MACHINERY, METHODS AND ISSUES RELATED TO BALLASTING

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"Indian Railways Vision 2020" envisages an ambitious growth and Network Expansion. The Vision aims at a major augmentation of capacity through doubling and quadrupling of lines, complete segregation of passenger and freight lines on High Density Network (HDN) routes, substantial segregation on other routes and electrification on busy trunk routes. The following are the broad goals to be achieved from 2010-11 to 2019-20 as per Vision 2020.

Doubling (including DFC)	12,000 kms
Gauge conversion	12,000 kms
New line	25,000 kms
Electrification	14,000 kms

Efficient project execution to ensure efficient utilization of resources and completion of projects within targeted time and cost would hold the key to attain the Vision. Capacity augmentation on the scale required for the Vision 2020 would not only require massive resources but also call for organizational and project-execution challenge of an unprecedented magnitude. Planning and project-execution process is proposed to be reorganized and reoriented to implement and deliver whole projects (for instance, an entire route, rather than small fractions at a time) strictly within the targeted time and budgeted expenditure. The message is loud and clear that we need to accelerate the pace of execution, climbing up on an exponential curve. To meet the challenges we, the Railway Engineers need mechanisation of project execution apart from a fast track approach to work. Mechanisation not only improves speed in construction and delivery but also help to achieve high quality standards. Though the shift towards massive mechanisation of construction activities in Railways has started quite some time back with launching of Project Unigauge, till now, only the earth work has been nearly fully mechanised. Other activities are not as mechanised as it could have been.

Ballast forms the most voluminous component of the track after earthwork. This paper discusses issues related to access for ballasting machinery, changing the method of measurement of ballast to reduce cost, improve quality and enhancing speed of construction, machinery and method of ballasting.

Access for Ballasting Machinery:

As per IRPWM Para 263, the bottom width of ballast profile for PSC straight track with 300 mm cushion is 4720 mm. In case of curves, twice the outer side dimension is 5020. The standard formation width is 6850/6250 mm. The available cess width is 1065/765 mm. This width is inadequate for movement of any machinery on one side of partially constructed track. Definitely machinery taking ballast or other materials will ride over ballast and contaminate it. They will also disturb sleepers. Some ballast under tyre pressure will be pushed into formation and lost.

In case of doubling projects, the available space for vehicle movement on the existing track side is 2650 – 2510 = 140 mm. With barricading, there is no space for normal work itself.

In case of ballasted deck bridges, the entire deck is occupied by ballast. Machinery has to climb over the ballast and sleepers to pass through.

Mechanisation is necessary for speedy execution. It is not economical to provide passage on one side of track. Therefore, machinery must move along the centerline of track. To avoid contamination of ballast and disturbing of sleepers, it is necessary to provide adequate formation widths, clearances and inter track spacing more than what is presently adopted.

A review needs to be done and the dimensions may have to be suitably increased to have adequate and safe working clearances to facilitate mechanisation.

Need for change in Method of Measurement of Ballast:

As of now, production of ballast is dealt independently at the quarry. After production, the present procedure requires transporting, stacking, measuring and after measurement leading and dumping at required locations. There are some disadvantages in the procedure and they present as opportunities for improvements. The disadvantages are

a) Loading and unloading of ballast twice first at quarry to stacking area second at stacking area to track location.

b) Manpower and machinery is used up for stacking.

c) Non availability of stacking area results in paying extra lead beyond initial lead. Also delays the collection.

d) The bottom of the stack invariably is contaminated as it is handled using excavators.

e) There is also loss of ballast which gets mixed with earth at stacking area. Loss of ballast takes place additionally due to spillages during leading and dumping.

f) 15 to 21 days are wasted in waiting period prior to and after measurement.

The opportunity for improvements is to eliminate stacking procedure and allow direct dumping on track. The concerns of Railways in this issue are:

- To ensure correct quantity of ballast as measured is only paid and to have a record of measurement.

- To ensure correct quality of ballast as per specifications.

The concerns of Railways are discussed below:

Quantity:

In the propose procedure, the full ballast profile could be measured at 25 m intervals of dimensions: B, D, H, C, E & H with simple tape measurements of the finished ballast profile as shown in the standard profile in Fig. 1, below.

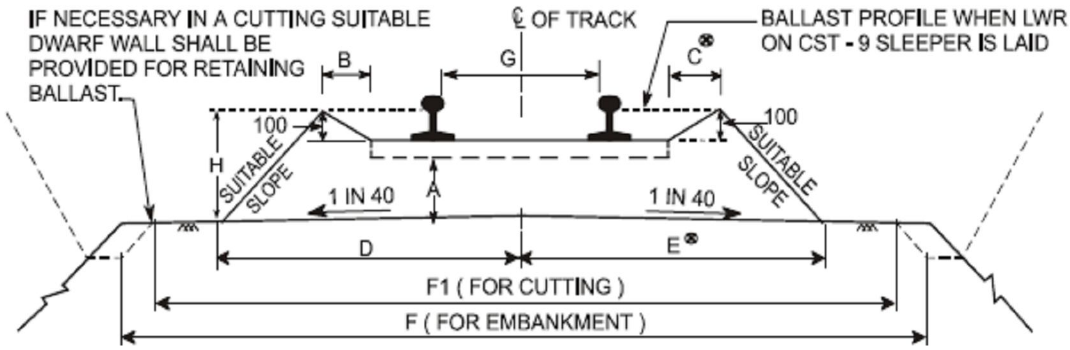

Fig. 1 - Standard Ballast Profile

In the existing procedure, ballast stack is measured generally with 12-16 measurements of 4 - lengths, 4 - breadths and balance depths. In projects the stacks are generally of large quantity. Assuming average stack size of 500 cum and average requirement of 2.2 cum per m, each stack could be spread over a distance of 227 m.

In the proposed procedure, using only 6 easy measurements, the cross section area and volumetric contents between two chainages could be arrived at. These measurements also ensure that finished profile confirms to standard ballast profile at each chainage. As the measurements are at closer intervals, the accuracy of measurement is much more than the presently adopted procedure. Also the measurements being more or less near the standard measurements, in order to confirm to the standard ballast profile, it is not possible to do malpractice.

Quality:

The inspection and checking of quality of ballast is at present done for every stack and at every 1000 cum of supply. As the visible surface area of each stack is less, it is possible that undersize and oversize goes unnoticed in the present procedure.

In the proposed procedure, the inspection and checking of quality of ballast for presence of undersize and oversize is done at every stage of ballasting in a far more surface area till final profile is measured. Other quality parameters could be checked as per the existing procedure. Thus quality inspection is more intensive and better in the proposed procedure.

Additionally procedure control of production at quarry and procedure for tallying quarry dispatch records and site receipt records could be set up so that only approved material leaves for site from quarry and reaches the site.

To prevent dumping of rejectable quality ballast, stiff reduction of rates /penalty for mandated removal could be prescribed. As the projects are to be awarded on turnkey basis, the possibility of a contractor attempting such malpractice is remote.

Hence the concerns of Railways are fully addressed. Rather than making payment for full stack quantity, we need to pay only for the actual quantity dumped at site. The disadvantages of existing procedure get eliminated and Railway saves time and cost. It also avoids contamination. Therefore it is recommended that the proposed procedure dispensing with stacking and measurement is adopted for accelerating construction in New lines, Doubling and Gauge Conversion projects. In track renewal and revenue ballasting, the existing procedure could be followed.

Machinery for Ballasting:

With existing formation widths and inter track spacing, all machinery should be planned to move along the centerline of track to minimize ballast contamination. A tractor used in Malaysian Railway for moving ballast distribution hoppers is shown in Fig 2. It is a heavy load tractor with modified axles with tyre spacing in same axle of about 3.6 m. adopted for MG. It will move on the formation along the track centerline without disturbing sleepers.

Photographs of bottom ballasting being done in Malaysian Railways shown in Fig. 3 – Fig. 5. The figures show a specially designed hopper for distributing the bottom ballast evenly along the width and length of the track.

The figures also show tippers, graders and rollers used for bottom ballasting.

Fig. 6 shows a Rail Lorry used for Placement of Crib Ballast after linking to enable lifting track to final level.

Apart from the above, we need excavators/loaders, profilers etc, to complete ballasting.

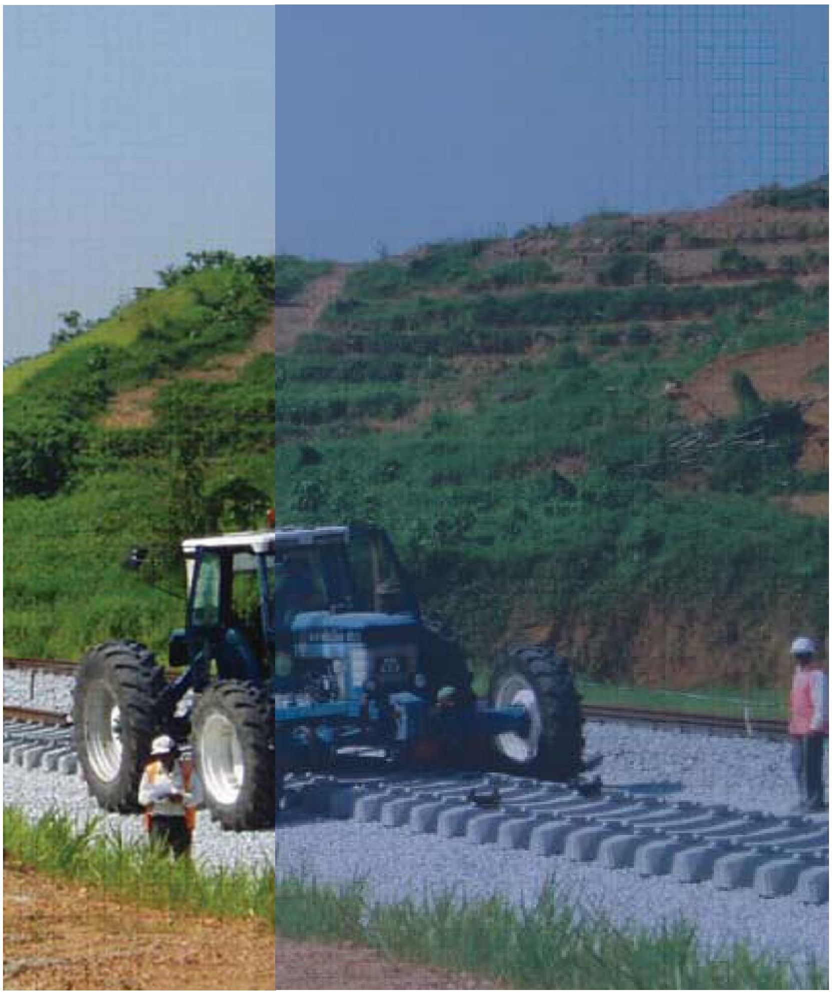

Fig. 2 - Road Tractor modified for use in Track works

Fig. 3 - Ballast Distribution Hopper

Fig. 4 – Grader for leveling the Ballast

Fig. 5 – Roller compacting the Ballast

Fig. 6 – Rail Lorry

Method of Ballasting:

The stages of ballasting of a new track after a new formation is constructed are:

Placement of Bottom Ballast.
Placement of Crib Ballast after linking to enable lifting track to final level.
Placement of Top Ballast to full profile

Placement of Bottom Ballast:

Bottom ballasting reduces the effort required to lift the track when linked on bare formation. It also ensures that ballast gets uniformly compacted and a good bed is available for track.

At present in IR, bottom ballasting is done using excavators to load the ballast in to tippers and tippers unload the ballast at site. This method does not ensure even distribution of ballast along the length of track.

To distribute bottom ballast without contamination, evenly along the length of the track the following method adopted in Malaysian Railways is suggested.

Generally bottom ballasting is done to a depth of 200 mm. An allowance of 30 to 50 mm is given to account for settlement of ballast after compaction. The ballast distribution hoppers (Hopper) are hauled by tractor and placed at centre of track at required chainage. The tractor is detached to make way for loading. Tippers unload the ballast in to hoppers. The hopper has gate control for opening and closing. After fully loading the hopper, the tractor is attached and the gate is opened. The ballast gets unloaded while being slowly hauled by the tractor. The bottom of hopper has a blade which drags the excessive ballast and levels up the heaps. Ballast loading could be done directly in to the hoppers by tippers from the quarry if measurement on track as explained in previous paragraphs is adopted.

Placement of Crib Ballast:

After placement of bottom ballast, sleepers are laid and skeleton linking of track is completed. The rails are clipped and made fit for movement of rail lorry. At this stage welding is not complete. The joints are clamped.

To facilitate easy movement back and forth two rail lorries are placed back to back and worked together. Ballast is loaded on the rail lorry at loading spots which should be as near as possible and has to be planned in advance, preferably before finishing earth work. Loading spots should have approach ramp and wider area for loading, turning of tippers, etc.

The rail lorries unload the ballast continuously from one end to other. The unloaded ballast will be used to lift the track by about 100 mm depth in two stages to near final level and alignment.

Placement of Top Ballast:

After placement of crib ballasting, two stages of lifting and packing, there will be some shortfall of ballast in the cribs. Shoulder also needs topping up. Top ballasting is to meet these requirements. It is done using the same arrangement of two rail lorries back to back, even though at this stage, it is possible to run ballast rakes. Rail lorries are more economical as compared to ballast rakes. The track is corrected to design alignment. After final tamping, the profiler is run to attain the standard ballast profile.

CONCLUSION:

Speedy execution needs mechanisation. Mechanisation needs adequate access space for the machinery. IR needs review the existing standards and increase the standard dimensions suitably, providing adequate working clearances for machinery to facilitate mechanisation. Speed of execution could be improved by cutting down the procedural time. The new measurement procedure suggested is in this direction. IR may consider and adopt the procedure for faster work, better quality and cheaper cost. The machineries and methods of track ballasting described in this article are in the positive direction of improvement of quality by avoiding contamination of ballast and reducing cost of ballasting and could be adopted for all New line, Gauge Conversion and Doubling projects.