Civil Engineering (TRACK)

Lesson- 2
Track Maintenance & Modernisation of Railway Track

2.0 Maintenance of Track

2.1 Need for Maintenance

Every structure which is subjected to wear and tear due to continuous use requires maintenance. Railway track is also subjected to heavy wear and tear due to constant use which generate heavy vibrations and tend to loosen the packing and fastenings: On curves, due to continuous rubbing of wheel flanges against the rail, there is heavy side wear in the head of outer rail. At joints due to existence of gap, there is vertical jerk with the passage of each wheel, which loosens the packing and also causes battering of rail ends. It is therefore necessary to keep the general condition of track under constant watch and take adequate action from time to time to make good the deficiencies caused due to continuous use of track. A good track should have generally the following characteristics :

(i) Sound condition of rails, sleepers and fittings;

(ii) All fittings be available and properly tightened;

(iii) Adequate good quality and clean ballast under the sleepers and also around it with full shoulder width;

(iv) Wear in rails, horizontal or vertical should be within limits;

(v) Alignment of rails should be perfect. Kinks or other defects should be within permissible limits;

(vi) Formation is stable with good drainage and slopes well protected by grass or stones pitching and

(vii) Longitudinal and cross levels should be in good condition and within allowable limits.

2.2 Manual Maintenance of Track

Most stretches of track on Indian Railways are still maintained manually. The manual maintenance involves use of gangmen tocorrect the deficiencies in the track. Track is divided into gangbeats each of 6 to 8 km under the charge of a gang comprising 16 to 20 Gang men headed by a Mateor Track Maintainer Gr. I. The maintenance of track can be divided into various activities as described below:

(a) Daily patrolling of track by Keymen

(b) Systematic through packing

(c) Overhauling and

(d) Picking up of slacks

(a) Daily Patrolling of Track : The first thing in the day is the patrolling of track done by the Keyman of the gang who goes up and down looking for missing bolts, keys are other important fixtures like fish plates and tighten up the loose bolts and fittings. He also looks for fractures in the rail. Later in the afternoon after completing one round of inspection, the Keyman tightens the fittings in a systematic manner from one end to other end completing about 250 metres every day.

(b) Systematic Through Packing: At least one round of Through Packing of track is done immediately after the monsoon season and well before the onset of summer season. Every week, 4 to 5 days are allotted for doing the work of through packing starting from one end of the beat. If possible a second round of through packing is also done before the onset of rainy season. Each gangmen is allotted 14 sleepers of work approx. Packing of Concrete sleepers is done by on track machine Through packing consists of the following activities :

(i) Opening of track: Ballast is opened on either side of the rail seat for a depth of 50 mm below the bottom of sleepers and for a width of 450 mm from the end of sleepers to inside.

(ii) Examination Rails, Sleepers and Fastenings: The rails, sleepers and all fastenings are thoroughly examined for wear and cracks. Defective sleepers and fastenings are replaced by new ones and loose fastenings are tightened.

(iii) Re-spacing & squaring of Sleepers: Sleeper spacing get disturbed quite often due to creep in the rail. The spacing of sleepers sis corrected on one of the rails and they are made square so that the sleepers are at right angle to the rails.

(iv) Aligning of track: Alignment of the track is corrected by sighting one of the rail as base rail. Alignment of the other rail is done by checking the gauge and adjusting the same if found slack or tight.

(v) Gauging : (1) Preservation of gauge is an important part of track maintenance especially through points and crossings. For good riding, the basic requirement is uniform gauge over a continuous stretch of track and such gauge should be allowed to continue so long as it is within the permissible limits of tightness or slackness.

(2) Gauging should only be done after ensuring that sleepers are truly square. Standard keying hammers shall always be used. Beaters and heavier hammers should not be used, as this causes overdriving of keys and strained lugs on metal sleepers.

(3) While it is desirable to maintain correct gauge, it may not be possible to maintain correct gauge due to age and condition of the sleeper. It is good practice to work within the following tolerances of gauge, provided generally uniform gauge can be maintained over long lengths::

Broad Gauge

a) On straight - 6mm to +6mm

b) On curves with radius 440 m or more - 6mm to +15mm

c) On curves with radius less than 440 m upto +20mm

Note : These tolerances are with respect to nominal gauge of 1676 mm.

Metre Gauge

a) On straight -3mm to +6mm

b) On curves with radius290 m or more -3mm to +15mm

c) On curves with radius less than 290 mUpto +20mm

Note : These tolerances are with respect to nominal gauge of 1000mm.

Narrow Gauge

a) On straight -3mm to +6mm

b) On curves with radius of more than 175m-3mm to +15mm

c) On curves with radius less than 175 mUpto +20mm

Note : The above tolerance are with respect to nominal gauge of 762mm.

(vi) **Packing of sleepers:** The purpose of packing is to fill up all the voids under the sleepers. Before packing of sleepers is started, the vertical level of one of the two rails is corrected by sighting and lifting the track wherever required. Sleepers are then packed manually by two gangmen working simultaneously at each rail seat. The other rails is then packed while correcting the cross levels. After packing is completed, alignment of track and top levels should be checked once again and minor adjustment carried out wherever required.

(vii) **Repacking of Joint Sleepers –** Before close of the work, joint sleepers should be attended once gain.

(viii) **Boxing ballast section and Dressing:** The last activity of packing is boxing and dressing of ballast section. Boxing means filling up the space between the sleepers back to its original profile. The bank should be attended and cess be dressed to give proper slope to it for proper drainage.

(c) **Overhauling of track:** Over a period of time, the ballast section becomes full of dirt and does not provide good drainage. It becomes therefore necessary to clean the ballast in sides and in shoulders occasionally to ensure good drainage. To achieve this object, about 1/3 rd to ¼th the track is attended every year so that the entire length of track is attended in a period of 3 to 4 years time.

Overhauling should normally commence after one round of through packing but it may be

done sometime along the cycle of through packing to avoid doing overhauling during summer season.

Overhauling comprises the following activities :

(i) Shallow Screening and making up of ballast

(ii) All items of Through Packing

(iii) Making up cess

(d) Picking Up of Slacks: 'Slacks' are generally those locations of track where the running is not good and the defects are to be attended to on priority. One or two days are kept in a week for picking up the slacks. During picking up slacks, the following items are attended to generally :

(i) Joint sleepers along with at least 3 sleepers on either side;

(ii) Approaches of level crossings and bridges.

(iii) Transition lengths of curves.

(iv) Approaches of points and crossings.

(v) Breathing lengths in LWR and

(vi) Stretches running bad.

2.3 Annual Programme of Track Maintenance

The following programme is normally followed annually on Indian Railways for systematic maintenance of track :

Period	Work
1. Post-monsoon asttention : For about six months after end of monsoon	1. Attention to run down length in the entire gang beat to restore section to good shape. 2. One cycle of conventional systematic through packing\ systematic directed track maintenance from one end of the gang beat to the other end including Overhauling of nominated section the beat. 3. Normally 4-5 days should be allotted for the work as per item no 2 and the remaining days for picking up of slacks, attention to bridge approaches, Level crossings and point and crossings over the entire gang beat. Works such as Lubrication of rail. joints, gap adjustment and curve re-alignment should be done during this period.
2. Pre-monsoon attention : For about 2 months prior to break of monsoon,	Normally 2-4 days in a week should be devoted to Cleaning of side drains, catch water drains, clearing

	of water ways, repairs to bank and picking up of slacks. In rest of the days normal systematic maintenance will be carried out.
3. Attention during the monsoon : For about 4 months	1. Attention to track as required; picking up of slacks. 2. Attention to side drains, catch water drains and water ways. 3. Patrolling of track during heavy rains.

2.4 Need for Mechanised Maintenance

The mechanised maintenance of track implies the deployment of track machines for day to day track maintenance works which are otherwise done by manual labour. The need for mechanised maintenance of track is felt due to the following reasons :

(i) With the introduction of concrete sleepers, the track structure has become very heavy it is no more possible for gangmen to lift the track.

(ii) There are chances of breakage of concrete sleepers if the same are hit by gangmen using the beaters.

(iii) Manual packing is very hard and strenuous job. It is not possible with manual maintenance to get good quality track which is essential for high speed operations.

2.4.1 Procedure for Mechanised Maintenance

Mechanised maintenance of track is done with the help of machines which are self propelled and run on the track while doing the maintenance operations. These machines are called 'On Track Tampers' and are also called as 'Tie Tamping Machines' as they tamp sleepers mechanically.

Most of the tamping machines carry out the following operations automatically and simultaneously:

(i) Tamping one or two sleepers at a time by vibrating and squeezing the ballast bed under the sleepers;

(ii) Lifting of the track according to pre-determined value;

(iii) Levelling the track to correct longitudinal and cross levels;

(iv) Aligning the track to perfect alignment.

2.4.2 Output of various types of machines now in use on Indian Railways

1. Duomatic tamper – 1200 to 1400 sleepers per hour.

2. Continuous tamper (CSM) – 2200-2300 sleepers per hour.

3. 09-3X Tamping Express - 2700-3500 Sleeper per hour.

2.4.3 Other Machines

In addition to the tie tamping machines, Indian Railways have got various other machines, which have been employed successfully. Brief description of these machines is given below:

1. Ballast Cleaning Machine: This machine is used to do work of deep screening of ballast. It is an 'on track' machine and can do deep screeing of about 200m to 300 m per hour.

2. Points and Crossing Tamping Machines: These machines are basically Tie Tamping Machines with special features to do the packing of sleepers at a point and crossing. This machine can also be employed to do the packing of a straight track.

3. Dynamic Track Stabliser: It is an 'on track' machine which helps in consolidation of ballast bed by imparting vibrations, thus consolidating the ballast cushion enabling initial higher speeds immediately after the work of deep screening or laying of new track.

4. Points and crossing laying machine: Indian Railways have recently imported two machines from Italy which can lay a complete set of points and crossings with concrete sleepers in a block of 4 hours. These machines are quite helpful in laying concrete sleeper set which is otherwise very difficult due to heavy weight.

5. Ballast Regulator: This machine is used after leveling & tamping work. The ballast profile is regulated by this machine by transfer of ballast in all directions. It gives progress of 1 Km/hr. The surplus ballast in track is collected & spread at locations where deficient by this machine.

*6. Plasser Quick Relaying System :*It is essentially a semi mechanized system of track renewal. PQRS consists of self propeeled cranes which moves on auxillary track of 3400 mm gauge having the same centre line of the track to be relayed. These portal cranes are capable of self loading and unloading from BFR.

*7. Track Relaying Train:*TRT is the system for complete mechanization of track renewal process.

2.5 Inspection Of Track

2.5.1 Purpose of Inspection

With the running trains, there is continuous degradation of track due to vibrations. The packing of sleeper gets disturbed, the fastenings become loose or some time come out of sleepers and there is general wear and tear in rails and sleepers. The purpose of inspection of track is to detect various flaws such as looseness of packing, loose or missing fittings, wear in rail, disturbance in cross levels and versines in curves, deficiency of ballast, unusual movements in long welded rails, inadequate or excessive gaps at joints, defects at level crossings such as inadequate gap at check rail and condition of track and bridges in general.

2.5.2 Methods of Inspections

Various methods adopted for inspection are as under:

(a) By Push Trolley/Motor Trolley

(b) By Engine of a fast train

(c) By rear most vehicle of a train

(d) By Track recording Car, and

(e) By Oscillograph Car and OMS instrument.

(a) By Push Trolley/Motor Trolley: This is the age old method of inspecting the track visually by Permanent Way Inspectors and Assistant Engineers. All visual defects of track such as loose packing, missing or loose fittings, broken sleepers, deficiency of ballast are noted during the inspection.

(b) By Engine of a fast Train: This inspection gives an idea of running quality of track. This inspecting officer keeps standing in the engine and records all jerks, vertical or lateral which are mainly due to loose packing, uneven cross level or misalignment.

(c) By Rearmost Vehicle of a train: By travelling at the rear end of the last coach in a running trains, one gets an idea of the running quality of track just as traveling in an engine. Main difference is that lateral alignment defects and cross level defects get amplified in the rearmost coach.

(d) Track Recording Cum Research Car (TRRC): TRRC consist of two cars, one instrumented and other auxiliary car. The Auxiliary accommodates Generator & other supporting facilities for its working. The Car records track parameters and vehicle parameters in analog & digital form. It can regard parameters upto 160 kmph speed TRRC competes the results through computers provided in the car.

(e) By Osillograph Car & OMS Instrument: Oscillograph car records accelerations in vertical and lateral direction when the train is running at full speed. The probes are kept at pre-determined locations which carry the acceleration through electric cables to the recording machines . This method of recording gives a very fair idea of various defects generated by rail wheel interaction due to track defects. OMS is the short name of Oscillation Monitoring System, which is portable machine which records both vertical and lateral accelerations

2.6 Welding of Rails

2.6.1 Necessity of Welding of joints

A rail joint, besides being this weakest point in the track, gives lots of problems to the Permanent Way Staff from the maintenance point of view. Due to discontinuity in the rail surface, it gives a knocking jerk to the moving wheel while the packing of ballast under joint sleepers becomes loose very often leading to loosening of fittings such as keys and fish bolts. Gap at the joints also widens during winter periods due to low temperature causing shrinking in the length of rails. Wide gap at joints give further rise to the knocking forces, which damages the rail ends due to battering. During summer season, the rails expand in length which results in jumping of gap at joints leading to buckling if other precautions are not taken. The best solution to avoid the problems

of a joint is to eliminate the joint itself which is done by welding the two ends of the rails together completely. Various methods adopted to weld a joint are described in the following paragraphs.

2.6.2 Methods of Welding rail joints

Purpose of welding is to fuse two ends of the two rails in such a manner so as to provide :

(i) Geometric continuity and smoothness in top table of the rails;

(ii) Return the original hardness and toughness of the rail metal;

(iii) Retain the chemical composition of the metal at and around the joint and

(iv) Obtain the strength in tension, compression and bending as per original section of the rail. Various methods adopted to weld the rails are:

(i) Thermit welding

(ii) Flash Butt welding

(iii) Electric Arc welding

(iv) Gas pressure or Oxyacetylene welding

The details of the first methods viz. Thermit welding end Flesh butt welding which are more commonly in use on Indian Railway are given below:

(i) Thermit Welding (Fig 2.1)

The underlying principle behind the method of welding is that when a mixture of finely divided Aluminium and Iron Oxide (Called Thermit Mixture) is ignited, an exothermic chemical reaction takes place with evolution of heat producing iron and aluminium oxide as indicated below:

Iron Oxide+Aluminium Powder = Aluminium Oxide + Iron + Heat

$$(Fe_2O3_2) \quad (2Al) = Al_2O_3 + 2Fe + heat$$

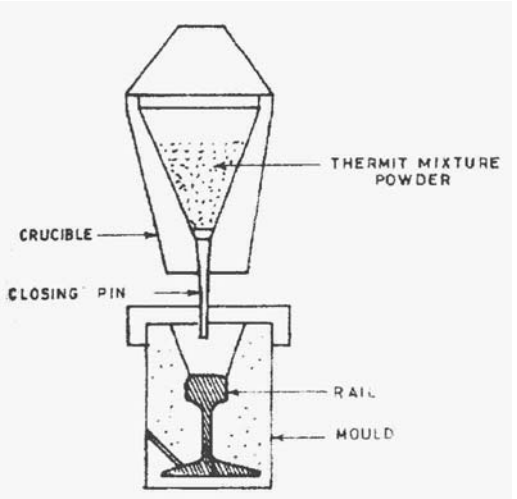

FIG. 2.1 THERMIT WELDING

It produces enough heat to raise the temperature to about 24500 C. The rail ends are preheated before starting the chemical reaction which takes about 10 to 12 min for air petrol, 4 to 4.5 min. for compressed air petrol and 2 to 2.5 min. for OxyLPG preheating. The chemical reaction is very fast and takes about 17 to 23 seconds. The iron gets melted due high temperature and is poured into the gap between the two rail ends which a re housed by a suitably designed mould. After 6 minutes for 25 mm gap and 12 minfor 75 mm gap joint of cooling, the moulds are opened and extra metal deposited chipped off by weld trimmerand finally the ends are filled to perfect section. The rails can be welded in track insitu in a

minimum traffic block of 60 minutes otherwise rails can also be welded on cess to obtain reasonable progress of welding. However, extra care is required to properly align the two rail ends and have correct gap as prescribed.

The method is best suited for doing welding in situ but the strength of welded rail is about 80% in fatigue as compared to strength of original section of the rail.

(ii) Flash Butt Welding: In this method of welding, the required heat to fuse the two ends of rails is generated by electric arc. The two ends of rails are firmly clamped in to jaws of welding machine. One of the jaws is stationary, whereas the other one is movable and as such the gap between the two rail ends can be adjusted. The rails ends are brought closer so that they almost touch each other. The electric power is switched on, thereby allowing an electric current of about 5 volts and 35000 amperes to pass through the air-gap between the two rail ends. Predetermined number of pre-heats (15 for 52 kg rail and 13 for 90 R rails) are given before rails are fused together. Lot of flashing takes place and considerable heat is generated by passage of heavy electric current between the rail ends. The temperature obtained at the rail ends is of the order of 15000 C. At this junction, the rail ends are pressed together with an enormous pressure of about 35-40 tonnes.

The quality of weld obtained by flash butt welding methods is much superior as compared to Thermit welding method as no extra material is added. The cost of welding is also low but the welding can be done only in a depot with heavy investment in terms of plants and equipments and other assets.

The average time taken for welding a joint is about 6 minutes for 52 kg rail and 5½ minutes for 90 R rail and number of joints that can be welded is about 60 to 80 joints in 8 hour shift.

Mobile Flash Butt Welding Machines

A few machines K355 type manufactured by M/s Plasser and Theurer have been procured to weld the rails in situ. The machines have portable electric generator which produce the required amount of electric power for welding the rail joints. The main advantage of using these machines is to weld such joints where it is not possible to transport the rails to welding plants but the cost of such welding is rather high.

2.7 Welded Rails

2.7.1 Development of Welded Rails

Indian Railways, keeping in pace with the advanced Railways of the world, have made phenomenal progress in welding of rails in the last few decades. The development of welded rail has been necessitated due to economic considerations coupled with the technical advantages that a welded track possesses over the fish plated track. Rails were initially welded into panel of 3 rails, 5 rails and 10 rails. The development of these rail panels, called short welded panels (S.W.P.) or short welded rails (S.W.R) was the first stage of development in the country. In course of time, the track technology got considerably advanced and a new concept of 'locking up of stresses'

in the rail, thereby resisting its longitudinal movement was developed. Accordingly long welded rails of varying lengths upto one km were laid to eliminate rail joints and to get more advantage of welding. A time has now come when the concept of 'continuous welded rails' is getting fast developed and welded rails are being laid continuously so as to get full advantages of a jointless track.

2.7.2 Theory of Long Welded Rails

The theory of expansion and contraction of metals with the increase and decrease of temperature is well known. A rail also expands and contracts depending upon the variations in temperature. The expansion of the rail is a function of coefficient of linear expansion of rail material, the length of the rail temperature, but as rails are fastened to sleepers which are embedded in ballast, their expansion and contraction due to temperature changes are restricted because of the restraint offered by the above factors. The restraint in the longitudinal movement of the rails gives rise to the locked up internal stresses in the rail metal. The resulting force, known as thermal force, is given by the following equation

$$P = EA \quad T$$

Where, P is force in tones

E is modulus of elasticity of rail steel = 2.15×10^6 kg/sq.cm or 2150 tonnes/sq cm.

A is cross sectional area of rail in sq.cm, and depends upon the individual rail section. For 52 kg. rail it is 66.15Sq.cm.

α is coefficient of linear expansion and is 0.00001152 per degree centigrade.

T is temperature variation in degrees centigrade.

Substituting the values of E,A, and T, the force for 1^0C rise of temperature for 52kg. rail can be derived as follows:

$$P = (2.15 \times 106) \times (66.15) \times (0.00001152) \times 1 \times 10^{-3}$$

$$= 1.638 \text{ Tonnes per degree centigrade.}$$

The value of E and ? are fixed for a particular type of rail steel. The value of cross sectional area depends upon the 'Sectional weight' of the rail. Substituting the value of sectional weight in kg. per metre in the above equation the force P can be given by the formula:

$$P = 31.5 \text{ S.T.}$$

Where, P is force in kg.

S is sectional weight in kg/metre.

T is temperature variation in centigrade.

For 52 kg.rail

P = 31.5x52kg. per unit degree centigrade.

= 1638 kg. or 1.638 tonnes per degree centigrade.

2.7.3 Definitions

(i) Long welded Rail (L.W.R.) Long welded rail is a welded rail, the central part of which does not undergo any longitudinal movement due to temperature variations. Normally, a length greater than 250 metres on B.G. and 500 metres on M.G. should function as L.W.R. The maximum length of L.W.R. under Indian conditions shall normally be restricted to one block section. (fig.2.2)

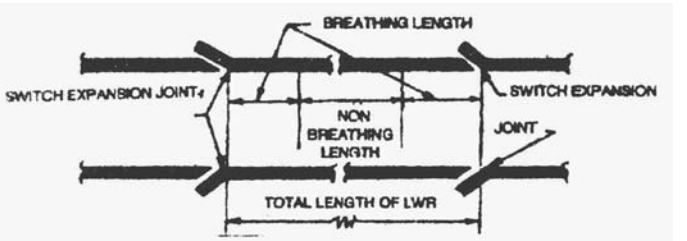

FIG. 2.2 LONG WELDER RAIL

(ii) *Continuous Welded Rail (C.W.R.)* Continuous welded rail is a LWR which would continue through station yards including points & crossings.

(iii) Short Welded Rail (S.W.R.) short welded rail is a 3 rail welded panel rail which contracts and expands throughout its length.

(iv) *Breathing Length :* it is the length at the both ends of LWR which expands and contracts on account of temperature variation.

(v) *Swith Expansion Joint(S.E.J.):* it is an expansion joint installed at each end of LWR to permit expansion /contraction of the adjoining breathing lengths due to temperature variation.

2.7.4. Track Structure For LWR/CWR

Due to very high force induced in LWR/CWR, the track has to be of high strength. The following track standard is laid down :

(i) **Rails:** 60 Kg/52 kg/90 R for BG & 90 R/75 R for MG

(ii) **Sleepers:BG** (a) Concrete sleepers with elastic fastenings;

(b) Steel trough sleepers with elastic fastenings

Sleepers : MG (a) Concrete sleepers with elastic fastenings;

(b) Steel sleepers with elastic fastenings;

Note : preferably for speed upto 75 kmph but must for speeds above 100 kmph

(c) Steel sleepers with keys/ CST-9 sleepers with keys (for speed not exceeding 100 kmph)

(iii) **Minimum Ballast Cushion** -300 mm for speeds above 130 kmph and 250 mm for speeds upto 130 kmph. The shoulder width is to be provided as 350 mm on straight and 500 mm on the outside of curves.

(iv) Sleeper Density–the minimum sleeper density(number of sleeper per Km) in LWR/CWR shall be as follows –

Types of sleeper	Sleeper Density
PRC Sleepers	1340 in Temperature Zone I & II
PRC Sleepers	1540 sleepers in Temperature zone III & IV
Other sleepers	1540 in all Temperature Zones

2.7.5 Track Maintenance for LWR & CWR

The standard of maintenance of LWR/CWR track has to be of very high order. The following precautions should be kept:

(i) Maintenance should be done only when the rail temperature isbetweentd+100C to td-30 0C where td is destressing temperature.

(ii) Lifting of track should be done when the railtemperature is below td+10 0C. Track should not be lifted by more than 50 mm at a time in case of concrete sleepers and 25 mm in other sleepers.

(iii) Special attention should be paid to locations such as breathing lengths, switch expansion joints etc.

(iv) All fastening should be kept tight.

(v) Ballast should not be deficient as it plays most important part against buckling.

2.7.6 Destressing of LWR/CWR

Destressing of LWR/CWR is an operation which removes the locked in stresses. All the fastenings are removed, rail panel is lifted on rollers and tapped. This allows free expansion. Destressing is done betweentm to tm+5 0C (for all rail sections in temperature zone I,II,III&90R&lighter Rail sections in Zone IV) and tm + 5 to tm + 100C(for 52/60 kg & heavier rail sections in temperature ZoneIV)where tm is the average (annual average) rail temperature. Destressing is done

(i) at the time of laying;

(ii) wheneverno. of temporary repair is more than 3/Km;

(iii) whenever the movement observed at SEJ is beyond specified limits, maximum designed gap & when tip of tongue rail/ stock rail crosses the reference line;

(iv) after special works like Through fitting renewals,Deep Screening, lifting / lowering of track, Major realignment of curve, Through sleeper renewal & rehabilitation of bridges and formation causing disturbance to track.

2.7.7 Short Welded Rails (SWR)

We have seen under long welded rails that a small length on either end called the breathing

length expands and contracts due to thermal forces whereas the middle portion called fixed length does not move as the sum total of sleeper resistance in breathing length becomes equal to the force required to neutralize the expansion/contraction due to change in temperature.

If the length of welded rail panel is small or equal to 2 breathing lengths then the entire rail panel will expand or contract due to change in temperature. Such a panel is known by the name Short Welded Rail (SWR). Thus in general a rail panel of 250 metres or smaller (15 rails welded together each of 13 m length will be called a Short Welded Rail (SWR).

In actual practice the length of panel is kept only 3x13= 39 metres i.e. three rails welded together because due to expansion/contraction in the entire length of SWR it becomes very difficult to maintain the sleeper packing and the gap at joints. The bolts start getting sheered during winter season if the length of panel is more than 3 rails welded panel.

2.8 Modernisation Of Railways

2.8.1 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 BG. System of Indian Railways till some time back was only 100 kmph. With effect from Ist 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 feasibity study of 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 vehicles. 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 higher speeds to a limited extent can be introduced on the Indian Railways without carrying out major changes in rolling stock and maintaining the track to slightly higher degree of maintenance. The Rajdhani Express was, therefore, hauled by WDM-4 locomotive and all coiled coaches. The speed of the train which was originally 120 kmph has been increased to 130 kmph from Ist November 1971 and the plans to increase the speed further is also under consideration of the Indian Railways.

As a step towards modernisastion, Indian Railways have introduced a new train from July, 1988' SHATABDI EXPRESS' on New Delhi-Agra-Jhansi-Bhopal Section with a maximum permissible speed of 160 kmph and further speed potential upto 180 mph. Many more Shatabdi express train & Inter-city express trains have also been introduced recently on various routes of Indian Railways.

Similarly on Metre Gauge the long time barrier of 75 kmph has been broken and trains with YDM-4 locomotive and ICF all coiled coaches are running at a maximum speed upto 100 kmpth from December, 1977.

2.8.2 Modernisation

Modernisation of railways is being done basically with an objective to have longer trains at faster speed safely and economically and to give better productivity and better customer service to rail users. This consists of modernisastion track, use of better designed rolling stock, adopting superior type of traction, having better signalling and tele-communication arrangements and using other modern technique in operations of railways system.

Various aspects of modernization of railways are basically proposed to be dealt in two sub-heads, which are discussed in subsequent paras:

(i) Modernisation of track

(ii) Other aspects of modernisation of railways.

2.8.3 Why track modernisation is necessary ?

(i) Increased volume of traffic, higher speeds and heavier axle loads demand heay track structure which can provide better service and require less maintenance.

(ii) Limitation of manual method of maintenance to maintain heavy track structure and to keep track parameters to close tolerance. The tolerance has direct bearing on riding characteristics and safety of the traffic.

(iii) Lesser traffic blocks due to heavier traffic density resulting in low productivity.

(iv) Change in social structure.

(v) Updating of technology.

(vi) Economic considerations.

2.8.4 Modernisation of track

This consists of the following sub-heads:

(i) Heavier track structure.

(ii) Modern methods of track maintenance.

(iii) Modern methods of track renewal and relaying.

(iv) Modern methods of track inspection and track monitoring.

2.8.5 Heavier track structure

(i) Use of wear resistance 90UTS/110UTS rails and heavier rail section viz 52kg/60kg for BG and 90 R for MG to increase the service life on rails.

(ii) Use of pre-stressed concrepte sleepers, elastic fastenings and rubber pads; increased ballast cushion of 350 mm or more and increased sleeper density of 1660 sleepers/km or so to give resilience to track and to keep down the maintenance efforts.

(iii) Use of long welded rails and switch expansion joints to provide smooth and fast rail

travel; use of mobile flash butt welding plant for welding of rails at site and use of SKV welding only at unavoidable locations to improve the quality of welding.

(iv) Consoslidation for formation sub-grade and other formation treatments to decrease the duration and intensity of speed restrictions.

2.8.6 Modern track maintenance methods

To provide better track geometry and smoother rail travel at economical cost, modern track maintenance methods are used. There are :

(i) Improvement in conventional maintenance: Use of small track machines petrol/diesel driven to replace conventional heavy tools to get the work done more efficiently and accurately with less manual fatigue.

(ii) Directed Track maintenance : Maintence of track as directed so as to improve the quality and reduce the track maintenance effort.

(iii) Mechanised Maintenance : Use of heavy on-track, mechanically to closer tolerances Most of the track machines can carry out automatically the work of leavelling, aligning and packing.

2.8.7 Modern methods of Track Renewal and track laying

(i) Use of mechanised Quick relaying system (PQRS) and track Relaying Train (TRT) to get increased out put of track renewals with better standards of track parameters.

(ii) Indian Railways also have two track renewal trains, which carry out automatically all operations of track renewals.

2.8.8 Modern methods of Track Inspection and Track monitoring

(i) Portable accelerometer to record horizontal and vertical accelerations.

(ii) RDSO Track Recording car for recording track parameters.

(iii) Track recorder-cum-research car including use of computers for track research work.

(iv) Ultrasonic testing of rails & use of SPURT car for detection of rail flaws.

2.8.9 Other aspects of modernisation of railways

(1) Use of better designed anti telescopicLHB coaches with better springing arrangements, better braking system for safe and smoother rail travel.

(2) Provision of universal couplers to provide uniformity in the coupling of coaches.

(3) Introduction of Diesel and electric traction to haul heavier loads at faster speeds.

(4) Introduction of modern signaling techniques to enable the trains to move at high speeds with safety.

(5) Management information system for monitoring and moving freight traffic to avoid idle time to increase its productivity.

(6) Computerisation of train reservation system to avoid human error and to give better customer service for reservation of berths for train journey.

(7) Use of computers and other modern management techniques to design and maintain the assets more efficiently and economically to increase productivity and to give better customer service.

(8) Use of modern techniques for better Communication at various levels of management.

2.8.10 High Speed Track on Advanced Railways of The World

The 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, but it has the disadvantage that because of the subsidence of ballast bed under traffic, maintenance required to keep the track to closer tolerance, is very heavy, particularly at high speeds.

Many of advanced railways of the world are already operating trains at speed of 250kmph and above. On the New Tokaido line, which was specifically constructed in 1964 for high speed traffic, trains are running at a speed of 285kmph and only recently German railways have introduced a superfast train which travels about 10cm above track by magnetic levitation and has a speed potential of 426 kmph. Chienese Railways also likely to introduce speed of 500 kmph on maglev.

The researches carried out, the technical know-how developed and experience gained on these Railway 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 upto 250 Kmph or so, but not beyond that. They are of the opinion that for higher speeds and low up-keep cost a new type of ballastless 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 ballastless track are continued on many of the advanced Railways and the results are quite encouraging.

Indian Railways do not have any plan of providing ballastless track for high speed routes because the maximum permissible speeds are at present only 160 kmph. The balalastless track, however, is being thought of due to many other considerations in case of underground Railways.

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