Iconic Rail Projects
Chenab Bridge - Kashmir rail link

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Ref: HA 434
If the voice in your dreams is not yours...

The IR committees are now history, consigned to the dusty archives.

It is time to discern threads in the directions IR has taken as political dispensations are set to alter, even if in small degrees after the Indian general elections in a few months. These five years have seen three railway ministers, two Chairmen of the Board, many Board Members with short stints, and quite a few landmarks. Picking three trends that define the period is possible.

The earliest phase was when multiple committees were expected to provide blueprints for big changes, that would alter IR working. Many of the thoughts expressed by these groups were thrown about as cure-alls till the reality set in and normal functioning resumed. None of these committees is even mentioned any longer.

The next phase was, if one may call it so, the 'tweet phase' when acts of good service were often portrayed as paths to transformation. IR's Transformation Directorate symbolised that approach, and often acronyms duplicated for policy changes. It had become difficult to keep pace with the flood of these acronyms or the policies these included.

The last phase has been more practical, focused on operational improvements, but often clouded in catchy words rather than big changes on the ground. Absorption of the budget into the general budget has helped to hide IR performance as never before. The kindled hopes that trains would run more to time and changes in work culture would seep in leading to operational improvements have not brightened, maybe not receded either.

It is difficult to associate these years with actions that will be counted as transformational in future years. In short, these have been more of the same years, short on improvements in public perceptions and on transparency. But hopes remain and that is a big YES to these years.

Every milestone is just a number, but also a time for reflection. As RAIL BUSINESS enters the 10th year of publication, the start in 2009 looked hazy, and the path has been bumpy. It is time to be grateful for what has been, but also to assess what could have been. The years crossed also reveal the many roads that we should have taken but did not.

The potential for scaling up the reach and resources of RAIL BUSINESS has always been there, but we have hesitated, may be typical of a restricted ambition. Even as we now have provided a medium for railway news, information, and opinions, it is clear that greater involvement could have been achieved.

Sincere gratitude, a big salaam, to all those who have supported the ideas that RAIL BUSINESS brings to the Indian rail sector.

(Vijay Raina)
Editor

...the dream is not yours.

From a TV advertisement, featuring Sachin Tendulkar.
The silence is eerie and perfect as if preserving itself against the future when the hum and clang of trains that will run few years into the future between tunnels T5 and T6, over the bridge 44 that will be on many picture books and engineering annals. As it is, the Kashmir end approach of bridge 44 lies may be 100 m away from where I am now, before it disappears into one of the long rail tunnels that define the Katra - Banihal line, a part of the much hope for Jammu-Srinagar rail link. The route has just a few km in the open that is off a tunnel or a bridge (that is 40% on the Udhampur-Katra section), and will be much of a world unusual, if not a record. The 27 tunnels and the 37 bridges that will form the line have been necessitated by the sectional topography of its geographical consist and the deep gorges that lie around the course of the Chenab river, as it winds its way from the mountainous stretch, across the Salal hydroelectric dam and powers station and to the plains before passing on to Pakistan.

Bridge 39 on the gorge
Bridge 44 on the Chenab will not be the only wow construction feature of the line. As one leaves Reasi town, the Eastward hills reveal a scar and a tunnel face. Shubhendra Chanda, Dy Chief Engineer, Konkan Railway Co (KRCL) points out the scar is the work site for Bridge 39, that he counts as the third toughest bridge construction, after the Chenab 44 and the just started bridge across the Ajni rivulet. The piers are built in hollow BOX construction that taper as it rises, an unusual choice and unlike the 'competitive' Imphal location that uses hollow cylindrical construction.

Vinod Kumar has been associated with the Srinagar project now for a decade, having been associated with the 12 km long Banihal tunnel earlier. He expects this ₹350 Cr site will be completed by end 2019, in time for project commissioning.

A friendly competition is right now on amongst rail bridge engineers in India for completion of the tallest bridge pier, measuring these not in meters but in terms of the Qutab Minar (73 m) or the Eiffel Tower, the intervening bridge deck also being the station platform serving Reasi district town location, a few hundred meters down the hill. The approach road built already to serve the construction sites may well become the 'station road' for the future. Viewed from the ground, the bridge piers seem to be heeded for the sky, as near 84 m of the 103 meters have been completed. Chanda explains that modern construction methods depend on slip form casing where the shuttering is inched continuously by the installed hydraulic jacks. The construction teams work 24×7, avoiding cold shuts in the concrete pour. In effect, the entire column is a single casting, ensuring its soundness.

On site quality
Recent problems with a column in Bangalore Metro have impacted operations severely and point to what any winking on quality control procedures can cause even in less tougher projects. An onsite accredited laboratory samples and controls each concrete batching lot.

The KRCL team responsibility for ensuring concrete quality, a key to the project health, lies with Savitri, an engineer who has come all the way from Cuddapa in Andhra. The kaleidoscope of India is shining in this remote location where these young Indians are building these 'temples of the future'. In our short stay we met with hard working young men from Ladakh, Jammu, Andhra. Karnataka, Assam, the Northern states; that is
what this project is all about: building the nation.

And that is why the impregnable Himalayas have to bend and bow a little as skilled workers led by spirited experts from India and abroad are scripting a new chapter in the history of engineering marvels of modern India ... the Story of USBRL (Kashmir link)

The complexity of the projects can even defy imagination, making one wonder at the naivete of the engineers and advisers who conducted the first route survey in 1902, even including an electrified line from Jammu to Srinagar. One wonders at the assertion that construction could not be started due to lack of financial resources and sanction of the government. Engineers now talk freely of how ‘striations of young fold

mountains’ are a big challenge, but that would have not been recognised then. Looking back, history should be grateful for that wisdom.

A Himalayan puzzle

The first step to link J&K with the ‘plains’ was the 44 km extension of a Jalandhar branch to connect Pathankot in 1952, and the state border was nearby. The Jammu extension followed in 1972, the Udhampur link opened in 2005 and then to Katra in 2016. While the Kashmirstay line stood in 2009, the Banihal tunnel T 80 commissioning in 2013 saw yet another piece in the puzzle completed. And now, the puzzle is making sense as the large pieces in the form of long tunnels and forcing bridges fall into place. As one drives along the highway connecting Reasi, a mental game of trying to work out the rail alignment through the steep hills on the side is engaging. One wonders which hill is hiding a long burrow hole that will become a rail track. That is a tough exercise as many of the tunnels are anything but straight, in some cases even taking a near U turn inside the hill. That was so as we drove more than 3 km inside the T5 tunnel, where two teams are working from the ends of the tunnel and hope to connect in a few months. One end of this tunnel will be the Bakral side that will lead to the Chenab Bridge B-44, the lead of this story.

Project engineers mention their time lines, often optimistic, with a current commitment of the line commissioning in 2022. That looks too challenging, but the puzzle now seems nearing finish. Some pieces still intractable cover the finishing aspects like track work in these difficult areas, power supply and the signalling works. Contract work for these aspects has not yet started; in any case, the physical work can commence only after the tunnels and bridges near finish.

The entire section will be built in ballastless slab and perhaps the type of slab and its construction methodology is yet to be made certain. A linked issue will be the types of sleepers to be deployed, and standard PSC and composite H beam constructions present two options, but the table is still covered with multiple options that needed to be cleared away.

A ruling gradient nearing 1:80 and the winding terrain present issues for deciding optimal train lengths for the section. Long trains on the section presents serious worst-case safety issues, of accessibility and rescue even though a large road work necessary for construction has been connected to all the puzzle pieces. IR has built the Kashmir valley line with full length 700 m long loops, expecting that such long trains will be on for the valley traffic. Of course, only 8 coach DEMU passenger trains are working and freight trains of any length may work only after say 2025. The long years in Badgam and Srinagar on the valley line look discordant.

With station spaces difficult to come by, and one station like Reasi being planned on a bridge, the need for these 700 m long crossing loops needs a fresh look for systemic design. Shorter loops are perhaps called for, with an immediate review.

The project has been split up for execution by IRCON and KRCL, broadly IRCON taking over the line beyond the Chenab bridge till Banihal and KRCL connecting Katra (except a 5 km portion directly by Northern Railway) and Dugga, the station beyond the Chenab bridge. Tunnel T13 was transferred to KRCL.

Disregard the do nots

The walls are lined with newspaper cuttings, seemingly of bridges and a closer look revealing these to be of the Chenab rail bridge. For Amit Kumar Gupta, Dy. Chief Engineer for the project, it is easy to recount the many salient features of this bridge that is already becoming an iconic site for engineers and rail fans, as the contours of the main steel arch take shape. One can take a stroll across the Srinagar end deck, resplendent in the morning sunshine but a look downwards can be revealing; the muddy Chenab waters 400 m below seem to be still and quiet. Bridge 44 will gather a lot of attention when it is tracked a few years from now.
The project reads like a list of things that conventional engineering listed as do not do's:

- Do not build tunnels in areas with 'striations in young fold mountain'
- Do not provide curves on bridges
- Do not have complex routes within a tunnel
- Do not leave embankment splices at more than 60 degrees.
- And a lot more.

Singh lists the many firsts for the bridge: the longest cable crane that can handle up to 37 t weight steel fabrication as it is moved from the aligned workshops into position on the archway and assembled. The bridge deck will support a double rail line, that will merge into the adjoining tunnels T5 and T6, with Salal A and B stations flanking before entering the tunnels. About 10,000 t of fabricated steel structures have been assembled giving the initial shape to the steel arch, even as most of the balance structure is awaiting cable crane handling and lowering into position.

The exact processes were later detailed from the bridge deck by Mallick, Dy Chief Engineer, KRCL and Pankaj Kumar, Exec. Engineer, Northern Railway who are responsible for site work and co-ordination.

Singh looks downcast as he lets know that this assembly and fabrication process has come to a stall since Sep 2018 due to a serious disagreement between KRCL and the prime bridge contractor CBUP, a for-project SPV formed by AFCCONS, VSL and ULTRA. The dispute is on interpretation of what is included in the lump sum contract and variations forced by the nature of the project. The design aspects and instrumentation required may also be a part of the differing perceptions on project content. We learn that over the project cost of ₹1270 Cr, arbitration, and the ensuing claims approximate ₹1350 Cr.

IR has awarded this project on nomination basis to KRCL who in turn have contracted the AFCCONS led JV. KRCL’s Jammu project team is led by R K Hegde, Chief Engineer, a Konkan ‘project veteran’ who has been associated with earlier KRCL projects. Hegde hopes that the bridge work will be completed in 2019, with the ongoing dispute resolution expected in coming months. Two key tunnels, T1 and T13, can be completed in a few months, as just about 300 m each is left over. Work on the 9.3 km T13, transferred to KRCL recently, started in Jan. For Hegde the tough bridge projects are on the Chenab, the Ajnai and the Reasi linked B39.

Hegde looks at his early years on the projects, listing that the priority was to create a network of road accesses which have been completed, except for an 8 km stretch to the T14 site. Each one is a technological and project management challenge unmatched in rail projects elsewhere.

It is very unusual for a rail project to be 87 % underground (in tunnels) much more than even modern metros like Delhi Metro. The 27 tunnels on the stretch range up to 12.75 km and execution is impacted as the alignment passes through the rugged terrain, three major geological thrust zones namely Reasi, Murree and one major Sangalgal fault. The steep slopes made the road construction very difficult.

Due to tectonic movements and thrusting especially hard rocks are more affected and become closely jointed. Water percolation into the ground during excavation, falling of loose rock can be expected. When thick shear zones comprising of crushed rock are encountered, cavities and chimney formation can be formed. When charged with water, crushed material starts flowing resulting in blockage of tunnel face. Squeezing and swelling problems are faced due to the presence of thrust faults in clayey rocks. Due to the presence of thick overburden/slide material along the tunnel portals, excavation of the tunnels becomes difficult.

Considering various available construction methods, the project teams have opted for the New Austrian Tunnel Boring ( NATB ) techniques which Hegde defines as ‘tunneling as you go’. NATB recognises that the terrain will vary sometimes indeterminably, and the
A 2.78-degree curve leads the completed bridge decks, viewed from the Kailu Village end (Kashmir direction). Train crossing will be possible at the two ends on the bridge, named Sali B and Sali A Stations.

The best option is to bore, assess the method required to meet the strata encountered, address the issues, and proceed. Hegde’s team of about 240 persons is an adept and professional resource. Thus far about ₹10,000 Cr value has been added, with deliveries in last two years approximating a satisfying ₹1000 Cr each. Recent progress has been dampened by the ongoing dispute and work stoppage but Hegde hopes that all his sites will be ready for track linking and related works in 2019. The worksite at the Ajni bridge may spill over.

The connecting roads are now in good motorable shape, providing material access. In many cases prefabricated girders, like the 8 m long sections, will be transported for offsite locations for the bridge installations, by itself a tough task for the project planners. Just 8 km roadway to connect the T14 tunnel is yet to be executed.

Tunnel issues
The tunnel digging process has also been transformed, from the drill and blast methods used till 2010 and the predominant use of the New Austrian Tunnel Boring method deployed now for most sites. As we went into Tunnel T5, the drilled portion had been supported by a steel lattice, that would be concreted before further excavation. The role of the experienced geologist in determining the work and progress schedule is crucial. Site engineers have now gained enough faith and experience in the NATB that is now deployed for all locations, including the escape tunnels.

Hedge and his team also informed that the first project plans did not include separate escape tunnels, instead providing an escape path in the same bore, just elongated for the purpose. Safety concerns in the worst case forced change in this plan and now all tunnels longer than 3 km are provided with man and vehicle sized escape tunnels. Air ventilation and illumination are other key safety concerns that have been addressed in the execution plans.

Acupuncture for the hill slopes
The sharp hill slopes, mostly in soil and soft rock, may be as steep as 60° and stabilization to prevent slides is a constant feature. This is visible easily as one views the foundations erected for the Chenab bridge. The earth work involved is humongous, as Mallick lays out that his teams have excavated nearly 8 lakhs c.m. soil for the foundations and the related structures. As normal bank slopes are not feasible in such sites, the soil is reinforced by rock bolts, cable anchors, and specially ordered Drywagd bolts, procured in 13 m lengths from the specialty German manufacturer. These can be combined to 30 m lengths for installation like the Chenab bridge structures.

From a distance these look like acupuncture pins, and they do serve to relieve the construction pains in these isolated places.

The flow in the Chenab is a pointer to its erosive capabilities as the water colour changed overnight to very muddy after a few hours of rain.

The deck work on the Kashmir side is now awaiting track laying. One more unconventional aspect is that these girders are on a continuous curve (2.74°) and the specially designed girders have been weldied after the deck pushing process into one continuous structure. The tracks on the bridge will be continuously welded, with provision of special expansion joints at the two approach ends. Mallick points out that these SEJ will be just above the S 10 and S 70 piers. Self-confidence should be a key tribute for project leaders at such unusual sites. Such construction seems to be a tough mix of art and science, where one can never be sure where the science ends and the art starts. And many superstitions begin and end at these projects sites. Mallick is one who has overcome his superstitions as he points that he had never seen such tall hills before he was posted to this site. His first week was laid out by his in-charge for a simple job: ‘just go around the area and get familiar with the hills’. Now the routes and the slopes are easily remembered as he tells the SUV driver to go to number 50 etc and the instructions sort like codes that a visitor cannot relate to. Each location has its unique views, like Mallick says for viewing this aspect, let us go to 70. We can only nod, without really understanding. At one such location, the support column for the cables that will be used to support the arch structure till its keystone completion is visible, as Mallick points out that this complex stayed for the heavy arch member is needed only for the arch construction stage and will be dismantled on completion.

The fear of the 13th has also been conquered, as Mallick lists that during his time at the bridge site, he started the excavation for the arch foundations on 13th Oct 2014 and the first deck pushing from the S80 workshop was also started on the 13th May 2014. These dates happened, and he is now guided by the pace of work and suitability rather than other considerations.

A bridge over the Anji Khad
The Katra-Barial bridge link will upset many established railway ‘norms’ of avoiding cable-stayed bridges as these cannot provide the needed low deck deflection, avoid bridges on curves, no platforms on bridges and many more. The fact that the Anji Khad bridge design has been decided upon last and may also be the last to be completed on the route points to its uniqueness. The first cable-stayed bridge to be constructed on IR, this will be joining tunnel T 2 on Katra side and tunnel T 3 on Reasi side over Anji Khad, a tributary of the Chenab. BK Sharma, Dy Chief Engineer co-ordinating the project site explained that the cable-stayed bridge
design by Italferr, an Italian consultant was chosen because it was the most suitable, or perhaps the only feasible, considering the typical site conditions. This bridge requires a smaller foundation on Katra side and all major activities are concentrated on the more accessible Reasi side. A wind-tunnel test by an international firm RWI and input data derived were used for designing for wind load, considering the bridge large span and height over the gorge. Site specific earthquake parameter studies were carried out by Department of Earthquake Engineering, Indian Institute of Technology, Roorkee, to define the seismo-tectonic framework for the region.

This is the young fold mountain taking shape. The lateral pressure from both spurs is forcing the land up. Ten lakh years later, you will have a new hill. Amit Kumar, Dy Chief Engineer, NR, commenting on the landslip at the site.

The structure mainly includes the main bridge of 473 m (290 m + 80 m + 75 m + 28 m), the ancillary viaduct 120 m and the 64.25 m central embankment (between main bridge and the ancillary viaduct), with its main span of 290 m and height 196 m above bed level. The single pylon of 193 m height will support 96 cables. Integrated monitoring by sensors installed at specified locations will record critical parameters on a real-time basis. After construction, it will be 195 m above the river.

Considering ease of construction and typical site conditions, bridge was divided into 3 parts:

- A 120 m long approach viaduct (called "ancillary") on Reasi side;
- A main bridge, crossing the deep valley;
- A central embankment located between the main bridge and an approach (ancillary) viaduct

The embankment shall be wider than the bridge deck to have room for auxiliary equipment and assembly workshop for deck components during construction phase.

An asymmetric scheme of the bridge was compulsory. Different solutions were compared and finally a cable stayed bridge, with only one tower placed on Reasi side, in a position where the disturbance to the existing slope is reduced, has been adopted. In order to limit the excavations, the foundation of the tower shall be based on a well, ensuring to reach the sound strata of the rock without disturbing the slope.

**Bridge instrumentation**

The Anji suspended bridge will come with its own instrumentation, a part of the approved design. IR will need to decide on means and methods for major bridges like the Chenab 44.

Main Bridge shall have two steel trusses of constant height, connected by transverse girders that support a concrete slab. The choice of a composite bridge section (steel and concrete) is considered convenient: the deck of the bridge in reinforced concrete assures a high resistance to the environmental actions (wind, rain etc.), thereby reducing maintenance interventions; the steel trusses guarantee light dead load combined with a high level of resistance. Besides, the global section of elements of deck is considered a box, so it has a very good torsional stiffness.

**Construction method**

The steel trusses, prepared in a factory located far from the site and subdivided in ten m long elements, shall be transported to the site workshop on the central embankment. Here the deck shall be prepared by bolting the transverse beams and horizontal stiffening to form segments that shall be pushed (pulled) into the final position without stays. The sequential construction will go on by cantilevering using 10 m long assembled segments and suspending the same with the stays to form deck girders. The concrete slab shall be cast in situ in three phases to complete the composite deck construction.
A tough route choice proven right

Several surveys for a rail link to Kashmir Valley had been conducted but not much headway could be made on account of the difficult terrain and the high cost involved. The GoI decided in 1994 to start construction of this line and instructions were issued to Northern Railway (NR) to take up the work, with construction in two phases: first Udhampur to Qazigund and later to Baramulla (in the Kashmir Valley).

For NR the first job was to get the final location survey of the line; they unsuccessfully approached various agencies including RITES but the work was avoided mainly on account of terrorist activities in the area. BS Agarwal, then Chief Admin Officer on NR wanted my consulting company to take over the work.

A progressive move

Some years earlier I had attended a workshop on the contributions that Remote Sensing Agencies (RSA) can make in modern projects. Increased use of computers in refining railway alignments by Digital Terrain Modelling was also discussed. I was quite convinced of finding a workable solution by applying remote sensing technology and the task was to find an expert who could deliver.

Navin Chandra had joined the Survey of India and worked to a Major’s rank and later mastered Remote Sensing Technology (RST) from a Netherland University. Later he set up the Hyderabad Map Set Private Ltd that carried out such surveys but to his disappointment, he could not secure many contracts for his expertise. He accepted to work on my assignment for RST application for the Final Location Survey of the new rail link. He felt that with the data available with the RSA’s in public domain it would be possible to mark out the final location. In this work he would need active support from a railway survey expert that I would be able to provide. We were ready to prepare a bid for the NR.

Building my team

As District Engineer, Bano (on the Jammu line) I had a good exposure to the methodology adopted in carving out new alignments, observing limitations imposed by various parameters. I was able to rope in my ex-colleague Gopalan who had a much longer experience in surveys, including the final location survey of Kathua-Jammu rail link.

Agarwal, CAO NR must have explored other options and was happy that we could find a solution and asked me to submit a formal offer. Our Method Statement described the steps:

- An extensive study with topographical sheets and satellite imageries; mark out possible corridors compliant with specified parameters.
- Evaluate each corridor, zeroing down on the optimal one
- Refine the alignment with latest aerial photographs available and possibility of dedicated aerial runs.
- Carry out digital terrain modelling to improve the alignment of the selected corridor.
- Mark out the best possible location of the stations, river, and road crossings etc.
- Work out the quantities and the cost etc.

The last preliminary survey by RITES had recommended a ruling gradient of 1 in 40, and the sharpest curve of 6 degrees. That alignment required a number of catch sidings, almost impossible to construct in such a hilly area.

With the problems that KK line (a dedicated freight line connecting Vizag for iron ore export) was facing with its sharp curves and steep gradients, I was reluctant to cut another problematic alignment. E Sreedharan, now better famed as the Indian Metro Man, also agreed for construction parameters, possibly with grade limited to 1 in 100 and curves less than 3 degrees.

The only foot forward

Our offer to NR was a single bid which NR could not accept that. The IR Board was convinced of the adoption of the new technology and, after multiple considerations, decided to accept our offer. It was very important to settle the construction parameters that we should follow. Naveen Chandra, looking for an alignment with the relaxed parameters, proposed an alignment via Katra instead of going toward Patnitop, the road route, that had been indicated in the preliminary survey. With this detour, it was possible to limit the grade to 1 in 100, and the curves to 2.75 degree.

Navleen Chandra and Gopalan formed a good team and we inducted Sharma who had good experience with a multinational company on a similar project in Africa. The bridge over river Chenab, with its long span and a deep gorge, posed a big challenge. I discussed possible bridge structure options with Birdall of the well-known consultants Stenman Boynton Gronqvist & Birdall, New York. Birdall suggested a few alternatives, one of these was fixed steel arch bridge now under construction.

Katra to Qazigund is all mountainous area and geological fault lines have been discovered. With our alignment proposal generally followed, some detours have been taken during construction in a search for greater ground stability. That is a short route to how the route via Katra was selected.
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The government’s announcement of completing the Kashmir rail link project within a 5-year time line was a shake up call as at that stage we did not have a detailed project report to act upon. The exact route was still ambiguous and the terrain was anything but easy. Frantic actions followed as the announcement did act to speed up our efforts to develop viable plans for practicable surveys and agencies. Nobody had visited the alignment on ground and the tentative alignment was based on the aerial survey. The entire region was mountainous, infested with terrorism. It was a challenge to mark the alignment on the ground and there were hardly any surveys of geological conditions.

A survey team of 10 persons escorted by 20 police personnel would leave in the morning and come back well before dark. Alignment in lots of 10 kms was pegged on the ground and detailed estimates prepared and sent to the Cabinet progressively. With so much uncertainty of the estimates, coupled with less working hours due to problem of terrorism, it was known from the beginning only that there was no way the work could be completed in 5 years.

The stretch was divided in two lots with one lot assigned to IRCON and the other to Konkan Railway and the execution was awarded to them with the approval of cabinet on cost+ basis.

Perhaps the premature announcement of the timeline laid the seeds for delays in generating enough technical support for the project which has long been in the making, but a completion does appear on the horizon.

### Making a choice for the steel arch bridge design

I have dealt with this project at many stages but one which I vividly recall is how the conceptual design of the bridge was conceived. I was GM, Northern Railway and on a visit to the J&K Project. In the evening after the long day, we were discussing about the bridging options on a shikara on the Dal Lake. Rakesh Chopra the illustrious CAO of the project and Ankush Krishna, Director IRCON, an astute structural engineer were with me. We discussed a number of options, drew sketches and evaluated their relative techno-economic feasibility and also the constructability. The idea which emerged finally after a marathon mental drill was for an arch bridge:

- Longer steel arch bridges are more stable particularly as the effect of wind is better handled. Here wind, not seismic, would have governed the design.
- Both the banks were firm and the skewback of arch could be better buttressed.
- It was relatively more convenient to construct.
- Its aesthetic appearance on the backdrop of Chenab Valley would be gorgeous. See how the attraction of the Sydney Harbor Bridge is irresistible.

We wanted to consult the best available experts in the country before it was finally selected. We convened a meeting of well-known names in bridge and structural engineering from the field, consulting firms and academicians. All of them were kind to accept my invitation and participated for over 3 hours in a brainstorming session in Bareda House. We could not afford to pay their fees but they were so interested in the national project that they traveled on their own. After long discussions, the group was unanimous in endorsing the conceptual design we had worked on. A steel arch bridge was the unanimous choice.

“This engineering marvel will stand tall as a symbol of human perseverance and endurance.”

The completion of the Chenab Bridge will symbolise the victory of confidence over scepticism. The structure, being unique anywhere in the world, is going to be the safest bridge at that height. As Member Engineering, I have been closely associated with the revival of work, which was almost stopped as doubts were raised about the safety of the bridge at that location. I visited the site and realised that all technical aspects had been taken care of, it is an excellent design with careful detailing. Engineers on the ground were fully confident that the job, although difficult, was not impossible but the doubts were in the minds of top management. Due to excellent leadership over the last five years all uncertainties are over and the job can be accomplished in the coming year or two.
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A must-visit spot for the Kashmir tourist

The ruggedness of the terrain and lack of any previous examples of rail construction of equal uniqueness make the Katra Banthal rail link project an exciting one to be working on. This project is a good pointer to modern India, willing to work beyond the obvious and aiming for the toughest.

We are now approaching completion on most key locations, and one can think of a time frame for commissioning in coming years. A few current difficulties should be resolved soon. All the teams are in place and we should be able to work out the balance contracts in the current year. The lessons that our experts are picking on tough project sites will be a big multiplier on various other projects across the county.

In a few years, the Katra Banthal rail link will be counted as the toughest engineering challenge that IR engineers have ever met. The Chenab bridge should get to be an essential on the Kashmir touristic circuit. We look forward to the day.

The Front End Teams

India on the equality march

Ms. Manju Gupta, now IR’s Additional Member: Electrical has a unique position as she is the first lady officer from the IR technical service cadre to have risen to this level. So far, only lady officers from IR’s finance service (IRAS) have often risen to such positions. IR technical services now include a good proportion of lady officers, some of whom can expect to rise to IR Board positions.

Ms. Gupta joined IR in May 1983 after a master’s degree in Electrical Engineering from IIT Roorkee and holds M. Phil and MBA degrees. Her long experience in the power sector, including solar and wind power, has helped in implementing various technology transformation programs across IR. Her earlier assignments were as Chief Electrical Engineer, West Central Railway, Jabalpur and Divisional Railway Manager, Bikaner.

Establishing gender equality

GE’s Roza loco depot is starting with positive culture elements, placing the customer/user at the centre of attention and respect, ensuring reliable delivery on time.

One interesting aspect is the attention to gender equality, with an 8 women team of technicians taking on independent completion of the loco commissioning protocols, including acceptance by IR engineers. GE has indicated that the group completed the task without any ‘punch list’ feedback.
Freight corridors set for partial operations

Anurag Sachan, MD, Dedicated Freight Corridor Corporation since Aug 2018, is an officer of Indian Railways (IR) Service of Engineers (IRSE). In his 35-year career, he has executed several extremely challenging and technologically advanced infrastructure projects. Prior to this assignment, Sachan was Chief Administrative Officer, Udhampur-Srinagar-Baramulla Rail Link Project, one of the most challenging and iconic railway projects that entail an investment of over Rs 3000 Cr.

Sachan has recorded notable projects to his credit, including critical projects in the dense Mumbai Suburban section, been closely associated with major capacity building infrastructure projects in Gujarat, Maharashtra and in remote parts of Odisha. One of his key management assignments was as Divisional Railway Manager, Northern Railway, Delhi where he was instrumental in bringing key changes to the railway infrastructure in the National Capital Region. Sachan is keen sportsman and a successful sports administrator.

For many years now, IR has set its hopes on commissioning of the two dedicated freight corridors, that it hopes will provide abundant train capacity on the congested North to East and West routes. The project, envisioned in 2005, can now see part commercialisation in summer 2019, with the entire routes set up for commissioning in 2020.

15th August 2018 marked an emotional milestone as the first trial freight train rolled across the New Ateli to New Phulera 190 km section that stretches across six stations.

### Western corridor

<table>
<thead>
<tr>
<th>Section</th>
<th>Length km</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rewari - Madar</td>
<td>306</td>
<td>Dec 2018</td>
</tr>
<tr>
<td>- Marwar</td>
<td>128</td>
<td>Feb 2019</td>
</tr>
<tr>
<td>Palanpur</td>
<td>207</td>
<td>Sep 2019</td>
</tr>
<tr>
<td>Makarpura</td>
<td>308</td>
<td>March 2020</td>
</tr>
<tr>
<td>JNPT</td>
<td>430</td>
<td>March 2020</td>
</tr>
<tr>
<td>Dari-Rewari</td>
<td>127</td>
<td>March 2020</td>
</tr>
</tbody>
</table>

### Eastern corridor

<table>
<thead>
<tr>
<th>Section</th>
<th>Length km</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Khurja Bhadan</td>
<td>200</td>
<td>Nov 2018</td>
</tr>
<tr>
<td>- Bhaupur</td>
<td>143</td>
<td>Jan 2019</td>
</tr>
<tr>
<td>- Mughalsarai</td>
<td>402</td>
<td>Oct 2019</td>
</tr>
<tr>
<td>- Sonnagar</td>
<td>126</td>
<td>Oct 2019</td>
</tr>
<tr>
<td>Khurja - Dadri</td>
<td>46</td>
<td>Dec 2019</td>
</tr>
<tr>
<td>Pilkhani Sahnewal</td>
<td>179</td>
<td>March 2020</td>
</tr>
<tr>
<td>Khurja-Pilkhani</td>
<td>222</td>
<td>March 2020</td>
</tr>
</tbody>
</table>

### New features

The DFC comes with many firsts on the IR network, like the 2x25 kV overhead power supply and full Train Protection and Warning System (TPWS, equivalent ETCS level 1) built on fully automatic (2 km spacing) signalling. Here again, full system utilisation will depend on suitably equipped locos only plying on the section, something that is unlikely as IR decided not to import Japanese locos under this project, as these were comparatively much costlier. The section can be commissioned with standard IR locos like WAP7/9 that provide adequate traction power on the relatively flat sections. All train control will be from centralised locations, ensuring minimal delays in transit.

The project is being funded by multilateral agencies (Easters by the World Bank and Western by JICA). International competitive bidding based on documents approved by funding agency has been followed as per conditions of the loan agreements. Bidding documents are framed so that they permit best international practices and new technologies in all fields of railway construction.

### Pushing the last miles

DFC is now a project under ripening and returns. That is the best message that AK Sachan, MD, Dedicated Freight Co (DFCCIL) conveys as he looks on the coming months of the challenge, calling the route completion a ‘game changer’ for IR traffic capacity. For Sachan, this is the first position in a corporate sector, but he has the right background for this job, as his most recent position on the IR, as CAO Construction that included the equally challenging Kashmir link project, would allude to.

Sachan adds that this stint so far in the DFCCIL has confirmed that IR managers have the skills and the experience to deliver on such mega projects, given the right authority and responsibilities.

Sachan points out the bottleneck procedures, like a general condition of contract document that works on the principle that ‘one size must fit all’ types of construction projects. The DFC approach has been different from the standard IR procedures, opting for design and build practices under EPC project management, delegating to the utmost.

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rail Business [Focus India] January 2019
The lack of design and build approach has restricted IR innovations in design and project management. DFCCIL has followed modern construction tools introducing the New Track Construction and overhead power supply installation train for the first time on IR.

A delayed start

The Khurja-Bhaupur (near Kanpur) section should see its first revenue earning freight trains start arrival in April 2019, with an ambitious projection that the 2822 km corridors could see commissioning in 2022. The routes are envisaged to generate 160 mt extra rail traffic, with an estimated 360 mtpa freight traffic transferred (~75% of existing traffic streams) from IR.

The Western corridor will mark a sea change in freight container traffic from JNPT Mumbai and the Gujarat ports. Necessary additions at JNPT for 2.2 m TEUs per year have been completed and expansion to 4.5 m TEU p.a. is planned. The already proven double stack operation on the Western corridor will be a major first, easing pressures on this route. While DFCCIL will mainly be the infrastructure owner, it has already granted approvals for rail connectivity projects: 2 by CONCOR near Mokapura and Swaroopganj, UPRVNL for serving the Karchana Thermal power plant and Internal Waterways for a multimodal terminal at New Arhaura Road (near Varanasi).

Accelerated progress

DFCIL has adopted a Design-Build Lump-Sum Contract Strategy based on FIDIC Yellow Book where the contractor is responsible for design, procurement, and construction, with the provision of independent engineers for project execution activities including clearance for design/methodology for execution. This also helps to review at various stage of project execution to ensure that work is being executed as per specifications and procedures. A related aspect is that the FIDIC Yellow Book provides the general conditions of contract (GCC) to maintain a balanced approach regarding obligations on the part of involved parties.

Overall physical progress of ~4%, over expenditure of ₹41,300 Cr has been achieved. With most track construction contracts already under execution, Sachan looks forward to the 2022 opening.

This rests on current completion of about 300 km track work, 145 major bridges (~120 more in progress), near completion of the land ownership process. 82% of contracts for electric and signalling have been awarded.

Another first is the OHE mast foundations being done by augering mechanism and the 4 OHE wiring train deployed, that can handle up to 3 km wiring per day, almost triple of that by conventional means. Modern technology has also been deployed in using drone surveillance on under construction sections.

This process can be tricky and DFCCIL has been able to address various concerns, even though above 70 patches, covering about 50 km are yet to be resolved. The issue size is refected in that DFC has been able to clear more than 1260 cases in EDCA and 339 in the WDFC. That sits above the nearly 10,000 cases of arbitration!

The 25 t issue

IR has empowered MD, DFC to open DFC routes should be completed. Sachan reiterates that under Indian practice, freight route opening for regular service does not need statutory approval by the Commissioner of Rail Safety while such clearance is needed only when interacting with passenger carrying routes. The routes are being set up to higher construction standards and no delays on this account are likely. Sachan also does not see any issues in permitting 25 axle load operations at the proper time, per recent IR Board directives. He has already started the process by commissioning well known French rail consultant to advise on the modality and the instrumentation methods to be deployed for 25 t operations on the 60 kg/m, 90 kg/m UTS rail routes.

The laid-out section is expected to
permit freight trains at 100 kph, though that seems unlikely in the next two years as IR has not yet certified any loaded wagons for that speed.

The Dankuni section
The Sonnagar Dankuni section was not originally part of the project proposal and can be considered a 'political invitee', whose seat at the table is still ambiguous. The freight on the EDFC originates mainly in the coal belts, that does not extend much beyond Dhanbad/Asansol, and additional freight traffic to Kolkata would not perhaps need a double line to dedicate corridor. This exception is officially up for PPP investment, which may be a case for postponing the project. For the record, 1063 ha required for the yet unfunded project has been mostly acquired. The track elements will be able to handle turnout speeds of 50 kph (current IR standard 30 kph) as the turnouts are canted (one rail higher than the other) and thick web switches have been used. Considering that this is freight only link, the need to control a train as the other passes on the main line will be minimal and this feature should be sparingly used too. Mobile communications per GSM E protocol will cover the system.

<table>
<thead>
<tr>
<th>Revenue need (in crores)</th>
<th>FY2021</th>
<th>FY2024</th>
<th>FY2026</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opex</td>
<td>4,173</td>
<td>5,713</td>
<td>6,911</td>
</tr>
<tr>
<td>Depreciation</td>
<td>454</td>
<td>1,445</td>
<td>1,906</td>
</tr>
<tr>
<td>Cost of capital</td>
<td>5,279</td>
<td>5,328</td>
<td>5,377</td>
</tr>
<tr>
<td>Tax</td>
<td>-</td>
<td>156</td>
<td>302</td>
</tr>
<tr>
<td>Net revenue requirement</td>
<td>9,906</td>
<td>12,641</td>
<td>14,406</td>
</tr>
</tbody>
</table>

The Freight Corridors: Peak Capital Expenditure

Accelerating the CAPEX
A good measure of the progress is provided by the Capex graph, where significant increases have been recorded since 2015 (1461 Cr) to the last FY (673 Cr). Sachan expects his figure to be even more. $600 Cr has been used in the first 8 months this year. The CAPEX is mirrored also by the track linking progress.
Freight corridors - a genesis of the concept

On the IR a common network delivers transport output for heavy freight, fast and stopping passengers and suburban services. Investments for capacity enhancement over the decades have been made on this common network, generating an amorphous system which is not optimum for any in the basket of services delivered. There is also an urgent need for reducing the unit cost of transportation which suffers in comparison with tariff prevailing in other freight transport railways. The vexed problem of speed mix which eats into section capacity along with the safety concern of the railways also needed to be addressed.

For fulfillment of this agenda a think tank that was closely associated with (name withheld on request... Editor) deliberated for several years and finally presented a concept paper recommending construction of a network of Dedicated Freight Corridors designed for operating high productivity freight stock with heavy trailing loads at speeds up to 100 kph. The problem of speed mix was substantially expected to be resolved through progressive separation of freight and passenger services as the freight networks expanded.

The existing network in the course of time was planned to be upgraded for fast passenger service operating at 200kph. Separation of heavy freight and fast passengers simultaneously would address the safety concerns in a large measure. For increasing the productivity of the freight stock, reductions in wheel diameter, floor height and coupling height were also recommended. The concept paper presented by the think tank in a September 2005 meeting was approved by the Board and the planning commission immediately. IR was directed by the government to launch a programme for implementation. This project is also the first serious foray by IR in heavy haul operations.

<table>
<thead>
<tr>
<th>Some milestones</th>
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</thead>
<tbody>
<tr>
<td>Sep 2005</td>
</tr>
<tr>
<td>First recorded concept presentation</td>
</tr>
<tr>
<td>Feb 2006</td>
</tr>
<tr>
<td>Concept approval, feasibility report</td>
</tr>
<tr>
<td>Oct 2006</td>
</tr>
<tr>
<td>Incorporation of DPCCIL</td>
</tr>
<tr>
<td>Nov 2007</td>
</tr>
<tr>
<td>Initial budget approvals</td>
</tr>
<tr>
<td>Sep 2009</td>
</tr>
<tr>
<td>IICA loan for Western corridor,</td>
</tr>
<tr>
<td>tranches in March 2013</td>
</tr>
<tr>
<td>Oct 2011</td>
</tr>
<tr>
<td>Loan agreement with the World Bank</td>
</tr>
<tr>
<td>Jan 2013</td>
</tr>
<tr>
<td>First civil and track contract for</td>
</tr>
<tr>
<td>Khurja-Shaipur awarded</td>
</tr>
<tr>
<td>Jan 2017</td>
</tr>
<tr>
<td>All contracts for VDFC awarded</td>
</tr>
<tr>
<td>Feb 2018</td>
</tr>
<tr>
<td>All civil contracts for EDFC awarded</td>
</tr>
</tbody>
</table>

Templates for the future

Preliminary Engineering cum Traffic Surveys for three potential freight corridors, assigned to RITES, have been accepted by the IR Board which has also communicated approval for undertaking a detailed project report for the Kharagpur-Nagpur section of the East-West Corridor and Kharagpur-Vijayawada section of the East-Coast Corridor in the first phase.

<table>
<thead>
<tr>
<th>Corridor</th>
<th>km</th>
<th>Cost ₹ Cr</th>
</tr>
</thead>
<tbody>
<tr>
<td>East-West Kolkata-Mumbai</td>
<td>2328</td>
<td>86805</td>
</tr>
<tr>
<td>Kharagpur-Nagpur</td>
<td>1150</td>
<td>42883</td>
</tr>
<tr>
<td>Parallel to IR: 368 km, detour: 784 km, 22 Junction + 13 crossing stations, land required 16748 ha, cost ₹16728 Cr (at 2014 price level), projected traffic (in mt): 851 in 2031 and 1410 in 2041.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>East-Coast Kharagpur-Vijayawada</td>
<td>1114</td>
<td>40419</td>
</tr>
<tr>
<td>Kharagpur-Vijayawada</td>
<td>750</td>
<td>24155</td>
</tr>
<tr>
<td>Parallel to IR, 575 km, detour 176 km, 10 Junction &amp; 11 crossing stations, land required 2493 ha, cost ₹4638 Cr, projected traffic (in mt): 548 in 2031 and 1192 in 2041.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Turn round on the 25-t axle load operations

IR Board has indirectly admitted technical misgivings on 25 t axle load train operations on the newly constructed dedicated freight corridors as the authority (and responsibility) for running such trains has been delegated to the MD, DFCCIL. An Oct 15 directive from the Board records that RDSO has found that 60 kg/m 90 kg/mm² UTS rails (used in these much-awaited corridors) are not fit to run 25 t axle load freight trains. All technical standards for these corridors are expected to be laid down by the Board, in consultation or prior agreement by RDSO and the delegation to the DFCCIL, which is essentially an infrastructure owner and constructor, should be unprecedented.

These dedicated freight corridors were expected to increase throughputs by various means including the increase in axle loads from 22.9 on the current IR wagons to 25 t.

It needs to be reiterated that back in 2004, IR had permitted limited use of 25 t axle loads on limited sections of the SER, ECR, and SWR, though the effort seems to have been stalled reportedly due to higher wear on the tongues of rail crossings. Most traffic on the freight corridors on the coal and iron ore belts will evolve from the spokes in current IR tracks and DFC can run 25 t trains only if these tracks are also authorised to carry 100 t wagons. The issue is that if new tracks built to the best standards cannot bear 25 t load, how can the old tracks do that. In effect, IR seems to have decided not to push for the 25 t loads, almost 13 years after the freight corridors were conceptualised. The original concepts for these lines indicate that the tracks would be later upgraded to 32.5 t axle loads, which clearly was just a hope, not backed by any technical assessment.

Measurement methods and specs for residual stresses have continuously evolved over the decades.

IR Rail Specification T-12:

- 1996 - ≤14 % of ultimate tensile strength
  (=12.6 Kg/mm²)
- 2009 - ≤19 Kg/mm²

The residual stress
The directive records that, ‘on scrutiny of past records, no detailed stress calculations could be found’. The issue revolves around how much residual stress from the manufacturing process may be carried over into the installed rails. This is an area of disagreement amongst experts though technical methods and specifications indicate limits. In effect, if high residual stresses are expected, then the additional dynamic stress that can be permitted would be lesser, reducing the applicable max axle loads and speeds permitted.

‘… in fact, in the past, rolling stock of 25 t axle load was permitted up to 50 kph on 90 kg/mm² UTS rails by taking an ad hoc value of 6 kg/mm² for residual stress against a provision of 19 on 60-80 mm rail slice’.

RDSO/IR trace back their residual stress assessment to 2000, when it was compared with the approach given in ORE Report D-71-RP2 and that recommended by an eminent track expert. RDSO had concluded that their methodology was in line with International practice. An expert added that prior to 1987, such residual stress was not considered by RDSO for total rail stress calculation while 6 kg/mm² was considered later as observed in the UK (based on residual stress of 25 % of the yield strength).

RDSO/IR assessment of rail stresses shows that even the 22.9 t axle load trains at 60 kph on 60 kg/m rails would induce, in the worst case, stresses nearing the yield point of the steel. The stress level would be comprised of these elements (all in kg/mm²):

- Bending stress: 9.9
- Residual stress: 24.5
- Thermal stress: 11.3
- Unforeseen conditions: 1.0

Undergraduate students (picture on the left) from IR’s National Rail Transport University, Yescalera were on hand as volunteers and helped with arrangements for the INNO RAIL Conference 2019. All the sessions saw excellent interactive participation. Photos show some of the conference participants.
Running trains at these high speeds requires absolute confidence in the track. Pandrol has been supplying rail fastening systems for over 75 years, and its portfolio of products for high-speed track continues to evolve, even as its latest designs embrace tomorrow’s demands for high capacity operation and low maintenance.

Pandrol system is a safe, reliable, threadless and self-tensioning system based on decades of worldwide experience. The high-quality manufacture and specifications ensure a fatigue free performance.

Sustained 50-year HSR applications

Pandrol’s first involvement in providing rail fastening solutions for high-speed ballastless tracks goes back to projects undertaken for East Japan Railway back in the 1990s though it adopted Pandrol technology in the 1980s to reduce the heavy maintenance burden of re-tightening the threaded fastening system that was standard throughout Japan at that time. Two of the Pandrol systems that gained popularity with East Japan Railway and later with Korea’s KTX and China High Speed CRH are e-Clip e1883 and Fastclip SFC systems. These base plated systems have lateral and vertical adjustment capabilities which are a fundamental requirement for a fastening system on ballastless track.

An e-Clips installation has been in place in the Haruna tunnel on the Joetsu Shinkansen since 1993. The ballasted track and about 10 km of ballastless track on the Nagano Shinkansen and extension of the Tohoku Shinkansen, North of Morioka, features e-Clips on 10 km of the slab track.

Pandrol e-Clips are also used on the 300 kph line from Brussels to the French border. Tests on this 80 km route have reached 355 kph, with regular 300 kph services since 1996. Some sections on the Brussels to Ostend and Antwerp routes are being upgraded to 200 kph from 160 kph.
Specialised machine solutions from Godrej

The Indian machine tool industry is now increasingly able to provide high productivity customised solutions for users. The Godrej and Boyce development of a 13.5m x3.5m x4.2m, 45 t CNC machining center for locomotive underframe deck machining in IR’s Diesel Loco Works, Varanasi, provides a good example of a multi-tasking solution for a singular application. This and related drilling operations were conventionally carried out by portable milling and drilling machines, but the process set up was slow, required specific machine operators and was prone to occasional errors also. After the milling operation, the deck miller was to be removed for drilling and tapping operations with a portable drilling machine. Multiple crane usage and manual settings with multiple jigs has been avoided, leading to a claimed productivity improvement by 300%.

The machined decks house the engine and other major equipment on the 22m, long, steel fabricated underframe.

The process started with DLW call for revising the conventional processes to remove a loco assembly bottleneck, and Godrej responded with this specialised solution.

A specialised vertical of Godrej tooling- for industrial machines-provides specialised solutions in metal cutting machines, jigs and fixtures, material handling solutions and robotics, with a wide range for railway and Metro applications. Over the years we have acquired substantial and varied experience for taking large complex assignments,’ Nagraj Pandit.

The developed unit has features like programme rotation and delivers all the processes in a single setting. Loaded with a Siemens 828 CNC controller that is coupled to three servo-motors for precise location of the spindle heads in the three directions. The main spindle motor is servo-control for programmable speed and feed rates. All the axis guiding elements are well lubricated and laser calibrated for high accuracy and repeatability. Any faults are synchronously displayed in the Machine Interface.

Pandit added that the company’s plan is to maximise localisation and to provide solutions for a customer’s special requirements, that could help reach a lead position with assured quality and cost control in a competitive market.

Appointment

Sanddeep Gulati, now MD, Egis India was earlier Chief Financial Officer, Alcatel-Lucent and Huawei.

Egis has been one of the leading global integrated infrastructure and engineering companies in India for more than two decades and one of the top three providers of comprehensive solutions for infrastructure engineering and project management. Egis expertise covers the complete range of rail transport including conventional and high-speed lines, regional and commuter systems, multi-modal hubs, freight rail, stations, platforms, rail, and road sites. Egis has been associated with France’s first high-speed rail links.

“We have the most diversified portfolio of projects among our peers, with some of the prestigious projects that comprise of eight Metro projects, three airports, two smart cities, Chhatrapati Shivaji Memorial & the Statue of Unity and many more.” Sanddeep Gulati
Big strides in Lucknow, a template for Kanpur

The success of the Phase I project has been encouraging enough for the government to rename the Lucknow Metro Co (LMRC) as UP Metro Co that will handle all Metro projects in Uttar Pradesh. Kumar Kashav, MD LMRC expects that the quick ‘plan to commissioning pace’ at 8.5 km in three years, that Lucknow has shown will be exceeded in the other planned Metros.

The initial plans for Kanpur Metro have been sent to the Ministry of Urban Development for in principle approval while that for Agra should be similarly processed in late 2019. Kashav and the Metro team will have their hands full.

Milestones per plans
LMRC achieved a recent milestone in receiving the complete set of Alstom India manufactured train sets in a very tight time schedule. The last of the 20 train-sets (4 cars each) for North South Corridor of Phase-1A was received in Nov 2018. Kashav points out that this is the fastest complete delivery of Metro trains in India.

LMRC has also achieved milestones in civil construction like by successfully completing the 177m long balanced cantilever Gornti river bridge and completion of 60m special steel span near Nishatganj over an operational IR track. The tunnelling work is now complete, station structures are well advanced and on the dot for the fast pace of commissioning that Lucknow Metro has set up. Other aspects of the commissioning are on hand, with completion of one coach depot, complete trials on the ATO signalling, Kashav stressed his team’s determination for on-time commissioning of the North South Corridor (Phase-1A corridor) in early 2019.

Ridership on the partially commissioned line has been encouraging, with expected initial enthusiasm based partly on curiosity on the first Metro in the city. The line has already achieved ridership approximating 14,000 per day, that should increase to 18,000 per day. As the phase I is completed in a few months, expectations for a 1.5 lakh ridership per day, with a peak of 14,000 per hour should be a satisfactory start for the 4 car operations. Kashav expects that the ridership could go up to 4 lakh per day as the complete set up is established.

The EW corridor of LMRC should take off with the award of the first contracts in mid-2019 as preparatory work is now complete. This will be a 12 station, 12 1/2 km line.
Lessons learnt
Keshav has been associated for many years with Delhi Metro and has carried many of his lessons and experiences successfully to Lucknow. He listed his lessons from here that he would like to carry to the other city plans:

- Precast superstructures, manufactured in suitably located casting yards, are the preferred option as on-site casting imposes severe limitations in cities that are often already choked with slow moving traffic.
- Various systems like fire and power supply could be redesigned for optimal costs.
- Integration of ticketing systems for other transport modes and civic services should be built in to the initial plans. For intermodal transfers at key stations, involvement of the city authorities with the station and adjoin area layouts should be taken on early. The ticketing operations could be outsourced to a suitable agency, like a bank.

Integrated ticketing solutions
- LMRC has signed an MoU with the Lucknow Municipalities for payment of house/property taxes through the ‘GoSmart’ card at the Metro Stations. LMRC is trying to provide additional facilities to the commuters for their benefit and convenience. This is a first in India for such integration for government services with Metro ticketing.

Private funding for Metros
Keshav points out that even as Indian Metros are making a mark, the urban transport scene is not encouraging with a negative growth in the public transport offerings. The transit speeds offered by the bus system are dismal, with Mumbai at around nine km per hour.

The numbers tell the story: India has achieved commissioning of about 25 km Metro lines per year, compared to China at about 300 k/year. The limitations of funding, construction agencies and methods and some gaps in designing need to be addressed in order to meet the almost insatiable urban transport needs of an urban population estimate at about 23 crores.

Divided and poorly shared responsibilities for urban transport are the other factors for concern. There is little effort for a multi-modal transport plan that integrates the planning processes. Such integration would also help boost Metro traffic as commuters avoid Metro transit due to first and last mile hurdles. Indian cities would have to mimic the model of integrated transport followed in most large cities in the developed world, say the BVG in Berlin.

The government’s recent Metro Policy permits private funding for new Metros and extensions. Current government funding for various Metros in the range of ₹14,000 Cr per year and that needs to be augmented. Thus far, the Indian experience with privately funded projects have been the Airport Line in New Delhi, Hyderabad Metro, the monorail and Metro One in Mumbai, and perhaps all of these have not succeeded in generating enthusiasm for other investments. One option could be to retain core funding and operations with the state bodies and consider leasing/outsourcing of all possible functions, including operations (as by Hyderabad Metro), rolling stock (leasing effort started by Delhi Metro) and even signalling equipment etc.

LMRC was a supporting partner for InnoRail India, 2018 conference.
Consider LRT for smaller Indian cities

As Indian Metros spread from the current 10 to an expected 25, a ‘me too’ attitude in favour of the standard Metro layout seems to shut out the case for more appropriate rail based urban transport options. The case for LRTs has not been helped by the dismal condition of Kolkata tramways or the lack of success of the Mumbai monorail.

‘Light rail transport (LRT) is a metropolitan electric railway system, characterized by its ability to operate single cars or short trains along exclusive rights-of-way at ground level, on aerial structures, in subways or, occasionally, in streets, and to board and discharge passengers at track or car-floor level’. In principle, train, tram, and Metro represent functionally and technically separate types of public transport infrastructure. Light rail does not need dedicated infrastructure but can use the three types of infrastructure available for urban rail-related public transport.

This book, by three researchers from the Netherlands, is a plea for investing in urban light rail. Lessons have been drawn from projects in European cities with their long tram histories and recent LRT projects.

The importance of urban accessibility is greater than ever, and the role of light rail cannot be overestimated. Light rail is much more than transport; light rail also means a social impulse, economic growth opportunities, a better environment, greater attractiveness and more favourable conditions in general.

LRT has the potential to make a leap in the quality of public transport for users. Experts discuss higher frequencies and improved comfort by new vehicles and the upgrading of stops. Due to an increased number of stops (compared to heavy rail train services), the required travel time from ‘door to door’ is decreased, while the overall travel time remains the same.

‘In the 61 cases highlighted in this book, success and light rail do not always come together. At all stages of a project, it may fail: during the preparation, during the tendering, during construction and even after opening. The misguided

Light Rail Transit Systems
61 Lessons in Sustainable Urban Development

Groningen Regio Tram project is considered an important international lesson and reference for future urban infrastructure projects.

Light rail is one of the solutions for providing the transport that the residents need, and it can improve the livability of cities. It is not, however, a standalone solution, and will always be part of a broader system of mobility that includes other modes of transport. It is therefore not an objective in its own right but one of the solutions for broader issues. Light rail can be a valuable addition in the rich tapestry of a door-to-door journey that comprises multiple modalities. The options are not the same in all countries’... Roger van Boxtel, CEO, Dutch Railway.

A first from Siemens

Boosting capacity and championing sustainability

India’s first 9000 hp electric loco traction converter has been flagged off by Ghanshyam Singh, Member Traction, IR Board. This converter, strategically designed to suit IR’s unique requirements for its first locally manufactured 9000 hp electric loco, is slated to roll out from the Chittaranjan Locomotive Works later this year. The advanced technology used aims to save energy cost, fuel expenses and carbon emissions. The converter has been completely designed, built, and manufactured at Siemens’ Nashik factory.
With more than 60 years of expertise in the field of Power Electronics, Electrical Engineering and Mechanical Engineering, Hirect has evolved into a beacon of solutions for Railways and Industries alike.

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Hirect aims to be the most comprehensive supplier to the Rolling Stock application of Railways, particularly Locomotives and the EMUs, including Traction Motor and Brake System.
OLA launches Ease of Mobility Index

“We believe that a better understanding of mobility in the country could inspire constructive conversation and innovation that has a direct impact on how we live. The Ola Mobility Institute has developed a unique framework to evaluate mobility scenarios in cities to ‘raise our collective understanding of this rapidly evolving sector’... Bhavish Aggarwal, CEO.

The Ease of Moving Index (EoMI) looks at 50+ parameters grouped under three pillars (People, Infrastructure, and Sustainability), and 43,000+ persons across 20 Indian cities were interviewed. The Index considers secondary data on parameters related to mobility infrastructure and sustainability goals and data on usage of intermediate public transport such as cabs and auto-rickshaws, travel times and speeds in cities, proportion of cashless transactions in everyday commute, and surface quality of roads.

“We find ourselves on the cusp of a new technology revolution. For the last generation, the Internet transformed the way we access information. Today, we are amid a radical shift in how people and goods move. We have significant potential to transform mobility from being legacy means of moving around to a source of livelihood and innovation. From driving to battery technology and data science, mobility also has the potential to create millions of jobs over the next few years.’

A wide and varying range of preferences by commuters makes it a complex activity for planners and policymakers to assess mobility requirements. Data generated from connected vehicles, GPS systems, digital transactions, on-demand entertainment devices and other electronic devices has the power to revolutionize mobility and empower policy makers.

The focus has now shifted to making mobility sustainable through the creation of a robust multi-modal public transportation and intermediary public transportation networks enabling first and last-mile connectivity. Shared mobility trumps personal vehicles as the preferred mode of commute and is widely expected to solve the problem of congestion, making mobility affordable for the common man.

EoMI aims to support policymakers, planners and practitioners, and businesses and citizens alike to identify mobility requirements of cities in India, challenges faced by public, and aspirations of the citizens, helping promote sustainable mobility through emerging technologies and business models, and enables cities to benchmark their performance with other comparable cities on various predetermined mobility parameters.

The EoMI provides for an overall score cum ranking of each of the 20 cities, grouped into metro, booming and promising cities were selected based on population, character of the city, culture, economy, and geography, and combines those insights with secondary data. Mobility needs are city-specific, and each city needs to have a different mobility strategy. The ranking is based on a survey of users of public transport, intermediary public transport and private vehicles across the selected cities combined with city-specific secondary data.

- **People:** the indicators of pattern of travel, quality of life, and perception.
- **Infrastructure:** the efficiency and reliability of mobility systems. The indicators of road condition, riding quality along with availability of parking spaces, infrastructure for cycling and network can help analyze the congestion profile of the cities along with facilities to support non-motorized transport for sustainable mobility.
- **Sustainability:** evaluates cities on their efforts to lower transport emissions, building non-motorized transport infrastructure, reducing air pollution, designing of green spaces during city and mobility planning, and on measures taken to increase the adoption of zero emission mobility. Another component of Mobility Planning captures people’s aspirations and together with the other three pillars can enable policy makers to fulfill the city’s mobility needs and improve its rankings.

For a yardstick for Mobility Planning, components of willingness to shift to public transport have been recorded and a response solicited on improvement in mobility scenario over the last 5 years. This presents with an opportunity to estimate the number of people who might shift to public transportation if last- and first-mile connectivity is improved, which will further offer insights on demand. Based on these insights, planners can design strategies that would bring maximum benefit in augmenting the patronage of public transport and a detailed analysis of the existing public transport system is also drawn. Reversing the trend in transportation, based entirely on fossil fuel-driven means and the exponential growth of personal vehicles, requires better urban planning and policy interventions. Urban transport planning and management is complex as it involves the consideration of affordability, local culture, environmental issues, financing, energy use, etc.
The opportunity for mobility in India is now.

Key observations

More than 60% of the people in the 20 cities report using public transport. More than 80% of the respondents feel that the mobility scenario in their cities has improved in the last five years. While in a few cities like Chennai, Jabalpur, and Kohima, policies and infrastructure have enabled non-motorized mobility through walking and cycling; cities like Kolkata and Delhi have shown how to embrace shared mobility to increase access and improve utilization of public transit.

Around 60% of the non-users are willing to shift to public transport provided its coverage, first- and last-mile connectivity, frequency, and comfort are improved. Integrating intermediate public transport with modes of public transit through offline and online multimodal terminals and fare integration can augment usage. Metropolitan cities like Delhi are already paving the way for this by making metro rail cards usable on buses as well. The growth of smart-card based metro rail usage and app-based IPT and public transit services has increased the acceptance of digital currency.

Strengthening digitization across cities would further enable the creation of seamless mobility across multiple modes, facilitating deeper partnerships between the public and private sectors, and help people move with ease. 10% of the users find public transport safe in general; 36% find it safe except at night; 35% find it somewhat safe; 19% find it unsafe to use public transport.

The OLA report does however miss a key link: that of the keystone role of a rail-based mass transit. The applicability of Light Rail Transit (LRTs) in growing cities has not been considered, leaving one with the impression that the cab aggregator has tried to look at its business profile rather than the system as a whole.

Environmental concerns will require that urban transport in megacities migrate to electric traction modes. Various governments have pushed for e-mobility plans, with the Delhi government just announcing its initiative for providing the necessary charging infrastructure with connected financial incentives. These and various other issues were tabled during the one-day seminar organized by the Delhi local network of the Institution of Engineering and Technology (IET), UK.

Early in 2013 the Indian government had targeted a major push that should have resulted in substantial e-conversion of urban road transport by 2010. In hard terms, the progress made so far has been symbolic; with e-rickshaws now dotting the urban landscape in many locations, purchase of a few hundred cars by the governments and little else. The horizon has now been shifted to a more modest 2030, when a 30% presence of e-vehicles in major cities is targeted.

Various agencies like the Bureau of Energy Efficiency (for setting standard and identifying structural and legal changes), Niti Aayog (Model concession agreements etc.) have been assigned defined roles in this process. Technology developments that are working to change to the e-platforms for urban mobility were listed. The e-vehicles of the future would depend hugely on Li-ion storage solutions and may be permanent magnet motors, and core academic research and industrial pioneer ship in both areas is needed if the 2030 vision is to make a significant mark.
Delhi Metro pushes for trainset leasing

Delhi Metro has moved a step closer towards developing a lease process for additional rolling stock for its expanding operations. DMRC has already announced a list of 11 qualified companies/JVs that can submit bids in its recently floated RFP, likely to be opened in March 2019. The award of contract for the 25 four car train sets (may be increased to 32 car sets in the defined time) to be used on its already operational 29.5 km Line 5 (Green Line) is expected in late 2019.

Delhi Metro has now been operational for 17 years and has procured all its rolling stock needs through direct purchase and maintains and operates these from its own depots. The lease effort now requires the contractor to supply the new train sets, at least 75% from India manufacture, and maintain these from fully functional car depots that DMRC will hand over. The first depot at Mundka would be handed over in time for the first train set supply and the other one at Bahadurgarh in time for the last ones. As the contractor supplies new train sets, DMRC would relocate its owned stock to Line 6, aided by the fact that the stock on Lines 5 & 6 is identical. The contractor is expected to complete the trainset delivery in three years and would be required to wet lease these to the defined availability levels for 35 years, the expected maximum service life of these coaches. Even as various responsibilities between the lessor and DMRC are well defined, suitable availability norms and penalties have also been included in the draft contracts.

The expression of interest call in late 2017 was open for manufacturers, investors, or a combination of these. K K Sabarwal, Director Finance, DMRC indicated that the lease draft document depended on the model documents initiated by the then Planning Commission in 2009, which have been successfully used by Indian Railways for the new loco leasing from factories in Marathwada and Madhepur. Response has been good, with 11 companies/JVs qualified for the now on-going tendering process (Of these, IL&FS is known to be under a serious restructuring process).

Qualified applicants
- Mitsubishi
- Bombardier India
- Equis India Fund
- China Rail Co CRR
- National Investment and Infrastructure Fund
- BEML India
- CAF Spain companies
- Alstom India
- IL&FS Rail
- I Squared Capital
- Mitsui Japan

Leasing to fill in a capital gap
The leasing effort may in part have been designed as the government is constrained for funding Delhi Metro expansion, particularly under the Phase 4 plans for 6 more lines that are under approvals by the state and central governments. Other equipment, say people movers like escalators and walk ways, worth nearly ₹1900 Cr, may be considered for leasing as the plan gets into execution.

The investor's view point
During a general discussion on the lease proposals, the issue of the 35-year time period was mentioned, as the norms for such lease contracts are often limited to 15 years, including in the aviation and rail freight sectors. A key reason would be the increased risks involved in a 35-year period, including the exchange rate fluctuations as payments are linked only to the Indian rupees. One view expressed was that it may not be a unsurmountable issue as at least 75% coaches are to be manufactured in India and maintenance costs would also be largely in rupees.

This may well be a learning and discovery process for DMRC, and like most other aspects, become a model for other Metros in India. It is understood that the planning process for some Metros has already factored in train set leasing and not direct procurement.

A structural change
Indian Metros are owned and operated by Central and State government JVs, while the local roads and transport responsibilities lie with the state or city authorities. A lack of a unifying responsibility has added to the mess, so visible every rush hour at all stations and the connecting city roads. Metros must make a bigger contribution to easing urban transport, assigning the last mile connectivity issues to a defined local authority would seem to be the only solution. Maybe it is a chicken and egg story, but the froth settles on the Metro commuters. Issues of a different type have affected the loss-making Gurgaon Rapid Metro (owned by the now troubled IL&FS) where low footfalls on the trains have led to a situation of ‘who owns the baby now’.

A distant solution is that a single local body like the city municipality aggregates all urban transport modes into a single authority (say like the S-Bahn in Berlin, that runs the successful U- and S-Bahn’s beside the buses and the trains) and coordinates all facility planning and schedules. That is a distant plan, but the connectivity issues need an early address if the mobility monas is to be corrected in the coming months.
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Leading the portfolio expansion by TEXMACO

Sandeep Fuller is now Managing Director Texmaco Rail & Engineering. He was earlier CEO of the Heavy Engineering Division, an umbrella company of this vertical of the Saroj Kumar Poddar chaired Advents Group.

Fuller brings over 25 years of diverse management and technical experience, having earlier worked with IR for nearly two decades as well as Larsen & Toubro. His core expertise includes areas such as Metro coaches and locomotives, traction operation and maintenance.

In the group, he spearheaded forays in to the BPC markets bagging prestigious orders from DFCCIL and Bangladesh Railways. He was also instrumental in securing Alstom and GE contracts for their prestigious locomotive projects.

Where Metros have failed to care and lead

The quality of Indian Metros has been at a high perch, rising mainly form the world-class technology and space templates set up by Delhi Metro. While the trains and the stations look proficient and swank, almost all cities have failed to look at ‘first and last mile connectivity’ and plan facilities for linked intermodal transport to facilitate door to door urban mobility.

Whether it is the New Delhi Metro linking to the New Delhi (IR) main station, or the traffic morass outside the Gurgaon HUDA terminal or the disorder at the Char Bagh Metro (Lucknow), most Metro stations share this label for not planning up the intermodal facilities from the concept stage, despite recognizing the need for these. The near chaotic situations at major Metro station approaches seem to have a common factor: that corrections are afterthoughts with little to show on the ground.

We know, but...

An interaction with the MD of an upcoming Metro was revealing as we asked him the reasons for this situation and he admitted that this area involves multiple state agencies, with each expecting the other to deliver on all fronts. The net result is a traffic morass outside the popular Metro stations. While Delhi Metro can be treated as a learning exercise, the lack of adequate project level plan by the subsequent Metros only shows lack of sensitivity.

A (retired) Delhi Metro Board member stressed that suitable linking plans at New Delhi stations existed but were not executed for want of agreement with the IR authorities. We recollect that Mangu Singh, MD, DMRC who has been associated with Delhi Metro planning for a long time, mentioned as much to us in a special interview a couple of years back.

Clearly, the Metros alone are not to blame but corrective actions are hardly visible on the ground. The issue has long been recognized: Delhi Metro is already running a few hundred feeder busses connecting some stations and is in the process of tendering for 10 more station feeder buses, including two slated for e-vehicles only. But the problem is the uncertain waiting time that commuters face for using these feeder buses. As one DMRC operations executive put it, these services are uneconomical for short feeder routes and now have 15 to 20 km long routes over congested prime time roads and commuters do not build such uncertain connectivity into their routine.

The pedestrian’s woes

Consider pedestrian last mile connections: the foot walks are often discontinuous, with potholes, varying levels, hoardings, and badly placed lighting poles all taking priority. It would be too much to expect the Metros alone to look at the pedestrian connects, and that reflects the core problem of responsibility.

The planning vacuum has been filled in by the informal transport taking over, with haphazardly piled auto rickshaws and other modes proliferating with hassle-full services. Corrections are being sought, like the just-announced DMRC plan for cycle stands at 20 of its stations. Cycle sharing also seems to be on the cards, with a hire charge of ₹10 per hour, too steep in our view, for a regular commuter. Media reports indicate a delivery time of a few months, with extension if successful.
'We did precisely that and in record time.'

The Train 18 story, right from the source

It’s not easy to recount the Train 18 journey. So many have contributed and there is always the risk that some part would get omitted or downplayed.

In all the countries with advanced or large railways systems, the trend for the last three decades has been to employ train sets for medium and high-speed trains, either with two power units at the end or with distributed power over the train. The advantages are in no detention at terminals, faster acceleration, energy efficiency, operating flexibility etc.

There was a pre-eminent need in India for train sets for at least two decades. We had been debating the issue for nearly twenty-five years but, as usual, the debates led to hardly any positive action, partly due to prevalent departmental turf wars. When I joined as General Manager, ICF, I found that my team had the capability and the enthusiasm to do something new and we decided that we must build a modern train set at ICF.

The imponderables presented were:

- How do we do it without a sanction from the Board?
- This type of a project for de novo design and manufacture would take up to four years; what with leadership changes, would this be taken to fruition?
- Gaps between what we want to do and what we are capable of.

I addressed the three issues in parallel. Despite opposition from some key players in the Board, I was able to convince the then CRB to give us the go ahead, that came in April 2017.

For other issues, my answers were rather poetic: “Our doubts are traitors and make us lose the good we oft might win by fearing to attempt”.

I told the key team members that the days of their doubts were over; we were going to harness our technical chutzpah to design and manufacture the best train ever made in India, matching world standards. And to make sure that the project did not hit any roadblock with change of leadership, we were going to do it well before Dec 2018 and hence the name Train 18.

We finalized the concept in multiple meetings in March/April 17. Nearly all the countries, except France, have moved to a concept of distributed power train sets with under-slung electrics and only a cab and no power units at each end. The advantage in such a system were obvious: more space for passengers. Our design would be suited to our conditions and realities: a train capable of 160 kph operation without any fancy red herrings like 200 kph speed, tilting, super aero-noise etc. It was also agreed that we would do it all on our own without the crutches of any technology transfer.

Our matrix of main features of all train sets was broken down into three categories: where we were almost there, where we could be there with some handholding by superior intelligence and where we could be there with judicious selection of vendors, including import, but strictly as per our specifications and drawings.

IR General Managers have now been empowered like no other business heads in India. We exploited it to the hilt and quickly finalized consultancy contracts for:

- New bogie design with fully suspended traction motors
- Improvements in design, tooling and processes for coach shell
- Interior styling concepts

At the end of the day, that worked very well. Our teams worked smoothly with European consultants and evolved the final drawings based on their successive concepts. The ownership and IPR remained with ICF, in a first of its kind exercise on IR.

Judicious selection of vendors for all bought-outs is a major factor in successful development of a rolling stock. The key team decided the list of such vendors; whether processed through open, limited or single tendering, no scope was allowed for delays. We had to order only on those firms which the team considered capable enough.

With the consultancy contracts in place, design work at
ICF was started in parallel. Iterations in the design and successive rework on drawings, both mechanical & electrical, took some time but were inescapable. Many specific-domain and cross-functional groups with well-defined responsibilities were formed and daily interaction encouraged. These ICF team members and the key vendors worked tirelessly regardless of the duty hours and thereby hangs a tale. Suffice it to say that this process drew blood, sweat and tears of all the participants and most, nearly all, of them went about it with a level of determination not seen often in government organisations.

Quick finalization of procurement process helped in faster development of sub-assemblies by the vendors; unlike the regular way of our working, all the key vendors were an important part of the design process in this project. The vendors setup design teams specifically for Train-18 and, the drawing approval process in all the key areas was put on a fast track through discussions and iterations involving vendors, ICF and consultants. Some imported components required changes after validation and analysis; ICF and the vendors worked tirelessly to complete this process with speed. For example, development of a noise-free air conditioning system with ducting required development of multiple models for cooling flow and analysis and later multiple prototypes and redesign mid-way of the project even after approval of drawings; these processes were gone through without demur and disappointment.

The making of Train 18 was a leap of faith...Shubranshu

That we could make a world-class train with indigenous developed technology and supplies and with full ownership of the intellectual property rights has fired the imagination of the nation, accustomed to high cost imported Metro trains and airports.

The first Train 18 was built in a record time of eighteen months from conception, a feat unparalleled anywhere. It was also built at less than half the global costs, which will go down further with serial production. But, no less than its making, the testing and validation of this new train proved the speed at which we could deploy the train. Against a normal testing time of four to five months, RDSO and ICF teams were challenged by the Chairman, Railway Board to complete the job in one month. That required us to completely redraw the test protocols without compromising on the comprehensiveness and safety.

Precise schedules
The tests started at ICF which has about a kilometre of free track in its vicinity. Low speed trials, up to 30 km/h, done over a few days, included functioning of brakes, tuning of software, interoperability of various intercommunications subsystems, such as the brakes, propulsion, automatic doors, regenerative braking etc. The train was despatched on Nov 12 to Moradabad for medium speed trials of up to 115 km/h. Since we had a complete train of sixteen coaches at our disposal for oscillation tests (unlike single vehicle tests), we instrumented coaches of the same type for loaded and empty trials in the same run (normally separate runs for loaded and empty vehicles). It also required double the amount of instrumentation on the train for which RDSO had to rework the bottom of the barrel for all its accelerometers and transducers. Simultaneous and overlapping testing was done for brakes, propulsion, regenerative braking and their interoperability.

Tests were started at 70 km/h unlike the normal start at 50 km/h. Gradual scaling up was done in steps of 10 to 15 km/h and all tests were successfully concluded between 20th and 25th November.

The Train 18 was then taken to Kota for high speed trials on the Rajdhani route from 29th Nov to 6th December. All the tests done at Moradabad were repeated at Kota at higher speeds. Emergency braking distance Tests were done at both locations and returned excellent figures. A speed of 180 kmph was achieved and it was time to distribute sweets to all onboard, beginning with the loco driver. Even though the train was inherently capable of up to 200 kmph, the speed was capped at 180. This was followed by Radio Frequency Interference tests by SAMEER, the Society for Applied Microwave Electronics Engineering & Research.

The teams from the Motive Power and Testing Directorates & ICF toiled round the clock for weeks, carrying out runs and tests in the day and compiling data in the night. There were no weekends, no holidays and no rest days. The CCRS certificate for 160 km/h reached the Railway Board on December 21, the all smiles day for us.  

The Train 18 train set has successfully undergone all the statutory and performance related field tests. From L to R: C Madhusudan Rao, Executive Director. Train Set Directorate, Harid M Akhtar, Executive Director, Testing Directorate, Arindam Bhowmik, Director, Prashant Kumar Singh, Director (all from RDSO), Shubranshu, Principal Chief Mechanical Engineer, ICF and Khaleel Shaikh Durri, Sr Divisional Mechanical Engineer, Kota Division.
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‘A suave and effective team leader’

V K Yadav, Chairman, IR Board

One seldom comes across a person who is as simple and down to earth as VK Yadav and yet so effective in every sphere of work. His characteristic smile with which he greeted everyone charmed visitors and public representatives. His enthusiasm and dedication towards work were contagious, resulting in his team members mirroring his attitude, reaping rich dividends. I had the occasion to work with him and observe him closely when he was Divisional Railway Manager, Lucknow and I had joined as General Manager on the North Eastern.

I am now delighted to learn of his appointment as Chairman, IR Board.

Managing the unusual

Typically, I recall an event on his division in which two feuding public representatives were jointly chosen as chief guests by the Railway Ministry. Our problem was that both insisted on speaking last and a grim scenario was painted should their demand not be acceded to. It took all of Vinod’s charm to amicably settle the issue by persuading one of them to back off and eventually the function went off smoothly. We would often relive the explosive situation and laugh about our discomfiture.

Yadav achieved a lot in his tenure, but two things stand out due to their indelible effect. The first was the construction of cab ways at Gorakhpur and Lucknow stations, which earned the appreciation of the passengers. The second and possibly his biggest achievement was successful completion of the Gorakhpur yard remodelling work along with route relay interlocking work within a stiff target of six months. The meticulous planning and coordination by his team resulted in the project being completed in time, with a minimum of traffic disruption and without any major post-re-modelling complications.

His leadership style and personality traits are exemplary and ensure that the team he leads remains highly motivated and willing to take on any challenge to make the impossible possible. His experience of working in other ministries and with international organizations is an additional asset. I am confident that under his leadership and direction, IR will scale new heights.

KK Atal, ex-General Manager

VK Yadav has chosen his professional career path with an appropriate mix of railway engineering management and diverse fields of development management, public policy, project management and international multilateral funding. His stints with UNIDO, the GoI department of industrial policy planning and the DFCCIL reflect in his values, outlook, and approach.

He has been a colleague when I was working as a director in DFCCIL, and I always value his contributions and efficacy. Yadav’s wide experience and the multiple window canvass of exposure has helped him develop a human-friendly problem-solving focus. His disarming charming smile, even in complex and difficult moments, is a natural behavioral attribute that provides him admirable leadership style. He has the skills to create a happy working ambience for his team and the organization around it. Such a leadership style of motivation, essential for a gigantic organization like IR, should be his strength as he leads a transformation in the IR system.
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Technology and project wows in Roza: a showcase for the world

When the first diesel loco depot (a shed in IR speak) for the newly contracted EMD locos was built in Hubli (Karnataka), the scale and improvements over IR’s other diesel sheds were distinct and almost always generated a wow. Of course, the transition from the steam to the diesels, and later electric, were the earlier wow moments. The Hubli shed was different as it was grander in scale, laid out as it was on a green field, unlike most diesel sheds that were on converted steam shed sites.

An upscale vision
The EMDs also came in with different upscale technologies like AC traction on the axles, upscale electronics and above all greater reliability and traction efficiency. The new GE and Alstom loco sheds being built for homing their new design leased locos for IR are the new wow moments, not for the grandeur of the construction, but for the deployment of the most current technologies and the very different business plans.

As reported earlier, the projects involve long-term leasing/purchase agreements by IR with GE and Alstom for new designs of locos, to be mostly manufactured in new factories on IR land, under JVs set up for the purpose. Prototype electric and diesel locos have been offered for IR certification with the GE locos permitted for freight operations up to 65 kph. New loco factories have come up at Madhepura (electronics) and Mathowra (diesels). This report updates the progress made on the deployment of the diesels from the Roza base, the latest of the wow moments on IR loco history.

Three streams for excellence
Sharan Singamamala, head of services organization, GE Transportation South Asia, looks back at what has been achieved on the diesels and in Roza, terming the effort as a merger of three streams of quality project management (infrastructure design and build), of systems and processes that work in the background and of developing HR resources in an area not replete with industrial resources.

He adds that GE targeted that the Roza facility must match the best in class right from the project concept stage. The resulting wows are now displayed as one goes around the facility, admiring the vision and processes deployed to create the infrastructure within the stipulated project lines.

**A showcase for the world stage**
GE manages about 80 maintenance sheds for its customers the world over but could count Roza as worthy of being showcased to a world audience of current and potential rail companies. The defining aspects are the unique business model that merged IR resources and needs with GE’s skills, resources, and developmental potential. A gathering of world rail experts could take place in 2019 with Roza taking the center stage for world’s attention. That would be a proud moment for India and all IR managers and experts connected with the project. In effect, the India model would be marketed for an international client base, a true example of the Made in India thrust.

The first 50 locos have been imported and have already undergone pre-commissioning checks by IR teams on a plan prepared by RDSA. The Mathowra loco factory is already working on loco numbers beyond the 51 one and this stream is expected to join the fleet in early-2019, at the expected rate of 100 locos per year. While the bulk of these will be 4500 hp design like the current ones, the contract provides for a later shift to 6000 hp prototypes also.

Roza has been designed for homing the first 250 locos, with the sister shed at Gandhidham servicing later inductions. Construction of the sister shed there has started in Oct 2018, well in time for the expected 2020 completion.

**Advance preparations**
A physical tour of Roza with Rajneesh Sah, Dy General Manager, and his colleague Dheeraj Mishra
fills in the wow details. Even before a loco has entered the inspection bay, its operational footprints have reached the GE personnel and the loco records auto-populated for on-arrival attention. Any part replacements needed would have also been located in the high reach warehouse and made available to the service personnel, perhaps even before the loco clocks in. The loco would cross a laser-based wheel profile check (being installed in line with the service bay), and, if needed, visit an India made underfloor wheel lathe also under installation.

With easy access and fill-in for lube oils and deionized water from well-laid pipelines, it would be just a few hours before the loco is made available for the next tour of train service; it may be up to 92 days before the loco touches Roza again.

Working to a US model
Sah points out the five service bays that are specifically designed for the expected workload of minor and major schedules, with one specifically for any service wrecks. This heavy wrek repair bay, expected to be used sparingly, is necessary as GE practices ‘do not call for intermediate overhauls in the shed’, as in the IR practice. The maintenance concept is different from the IR practice of attending to major assemblies within the shed premises; unlike as in the IR shed designs, one does not see any area for the truck, electric machines, compressors, traction controls, air brakes and the like.

Sah explains that GE reliability performance ensures much lower generation of such out of course repairs and that these would be attended to in the backup facilities like the GE Multimodal Factory at Pune or by the GE vendors. That would be a major difference over IR practice. The vision is simply expressed, ‘the locos should stay the least in Roza and fail hardly ever in service’. GE’s specialty remote monitoring would catch any incipient failure before that happens.

Big tech is watching!
That naturally takes us to the remote monitoring and diagnostic center (RM&D) that is in conversation with all GE locos operating in India. The electronic handshake is constant with immediate talk in case of a service issue and a possible ‘red button attention’; otherwise the data transfer conversation takes place every 10 minutes. The RM&D responsibility lies with RK Singh, an ex-Air Force expert who sits alongside his 3-station voice response team, facing a large screen video display that shows the exact location of all the GE locos, flipping to any service messages at a mouse click.

With only 19 locos in IR service on the day of the visit, the call upon toll-free 18001296688 is yet limited to about 30 calls per week, but this will go up as two or three locos join the IR fleet every day in coming days. One can well imagine the conversation and action load when all the 1000 contracted locos join service in about ten years from now.

Live attention
Dec 18, 2018. 11:30 a.m.

Singh explains that at present the interaction with IR driving personnel is more on ‘how to’ and any service disruption has not occurred so far. As we absorb the uber-technical ambiance, a driver instructor calls in to report with a message that ‘lube oil level in 49018 shows add + …’. The service team responds that ‘this is an advisory message and the loco is fit to run till its scheduled service time’.

In another case, a driver on 490002 messaged that his power control switch that operates as an emergency override had tripped as he was at 30 kph and the brake pipe pressure dropped. He was advised to check on the brake pipe connection between the loco and the train. Presto! The message works, and the driver avoided unnecessary sweat as the train resumed its run in a few minutes.

As the IR loco driver fleet gains numbers and skills, this call-up service should prove to be good on job help like to a driver who did not go through the startup safer protocols and could not crank a loco. Singh expects many more success stories over the next few months.

The GE/Cisco designed service center uses GE’s SFDC tool as the base. This service is person to person and currently unique, that is why it is an unexpected background wow.

And the people wow
Roza is the antithesis of a technological center like Bengaluru that is replete with the right manpower, finding the right people to man positions in Roza may not have been easy. GE has been able to tap in diverse experience backgrounds, with experts from the armed forces, the IR, IC engines and auto sector maintenance interacting with us on a single day. This is a microcosm of India in action.

Singamala points out that GE had a well-planned recruitment strategy that went beyond just offering a competitive package. After an initial
The project is expected to bring in a paradigm shift in IR manufacturing and maintenance philosophy for locomotives. The contract, structured in a way to promote Make in India, envisages equitable allocation of risks and responsibilities offering adequate flexibility to the contractor to innovate and improve performance. This performance-based contract specifies KPIs like availability, reliability and fuel efficiency and failure to achieve a threshold performance would attract penalties.

... Ms. Manju Gupta, Additional Member, IR Board.

For AK Singhal, Divisional Railway Manager, Moradabad, Roza has added a new dimension to his division that lacked a diesel shed till the commissioning in 2018. These locos will operate predominantly on the coal circuits, often far from the divisional base, providing his division with a longer footprint. The exact circuits for the GE diesel operated trains are evolving, with current coverage on the Northern, East Central and the North Central Railways. Singhal added that his control staff and crews are motivated to work on these advanced locos and cooperation for the loco build up has been positive.

Senior executives in the IR Board who are responsible for the JV contracting and operations also expressed satisfaction that GE has delivered its locos and the infrastructure on time and in full compliance. As the home base grows to near 250 in the coming two years, Roza will be an important contributor to the fluidity of the freight traffic in the identified operational circuits.

A batch of loco drivers from IR under training in Roza. Each driver is trained and certified on the CORYS driving simulator before they can handle a train.

batch of about 12 persons for supervisory positions (that depended on ex-IR personnel also), they recruited 25 diploma holding youngsters and trained them in the Roza facility for technician positions. As we visited Roza, these youngsters were being trained in cross-functional disciplines to ensure multitasking abilities. The recruits undergo a 3-stage training, covering basic cross-current theories, an on-site curriculum and on job work under oversight.

The 60 recruits are expected to fill in current needs, particularly as the manpower expected for these modern locos with high availability records and the remote diagnostics, will be much lower than the benchmarks worked in IR shed currently. The training center is being equipped with a 12-cylinder diesel engine that would permit near live attention to various assemblies before the technicians can work with their hands on the real thing. The success of the GE apprenticeship model, particularly at Marhowra, has been recognized.

Training the drivers
Roza has also been contracted to train drivers for the GE locos and already about 600 persons have qualified from this well-equipped facility. The Roza familiarization and handling courses over a weekinclude a basic introduction to the GE loco features, driver interfaces and troubleshooting diagnostics including the computer-assisted onboard diagnostics.

An impressive CORYS dynamic simulator mirrors the GE loco all the way, using a suitably aligned visual display that honours the Indian landscape and ambience and all the operating rules and service conditions that drivers on IR train face. A driver is expected to develop the right feel and muscle memories of the loco traction and braking capabilities. The facility should train about 800 persons per year, enough to catch up with the 4 crews per loco in service that is likely.

A 60-bedded hostel provides a high level of comfort and convenience, with well-designed accommodation, packaged with entertainment and an equipped gym too. That should be enough for IR drivers to opt for GE training courses, rather than being forced to attend.

A look back on the lighter side

A 100 years ago, the loco colony next door to the steam shed would have been full of coal dust covered residents as they came back from operating steam locos that belched black smoke continually. After a shift’s work where the firemen would have shoveled a few tons of coal into the boiler, the colony, howsoever shabby, would have been a good repose.

It was another matter that the ‘loco colony’ was not up on the social scale that railway employees reckoned; the loco men were often illiterate and considered brash. But it was the center of the little town.

What remains of that colony is now being demolished for rail access to a rail welding plant planned nearby. During the years before the GE shed came up, the colony had practically gone to seed, and a local sindian population had owned the area. As the GE facility came up, the ownership of the area was in dispute that is now partly addressed by a leased langur who, with his master, roams the area, keeping the shed area free of these past masters.
Induction of GE locos in the IR fleet marks the beginning of a third wave of major technological jump in diesel traction following the ALCOs (1960s) and the EMDs (1990s). GE has delivered on its commitments, with 50 locos already on offer as per contracted timelines.

This induction also marks a major milestone in the Make in India initiative towards modernizing rail infrastructure. This PPP effort has been possible through strong collaboration between IR and GE.

This project has a 26% equity stake for IR, a total investment of about ₹13,000 Cr and includes supply of 700 x 4500 hp and 300 x 6000 hp locos over 10 years. Two of the 6000 hp locos have already been shipped directly from USA.

These locos incorporate various current elements like electronic fuel injection systems, auxiliary power units, for better and guaranteed fuel efficiency, emission compliance to UIC 1 norms, first time in India, IGBT based traction system, and are digitally enabled, setting new standards for availability and reliability, with a remote monitoring and diagnostics backup.

These locos are provided with many features for the driving crews comfort like HVAC, hot plate, heated windshields, toilet, etc., one of our prime focus areas.

After fulfilling the tedious initial performance trials and salutary approvals, these locos have started the operations silently.

Northern Railway has been the key beneficiary of the GE project as the first 250 locomotives shall be based in the depot at ROZA. NR provided the necessary assistance such as licensing, loco movement, and oscillation trials, etc.

The initial field response has been very encouraging, and operations have started without any issues. The crews have appreciated the locos and shared good acceptance. The initial constraint of limited trained crews is also being gradually overcome. Due to their guaranteed reliability and availability, these shall be the preferred locos for operations in some congested and critical railway sectors that have been identified.

ICF installs India’s First VR Driver Training Simulator

ECOSAFE - India’s First Virtual Reality Driver Training Simulator, designed specially for Train-18, was successfully commissioned at the Integral Coach Factory Design & Development Center in Chennai. The Simulator not only acquaints loco pilots with the cockpit and operations of the new trainset, it also measures driving efficiency by providing energy-consumption based scoring results as well as helps improve emergency response time by simulating unfavorable weather conditions and incidents and measuring driver response.

In addition to a realistic driving experience with a full-scale driver cab and actual driver’s desk with all switches and controls, the simulator provides added realism by using Virtual Reality as the primary mode of operation. Additionally, a desktop display mode duplicates the ongoing VR simulation. The software allows multiple training scenarios over one VR World (route) in one train (in multiple configurations). Future extensions for multiple routes and trains are possible.

The modular software structure allows easy customization and the train, scenery, signalling, and routes (track) are all modeled as per actual Indian conditions. The simulation engine is based on the actual physics of the trainset ensuring acceleration, braking, displays, and other features exactly replicate the real train. The system uses a combination of VR controls along with real controls and some controls are available remotely (e.g. for the Trainer Module). Software maintenance, upgrades, and add-ons can be performed remotely.

The key benefit of the VR technology is that while providing complete realism and functionality except motion] of a full-size simulator and with added VR realism, the simulator is available for a fraction of the cost of a full-blown simulator and requires minimal infrastructure. Its compact size and low cost allows massive scalability.

Conventionally, to get training, a loco pilot has to take a ‘leave-of-absence’ from duty and travel to a Training Centre. Given the shortage of train drivers and the cost of training, this is not always possible. With the EcoSafe concept, now, for the first time, it is possible to bring the trainer to the trainee, as the system can be installed in various driver-waiting lobbies.
Innorrail 2018 provides improved dialogue

‘A period of long status quo has been challenged with the formation of four verticals, targeting better usage and class of special technical resources’... Virendra Kumar, Director General, RDSO.

In an exclusive interview, he pointed out that different directorates in need of a common tool like finite element analysis would struggle and deploy independent resources for a generic solution. Product approvals, instead of process approval, meant long time periods for action and lack of specialization in the deployment of such tools that have become basic to most design functions.

The IR Board has already approved these four verticals of administration, quality assurance, design, standard and short-term research, and long-term research, the last aligned to the much delayed Srstha initiative. Each of these verticals will report to a head; thus, the QA functions under mechanical, civil and signalling functions would be assimilated under a single vertical head. Kumar adds that this would pool resources, permit application of more modern approaches and do away with time delays that occur when personnel do not have the skills and the bench strength for addressing issues.

Another example is that of diesel and electric locos, electric and diesel multiple units and diesel engine development that existed as separate directorates, reporting to the DG. These were often involved with ‘turf battles' and suboptimal resource usage. This will now be corrected with clubbed functions leading to skill and resource consolidation. This re-organisation has already led to a leaner setup, with a near halving of executive director positions, each of which was an independent decision center earlier.

Addressing ongoing operational developments, a trainset directorate has been carved out from existing resources of the motive power (diesel traction), electric loco and EMU directorates. The detailed mandate for this change is now under internal discussion.

All laboratories are being revamped and modernization of design and testing infrastructure is in process.

Headway on SRESHTA

Another step forward is the Board’s acceptance of a draft project report (prepared by an Australian consultant) for setting up long-term research center around the much talked about SRESHTA initiative. This approval that had been held up for some time now comes with a caveat: it was earlier proposed in the project report that SRESHTA would be independent of RDSO and instead function under the direct control of the IR Board. This has not been accepted, and the long-term research function would now be a key vertical under the DG RDSO.

It is understood that SRESHTA would be allowed to develop a specialised research cadre, including by direct recruitment of specialists. That process may be some time away as IR needs to define and issue relevant recruitment rules that define cadre controls and related issues.

SRESHTA would have customised authority schedule for ‘creating an enabling environment for specific research activities’. This vertical would broadly function on the ISRO/DRDO model. Cooperation agreements, already been agreed to with respected institutions like the Japanese RTRI and South Korean KRRl, will need to be converted to defined projects.

The 2019 palette

‘Winds of change are now blowing in all the areas of rail operation and management: stations are being improved, ticketing and a whole lot of passenger interfaces are being upgraded. On the technical front, mobility has been a cause of concern and multi-pronged strategies are being formulated.’

Kumar’s wish list for 2019 is based on current successes as he lists the rail fracture detection system, safety linked train control TCAS, induction of the on-trial Train 18 trainset into commercial service, standardisation of the 3 phase traction propulsion for multiple unit train EMUs, fog vision for train drivers, and clarity on introducing 25 t axle load wagon operations, particularly on the dedicated freight corridors.

The intervening months could have been used by RDSO to pinpoint specific projects for execution under this research thrust, kick-starting these now but that has not happened so far. These projects must be
Key concerns on deployment

On the eve of INNORAIL, Kumar listed his technological expectations from the exhibits and interactions:

- Automatic train protection: IR's internal development of the Train Collision and Avoidance System TCAS. Extension of the system to 1100 km has been sanctioned.
- Reliability and maintainability through better equipment and online monitoring.
- Higher speed operation through Train 18 and similar products.
- Better passenger comfort: improved passenger conveniences and information, including on-board and content on demand.
- Improving rail structure to permit 25 t axle load operation.
- Artificial intelligence, IoT, big data and analytics.
- Improved rail maintenance through automation.
- Bridge health monitoring.
- Automated inspection systems for rolling stock (SMART Yards) and onboard condition monitoring.
- New design wagons for specific commodities.

Kumar has earlier contributed (1999-2003 in an earlier spell in RDSO) to wagon design development and recollects the introduction of the light weight CASNUB bogie frame, the design for the 8 wheeled freight brake vans and the pilot introduction of 60 wagons with bogie mounted brake systems. The latter is now a standard for most new IR wagons. He was also involved with the trials and clearance for freight train running at 100 kph max.

Kumar appeared hesitant in naming mentors, perhaps avoiding offending those not mentioned but recalls that he was impressed with the soft skills of his senior NP Singh, then Exec Director in the wagon directorate. He adds that Singh was a team man, on excellent rapport with all departments in RDSO, and almost never lost his cool.

A graduate from Roorkee, Kumar had a two-year stint at Petrawon thermal plant and has seen IR postings all over the network. As he looks back, his advice to younger IR engineers is that they have faith in technology.

And the simple and forceful: 'deliverance is the key, everything else is just a process'.

He would like the young managers to judge their strengths and work on them, delivering on time, every time.

The wagon bogie imbroglio

Considering his past association with wagon design, we could not but ask him about IR's inability to induct a new wagon bogie even though two major initiatives were launched with a well-known manufacturer and a design company (both from the US) some years back and substantial work was carried out on both projects. While one project has run into precontractual problems and current arbitration, the other seems to be stalled also.

Kumar indicated that his wagon team could work on developing their own wagon bogie design, but that is much into the future. RDSO/IE is also working on proposals for easing the acceptance of new bogies offered by investors under the wagon leasing/ownership schemes. The details may be made public in the coming months.

Partnering with vendors

RDSO has initiated steps to improve vendor out-reach and interface, with more than 35 interactive vendor meets held in cooperation with professional bodies like CII, MSME associations etc. in industrial centers across the country.

'Our prime concerns have been quality, technological upgrades, improving efficiency, enhancing train speed, and increasing throughput. I am very hopeful and excited that events like INNORAIL will greatly help in creating awareness at the functional levels amongst decision makers from all IR wings and help in charting the future technology roadmap.'

Kumar feels that the new vendor and design change approach should compress project times from a near three years earlier to maybe six months. He is determined to watch changes and ensure promised delivery and the RDSO interaction process has been eased with nearly 150 procedural changes, each smart though small.

Shipment acceptance on WTC

RDSO QA has been authorised to accept qualified manufacturers' work test certificates and the time-consuming lot inspection processes will be broadly avoided. RDSO should soon be deciding on the items and industries that would qualify for this fast-track process. Another significant step involves simplifying product specifications, to take out repetitions and verbosity.

For easier vendor development processes:

- Online system for vendor registration, with system generated alerts/messages to stakeholders at every stage.
- Clear timelines, defined and shared in the public domain.
- Process cycle time drastically reduced from 30 to six months (excluding field-testing time).
- Open-ended EoIs published for all 641 'RDSO controlled components'.

On the international stage

In continuation to discussions held during InnoTrans Berlin 2018, regular meetings with industries have started with a follow-up meeting in Dec 2018. As reported earlier, a possibility of India joining INNOTRANS as a partner country in the 2020 show has emerged. That would mean that various Indian exhibitors are clubbed together under a single canopy with India specific presentations and meetings.
Raising the quality bar for Indian rail industry

For Sachit Jain, Chairman, CII Northern region, railway is an act of belief, as he grew up in a railway colony, taking in the 'spirit of togetherness that IR instills'. In his address at the inaugural event, he shared his vision for a 'more business-like approach' by IR arms, pointing out that raising quality levels by institutionalised methods is the way forward. He charted that manufacturing industries for the rail sector need to invest and plan for quality test processes and instrumentation to raise the QA bar significantly.

Building in quality

Jain interacted with us on the side lines of the conference, pointing out that the IR procurement procedures, like other government entities, focus on the lowest bidder (the L1 syndrome) for awarding work and supply contracts, with quality aspects almost creeping in as afterthoughts. Under the L1 process, the concerned department examines various offers, shortlists the vendors, and commercial offers are then evaluated. The L1 is selected and awarded the tender. A common criticism many a times is that the contract is awarded to L1 and not to a vendor with much more sophisticated/better equipment/material, may be virtually costlier than L1 at the first sight.

'The bridge has to be forced to ensure that quality material is procured'.

Suggested re-emphasis

- IR should specify a minimum technical specification and quality for all input materials viz. steel, copper, alloys, etc. This will lead to application stage rejection of the vendors having non-compliant materials.
- As technology is advancing at a fast pace, there is need to build in processes, identify new vendors and encourage existing vendors to keep pace with the changing requirements.
- Choice of forward looking vendors is a critical to long term well-being. Main and sub-assemblies are generally provided by large vendors. In this sphere also, it is important to consider changing requirements and advancements.

Monitoring water erosion on bridge foundations

Work has begun on installing structural health monitoring systems on a series of river and sea bridges across India. These new contracts come as part of a recent push into the Indian market by Strainstall (local Indian partner Tranz Rail Solutions). The first installation will be on India’s second longest rail bridge, the two km structure iconic Pamban Bridge connecting the island in Tamil Nadu to the mainland network. Further three bridges in Assam, two in the Mumbai area and two in North of Delhi are also planned.

IR is keen to deploy scour safety systems on its river bridges to provide real-time alerts in the event of heavy rain or flooding. Scour is the primary cause of bridge failure, occurring when strong currents remove and alter the river or sea bed around a bridge pier, potentially undermining bridge foundations, and destabilising and weakening the structure.

A team is installing scour sensors on each bridge to monitor river or sea bed levels, then Smart Asset Management System software will be used to store, analyse and report the data. This will provide bridge managers with the information to be able to effectively target resources to the bridges deemed to be at greatest risk.

Strainstall’s scour monitoring that uses a solar-powered autonomous real-time river bed depth monitoring system is installed on each bridge and a sensor uses sonar acoustic technology (a 'ping') to regularly measure the river bed depth on both upstream and downstream piers. This information is processed by an integrated data logging system which uses high frequency wireless transmission to send information about the varying depth of each pier and 3G/4G data transmission to take the information to cloud-based server. Data is channelled through a dedicated and specially configured web portal which gives the customer real-time information on river or sea bed depth.

'We are excited to be working so closely with IR which means our bridge monitoring systems will have a positive effect on the network safety. Several recent bridge collapses could have been prevented through real-time monitoring, and we aim to demonstrate our effectiveness on these first projects.' Damian Griffiths, Regional Manager, Strainstall Malaysia.
New BONATRANS wheel for LHB/Fiat bogies

17 cases of wheel breakage have been reported since 2005 on IR’s LHB coaches, including two in April 2018. BONATRANS has responded with a physical redesign of the shape and offered an optimised material that should eliminate service problems faced on the existing version.

'A new BONATRANS wheel is a typical game changing innovation based on the data mining analysis, so typical of 4.0 industry revolution.'

—Vijay Kalyani, BONATRANS India.

The Fiat/LHB bogie, the most widespread type used for passenger rail in India, uses wheels which, unfortunately, have not been trouble free. It is the reason why BONATRANS has, as a problem solver, stepped in with its best to improve the design and eliminate such cases.

A new design wheel has been developed based on BONATRANS’s FRACAS methodology: Failure Reporting, Analysis, and Corrective Action System.

The main idea of new design was easy and could be summarized in moving of critical point from the thinnest part of web to the thickness part of the web including large cut-down of the level of maximum fatigue stress due to all combination of the possible loads in real service. The calculations were not so easy, with strength calculation made by Finite Element Method using MSC Marc and Nastran software. With a proper setup of all boundary condition by BONATRANS engineers’ team, the wheel strength analysis was successful, and the new wheel could be optimized from shape point of view.

The material specification could also be changed for improving resistance of wheel against wear, rolling contact fatigue and thermal cracks which form by the heat created on the tread profile from wheel slip on the rail.

Three main benefits with the new BONATRANS wheels:

- Higher safety through better web shape; cracked wheels will quickly be forgotten history.
- Decreased maintenance cost through lower frequency of wheel changing. BONATRANS estimates that two changes of the new wheels will replace three changes of original IR wheels.
- Lower weight.

Material upgrade

There is no single material that ideally fits all types of rolling stock and operational conditions and the aim of development activities has been to find the right match for various conditions, optimizing and balancing among hardness, tensile strength, and fracture toughness. Further improvement could be achieved by using BONATRANS specially developed material with higher resistance against wear and rolling contact fatigue. BONASTAR® solution sets itself apart from other materials in the market due to research and development over the last ten years. The BONASTAR® family of improved steel grades for wheels can be offered that can bring 10 to 30% savings in life cycle costs.
A voice for preservation

An issue close to my heart is the restoration of the MG section of Haflong Hill from Mahur to Harangjiao on the NFR. It is a 40 km MG section, abandoned since 2015, over Haflong hill that remains undisturbed after the broad-gauge conversion of Lumding Badarpur route. The BG route is diverted to the opposite hill of the Jatinga river valley.

Construct in 1899 to 1904 to connect the crude oil production and tea gardens of upper Assam to Chittagong port, this was the "MG main line" of the erstwhile Assam Bengal Railway. The bridges on this section are unique in that these are constructed with a curve and a gradient as part of the route. A few tunnels and several vantage viewing points dot the route.

One way to restore this railway heritage would be to invite private sector to develop the line as a tourist destination in Assam and club it with tours to Kaziranga. It could be used for steam railway tours and other activity like trolley rides, mountain biking, nature trails etc. On clear days, the railway could also offer exceptional viewing points of the Jatinga River Valley. I would say that this section is long enough to be included in the group of "Hill Railways" of India along with the DHR and Kalka-Shimla and later inscribed by UNESCO as a world heritage.

A good starting point now would be to ensure that the alignment is not tampered with for other projects and it is kept free of encumbrances for future development. ISRS will work in this direction, but this will be a long haul project that is but a dream right now.

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2419 D now preserved in history

Special coach 2419 D, much like the old railway saloons that still run on IR, has a special place in history and in railway lore. This historically precious coach, destroyed in the closing year of World War II, duplicated with all its solid teak wood livery, was put on the world media stage as France and Germany commemorated 100 years of the end of the War in special events in a reconstructed memorial at the small (now abandoned) station Compiegne, 60 km north of Paris. This originality has been partially preserved by leaving the embedded rails at the memorial location.

2419 was owned by French Marshall Foch and the 1918 signing of the Armistice took place in this carriage, chosen as it was remote and discreet and protected from any detection by the Germans. The Armistice was the result of a hurried and desperate process. The German delegation crossed the front line in five cars and was escorted for ten hours across the devastated war zone and taken to Compiegne destination aboard a private train parked in a railway siding.

Reversed roles, again in 2419 D

Adolf Hitler did not forget the event and the Germans had their revenge in 1940, when another accord signed in the same railway carriage in the same place forced France to end fighting in the initial years of World War Two, essentially marking a French surrender. It is said that Adolf Hitler sat in the same seat that Foch used in 1918, adding to the deliberate humiliation. The carriage was exhibited in Germany but was destroyed in the closing year of WWII in 1945. 2419D now has a permanent place in history and railway lore.
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