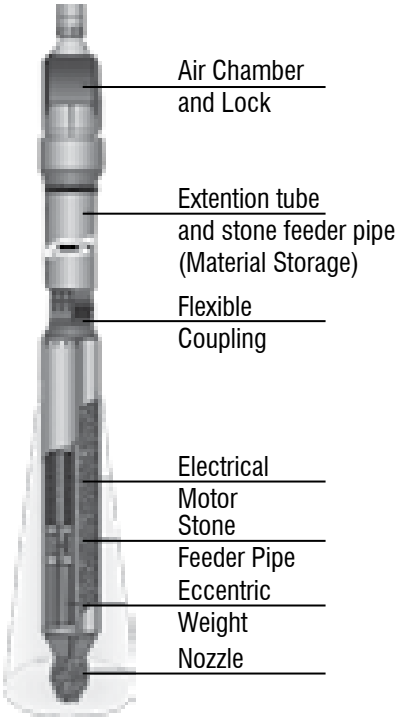
The detail of pattern of stone columns has been shown in Annexure 1.

4.0 Method of Execution

Stone columns consist of crushed coarse aggregate of various sizes. The proportion and sizes of coarse aggregate is decided by design criteria. Coarse aggregate in design proportion is placed into soil at regular intervals. This is done either by using dry or wet top fuel by vibrator which are fixed into ground. The aggregates are then allowed to take place the displaced soil which exerts pressure on surrounding soil hence, improve the bearing capacity of soil. Vibrating probe break down the course of surrounding soil thus the density the surrounding soil.

Depth vibrator

The cylindrical depth vibrator is typically between 3 m and 5 m long and weighs approximately 2 tons. The core element of the vibrator is an electrically driven eccentric weight, which induces the horizontal oscillation of the vibrator.



4.1 Preparation

The Vibrocat positions the vibrator over the required location of the compaction point and stabilizes itself using hydraulic supports. A wheel loader fills the skip with aggregate.

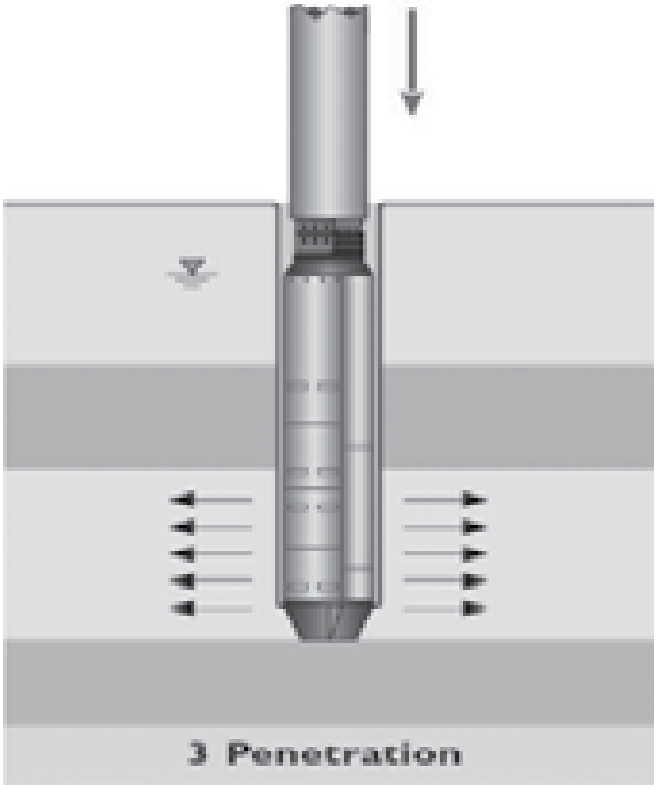
4.2 Charging

The skip is lifted and empties its contents into the air chamber. Once the air lock is closed, the Material flow towards the vibrator tip is assisted by pressurized air.



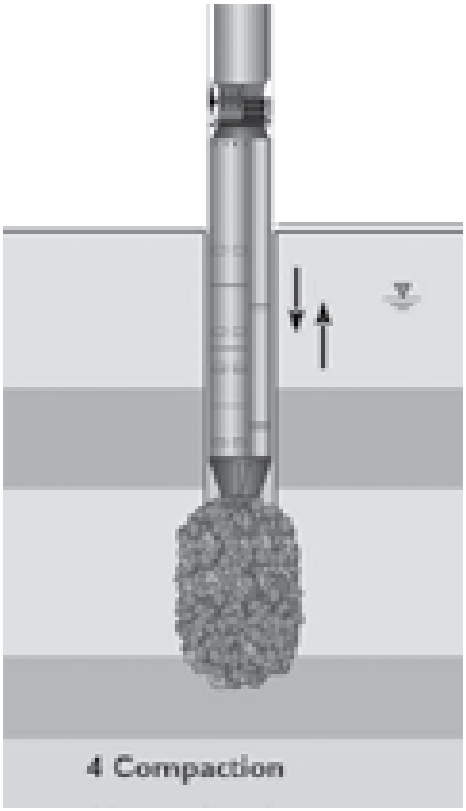
4.3. Penetration

The vibrator displaces the soil and is lowered to the design depth, aided by the compressed air and by the vibrocat's pull-down.



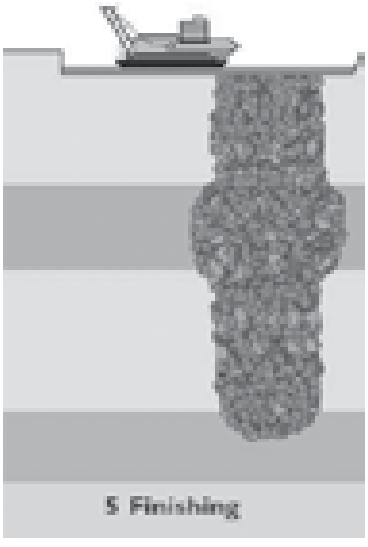
4.4. Compaction

After reaching the maximum depth the vibrator is pulled up slightly, causing the aggregate to fill the cavity created. During re-penetration the aggregate is compacted and pressed into the surrounding soil.



4.5. Finishing

The stone column is built up in alternative steps up to the Design level. During the final levelling, the surface required to be re-compared or a blinding layer is required as an alternative.

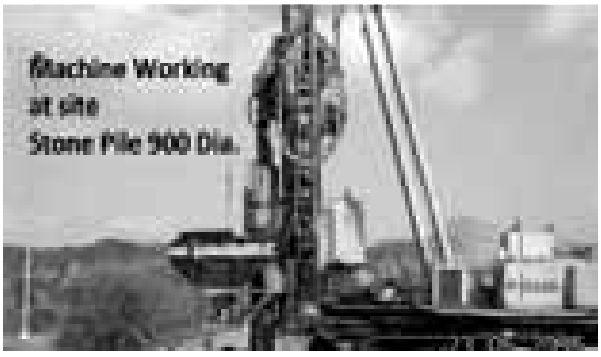


5.0 Execution at Site

The stone piling work was executed at site by the highly sophisticated Keller machine by bottom feed vibrator. The aggregates were fed directly to the tip of the vibrator, creating a continuous columnThe machine was having the facility of measuring the depth of stone column, verticality of the stone column, Values such as time, depth, penetration/ pullout speed, pull-down force and current can be graphically displayed and printed.

The Principle of the stone piling was based on the compression of the soil between the stone piling without removing the earth. At site initial bore of 450 mm was done with vibrator. The vibrator displaces the soil and was lowered to the design depth of 16 to 18 m. After reaching the maximum depth, the vibrator was pulled up slightly, (approx. 700mm height at one stretch) causing the aggregate to fill the cavity created thus making the stone column of 450 mm in pulled up length. Then vibrator was re-penetrated in filled up aggregate, again for 450 mm bore and aggregate was refilled in bore created thus making the stone column in pulled up length of 900 mm dia. Thus in each stretch of approx. 700 mm height aggregate was filled in 450 mm bore, which was re-penetrated and again the aggregate was refilled in cavity created to make it 900 mm dia columns. The process was continued till design level was achieved.

The work was done under close supervision of Railway engineers. The theoretical quantity of the aggregates was calculated i.e.0.635 cum/m for 900 mm stone column. Aggregate required for the stone piling were stacked and measured to ensure minimum required consumption. The actual consumption of the aggregate was also correlated with theoretical consumption and stack measurement. The depth of the pile was checked/verified at every meter and the actual diameters of stone columns were also physically checked at cut off levels.





6.0 Improvement in Bearing capacity

Plate Load test were conducted after the stone column work to assess the capacity of individual stone pile and the overall improvement in bearing capacity.





Plate load for bearing capacity of soil Plate load test on stone pile

The ultimate bearing capacity of soil was found to be more than 76.41 t /m2 at total settlement of 17.41 mm. Taking factor of safety as 3, the safe bearing capacity was calculated as 25t/m2. The safe bearing capacity of stone column was tested which was found more

than required value of 22t/m2 as per design criteria. The test results are given in Annexure –II.

7.0 Cost

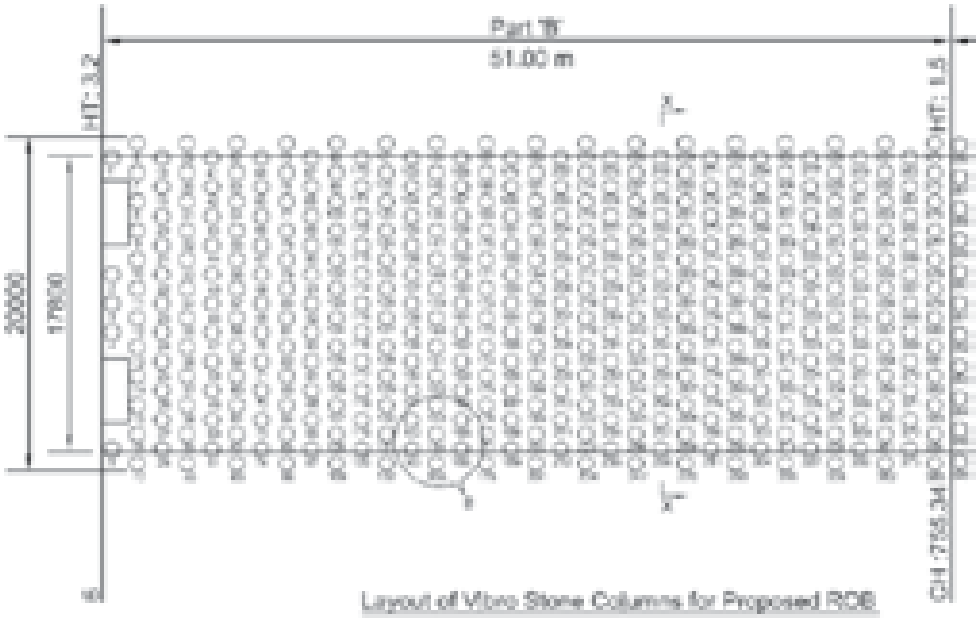
The cost of stone columns for 900 mm dia was worked out as Rs. 2297 per rm.

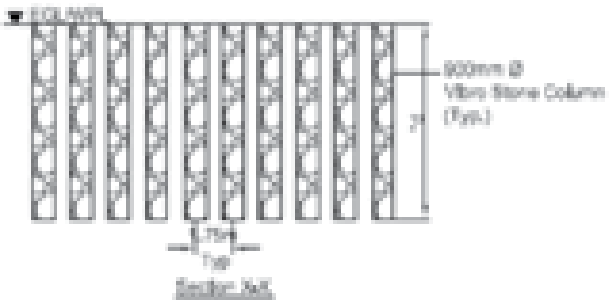
Area for improvement by stone columns at Uran end	: 17.7 mx51m = 902Sqm
No of columns done in this area for 900 dia	: 358 no
Average depth of the stone columns	: 16M
Total Length for 358 nos stone columns	: 358X16= 5728 RM
Cost of the columns per running meter	: Rs.2297/RM
Total cost	: Rs.1,31,57,216 (5728 * 2297)
Cost for ground treatment per sqm.	: Rs 1,31,57,216 / 9025 = Rs 14586.7 per sqm

8.0 Conclusion

Ground improvement is an important requirement in today's construction industry. The stone column technique is very effective method to improve the strength parameters of soil like bearing capacity and reducing consolidation settlement. It offers much economical and sustainable alternative to pilling and deep foundation solution. It gives quick and immediate results when compared to consolidation by PVD drain. Also it is cost effective in short duration work. Ground improvement when implemented through stone columns aid much stable solution to construction in soil of poor bearing capacity.

Annexure I







Test Report of Plate load test on stone pile

S & R Geotechniques Pvt. Ltd.	Document no SRGeo/JMM/RPT/16	Page 8 of 24
REPORT ON STONE COLUMN LOAD TEST	Rev. No R0	

7.0 Findings / Results

From the Load vs. Settlement curve it was observed that-

Sr. No.	Diameter of Stone Column, mm	Design Load of Column, Tons	Settlement of Stone Column at design load, mm	Test Load, Tons	Total settlement of Stone Column under test load, mm	Net settlement of Stone Column, mm	Elastic Settlement of stone column, mm
1	900	17.27	1.50	34.56	3.08	1.95	1.13

The Ultimate bearing capacity at column location – 44.0 t/m²

The Safe Bearing Capacity at column location is more than – 22.0 t/m²

Test Report of Plate load test bearing capacity of soil

S & R Geotechniques Pvt. Ltd.	Document no SRGeo/JMM/RPT/16	Page 8 of 24
REPORT ON STONE COLUMN LOAD TEST	Rev. No R0	

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The Ultimate bearing capacity at column location – 44.0 t/m²

Construction of Subway at Hubli Station

By
Ravindra Biradar*

1.0 Introduction

Hubli station is an A1 class station with a large footfall passengers every day. There are a total of five roads and five platforms over which passenger trains are dealt. There is one FOB connecting all the platforms and another connecting platforms 2,3 & 4,5. There is an existing subway connecting PF 1 and 2,3 without being extended to PF 4&5 rendering it difficult for passengers to go from one end to the other through the subway. The limited connectivity of the subway was also creating a lot of congestion on the existing FOB at the time of train arrival and departures. Extension of the subway meant the easing of this congestion and elimination of the bottleneck in the passenger traffic in the station. It would also facilitate the easy movement of parcels and other goods from PF 4&5 to other platforms and station building.

2.0 Planning Overview

The subway which was ending near the end of PF 2&3 had to be extended to PF 4&5. The exit from the extended portion of the subway towards PF 4&5 was planned to be provided in the form of a ramp on one side and steps on another. Hubli being a busy station, the extension work had to be planned to be taken up and completed in the minimum time possible so as to reduce the impact on operations. It was decided to use pre-cast segments as against in-situ construction saving us some time. There were a lot of space constraints as there are goods lines and workshop on one side and passenger lines and station on the other side which led to the adoption of cut and cover technique rather than box pushing. The constraints were true also in case of the space available for movement of vehicles. This led to the decision to use the 140T rail mounted crane instead of a road crane. The block had to be planned in such a way that maximum number of lines are in use at any point of time. The existing COP on PF 4&5 was also to be dismantled in the stretch of the exit from subway to the platform as it was a standard IRS type shelter with one column at the centre. A two column COP had to be provided so that the columns lie on either side of the ramp and steps. Launching of boxes was to be taken up in a pre-determined sequence because of the constraints w.r.t the crane and placement of BFR's. It was decided to launch first five segments and base slabs across the track starting from Rd3 by propping the crane on Rd3 and taking the BFR formation on Rd4. All the other segments were to be launched by propping the crane on Rd-4 and placing the BFR formation on Rd3. Based on all these considerations, following activities were finalized and planned for:

- Casting of pre-cast segments
- Sequence of the launching of the segments
- Loading of pre-cast segments in BFRs and their marshalling
- Movement of loaded BFRs and marshalling the empties
- Fabrication of steel structure for erection of COP on PF4&5
- Dismantling of COP on PF 4&5
- Place for propping the crane
- Sheet piling to protect the slopes of the excavated site
- Cast-in-situ construction activities for the junction arrangement
- Repairs to PF 3,4&5
- Erection of new COP on PF 4&5

3.0 Detailed Plan

- **Casting of Pre-cast segments** – A total of 9 boxes 6m wide,3.5m high 1.53m long and base slabs for these boxes were cast to be placed

*XEN/Track/SWR

across the track over a length of 19m connecting the two island platforms. 15 boxes (5 boxes each of one size)of three different sizes and the corresponding base slabs were cast for being placed in the ramp portion. The ramp had to be provided with a slope of 1 in 12 for which after a set of five boxes, an offset was to be given and the next set of five boxes were to kept 0.64m higher repeating the same for the third set of five boxes. As the subsequent set of five boxes were placed at higher level w.r.t. the previous set, they were cast of a smaller size, so that they don't extend above the platform surface. Two boxes and base slabs were cast for the platform exit with steps. The units were cast in the yard at a distance of about 1km from the site of the subway.



- **Fabrication of steel structure for erection of new COP on PF 4&5** – All the required components of the COP to be erected on PF 4&5 were fabricated before hand

- **Sequence of launching of pre-cast segments** – The sequence of launching of boxes was so decided as to minimize the time consumed. It was decided to start launching across the track beginning from Rd3. First five boxes and base slabs were to be launched with the crane propped on Rd-3 and the loaded BFR's on Rd-4 after which the excavation could be filled up, track linked and Rd-3 made available for taking trains. The next four boxes and base slabs were to be launched with the crane propped on Rd-4 and the loaded BFR's on Rd-3. The two boxes on the steps side were to be launched with the crane on Rd-4 but on other side of the excavation. Out of the remaining boxes to be placed in the ramp portion, the crane had to be propped at three different locations on Rd-4 and the BFR's taken on Rd-3.



- **Loading of pre-cast segments in BFR's and marshalling -** A 30 BFR rake was used to load segments each on one BFR. It was decided to make a set of five BFR's whilst it be difficult for movement as the segments were loaded upright and even a small jerk during movement would destabilize the boxes and lead to an untoward incident. So, while loading the BFR's were marshaled and the boxes already marked as per the sequence were loaded in such a way as to make a set of five BFR's which when pushed would bring the required adjacent to the crane





- **Arrangement for securing the loaded segments -** As the segments were loaded in an upright position, the stability of these boxes during the 1km long movement was doubtful. A custom arrangement was made by fixing a frame made of angles to the BFR extending upto half the height of the boxes on all the four sides. In addition thick nylon ropes were also wound around the boxes and secured with the BFR



- **Dismantling of COP on PF 4&5** – Dismantling of COP was planned from D-3 to D-1 days. S&T cables and electrical connections had to be removed beforehand. Dismantling work was taken up from 22:00hrs to 05:00hrs during the period when the number of trains and passengers were least. Proper barricading was done on the PF edges and boards informing the public of the work were put at all suitable places in the station



- **Dismantling of other structures in between PF3&4** – On D-1 day, structures like fuel pipe, water hydrant for train watering and electrical poles and wires were dismantled in coordination with the respective departments. The existing track was removed and CC Apron dismantled.



- **Excavation work** – Immediately after availing the block, i.e. D-day, excavation was first taken up across the track where the boxes were to be launched first. The cuts had to be made vertical and the width of excavation was to be exact as the location of props of the crane on Rd3 was adjacent to the top edge of the excavation. Even the BFR formation with loaded boxes was to be brought upto the edge of the excavation for the boxes to be lifted and launched. The place for propping the crane and the placement of the BFRs with loaded pre-cast units was decided after carefully going through the reach of the crane and

the size of the box. The PF was dismantled at that location to accommodate the props and the base was prepared using steel and wooden matting to reduce the stress.



- **Carriage of excavated earth and other debris** – There is only a single narrow approach for the trucks to enter the yard. It involved crossing of four tracks. Check rails were first inserted and pathway prepared for the movement of the tracks. Barricading was done at the edge of the platform and the path defined for loaded and empty trucks which had to move on only one identified side of the platform. A low lying area near the yard was identified for dumping the earth and machines kept to level it.

- **Sheet piling to protect the slopes** – As the excavation slope was vertical and the load of the crane and the loaded BFR's was coming directly onto the slope due to its proximity creating conditions favorable for slope failure, sheet piling was adopted. Rail pieces were to be driven going up to 0.5m below the excavation level, extending up to the full height of excavation as intermediated supports. A portable boring machine was brought to the site to drill holes for driving the rail pieces. 3mm thick MS sheets were then connected to the rails.





- **Launching of boxes** – The first five boxes were launched and the track linked and Rd-3 given fit to take trains at the end of D+1 day. Excavation was then begun on PF 4&5 to launch the remaining boxes from locations as explained above. The remaining boxes were launched on D+2 and D+3 days. Backfilling was done immediately after launching and the soil was saturated with water and some rolling done to ensure maximum compaction



- **Cast-in-situ construction activities for junction arrangement** – At the end of the extended subway near the two exits to the platform a framed structure was to be constructed to support the opening. Immediately after placing all the boxes in position, the raft foundation concreting was done. The column, beam and slab reinforcement was also made ready and casting completed by the end of D+7 days



- **Cast-in-situ construction activities for ramp portion** – Precast segments were laid in the ramp portion for a length of 15m out of the total length of 72m and in the steps portion for a length of 3.06m out of a length of 16m. U-troughs were constructed cast-in-situ for the remaining length on both sides. The readily cut reinforcement was placed and the bottom layer concreting carried out first. The wall was then raised in steps.

- **Construction of new COP foundations** – After the completion of launching of the segments in the ramp portion, backfilling was done and the soil saturated with water and rolled for attaining maximum compaction as the foundation for the new COP had to be cast in the backfilled soil just touching the face of the boxes and U-troughs. A total of 30 column foundations were to be casted out of which the columns to be cast in the backfilled soil were kept for last to provide sufficient time for compaction of the soil

- **Placement of pre-cast PF wall units** – After construction of the COP foundations, precast platform wall units were placed throughout the length where the PF was dismantled except the subway portion where CC brick wall was built. Backfilling was then carried out for preparing the PF surface

  Sealing joints in the boxes and waterproofing – As segmental construction technique was adopted, one of the most important activity was sealing of the segmental joints preventing the ingress of water. For sealing joints, sheets of polypropylene material were used; the entire joint was filled with this material which is water proof and then channels were provided throughout the length of the joints to arrest any water that may escape through the paper thin gaps and enter the subway. The outlets of these channels were connected to the drain in the subway. The joints between the channels and the segments were packed with a silicon based sealant. This method has helped in arresting the leakage of water to a very great extent but needs regular attention during rainy season when the water flow increases.



- **Erection of COP on PF 4&5** – Along with the backfilling, the erection of COP columns and other components was simultaneously taken up and completed



4.0 Activities that Require Special Attention

- **Loading the segments on the BFRs and securing them** – Proper safety precautions are to be observed at site lest people get injured as heavy machinery and large loads are involved.

- **Marshalling the BFRs** – All the boxes and the BFR's are to be numbered beforehand. The sequence of launching and the rake formation is to be decided and a chart made depicting the same which would make it easy for unloading the segments at site. The plan is to be prepared in

coordination with the operating department as it is they who would be executing the marshalling and shunting operations and providing the requisite box at the required location for launching



- **Efficient disposal of excavated earth** – As the magnitude of earth work involved is large, the disposal of the earth becomes critical activity. Sufficient number of tippers and proper approach is to be provided so that the turnaround time of the tippers is minimum. The place for dumping also needs to be selected and sufficient number of machines like excavators need to be kept at both the site of excavation and the site of dumping

- **Sub-surface water** – As the depth of excavation is more, chances of encountering sub-surface water are more. During this work, water has risen to a level where the machines were half submerged. To add to the woes, the water was mixed with the soil forming clay making the movement of the even the machines difficult. It wasn't even possible to load it into trucks. Although pumps were kept ready, as a crude solution, some additional earth was excavated and mixed with the clay which made it a little easier to pick it up and load it into trucks. This saved us a lot of time



- **Preliminary works for BD crane** – The technical parameters of the BD crane viz. the reach of the boom, load carrying capacity at various radii and angles, overall dimensions need to be studied and discussed with the personnel manning the crane to get an idea about the way the crane operates depending on which other processes like loading, unloading, infringement clearance, propping location of the crane can be finalized. All permanent and temporary structures coming in the swing area of the crane at the site need to be cleared in advance. Firm base needs to be prepared for the props of the crane. The slings and lifting cloth needs to be checked for any damage which otherwise becomes a safety hazard at site. An additional BD crane was also kept as a standby as it was critical for the completion of the work in time

- **Coordination with other departments** – As, the quantum of work involved is large, greater number of departments would be involved which needs to be anticipated well in advance so as to have proper coordination to get the work done by them in time. Operating department for blocks, electrical department for lighting, Mechanical department for operation of BD crane, RPF to prevent unauthorized people from entering the site, S&T department for any cables that can be encountered during excavation

- **Safety at work site -** As trains are being received on other platforms adjacent to the work site, it becomes very important to provide proper barricading at required places. Proper caution boards needs to be put at prominent places in the station informing them of platforms being blocked for work, trains being rerouted e.t.c.

- Safety of personnel – Safety helmets were made available at the site in sufficient numbers not only for the personnel present and involved in the execution but even for inspecting officials as the depth of excavation was large and lot of heavy materials were being dismantled or launched

■■■

IRICEN Library(A Resource Centre)

By
Surendra Kumar Bansal*
Shailendra Prakash**

Synopsis:
The library at IRICEN is one of the biggest library in Indian Railways which plays a vital role in knowledge building of Faculty members, trainee officers and preparation of M-tech project. It is well stacked library of 45000 books, 60 nos. of Technical journals (National/International), Conference proceedings, UIC codes, Audio Video technical films. Implementation of E - granthalaya to facilitate Railway officers to keep their knowledge up to date is in process.

Located in the historical and cultural city of Pune, IRICEN imparts training to approximately 100 engineers / managers at a time. Engineers from railways of the developing countries as well as other government departments/private organisations are also trained. The training programmes are generally residential in nature.

Infrastructure for conducting various training programmes includes a well-stacked technical library, computer centre, material testing laboratory, model room/ museum, hostel, mess and recreational facilities for the trainee officers.

For achieving excellence in training, IRICEN has obtained ISO 9001-2008 certification. As per letter of certification issued by M/s. Det Norske Veritas (DNV) Holland (the certifying body), the certificate is effective from 31st December 2014 to 30th December 2017.

At present IRICEN library has about 45000 books & 60 Indian & Foreign technical Journals, which include all the subjects on railway engineering, track, bridges, construction, computers, management, reports on railway issues, derailments, RDSO reports of various departments, specifications, Indian Railways Manuals on P Way, Bridges, LWR, SWR. Manuals on all branches of Railway working i.e. Civil, Construction, Electrical, mechanical, Signal, operation, Medical updated with latest correction slips in sufficient copies. Lecture notes for the trainee officers, Books on general topics, English literature are also available in library along with large stock of technical films & Video CDs.



Iricen Library (Reading hall)

Iricen library implemented a new library automation software E-Granthalaya 4.0 for library management system. After fully implementation of this software it will facilitate efficient functioning of library, on line Library Management System where one can select books from his interest through library search. E-Granthalaya has been commissioned in IRICEN library.

Caption of E-Granthalaya (as on web)



* Dean / IRICEN
** LIA / IRICEN

The work of connecting all libraries of CTIs on Indian Railways will be completed shortly. It will help the engineers to know the latest publications its availability & location to refer the same.

Thus IRICEN LIBRARY helps the Railways Engineers to keep their knowledge up-to-date through its knowledge bank.

E- journals (List Annexure B)

International Conference proceedings (List Annexure C)

RETS Publications (List Annexure A)

From the recent past, Probationary Officers have started being awarded the M. Tech Degree by the Department of Technology, SPUP (Savitribai Phule University of Pune). The duration of this course is 2 years, in which the officers have to submit dissertations on various subjects, relating to Railways. IRICEN library plays very important role of providing up to date literature on subject and cope up for the higher studies for M-Tech Degree.

IRICEN Library has started online subscription for 18 International important journals (ASCE – 09 numbers, ICE- 04 numbers and Proceedings of Rail and Rapid Transit) from 2016. This will play an important role for dissertation works for M.Tech Project. These foreign technical journal can be referred to on line.



IRICEN Library Journal Section

World Congress on Railway Research (WCRR) papers, UIC codes are downloaded and kept on the PCs for reference in the reading room of the Library. IRICEN library is a Institutional member of British Library and the user can access from British Library. Membership of BSI (British Standard International) and European Standard has been obtained this year.

IRICEN is institutional member of Indian Green Building Council (IGBC), International Association for Bridge and Structural Engineering (IABSE), Indian Concrete Institute (ICI) and get the regular journals/ news letter from these institutions.

After obtaining the ISO certification, World Railway Section was introduced in the library. This section has been enriched by buying books related to different railway systems and providing significant information in the form of books through internet.

After shifting of Library to Koregaon Park, new section for Children is introduced, for children of Faculty, Trainee officers & Staff.

Lecture notes on different subjects are also compiled and kept in library since 1995.

Track related : 23 nos.

Bridges related: 17 nos.

Works related : 30 nos.

Project reports of various courses are kept in library for reference.

A quarterly technical journal named “IRICEN Journal of Civil Engineering” is published by IRICEN, which includes technical papers by the officers on Indian Railways, News from railways around the world and news about new product relating to railways.

To give stress or preference to Rashtra Bhasha, more than 2000 hindi books of well-known authors are there in library. The Hindi section also includes technical books in Hindi. For recreation, various Hindi & English fortnightly(05), monthly(08) & quarterly journals/ magazines (04) are available for reading.

For better & faster communication internet 100 MBPS net connectivity has been provided for the users of library. Soft copies of UIC codes, World Congress on Railway Research (WCRR), American Railway Engineering and Maintenance-of-way Association (AREMA) Manual of Railway Engineering, Engineering Track Maintenance Field Manual(USA) are kept in IRICEN library reading room.

IRICEN Library keeps the synopsis of various articles of various technical journals on net, so that the

officers can know & can read the original article, if they found useful.

IRICEN has published 30 technical books, on various subjects, & are available for sale for the nominal price. (list attached Annexure "A")



IRICEN Publications

Annexure "A"

LIST OF IRICEN PUBLICATIONS (BOOKS)

SN	Title	Price(Rs.)
1	Compendium of Instructions Related to Inspection and Competency Certificates in Engg. Dept	60
2	Fundamentals Building Orientation & Green Building	40
3	Underwater Inspection of Bridges	80
4	Quality Control in Mechanised Track Relaying	30
5	Quality Control in Mechanised Track Relaying (in Hindi)	30
6	Construction & Maintenance of High Speed Railways	170
7	Rain Water Harvesting	30
8	Turnout	80
9	Investigation of Derailments	100
10	Bridge Inspection & Maintenance	80
11	NDT testing of bridges	80
12	Welding Techniques	50
13	USFD	90
14	Railway Curves	80
15	Bridge Bearings	60
16	Track Monitoring	70
17	Concrete Technology	60
18	Handbook of Material Testing	50
19	Layout Calculations	120
20	Long Welded Rails	50
21	Rail steel	25
22	River training and protection works	50
23	Inspection, assessment, repairs & retrofitting of Masonry Arch Bridges	50
24	Water supply	25
25	जल आपूर्ति	20
26	कंक्रीट टेक्नॉलॉजी	50
27	रेल जोड़ों का देखभाल	10
28	Handbook for Track Maintenance	500
29	Monograph on Casnub Bogie	60
30	Monograph on ICF All Coil coaches	60

Railway Engineering Technical Society Publication

1	Steel Structure and Fabrications	100
2	Drawing and Estimates	100
3	Plumbing and Pipelines	75
4	Carpentry and woodwork	50
5	Masonry and Concrete	80

Annexure "B"

International Technical Journals (E journals)

1	ASCE – Bridge Engineering
2	ASCE – Composites For Construction
3	ASCE – Computing In Civil Engineering
4	ASCE – Construction Engineering & Mnagement
5	ASCE – Geotechnical & Geo Environmental Engineering
6	ASCE – Materials in Civil Engineering
7	ASCE – Stuructural Engineering
8	ASCE – Surveying Engineering
9	ASCE – Transportaion Engineering
10	ICE - Bridge Engineering
11	ICE - Magazine of Concrete Research
12	ICE – Proceddings – Sturctures & Buildings
13	ICE – Proceedings – Civil Engineering
14	ICE -Construction Materials
15	IRJ – International Railway Journal
16	Railway Age
17	RT & S – Railway Track & Structures

Annexure C

List of Proceedings of International Seminars available in library

1. Proceedings of Heavy Haul:

Seminar	Place and Year	Availability
2nd Conference	Colorado USA , 1982	Hard Copy
3 rd Conference	Vancouver, Canada, 1986	Hard Copy
4th Conference	Austrlia, 1989	Hard Copy
Conference	Colorado, USA, 1990	Hard Copy
5th Conference	Beijing, 1993	Hard Copy
Mini Conference	USA 1994	Hard Copy
Conference	Vancouver, Canada, 1996	Hard Copy
Conference	New Delhi, 1996	Hard Copy
6th Conference	Cape town, 1997	Hard Copy
Conference	Mosco, 1999	Hard Copy
7th Conference	Brisbane, 2001	Hard Copy
Conference	Paris, 2003	Hard Copy
8th Conference	Rio De Janerio, 2005	Hard Copy
9th Conference	Shanghai, China, 2009	Soft Copy
10th Conference	New Delhi, 2013	Hard Copy

2. World Congress on Railway Research (WCRR)

Seminar	Place And Year	Availability
1 st	Florence, 1997	Soft copy
2	Tokyo, 1999	Soft copy
3	Cologne, 2001	Soft copy
4	Edinburg, 2003	Hard /Soft
5	Montreal, 2006	Hard/Soft
6	Seol, 2008	Soft copy
7	Lille, 2011	Soft copy
8	Sydney, 2013	Soft copy

(A link of all WCRR proceedings given in Reading hall computers)

3. International Union of Railways (UIC codes in soft copies)

Interaction conference, Railway Track technology	NDLS, 1996	Hard Copy
Conference on Safety aspects of Railway Track	Paris, 1999	Hard Copy

4. Scientific Society of Mechanical Engineers

Railway Bogie and Running Gears	Budapest, 1998	Hard Copy

5. Railway Engineering

Maintenance and Renewal of Permanent Way	London, 1998	Hard Copy

6. Society for Technical Communication

Proceedings technical communications	Houstan, 1973	Hard Copy

Following Proceedings of International conference we purchase last financial year (2015-16)

11th Conference UIC	1-3 apr. 2014 Istambul	Soft copy (Purchsed on Aug 2015)
	ERTMS atlas (UIC)	Soft copy (Purchsed on Aug 2015)
UIC study for European railway infrastructure for freight	2015	PDF (available in Reading hall PC)
Proceedings of the 1st International Workshop on High-Speed & Intercity Railways–Vol.1 2015 By Ni, Yi-Qing, Ye, Xiao-Wei	2015	Hard copy
Proceedings of the 1st International Workshop on High-Speed & Intercity Railways – Vol.2 2015 By Ni, Yi-Qing, Ye, Xiao-Wei	2015	Hard copy
The 2nd International Symposium on Rail Transit Comprehensive Development (ISRTCD) Proceedings 2014 By Xia, Haishan, Zhang, Yunan	2014	Hard copy
Noise and Vibration Mitigation for Rail Transportation Systems 2015: Proceedings	2015	Hard copy

Modifications to BCM in Case of Engine Failures

By
Surendra Kumar Bansal*
Prasad Rao**

Plasser BCM machines are provided with 2 Engines of Duetz model. Engine -1 controls the operations related to Ascending trough / Descending trough, Rotation of all the belts, including driving etc., Engine-2 controls the operations of the Screening units, Cutter chains, Ballast distribution, etc., apart from driving. The working atmosphere at BCM work site are generally highly dust prone and the probability of the engines failing during BCM operations are not uncommon. The dust generated during BCM working has a tendency to interfere with the engine turbo charger in case of hose pipe failure causing the Engine to fail.

In the course of working if engine-1 fails, it would be a herculean task for the operator's to lift and lock both the Ascending and Descending troughs. In field many block failures have been attributed to the failure of engine-1 and inability to lift and lock both the troughs. In all such cases machine staff, have to first dis-engage the hydraulic cylinders and then rely on the P.Way staff for lifting the troughs with the help of mechanical jacks and locking with chains. This process of lifting and locking with the help of mechanical / hydraulic jacks (if available) is a time consuming process taking a minimum of one hour. Apart from block bursting the fatigue created on the Machine operator is so large that the progress for the next three days is affected.

Plasser in it's design of New BCM machines has provided one emergency pump to lift and lock the Ascending and Descending troughs. The usage of this emergency pump is very remote as it is used only in case of failure of the engine. However in reality when the engine No. 1 fails the above emergency pump HY 40.510 if operated does not function as the dust during BCM working would have caused it's seizure and made it non functional. Replacing this pump once in 6 months to keep the emergency backup system functional is a costly solution as the pump would cost approximately around Rs. 15 Lakhs. The chances of these pumps, failing even without working, is very high and is to be continuously monitored.

To overcome such type of problems CPOH/RYP has designed a simple hydraulic circuit from engine No. 2 (the other working engine) to lift and lock both the Ascending & Descending troughs within a few minutes, preventing block bursting and saving the operator from worksite anxiety.

Circuit modification

The hydraulic pump 62.05.3000.572 which is mounted Engine-2 is mainly used for ballast distribution / regulation and is a continuously operated pump. The pressure line from this pump is tapped and connected to the Ascending / Descending trough valve banks through a stop cock and check valves. In case of engine-1 failure this hydraulic pump is activated to build enough pressure for lifting the ascending / descending troughs and locking. This advantage of the above pump not being continuously loaded is utilized for the above activity.

Operational procedure:

In case of failure of engine No. 1 the step wise procedure for lifting & locking the Ascending / Descending troughs is as under:

1. Switch on the switch in panel no. 5.
2. Open the stop cock.
3. To lock the ascending trough (a) Press and hold the micro switch of descending trough joy stick (b) Operate the ascending trough joy stick for lifting and locking as in the normal course.
4. To lock the descending trough (a) Press and hold the micro switch of the ascending trough joy stick (b) Operate the descending trough joy stick for lifting and locking as in the normal course.

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5. Normalise the switch in panel no. 5 after ensuring the lifting & locking of the ascending / descending troughs.
6. Close the stop cock.
7. Clear the block section on Engine no. 2.

Additional Spares required:

1. Check valves - 02 Nos.
2. Stop cock (1/4"Ball valve) – 01 No.
3. 2 Way switch – 01 No.
4. Hoses & elbows as per requirement.

Staff involved in modification:

The above modification was an indigenous adaption at CPOH/RYP by the staff under the supervision and guidance of Dy.CE/CPOH/RYP.

■■■

रेल गीत

भारत की रेल महान है।
प्रगति की पहचान है।
भारत की ये शान है।
देश की ये जान है।
इंडियन रेलवेज वी लव इंडियन रेलवेज।

आंधी आयें तूफां आयें
इसका तो चलना है काम
पर्वत जंगल दरिया घाटी
पार करें न ले विश्राम
बैठ के इसमें सफर करें
ये हर दिल का अरमान है
भारत की ये शान है
देश की ये जान है
इंडियन रेलवेज वी लव इंडियन रेलवेज ।

तेज चले और सेफ चले
वक्त की पाबंदी से चले
रेल बढ़े तो देश बढ़े
रेल के फूल से देश खिले
भारत के अर् विकास में
रेल प्रम सौपान है
भारत की ये शान है।
देश की ये जान है।
इंडियन रेलवेज वी लव इंडियन रेलवेज।

सरहद पर सेना बन जाए
और दुश्मन को सबक सिखाए
मंदिर मस्जिद और गुरूद्वारा
सबको तीर करवाये
देश को ऐसे जोड़ा
एकता का ये निशान है
भारत की ये शान है।
देश की ये जान है।
इंडियन रेलवेज वी लव इंडियन रेलवेज ।

इंजन डिब्बा पटरी सिग्नल
इनकी हिफाजत में मशगूल
रेल के मजदूरों की वफाई
करता सारा मुल्क कबूल
पटरी की सलामती में
कीमैन लगाते जान है
भारत की ये शान है।
देश की ये जान है।
इंडियन रेलवेज वी लव इंडियन रेलवेज।

भारत की रेल महान है
प्रगति की पहचान है
भारत की ये शान है।
देश की ये जान है।
इंडियन रेलवेज वी लव इंडियन रेलवेज।
भारतीय रेल अपनी भारतीय रेल
इंडियन रेलवेज वी लव इंडियन रेलवेज।

Source:http://www.railnews.co.in

Lateral Resistance of Railway Track

By
Bharat Bhushan*

1.0 Introduction

As rail traffic runs along a route, the forces imposed upon the track cause the ballast to settle, and hence the track geometry deteriorates. At a specified value of deterioration the track geometry needs to be restored by tamping or other methods. As the deterioration is mainly in the vertical direction, this aspect has been more widely studied and models have been developed to predict vertical track geometry deterioration. On the other hand, lateral track deterioration is not as well understood. This work is undertaken to contribute to the fundamental understanding of the mechanisms of track lateral deterioration, therefore making the effective control and reduction of the lateral deterioration achievable.

2.0 Component Parts of Railway Track



The Typical components are

1 – Rails: The function of the rail is to guide and support the vehicle.

2 – Sleepers (or ties): Sleepers support the rails vertically, laterally and longitudinally by sitting inside the ballast layer. There are three contact surfaces between the sleeper and ballast: the sleeper base, the sides of the sleepers and the sleeper ends. It is understandable that the more friction force is provided by the ballast, the more stable the track system will be. Therefore, the shape and mass of the sleeper are significant contributors to the stability of the track system.

3 – Rail Fastenings: The rail fastenings secure the rail to the sleepers to maintain the gauge, transfer the dynamic load from the wheel-rail interface to the sleeper and provide electrical isolation between the rail and the sleeper.

4 – Ballast: The ballast layer holds the sleepers in position, distributes the forces from sleepers to subgrade, provides some resilience to the system and aids drainage. Ballast is classified into four types by function and location

Crib ballast is located between sleepers, providing mainly longitudinal resistance and some lateral resistance.

Shoulder ballast is positioned at the end of the sleepers, giving sufficient lateral resistance to the sleepers.

Top and sub ballast, also known as load bearing ballast, mainly support the sleepers vertically.

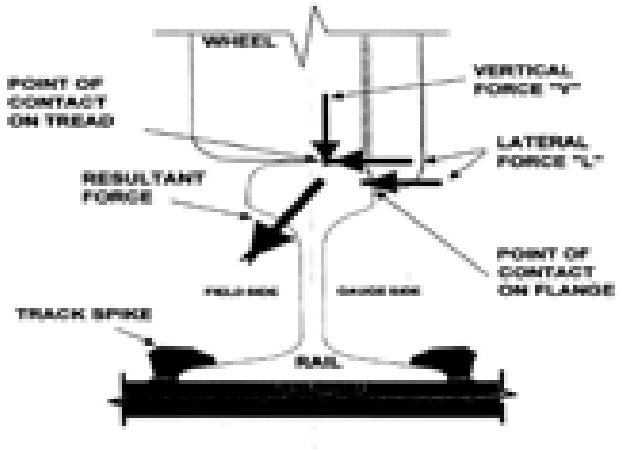
5 – Subgrade: The subgrade is the original ground that the track system is constructed on, absorbs all the forces from the ballast.

The track system supports the loads due to the passage of vehicles, spreads the load into the ground, provides guidance to the traffic and resists traction and braking forces.

3.0 Causes of Lateral Deterioration

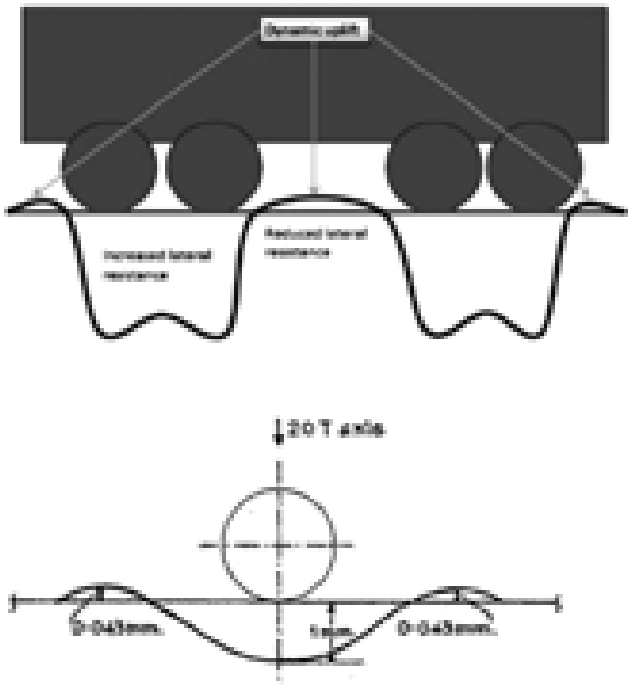
(a) Rail wheel Interaction and curvature of track: A moving vehicle causes forces between the wheel and rail at the contact patch, which can stress the rail laterally. The lateral force acting on the rails varies with different track curvature, cant and speed. The lateral forces on the high rail of curved track whose radius of curvature is small are much bigger than those on a large curve radius on account of the lateral forces.

*Dy CE/TP,NE Rly, Sr. Prof. Course 16203



The deterioration in the lateral direction is a nonlinear phenomenon because of the highly nonlinear behaviour of vehicles in curves or on straight track due to possible hunting behaviour, and is related to forces on both vertical and lateral direction. As the most important interface between vehicle and track, the wheel-rail contact condition has an extremely large influence on lateral deterioration. Wheel and rail profiles with different wear conditions can cause altered vehicle-track lateral dynamic interaction. It is found that increasingly worn wheel/rail profiles can effectively increase the lateral deterioration.

It is important to note that when a vehicle runs on the track, the lateral resistance will be weaker on the dynamic uplift sections as shown in Figure



(b) Due to high thermal forces in LWR : Increasing the speed limit of railway tracks is applicable by welding rail joints and employing Long Welded Rails (LWR) and elimination of rail joints causes huge longitudinal forces in the rails leading to the track lateral movement.

(c) Due to track stiffness: Lateral deterioration is also affected by decreasing all the track stiffness values, damping values and the mass of rails and sleepers, or alternatively, by in increasing the sleeper spacing.

This resistance comes from two sources: one is the lateral bending rigidity of rails and the other is the torsion rigidity of fasteners. Fastener torsion resistance is depending on the kind of sleepers and fasteners, toe load, and the relative rotation between the sleeper and the rails

(d) Due to sleeper ballast friction: The sleeper-ballast interface is found to play the most important role in lateral deterioration. The interfaces between the sleeper and ballast shoulder, crib and base determines the non-linear characteristic such as hysteresis and sliding features. Improving the strength of the sleeper-ballast interface can improve the elastic limits and hysteresis characteristics, hence reducing the lateral deterioration.

(e) Due to track maintenance activity: Track maintenance such as ballast cleaning, tamping for surface/alignment, and subsequent compaction of the ballast layer under traffic or using mechanical stabilization influences the bottom and side restraint by changing the ballast characteristics.

4.0 Track Lateral Stability Mechanism

Track lateral stability is a key requirement to ensure safety and passenger comfort. Track lateral shift and buckling can cause serious running stability problems or even derailment. Therefore, it is important to identify the mechanism of track lateral movement under dynamic wheel loads. Lateral displacement resistance plays an essential role in stabilising the track, and it is mainly influenced by the lateral sleeper support, stress free temperature, condition of joints, friction between sleeper and ballast, and the effect of tamping.

	Event	Major causal factors
1.	Formation of initial track misalignments	(1) High l/v's and longitudinal forces (2) Reduced local track lateralresistance (3) Initial imperfections (welds) and defects
2.	Growth of misalignments	(1) L/v increase due to the imperfections (2) Increase in longitudinal forces (3) Track "dynamic uplift" due to vertical loads (4) Many cycles of l/v's
3.	Buckling	(1) High longitudinal force (2) Reduced to (stress-free temperature) (3) Misalignments generated by track shift (4) Dynamic uplift wave (5) Weakened lateral resistance

For an initial working definition, track lateral shift can be defined as "the formation and growth of lateral track misalignments due to high lateral to vertical load ratios (L/V's) and longitudinal forces". It is construed to be the first two stages of the track lateral stability process as indicated in Table 1. The resulting misalignments are typically "small" in magnitude and may, in conjunction with other conditions, lead to track buckling which is a "large" amplitude instability event.

The L/V's are lateral to vertical load ratios where the net lateral load applied to the track by one axle of a truck resulting from the flanging forces and the two lateral components of the wheel/rail frictional force at both wheels on the axle are divided by the total vertical axle load. This L/V ratio is very instrumental in the overall track shift mechanism. If the vertical force is high, the resistance between the ballast and the sleeper is high. Therefore, the L/V load ratio is a critical parameter in track lateral movement.

Typical track buckling under the train is caused in summer at high rail temperatures in the areas of the lift off wave of the track grid under the passing train. Lateral resistance in the area of the lift off wave is reduced by 20-40% (reduced underside friction resistance of the sleeper in the ballast).

Track buckling can only be prevented when there are sufficient resistance forces with which the track grid is held in ballast. This resistance is called resistance to lateral displacement or lateral resistance.

5.0 Factors Affecting Lateral Resistance of Track

The lateral resistance is influenced by the following factors:

1. Type, weight, dimensions and spacing of the sleepers
2. Type and state of rail fastenings
3. Granular composition of ballast bed
4. Quantity of ballast bed material between and end of the sleepers (ballast bed shoulder)
5. Composition of the ballast bed

Lateral resistance of the ballast is one of the most important factors to prevent the expansion and track buckling. According to the tests results, from the summation of the track lateral resistance it is known that the proportion of the ballast, rails and fastenings from the total lateral resistance are 65%, 35% and 10%, respectively.

The lateral resistance of sleeper-ballast interface can be divided into three components: sleeper bottom resistance, sleeper side resistance, and sleeper end or shoulder restraint. All three vary with sleeper material, ballast type, ballast gradation, and strength, which is partly a function of ballast compaction.

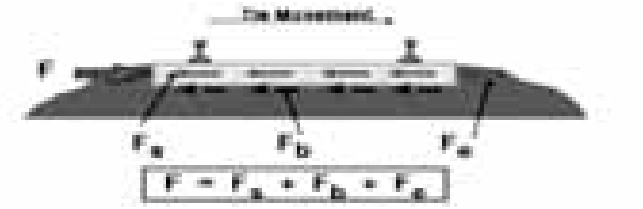
The bottom resistance component is resistance at base of the sleeper which depends on the friction between ballast and underside of sleeper and is most influenced by sleeper type, weight, and vertical load (normal force), which affects the friction developed at the tie bottom-ballast interface.

Long Side resistance is the resistance at the long sides of the sleepers which is derived from the active ballast pressure in accordance with classical soil pressure

theory. This friction is most influenced by crib content due to interlocking of the ballast and friction of the ballast against the side of the sleeper.

End restraint is mostly dependent upon the shoulder geometry since the shoulder ballast resists tie movement mainly through ballast shearing resistance (i.e., an increase in shoulder width generally results in an increase in shoulder restraint).It only becomes effective when the sleeper presses against the ballast bed after a displacement

The resistance between a simple mono-block concrete sleeper and the ballast bed is shown in figure below:



Fs= friction on both sides of the sleeper

Fe= passive pressure at both ends of the sleeper (shoulders)

Fb= friction at the bottom.

The total resistance to lateral displacement is made up of the following portions:

1. Sleeper underside friction 45-50%
2. Sleeper end resistance 35-40%
3. Long side resistance of sleeper 10-15%

Track maintenance such as ballast cleaning, tamping for surface/alignment, and subsequent compaction of the ballast layer under traffic or using mechanical stabilization influences the bottom and side restraint by changing the ballast characteristics.

6.0 Measuring Methods of Lateral Resistance

The resistance to lateral displacement can be measured by the following methods:

1- Single sleeper (Tie) Push Test (STPT)

2- Panel displacement test

3- Mechanical track displacement test

4- Continuous dynamic measurements of lateral resistance

These methods measure the force versus sleeper or track panel displacement.

Single sleeper (Tie) Push Test (STPT)

STPT is a laboratory method to determine the lateral resistance of a sleeper. In this method, the displacement of sleeper is measured proportional to the applied force by applying the force to the sleeper. Often, this displacement is recorded up to 0.2 mm.

In order to implement this test, the four fasteners of a sleeper must firstly be removed and then a hydraulic jack must be installed to the shoulder fasteners. Consequently, the sleeper is pushed against the rail with the help of a hydraulic device by applying the force to the shoulder fastener. On the other hand, a LVDT should be mounted on the sleeper (such as a hydraulic cylinder connection) to measure the amount of sleeper displacement by moving the sleeper and gauge returning and to record the lateral displacement of a sleeper by the processor.

Panel displacement test

In Panel displacement Test method, a frame of 4-6 meters is placed on the foundation, and then after applying the force to the panel, the displacement is measured. Thus, in this test, the lateral resistance of track panel is measured.

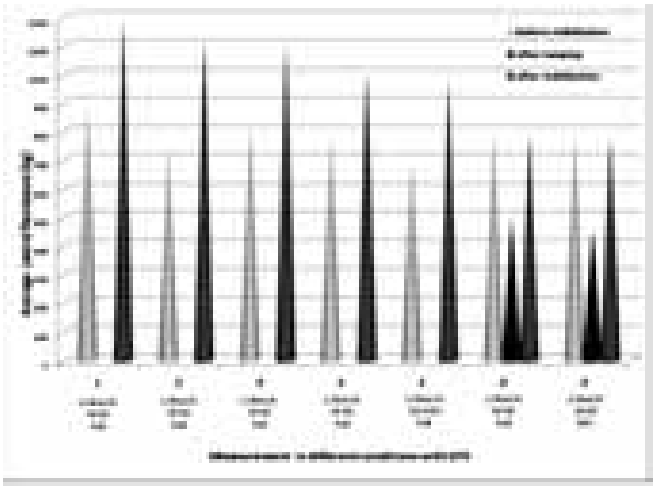
Mechanical track displacement test

In Mechanical track displacement Test method, additional equipment's are attached to the tamping machine, in which the track lining and lifting cylinders provide the lateral and vertical forces, respectively. The lining value transducers also measure the displacements in tamping machines.

Continuous dynamic measurements of lateral resistance

The track lateral resistance can be measured by employing The Dynamic Track Stabilizer (DTS) with the additional equipment's during the operation .In

figure below test results are presented by Plasser and Theurer for different speeds and frequencies. The lateral resistance of the track has been increased by employing the dynamic track stabilizer after the tamping. The advantage of the continuous dynamic measurement method of the dynamic track stabiliser lies in the fact that it is a non-destructive method that offers real-time results directly after track maintenance, and enables the evidence that the track meets the minimum lateral resistance required.



7.0 RDSO Report no. 156 on Lateral Ballast Resistance

RDSO studies conducted on various aspects of lateral ballast resistance have indicated the values of maximum lateral ballast resistance as given in the Table below based upon report no.156 RDSO report no.156 indicated maximum lateral ballast resistance by a PRC sleeper is 958 kg (consolidated), 796 kg (through packed) and 650 kg (deep screened) in a BG track.

8.0 Conclusion:

Track buckling can only be prevented when there are sufficient resistance forces with which the track grid is held in ballast i.e. lateral resistance. The obvious solution to prevent the lateral movement of sleepers during the buckling is the increase of track lateral stiffness. A method to increase the track lateral stiffness is increasing the width of the ballast shoulder and the ballast between the sleepers. Another method is to increase the lateral stiffness of the rail sleeper structure. Presently, IR is maintaining the ballast shoulder width to 0.35 m which is increased up to 0.50 m on outer side of curve. In the former Soviet Union railways, in freight tracks with wood and concrete sleepers, the shoulder width of 0.45 m have been proposed. In Japan, the width of ballast shoulders should be chosen at least 40 cm. In addition, ICE railways in Germany also use 50 cm wide shoulders. Tamping is a maintenance method that has an adversely affect on the lateral stability of the track because it distribute the ballast under the sleepers. After tamping, dynamic track stabilization method is necessary to be used to re-dense the ballast. Track maintenance activity should be avoided at high temperatures and ballast should not be disturbed during hot weather.

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A technical paper presented by Shri R. P. Singh Asst. Professor Track/ IRICEN on **"Design of Track Transitions on Railway Bridge approaches"** International Geotechnical Engineering Conference (IGEC 2016). This paper was written jointly by Shri Saurabh Singh IRSE 2013 (M,Tech Railway Technology student) and R.P.Singh Asst. Professor Track/IRICEN was adjudged 2nd in bes paper presentation category.

The conference was organized by International Society of Soil Mechanics and Geotechnical Engineering (ISSMGE) and Indian Geotechnical Society (IGS) on the theme "Sustainability in Geotechnical Engineering Practices and Related Urban Issues" during 23-24 September, 2016 at Hotel Ramada Powai Convention Centre, Mumbai, India.

Formation Rehabilitation
A Case Study

By
Alok Kumar Jha*

1.0 Introduction

The Gauge conversion of Barauni –Katihar (BJU-KIR) section (179 km) was done in 1984.The initial double line MG section was converted into single line broad gauge section. The section has its own importance of being the shortest and most widely used link to the north eastern states. With increase in traffic the doubling of the patch was sanctioned in patches and was similarly commissioned in phase wise manner. The section of Gauchhari (km 100.13) - Pasraha (km 92.05) –Narayanpur (km80.05) of BJU-KIR section has always created embankment problems. The problems have been their due to black cotton soil and water logging for longer duration. The location of track in this patch is such that in North is river Kosi and in South is river Ganga. The soil in this patch is black cotton soil. Black cotton soil has a tendency to shrink and swell excessively. When these type of soil come in contact with water, they swell and when becomes dry, it shrinks. This alternate process of swelling and shrinking results in the differential settlement of foundation which in turn causes cracks in formation. The section has undergone many embankment problem resulting in slewing of tracks to various alignments in different phases of time which is quite evident from goggle maps.







The present alignment consists of six reverse curves each of 02 degrees in four kilometre patch and three reverse curves of 03 degree each in a patch of one kilometre. This is due to problematic embankment and floods of Kosi and Ganga. One more contributing factor of deterioration is that there is no balancing bridge in the entire stretch which causes hydraulic gradient whenever water of either Kosi or Ganga causes flooding.

Therefore necessary precautions need to be taken during construction to avoid any damage triggered by geotechnical considerations. The down line which was commissioned in May 2009 closed in October 2009 itself. The negligence to geotechnical properties during construction stage led to the weakened track that caved in following incessant rains in the area. The restoration work itself amounted to approx 18.0 crores

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and a time span of seven years.

The work of restoration of doubling work has been completed and section has been commissioned on 31-07-2016 for traffic operation.

2.0 Locations of Bank Subsidence

Km 82/9-83/0 & km 98/5-6

Sinking of track took place at left side slope of the bank (facing Narayanpur) slipped at the locations km 82/9-83/0 and 98/5-6 between Gauchhari-Narayanpur and later on it was found that there was vertical sag of about 40-50cm and lateral shifting about 30cm. Amount of sag and shifting gradually increased even due to self weight.

Km 93/0-1

On 07.10.2009 there was heavy rain in the problematic area since 14 hours and the bank slipped suddenly at the location Km 93/0-1 and train no. 5708 (Amarpali Express) while passing the spot in midnight derailed with loco and following six coaches. Prior to this train, train no. 5714 (Intercity Express) had passed at this location and no jerk was felt by the driver. The special patrol man deputed had also crossed this location prior and no abnormality was found by him in the track. It was observed that the embankment has sunk by about 1.75 meter vertically in the length of 25 meter.



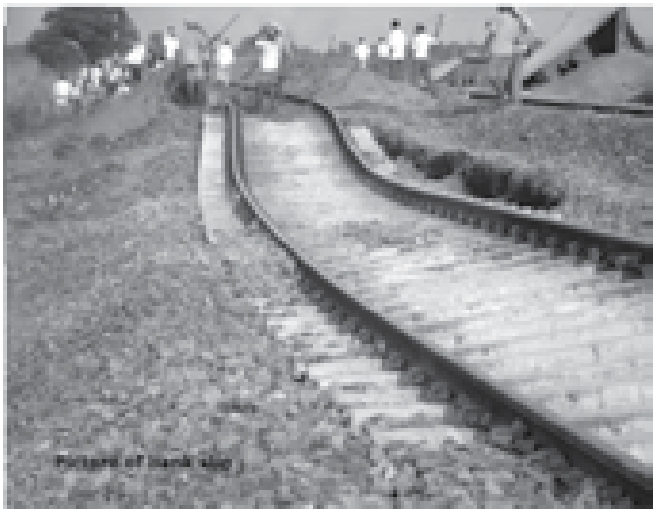




Bank slip and settlement







Photographs Of The Bank Slip And Embankment Failure

3.0 Site Observation

The main observations are as follow:-

(i) In entire section, the toe of the bank is submerged with water for considerable period of the year.

(ii) Surface drainage of formation top is poor as the cess and slope are with dense vegetation and bushes.

(iii) At number of places, cess width is deficient or eroded causing ballast rolling down through side slopes.

(iv) Five locations are identified where severe slips have occurred in past.

(v) Base failure is clearly visible and heaving of base soil has been observed at failed locations.

(vi) Borrow pits are adjacent to the toe of embankment and are filled with water upto 4m depth.

(vii) No bridges have been constructed in entire 20 km length for balancing water way neither under the road nor rail embankment.

(viii) Road embankments have also failed (Bank slip) near the failed locations of railway embankment km 92/9-93/1 and 82/9-83/0.

(ix) From cross-sections of existing formation of MG & proposed formation for BG doubling, it is evident that general slope of embankment in MG was flatter than 2H: 1V with berm of approx. 3 to 6 m wide. However, steeper slope had been adopted for BG embankment after doubling i.e. 2H: 1V without berm which is leading to instability of slope at many locations.

(x) During collecting ballast penetration details, it was observed that the track was laid over old MG formation without removing caked up ballast. Therefore, no ballast penetration is observed.

(xi) Leveling of top of existing formation for MG was done by using local soil before laying track & ballast for BG.

4.0 Cause of Problem

There was sinking in the formation and lateral movement of slope. The factors involved in the settlement of bank and slope movement include:-

i) Use of vulnerable soil i.e, CH (highly plastic clay) in the construction of bank.

ii) Development of high level stresses due to non provision of blanket .

iii) The borrow pits are existing very near to the toe of the embankment.

iv) Continuous existence of river water along the embankment and toe is submerged almost throughout the year.

v) The benching was not done during gauge conversion and doubling work .

vi) During construction of DN track the top 1m stabilized soil and caked portion was removed

and filled with un-compacted stone dust which destabilizes the top of formation.

5.0 Analysis of Soil Test Results

i) From the test results, it was observed that original soil used in the bank construction is CH type i.e. clay of high compressibility. Since the area lies in black cotton soil as such dissipation of pore pressure will take place by draining out water through slope or from top of the embankment leading to slope flattening and disturbance to track geometry.

ii) Differential free swell index ranges from 60% to 70% i.e. more than 60% indicates highly swelling type of soil. Such a soil under submerged conditions will swell and cause reduction in density of formation soil and hence, reduce the bearing capacity leading to bulging of formation of soil along the side of embankment.

iii) Natural moisture content of the soil varies between 23.36% to 28.89%, while plasticity limit ranging from 27 to 29 shows that soil is in plastic state leading to low bearing capacity and bulging of slope.

iv) Fines (passing 75μ sieve) in the soils vary between 91% to 97%, while liquid limit varies up to 68%. Hence, there will be significant loss of shear strength on its saturation resulting into ballast penetration in future. As liquid limit more than 50% and plasticity index more than 25 depicts that the soil is very poor in drainage. As no blanket is provided at the top of formation, Water enters the bank from top due to poor surface drainage conditions and by capillary action from bottom due to stagnation of water at the toe, it further deteriorate the sub surface drainage and reduces strength of soil.

v) The plasticity index (PI) varies from 31 to 37 and MDD (Maximum Dry Density) is in the range of 1.78-1.82 gm/cc. The soil is cohesive and having quite low MDD value, hence not good for formation and may create formation problems. Due to poor drainage condition water in the body of bank could not drain out and led to instability due to shear failure of soil.

vi) Shrinkage limit test results indicate that bottom and top sub-grade soil is highly shrinkable in nature which may create problem in summer season.

6.0 Recommendations

A. Unfailured locations

(i) All borrow pits should be filled in by locally available earth which is available in the external portion of embankment a distance of H + 3M from toe of bank.

(ii) The sub bank of 3m width should be made along the entire section by transporting good earth.

(iii) Earth work along with the new embankment up to cess level should be done by providing proper benching with the old bank.

(iv) Earth work should be done in layers with compaction by small rollers of 900m to 1000m width in layers starting from bottom.

(v) The earth work will be with 3H : 1V slope and cess width of 1.2 M (Minimum).

(vi) Top of formation should have a cross slope of 1 in 30.

(vii) Sand layer of 20cm at base and berm level should be provided for dissipation of excess pore water pressure.

B. At the location of slips

(i) All borrow pits should be filled in by locally available earth which is available in the external portion

of embankment a distance of H + 3M from toe of bank.

(ii) The sub bank of 3m width should be made along the entire section by transporting good earth.

(iii) Earth work along with the new embankment up to cess level should be done by providing proper benching with the old bank.

(iv) This earth work should be done in layers with compaction by small rollers of 900m to 1000m width in layers starting from bottom.

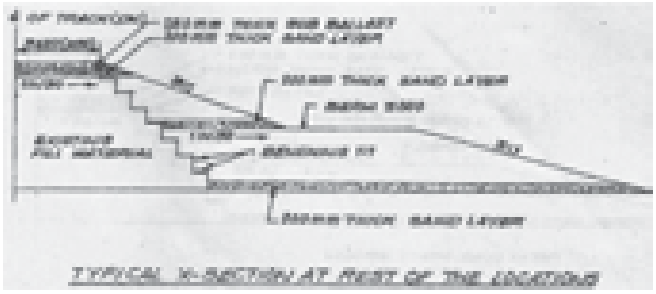
(v) At the location of slips entire loose earth should be removed and adjoining borrows pits should be filled up with it. First sub bank should be made to 3 m width and earth work in the bank should be done with the side slope of 4 : 1 and maintain cess width as 1.2 m(minimum).

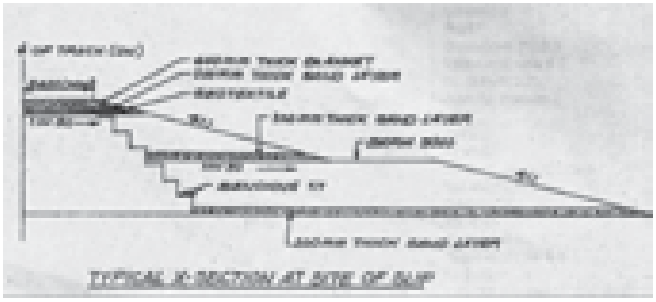
(vi) At all such locations which are around 12 Nos. approximately blanket for a depth of 60 cm along with the Geo textile over 20 cm layer of the sand to be provided at these locations. Typical profile of embankment at such location is reproduced below.Geotextile to be used is non-woven and with specification of 500 gsm.

(vii) Top of formation should have a cross slope of 1 in 30.

(viii) To monitor the track and to avoid this type of miss-happening in future, fix the permanent reference points at the centre of track, cess and slope at three sections in the slipped portion & between Gauchhari and Narayanpur stations to measure vertical and lateral movement at regular time interval (every fortnight) with respect to a permanent bench mark and maintain the record.

This is to be extended at all possible vulnerable location.





7.0 Construction Pictures







Protection of site and dismantling track and making space for treatment.







200 mm sand below geotextile followed by 600 mm blanket material



Benching





Slope preparation boulder pitching

8.0 Conclusion

The section of Gauchhari (km 100.13) - Pasraha (km 92.05) –Narayanpur (km80.05) of BJU-KIR section has created embankment problems due to black cotton soil and water logging for longer duration due to floods of Kosi and Ganga.In addition to this the absence of balancing waterway creates hydraulic gradient across the track ,assisting seepage through embankment. Necessary precautions were not taken during construction to avoid any damage triggered by geotechnical considerations. This resulted in severe problems and high cost as well as operational problems. The negligence to geo-technical properties and specific terrain during construction stage led to the weakened track that caved in following incessant rains in the area. The restoration work itself amounted to approx 18.0 crores and a time span of seven years.

While undertaking any new work or proposing rehabilitation work in existing line due consideration should be given to the geotechnical parameters and specific terrain. All geotechnical investigations should be carried out for proper embankment design i.e., top width, slope, sub bank, and slope protection arrangements. The slope stability analysis of existing soil and soil of borrow pit should also be undertaken. The complete past history of banks should be also analyzed to arrive at techno-economic design of embankment. The thickness of blanket material and other protective measures should be designed and planned before execution of the work.

The construction of the embankment should be done with proper quality control and strict adherence to the designed parameters with proper maintenance of the field records. Regular and random field tests should be done to check and maintain quality of work and for better work appreciation.

It should always be emphasised that embankment is the most important structure of track and not just filling of soil.

■■■

Strategy and It's Implementation for Growth and Sustainability of Infrastructure and Operations : A Case Review of Indian Railways

By
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Abstract:-

Indian Railways has extensive infrastructure and operations that traverses PAN India. It is one of the largest transportation and logistics hub in the world. As per 2014-15 data, Indian Railways runs 12,000 trains to carry over 23 million passengers per day and generates a passenger revenue of INR 421,896.1 (in millions). It also runs more than 7,000 freight trains per day carrying about 3 million tonnes of freight every day (2014-15 data) and generates a freight revenue of INR 1095.26 (in millions). In this review paper, we look at the present status quo of Indian Railways in terms of its Infrastructure & Operations and the key initiatives as part of their strategy for future direction to achieve growth and sustainability.

Technology Development - The Technology would involve outlining strategies for modernization of Railways with a focus on track, signalling, rolling stock, stations and terminals to improve the operational efficiency, safety, providing passenger amenities and augmenting existing capacities of Indian Railways through indigenous development. Social Service Obligations - Indian Railways carries out certain transport activities which are essentially uneconomic in nature in the larger interest of the economically disadvantaged sections of the society. Losses incurred on this account falls under Social Service Obligations of Indian Railways. Working of uneconomic branch lines, too, imposes a heavy burden on IR's finances. A gap is thus created between the revenue income generated through these services and their running costs. Green Initiatives - Reducing the carbon footprints by improving fuel efficiency, energy efficiency, use of Alternate fuels like – CNG and bio diesel, use of Renewable Energy sources like Wind power and Solar power. In order to reduce dependence on fossil fuels, it intends to expand sourcing of solar power. Non Fare Revenue Generation- Indian Railway intends to increase non fare revenue by undertaking the initiatives like Station Redevelopment, Monetizing land along tracks, Monetizing soft assets, Advertising, Overhaul of Parcel business, Revenues from manufacturing activity. Increase in Investment- Indian Railways encourages investment from both domestic and foreign investors. 100% FDI through automatic route has been permitted in the railway sector. Fast track implementation and continuous monitoring of these key aspects would help shape a new age Indian Railways. Enhanced Safety - To increase operation efficiency and to enhance safety in train operations by using Advanced Signalling System. Indian Railways has taken measures like Train Protection and Warning System, Train Collision Avoidance System, Provision of Fire Extinguishers, All India Security Help Line: 182 working round the clock for security related assistance to passengers.

1.0 Introduction

The history of the Railways in India is conventionally dated to 16th April 1853, when a train left Bori Bunder for Thane (then Tannah). Strictly speaking, this was the first commercial passenger train, since Railways were earlier used for other haulage purposes. With three steam locomotives (Sindh, Sultan and Sahib) that journey took 1 hour and 15 minutes in 1853. Now, India has the fourth largest railway network in the world, covering 29 States and 3 Union Territories, about 7,200 stations - from Baramulla in the north to Kanyakumari in the south and from Naliya in the west to Ledo in the east. Its network of 65,000 route kilometers is more than one and half times the circumference of the earth. It has joined the select

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club of countries comprising Chinese, Russian and United States Railways with an originating freight loading of 1008.09 million tonnes (i.e. one billion plus) in 2012-13. The national carrier plays a significant role in development and growth of the country and touches lives of all its people across the country. It runs nearly 19,000 trains – about 12,000 passenger trains that carry more than 23 million passengers and freight trains that carry around 3 million tonnes of freight per day. Indian Railways (IR) has played a significant role in the development and growth of industries. The textile industry in Mumbai, the jute industry in and around Kolkata and the coal industry in Jharkhand are examples. Raw materials are carried to factory sites and finished goods are carried to markets. Agricultural produce is carried cheaply through bulk rail transportation. Apart from the national integration objective, in times of natural calamities (droughts, floods, famines and earthquakes) and man-made calamities (disturbances, insurgency), IR has helped with relief and rescue, as well as movements of police, troops and defence equipment, when required.

"Railways are found to focus strong backward linkages (demand pull from other sectors) with manufacturing and services. It appears that increasing the railway output by INR 1 would increase output in the economy by INR 3.3. This large multiplier has been increasing over time, and the effect is greatest on the manufacturing sector. Investing in the IR could thus be good for 'Make in India'…Further, there are sectors where railway services are an input to production (forward linkages). An INR 1 push in railway sector will increase the output of the other sectors by about INR 2.5. Combining forward and backward linkage effects suggests a very large multiplier (over 5) of investments in the Railways." Even without these precise numbers, the multiplier effects are obviously visible.

The biggest challenge facing Indian Railways today is its inability to meet the demands of its customers, both freight and passenger. Apart from the Quantum of Investment, Quality of Delivery is also an issue. Cleanliness, Punctuality of Services, Safety, Quality of Terminals, Capacity of Trains, Quality of Food, Security of Passengers are issues that need attention.

To shape new age Indian Railways for future growth and sustainability, new steps like Technology Development, Social Service Obligations, Green Initiatives, Non Fare Revenue, Investment in Indian Railways, Enhanced Safety operations is the need of hour and is discussed in depth below.

Table 1 : Indian Railways Statistical Snapshot (2013-14)

Number of passengers carried (millions)	8,397
Passenger kilometres (billion)	1,159
Passenger earnings as % of gross earnings	25.28
Express long-distance passenger as % of passenger earnings	80.49
Average suburban lead (km)	37.0
Average non-suburban lead (km)	257.5
Number of railway stations	7,172
Number of railway stations identified for multi-functional complexes	196
Number of daily passenger trains	12,961
Average speed of mail/express trains on broad gauge (km/hour)	50.6
Average speed of ordinary passenger trains on broad gauge (km/hour)	36.0
Average rate per passenger km (paise)	31.53
Revenue originating tonnes (million)	1,051.64
Net tonnes km (billion)	691.66
Bulk freight as % of goods earnings	88.87
Number of daily goods trains	8,637
Wagon turn-around time on broad gauge (days)	5.13
Average speed of goods trains on broad gauge (km/hour)	25.9
Average net load of goods trains on broad gauge (tonnes)	1,686
Average rate per NTKM (paise)	137.5
Proposals for private freight terminals	47(19 finalized)
Working expenses as % of gross earnings (operating ratio)	93.60
Number of employees (thousands)	1,334
Wage bill as % of working expenses	49.13
Rate of return on capital (%)	7.42
Number of locomotives	9,956
Wagons	2,45,267

Coaches	66,392
Land owned by Indian Railways	4.55 lakh hectares
Train Accidents (Excl. KRCL) (Nos.)*	117
(i) Collisions (Nos.)	4
(ii) Derailment (Nos.)	52
(iii) Level Crossing (Nos.)	51
(iv) Fire in trains (Nos.)	07
(v) Miscellaneous (Nos.)	03
(vi) Accident per million train kms (Nos.)	0.10
Consumption of Fuel/Energy by Locomotive*	
(i) Diesel (Million litres)	2789.26
(ii) Electric (Million KWH)	15169.16

Source: Report of the Committee for Mobilization of Resources for Major Railway Projects, June 2015

*Indian Railways Yearbook 2014-15 - Other Important Statistics

2.0 Technology Development

Research Design and Standards Organization (RDSO) is the sole R&D organisation of Indian Railways and functions as the technical advisor to Railway Board, Zonal Railways and Production Units. One of the major roles that RDSO has played is that of developing and maintaining standards and specifications which ensure that all different technologies are able to work together as a system, in turn making it possible for IR to operate seamlessly without any technology limitations.

RDSO also offers international consultancy services in matters pertaining to design, testing and inspection of some of the important activities and projects undertaken/completed by RDSO during the year 2014-15 are given below:

1. Safety:

- Development of Radio Based Advance Warning System for Unmanned Level Crossing.
- Safety against fire in IR coaches.
- Safety at Unmanned Level Crossing- provision of hoarding to warn road users.
- Development of Crashworthy Design of Coach.

2. Passenger Amenities

- Development of Double Decker Coach Design.
- Development of Hotel Load Converter.
- On-Board Wireless Public Address System.
- Code of practice for improved passenger amenities to be provided at Adarsh Stations.

3. Infrastructure

- Wagon to carry bulldozer for Accident Relief.
- Investigation of ballast less track problems in tunnels on Konkan Railway.
- Development of high rise OHE STT-49 maintenance schedule of MTRC system for GSM-R
- Remote Unmanned Data Logger.

4. Operational Efficiency

- Development of specification for 2200hp Diesel Engine for DMUs over IR.
- Specification for 4500/5000 HP Dual Mode locomotive for passenger service.
- Preparation of draft specification for Dual Mode Goods Locomotive.
- Alternate Drive Gear System suitable for 200 kmph.
- New Insulation Scheme used for EMU/MEMU (Type-4601).

5. Indigenous Development

- Improvement in ride quality and speed potential of WDG5 locomotives.
- Design modification of HTSC FAB-II fabricated bogie frame for HHP locomotives.
- HTSC fabricated bogie frame with TBU application for HHP locomotives.
- Design & development of Cast ALCO Engine Block.

3.0 Social Service Obligation

Indian Railways carries out certain transport activities which are essentially uneconomic in nature in the larger interest of the economically disadvantaged sections of the society. Losses incurred on this account fall under Social Service Obligation of Indian Railways.Net Social Service Obligation borne by IR in 2014-15 is assessed at 25,346.94 crore excluding staff welfare cost (4,797.50 crore) and law and order cost (3,415.43 crore). These costs impinge upon the viability of Indian Railways system.

The main elements of Social Service Obligation in IR are losses relating to:

Losses on transportation of Essential Commodities carried below cost

As part of the Railways' Social Service Obligation, certain essential commodities of mass consumption like fruits and vegetables, sugarcane, paper, charcoal, bamboos, cotton raw pressed etc. are carried below cost of operation in order to contain their market prices.

The total losses on the movement of these commodities in 2014-15 amounted to 68.92 crore (refer table 2)

Table 2 : Losses on transportation of Essential Commodities

Commodities	**Losses (in Crores)**
Fruit & Vegerables	33.71
Bamboos	12.87
Charcol	7.08
Paper	5.36
Other Woods	4.87
Cotton Raw pressed Cotton Manufactured other than	2.54
Piece Goods	1.29
Sugar Cane	0.61
Glass Wares	0.53
Brick Titles	0.03
Fire Wood & Other Fuel	0.03
Total	**68.92**

These commodities constituted 0.71% of the total revenue NTKMs and 0.31 % of freight earnings in the year 2014-15

Losses on Passenger and Other Coaching services

These journeys constitute 79.5% of total traffic but provide only 17.9% of total passenger earnings.

- Non-Suburban commuters availing Season Ticket concessions up to a distance of 150 kilometres. These journeys constituted 21.7% of Non-Suburban Traffic but provide 1.2% of Non-Suburban passenger earnings only.

- Commuters availing concession Monthly and Quarterly Season Tickets on Suburban Sections of Chennai, Kolkata, Mumbai and Secunderabad. Journeys performed by passengers holding season tickets formed 60.7% of Suburban Traffic but provide 41.3% of Suburban passenger earnings only.

Indian Railways incur losses every year by performing a variety of unremunerative services. These losses are mostly due to the following reasons:

(a) Low ordinary second class fare

(b) Suburban and non-suburban season fare

(c) A variety of concessions granted on passenger ticket and

(d) Transportation of certain commodities below cost.

Uneconomic Branch Lines

Working of uneconomic branch lines, too, imposes a heavy burden on IR's finances. A gap is thus created between the revenue income generated through these services and their running costs.

Despite concerted efforts to enhance earnings on branch lines, most of such lines remain commercially unviable. The Railway Reforms Committee recommended closure of 40 such lines but due to stiff public resistance and opposition of State Governments towards withdrawal of such services, only 15 lines have been closed permanently by the Railways. A review of the financial results of existing

96 uneconomic branch lines for the year 2014-15 shows that, on an original investment on these lines of the order of 3,741 crore, loss during the year 2014-15 amounted to 2,056 crore.

New lines opened for traffic during the last 15 years:

The Railway Convention Committee (RCC) in its 9th Report on this subject has noted that in the present state of Railway finances and prevalent high costs of construction, the Railways are not in a position to inject adequate capital investment in under-developed areas. Therefore, they have felt that reliefs like making available land free of cost and waiver of dividend payment on such lines for a minimum period of twenty years are justified. Periodic reviews have revealed that of the 17 lines examined in 2014-15, as part of Social Service Obligations of the Railways for development of backward areas, all lines are showing either negative or unremunerative returns. The name of the branch lines are listed below:

Table 3 : Periodic review of lines in 2014-15

1	Lanjigarh-Bhawanipatna-Junagarh(BG)54.5 Kms.	10	New Morinda-Sahnewal (BG) 52.18 Kms
2	Abohar-Fazilka (BG) 34 Kms.	11	Chandigarh-Morinda (BG) 43.89 Kms.
3	Taran Trn-Govindwal (BG) 21.416 Kms	12	Una Himachal-Churaru Takrala (BG) 16.5 Kms
4	Ludhiana-Sahnewal (BG) 15.11 Kms.	13	Rewari-Jhajjar-Rohtak (BG) 81.257 Kms
5	Udhampur-SVDK (BG) 25 Kms	14	Kolayat-Phalodi (BG)112Kms.
6	Jammu Tawi-Udhampur (BG) 53 Kms	15	Madar-Pushkar (BG) 25.7 Kms.
7	Banihal-Baramula (BG) 13.7 Kms.	16	Kakinada-Kotipalli (BG) 44.7 Kms
8	Churaru Takrala-Amb Andaura (BG) 11.17 Kms.	17	Chikkabanavara-Nelamangala (BG) 14 Kms.
9	Penukonda-Dharmavaram via Puttaparthi(BG)53 Kms.		

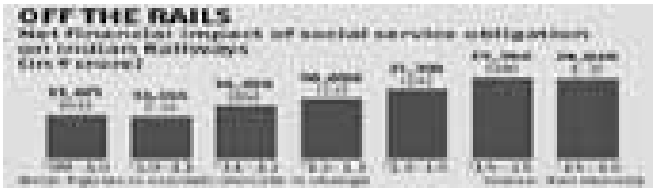


Figure 1 : Net Financial Impact of Social Service Obligation on IR

The Net Social Service Obligation borne by IR in 2014-15 assessed at 25346.94 Crore, constitutes 16.1% of the total revenue earnings and 17.7% of the total working expenditure.

The details of Net Social Obligation in terms of revenue expenditure and losses is as follows: (in million) 2014-2015

- Loss on essential commodities carried below cost of operation 689
- Loss on coaching services
  (a) Non-suburban 287,353
  (includes loss of 20,561 millions on uncconomic bracnh lines)
  (b) Suburban 47,556
  Total loss 335,599
- Net social service obligation 253,469
  (excluding staff welfare and law & order costs of 82,129 million)

4.0 Green Initiatives:-

Railway is the most environment friendly mass transport system due to its inherent energy efficiency and minimal utilisation of resources. Growth of Indian Railways to regain its premium role in the transport scenario will be a crucial requirement for the sustainable development of Indian Economy. Presently, Railways is about 12 times more efficient in freight traffic and 3 times more efficient in passenger traffic as compared to the road transport which is presently the major player. It has been estimated that for the sustainable development of Indian Economy, the inter-model share of freight traffic by rail should go up from the present 36% to 45% in the next 15 years. Railway has committed to focus on environment sustainability initiatives which include energy audit, setting up solar plants, use of alternate fuels, improving the energy efficiencies on traction & non traction side etc.

Various energy efficiency measures adopted through

technology inputs have resulted into sustained reduction in electric energy consumption. During the last year a reduction of about 2 % in traction energy and 3 % on non-traction energy has been achieved. In the case of Diesel traction, similar efforts have resulted in the reduction in Specific Fuel Consumption (SFC) by 2% during 2015-16. Guidelines have been issued in 2015 for promoting use of LEDs and other energy efficient appliances and equipment across the Railways. This includes mandatory use of LEDs in all new passenger coaches and railway stations and buildings.

IR is very conscious about saving energy, as energy saved is energy generated. Following major energy conservation initiatives have reduced the energy consumption:

(a) Segregating of 70/30 lighting circuits at platforms

(b) Use of CFL fittings at corridors, staircase, toilets & bathrooms

(c) Adoption of T-5 fluorescent tube lights in place of T-12 FTL fittings

(d) Use of automatic power factor correction panels in HT/LT substations

(e) Replacement of old 90 watt ceiling fans be 60 watt ceiling fans

(f) Use of electronic fan regulator in place of conventional fan regulators

(g) Provision of LED based station name board in place of neon sign board

(h) Timer switch on high mast towers-yard lighting/ street lighting

(i) Use of electronic ballast in place of conventional ballast in FTL circuits and metal halide circuits

(j) Automation of pumps

(k) Use of energy efficient pumps in place of old inefficient pumps

(l) Efficiency measurement of pumping installation and implementation of action plan

(m) Use of energy saver for: (a) Pumps (b) Lighting circuits (c) Air conditioning circuits (d) machines in workshops

(n) Use of occupancy sensors for light control in (a) officer's chambers (b) conference rooms (c) waiting halls

(o) Use of VVF control for cranes, lifts and escalators

(p) Use of 3 star and above labelled electrical products and equipments

As per the estimates Railways have been saving more than 400 M Units of electric energy through these means in its Electric Traction and Non Traction energy uses. These measures by Indian Railways have resulted into huge savings of electricity for non-traction applications despite increase in connected load by about 5%.

On traction side, deployment of new generation energy efficient electric locomotives and electrical multiple units (EMUs) with 3 phase IGBT Technology for EMUs in Mumbai Suburban area is expected to reduce emission of 600 tonnes of C02 per annum per train due to regenerative braking features. Introduction of latest energy efficient Locomotive technology is expected to reduce 500 tonnes of C02 annually due to regenerative braking features of new 6000 HP locomotives have further resulted into reduction in Specific Energy Consumption (SEC).

Improvement in Fuel efficiency in Diesel Traction:-

Following measures planned to improve Specific Fuel Consumption (SFC) through technological intervention:

- Provision of Auxiliary Power Units (APU) on all diesel locos
- Common Rail Electronic Direct Injection (CReDI) I Electronic Fuel Injection (EFI) system.
- Guidance for Optimized Locomotive Driving (GOLD)
- Multi Genset locomotives
- Miller Cycle Turbocharger
- Smart Multiple Units

Improving Energy efficiency on account of trailing Rolling Stock:-

- Pay load to tare ratio will be increased to 4.0 for ARI Gondola wagons and 4.21 for BOXN25 Design.

- Commodity specific wagons are also being developed.

- These measures will enable higher throughput and result in reduced GHG emissions for the same freight traffic.

- Improved design Stainless Steel Coaches also provide higher carrying capacity. With increasing share of such coaches, PKM to GTKM ratio will improve resulting in reduced GHG emissions for carrying the same passenger traffic.

The Railways which have already achieved a 19.7 % improvement in Specific Fuel Consumption for Freight Service Locomotives and 21.2 % improvement for Passenger Service Locomotives during the last 10 years should further improve its energy efficiency for both diesel and electric locomotives thereby facilitating the reduction of GHG emissions in India.

For sustainability of our environment and to address the challenges of dealing with the threat of changes in global climate and also to reduce dependence on fossil fuel in line with Jawaharlal Nehru National Solar Mission, Indian Railways is harnessing green energy.

Wind Energy:-

The first Wind Mill of IR of 10.5 MW capacity in Tamil Nadu for meeting most of the energy demand of Integral Coach Factory (ICF), Chennai commissioned in Mar 2009.

IR has further planned to establish additional capacity of 157.5 MW wind mill plant in wind rich areas in Joint Venture (JV).

MoU has been signed between Indian Railways and Railway Energy Management Company Limited (REMCL) for setting up of windmills to the capacity of 157.5 MW.

- Out of which 26 MW Windmill Plant in Khodiyasar Village, District Jaisalmer -Rajasthan has been commissioned on 16th October 2015.

- Remaining 131.5 MW Wind Mill are being planned to be installed in the state of Andhra Pradesh.

- Beside this IR is also setting 10.5 MW wind mill plant through Railway funding in the state of Tamil Nadu.

Solar Energy:-

Solar Photo Voltaic (PV) modules of about 5.5 MW capacity have been provided for solar lighting system at following locations:

- About 525 Railway stations

- 20 office buildings

- 4100 Level crossing gates,

- 600 solar based street lights in colonies/training schools,

- 6.6 Lakh Litres per Day (LPD) solar based water heaters in running rooms/hospitals/rest houses/ canteens/base kitchens.

MoU between Ministry of Railways and Ministry of New & Renewable Energy (MNRE) for co-operation in the Renewable Energy to bring in a change in the energy mix & Solarisation of Railways.

IR has further sanctioned the works for harnessing solar power of 9.8 MWp (Mega Watt peak) with subsidy from MNRE as per following details:

- 200 railway stations identified for installation of rooftop solar plant

- Roof top of 26 buildings

- 2000 Level Crossing gates

- The next significant effort was the 2 MW Solar Power Plant commissioned in 2014 at Modern Coach Factory, Rae Bareily, which is catering to about 25% of the factory's energy consumption.

- 1 MW Roof Top Solar Power Plant was commissioned in 2015 at Shri Mata Vaishno Devi Katra Railway Station of Northern Railway.

- 200 MW Solar Projects are being planned under PSU scheme with VGF support of MNRE.

- Railways till date have set up a total of 11 MW solar power plants at administrative buildings,

stations & hospitals. Works are in final stages for 6.5 MW capacity plants which include 500 KW at Varanasi, Secundrabad and Jaipur etc.

- In a pilot project to improve facilities at railway stations, the Western Railway (WR) has installed solar panels at its Matunga Road railway station. The 48 panels — of 280 Watt each — altogether would generate 48 kilowatt (kW) hours per day and replace the daytime energy usage of the entire railway station. Railway officials said the solar energy usage would also save around Rs 2 lakh per annum. "The solar panels, installed on a pilot basis at the Matunga Road railway station on June 20 2016, would replace the daytime conventional energy usage of the station. They will be used for substituting electricity usage for administrative work across the station in the daytime. We expect to save at least 30-40 per cent electricity consumption a day, through the use of solar panels.

The policy initiative to directly procure bio-diesel for 5% blending with High Speed Diesel (HSD) Oil, will facilitate reduced dependence on Fossil fuel. Also, the conversion of pure diesel based motive power systems into partially CNG powered vehicles is an important strategy towards clean fuel usage. Indian Railways commenced blending of 5% bio-diesel in HSD oil in few Zonal Railways for traction purposes. Approximately 4100 KL of bio fuel was consumed by Indian Railways in the last year. Indian Railways provided 27,000 Bio-Toilets in trains in the last two years. A target of 30000 Bio-Toilets set for 2016-17.

5.0 Non Fare Revenue Generation:

The Minister of Railways, Shri Suresh P. Prabhu has said that Indian Railways will increase the revenue through non fare sources. While introducing the Railway Budget for 2016-17 in Parliament, the Railway Minister said that the current revenue through non-fare sources is less than 5% and it will be increased to world average of 10% by next five years.

In compliance of the Railway Minister Shri Suresh Prabhakar Prabhu's budget speech to reorganize Railway Board along business lines and setting up cross functional Directorates in Railway Board to focus on areas for enhancing revenues by 10% to 20% from Non Tariff sources Ministry of Railways has decided to constitute a new Directorate named as Non Fare Revenue Directorate (NFR) in Railway Board's Office, Rail Bhawan, New Delhi.

Broad items of work to be handled by Non Fare Revenue Directorate would be as under:

1. Advertisement at stations;
2. Commercial exploitation of vacant land and space rights over station buildings including station redevelopment;
3. Advertisements on coaches (both inside/outside) and on locos;
4. Sponsorship of uniforms for railway personnel, wherever in vogue;
5. Advertisements through hoardings on land alongside tracks and on land near railway stations;
6. Commercial farming alongside railway tracks;
7. Monetization of soft assets, including generation of revenue from websites through advertisements and web links;
8. Sidings and way leave charges;
9. Operation/licensing of Multi Functional Complexes;
10. Parking of vehicles in railway land other than at stations;
11. Advertisements on wagons, FOBs, ROBs, RUBs, Railway buildings, Loco sheds, Production Units, Structures on railway premises (like water tanks, microwave towers, OHE masts etc);
12. On board (trains) and off board (station) entertainments, magazines on trains, displays at railway premises including stations (LED screens, video walls, translides etc.)
13. Sponsorships of activities and events at stations, branding etc;
14. Operation of Pay and Use toilets in land outside

railway stations (circulating area, approach roads, near LC gates etc.);

15. Radio, Video, Internet, WiFi, Mobile Apps, Interactive services (like video games etc.) in railway premises including stations;

16. Tourism

The Railway Minister said that following initiatives will be taken to generate Non Fare Revenue this:

- Station Redevelopment:- A major programme of station redevelopment has been initiated to monetize land and buildings through commercial exploitation of vacant land and space rights over station buildings.

- Monetizing land along tracks:- Railways will lease out the land available adjacent to tracks to promote horticulture and tree plantation. This will generate employment to under privileged sections, augment food security and also prevent encroachment. Possibility of using these tracks for generating solar energy will also be exploited.

- Monetizing soft assets:- Railways to monetize the data collected on passenger preferences, ticketing, commodity, train running on various services and operations. IRCTC also offers opportunities of taking of ecommerce activities on large number of hits that it receives.

- Advertising:- Railways to use its vast physical infrastructure for commercial exploitation through advertisement. Special focus will be given to exploit extra potential of stations, trains and land adjacent to tracks.

- Overhaul of Parcel business:- Railways to liberalize its current parcel policies to increase the non fare revenue. It will expand its service offerings especially to growing sectors such as ecommerce.

- Revenues from manufacturing activity:- Railways to put focus to increase productivity and better manufacturing practices to become a meaningful player in the domestic and international markets. It is aimed to generate annualized revenues of about Rs.4,000 crores by 2020.

Indian Railways has appointed E&Y as consultant to tap advertising potential of stations and trains, E&Y will identify assets and pricing strategy across 7000 stations for the purpose of advertising. This is the first time in the country that such a large scale project on advertising for Railways has been initiated. Minister of Railways has always been emphasizing on increasing revenues through non fare box route especially through advertising. The exercise to help developing packages meeting specific demographic and geographic needs ensuring ease of business to advertisers and increased transparency and accountability. Initial estimates have indicated an advertising potential on Railways in excess of Rs. 5000 Crores over the next few years.

E&Y with its specialized offering Marketing and Advertising Risk Services (MARS) will help athe Indian Railways to identify assets across its stations for the purpose of advertising and will also develop a pricing strategy to evaluate them for advertisers. The firm has commenced its exercise.

In preliminary discussions held between Railway Officials and E&Y officials, it was emphasized that the exercise is to be completed in a time bound frame. In these discussions, Chairman, Railway Board, Shri A. K. Mital pointed out “this current move by the Indian Railways will allow for revenue enhancement for the enterprise without putting any burden on its passengers. In the past, the railways has used its assets to earn revenues through advertising but limited to train wraps and display spaces in stations. This is the first time in the country that a large scale project to identify and leverage pan India advertising opportunities has been initiated.”

6.0 Investment in Indian Railways

The investments in the Railways usually earn a return. A new track will generate more traffic; more wagons will carry more freight, better signalling will allow more trains to be run, thus generating more revenue. IR has historically been financed largely through internal accruals and from budgetary support and not from external financing.

A policy for participative models for rail connectivity and capacity augmentation projects was issued in December, 2012 with the aim of attracting private investments in building/construction of last mile connectivity’s.

The policy provides following five models for implementation of various types of rail-connectivity and capacity augmentation projects:

- Non-Government Private Line Model
- Joint Venture (JV) model
- Build, Operate and Transfer (BOT) model
- Capacity augmentation with funding provided by customers
- Capacity augmentation through annuity model

Non-Government Private Line Model

Applicable to first and last mile connectivity projects at either end of the rail transportation chain providing connectivity to ports, mines, logistics parks or large-sized cluster of industries, which are handling goods traffic for multiple consignors or consignees.

As the project line is on private land and the assets are fully private infrastructure, it will be transferred to IR in case of violations of specified terms of agreement at terms set out in the Agreement or by mutual consent at such terms as may be mutually agreed.

Joint Venture (JV) model

It is generally applicable for sanctioned bankable new line and Gauge Conversion projects having clearly identifiable stake holders either as user of the line or utilities such as ports, mines, exporters, plants and the State Governments. 30 years of operation or attainment of pay-back of equity invested at a discount rate of 7% above the rate.

Government of Karnataka was the first State to set up Joint Venture (JV) Company with Ministry of Railways (MoR) for taking up Railway Projects in their State. Later, Memorandum of Understanding (MoU) for setting up JV Companies by Maharashtra, Orissa, Andhra Pradesh, Kerala, Chhattisgarh and Telangana has also been signed. Partnership with State Governments, Industry is being encouraged to undertake coal and mining connectivity projects.

Build, Operate and Transfer (BOT) model

This model shall be applicable to the sanctioned Railway projects where it is not possible to identify a stakeholder or strategic investor who can take a lead in making investment in the project line. These will be sandwiched on sanctioned new line and gauge conversion projects or dedicated freight corridors

Selection of investors will be done through competitive bidding process. The concessionaire so selected will design, build, finance, maintain and transfer the railway line at the end of concession period. Concession period will be fixed at 25 years.

Capacity augmentation with funding provided by customers

The single user rail connectivity to mines and plants is provided under the private siding policy. Such a policy has been found wanting in case where the length of the rail connectivity is long and cost of construction is so high that it cannot be loaded to the main facility/project. The industry recognises the fact that such single -user connectivity cannot be provided by the railways with their funds or by providing commercial returns to investors. Many such longer rail connectivity, though initially for single users, have significant potential to become multi-user facilities in future with development of other industry, mining etc. Nevertheless, they do expect a partnership with Railways to develop the rail infrastructure speedily in a manner which does not put undue burden on Railways.

The project developer will develop, construct and maintain the line as per IR standards. IR shall operate the line, collect the freight and pay 50% of the apportioned earning computed in terms of Inter-Railway adjustment as compensation to the original developer till the estimated cost of the project sanctioned/vetted by IR at time of execution of agreement is recovered.

Capacity augmentation through annuity model

This model is applicable to sanctioned doubling, third line and fourth line projects where it may not be possible to find funding from any specific user.Three of these models (private line, JV and customer funded) involve participation of strategic investors/customers and two other (BOT and Annuity models) are pure PPP models.

Ministry of Railways for the first time has decided to launch three annuity projects Badrak Nargundi 3rd line (900Cr.), Nagpur – Wardha 3rd line (550Cr.) and Kazipet Vijayawada 3rd line (1566 Cr.) in the current calendar year.

Table 4: Examples for External Investment in Railway Systems

S. No.	Type of External Investment in Railways	Example
1.	Joint Venture with provincial government for suburban rail transit	Mumbai Railway Vikas Corporation Ltd (MRVC Ltd) is a 51:49 joint venture (JV) between Ministry of Railways and Govt. of Maharashtra.
2.	Joint Venture with provincial government for local railways	Hassan Mangalore Rail Corporation is a joint venture between Govt. of India, Govt. of Karnataka and others.
3.	Joint ventures with local shippers	Kutch Railway Co. Ltd. connects Adani's Mundra port in Gujarat to the Mumbai Delhi line. JV between South Eastern Coalfields, Govt. of Chhattisgarh and Railways
4.	Leasing of Rolling Stock	Indian Railway Finance Corporation (IRFC) is involved in leasing of rail assets in India. Almost all new rolling stock, coaches, wagons and engines are now leased through IRFC. However, older rolling stock continues to be owned by Indian Railways.
5.	Public Private Partnerships (PPP) for building and operating entire railways	There are a number of PPP projects on Indian Railways. These include the Pipavav Rail Corporation Ltd. And the Bharuch Dahej Rail Corporation Ltd.
6.	Leveraging Railway Assets such as railway right-of-way by communications companies and commercial development of Railways owned/acquired real estate.	RailTel has about 42,000 km of optic fiber cable running along the railway right-of-way, which it sells to telecom companies in India A large parcel of land was offered in Mumbai, by the Railways and sold on auction.
7.	Station development for urban rail	Delhi Metro Rail Corporation (DMRC) has a policy of revenue generation by selling land around stations, as do metro railways in other cities.
8.	Market financing of Railway Companies by attracting private investors to buy bonds or equity shares in railways	CONCOR, the container services operator in India is publicly listed with 25% foreign holding and an overall market capitalization of USD 5 bn.

Source: Report of the Committee for Mobilization of Resources for Major Railway Projects, June 2015

To attract Foreign Investment in the rail sector required changes in the policy framework, Government of India, reviewed its policy for private investment in rail infrastructure and amended the list of industries reserved for public sector. It has been decided to permit 100 percent FDI in the following activities of the Railway Transport sector for construction, operation and maintenance of the following:

- Suburban corridor projects through PPP,
- High speed train projects,
- Dedicated freight lines
- Rolling Stock including train sets, and locomotives or coaches manufacturing and maintenance facilities,
- Railway Electrification,
- Signaling systems,
- Freight terminals,
- Passenger terminals,
- Infrastructure in industrial park pertaining to railway lines or sidings including electrified railway lines and connectivity's to main railway line; and
- Mass Rapid Transport Systems.

Table 5: Investments from Foreign Institutions for Expansion and Modernization of Railways

S. No.	Name of the Funding Agency	Project	Loan Currency	Loan Amount	Amount disbursed till (31.01.2016)	
				(in Millions)	Loan Currency (in Millions)	Equivalent Amount (in Crores)
1.	International Bank for Reconstruction And Development	Eastern Dedicated Freight Corridor	US Dollar	2,075	150	922
2.	Japan International Cooperation Agency	Western Dedicated Freight Corridor Phase I	Japanese Yen	230,603	27,985	1,593
3.	Asian Development Bank	Rail Sector Program	US Dollar	280	149	925
4.	International Bank for Reconstruction And Development	Mumbai Urban Transport Project (Phase 2A)	US Dollar	385	182	1,071
5.	Japan International Cooperation Agency	Kolkata East West Metro Project II	Japanese Yen	23,402	13196	777
6.	Memorandum of Understanding has been signed with Japan International Cooperation Agency for funding of High Speed corridor between Mumbai – Ahmedabad. Total Project cost is estimated to be ; 97,636 crore (including price escalation, Interest During Construction (IDC) and import duties) 81% of the project cost funded by Government of Japan loan for 50 years at 0.1% per annual interest with 15 years moratorium periods.					

Source: - Press Information Bureau, Government of India, Ministry of Railways dated: 04.03.2016

- A Memorandum of Understanding with LIC of India for obtaining funds to the tune of Rs.1.5 lakh Crore signed.
- Ministry of Finance approved issue of tax free bonds by IRFC amounting to Rs.6,000 Crore.
- Discussions initiated with World Bank for setting up a Railway Infrastructure Development Fund of around USD 30 Billion.

Sale and Lease Back of Non-Land Assets

IR has a number of other assets that can be leveraged to raise revenue. Two such examples, based on existing practice, are (i) rolling stock and (ii) track, rolling stock today is almost entirely leased from the IRFC, which issues bonds to finance their purchase. However, there is an older complement of rolling stock that is not leased. This comprised, as of March 2014, 1533 diesel locomotives, 2980 electric locomotives, 13,000 coaches and 93,250 wagons. This rolling stock can be sold to IRFC (or other leasing companies) and leased back from them. This would generate resources for investment which can then generate the revenue to service the lease. Track can also be similarly sold and leased back. Indeed, Konkan Rail Corporation has earlier, done such a transaction. This again generates investible resources.

Sale of Equity

IR has thirteen undertakings in which it holds either the entire or a substantial stake. Of these, only CONCOR is listed. There are other corporate entities, including RITES, IRCON, IRCTC, etc., which can be listed.

On 8th March 2016, The President of India (acting through the Ministry of Railways, Government of India) proposes to sell 97,48,710 equity shares of Container Corporation of India Limited of face value of INR 10

each, representing 5% of the total paid up equity share capital of the company for Retail Investors and non-Retail Investors through a separate designated window of the BSE Limited and National Stock Exchange of India Limited.

Table 6 : Proposed Investment Plan by IR for the Period (2015-2019)

Items	Amount in Crores
Network Decongestion (including DFC, Electrification, Doubling including electrification and traffic facilities)	199,320
Network Expansion (including electrification)	193,000
National Projects (North Eastern & Kashmir connectivity projects)	39,000
Safety (Track renewal, bridge works, ROB, RUB and Signalling & Telecom)	127,000
Information Technology / Research	5,000
Rolling Stock (Locomotives, coaches, wagons-production & maintenance)	102,000
Passenger Amenities	12,500
High Speed Rail & Elevated corridor	65,000
Station redevelopment and logistic parks	100,000
Others	13,200

Source: Report of the Committee for Mobilization of Resources for Major Railway Projects, June 2015

Estimated requirement of investment is Rs. 8,56,020 Crores (approximately 135 billion US Dollars) over five years to augment infrastructure capacity and modernisation.

7.0 Enhanced Safety

There were 131 consequential train accidents in 2014-15 as compared to 117 in 2013-14. Train accidents per million train kilometres, an important index of safety, are 0.10 in 2013-14 and 0.11 in 2014-15.Safety of Indian Railways is covered in different aspects such as:

- Safety to avoid collisions
- Passenger safety and security
- Safety at unmanned level crossings
- Safety to avoid fire accidents

Measures to Avoid Collisions

To increase Efficiency and to enhance Safety in train operations, Advanced Signalling System with Panel/ Route Relay/Electronic Interlocking (PI/RRI/EI) along with Multi Aspect Colour Light Signals have been progressively provided at 5,317 stations i.e. about 85% of Broad Gauge stations of Indian Railways, replacing outdated Multi Cabin Mechanical Signalling System involving a large number of human interfaces.

- Modelling and validation of interlocking for railway signalling systems:- Object is to develop tool to improve the reliability & safety aspect of present EI systems. With this model, conversion and verification of safety rules for signalling system based on yard plan, control table and generic signalling circuits shall be possible.

- Development of Train Protection & Warning System (TPWS):- TPWS is a continuous supervision system that provides safety in train operations by dynamically monitoring the speed of the train against specified limits & eliminates risks arising due to cases of Signal Passing at Danger (SPAD).

  TPWS (ETCS Level-1) (European Train Control System) has been commissioned on 50 RKMs. suburban section of Southern Railway. Commercial trials of pilot project on 200 RKMs. of Northern/North Central Railway have been conducted with 35 locomotives on nominated trains. During 2014-15, TPWS system has also been introduced in commercial service on all the rakes on Dum Dum-Kavi Subash section of Kolkata Metro (25 RKMs).

  With the rolling out of Indian Railways' "zero-accident mission", several global players, including French firm Thales, have geared up to be part of the plan to provide latest technology for strengthening the safety of India's rail network. Indian Railways intends to implement Train Protection Warning System (TPWS) on a total of approximately 7,900 km of main lines across the country out of which 3,300 km has already been budgeted.

Currently, TPWS, a technology meant to prevent train accidents due to drivers' failure, is being implemented on 68-km long rail line near Chennai on a pilot basis by Thales, a major player in rail transport market which offers effective signalling and supervision to telecommunications for mainline rail and metro system. The pilot project is expected to be completed by the year-end.

- Development of Train Collision Avoidance System (TCAS):- TCAS has dual capability of preventing train accidents caused due to Signal Passing at Danger (SPAD) or non observance of speed restrictions by train drivers as well as preventing train collisions. Train Collision Avoidance System (TCAS) is meant to provide protection by preventing trains to pass signal at Danger (Red), excessive speed over turnouts / Speed restrictions and to avoid the situation in which more than one trains are on the same track to cause collision, in case operations are not able to control so.

- Train Management System (TMS) /Centralised Train Control (CTC):- TMS helps in real-time monitoring of trains in the control room. The arrival status of local trains is displayed on indicators installed on platforms in the form of a countdown (in minutes) to the train's arrival on the platform accompanied by automatic announcements on platforms.

  Train Management System (TMS) /Centralised Train Control (CTC) covers following two categories of functions:

I. Centralized operation of signalling systems for a large section encompassing multiple interlocked stations.

II. Centralized real time monitoring of train traffic for enabling efficient decision making for traffic control of large section.

- Development of Advanced Auxiliary warning system (AAWS):- It is a microprocessor based control system, which continuously monitors the speed, direction of travel, distance travelled, aspect of the signal passed and alertness of the motorman and thus increases the safety of railway system. It is a safety device preventing the unsafe situation due to the human failure, compels the motorman to obey the aspect of the signal and maintain the correct speed. If it is not well acknowledged with in time AWS decelerates the train and applies brake to stop train.

- Development of Capacity Optimization & Simulation Tool (COST):- The development comprises of design of basic software tool for computation of line capacity of any Indian Railway section taking into consideration various parameters like type of block working, block length, signal spacing, speed restrictions, and other parameters that would have an effect on line capacity. The tool would be used for examining the effect on line capacity of the technological improvements like Intermediate Block Signalling, introduction of new stations, doubling/tripling/quadrupling, etc.

- On Board Display of Signal Aspect (OBDSA):- OBDSA is intended to provide display of line side signal aspects inside Loc Pilot's Cab. It would be a portable device to be carried by Crew on duty. It shall be deployed in Absolute Block Section Territory and OBDSA equipped Locomotive shall be interoperable in TCAS (Train Collision Avoidance System) equipped section.

- Railways to test 'third eye' to check deaths, mishaps on tracks:- Indian Railways is getting a third eye to check death and destruction on its tracks. India will be the first country to use radar and laser-based terrain-imagining vision system called Tri-Netra in railways for monitoring obstructions on tracks to prevent mishaps. The device will also record all events on the tracks for post-event analysis. It is for the first time that infrared and laser technology is being used by any railways to prevent collision.

Passenger Security and Safety

Dynamic measures undertaken by Railway protection

force to come up to the expectations of the travelling public for a safer travel during year 2015-16:

- Making emergency reach out short code security helpline number 182 a dependable service
- Operation smile (II)
- Special drive to rescue missing/abandoned children
- Augmenting security through CCTV's at 202 sensitive Railway stations
- Special emphasis on safety of women passengers
- 10% of vacancies in Sub-Inspectors category reserved for women
- RPF escort enhanced from 1200 to 2400 trains daily
- Security apps on mobile phones of railway passengers, especially women to alert RPF
- Whistle Alert Scheme in ladies coaches of local passenger trains act as auxiliary tool for alerting RPF
- Child posters for safety awareness & operation smile ii reinforce commitment to prevent possible child trafficking or abuse on Railway premises.
- All the ladies special trains running Metropolitan cities are being escorted by lady RPF constable.
- Passenger awareness programmes are being launched by announcement through loudhailers / PA system as well as pasting of stickers providing the Security Help Line Numbers of RPF Security Control Rooms for reporting the untoward incidents of crime and sexual harassment so that immediate action can be taken against miscreants.
- Under the Nirbhaya fund scheme, installation of CCTVs in approximately 1000 railway stations proposed 50 stations has been taken up as pilot project.

Measures to Curb Accidents at Unmanned Level Crossings

Various measures taken by Indian Railways to prevent accidents at level crossings are as under:

- Containing the proliferation of Level Crossings (LCs) at source: - A policy decision has been taken not to permit any new LC either on existing line or any new line/gauge conversion to be commissioned henceforth. However, in exceptional cases, retention of unmanned LCs on new line or gauge conversion can be permitted with the approval of Railway Board.
- Progressively eliminate all unmanned Level Crossings

(i) Closure: Closing unmanned Level Crossings having nil/negligible Train Vehicle Unit (TVU).

(ii) Merger: Merger of unmanned Level Crossing gate to nearby manned or unmanned gates or subway or Road Under Bridge (RUB) or Road Over Bridge (ROB) by construction of diversion road.

(iii) Provision of Subways/RUBS: To improve safety of train operation and reduce inconvenience to road users, Level Crossings are being replaced by Road Over/Under Bridges/Subways (ROBs/ RUBs) in a phased manner based on the quantum of traffic.

(iv) Manning: The unmanned level crossings which cannot be eliminated by above means will be progressively manned based on rail-road traffic volume, visibility conditions.

Measures to Prevent Fire in Trains

- Use of Fire Retardant Furnishing Material - such as fire retardant curtains, partition panelling, roof ceiling, flooring, seat and berths along with cushioning material and seat covers, windows and UIC Vestibules etc.
- Introduction of Automatic Fire and Smoke Detection System - A pilot project for field trial with Automatic Fire and Smoke Detection system has been taken up in one rake of New Delhi-Bhubaneswar Rajdhani Express.
- Provision of Fire Extinguishers
- Inspection of Electrical & LPG Fittings in Pantry Cars

8.0 Recommendations

Government of India is focusing now to overcoming challenges to Reorganize, Restructure and Rejuvenate Indian Railways: 'Chalo, Milkar Kuch Naya Karen'.

This can be achieved by fulfilling above mentioned key initiatives, strategies and recommendations like:

1. Reserved accommodation on trains available on demand by increasing the number of coaches in the trains and eliminating the waiting list boarding tickets like as a pilot initiative in Rajdhani Express and Shatabdi Express trains.

2. Time tabled freight trains like 'Cargo Express' between Domestic Container Terminal (Okhla) and Bengaluru.

3. High end technology to improve safety record like 'Tri-Netra'

4. Semi high speed trains running along the golden quadrilateral like TALGO running at a speed of 180kmph in Delhi-Mumbai corridor.

5. Zero direct discharge of human waste: By making use of Bio Toilets in each and every route like India's First Green Railways Corridor – A 114 Km Stretch Rameswaram-Manamadurai track in Tamil Nadu with Zero Human Waste Discharge.

6. While IR continues with the Social Service Obligations, they can reduce the Revenue Purge by partially allocating the funds from Seventh Pay Commission.

In house Emergency Medical assistance and necessary medical facilities should be provided to the passengers in case of emergency while travelling in train.

9.0 Conclusion

As Delhi Metro is the backbone of Delhi NCR and Mumbai Local is the backbone of Mumbai, similarly Indian Railways is the backbone of the nation; it has played a significant role in India's development, which is good but not enough to list India in ranks of the developed economy. To achieve overall projected growth, Indian Railways need a sustainable & modern transportation infrastructure network and efficient operations which will have all the required constituents of an international level transportation system.

In this case review paper, we have touched on certain key initiatives and strategies by Indian Railways like Technology Development, Social Service Obligations, Green Initiatives, Non Fare Revenue, Investment in Indian Railways, Enhanced Safety which would help Indian Railways achieve growth and sustainability anticipated in the years to come.

To implement these strategies, Indian Railways will have to manufacture energy efficient rolling stocks, extract the sources of revenue generation by taking care of the needs of the common man, Conduct Research and Development activities in an organized manner, Upgrade the competency levels of the employed workforce by providing them with requisite training like as imparted by Indian Railway Institute of Civil Engineering (IRICEN) to adapt to the changing scenario and to generate higher Return on Investment (RoI) for the continuous inflow of Capital for the Infrastructure projects.

We hope this paper will help future Engineers and Professionals to understand the key steps taken by Indian Railways in a structured and organized manner to mark a new beginning of a "Sustainable Era".

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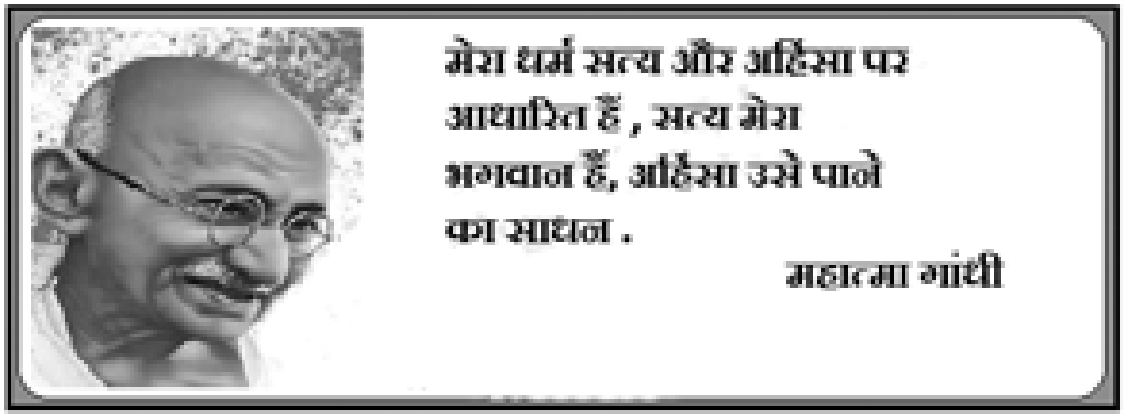
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INDIAN RAILWAY INSTITUTE OF CIVIL ENGINEERING – PUNE
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			OFFICE	RESIDENCE	OFFICE	RESIDENCE	
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4.	Sr. Prof. Bridge-2	RAMESH PINJANI	62412	62843	26113408	26130078	74200 41103
5.	Sr. Prof. Project	VIRENDRA KUMAR	62413	-----	26128680	-----	74200 41104
6.	Sr. Prof. Track -1	C. S. SHARMA	62415	62841	26111809	26069462	74200 41105
7.	Sr. Prof. Works	-----	622422	62852	26113279	26137339	74200 41106
8.	PS-1 to Director	GANESH S.	62430	62848	26123680	26136780	74200 41110
9.	Prof. Bridge	S. K. AGARWAL	62418	55953	26113137	20244073	74200 41111
10.	Prof. Track - 1	A. K. PATEL	62423	-----	26113452	20270890	74200 41112
11.	Prof. Track - 2	S. PAKHARE	62424	62850	26137021	26138629	74200 41113
12.	Prof. Track Machines	M. B. DEKATE	62411	62849	26113455	26124615	74200 41114
13.	Prof. Works	GAUTAM BIRHADE	62417	55987	26050645	26154164	74200 41115
14.	AP/F&A	D. G. JOSHI	62722	55045	-----	20240400	74200 41122
15.	Asso. Prof. Track-1	N. K. MISHRA	-----	55955	26122271	20244072	74200 41123
16.	Assist. Prof. /Track-1	J. M. PATEKARI	62721	62846	-----	26139561	74200 41128
17.	Assist. Prof. /Track-2	R. K. KATHAL	62751	-----	-----	20264123	74200 41129
18.	Assist. Prof. /Track-3	R.P. SINGH	62899	-----	26127817	20264393	74200 41130
19.	Assist. Prof. Works-1	N. R. KALE	62723	62845	-----	26132358	74200 41131
20.	SI/Bridge - 1	V. N. SOHONI	62825	55979	-----	-----	74200 41136
21.	SI/ Computer-1	A. A. NIZAMI	62620	-----	-----	-----	74200 41139
22.	SI/ Computer-2	M. D. JADHAV	62640	-----	-----	-----	74200 41140
23.	SI/Elect-1	R.S. KOPTIKAR	-----	-----	-----	-----	74200 41141
24.	SI/Mech - 1	M. VERGHESE	62751	-----	-----	-----	74200 41144
25.	SI/Mech - 2	R.A. SAYYAD	62716	-----	-----	-----	74200 41145
26.	SI/S&T- 1	N.K. MEHER	-----	-----	-----	-----	74200 41146
27.	SI/S&T- 2	R.K. SINGH	62640	51715	-----	-----	74200 41147
28.	SI/Track-1	PRAVIN KOTKAR	62726		-----	-----	74200 41148
29.	SI/Track-2	L. P SHRIVASTAV	62359	55977	-----	-----	74200 41149
30.	SI/Track -3	R. SHARMA	62101	-----	-----	-----	74200 41150
31.	SI/Track -5	S. BHEEL	62724	-----	-----	-----	74200 41152
32.	SI/Track-6	V.K. SHARMA	-----	-----	-----	-----	74200 41153
33.	SI/Track-7	P. K. KADIA	-----	-----	-----	-----	74200 41154
34.	SI/Track-8	J. PRASAD	-----	-----	-----	-----	74200 41155
35.	SI/Track-9	R. CHAUDHARY	62101	-----	-----	-----	74200 41156
36.	SI/Works-1	A. V. DASARE	62823	-----	-----	-----	74200 41161
37.	SI/Works -2	S. N. POPHALE	62725	-----	-----	-----	74200 41162
38.	SI/Works -3	V. SASHIKUMAR	62822	-----	-----	-----	74200 41163
39.	SI/Works -4	G.M. AGATKAR	62725	-----	-----	-----	74200 41164

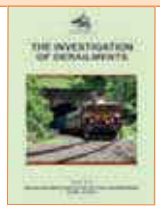
IRICEN's CALENDAR OF COURSES 2016 (Rev. 14)					
Course No.	**From**	**To**	**Name of the course**	**Duration**	**Eligible Group**
PROBATIONARY COURSES					
16007	22-08-2016	21-10-2016	IRSE Ph.II (Gr.P)	9 weeks	IRSE (P) 2014 Exam.
16008	17-10-2016	21-10-2016	IRSE Posting Exam	1 week	IRSE (P) 2013 Exam.
16009	07-11-2016	06-01-2017	IRSE Ph.II (Gr.Q)	9 weeks	IRSE (P) 2014 Exam.
16010	01-08-2016	05-08-2016	IRSE Joining	1 week	IRSE (P) 2015 Exam
16011	15-11-2016	29-12-2016	IRSE Ph. I (Gr. P)	7 Weeks	IRSE (P) 2015 Exam
16012	15-11-2016	29-12-2016	IRSE Ph. I (Gr. Q)	7 Weeks	IRSE (P) 2015 Exam
17001	09-01-2017	20-01-2017	IRSE M.Tech, Sem-II	2 weeks	IRSE 2014 Exam.
17002	23-01-2017	03-02-2017	IRSE M.Tech, Sem-I	2 weeks	IRSE 2015 Exam.
INTEGRATED COURSES					
16103	06-09-2016	01-12-2016	Integrated	12 weeks	Gr.B officers
16104	02-01-2017	23-03-2017	Integrated	12 weeks	Gr.B officers
SR. PROFESSIONAL COURSES					
16204	02-01-2017	02-02-2017	Sr.Prof(Br &General)	5 weeks	JAG/SS officers with minimum 6 years of Service in Gr.'A'
PCE/HAG/SAG/SEMINARS/WORKSHOPS/MEETINGS					
16307	06-10-2016	07-10-2016	CBEs' Seminar	2 days	CBEs
16308	07-11-2016	08-11-2016	IRICEN Day Seminar	2 days	IRSE 90' Batch
16309	01-12-2016	02-12-2016	PCEs' Seminar	2 days	PCEs
SPECIAL COURSES (TRACK/BRIDGES/WORKS)					
16425	12-12-2016	30-12-2016	Bridge Design Asstt (B-1)	3 Weeks	ABEs/DESIGN ASST
16427	05-12-2016	09-12-2016	Modern Surveying (C-1)	1 week	JS/SS/JAG of Con-struction Organization

Course No.	From	To	Name of the course	Duration	Eligible Group
16428	03-10-2016	07-10-2016	Arbitration for Arbitator (W-3)	1 week	JAG/SAG
16429	10-10-2016	21-10-2016	Mechanized Track Maint., Renewal,Rail Grinding, USFD & Track Monitoring, (T-1)	2 weeks	JS/SS/JAG
16430	17-10-2016	25-10-2016	Steel Structure (B-3)	9 Days	JS/SS/JAG
16431	15-11-2016	18-11-2016	Points & Crossings and Yards (T-3)	1 week	JS/SS/JAG
16432	15-11-2016	25-11-2016	Contract, Arbitration and Project Management (W-2)	2 weeks	SS/JAG
16433	21-11-2016	25-11-2016	TMS (T-5)	1 week	JS/SS/JAG
16434	05-12-2016	09-12-2016	Arbitration for Arbitator (W-3)	1week	JAG/SAG
16435	05-12-2016	09-12-2016	Special course for NTPC Engineers (NTPC)	1 week	NTPC Engineers
AWARENESS COURSES					
16711	02-01-2017	06-01-2017	Awareness course	1 week	IRSSE Prob. 2014
16712	26-12-2016	30-12-2016	Awareness course	1 week	IRSME Prob. 2014



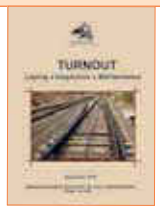
IRICEN SSTW(SR.SUPERVISORS TRAINING WING) COURSES (Rev. 13)					
Course No.	**From**	**To**	**Name of the course**	**Duration**	**Eligible Group**
16879	10-10-2016	14-10-2016	Track Monitoring (TMo)	1 week	SSEs/P.Way
16880	28-11-2016	02-12-2016	Land Management (LM)	1 week	SSEs/Works
16881	03-10-2016	07-10-2016	Building Construction (BC)	1 week	SSEs/Works
16882	28-11-2016	02-12-2016	Contract Management (CM)	1 week	SSEs
16883	10-10-2016	14-10-2016	Concrete Technology (CNCT)	1 week	SSE/Works of Const. Organization
16884	21-11-2016	24-11-2016	Formation (FMN)	1 week	SSE/Works of Const. Organization
16885	17-10-2016	21-10-2016	Insp.& Maint. of Bridges (BR)	1 week	SSEs/Br
16886	15-11-2016	25-11-2016	Rail Wheel Interaction & derailments (RWI)	2 weeks	SSEs & Instructor of ZRTI/DTC/P.Way
16887	15-11-2016	18-11-2016	Long Welded Rail (LWR)	1 week	SSEs/P.Way
16888	15-11-2016	24-11-2016	USFD,Welding & Rail Grinding (USFD)	2 weeks	SSEs/P.Way
16889	10-10-2016	20-10-2016	Mech.Track Maintenance & Renewals (TM)	2 weeks	SSEs/P.Way
16890	28-11-2016	07-12-2016	Points, Xings & curves (PXC)	10 Days	SSEs/P.Way
16891	05-12-2016	08-12-2016	TMS	1 week	SSEs
16892	05-12-2016	09-12-2016	Long Welded Rail (LWR)	1 week	SSEs/P.Way
16893	12-12-2016	16-12-2016	Track Monitoring (TMo)	1 week	SSEs/P.Way
16894	12-12-2016	20-12-2016	Fabrication of Steel Bridges (FSB)	9 Days	SSEs/Bridges
16895	12-12-2016	23-12-2016	Rail Wheel Interaction & derailments (RWI)	2 weeks	SSEs & Instructor of ZRTI/DTC/P.Way
16896	19-12-2016	30-12-2016	Mech.Track Maintenance & Renewals (TM)	2 weeks	SSEs/P.Way
16897	19-12-2016	29-12-2016	USFD,Welding & Rail Grinding (USFD)	2 weeks	SSEs/P.Way
16898	26-12-2016	30-12-2016	Formation (FMN)	1 week	SSE/Works of Const. Organization
16902	3-10-2016	28-10-2016	Special Course on Professional Training to DFCCIL	4 weeks	Asst. Managers / Executives of DFCCIL

बिक्री हेतु उपलब्ध इरिसेन तकनीकी पुस्तकें (IRICEN TECHNICAL BOOKS AVAILABLE FOR SALE)



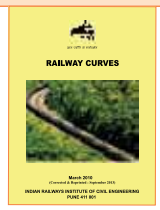
The Investigation of Derailments

₹ 130/-



Turnout

₹ 80/-



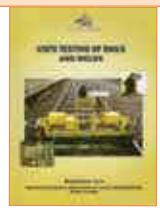
RAILWAYS CURVES

₹ 80/-



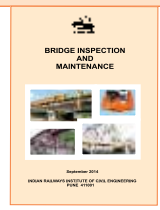
Track Monitoring

₹ 70/-



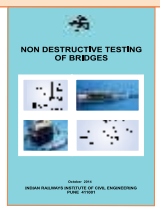
USFD Testing of Rails and Welds

₹ 90/-



Bridge Inspection & Maintenance

₹ 80/-



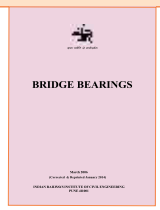
Non Destructive Testing of Bridges

₹ 80/-



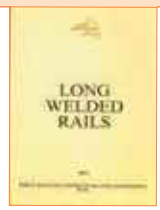
Concrete Technology

₹ 60/-



Bridge Bearings

₹ 60/-



Long Welded Rails

₹ 50/-



Layout Calculations

₹ 120/-



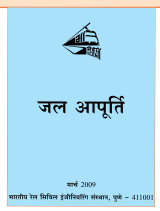
Welding Techniques

₹ 50/-



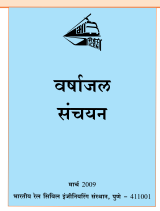
Alumino-Thermic Welding

₹ 10/-



जल आपूर्ति

₹ 20/-



वर्षाजल संचयन

₹ 20/-



Handbook of Material Testing

₹ 50/-



River Training & Protection works for Railway Bridges

₹ 50/-



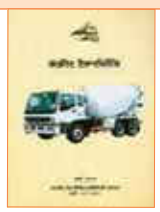
Rail Steel

₹ 20/-



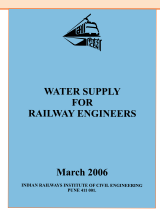
Inspection, Assessment, Repairs & Retrofitting Of Masonry Arch Bridges

₹ 50/-



कंक्रीट टैक्नॉलॉजि

₹ 50/-



Water Supply For Railway Engineers

₹ 25/-



Quality Control in Mechanised Track Relaying

₹ 30/-



मशीन द्वारा ट्रैक नवीनीकरण में गुणवत्ता नियंत्रण

₹ 30/-



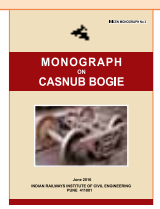
Construction and Maintenance of High Speed Railway

₹170/-



Compendium of Instructions related to inspections and Competency Certificates in Engineering Department

₹ 60/-



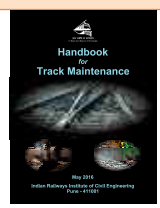
Monograph on Casnub Bogie

₹ 60/-



Rain Water Harvesting

₹ 30/-



Handbook for Track Maintenance

₹ 500/-



Monograph on ICF All - Coil Coaches

₹ 60/-



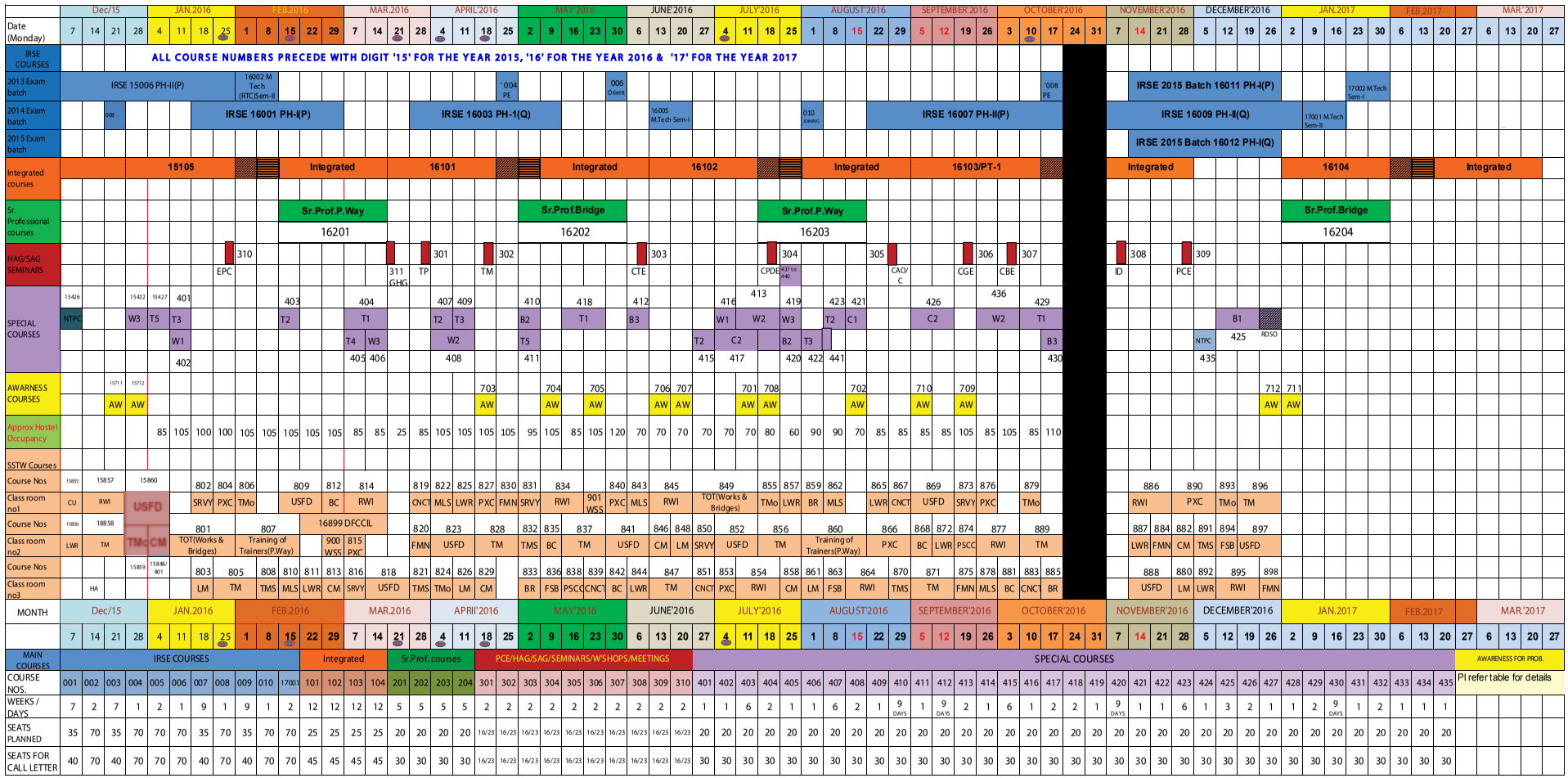
Under Water Inspection of Bridges

₹ 80/-

Copies of IRICEN books can be obtained from the librarian of IRICEN against cash payment. Demand Drafts drawn in favour of "Sr. Divisional Finance Manager, Central Railway, Pune " are also accepted. If these are requested to be mailed, add suitable postal charges.

INDIAN RAILWAYS INSTITUTE OF CIVIL ENGINEERING, PUNE - 411001

CALENDER OF COURSES 2016 CHART (Rev.14)



SPL COURSES	COURSE NAME	No.	No.	No.	No.	TOTAL	WEEKS / DAYS
T-1	MECHANIZED TRACK MAINT. & RENEWAL,RAIL GRINDING, USFD & TRACK MONITORING,	404	418	429		3	2
T-2	RAIL WHEEL INTERACTION& DERAILMENT	403	407	415	423	4	6 DAYS
T-3	POINTS & CROSSINGS AND YARDS	401	409	422	431	4	1
T-4	RAILWAY FORMATION & GEO TECH INV	405				1	1
T-5	TMS	411	424	433		3	1
B-1	BRIDGE DESIGN ASSISTANT	425				1	3
B-2	PSC	410	420			2	9 DAYS
B-3	STEEL STRUCTURE	412	430			2	9 DAYS
W-1	LAND MANAGEMENT	402	416			2	1
W-2	CONTRACT & ARBITRATION AND PROJECT MGMT	408	413	432		3	2
W-3	ARBITRATION FOR ARBITRATOR	406	419	428	434	4	1
C-1	MODERN SURVEYING	421	427			2	1
C-2	CONSTRUCTION ENGINEERS	417	426			2	2
NTPC	SPECIAL COURSE FOR NTPC ENGINEERS	414	435			2	1
						35	

AWARENESS COURSES FOR PROBATIONERS OF OTHER DEPTT					
AWARENESS COURSES	Course No	SEATS PLANNED	Course No	SEATS PLANNED	WEEK
ACCOUNTS					1 WEEK
ELECTRICAL ENGG					1 WEEK
MECHANICAL ENGG					1 WEEK
SIGNAL ENGG	16701				1 WEEK
STORES					1 WEEK
PERSONEL					1 WEEK
TRAFFIC	16706	32	16707	31	1 WEEK

SN	Course code	SSTW COURSES	No.	No.	No.	No.	No.	No.	No.	No.	No.	Total	Wks	Total wks
1	TOT(P.WAY	Training of Trainers (P.Way)	807	860								2	3	6
2	TOT(B&W)	Training of Trainers (Works & Bridges)	801	849								2	3	6
3	RW	Rail Wheel Interaction & derailments	814	834	845	854	864	877	886	895		8	2	16
4	TMS	TMS	808	821	832	870	891					5	1	5
5	PXC	Points, Xings & Curves	804	815	827	840	853	866	876	890		8	1	8
6	USFD	USFD, Welding & Rail Grinding	809	818	823	841	852	869	888	897		8	2	16
7	LM	Land Management	803	826	848	861	880					5	1	5
8	MLS	Mangement of Store & Land	810	822	843	862	878					5	1	5
9	TMo	Track Monitoring	806	824	855	879	893					5	1	5
10	BR	Inspection & Maintenance of Bridge	833	859	885							3	1	3
11	LWR	Long Welded Rails	811	825	844	857	865	872	887	892		8	1	8
12	TM	Mechanized Track Maint. & Renewals	805	828	837	847	856	871	889	896		8	2	16
13	CM	Contract Management	813	829	846	858	882					5	1	5
14	FSB	Fabrication of Steel Bridges	836	863	894							3	9 Days	3
15	PSCC	PSC Construction	817	838	874							3	9 Days	3
16	CNCT	Concrete Tech	819	839	851	867	883					5	1	5
17	FMN	Formation	820	830	875	884	898					5	1	5
18	BC	Building Construction	812	835	842	868	881					5	1	5
19	SRVY	Survey	802	816	831	850	873					5	1	5
20	WS	Water Supply and Sewerage including	900	901								2	1	2
21	DFCCIL		899									1	1	4
												101		136

indicates Holiday in that week

Indicates Monday being holiday

1 Week at RDSO for BDA course

To IRTMTC / RDSO

BREAK FOR PROJECT