सत्यमेव जयते

भारत सरकार
रेल मंत्रालय, (रेलवे बोर्ड)
नई दिल्ली-११० ००१

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(RAILWAY BOARD)
NEW DELHI-110001

D.O. NO.2006/CE-I/Geo/235

July 04, 2007

My dear (PCEs – all Indian Railways except SCR)

Sub: Formation treatment

The progress of formation treatment, by and large, on the Railways has been observed to be very slow. With the heavier axle loads now moving almost on all the Railways, it has become apparent that its impact on formation is watched, controlled and repercussions mitigated.

In this respect, South Central Railway has done an extremely good work for rehabilitation/strengthening of existing formation and embankment. They have used the BCM for laying a geogrid after ballast cleaning and also used sand for filling pockets with the help of dynamic track stabilizer. These methods have been found to be quick, cost effective and has improved the track maintenance and running quality greatly.

A copy of the paper on experience of South Central Railway is enclosed. You are requested to use the experience for rehabilitation of formations on your Railway.

Yours sincerely,

4/7/07

(Rakesh Chopra)

Encl: as stated above.

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O/C

P.I. issue
5/7/07

Copy to: Shri R.K. Goel, PCE/SCR, Secunderabad.
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Ministry of Railways
Railway Board
6/7/07

South Central Railway

# Experience of South Central Railways

# In

# Rehabilitation of Yielding Formations

Under the guidance of


**Shri R.K.GOYAL**

Pr.CE/SC, S.C.Rly

&

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## Index


| Sl. No. | Description | Page |
|---|---|---|
| 1. | Summary of Rehabilitation Methods. | 1 |
| 2. | Rehabilitation of yielding formations using aluminium alloy girder method. | 2 – 3 |
| 3. | Rehabilitation of yielding formation by rolling of ballast using vibromax. | 4 – 5 |
| 4. | Rehabilitation of yielding formations with moorum blanketing by enforcing single line working | 6 – 8 |
| 5. | Rehabilitation of yielding formations by automatic laying of geogrid with BCM. | 9 – 14 |
| 6. | Rehabilitation of yielding formations by sand dumping along with provision of wider cess and sub bank | 15 - 20 |

## Experience of South Central Railways In Rehabilitation of Yielding Formations

| Sl. No | Method | Route | Total Progress | Year of Execution | Requirement of Minimum Traffic Block | Requirement of SR | Rate of progress | Cost per Km | No of PSRs Cancelled |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Aluminum Alloy Girder Method | Wadi - Guntakal | 2.2 Km | 2000 - 02 | 4 Hours | 10 KMPH | 12m | 65 Lakhs | 1 |
| 2 | Ballast rolling using Vibromax | Wadi - Guntakal | 6.0Km | 2005 | 3 to 4 Hours | 20 KMPH | 175m | 26 Lakhs | 1 |
| 3 | Moorum blanketting enforcing single line working | Wadi - Secunderabad | 8.0Km | 2007 | 60 Days | 20 KMPH | 8 Km | 40 Lakhs | – |
| 4 | Automatic laying of Geogrid by BCM | Vijayawada - Visakhapatnam | 6.1Km | 2006 - 07 | 3 Hours | 20 KMPH | 175m | 18 Lakhs | – |
| | | Kazipet - Balharsha | 0.3Km | 2006 | 3 Hours | 20 KMPH | 175m | 18 Lakhs | 1 |
| 5 | Sand dumping with wider cess and sub bank | Kazipet - Vijayawada | 1.5Km | **1996** | 1 Hours | No SR | 1Km | 8.4 Lakhs | 1 |
| | | Hubli - Hospet | 0.3Km | 2001 - 02 | 1 Hours | No SR | 1Km | 8.4 Lakhs | 1 |
| | | Vijayawada - Visakhapatnam | 57Km | 2004 - 07 | 1 Hours | No SR | 1Km | 8.4 Lakhs | 14 |

## 1. REHABILITATION OF YIELDING FORMATIONS USING ALUMINIUM ALLOY GIRDER METHOD

**A) Method of working:**

- This is like using a relieving girder for a bridge rebuilding under traffic. Aluminium Alloy 6.6 m long light weight girders are to be used.
- First cribs are to be inserted in the track to facilitate support of the girders. Then girders are to be inserted duly supporting on cribs. Earth below the girders is to be removed and then blanketing material shall be filled up duly compacting each layer by surface vibrator.
- Then girder is to be shifted to next location.
- A traffic block of 4 hours is required for insertion/removal of girders and the daily progress of rehabilitation is only 10 to 15 m.

**B) Limitations:**

- The progress is almost negligible and does not commensurate with the effort.
- The safety of running of trains is endangered during the course of execution and therefore the field officials are highly discouraged to adopt this method.
- About 20% of the track remains virtually uncompacted.
- Severe speed restriction of 10 kmph is required for quite long duration.
- Labor requirement during block is very heavy. About 300 labourers are required. Mobilizing this much labour continuously is a practical limitation.
- Splitting of formation at toe of ballast and on cess is normally observed in the initial days after formation treatment.
- At the locations where crib support will be given (constitutes about 20% length), the compaction was further less and loose pockets formed in the formation.
- Ballast puncturing at rail seat upto 25 cm was observed due to improper compaction specially in top layers due to insufficient headway for compaction.
- With the result, huge amount of ballast got punctured into the formation over the years.

- Because of the above problems, track continued to give maintenance problems to some extant or the other in the initial years. It takes almost 5 years for the track to stabilize and perform satisfactorily. Quite a long period.

**C) Cost analysis:** **Unit : Per Km**

- Cost analysis for the scheme does not lead to any meaningful conclusion because of huge penetration of ballast in the initial 5 years; continuance of speed restrictions for prolonged period; compulsion of deploying departmental gangmen for picking of slacks etc.

- However, taking the above difficulties into consideration the approximate **cost per km works out to Rs.60 to 70 lakhs**

**D) How this scheme works for rehabilitation of yielding formations ?**

- The blanket material provided under Aluminium Girder can not be compacted as per the specifications of the RDSO due to limited head room and in fact 20% of the length will be left without any compaction. Due to these reasons the track continuous to give maintenance problem for about initial 5 years which is a quite long period. In the process large quantity of ballast gets penetrated. After adequate consolidation during the initial 5 years under running of trains, the formation starts behaving satisfactorily as envisaged in the RDSO guidelines for provision of designed blanket layer.

**E) Experience of South Central Railways :**

- This method has been tried for rehabilitation of yielding formation of about 2.2 kms from km 664/8 to 662/0 (Up line) between Wadi – Nalwar stations of Guntakal Division which is situated on Wadi – Guntakal golden quadrilateral route.

- It took almost 2½ years to complete rehabilitation of 2.2 kms during the years 2000 – 2002.

- The existing PSR of 30/50 kmph has been cancelled after 5 yrs of consolidation under the running train loads.

- Due to the above said limitations this method has been discontinued and further rehabilitation works have been continued using **"Rolling of Ballast by Vibromax method".**

## 2. REHABILITATION OF YIELDING FORMATION BY ROLLING OF BALLAST USING VIBROMAX

A) **Method of working :**

- Under the Traffic Block of 3 to 4 hours, the track (for about 150 to 200 m) shall be dismantled.
- The existing ballast shall be leveled and moorum as per specifications of blanketing material shall be dumped equal to about 200 to 300 mm thickness.
- Rolling shall be done by vibratory roller (Vibromax) of 100 to 120 KN static weight or equivalent capacity for about 25 to 30 passes. It will be observed that the major quantity of moorum will be going into the voids and the level of ballast will also go down by 150 to 200 mm.
- Again the track shall be linked. Already collected ballast shall be dumped to facilitate kutcha packing and clearing the block.
- Further, new ballast shall be dumped for obtaining full cushion and the track shall be lifted in stages and the caution order shall be relaxed in stages.

B) **Pre block arrangements :**

- Earth work shall be carried out for roller refugees including ramps at every 150 to 200 m (anticipated progress per block).
- Adequate quantity of new ballast of about 2300 cum per km shall be collected along the cess.
- Adequate quantity of blanketing material (like moorum) shall be collected along the cess.
- A vibratory roller (Vibromax) and adequate labour shall be arranged.

C) **Cost analysis :** **Unit : Per Km**

- Earth work for Roller Refugees (including ramp)
  5 locations/Km x 6 m x 6 m x 3 m average bank height x Rs.125/- per cum — Rs. 67,500/-
- Ballast including dumping:
  (Full Qty of about 2300 cum per km) x Rs.750/- per cum. — Rs.17,25,000/-

- Blanketing material supply and dumping (5 m width x 0.3 m thick) @ Rs.350/- per cum — Rs.5,25,000/-
- Hiring of Vibromax (monthly 20 blocks of 4 hrs. each @ 150 m per block i.e. 3 km per month) @ Rs.1,20,000/- per month; per km works out to — Rs. 40,000/-
- Dismantling, leveling of ballast and relinking of Track, lifting, packing,etc., at Rs.250/- per m — Rs.2,50,000/-

**COST PER KM** — **Rs.26,07,500/-**

D) **Limitations :**

- Rail levels will be raised by 200 to 350 mm. Therefore, adoption in electrified sections, near yards and near major bridges may be difficult. In such situations the scheme shall be suitably modified.
- Approach roads and land is required for collection of ballast, blanketing material. In case of tank areas, marshy lands and waterlogged areas, this method cannot be adopted since huge costs shall be incurred for making approach roads and leveling of ground.

E) **How this scheme works for rehabilitation of yielding formations ?**

- When the ballast is fully compacted with Vibromax and the voids are fully filled with blanketing material such as moorum, provides fairly hard and impenetrable support to the new ballast and track. This works similar to popular WBM (water bound mecadam) roads which give fairly good performance against wear and penetration. Further this works something similar to RDSO specified blanket layer.

F) **Experience of South Central Railways :**

- This method has been successfully adopted for rehabilitation of yielding formation of about 6 kms from km 664/0 to 669/32 (Down line) between Wadi – Nalwar stations of Guntakal Division which is situated on Wadi – Guntakal golden quadrilateral route.
- The work was planned and completed (along with TSR (P) from CST-9 with SWP to PSC with LWR) within a period of 3 months from Jan., to Mar.,2005.
- The existing PSR of 30/50 kmph has been cancelled during Jan.,2006.

## 3. REHABILITATION OF YIELDING FORMATIONS WITH MOORUM BLANKETING BY ENFORCING SINGLE LINE WORKING

**A) Method of working :**

- Single line working shall be enforced duly taking adequate traffic block of about 20 to 40 days depending on length of track to be rehabilitated.
- The track under identified stretch shall be completely dismantled.
- The existing clean ballast and fouled ballast shall be scooped and stacked separately for re-usage.
- The existing formation upto 1 m depth shall be got excavated using Poclainers/JCBs. The top of excavated formation shall be rolled using Vibromax duly leveled.
- The blanketing material such as moorum shall be dumped and rolled with Vibratory rollers (Vibromax) of 100 to 120 KN static weight or equivalent capacity in 3 layers of each 30 to 35 cm following the same camber profile as provided in the sub-grade layer and to be maintained upto the top layer.
- Number of passes of Vibromax shall be established through trails for optimizing the compaction effort. Sprinkling of water shall be carried out for maintaining optimum moisture content during compaction. The speed of the Vibromax shall not exceed 5 kms per hour.
- The quality control checks on finished blanket work per each layer shall be exercised as per RDSO guidelines.
- The removed clean and screened ballast to a thickness of about 150 to 200 mm shall be dumped and rolling shall be done with Vibromax duly leveling the ballast.
- The track shall be linked.
- Further, new ballast shall be dumped for obtaining full cushion and track shall be lifted in stages and traffic shall be restored and the caution order shall be relaxed in stages.

**B) Pre block arrangements:**

- Adequate quantity of blanketing materials such as moorum shall be collected along the cess.
- Adequate quantity of new ballast of about 1,000 to 1,500 cum per Km shall be collected along the cess.
- Vibratory roller (Vibromax), JCB/Poclainer and adequate labour shall be arranged.
- Lighting arrangements for night working shall be made for the entire length.
- Soil testing laboratory at site shall be established for exercising quality control checks during the execution of blanketing work

**C) Cost analysis:** **Unit : Per Km**

| | |
|---|---|
| Dismantling, re-linking, lifting, packing of track etc., @ Rs.225/- per m | Rs.2,25,000/- |
| Ballast including dumping: (About 1250 cum per km) x Rs.750/- per cum. | Rs.9,37,500/- |
| Blanketing material supply and dumping including Compaction (8 m width x 1.0 m thick) @ Rs.300/- per cum | Rs.24,00,000/- |
| Cutting of formation @ Rs.75/- per cum | Rs.4,20,000/- |
| Lighting arrangements and charges for soil testing lump sum | Rs.15,000/- |
| Turfing and other incidental charges for S&T etc. | Rs.50,000/- |
| **COST PER KM** | **Rs.40,47,500/-** |

**D) Limitations:**

- Enforcing single line working in busy routes is very difficult and therefore getting a traffic block is always uncertain.
- Approach roads and land is required for collection of blanketing material. In case of tank areas, marshy lands and waterlogged areas, this method cannot be adopted since huge costs shall be incurred for making approach roads and leveling of ground.
- Very costly as much as Rs.40 lakhs per Km.

**E) How this scheme works for rehabilitation of yielding formations ?**

- This method is an ideal way of rehabilitating yielding formations by providing a blanket layer of adequate designed thickness as per the RDSO specifications.

**F) Experience of South Central Railways :**

- This method has been successfully adopted for rehabilitation of yielding formation of about 8 kms from km 65/4 to 68/11 (3.5 kms on down line) and km 65/4 to 69/11(4.5 kms on up line) between Tandur - Mantatti stations of Secunderabad Division which is situated on Wadi – Secunderabad route.

- The work was planned and completed from 7th April to 7th May, 2007 (30 days for 3.5 kms on down line) and 16th May to 16th June, 2007 (30 days for 4.5 kms on up line).

- The existing PSR of 80 kmph will be cancelled in due course of time.

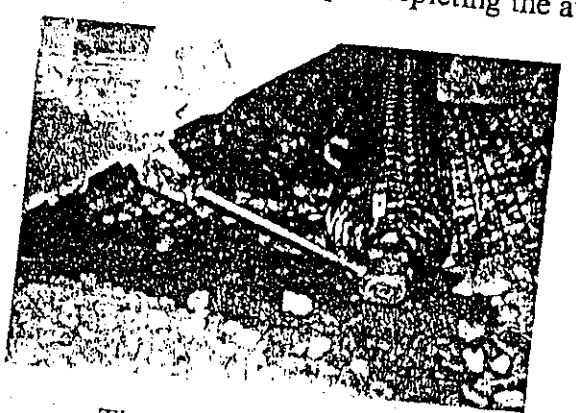
## 4. Rehabilitation of yielding formations by automatic laying of Geogrid with BCM.

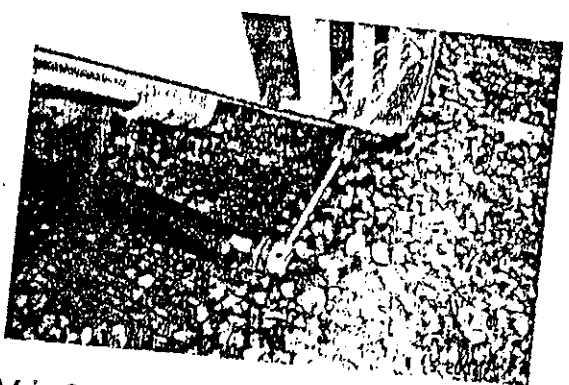
**A) Recommended specifications of Geogrid:**

- Type of Polymer : Polypropylene, UV light resistant.
- Roll width : 3.8m
- Roll length : 50m
- Roll weight : 65Kg
- Square aperture size : 61mm x 61mm
- Ultimate load : 30KN/m (both directions)
- Load at 2% strain : 11.0KN/m (long), 12.0KN/m (lateral)
- Load at 5% strain : 22.0KN/m (long), 25.0KN/m (lateral)
- Strain at ultimate load : 9%
- Minimum junction strength : 95%

**B) Attachment to BCM for automatic laying of Geogrid:**

- The Photographs depicting the attachment to BCM are as under:





- The dimensional sketch of attachment to BCM is furnished as annexure.

**C) Method of working:**

- Necessary attachment to BCM as shown above shall be made ready which is very simple and can be got fabricated in the local market.
- The length of normal cutter bar is 4.1 m which is used regularly for plain track deep screening. An extension of piece of 0.5 m length should be added to the normal cutter bar. These extension pieces are readily available with all the BCMs. So the total cutter bar length required for automatic laying of Geogrid will be 4.6 m.

- The following are the laying specifications of Geogrid:

| | | |
|---|---|---|
| • Length of each roll | : | 50 m |
| • Dia of each roll | : | 375 mm |
| • Length of overlap between two rolls | : | 300 mm |
| • Depth of laying | : | 400 mm |
| • Progress of laying | : | 200 m in 3 to 3 ½ hrs traffic block |

- All the BCMs are capable of screening the ballast upto 400 mm below the bottom of sleeper and accordingly Geogrid should be laid at a depth of 400 mm so that the same Geogrid will not interfere during the next deep screening operations may be after 10 yrs.

- Adequate number of rolls shall be carried to the site by keeping in the BCM itself on the day of block.

- The Geogrid gets automatically unrolled along with deep screening and care shall be taken to stop the BCM for about 5 minutes after completion of the first roll so that next roll can be attached with 300 mm overlap. In the overlap length and during the starting of the first roll, adequate number of U shaped nails (made of MS wire) should be driven to provide adequate resistance against movement of Geogrid roll along with BCM.

- The procedure shall be continued till the entire length under rehabilitation is laid with Geogrid.

**D) Pre block arrangements:**

- Attachment to BCM for automatic laying of Geogrid shall be made ready duly carrying out one or two trial blocks in the unimportant sidings/yards.

- The quality of Geogrid shall be got tested in a independent laboratory and Engineer-incharge should be well aware of the quality assurance.

- Adequate numbers of Geogrid rolls shall be procured well in advance and the same shall be stacked properly failing which the dia of the rolls will be enlarged and problems will be faced during laying.

- The health of the BCM especially the cutting chain shall be in good condition so that interruption to Geogrid laying is minimized.

**E) Cost analysis:** **Unit : Per Km**

- The cost of Geogrid @ Rs.208/- per sqm; 3.8 m roll width x 1000 m — Rs.7,90,400/-
- Hire charges of BCM including pre and post block works and cost of tie tamping and DGS @ Rs.700/- per m — Rs.7,00,000/-
- Cost of cess repairs @ Rs.110/- per cum; 3,000 cum per km — Rs.3,30,000/-

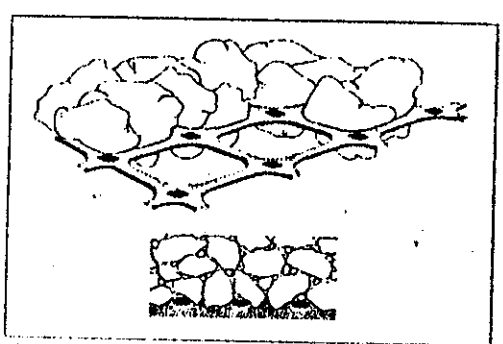
**Cost per Km -** **Rs.18,20,400/-**

**F) Limitations:**

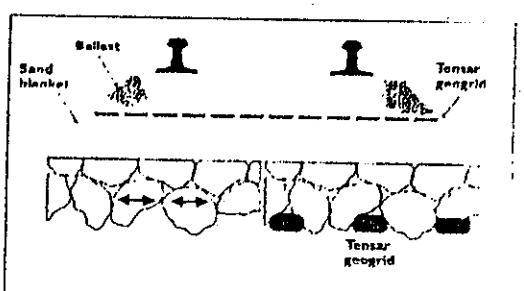
- Ensuring quality of Geogrid under open tendering system will be very difficult.
- The already laid Geogrid might interfere during next deep screening by BCM after 10 yrs.
- This scheme does not address the problem of drainage of yielding formations.

**G) How Geogrid helps in rehabilitation of yielding formations ?**

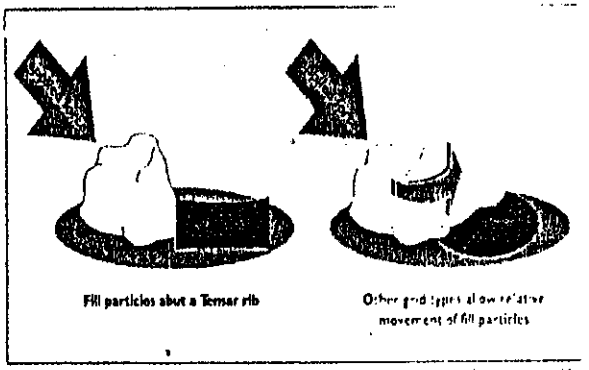
- Geogrid provides direct ballast reinforcement having stiffening effect.
- Geogrid provides interlocking of ballast particles and thus
  - Improves shear
  - Reduces elastic deflection
  - Controls differentials settlement
  - Improves bearing capacity.
- Geogrid with high tensile stiffness allows load to be taken at very low strain.
- Geogrid with high junction strength and rigid square apertures enables effective transfer of load.
- Further, the following three diagrams depicts the load transfer mechanism:



*The interlock mechanism.*




*The interlock between the grid and the ballast limits lateral movement of particles even when dynamic loading is applied. In practice this means that the settlement rate of the ballast is reduced.*




*The unique cross-sectional shape of Tensar ribs provides ... other grid types with more rounded profiles.*

H) **Experience of South Central Railways** :

- This method has been successfully adopted for rehabilitation of yielding formation of about 6.4 kms as per the details given below:

  - First trial – Km.592/29 – 593/1 for 100 m length laid on Up line during April, 2006 on Vijayawada Division of Vijayawada-Visakhapatnam section.

  - Second trial – Km.205/9-27 for 300 m length laid on Up line during Sept.,2006 on Secunderabad Division of Kazipet – Balharsha section. The existing PSR of 90 kmph has been cancelled.

  - Further 6.0 kms of Geogrid has been laid during April-May, 07 on Vijayawada Division of Vijayawada-Visakhapatnam section at Kms. 550/15-554/0 : 3.5 kms on Up line, km.563/3-562/23: 0.4 kms on Up line, km.569/1-568/13: 0.65 kms on Up line, km.629/34-630/16 : 0.4 kms on Dn line, km.634/33-633/21: 1.05 kms on Up line.

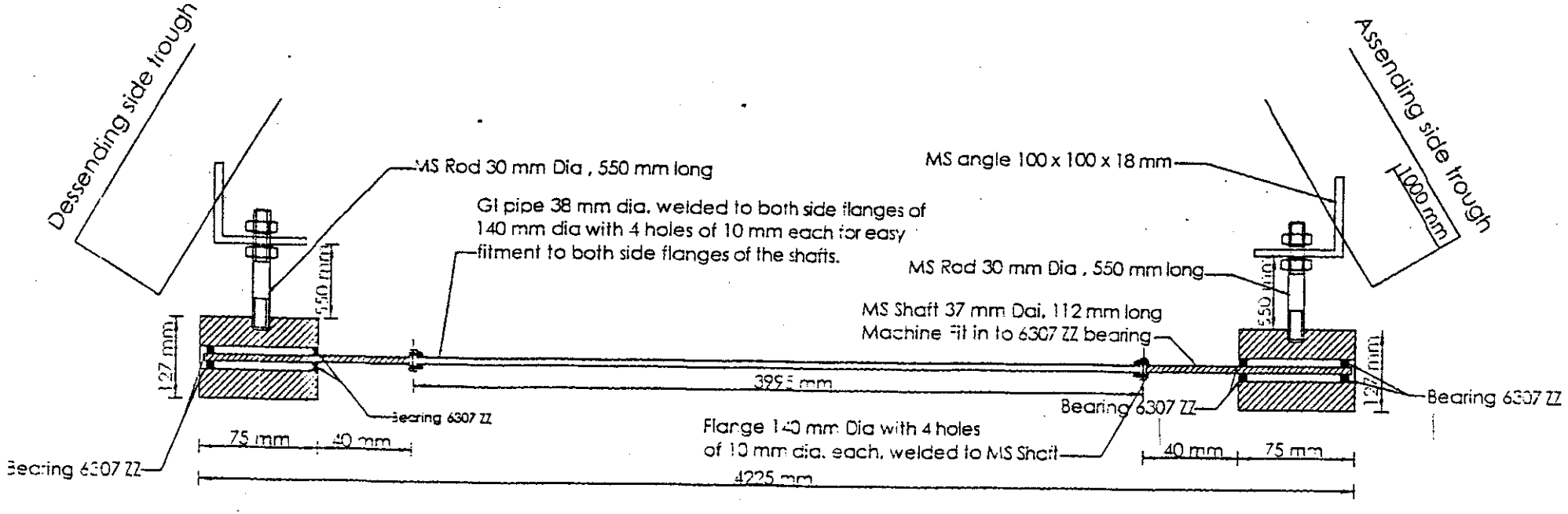
  - These 6 kms of recently laid length in bits have been selected in such a way that all kinds of site problems such as tank areas, high banks, very low cess areas without any possibility for carrying out cess repairs etc., have been selected.

  - Further performance is under close observation duly recording the cross levels once in 10 days on every $10^{th}$ numbered sleepers.

  - Further the existing PSRs of 75 kmph will be cancelled in due course of time.

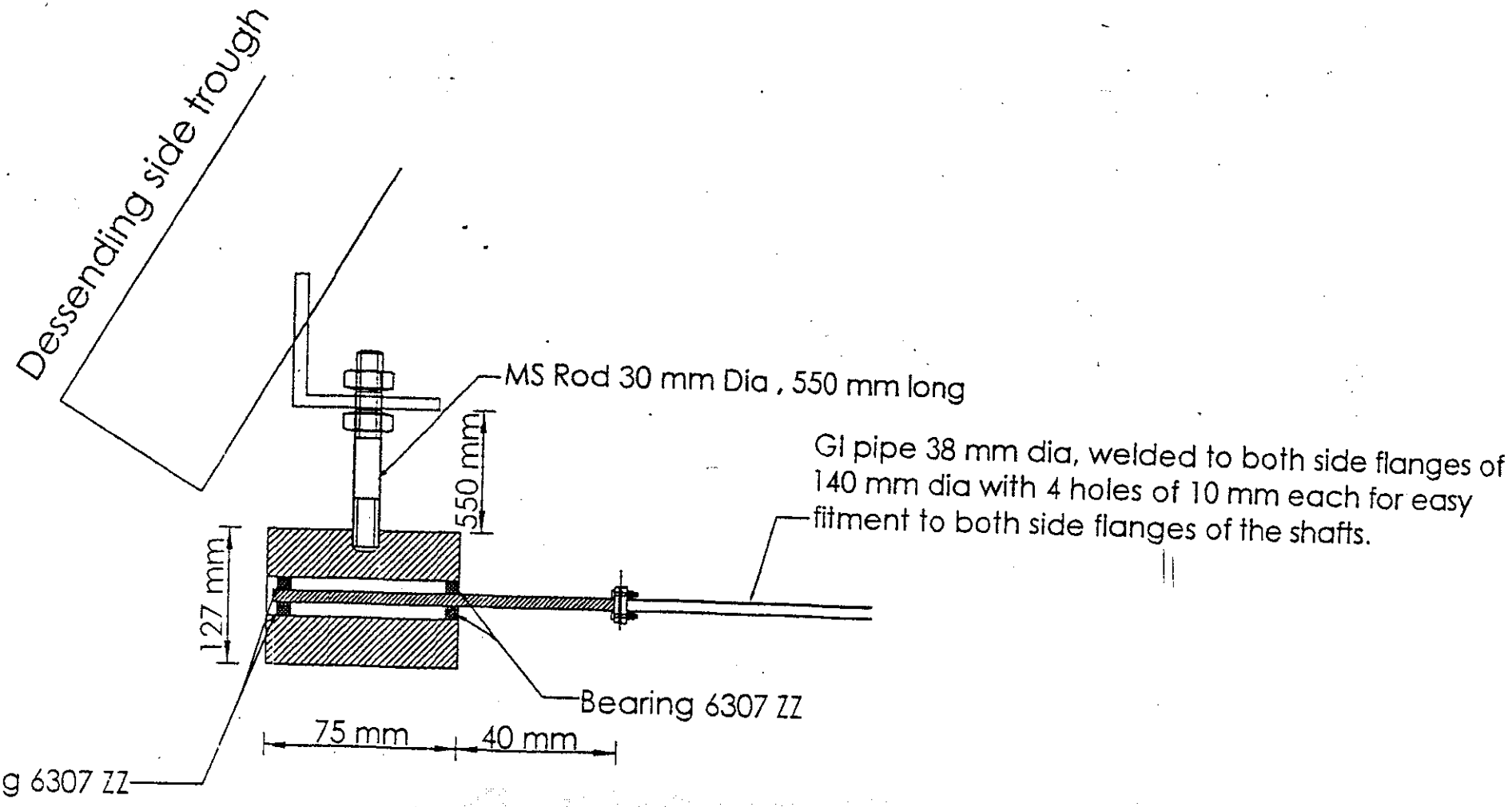
ANNEXURE

# ATTACHMENT TO BCM FOR AUTOMATIC LAYING OF GEOGRID



ANNEXURE

# ATTACHMENT TO BCM FOR AUTOMATIC LAYING OF GEOGRID



## 5. Rehabilitation of yielding formations by sand dumping along with provision of wider cess and sub bank

**A) Method of working :**

- Normally, yielding formations/bad banks are characterized with heavy penetration of ballast into sub-grade as much as 2 to 2.5 m, 10 to 20% of annual loss of ballast, very very low cess with bulged slopes, lateral spread of toe of bank, the track being situated in tank areas/waterlogged/marshy areas with difficult road approaches for carrying out cess repair works, borrow pits with stagnation of water being situated very close by the toe of bank etc. Therefore, the first step should be to understand these properties.

- Based on these ground realities, cess repairs with wider cess upto 4.0 – 4.5 m from central line of track shall be carried out. Along with the cess repairs, a sub bank of about 3.0 m wide of suitable height shall also be carried out which will enable to carryout cess repairs in case of tank areas/waterlogged/marshy areas by acting as approach road. The wider cess along with the sub bank will provide adequate confinement for the naturally formed blanket layer (the voids of penetrated ballast filled with the dumped sand).

- The depth of clean penetrated ballast cushion with interconnected voids should be found out at every 200 m by excavating the formation. The requirement of sand can be calculated as under :-

  - The 1st round requirement of sand is to be calculated as 30% of the quantity beyond a clean cushion of 150mm for a ballast width of 5m. For example in a km if the average clean penetrated ballast cushion is 500mm, then the quantity of sand required in 1st round = 0.30 x (0.5-0.15) x 5 x 1000 = **525 cum.**

  - The 2nd round requirement of sand is to be calculated as 20% of the quantity beyond a clean cushion of 150mm for a ballast width of 5m. For example in a km if the average clean penetrated ballast cushion is 500mm, then the quantity of sand required in 2nd round = 0.20 x (0.5-0.15) x 5 x 1000 = **350 cum.**

  - The 3rd round requirement of sand is to be calculated as 10% of the quantity beyond a clean cushion of 150mm for a ballast width of 5m. For example in a km if the average clean penetrated ballast cushion is 500mm, then the quantity of sand required in 3rd round = 0.10 x (0.5-0.15) x 5 x 1000 = **175 cum.**

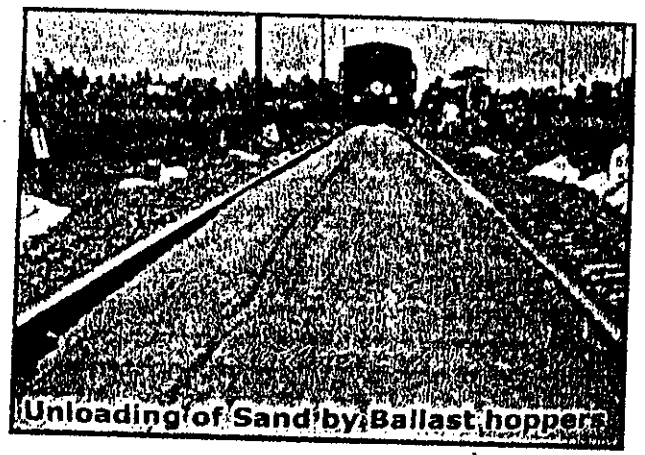
- The required quantity of clean course river sand should be collected at a Ballast Depot and the same should be loaded into hoppers in non rainy day and the same shall be unloaded in the identified yielding formation location.

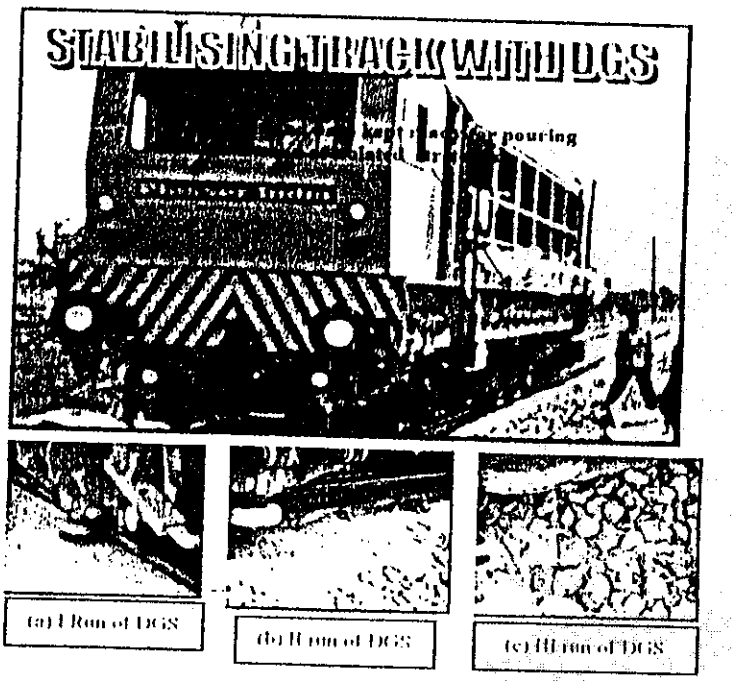
The calculated sand shall be unloaded at center (~40%) and on both sides (~30%) each side.

- Alternatively, the required sand can be collected alongside the cess and can be dumped into the track.

- With the passage of traffic, the unloaded sand penetrates down the layers of penetrated ballast and fills up the interconnected voids. The penetration of sand under traffic is so evident that within one or two days, the entire sand which is dumped upto brim of rails simply disappears into the ballast voids.

- The best is to utilize dynamic track stabilizer (DGS) wherever available for expediting uniform penetration of sand. The DGS shall be used in 3 to 5 rounds of passages and due to vigorous vibrations, the rate of penetration of sand will be much faster and more and more quantity of sand will get penetrated which will make the rehabilitation process much faster.


Unloading of Sand by Ballast hoppers





(a) I Run of DGS


(b) II run of DGS


(c) III run of DGS

- The cross levels at every 10th sleeper should be recorded once in 10 days on the same numbered sleepers which is one of the most important step of this scheme.

- Due to vibrations of running trains/DGS, the sand penetrates in due course of time, reaches the bottom most pockets of ballast and starts filling the voids from the bottom, thereby the voids of top layers of ballast gets emptied. This situation can be understood either by variation in cross levels or by excavating the formation, the level of penetration of sand can be easily noted.

- At this juncture 2nd round of sand dumping should be planned. DGS should be again run. The unloaded sand will penetrate down through the voids of

penetrated ballast and further fills up the voids in the middle/top layers of penetrated ballast.

- Further, after few months, the extent of penetration of sand into the voids of penetrated should be assessed either by observing cross level variations or by excavating the formation.

- This process of dumping of sand should be continued for 2 to 3 rounds till all the voids in the penetrated ballast are filled with sand.

- **Sand feeding at isolated locations :** Even after successful unloading of sand in the requisite number of rounds, still some bad pockets may be left out where riding continues to be poor and where cross levels may be varying. This indicates that further quantity of sand has to be fed in the isolated stretches of 1 TP or 1 rail length here and there. Normally, such a small stretches of unloading cannot be organized through hoppers. Therefore, the same should be fed by dumping through readily made available sand bags at site. These sand bags can be transported from Ballast Depot to the isolated locations either by DGS or by hoppers/BFRs. The sand in the bags will be dumped till the variation of cross levels stop.

- Provision of wider cess along with sub bank and process of sand dumping can be carried out either parallel or one can follow other.

- Only in very rare cases, where the track was abused due to presence of fish plated joints/kinky welds etc., and deep screening was not carried out for quit long time which has led to caking of ballast, in such cases only pumping/blowing of sleepers should be noticed and the track drainage might be a problem. In this case, the depth of clean penetrated ballast cushion with interconnected voids will be very less for the sand to penetrate (~150 to 250 mm). Rehabilitation of such abused formations will be much simpler in which case, deep screening by BCM should be carried out to a slightly greater depth of 350mm and about 400 to 600Cums of sand per Km should be unloaded and further track can be lifted by 50 to 100mm, so that the bottom 150 to 200mm of ballast mixed with sand will provide a stable bed. Such rehabilitations are easy since the dumped sand can not escape vertically due to presence of caked up ballast beyond 350mm of deep screened portion.

- In this way the rate of progress of rehabilitation can be as high as 30 to 40 kms in one Sr.DEN/DEN section in one year.

**B) Cost analysis :** **Unit : Per Km**

(a) Cost of sand Treatment

Total Requirement of sand say @ 700 Cum per Km @ Rs.220/ cum

= Rs1.54 Lakhs .....(a)

(b) Cost of cess repairs & sub bank @ 6000 Cum per Km @ Rs.110 per Cum

= 6000 x 110 = Rs.6.60 Lakhs.....(b)

(c) Cost of DGS working for early stabilization in 3 rounds

= Rs.8000/- x 3 = Rs 0.24Lakhs ....(c)

(Rs.8,000/- is adopted based on CTE circular No.01/TM/2006)

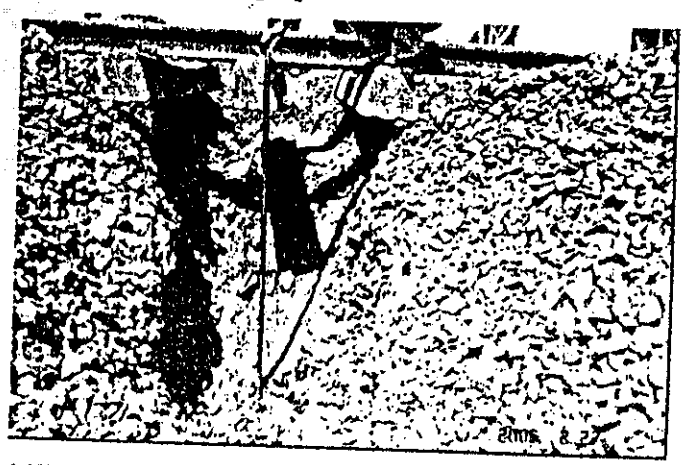
**Total cost per Km = (a)+(b)+(c) = Rs.8.38Lakhs per Km**

**C) Limitations:**

- This scheme is so simple that normally it is difficult to believe the results.
- In the past sand dumping method was tried half-heartedly and there is a misconception that this scheme gives only temporary relief. This has to be well understood that this scheme will give good results only when wider cess along with sub bank are provided along with dumping of sand in 2 to 3 rounds till all the voids in penetrated ballast are filled with sand.
- Mere sand dumping will not give the desired results since sand escapes laterally. Therefore, provision of wider cess along with sub bank is a must for providing requisite confinement.

**D) How this scheme works for rehabilitation of yielding formations?**

- The problem of weak sub-grade has turned into a different problem of managing the compressible voids in the penetrated ballast. Further due to the voids available in the penetrated ballast, train loads cannot be sustained and thus the cross-levels continue to vary.
- A typical cross section of yielding formation and the voids of penetrated ballast filled with sand at 400 mm depth can be seen in the following photographs.



1.KM 592/29-31 : A VIEW OF YIELDING FORMATION

2. KM 592/29 – 31 : close view of sand filled up the voids in the penetrated ballast at 400mm depth acting as NATURALLY DESIGNED BLANKET MATERIAL.

- The presence of sand in the voids of penetrated ballast acts as a naturally designed blanket layer, which is coarse, granular and well graded and makes the ballast denser by interlocking the ballast particles and improves the stability and acts as dense blanket layer with much higher load bearing

capacity. With this, the amount of stresses that are transmitted to the formation are much reduced, the distribution becomes more uniform and will control differential settlement due to raft action.

- Huge quantity of ballast gets penetrated into the sub grade spreading the bank slopes and the toe of bank gets shifted away from the track thereby cess becomes low. The situation gets worsened in case of marshy lands, tank areas and borrows pit areas. The provision of sub bank and wider cess with good fill material adds stability to bank, improves slope-stability, arrests the entry of water at toe of bank Because of the added weight near toe of bank further lateral spread of toe and the soil bulging at toe is prevented and hence, offers more resistance against ballast penetration. Thus the bearing capacity improves.
- The sub bank also acts as an approach road for carrying out cess repairs, which is otherwise not possible, and these locations were thus neglected for many years without any cess repair work. This will also help in future track maintenance activities.
- The penetrated sand will also fill up the cracks developed in the formation mainly during the summer season where expansive type soil gets cracked. Also over years while the sand mixes with the existing impervious soils, to certain extent the penetration of sand in top layers of formation will alter its properties favorably.

That is how sand treatment coupled with wider cess and sub bank is a complete solution for yielding formations, which does not require any caution order, traffic block, easy for execution and simple to understand and most important being speed in progress with least cost.

**E) Effect of Sand Treatment on the track drainage :**

- Normally, no pumping/blowing of sleepers is noticed in yielding formations/ bad banks due to presence of very low cess and high ballast cushion. Therefore, drainage is not at all a problem, in case of most of the yielding formations which is practically seen at site. This said phenomena is very difficult to be believed unless one practically sees at site.
- Only in very rare cases, where the track was abused due to presence of fish plated joints/kinky welds etc., and deep screening was not carried out for quit long time which has led to caking of ballast, in such cases only pumping/blowing of sleepers is noticed and thus the drainage is problem.
- The presence of sand in the penetrated ballast reduces the voids and thus water holding capacity in the formation is greatly reduced.
- The presence of sand in the penetrated ballast reduces the rate of percolation of water into the formation and thus facilitates lateral drainage.
- The presence of sand in the penetrated ballast also prevents upward migration of fines due to reduced voids in the formation.

**F) Experience of South Central Railways :**

- S.C.Railway has gained **10 years** of experience in adopting this scheme.

- This method has been successfully adopted for rehabilitation of yielding formation of about **59.11 kms** as per the details given below:

  - First trial – Km.541/0 – 542/14 for 1.5 km length on Dn line was carried out during **May, 1996** on Secunderabad Division of Kazipet-Vijayawada section on Grand Trunk Route. The existing PSR of 50 kmph has been cancelled after 2 years of observation.

  - Second trial –For 300 m length was rehabilitated on a bridge approach during **2001-02** in Hubli Division (then part of S.C.Railway) of Hubli-Hospet section. ,The existing TSR/PSR of 30/50 kmph has been cancelled after observation of 3 months.

  - Third trial – Km.527/16 – 528/16 for 1.0 km length on Dn line was carried out during **March, 2004** on Vijayawada Division of Vijayawada-Visakhapatnam section. The existing PSR of 75 kmph has been cancelled after $1^1/_2$ years of observation.

  - Further, 57 kms of worst yielding formations at 26 locations have been rehabilitated during 2004-07 on Vijayawada Division of Vijayawada-Visakhapatnam section. So far total 14 PSRs have been cancelled at the following locations:

    1. Km. 527/16 – 528/16 (Dn line); 2. Km. 560/10 – 565/30 (Dn line)
    3. Km. 586/32-587/38 (Dn line); 4. Km.592/20-593/10 (Dn line)
    5. Km. 631/0-634/20 (Dn line); 6. Km. 565/31-563/31 (Up line)
    7. Km. 587/43-586/25 (Up line); 8. Km. 590/27-590/01 (Up line)
    9. Km. 593/11-592/11 (Up line); 10. Km. 599/13-598/13 (Up line)
    11. Km. 634/00-631/00 (Up line); 12. Km. 664/13-662/00 (Up line)
    13. Km. 753/05-752/27 (Up line); 14. Km. 527/0-526/19 (Up line)

  - The balance **7 PSRs + 1 TSR** where rehabilitation works are completed and are under observation will also be cancelled during the next 6 months time.

  - On trial basis as per the directions of **Shri S.P. Sahu, CTE/SCR,** sand piling has been carried out at km. 650/25-15 for 350 m length on Up line of Vijayawada-Visakhapatnam section where the formation used to give frequent trouble. The work was completed during April, 2007. 200 mm dia sand piles at 3 m centre to centre spacing have been provided on the embankment slopes and cess. This is kept under close observation.