MECHANISED LINKING OF TRACK

By- Manoj Arora*
N K Khare**

Synopsis

Linking of track at construction site has been executed mostly by manual method in Indian Railways. Because of manual process, there is enough opportunity to improve the quality of linking by mechanizing this job. It has been an experience that whenever any industrial process has been mechanized, it has led to improved productivity, improved quality and better economy. So it can be safely presumed that like any other industrial process mechanization of track linking work will improve quality. There are many methods of mechanized linking of track. The most important job with the construction engineers to decide the suitable method of linking keeping in view the local geographical conditions. In this article, few methods of mechanized linking have been discussed with their relative advantages and disadvantages so that construction engineer can select the most suitable method.

1.0 Introduction:

In the Indian Railways new track linking work is normally executed manually. At most of the construction sites, track is normally commissioned in small patches and opening them to traffic, is normally at low speed, which is increased after giving necessary attention to the track. Track linking is done by collecting huge number of labours. It is very difficult to find such a huge number of trained manpower for linking work. Hence the working methodology and quality of linking vary from site to site depending upon the skill level of the available supervisor and manpower. Normally, following jobs are involved in track linking:

1. spreading of ballast
2. Spreading of sleeper, rail and fittings
3. Linking of track
4. Follow up activities like welding and packing.

In this article activity No.2, i.e. Spreading of sleeper, rail and fittings and activity No.3, i.e. linking of track have been discussed in detail. Four different methods of mechanization of these activities have been described along with their relative advantages.

2.0 Disadvantages of manual linking work:

Spreading of track material and its linking is a huge task as the total weight of the sleeper used in 1 km. of track is approximately 450 tons and the weight of rail for 1 km is approximately 120 tons. If we add the weight of other track fittings like ERC, liner, rubber pad, point & crossing material, check rail, guard rail, etc. the total weight of material to be handled will be of the order of 600 tons. In case of tough terrain because of forest or hilly area such a heavy track material is required to be transported along narrow strip (i.e. formation) even on sharp curves, bridges and tunnels. As the width of formation is limited, movement of vehicle for transportation of materials is quite difficult. Moreover, plying of

* Senior Professor Track-1 IRICEN, ** Associate Professor IRICEN

vehicles over formation also causes severe damage to the formation. At the same time dragging of material also does the similar damages to the formation. Now-a-days attempts are being made to roll the ballast with the help of vibratory rollers, so as to provide better support to the track initially. But if the track material is pulled on the formation after ballast compaction, the compacted layer is also disturbed by dragging action.

In the process of hauling or transportation, sleepers and rails get damaged, many small fittings are also lost. Reference pegs erected for alignment are also damaged so it becomes very difficult to align and level the track to the desired place. Where as, in the mechanized approach, transportation of rails, sleepers and fittings and linking of track is ensured systematically from one end to other, with proper quality of linking.

In case of targeted work of opening of track, large number of trained manpower for linking is required for manual working. Finding such a big trained manpower is tough. Availability of labour in India is also affected by festivals and cropping seasons, which may affect the progress. Hence it is difficult to complete the work in scheduled target.

In case of doubling/Tripling work, lot of trucks and cranes ply for spreading of track material, plying of so many vehicles and cranes may create infringement to the adjoining track on which trains are running. Many accidents have taken place because of this in the past.

It has been an experience that whenever any industrial process has been mechanized, it has led to improved productivity, improved quality and better economy. So it can be safely presumed that like any other industrial process track linking work will be mechanized in future. However, there are few factors which may affect the success of mechanized system in India.

2.1 Following factors are important for mechanization of track linking work

1. Approach of the executive and supervisors involved
2. Small sections of linking in one opening
3. Discontinuity in formation at the time of linking

2.1.1 Normally officers involved with track linking find it more comfortable with manual working, as it requires less involvement of officers at higher level. They also fear whether the machines, railway wagons and locomotive required for mechanized linking will be available in time or not. Further, because of the fear of non-availability of spares of machines and technical know how, people are afraid of going for mechanization. Since ages linking have been done manually hence people feel comfortable with the manual system. Although in most other aspects of execution of work, let it be earth work or bridge work, mechanization have taken place but executives are still not willing to push the mechanization work for track linking. Whatever little mechanization have taken place in the railways, it is due to initiative of contractors. Such initiatives are normally driven by the economy to contractor but not by quality considerations.

2.1.2 Normally small patches of track linking (20-30kms) is done at one instance. For such a small patch for linking work, purchase of any heavy machinery may not be justified. Since any such machinery will find its utility only in Railways, such machines are going to remain

idle for rest of the year with contractor which makes it unviable. Tailor made machines for new track linking work available in the world is quite costly. So there is a need to innovate about the mechanization so as to economise the track linking work.

2.1.3 In our construction sites many activities are executed simultaneously. Normally the bridge work remains incomplete till end, so the formation at the approach of bridges normally remains incomplete till the end of bridge work. In such circumstances, execution of formation work is done upto the bridge approach. Hence there is always a likelihood of finding discontinuities of the formation while executing track work. Any big machinery will not allow jumping over the discontinuity. So this factor is a big bottle neck for utilization of any heavy machinery. So this factor also necessitates innovation in construction machinery so as to design a machine which is more versatile in nature.

3.0 Mechanised systems:

The mechanized systems which are discussed in this article can be distributed in three different categories.

1. Machines specifically designed for new track linking
2. Machine available with Indian Railways which can be utilized for new track linking, and
3. Improvised machines which can be manufactured locally.

3.1 Readymade new track linking machines (normally called NTC) are available, manufactured by world famous manufacturers of machines. Such machines are quite modern and capable for achieving fast progress. Most of the activities by such machines are mechanized with sufficient quality control measures. Such machines have been developed by Harsco Track Technology as well as by Plasser & Theurer. Such machines are having front part designed to travel on both rail as well as on formation. It has a rail wheel set, when lowered it allows the machine to run on track and at the same time it is also provided with crawler, when lowered the machine can move on the formation. This particular arrangement allows the machine to work for linking of new track. Ten rail panels received from the steel plant may be loaded on these machines. After reaching to the site of linking these long panels are pulled ahead of machines by an arm for certain distance, then it is attached to another crawler running on formation which pulls the rail ahead on formation. This rail will be laid by machine in the track after laying of sleepers by machine. Sleepers are kept loaded on special wagons. Such special wagons are provided with a special rail on its side for movement of gantry. Gantries provided on this machine can lift group of sleepers, move on special wagon for feeding it to the conveyor, which further transport these sleepers to either on formation or on ballast bed. This machine can achieve a progress of 300m per working hour. Even if

machine works for 4 to 5 hrs. per day it can easily achieve a progress of 1 km. of linking per day or even more. Only limitation could be about supply and loading of rail, sleeper and fittings. Cost of this machine and availability of linking work for the good part of year is one of the major concerns. If the work is made available over a reasonable part of year, initial cost of this machine can be justified. One more important limitation of this machine is that it will not be able to jump over the discontinuities of formation. However, this machine can provide a very fast track construction of high quality. Even 10 rail panels can be laid from beginning.

3.2 There are two different machines available on Indian Railways, which can be utilized for new track linking. Following machines are available:

1) Russian track relaying train (RTRT)
2) PQRS

Two portals of Russian track relaying train and many sets of PQRS are already available over Indian Railways for relaying of track. On most of the existing routes laying of concrete sleeper work is complete. However, at many routes replacement of PSC 12 sleepers to PSC 14 sleepers work is in progress. However, as per the present status, such machines can be spared from the relaying work and with little modification these machines can be used easily for new track renewal work.

3.2.1 Russian Track Relaying Train

This machine was imported from Metex JSC (a Russian firm). This machine is

having cantilevered projection at the rear end. With the help of a gantry moving over cantilever structure, track, panels upto 26m length can be laid on formation or on compacted ballast bed. After laying of panels and it's joining with the existing track, this machine further moves over the recently laid panel to reach, near the end of track for laying of subsequent panels by this machine. In this way track is linked from one end to other. To operate this machine track panels are pre-fabricated in a

yard and loaded on this machines in four layers. In fact a bundle of four track panel is loaded on every special BRH. On such BRH special rollers are provided on which the bundles of panels are moved longitudinally by pulling mechanism. By such pulling action, bundles of panels are brought within the reach of gantry.

This machine can also provide a progress of 200m per working hour. If the material and the pre-fabricated panels are supplied promptly, progress of 1 km. per day can be achieved. However, this machine cannot jump over discontinuity in formation. At present 2 sets of this machine is available in Indian Railways.

3.2.2 PQRS:

The conventional PQRS machine which are already available with Indian Railways, (i.e. 9 ton capacity) can also be utilized for linking of new track. In this system also prefabricated panels are loaded on modified BRH and such rake is moved to the linking site. These panels are laid on the formation, after reaching to the work site, with the help of PQRS portals running on auxiliary track. Panels laid are connected to the existing track with the help of fish plate and the rake with new panels is moved ahead for further laying of panels. However, this system requires linking of auxiliary track for working of PQRS, which involves spreading of rails and sleepers for making auxiliary track. Linking of auxiliary track is a manual activity. Hence progress depends not only on fabrication of panels but also on linking of auxiliary track. It is felt that with reasonable number of labours upto 300 to 400 meters progress can be achieved per day. But only single rail panels can be laid by this method, which are required to be further welded by either thermit welding or mobile flash butt welding.

3.3 Improvised portal

Improvised portal are locally manufactured portal, design of which is motivated from PQRS. It is made up of steel members. It can lift track panel or group of sleepers and run on auxiliary track. Longitudinal movement of portal and lifting and lowering of panel by this portal is done by a diesel engine mounted on this portal. Forces are transferred by gears, belts or ropes. In order to use this machine auxilliary track is required to be assembled manually.

In this machine a horizontal beam is provided with hooks at the desired spacing. Such hooks can hold sleepers from inserts. Every pair of hook is supposed to lift one sleeper. Because of such hooks, it is not required to fabricate panels, which is the case with PQRS. This portal may lift 15-20 sleepers in one round and move to the location where these are to be laid. After reaching to the location sleepers are released on formation or ballast bed and portal moves back to bring more sleepers. By this process only sleepers are laid initially and after completion of sleeper laying, rails available as auxiliary track are moved inward and fixed on sleepers. Hence by this process double handling of rail is avoided. Since in this

system sleepers and rail are to be transported to the suitable locations (near null points) by road, no transportation of sleepers and rails or panels are required through railway rake. This machine can also be dismantled and reassembled at locations to tackle dis-continuity in formation due to delay in construction of bridges. So this method provides a good solution to the problem of discontinuity in formation. This machine can be manufactured locally at low cost (approximately, Rs.5 lakhs). It can be operated and repaired by less competent operator. To support this machine one crane (Hydra) may be required to lift the sleepers from the road vehicle and to lay on formation in between the auxiliary track. Normally track is made of single rails, to be welded by either thermit welding or by mobile flash butt plant to make LWR.

4.0 Comparison of various methods:

All the four methods discussed above have certain advantages and disadvantages. One can further try innovations, specially with the PQRS method and improvised portal method. In all the methods degree of mechanization is different and hence the achievable progress is also different. Comparison of all these methods with manual track linking method has been drawn in the table below:

COMPARISON OF VARIOUS METHODS

METHODS → / FACTORS ↓	MANUAL LINKING	PQRS	NTC	RTRT	IMPROVISED PORTAL
Discontinuity in formation	Possible	Not possible	Not possible	Not possible	Possible
Handling of material	Manual	Semi-mech.	Mechanised	Mechanised	Semi- mech.
Auxiliary Track	Not Required	Required	Not Required	Not Required	Required
Handling of rail	One time	2 times	One time	One time	One time
Length of rail	13m	13m	130m	26m	13m
Assembly yard	Not required	Required	Required	Required	Not required
Economy	Cheap	Slightly Costly	Costly	Slightly Costly	Cheap
Quality	Poor	Good	Best	Good	Good
Safety of adjoining track	Low	Good	Very good	Good	Good
Dependency on labour	Very high	Medium	Very less	Very Less	Less
Progress/day	Variable	300-400m	1000m	1000m.	400m.

4.1 Discontinuity in the formation:

Out of the four mechanised method, improvised portal can work best in case of discontinuity in formation. One can try to shift PQRS portal also in case of discontinuity in formation. But NTC, RTRT cannot be used in case of discontinuity in formation. In case of manual linking discontinuity in the formation is not a big concern, except in the case of high banks, where it is difficult to transport track material.

4.2 Handling of material

In case of NTC machine and Russian TRT, handling of sleeper and rail is fully mechanized whereas in case of PQRS and improvised portal it is semi-mechanised and hence the amount of labour required for PQRS and improvised portal will be more than the NTC and Russian TRT. In case of manual linking handling of material is mostly manual, which may cause damage to the track material.

4.3 Auxiliary Track

NTC and Russian TRT do not require auxiliary track. However, PQRS and improvised portal require preparation of auxiliary track. Preparation of auxiliary track requires high number of labours. It is a big bottle neck in the progress of linking of track. Because of requirement of auxiliary track in case of PQRS, double handling of rail is required, however, in case of improvised portal, rails are required to be handled once, although it requires auxiliary track

4.4 Length of panels laid

NTC can easily handle a panel upto 130m length, Russian RTRT can handle upto 26m length whereas PQRS and improvised portal can handle only 13m length in case of new construction. However, in case of doubling or tripling, longer panels may be unloaded from the existing track with the help of EUR. These panels can be used initially for auxiliary track for the working of PQRS and improvised portal thereafter these are laid in the track. However, with Russian TRT, length upto 26m can also be handled. In case of gauge conversion if required 10 rail panels can be unloaded on MG track with the help of EUR before closure of MG track. These panels may be used afterwards for new track linking. In case of manual linking rails only upto 13m length can be handled.

4.5 Requirement of assembly yard

In case of PQRS and Russian TRT assembly yard is required where sleepers and rails are unloaded and panels are prefabricated and loaded in the rake. In case of NTC, loading of sleeper and long panels of rails is required to be done in the assembly yard. In case of improvised portal no assembly yard is required.

4.6 Capital and overall cost

NTC is the state of art machine which may be either be procured by Railways and given to contractor or contractor can be asked to purchase for their utilization. But in any case this machine will become viable from the capital cost points of view only if linking of long stretches is done by this machine. PQRS and Russian TRT is also slightly costly,

however, since these machines are available over Indian Railways, capital cost is not a much of issue. Improvised portal is much cheaper in comparison to other machines. Comparison of cost required for manual linking and by improvised portal for one kilometer of track has been given in para 5.0.

4.7 Quantity of linking

Because of fully mechanized working, NTC may provide the best quality, however the quality provided by Russian TRT, PQRS and improvised portal may also be reasonable.

4.8 Safety of adjoining track

All these machines are well deigned to take care of safety of the adjoining track. However, while working, some precautions may be required to be taken. Because of mechanised working, requirement of plying of road vehicles and road crane in vicinity of existing track (in case of doubling or tripling) is very much reduced. Such road vehicles are much bigger threat to the safety of the adjoining track as compared to these machines. So the overall safety of adjoining track in case of doubling or tripling will improve by mechanization.

4.9 Dependency on labour

In case of manual linking progress is fully dependent upon availability of labour. Availability of labour is highly variable and we can not be assured of their presence. In case of NTC and RTRT labour requirement is very less. In case of improvised portal requirement of labour is low. Linking of 1km of track requires approximately 200 man days as against approximate 800 man days required for manual linking.

4.10 Progress achievable

Since NTC and Russian TRT does not require auxiliary track, this can easily provide a progress of 1 km. linking per day provided enough sleepers, fittings and rails are promptly supplied. However, in case of PQRS and improvised portal, manual element is more and the maximum progress achievable may be limited to 300-400m per day.

5.0 Comparison of cost of working with improvised portal vis a vis manual working

Cost of Work- If the system of mechanized linking of track is designed thoughtfully, it need not to be costlier than manual linking. The semi mechanized approach of improvised portal can really provide much better quality at reduced cost as compared to manual linking process. A comparison of cost of linking of 1Km track in a normal level terrain has been drawn for manual as well as for improvised portal. Following assumption has been considered to draw comparison of cost:-

i) Single rails and sleepers have been already brought to the null points available on the formation.
ii) Cost of spreading and profiling of ballast have not been considered as it is same for both the cases.
iii) All the fastenings have also been transported to the null point by trailer.
iv) The cost for packing the track after linking, have not been considered in both the cases.

5.1 Cost of linking of track by manual method: While linking by manual method, cost of spreading of sleeper, rail and fittings along the formation as well as the cost of linking of rail after spreading and spacing of sleeper have been considered. It is found that the cost is approximately Rs.2 lakhs per Km.

5.2 Cost for track linking with improvised portal: In this case, the cost of spreading of rail along the formation and making auxiliary track, lifting of sleeper from the dump near the null point and stacking on the centre of formation at the same location as well as the cost of spreading of sleeper at the desired spacing all along the track with the help of portal, slewing and fixing of rail on sleeper and transportation of fittings have been considered. The cost works out to Rs.1,30,000/- per km.

The estimates have been made based on rates prevailing at few places over Indian Railway and job analysis. In this way, one can see that the cost of linking is reduced by 35 to 40% by using improvised portal. Additional equipments required are of negligible cost (hardly 3-4lakhs), and at the same time quality of linking is of much higher standards. Damages to the track components and formation and loss of ballast are also minimised.

6.0 Conclusion :

It has been proved at many opportunities that the quality and the safety at work spot can be improved only by providing method statement in the tender document. This method statement should be able to dictate safe working system. The expected quality is also likely to be better when method statement is provided. So, compilation of various systems available has been provided along with their relative pros and cons of various methods. Depending on the geometry, road approach to the site, length of the stretch of track to be linked, one should select the method of working which may be provided in the tender document. If we leave the decision of methodology to be followed to the contractor, they may continue to work with the manual system which is in practice at present. Manual method of linking does not require specialized machine and manpower, the capital cost required to start work is also less but it causes damages to rail sleeper, formation and fitting. So in order to improve the quality of work mechanization is extremely important.
