Mechanised Track Construction on DFC Projects

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1.0 Introduction:

The Indian Railway's quadrilateral linking the four metropolitan cities of Delhi, Mumbai, Chennai and Howrah commonly known as the Golden Quadrilateral and its two diagonals (Delhi-Chennai and Mumbai-Howrah), add up to a total route length of 10,122 km constituting 16% of the total Route Kms. This Golden quadrilateral carries more than 52% of the passenger traffic and 58% of revenue earning freight traffic of IR. The existing trunk routes of Howrah-Delhi on the Eastern Corridor and Mumbai-Delhi on the Western Corridor were highly saturated, line capacity utilization varying between 115% to 150%. The surging power needs requiring heavy coal movement, booming infrastructure construction and growing international trade led to the conception of the Dedicated Freight Corridors along the Eastern and Western Routes, to begin with. Ministry of Railways has planned to construct Dedicated Freight Corridor covering about 3325 Route kms on two corridors viz Eastern Corridor from Ludhiana (Sahnewal) to Sonenagar/Dankuni and Western Corridor from Jawaharlal Nehru Port, Mumbai to Tughlakabad/ Dadri near Delhi; the two corridors meeting at Dadri.

About 70% alignment on Bhaupur-Khurja section of EDFC is parallel to IR and detours have been planned at major stations with thick habitations. On this section, the civil works to construct a double line corridor to run freight trains at a speed potential of 100 kmph for freight are underway. The formation is designed for an axle load of 32.5 tonnes and track for an axle load of 25 tonnes. A host of new technologies like Mechanised laying of track with New Construction machine, canted turnouts with speed potential of 55 Kmph on loop line, rubberized surface at level crossings enabling quick removal and placement for mechanized maintenance, friction buffer stops etc are being introduced for the first time.

2.0 Why Mechanised track laying:

With the increase in speeds and axle loads, the track structure became heavier because of use of 60 Kg rails and PSC sleepers. Also with long welded rails becoming necessity and need to eliminate field welds, the length of panels to be laid gradually increased from 10 rail panel (130 m) to 20 rail panel (260m). The arduous task of laying these heavy track components led to advent of semi-mechanised means like PQRS, which brought some respite by way of mechanized handling and laying of panels. In the recent times efficient high performance machines like New Track construction machines

(NTC) have been developed which bring substantial ease and efficiency in track construction with integrated logistic arrangements for mechanized handling, movement and laying of heavy track components like 260 m long rails and PSC sleepers. The machine provides continuous action assembly line kind of laying with high speed and accuracy. The output of the machine can be as high as 1.5 Kms a day. These machines not only accelerates speed of construction but also help in careful handling and placement of rails and sleepers, achieving high initial quality in track laying. It is well known fact that the initial quality of track laying determines its performance and service life.

3.0 The NTC Machine:

On Bhaupur- Khurja section the mechanized track laying is being carried out with Ms Harsco Rail's New Track Construction Machine. The salient features of this machine are:

INNOVATIONS	KEY SPECIFICATIONS	
-Approx 3 times faster than manual -Mechanised flow of materials through moving gantries. -Placement of sleepers to pre-determined spacing -Capable of laying rails upto 136 lbs and 260m long	Length	45 m inclusive of front end loader
	Weight	250 tonnes
	Productivity	1.5 Kms per day
	Working speed	10 sleepers per minute
	Travel speed	80 Kmph

The machine consists of

a) **Truss frame:** The NTC unit is supported at one end by a specially modified flat wagon running on the newly laid track and at the other end, by a crawler running on the ballast bed. The truss frame contains a conveyor system for carrying the sleepers down to a laying mechanism which places the sleepers on the rolled and prepared ballast bed at a precise and predetermined spacing.

b) **Gantries:** A self-propelled gantry, requiring one operator, keep supplying the sleepers to the conveyor systems. The sleeper handling flat wagons are equipped with auxiliary rails which form a continuous running rail for the gantry to move on flat bedded wagons loaded with sleepers. Pivoting extensions between the wagons allow the gantry to operate on curves. After being dropped by the gantry, the sleepers move via the conveyor system on to the prepared ballast bed.

c) **Rail Laying/Threading unit**: 260 m long rail is unloaded through a rail puller and laid along the prepared ballast bed. The NTC machine threads the rails on

the sleepers through guides located at the rear end of the unit, driving them inwards. Final placing of the rail on the new sleepers is controlled by an operator who guides the rail precisely onto the sleeper seat.

d) **Wagons**: The NTC formation has wagons carrying rails sleepers and fittings commensurate with the laying requirement for the day. On Bhaupur- Khurja section, a formation of NTC machine with 22 Nos of BLC wagons with specially designed superstructure to carry 12 Nos of of 260 m long rail panels (1.56 km) and matching 2590 Nos of 60 Kg PSC sleepers is taken into section using a powered utility vehicle (UTV).

Fig: New Track Construction Machine

4.0 Base Depot:

All the track components are stocked and transported from a well-designed Base depot, which is essentially a yard with connection to nearest station yard of IR to facilitate bringing heavy P. Way materials like rails and sleepers. On Bhaupur- Khurja section one base depot for a length of about 100- 120 Km has been planned. Rails rolled in the length of 87 m are welded into 260 m rail panel at rail manufacturer's facility. These rails are moved on IR network in the rakes carrying 60 strings of 260 m rail panels (936 Tonnes, 7.8 Km) and brought into DFCCIL's base depot through connecting IR yard. There are three Base depots in the length of 351 Kms connecting to nearest IR station yard. The following are essential features of this base depot:

(i) Three reception and dispatch lines to bring material rakes from IR and dispatch them with NTC. A RCC platform embedded with cross rails having capacity to stack 10,000-15,000 tonnes of 260 m long rails.

(ii) 21 Nos of 2 tonnes capacity Synchronized overhead gantries have been provided for unloading Rail panels from incoming rail rake and loading them on NTC formation for laying.

(iii) Presently the sleepers are loaded using Hydra cranes. However, a Goliath crane with sleeper lifting Grab capable to handle 60 sleepers at a time is being installed. Sleepers in NTC formation are loaded in three layers each having 40 sleepers.

(iv) Yard is designed to provide two exits for constructing two lines.

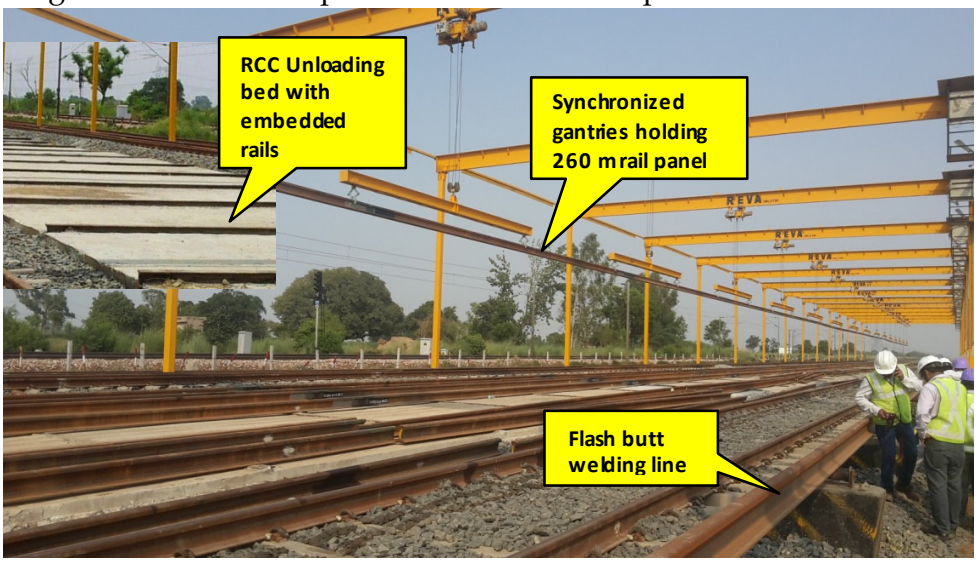
(v) A separate area is earmarked for stacking of sleepers in layers, each layer carrying not more than 25 Nos of sleepers. This area is sufficient to hold about 60-70% of total requirement of sleepers.

(vi) Workshop with essential machinery, repair and maintenance facilities etc. has been established in yard.

(vii) The base depot also has a welding line and Mobile Flash butt welding unit is used to weld the free rails into 260 m panels, if required. A weld testing laboratory with facility to conduct essential tests on welds like Brinell hardness test, tensile test etc has been provided.

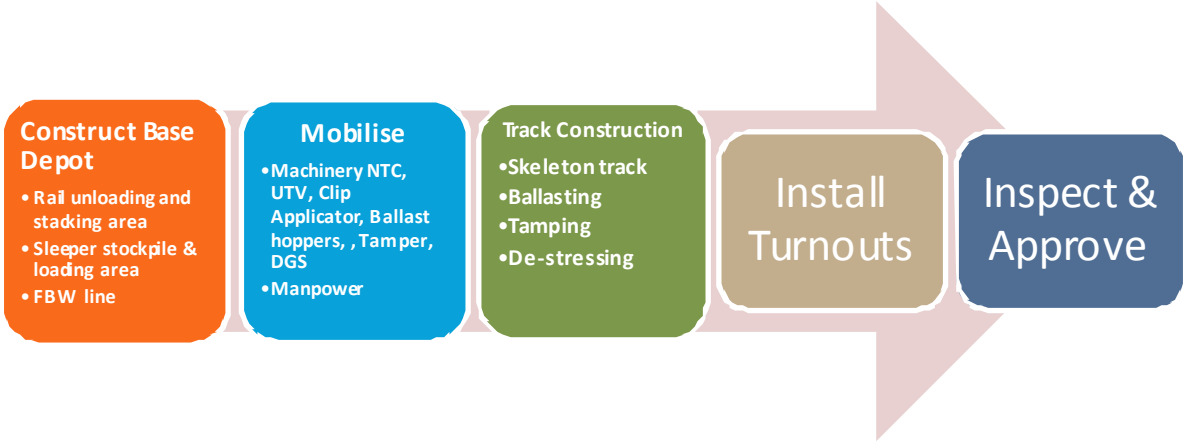
(viii) Lighting all along the yard length is essential as most of loading and other activities are performed during night time. Construction yard has to be in action round the clock to achieve a production of 1.5 km of skeleton track per day.

(ix) Covered stores for storing track fittings, machine spares, consumables and fuel etc are also provided in base depot. Ballast stacking and loading arrangements have been provided in the base depot.



5.0 Sequence of Construction:

The sequence of construction can be pictorially described as follows:



The track construction activities can be divided into two parts:

(i) Activities at Base Depot

(ii) Activities in Field.

5.1 Activities at Base Depot:

The following are important Base depot activities:

(i) Unloading 13m/260 m rail panels from incoming rail rakes, with synchronized overhead gantries and stacking them at nominated stacking area.

(ii) Welding of 13 m rails into 260 m long rail panels, in case 13 m rails are received.

(iii) Loading 12 Nos (6 pairs) of 260 m long rail panels on NTC formation using same overhead gantry cranes. Rail loading usually takes 120-150 minutes.

(iv) Moving the formation to sleeper stacking area and loading 2590 Nos of sleepers in layers, separated by wooden battens, using Hydra cranes. Each BLC wagon has three layers of sleepers each layer having about 40 Nos of sleepers. The sleepers are loaded on the formation in 10-12 hours time. With the commissioning of Goliath crane this loading time is expected to reduce to 6-8 hours.

(v) Loaded material train is pushed into the section to be laid at a restricted speed of 25-30 kmph, with two powered UTVs; movement is piloted by a pilotman holding walkie talkie ensuring its safe movement.

5.2 Activities in field:

(i) **Preparation of ballast bed**: The ballast is spread to required width on finished formation, in two layers each 100 mm thick. Each layer is rolled and compacted using 8 tonnes roller. This provides initial uniform ballast cushion of 200 mm.

(ii) **Transferring alignment on ballast bed**: Using a Total station, the centre line of alignment is precisely marked on the prepared ballast bed using lime powder for guiding the movement of NTC machine. Machine is moved on the centre line marked on compacted ballast bed with a hand held remote control that steers the front end crawler.

(iii) **Pulling out rail panels and spreading on compacted bed:** Ends of first two rail panels loaded in material train are pulled and threaded into the roller lines on NTC machine with the rail puller arrangement on the machine and these are then pulled up to the front end of NTC machine. The ends are then clamped using friction based web clamps having eye on one end which is tied to pulling Dozer (capacity 325 HP). Rail panel supported over rollers at every 6-10 m, is then gradually lowered on the ballast bed. The subsequent rail panels are drawn by connecting their webs with the preceding one using web based special friction rail clamps. The rail panels are unloaded on both side at a lateral separation of about 1700 mm leaving space for working of NTC machine.

(iv) **Laying sleepers and threading rails using NTC machine:** NTC machine can be self-propelled at speed of 15 Kmph while laying the track. The machine has an onboard computer (Jupiter Control system) which brings precision in laying with speed. The sleepers are picked up by moving gantries in the rear and brought upto conveyor belt and dropped. The sleeper layer mechanism lower and drop first sleeper onto the track surface. The Jupiter Control System uses the position of this 1st dropped Sleeper as the reference point and determines the location for subsequent sleeper drop. As the machine moves forward a sleeper spacer lowers down to ballast bed and adjusts the sleeper dropped to desired sleeper spacing. This cycle keeps going for all subsequent sleepers dropped and the sleepers are adjusted to their precise location as per pre-determined spacing. The machine has a pointer attached at the centre of the truss beam in front end of it. With a hand held remote control an operator moving ahead of NTC machine steers front crawler ensuring that the pointer under truss beam remains aligned over the centre

line marked on ballast bed as it propels forward. This ensures that machine lays track at desired centre line.

The pad operators install pads on each end of the sleeper it moves on sleeper conveyor. Another operator uses manual controls to position rail clamps and threads rails onto the newly laid sleepers.

Fig: Pointer attached underneath truss beam on the front end to guide movement on marked centre line

Fig: Sleeper dropped from conveyor belt

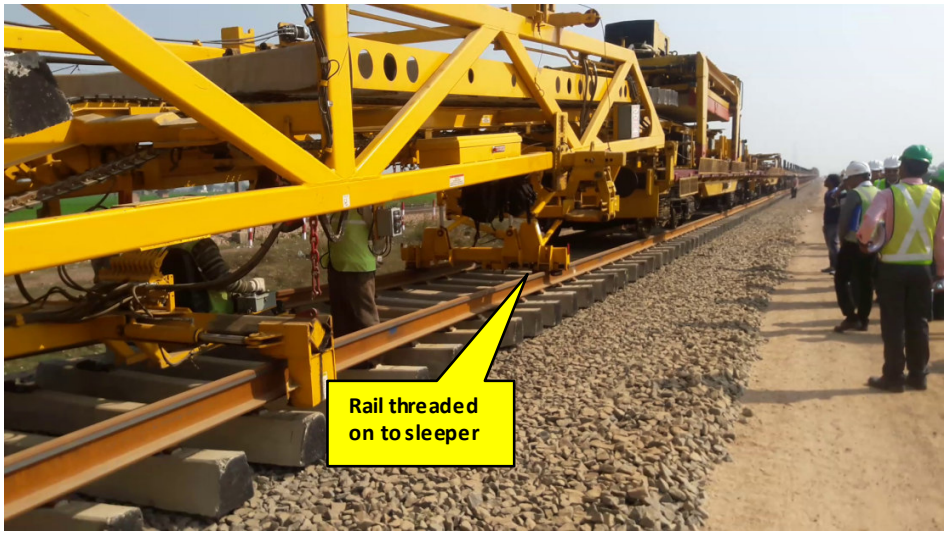


Fig: Rail panel being threaded onto sleeper

(v) **Checking of skeleton track:** The alignment, levels and sleeper spacing of newly laid track are then checked. Minor corrections, if required, are given by nominated gang with competent supervisor before clipping of sleepers. The machine is then moved back to base depot.

(vi) Thereafter rear works like ballasting and first round of tamping with double insertion is done.

(vii) A survey trolley is then run to find out the coordinates of existing alignment, which is compared with the design alignment and design feed for the tamper is generated. The tamper then does the required correction to alignment and levels, while working in design mode.

(viii) Subsequently one or more round of tamping brings the alignment of track within the prescribed tolerance. Thereafter ballast regulator followed by DGS is run to stabilize the track.

6.0 Operator/Staff Deployment for NTC Working

The operator requirements for the efficient operation of the NTC machine are listed below.

1. Supervisor- 1 No.
2. Main Control Operator- 1 No.
3. Reference Line Setter (Plumb Line)- 2 Nos
4. Liner / Gauger Operator- 2 Nos
5. Pad Installation Operators (2 Nos)
6. Gantry Operators (2 Nos).

7.0 **Conclusion:**

Dedicated Freight Corridor Corporation has taken up the task of constructing freight corridors along high capacity utilization network of Indian Railways. The work on two corridors viz. Eastern and Western are underway and they are targeted to be completed in phased manner by year 2019. With the growing demand for transport, more of such corridors will come in near future. Heavier traffic demands use of higher UTS rails and heavy concrete sleepers which are susceptible to damage, if handled manually. Also the track geometry and initial quality of laying determines the service life of track components. The challenge before DFCCIL today is to lay the heavier track structure in a compressed timelines, which can be achieved only by mechanization of track laying. Although in Indian environment where labour is not costly when compared to Western Countries, the mechanized track laying may not bring saving in cost but it is the speed and quality of laying which mandates use of mechanized track laying machines.