Working of Suburban Section with overaged Infrastructure of Sealdah Division

Experiences & Innovations

S.N. Panda,Dy. CMM/C/MLG
M.K. Agarwal,Sr. DME/O&F/LKO
Rajesh Prasad,Sr. DEN/Co-ord./SDAH
N.K. Siddiqui, DEO/Bangladesh/Rly.
Jaya S. Chauhan, CSC/RPF/NER

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Project Guide:- SPCE

Working of suburban section with over-aged infrastructure - Experience and Innovations.

Synopsis.

East Bengal Railway was formed on 1.7.84 and Sealdah division became the part of E. Railway on 14.4.1952 after the organization. The division caters mostly suburban traffic of approximately 700 trains per day. The division is having problems of encroachments, trespassing, poor drainage, heavy pressure of running of suburban traffic etc. The division has been neglected for a quite long time resulting increase of no. of rail fractures, derailments, imposition of Temporary Speed Restrictions etc. After inception of SRSF a lot of works were required to be undertaken. In this paper, experiences, innovations done for improving the division have been highlighted.

1.0. Introduction of Sealdah division.

The Railway network under the jurisdiction of Sealdah Division earlier formed the Western part of Eastern Bengal Railway. Then eastern Bengal Railway was formed after the State acquired the lines owned by the Eastern Bengal Guarantee Railway on 1st July 1884 and amalgamated with the North Bengal State and South Eastern Railways. On 1st July 1942 Assam Bengal Railway and Eastern Bengal Railway were amalgamated to form Bengal Assam Railway system which was divided according to the political boundaries and Sealdah Division became a part of Eastern Railway on 14.4.1952 after reorganization.

1.1. Boundary of the Division

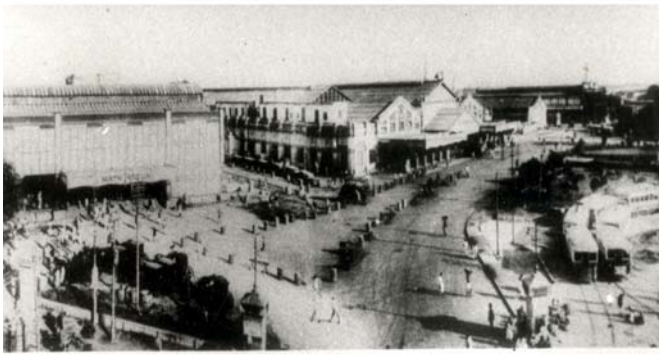
Serving six major Districts of the State, this Division covers the geographical Land mass between river Hooghly on the west, Bangladesh on the north and the Eastern side and the Sunderbans flanks. Kolkata is the Central Business District of West Bengal and the flow of passenger traffic is basically centralized towards Kolkata. The Sealdah Terminal is more or less situated in the centre of Kolkata and thus Sealdah Station itself plays most vital role in management of suburban traffic. Another terminal at Chitpur is sanctioned and is in advance stage of completion.

1.2. **Important Places**

Kolkata, Barrackpore, Diamond Harbour, Dakshineswar, Bally, Krishnanagar City, Nabadwip Ghat, Murshidabad, Plassey, Shantipur etc. attract visitor in a large numbers throughout the year due to their historical and ritual background.

1.3. **Other details of the Division**

The Sealdah terminal has two sub-terminals viz. Main/North corridor and South corridor. The main corridor is further divided into three spurs – one from Dum Dum Jn. towards Dankuni (Howrah Division), second towards Naihati – Bandel (Howrah Division) – Ranaghat – Gede, Ranaghat –Shantipur, Ranaghat – Bangaon, Kalyani – Kalyani Simanta, Shantipur – Krishnanagar City – Nabadwip Ghat (NG), Krishnanagar – Lalgola and third towards Bangaon – Barasat – Hasnabad. In South Budge Budge line takes off from Ballygunge station. Canning section start from Sonarpur, Lakshmikantapur – Nischindipur and Diamond Harbour branches takes off from Baruipur. The narrow Gauge section Shantipur – Krishnanagar City – Nabadwip Ghat. There is linking between Main/North section and South section via Kankurgachhi – Ballygunge chord line. Dum Dum Jn. also plays an important terminal where Metro and Circular railway terminates ex. Tollygaunge and Princep Ghat respectively. This Division also serves Bangladesh Railway Traffic via Gede and Petrapole.
Photograph of Sealdah Station is as follows:



(75 years back)

(as of now)

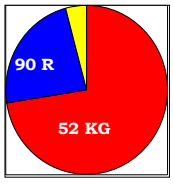
Old and new SDAH station photographs showing the metamorphic changes, which are taking place.

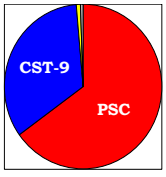
1.4 Typical problem of the division is heavy pressure of running suburban trains (700nos.) on tracks having nil cushions of ballast and on 90 R rails and CST/9 pots. The system map of Sealdah division is attached as **Annexure 1 & 2**. The corridor blocks have been provided during night only and details are annexed as **Annexure – 3**. The problems are further compounded with 1400 nos. of vacancies of gangmen. The vacancy problem was further aggravated because of poor literacy of gangmen as of now. These two statistics are available at **Annexure 4 & 5**. The typical track structures as on 1.4.02 and 1.4.05 are as under:

TRACK STRUCTURE

(Only Passenger Line) (As on April '02)

RAIL			SLEEPERS		
BROAD GAUGE					
52 KG	802.91	KM	PSC	718.77	KM
90 R	255.18	KM	CST-9	370.12	KM
90 BS	47.30	KM	WOOD	10.30	KM
			ST	6.20	KM
	1105.39	KM		1105.39	KM

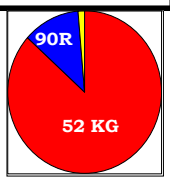


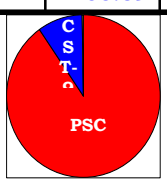


TRACK STRUCTURE

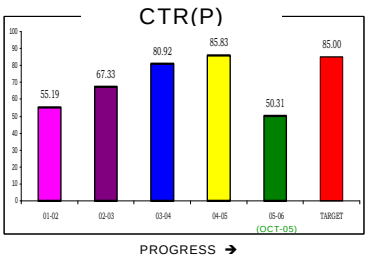
(Only Passenger Line) (As on April '05)

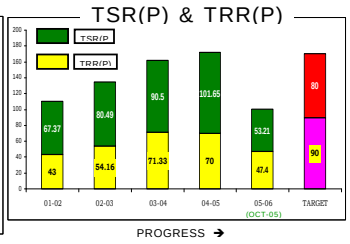
RAIL			SLEEPERS		
BROAD GAUGE					
52 KG	956.79	KM	PSC	998.87	KM
90 R	132.30	KM	CST-9	102.22	KM
90 BS	16.30	KM	WOOD	4.30	KM
	1105.39	KM		1105.39	KM

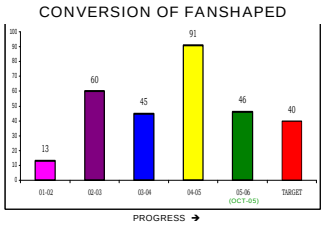


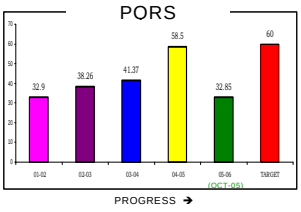


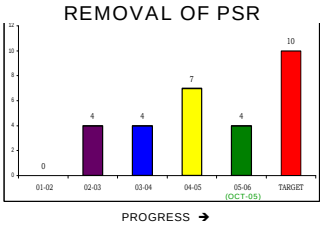
1.5. Progress of CTR(P), TRR(P), TSR(P), Deep screening, Permanent speed restriction, removal of LWR conversion are as under:

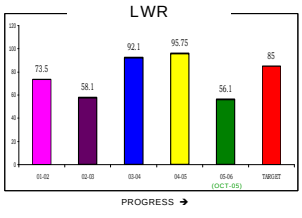


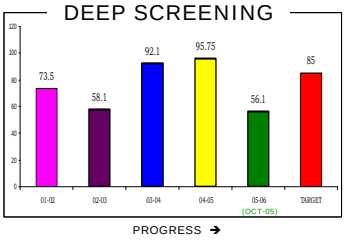












Progress in last 3.5 years	
CTR(P)	284 kms
FSLO	242 nos.
PQRS	172 kms
PSR removal	19 nos.
Deepscreening	303 kms
LWR	302 kms

Nearly **200 crores of Rs.** has been spent in last 3 ½ years by the division. Similarly more than 13 crores have been spent on the Passenger Amenity items. Facts and figures about the expenditure is as under

EXPENDITURE ON PASSENGER AMENITY

(Fig in thousand of Rs.)

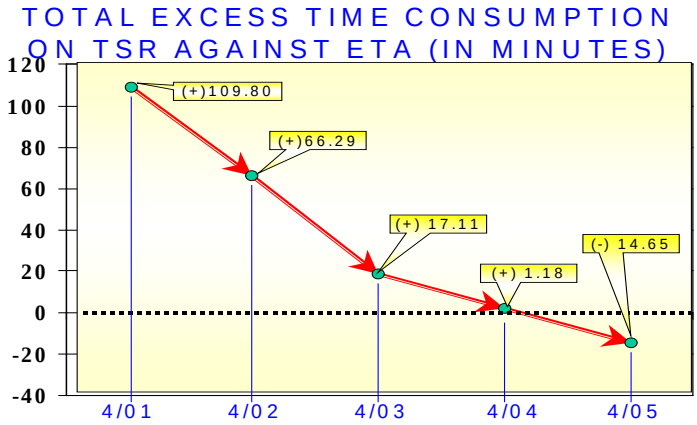
Year	Expenditure during last three years.	Final grant	Expenditure
2002-2003	DRF	1270	1942
	DF	40077	40369
	OLWR	230	0
	TOTAL	41577	42311
2003-2004	DRF	700	417
	DF	32465	35541
	OLWR	0	0
	TOTAL	33165	35958
2004-05	DRF	4809	5266
	DF	43038	43634
	OLWR	50	0
	TOTAL	47897	48900
2005-2006	DRF	3230	2184
	DF	50336	7080
	OLWR	125	0
	TOTAL	53691	9236

Expenditure & Allotment'05 under

FIG IN CRORES.

Year	Original Grant		Final Grant	Expenditure
2002-03				
PH - 31	SRSF	37.78	35.00	37.89
PH - 32	SRSF	8.06	8.5	8.58
2003-04				
PH - 31	SRSF	44.34	49.02	52.45
PH - 32	SRSF	4.76	2.41	2.83
2004-05				
PH - 31	SRSF	48.00	72.00	65.21
PH - 32	SRSF	08.00	3.20	3.38
2005-06				
PH - 31	SRSF	60.00	0	51.22
PH - 32	SRSF	3.14	0	0.28

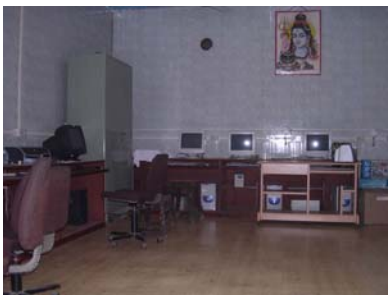
Over a period of time a lot T.S.R.s have also been reduced as per the following:



2 .0. Infrastructure required and to be developed - in order to meet the requirement, it was necessary to develop the proper infrastructure for monitoring and execution of the works. The following infrastructures developed by the division need to be highlighted.

- Engineering Control (100% computerized)

Engineering Computer Cell (having all modern techniques facilities).



The outputs, which can be generated and monitored, are attached as **Annexure 6-10.**

3.0. Experience and innovation.

3.1. PQRS portal base:

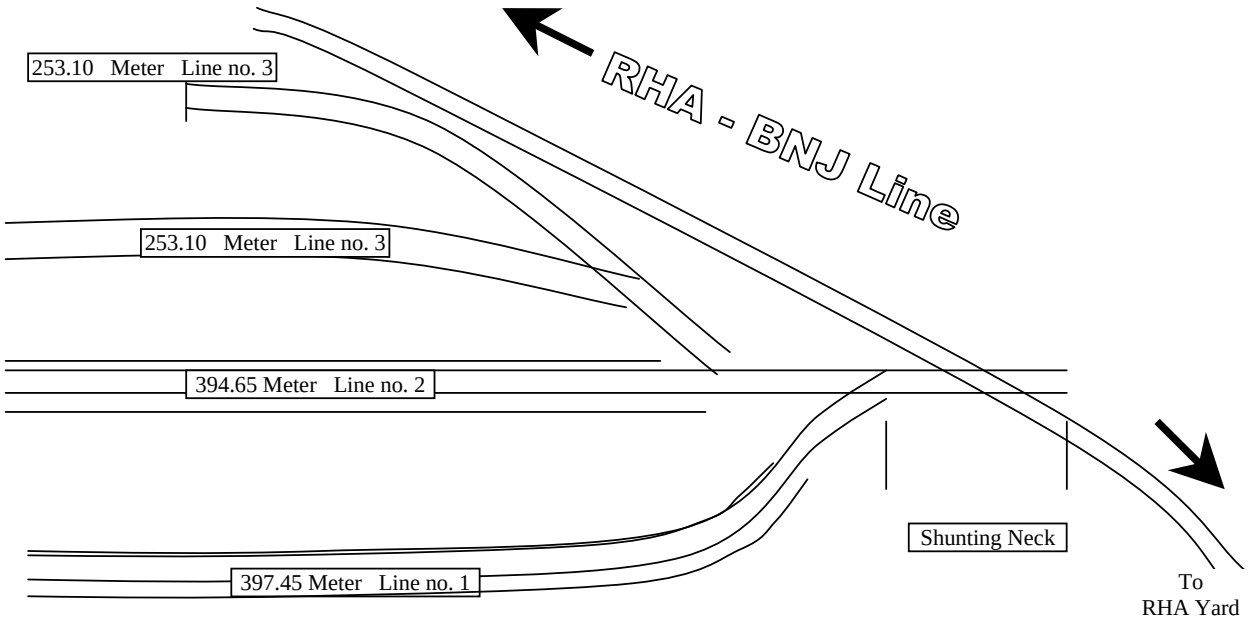
3.1.1 General Introduction:

In view of heavy track structure to cater the requirement of heavy axle loads mechanized renewal has almost become a necessity. This is more so when availability of block is only during night and speedy renewal is required due to worn out track structure of Sealdah division. Due to this, mechnised track renewal by PQRS during night hours without power block and by using contractor's portal at base in Sealdah Division has been adopted and in spite of many constraints like availability of limited block period, non availability of sufficient no. of BFR's, availing blocks only during night hours and other difficulties relating to operating department, maximum progress of 10.10 Km. in Dec '04 achieved. The rationale behind using

contractor's portals at base will be explained later in the paper.

3.1.2 PQRS Base:

PQRS base is a place where the panels are fabricated and load of prefabricated panels is formed and taken to the site for laying at site. PQRS base was made at Ranaghat because of many factors such as availability of suitable space near railway lines, existence of big yard like CRE yard and fuelling point, availability of local power for shunting and for other purposes and so on. Availability of local pilot and non-interference of yard movement was of great help as the base depot is appropriately 2.0 km. for main station. The layout of RHA base is placed as follows:



The salient features of Base are as follows :-

- There are altogether 4 lines out of which two lines are having AT lines. All the activities of fabrication and dismantling are carried out on these two lines only.
- Line No. (1) is used for stabling of PQRS rake and shunting purpose occasionally. This line is also used for loading the scrap or released materials.
- Line no. 4 is exclusively used for loading of scrap and released materials.
- At a time 10,000 sleepers can be stacked in the base.
- If blocks for PQRS work are taken on alternate day, the base can fabricate and dismantle 60 panels per day without any difficulties.
- For all the activities at base, contractor's portals were unavoidable and used without much of problems.

3.1.3 Why Contractor's Portal at Base ?

Contractor had deployed his own 2 no. of portals at PQRS base. These portals were very sturdy and less immune to break downs. These were very effective too.

The Portal was very innovative in design to handle higher loads with very low fuel consumption of around 3-4 liters/hours.

(i) Benefits of using Contractor's Portals at Base:

As per agreement payment made to the Contractor for fabrication of one panel and loading it into BFR having a length of 12.60 m. (Panels used in the division used to be 12.6 to 13.02 m).

a. Unloading of PSC sleepers – 7.50x21 = Rs. 157.5.

b. Spreading of PSC sleeper - 7.00x21 = Rs. 147.0

c. Linking of PSC sleeper - 12.6x24.50 = Rs. 308.7

d. Loading of panels into BFR - 12.6x20.50 = Rs. 258.3

Total **Rs. 871.50** per panel

So total cost of fabrication, handling and loading of one panel is Rs. 871.50.The rate was further reduced by 15% in subsequent contracts.

If we use departmental portals, cost per panel would be approximately the double i.e. Rs. 1700/- per panel as per the following.

Average cost of maintaining 2 portals per months.

= Rs. 2,10,830 x 2 (approx)

= Rs. 4,21,660/-

Cost of 15 no. labourers = 15 x 100 x 30.

Total cost = 421660 + 90000

Rs. 5,11,660/-

Average no. of panels per month = 342

So cost per panel

= Rs. 5,11,660/342

= Rs. 1496.08 per panel.

If we add the cost of repairs of the aged portal M/C, overtime allowance of staff, depreciation cost of machine, reduction of the staff efficiency, the cost would be morethan Rs.1700 per panels besides poor reliability.

(ii) Features of the Indigenous (Local) Portal Gantry machines are as per the followings: -

▶	Maximum speed	=	40 Kmph
▶	Moving Dimension of machine	=	21' X 13'
▶	Capacity	=	15 T (minimum)
▶	Engine	=	S – Model Engine of Tata
▶	Lighting arrangement	=	4 higher power lamps are fitted to work during night.
▶	Fuel consumption	=	2.0 – 2.5 Lts of HSD oil / hour during slow motion mode and it can go up to 3.0 to 4.0 Lts during

			working mode.
▶	Members of portal can be dismantled and transported by road. It does not need any BFR for it's movement.		
▶	Easier to fabricate and erect portals.		
▶	Cost	=	Rs. 2.5 to 4.0 Lakh depending upon how old Engine has been used.

(iii) **Kinds of Portals:** There are two kinds portals Hydraulically and Mechanically operated. Both have been found satisfactory.

Portals of the following manufacturers have been tried and performance has been satisfactory.

▶	Hydromech 62 G. T . Road, Megasol. Phone - 0341 – 3100325.
▶	Guru Govind Engineering Works. 77, Fazal gezing, Kanpur. Phone – 0512-2298560.

3.1.4 Night working

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Working during night corridors.

The corridor blocks (please refer Annexure 3) provided in various sections planned for renewal are during night e.g.

- RHA – GDX section – 4 hrs. (00.00 to 4.00 hrs.).
- KLNP – STB section – 3 hrs. (02.15 to 05.15 hrs.).

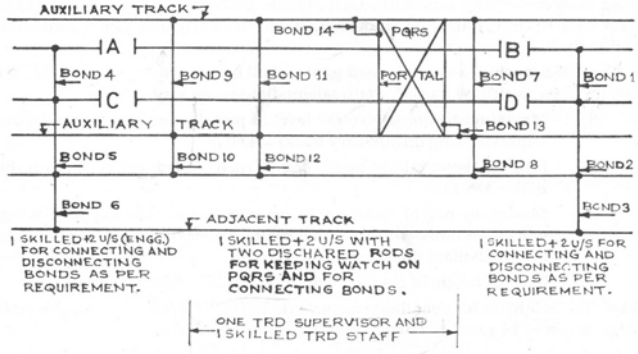
So it was necessary to provide adequate lighting over the whole stretch where blocks used to be planned. 2 Diesel driven generators with one no. of stand by are placed centrally having capacity of 5.0 to 7.5 KVA with tube lights placed at an interval of 20 m. The provision of adequate light used to be the part of the agreement and no extra money used to be paid to the contractor.

The biggest disadvantage of old CST-9 track is failing of pots during renewal of PQRS, which could endanger the safety of men working at site. To eliminate this problem it was necessary to provide adequate fittings to the CST-9 besides providing adequate lighting arrangements at the renewal site.

3.1.5 Working with or without power block.

KNJ – LGL section is non – electrified section so power block was not required but in other section due to requirement of power block, good amount of margin used to be wasted besides affecting the adjoining sections.

Bonding diagram of PQRS working without power block.



As such PQRS work without power block became the requirement, all bonds, discharge rods, to be transported, carried, connected and disconnected by Engg. staff as per directive of TRD supervisor/skilled staff. The details of bonding diagrams is as follows :

- PQRS working zone is ABCD.
- Bonds 1,2,3,4,5 and 6 are to be connected before opening rail at ABCD.
- Bonds 7,8,9,10 are to be connected before putting the portal on auxiliary track.
- Bonds 13,14 are to be connected by Engg. staff for earthing PQRS portal

with auxiliary track before lifting the portal from BFR and reloading on BFR.

- Bonds 11 and 12 are to be connected, if the beat of PQRS is more than 300 m.

In this connection joint guide lines of Engineering and Electrical (TRD) has been issued by CE and CEE vide letter no. W 520/2/3/12/Pt. 8 dt. 9.02.90. The instructions were having following restrictions.

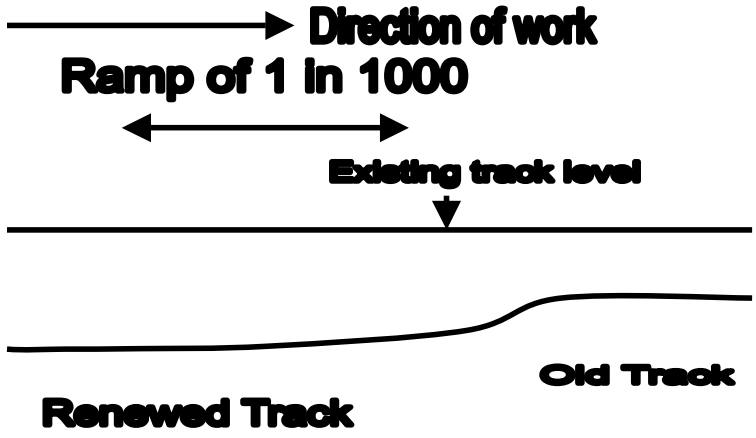
- Confined to day light only.
- To be avoided when in inclement weather i.e rains, fog etc.
- High humidity to be avoided.
- Not applicable to under over-line structures such as FOB, ROB, flyover, etc.

But few traffic blocks without power blocks were taken during night hours having above restrictions and it is confirmed that with sufficient precautions it can be done but it is not recommended..

3.1.6 Planning and quality control management.

<u>Planning before block</u>.

- Since renewal in RHA – GXD, KLNP – STB, KNJ – LGL line, was from CST – 9 track to concrete sleeper track special care was to be taken before actually availing the block.
- Sufficient AT were made in advance, proper care were taken to provide CST – 9 plates at every 2 m for AT.
- Where-ever LC gates or bridges were to be met during block, Ramp (1 in 1000) was made by excavating the ballast beneath the track, so that during actual working extra time would not consume in providing ramp out at the end of the work.



At the beginning of the track 50% of renewed track in ramped portion is lifted by the portal then the work used to be started in old track.

- The ballast from the pockets of CST – 9 plates used to be cleaned to avoid unnecessary transportation of ballast to the base.
- AT used to be laid over the bridges also (upto a span of 20') with rail clusters..

(v) <u>PQRS work during block.</u>

a. Since PQRS work was also done without power blocks special precautions were to be taken.

b. Proper earthling and bonding were ensured as per Joint circulars issued by CE & CEE. But on isolated days having rainy nights or overcast whether we thought it fit to avail power blocks.

c. The track had concrete sleepers interlaced at few locations. While lifting the existing panels, the pandrols were opened so that concrete sleepers are left at their position and removed from track before laying new panels.

d. Wooden sleepers interlaced were also released in the same way but these wooden sleepers were kept in the next tray to be carried to the base.

e. Since the RHA – GXD is a double line track, Mechanical hooter with a man was provided at the site. The hooter was placed at least 600 m from the actual spot of work so that after seeing an approaching train , the man could blow the hooters and the men at work could be alerted. Apart from hooter one moveable whistle board with luminous paint was also provided on the other track in the direction of approaching train.

f. At the end of the work, site in-charge ensures track parameters within limit & records G & XL and certify the track parameters in a register regarding safety of the track and then block is cancelled.

g. Two cylinders of gas (one of DA & other of oxygen) were always kept ready at the site with a cutting torch for use in case of emergency.

h. Released rails after rail renewal on next day of the block were trolleyed and kept in the converted panel tray so that they could directly be brought to base with the released panels.

(vi) <u>Advance planning.</u>

a. Existing fitting surveys were carried out with the contractor for proper accountal of released materials and avoid disputes with contractor regarding returns of released materials.

b. Initial L – section were taken and proposed level were also marked on each mast and other permanent structures.

c. LWR plans were prepared and got approved.

d. Sufficient quantity of ballast were ensured to be available during PQRS work.

e. Deep screening is planned after PQRS manually and at certain location by BCM.

3.2 Improvement of diamonds and innovation of rubber pad for Fanshaped layout.

3.2.1 Sealdah division is having more than 56 nos. of diamond crossings and renewal is taking time for want of supply of materials. 2 nos. of diamonds have been replaced with concrete sleepers in DDJ yard.

Due to increase in no. of speed restriction and non-availability of wooden sleepers the division has developed a special kind of arrangement for maintaining the diamond crossing for track circuited as well as non-track circuited area. For the track circuited area steel casing of the old points and crossings sleepers were used as pad plate for

provision of insulation, where as for the non-track Circuiting area simply bent tie-bars were used for holding of gauge.

(Photo showing insulating casing for better maintenance of Diamonds)

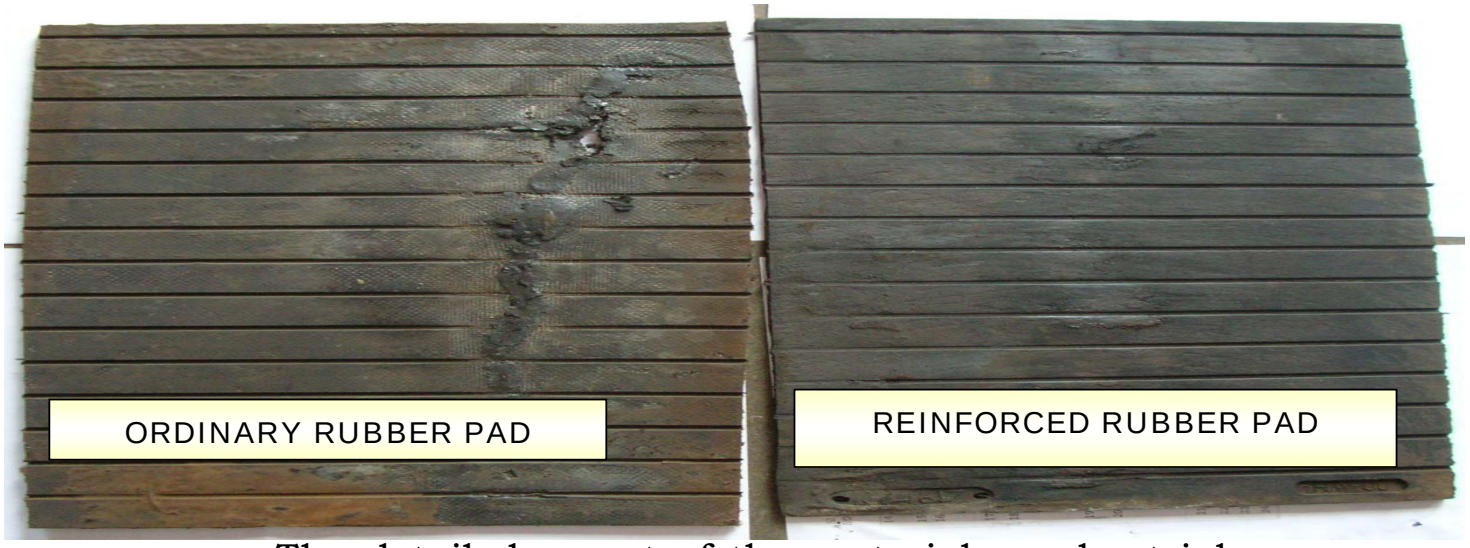
(Photo showing bend tie bars for better maintenance of Diamonds)

This system was also asked for implementation in Northern Railway (copy marked as **Annexure-11**).

3.2.2 Improvement to the grooved rubber sole After introduction of the above system the frequency of attention to the diamond crossings which was earlier twice a week, was

reduced to once in fort-night and the derailments were totally stopped. The above maintenance practice was also appreciated by the then PCE/E.Railway and the plates under fan shaped points and crossings.

Due to heavier track structure and load over the points and crossings, the existing rubber pads are normally crashed for a period of 6 months, resulting had riding and damage to the concrete sleepers. To sort out this problem, special kind of rubber pad was developed by the division using same thickness, but having reinforced with nylon chords in 2 layers. The costing of such rubber pads is expected to be Rs. 20,000/- per set, whereas the cost of the ordinary rubber pad is Rs. 6000/-. The performance of the rubber pad has been exercised with certain modification. The same can also be used. The matter is already under stage of approval by RDSO and Board. Report of Chief Track Engineer is attached as **Annexure – 12.**



The detailed report of the materials under trial is as follows:-

PERFORMANCE REPORT OF MATERIAL UNDER TRIAL

Name of the material	**High performance reinforced glued rubber sole plate for point & crossing**
Name of the manufacturer	**Rawatsons Engineering Pvt Ltd.**
Date of laying	**14.12.2002**
Section	**Sealdah – Naihati**
Station	**Ichhapur**
Location	**Point no. 35A, km 26/19Q to 26/23Q on main line**
GMT	**11.82**
Track structure	**52 kg 1 in 12 fanshaped layout with 1 meter long fishplate.**
Drawing	**As per RDSO drawing no. T-4610 to T-4622**
Date of inspection	**29.11.2005**
GR sole plate taken out	**Sleeper no. 69 (nose of X-ing), 73 (back leg of CMS X-ing) & lead portion (on main line)**

The rubber pads are designed with certain specifications. Values specified vis-à-vis values obtained is marked as Annexure-13.

3.3 Heavy repairs to Bata ROB No.29

3.3.1 General Introduction:

The BATA ROB(Br No.29A) is located between AKRA & NUNGI Railway Station crossing railway lines in Ballygunge – Budge Budge section about 10 km. away from sea coast. The bridge is made of seven RCC- T beam girders of 10.80M span. The said ROB was constructed about 40 years back to connect Maheshtala with Bata Nagar of South 24 Parganas. Due to its proximity to sea where intensity of corrosion ranges between 0.1mm to 0.25 mm per year, the concrete is severly affected by costal area

corrosion. It was not the practice in 60's and 70's to provide in anti corrosive coating on either reinforcement or concrete surface. This however has now been introduced in IS:456:2000. As a result of severe weathering affect of costal environment, the RCC beams and other structure of the ROB has been giving problem for last 10 years.
Several patch repair programme were carried out earlier. The bridge was attended by cement grouting, shotcreting & epoxy grouting on different occasions during last 10 years but these could not give lasting solution due to excessive corrosion.

- Only option was available to re-build the bridge at a cost of Rs.1.2 crores. Necessary proposal ;in work programme was also made for sanction.

3.3.2 Condition of the structures before Repairs

i) During the hollowness test it was found that only the two end beams are badly affected and major reinforcement were exposed and damaged due to corrosion to the maximum extent.

ii) The cantilever beams supporting the footpath were also damaged and reinforcement in some locations of deck slabs were totally and exposed.

iii) It was found during the inspection that some patch repairing work with EPOXY MOTAR was done at site but cavity remained in the end beams.

iv) The cover concrete at bottom centre of end beams spalled & fell down. The reinforcement at the bottom were exposed

& corroded. The diameter reduced to 30 to 40% in some of the rods as seen to the bars already exposed.

v) Cavities were noticed in the end beams & cantilever footpath beams.

vi) In several areas of deck concrete, signs of reinforcement corrosion was observed along with de-lamination of cover concrete.

vii) It was apprehended the strength of the affected beams were reduced considerably & required strengthening. Any further deterioration of the structure could cause collapse of the structure causing fatal consequences on safety of road traffic, train services and passengers both on the road and train.

3.3.3 Repair & Strengthening Scheme :

The condition of the structure was such that the bridge need immediate attention. Following solutions were possible :

i) Remove the damaged girder & replace with new girders.
ii) Repair & strengthening the existing girders & structures.

Removal & replacement of existing girders was a time consuming & costly option. Even through repeated repair efforts had failed earlier, a special lasting method of repair & strengthening was considered more economically favorable & operationally acceptable.

Discussion were carried out with some of the construction chemical manufacturers and following scheme of repair & strengthening of the structure was carried out.

a) Remove damage concrete & wash thoroughly to make free from all loose particles.
b) Repair reinforcing rods & strengthen the reinforcement by putting additional rods by welding.
c) Repair of big cavities in RCC T Beam having congestion of reinforcement bars by pumping Non-shrink free flow by grouting with high strength cementitous grout.
d) For strengthening the T Beams, additional external reinforcement shall be provided to increase the load bearing capacity. Such external reinforcement will be provided by laminating Carbon Fibre Reinforce Plastic (CFRP).
e) Carry out patch repair to the delaminated deck & beams by using protective coating to the rebars.
f) To enhance durability of the structure apply protective & water proofing coating to all concrete surface.

3.3.4 Specification and Procedure for repair of Big cavities in RCC beam.

- First 20mm dia holes were drilled into the beam at 1000 mm C/C both from bottom and from side and in staggered manner and the effective distance between two holes was kept as 500 mm C/C.

- Then 150 mm long GI/MS nozzle, 15 mm diameter and threaded at one end for at least 50 mm was fixed using suitable Epoxy based adhesive.

- Then the beam was covered with plywood formwork keeping all threaded portion of all nozzles outside of the formwork. A layer of polythene sheet laid over plywood to obtain a non-leaky surface during grouting. All joints of plywood were sealed with suitable Epoxy patching adhesive.

- After completion of formwork water flushing was been resorted through the nozzle by using a Grout Pump. Such water flushing continued till the surface in the RCC Beam became SSD and clean water came out from each nozzle. The air cleaning was also done to remove excess water. This is necessary to ensure proper bond between grout & old concrete surface.

- After 1 to 2 hours of flushing non-shrink cement based grout (SIKAGROUT 214) admixed with a corrosion inhibitor was pumped through nozzles & continued till refusal through other nozzel. Pressure for such pumping of Grouts was kept at 3 Kg/Cm2 to 7 Kg/Cm2 for effective pumping/grouting. A positive grout pump is used for this purpose. A suitable gun attached with pneumatic air of desired pressure is used for pumping inside such big voids. Thus job was finished very quickly as grout used is a quick setting grout.

3.3.5 Specification & procedure for spall repair in concrete caused by corrosion of reinforcement bars :

- All unsound concrete was dismantled and removed by chipping on all affected and adjoining areas of concrete. The surface was cleaned by hard bristle brush. The corroded reinforcements were also cleaned by wire-pin brush and emery cloth as thoroughly as possible. The circular brush was also utilized for cleaning.
- The chipped off areas was then washed with freshly water jet.
- New reinforcement bars were welded on the damaged reinforcement bars, where reduced by more than 25% of the original diameters by tack – welding.
- Polymer modified cement based anti-corrosive protective coating was applied on steel reinforcing rods. Two coats were applied on all exposed reinforcement as per manufacturer's recommendation.
- For the purpose of proper bonding of reinforcement & grout, a bond coat consisting of Cement: Water: Latex based bonding agent (SIKA Latex) in the proportion 5 Kg: 4 Kg: 1 Kg was applied on the concrete surface.
- The concrete section was then built up to its original section dimensions as follows :

a) Built up thickness up to 30 mm .

The damaged concrete surface was built up by using cement sand mortar mixed with water proofing compound like SIKA LATEX. The mixed proportion was as under.

Cement : Sand = 1 : 4

SIKA Latex = 2.0 Kg per bag of cement (4%).

b) Built up thickness more than 30 mm

When the built up thickness is more than 30 mm the damaged surface was built up by using a micro concrete of cement, sand, stone chip mixed with water proofing compound like SIKA LATEX. The mixed proportion was under.

Cement : 1 PBV

Sand (FM 2-2.5) : 1.5

10mm down coarse Aggregate Graded : 2.0 PBV

W : C Ratio : 0.4 to $\pm$ 0.02

SIKA Latex : 2.0 Kg per bag of cement.

- Finishing repair was done with material to match with the original concrete surface.
- Curing of repaired area by water spray/wet burlap was done for 3 days.

3.3.6 Strengthening of distressed beams by application of SIKA Carbodour Laminates :

- The surface was cleaned and made it free from grease, oil, loose particles, cement laitance etc. Blast cleaning, scrabbling and grinding was also been done to clean the surface. The concrete surface on which the carbon laminate is to be applied should be completely leveled & formwork marks removed. As such the concrete surface was scrabbed to make level. After cleaning, all dust was removed by using an industrial vacuum cleaner. Planeness of the prepared surface was checked with a metal batten (the tolerance for 2 meters long batten was max. 10 mm).

- The epoxy based adhesive (SIKADUR 30) was applied as bonding layer. SIKADUR 30 components were stirred well in supplied containers. The component 'B' (hardener) and component 'A' (resin) in correct proportion were mixed with a slow speed (Max. 500 RPM) electric hand mixer fitted with a spiral stirrer so that as little air as possible is being entrained. The mixing was done for about 3 minutes for uniform appearance.

- Well-mixed SIKADUR-30 was applied carefully to the properly prepared concrete substrate with a spatula, trowel or float to form a thin layer of max 1 mm thickness.

- SIKA CARBODOUR laminate was cleaned & placed on the adhesive after cutting these to correct size & shape to fit the structure.

Using a rubber roller, the laminates were pressed onto the epoxy adhesive until the material is forced out from both the sides. Surplus epoxy adhesive was removed. All these were done within the pot life of the adhesive.

Amount of adhesive used was as per manufacturers direction.

- When Sikadur-30 has cured, film on top of the laminate was removed. As final check, the laminates were tested for hollowness by tapping lightly with a mallet.
- Finally the top of the laminate was painted with anticorrosive paint (Sikagard-550W Elastic).

3.3.6 Specification and Procedure for surface preparation & application of protective coating to all exposed concrete surface below the deck :

- Surface preparation : First of all patch repair to concrete surface by using a Latex modified mortar as stated earlier was done. Then whole surface was cleaned by using appropriate rotary wire-brush or hand wire-brush and then cleaned by Air and Water.
- Protective coating : The whole concrete surface was treated with 2-coats of CEMFLEX-CEMENT slurry; an acrylic polymer based protective coating.

3.3.7 Cost estimate of the work :

SL NO	DESCRIPTION OF WORK	UNIT	QTY.	RATE/UNIT (Rs)	TOTAL AMOUNT (Rs)
1.	Repair of big cavities in RCC Beam by pumping Non-shrink cement based flowable high strength grout.	Kg	2000	525/=	10,50,000/=
2.	Strengthening of repair T-Beams by laminating one no 150 mm wide & 1.2 mm thick Carbon Fibre Reinforceed plastic plate CARBODOUR S1512 to the bottom of RCC T-Beam & using its adhesive SIKADUR 30 (LP) and along with 4 nos L-shaped Carbodour plate.	Metre	30	5,100/=	1,53,000/=
3.	Patch repairing of all distressed concrete in RCC Deck Slab as per enclosed specification.	M^2	10	315/=	3,150/=
4.	Surface preparation, supplying & applying Acrylic Polymer – Cement Slurry protective water proofing coating (2 coats) to the bottom surface of RCC Deck Slab.	M^2	200	105/=	21,000/=
	Total cost of work was Rs.				Rs. 12,27,150/-

The cost of this work was more as the work was to be done only during night blocks of 4 hours everyday. Availability of block period uncertainty in utilization of labor etc. in situation where no blocks are required & where no night working is involved, the cost will come down subsequently.

3.3.8 **Sequences of heavy repairs under taken is as under:**

3.3.9 Outcome of the heavy repairs under taken in Br.No.29 :-

The condition of the ROB no. 29 was such that the replacement of the structure was only solution. This solution was not practical as this would have necessitated closure of the road & block of the railway line passing below. Moreover the cost of complete rebuilding was Rs.1.4 Crores against which only Rs.12.7 lakh was paid.The repair & strengthening was to be done in situ under traffic by taking designed block of track during the night. The big cavities in RCC beam were repaired & Sika Carbodour laminates were pasted.

Spalling of concrete due to corrosion in reinforcement is a very common problem resulting disbondment in concrete which further increases the rate of corrosion and finally it goes into a vicious cycle till the structures fails. Through this special treatment all corroded bars were removed, new bars were added, all bars were cleared and protective coatings were applied, cavities are filled up with grout and finally laminates were pasted. The procedure adopted has affectively repaired & strengthened the structures to its original strength if not more & enhanced the life of the structures at least 20 years similar to that of a new RCC structure. The repair & strengthening is thus adequately comparative. This type of repair is first of its kind in Indian Railways and it may have got further rehabilitation of such bridges.

4.0 Conclusion and recommendations: In this paper efforts have been made to high light the innovations done to achieve some extra ordinary progress. There were 4 innovations and economics have been worked out. All the four items in this paper have got future in Railways as indicated below.

4.1 Economics of Contractor's portal at base:

	With Rly.'s portals	With Contractor's portals
Cost per panel	Rs.1700.	Rs 871.

4.2 Innovative Maintenance of Diamond crossings:

	With conventional method	With innovative methods
Maintenance Effort	2 times a week	Once in fortnight
Speed restriction	30 – 45 kmph	Normal

4.3 Performance of Modified and reinforced rubber pad:

	RDSO approved.	Modified & reinforced one
Cost	Rs 6000.00	Rs 15000.00
Life	6 months	10 years
Maintenance Efforts	Once in 10 days	Once in 1 month
Vertical Acceleration	> 0.25 g	< 0.15g

4.4 Performance and Economics of special repairs to Distressed Bridge:

	For rebuilding already planned	For rehabilitation incurred
Cost	Rs.1.4 crore	Rs 12.27 lakhs

High Performance Rail Pads

Sl No.	Test parameters	Value specified by RDSO as per revised spec 2000	Obtained value
1.	Hardness, Min.	80	
2.	Tensile Strength Min.		
A	Before Aging, kg/cm2	120	140
B	After ageing 100 oC for 96hrs.,kg/cm2	100	120
C	Retention after ageing, %	80	85
3.	Elongation at break, % min.		
A	Before ageing	200	200
B	After ageing	150	200
C	Retention after ageing,%	70	75
4.	Relaxed modules at 100% elongation		
A	Before ageing ,kg./CM2	50-75	54
B	Change after ageing	(-10) to + 30	65
5.Compression set subjected to 50% compression at 100 1C oC for 24hrs, % max	30	18	
6.	Tension set subjected to 50% stretch at 100 1C for 24 hrs ,%max	25	20
7.	Load deflection under a load of 15 ton for 1 min, MM	0.70-1.00	0.8
8.	Elec. Resistance, mega ohms min.		
A	Before immersion	100	>100
B	After immersion in distilled water for 48hrs. at ambient temp.	100	>100
9.	Specific Gravity	1.20- 1.50	1.3
10.	Ash content ,% max	40	26
11.	Creep Resistance	Not Specified	Excellent
12.	Impact Attenuation	-do-	>25%
13.	Variation in secant stiffness and impact attenuation before and after durability	-do-	<25%

WORKING OF SUB-URBAN SECTION WITH OVER-AGED INFRASTRUCTURE OF SEALDAH DIVISION

EXPERIENCES & INNOVATIONS

S.N.Panda — **Dy.CMM/C/MLG**
M.K.Agrawal — **Sr.DME/O&F/LKO**
Rajesh Prasad — **Sr.DEN/Co-ord/SDAH**
N.K.Sidiqui — **DEO/Bangldesh/Rly.**
Jaya S. Chauhan — **CSC/RPF/NER**

Under the guidance of
Sri M.B.Vijay,SPCE

AMP 04/2005