

TRACK MODERNISATION

CHAPTER-1

MODERNISATION OF RAILWAYS

1.1 INTRODUCTION

Indian Railways, in keeping pace with advanced railways of the World, have been modernizing its railway system for quite some time. The maximum permissible speed of the train on B.G. system of Indian Railways till few years back was only 100 kmph. With effect from 1st March; 1969, the maximum speed was increased to 120 kmph on Delhi Howrah route. The increase of the speed has been possible after carrying out extensive investigations and trials in the shape of feasibility study on Rajdhani route with WDM-4 locomotive and ICF-all coiled coaches. The study was based on the fundamental concept that safety and comfort at high speed is dependent upon inter-action of the track and the vehicle. If the suspension system of the rolling stock is very good, the track maintenance may be even of comparatively average quality to get a reasonable level of comfort and stability at higher speeds. Based on this concept, it was considered that average speeds to a limited extent can be introduced economically on the Indian Railways without carrying out major changes in track structure by selecting better type of locomotives and rolling stock and maintaining the track to a slightly higher degree of maintenance. The Rajdhani Express was, therefore, hauled by a WDM-4 locomotive and all coiled coaches. The speed of the train which was originally 120 kmph has been increased to 140 kmph was a plan to increase the speed to 160 kmph is also under consideration of the Indian Railways. **Semi High speed trains of 200 kmph are also under trial from 2016. Nine different routes have been identified in India for running Semi high speed trains.**

Similarly on Meter Gauge, the longtime barrier of 75 kmph has been broken and trains with YDM-4 locomotive and ICF at coiled coaches are running up to 100 kmph from December, 1977.

1.2 MODERNISATION OF RAILWAYS

Modernization of railways is done basically with an objective to run heavier trains at faster speeds safely and economically and to give better productivity and better customer service to rail users. This consists of modernization of track, use of better designed rolling stock, adopting superior type of traction, having better signaling and tele-communication arrangements and using other modern techniques in operation of railway system. The brief break up of various aspects of modernization of railways are given below:

1.2.1 Modernization of track

- (i) Use of heavier rail sections like 52 Kg. and 60 kg/m and use of wear resistant rails for heavily worked sections to increase the life of rails.
- (ii) Use of curved switches of 1 in 16 and 1 in 20 type for smoother entry in the yards.
- (iii) Use of prestressed concrete sleepers and elastic fastenings like Pandrol clips etc. to give resilience to track and smooth rail travel at high speeds.
- (iv) Use of long welded rails and switch expansion joints to provide a smooth and fast rail travel.
- (v) Modernization methods of track maintenance like mechanized maintenance, measured shovel packing etc. to provide a better geometry of track for high speeds and smooth travels.
- (vi) Track monitoring by **Track Recording Cars**, Portable Accelerometer and **Oscillograph cars** so as to assess standards of track maintenance and to plan for its better maintenance.

1.2.2. Other aspects of modernizations of railways.

- (I) Use of better designed anti telescope, **LHB** coaches with better **suspension** arrangements, better braking system for safe and smoother rail travel.
- (ii) Provision of universal couplers to provide a uniformity in the coupling of coaches.
- (iii) Introduction of diesel and electric traction to haul heavier loads at faster speeds.

- (iv) Introduction of modern signaling techniques to enable the trains to move at high speeds with safety.
- (v) Management information system for monitoring and moving freight traffic to avoid idle time and to increase its productivity.
- (vi) Computerization of train reservation system to avoid human error and to give better customer service for reservation of berths for train journey.
- (vii) Use of computers and other modern management techniques to design and maintain the assets more efficiently and economically, to have efficient human resource development (HRD) to increase productivity and to give better customer service.

1.3 EFFECT OF HIGH SPEED TRACK

The investigation for high speed trains have revealed that increase of speed does not necessarily result in corresponding increased deformation and stresses in track components, necessitating use of heavier track structure. The important factors influencing loads, deformations and stresses in track component were found to be the parasitic movements of the vehicle on the track viz. pitching, rolling bouncing etc., which depended upon the standard of maintenance of the track. An important conclusion was, therefore, derived that on a given track structure it is possible to operate the same vehicles at higher speed without imposing any additional loads and stresses, provided the standard of maintenance of track and vehicles was sufficiently improved as not to increase the parasitical movements of the vehicle at higher speeds. The existing track structure on the Rajdhani route has been considered to be of adequate standard for high speeds up to 120/140 kmph.

To get still higher speed of the order of 160/ 200 kmph, the standard of maintenance required should be very high as the track will have to be maintained to very close tolerances. The maintenance of existing track to such close tolerances may be uneconomical and adopting of an improved track structure, which can be maintained to closer tolerance with comparatively lesser cost, may become necessary. Modern track structure, consisting of long welded rails with concrete sleepers and elastic fastenings may possibly meet such a requirement. The cost of this modern track may be comparatively higher, but it can definitely be maintained to closer tolerances with very little cost.

1.4 MEASURES TO BE TAKEN TO IMPROVE THE TRACK FOR HIGH SPEEDS.

The measures which are normally taken to improve the track under Indian conditions to achieve high speeds discussed in subsequent paragraphs. Most of these measures have been adopted for increasing the speed on Rajdhani routes. These measures provide only very broad outlines and details have to be worked out in each case individually, suiting to the requirement of the particular section.

1.4.1 Formation Treatment

A detailed study of formation soil is taken of the section, where there has been difficulty in maintenance of permanent way due to bad formation. The investigations include finding out the previous history and behavior of these bad spots, collection of undisturbed soil samples, information about existing drainage arrangements and collection of such other data. Rehabilitation measures are planned depending upon the nature of trouble. Generally any of the following measures may possibly be able to remedy the trouble.

- (i) Provisions of suitable blanketing material of required depth with or without water proofing membrane such as polythene sheets.
- (ii) Provisions of sal-bullah piles at the end of sleepers.
- (iii) Cement grouting of ballast pockets as well as of formation.
- (iv) Lime treatment of formation either by lime or by lime grouting.
- (v) Provision of sub-bank and flattening of slopes, wherever existing slope is inadequate and the bank has a potential danger of slip.

1.4.2 Improvement in Track Structures

- (i) *Track renewals:*

The track renewal works are planned on the liberal scale on age-cum-condition basis. New track should be laid with 60 kg Rail on concrete sleepers and elastic fastenings; Use of concrete sleepers should also be well planned. Along with track renewals deep screening of ballast and treatment of bad formation should also be done.

(ii) *Welding of rails.*

Single rails are converted onto 3-rail panels, and 5-rail panel and into L.W.R. on a programmed basis to get better track structure. Welding of lead rails in turnouts and welding of joints in the approaches of bridges and level crossing is done to get better maintainability of track on these locations.

(iii) *Providing adequate ballast cushion:*

Great stress is laid on training out the ballast so as to provide a full ballast cushion. For this purpose apart from procuring the ballast in the queries, ballast is also taken at a number of depots of different stations and also along the cess.

1.4.3 Improved methods of track maintenance

(i) *Mechanized maintenance:*

A judicious combination of mechanized maintenance by 'on track' tampers and the manual maintenance is made to maintain high speed routes, particularly sections having long welded rails; 'On track' tampers are able to maintain very effectively long welded rails laid on concrete sleepers.

(ii) *Measured Shovel packing:*

M.S.P. technique is normally introduced to maintain turnouts and the wooden sleepers at joints to get better maintainability of these locations. **It is obsolete now a days.**

(iii) *Directed Track Maintenance:*

D.T.M. which enables the track to be maintained to better tolerance, is generally introduced in most of the sections of high speed routes. This helps the track Engineers to maintain the track to closer tolerances with lesser input of labor.

(iv) *Ultrasonic Rail flaw detection:*

With a view to minimize the incidence of rail fractures, ultrasonic testing is introduced in most of the sections of high speed routes.

(v) *Improvements of curves:*

A systematic program is made for checking the versines and curves are realigned on the standard criteria. The limits of maximum cant and cant deficiency are laid down for high speed routes and these are adopted for the curves of high speed routes.

1.4.4 Track tolerances and Track Recording

Service tolerances have been laid down on Indian Railways for high speed routes. For maintaining the track to these closer tolerances, frequent recording of track is done by **TRCs**, Oscillograph Cars and portable accelerometers. Constant monitoring of track by these Cars make the P.Way-men at all levels alert and quality conscious and helps in better maintenance of track geometry.

1.5 TRACK RECORDING

Track recording consists of objective method of assessment of the quality of track with the help of sophisticated equipments. A continuous record of various track parameters is made with the help of track recording devices from which an assessment can be made about the running quality of track. Track recording is normally done by using any of the following equipments:

- (i) Hallade Track recorder
- (ii) Amsler Track Recording car.
- (iii) Oscillograph Car.
- (iv) Portable Accelerometer.
- (v) Track Recording-cum-Research Car.

(vi) Track Recording Trolley.

(i) Hallade Track Recorder:

The Hallade Track Recorder is a portable instrument which produces a graphic records of the various parameters of track, over which it is carried in the train. The instrument basically consists of four sets of pendulums which are operated as a result of irregularities in various track parameters and which in turn control the movement of needle points called 'styles' resting on the drum with the plotting paper.

The instrument is carried on a base plate which is placed in the Centre of the bogie of a fast moving train. Hallade Track Recorder records vertical oscillation, lateral oscillation and bouncing effect. The defects exceeding 6mm are noted and number of such defects then calculated, which give the condition of health of track. (It is obsolete now).

(ii) Amsler Track recording Car:

It is a special type of vehicle about 22 meter long and has measuring devices to measure unevenness, twist, gauge, and alignment. These parameters are recorded in a chart called track recording chart, from the cabin of the vehicle which moves at a specified speed in train formation.

Based on the Amsler car recording, track on the Indian railways has been classified into 4 categories for each of the parameters of unevenness, twist, gauge and alignment viz. A, B, C, & D. (It is obsolete now).

(iii) Oscillation Cars:

Oscillation Car is a mobile laboratory-cum-instrumented car having pen type recorders, which are connected to accelerometers, lead cells and LVDTs, (linear variable differential transducer). The oscillograph car runs are made to assess the safety and stability of locomotives and vehicles as well as the standard of track maintenance.

1. Vertical and lateral acceleration of the vehicle.
2. Instantaneous wheel loads at spring level.
3. Lateral force at axle box level.
4. Bogie rotation.
5. Bolster swing etc.

(iv) Portable accelerometer;

The portable accelerometer is essentially a mechanical equipment and uses air for damping purposes. It is sensitive to acceleration in two different directions. The accelerations are recorded by a set of pens on a paper roll. It is sealed unit and no operative adjustment can be done on this piece. The only adjustment required is for the control of needle points on the paper. This is done by turning a screw.

The portable accelerometer is kept on the locomotive cab or on the trailing vehicle. It gives an assessment of the riding performance of the rolling stock as well as the condition of maintenance of track. Peaks above 0.2g recorded on the cab of locomotive in the vertical and lateral mode are calculated per kilometer of track. The number of peaks above 0.2g for particular accelerometer run are then compared with those of the previous run for objective assessment of the condition of track maintenance.

Frequency of track recording

Track recording is normally done at the following frequency by various track recording Cars.

TYPE OF Recording	CLASSIFICATION of B.G.	CLASSIFICATION of M.G.	FREQUENCY OF inspection
1. By Track Recording Car	Routes with speeds above 130 kmph	-	2 months
	Routes with speeds above 110 and up to 130 kmph	Specified high Speed routes	3 months
	Other A & B routes	Trunk routes	4 months
	C & D routes	Main lines	6 months

	E routes		12 months
2. By Oscillograph car	Gr.A routes	High speed routes	6 months
3. OMS -2000	speeds above 100 kmph Other routes	speeds above 75 kmph other routes	once every month once in 2 months

These modern methods of track recording enable the railway Engineers to maintain the track made efficiently and trains can run at higher speed with better safety standards.

1.6 High speed trains on Indian Railways

The present maximum permissible speed on Broad Gauge (B.G.) on Indian Railways is 140 kmph on Delhi-Agra Section. Regular high speed passenger services at 130 /120 kmph also exist between New Delhi-Howrah and New Delhi-Bombay Central Sections. Efforts are being made to increase speed of a few trains on certain nominated sections to 160 kmph. Trials have been conducted up to 180 kmph on WAP3 locomotive fitted with Mark-IV bogies and the locomotive has been found suitable for a maximum operating speed of 160 kmph. On coaches side, IRX shell on IR-15 (Lately IR-20) bogies have been tested up to 180 kmph and found to exhibit satisfactory riding characteristics.

1.6.1 Track Structure for high speed routes:

It is felt that the existing track structure can be upgraded only to accommodate speed up to 160 kmph. For speed higher than 160 kmph, track will have to be newly laid as existing formation in many cases may not be in position to take up the full load. The track structure required for speed higher than 160 kmph and up to 200 kmph has not yet been finally designed. However, following track structure is being contemplated for the speeds up to 160 kmph and for speeds 160 to 200 kmph (Please see table)

S. No.	Track	Track structure for Speeds up to 160 kmph	Track structure for speeds 160 to 200 kmph.
1	Rails	60 kg & 90 UTS	71 kg & 90 UTS
2	Sleepers	Mono block PRC Sleeper	Mono block PRC Sleepers
3.	Sleeper density	1660 No. per km.	1660 No. per km
4.	Fastenings	ERC clip mark III with Rubber PAD 6 mm Thick & Liner Steel Or GFN	Same as Col 2
5.	Points & Crossings	Thick web, head hardened Switches and cast Manganese Crossings on PRC sleepers	same as Col. 2.
6.	Ballast Cushion	250/300 mm depth with 150 mm sub ballast	hard stone ballast with 300mm cushion over 150 mm Sub-ballast.
7.	Formation	Stable with penetration of Ballast less than 300 mm	well compacted and stable.
8.	Miscellaneous	Existing track may serve The purpose	Constraints to be removed.

1.6.2 Future Planning of high speed trains on I.R.

Indian Railway are planning to construct four high speed rail corridors to provide bullet (High speed) trains at 250 to 300 kmph; one in each region of the country and plan for at least 8 more corridors connecting commercial, tourist and pilgrimage hubs.

Six corridors have already been identified for technical studies on setting up High Speed Rail Corridors. These are:

- (i) Delhi Chandigarh-Amritsar
- (ii) Pune-Mumbai-Ahmedabad
- (iii) Hyderabad-Dornakal-Vijayawada-Chennai
- (iv) Howrah- Haldia
- (vi) Chennai-Bangalore-Coimbatore-Ernakulam
- (vii) Delhi-Agra-Lucknow-Varanasi-Patna.

These could be built as elevated corridors keeping with the pattern of habitation and the constraint of land in our country. The Railways will use the PPP mode for investment and execution, and draw on other technologies incorporating the highest standards of safety and service quality.

1.6.3 High Speed Track on Advanced Railways of the World

Technical concept of a Railway track consisting of ballast, sleepers and rail with fastenings is very old and has stood the test of time. The system is simple and can be rapidly extended, renewed or dismantled with almost full recovery of materials; It has, however the disadvantage that because of the subsidence of ballast bed under traffic, Maintenance required to keep the track to closer tolerances, is very heavy, particularly at higher speeds.

Many of advanced railways of the world are already operating trains at a speed of 200 kmph and above. On the New Tokaido line, which was specifically constructed in 1964 for high speed traffic, trains are running at a speed of 220 kmph. Based on the encouraging results of the New Tokaido line, another high speed corridor namely 'Shinkansen Net Work' was constructed for running trains at higher speeds. Presently electrified non-tilting trains including Japanese Shinkansen Railway & French TGV & German ICE trains are running at speed 250-300 kmph.

Maglev systems being developed in Japan and Germany. These are combinations of super conducting magnets and Linear motor technology and have a non-adhesive drive system independent of wheel and rail frictional forces. These trains are running at speed about 350 kmph.

The maximum speeds achieved and recorded in some of the European Railways are given in Table 1.1

Table 1.1 Maximum speeds on European Railways

<i>Name of the train</i>	<i>Maximum speed</i>	<i>Year of introduction</i>	<i>Sections for high speeds</i>
1. Inter-city Express	280 kmph	1991	Hamburg to Munich via Frankfurt & studgart
2. X-2000	210 kmph	1990	Stockholm to Gotenburg
3. ETR-460	260 kmph	1994	Rome to Milan: Rome to Venice
4. ETR-500	300 kmph	1996	Naples to Milan & Turin to Venice
5. AVE	270 kmph	1992	Madrid to Seville
6. Euro star	300 kmph	1994	Bruxeues to Lille to Paris
7. TGV	300 kmph	1996	Paris to Lyon
8. Maglev Trains	350 Kmph	2003	Japan & Germany

*The section indicated are only few typical sections.

The researches carried out, the technical know-how developed and experience gained on these Railways systems in the matter of design of permanent way, standard of maintenance etc. are of considerable importance and guide to the various Railway Administrations.

The German Railways have made a study of the potential of conventional track for high speeds. The experience indicates that the conventional track may be alright for speeds up to 200-250 kmph, but not beyond that; they are of the opinion that for higher speeds and low upkeep costs, a new type of ballast less track consisting of concrete slabs fastened to rails with elastic fastenings may be required. Such a

track will have initially high cost, but is likely to have little or no maintenance during its life span. Experiments on such ballast less truck are continued on many of the advanced Railways and the results are quite encouraging.

Indian railways do not have any plan of providing ballast less track for high speed routes because the maximum permissible speeds at present are only up to 140 kmph. The ballast less tracks, however, is being thought of due to many other considerations in case of underground Railways. A typical section of ballast less track proposed to be provided on underground Railways under Indian conditions is given figure 1.1

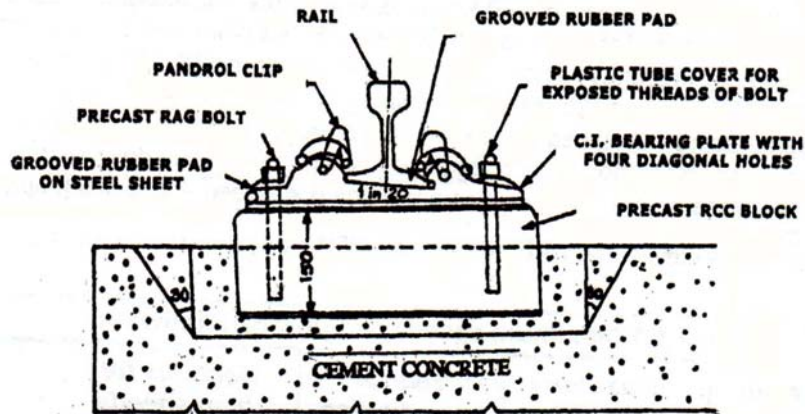


FIG. 1.1 BALLASTLESS TRACK FOR UNDERGROUND RAILWAYS