

# MAINTENANCE OF TURNOUTS

AND

## INTRODUCTION TO YARD MAINTENANCE INDEX (YMI)

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### ABSTRACT

*Our experience of past so many years has shown that for proper and secure railway transportation, we need a reliable track. This reliability will only come when the Yards and their Components are given utmost importance. The Yards are the areas which require enhanced maintenance owing to its complex nature and difficult working environment. However, Off Late it has been seen that Yards are Areas where maintenance and renewal activities are suffering and due to this several derailments and accidents are taking place.*

*This paper has been written to introduce a completely new concept of Yard Maintenance Index (YMI). This Paper shall also outline the brief of this index which shall help in creating aids for various works, maintenance activities and shall also compare yards for adopting better methods of maintenance and focusing of activities which are the need of the Yard.*

### 1.0 INTRODUCTION

Turnout is the track structure which permits movement of train from one track to another. It is probably the most complicated component of track. Because of its complicated design and certain inherent deficiencies, speed on turnout while negotiating towards turnout side in Indian Railways till recently was limited to 15kmph or 30 Kmph depending upon the type of turnout. Now to improve traffic potential, there is a need to increase speed potential of turnout. Increase of speed on turnout requires better design of turnout, better maintenance practices and perfect layout arrangement. Therefore, this paper has been written for elucidating some major problems associated with maintenance of Turnouts and some remedies as well.

Further, it is seen that Gradation of Yards is not available in our IRPWM due to which it is very difficult to assess the Condition of that Yard and the Work Input required to uplift the Maintenance and Up-Keep of Yard. Hence, a YARD Maintenance Index (YMI) has been elucidated in this Paper for adoption in Indian Railway System.

## **2.0 MAINTENANCE OF TURNOUTS**

Over the last 20 years, almost all the turnout of main line and running loops have been replaced by the curved switches laid on concrete sleepers. In goods yards a small percentage of turnouts are yet to be converted to turnouts on concrete sleeper. New design of turnout laid on concrete sleepers is sturdier than the earlier designs and permits higher speed on turnout side, at the same time it requires less maintenance.

When the design of fan shape layout was adopted on IR, it was presumed to be a fit and forget type of layout. But, far from this, the performance of these layouts has been ridden with problems. These problems are associated as much with design as with maintenance practices. These problems along with the remedies have been discussed below:

### **2.1 CORROSION OF SCREW SPIKES IN SWITCH PORTION**

Screw spikes in switch portion are getting frequently corroded due to accumulation of dust, water, foreign materials, overnight waste soil etc. in between screw spike polyethylene dowel. The situation becomes severe in corrosion prone yards having more number of passenger trains in early morning and evening. Due to excessive corrosion of screw spikes, its section reduces and also it gets broken while removing and thus makes sleeper damaged or ineffective.

Remedial measures suggested:

- A. Using galvanized screw spikes.
- B. Applying anti corrosive paint to screw spikes during initial laying.
- C. Frequent examination of screw spike and greasing/ applying anti corrosive paint.
- D. Cost of 233 screw spikes @ Rs.22 per screw spike in one set of 1 in 12 T/O comes to Rs.5126. Cost of T/O sleeper per meter length is approx. Rs.850. Cost of screw spike is very less in comparison to cost of sleeper, hence to avoid any damage or being sleeper ineffective, screw spikes may be frequently renewed.
- E. Filling dowel hole with proper grease and then inserting and tightening screw spike.

### **2.2 DISPLACEMENT OF GRSPS IN THE MIDDLE PORTION OF SLIDE CHAIRS**

Rubber pads under slide chairs are held by screw spikes at four corners. It is observed that the rubber pads in the middle portion of the slide chairs are getting disturbed in the direction of the train movement. At this juncture, the rubber pads come in contact with grease, which lead to faster displacement of the rubber pads. This problem has been observed mainly in sleeper nos. 4 to 15.

Remedial measures suggested:

- a. Pasting rubber pad with glue/ epoxy to sleepers.
- b. Increasing thickness of GRSP from 6mm to 10 mm.

- c. Replacement of GR by reinforced elastomeric material or by suitable high strength damping material.

### **2.3 BREAKAGE OF GAUGE TIE PLATE AROUND THE BASE OF STOPPER**

There have been instances of breakage of gauge tie plate around the base of stopper on sleeper no. 3 of the T/O. This is due to heavy thrust encountered by the stock rail at the toe of switch.

Remedial measures suggested:

- a. Suitable pre curving of stock rail at the time of laying of Turn Out.
- b. Improved welding and sturdy design.

### **2.4 GRSPS GETTING DISPLACED IN LEAD RAIL PORTION AND UNDER CMS CROSSINGS**

It is observed that rubber pads are getting displaced in lead rails as well as under CMS crossing portion. Also, wear in rubber pad is faster especially under CMS crossings. If the rubber pads get worn out and are displaced from under side of rail seats, the rail seat on PSC sleepers would get damaged, which would require replacement of PSC sleeper. In view of this it is urgent to undertake suitable preventive steps to avoid such a situation.

Remedial measures suggested:

- a. Perfect Laying of Turn Out. Sleeper Spacing should be marked with Cumulative Spacing Tape (50 m)
- b. To provide Rubber Pads with Horns for Lead Portion
- c. Elastomeric pads can be tried in place of GRSP.
- d. Rubber pads may be pasted to PSC sleeper with suitable adhesive (epoxy).
- e. Ensuring proper packing of sleeper and full fittings.
- f. Providing and ensuring gapless joint during service between tongue rail - lead rail, lead rail – CMS crossing and CMS crossing-Running Rail.

### **2.5 JOINT AT THE JUNCTION OF TONGUE AND LEAD RAIL**

This joint at present remains fish plated as per provision of manual. The joint at the Junction of Tongue and lead rail result in heavy stress and vibration in switch and lead rail portion. This causes battering of joint, breakage of switch fittings, crushing and shifting of rubber pads, damage of PSC sleepers and ultimately disturbing parameters of Turnout.

Remedial measures suggested:

- a. Providing and maintaining gapless joint with 1m Long Fishplate.
- b. Exploring possibility of allowing welding of this joint.

## **2.6 JOINT AT THE BACKLEG AND FORELEG OF CMS CROSSING.**

The joint at the backleg and foreleg of CMS crossing result in heavy stress and vibration in crossing portion. This causes bad running, loose packing, fish plate fracture, wear of inserts, loss of toe load of ERCs, wear and shifting of rubber pads, grooving and damage of PSC sleepers.

Remedial measures suggested:

- a. Providing and maintaining gapless joints by adopting improved design of gapless joint by inserting proper thick ferrules in fishplate hole and rail hole. Use Drill Twist of 26.5mm for Rail Behind CMS Crossing.
- b. Use of Weldable CMS crossing/ Heat Treated Crossing.

## **2.7 MAINTENANCE OF STIPULATED GAP BETWEEN LEADING STRETCHER BAR AND RAIL BOTTOM.**

As per manual there should be gap of 1.5 mms between leading stretcher bar and bottom of rail. Although this parameter is very useful in avoiding breakage of tongue rail tip and two route of wheel, it is very difficult to maintain gap of 1.5 mm on both side of track due to some twist, impact and thrust on switch portion.

Remedial measures suggested:

- a. Inspect and attain this periodically using washer.
- b. Improving design of stretcher bar assembly in consultation with S&T.

## **2.8 HOUSING AND SETTING OF TONGUE RAIL UP TO JOH.**

The fan shape layout envisages provision of spring setting device (SSD) in the switch assembly, but in field, few SSDs are now being supplied only recently. In the absence of SSDs, housing of switch is not proper. Efforts should be made to provide all the fan shape layouts with SSDs. Also, the design of fan shaped layout envisages double stretcher bar with motor operation for ensuring perfect setting up to JOH, but in the field, this requirement is not always complied with.

## **2.9 PROBLEM IN TRACK GEOMETRY CORRECTION POST LAYING.**

It is very difficult to change parameters of a Fan shaped layout like three point offset of tongue rail – curved lead assembly etc. once laid in correctly.

For ensuring proper geometry, due care is required to be taken at the time of laying. Pre-bending of stock and lead rail in case of laying on curve, checking curvature of stock and tongue before laying, proper spacing of sleepers etc. should be ensured so as to ensure proper design parameter post laying. In case of misalignment of existing layout, proper fixing of SRJ and overall length should be calculated and validated in the field before a actual replacement.

### **3.0 YARD MAINTENANCE INDEX (YMI)**

#### **3.1 TURNOUT INDEX (TI)**

As it is evident from the discussion in the foregoing paragraphs, Turnouts form a very essential component of Yards and their maintenance is even more pertinent so as to upgrade the Yard and maintain it in a proper shape and standard. So the first parameter constituting 05 Marks in Yard Maintenance Index are the Turnouts.

The Weightage of 05 Marks shall be distributed in the No. of Turnouts in the Yard. For example, if there are 100 Turnouts in a Yard then each turnout irrespective of its design shall constitute 0.05 Marks. Further, the Percentage of 0.05 Marks for that particular Turnout shall be determined based on the Category of Turnout in which it falls which have been listed below. In the end, while computing the YMI, the Turnout Index (TI) shall be calculated based on the Marks for Each Turnout and further its aggregation.

In order to achieve flawless turnouts, it is essential to list the areas which are required to be maintained to a proper standard. These items have been categorized into 03 Groups, which shall be form the basis of marking of Yards.

Sl. No.	Groups	Features	Marks
1	<b>Minimum</b>	<ul style="list-style-type: none"> <li>• Track Structure PSC (No Wooden Sleepers)</li> <li>• Curved Switches</li> <li>• CMS/ Heat Treated Crossing</li> <li>• Nil Missing/ Jammed ERC's</li> <li>• Nil Missing/ Jammed/ Broken Screws</li> <li>• Nil Missing/ Crushed/ Worn-Out Rubber Pads</li> <li>• Standard Heel/ Distance Blocks and Bolts</li> <li>• No Water Accumulation i.e. Proper Drainage</li> <li>• Greased ERC's and Screws.</li> </ul>	If All features of this Group are complied, then 40% Marks for the Turnout
2	<b>Recommended</b> <i>In Addition to features of "Minimum" Requirement</i>	<ul style="list-style-type: none"> <li>• Adequate Turnout/ Crossover Length</li> <li>• Welded SRJ</li> <li>• Clean Ballast Cushion &gt; 150 mm</li> <li>• No Chipped/ Cracked/ Knife edge/ Twisted/ Worn-out Tongue Rails</li> <li>• Standard Check Rail</li> <li>• Complete Inspection Marking</li> <li>• All Entry and Exit Sleepers inserted</li> <li>• Nil Broken Sleeper exists</li> <li>• No Missing Distance Block/Bolts</li> <li>• Housing of Tongue Rail is upto 03 Sleepers</li> </ul>	If All features of this Group are also complied, then 70% Marks for the Turnout.
3	<b>Desirable</b> <i>In Addition to features of "Minimum" and "Recommended" Requirement</i>	<ul style="list-style-type: none"> <li>• Correct Sleeper Spacing</li> <li>• Clean Ballast Cushion &gt; 250 mm</li> <li>• Nil Burr on Stock/ Tongue Rail</li> <li>• 03 Hole Distance Block</li> <li>• 1m Fish plate on Crossing Joints with J-Clip</li> <li>• Clearance of Stretcher Bar is between 1.5-3.0mm</li> <li>• Gapless CMS Crossing</li> <li>• All Welded Joints (except Back and Forth of CMS Crossing)</li> <li>• Wear on Crossing is upto 2mm</li> <li>• Housing of Tongue Rail is upto 04 Sleepers</li> </ul>	If All features of this Group are also complied, then 100% Marks for the Turnout.

Based on the Criteria Above, TI is calculated.

Apart from Turnouts, Yard is also comprising various loop Lines and Connecting Tracks. The maintenance of these lines and Connecting Tracks also account a major role in the maintenance of Yards as a whole. Important features which account for in such a scenario have been discussed below along with the weightage given for the same.

### 3.2 DRAINAGE AND BALLAST CUSHION INDEX (DBCI)

Proper ballast cushion and drainage on Track improves riding qualities and better retention of track geometry. Ballast must be deep screened at the time of laying of Track and Turnouts, because after laying it becomes difficult to deep screen ballast. Proper ballast cushion should be ensured during deep screening. Proper longitudinal and cross drains along with Boxing and Dressing of Ballast with Proper Cess should be provided to ensure that there is no stagnation of water.

The Weightage of 02 Marks shall be distributed to Drainage and Ballast Cushion.

For ensuring adequate cushion during service and to avoid center bound sleepers, midlife deep screening is also suggested.

<b>Drainage and Ballast Cushion of Yards</b>		
Lines having No drainage/ Ponding of Water/ Track Circuiting Issues or Mud-Pumping or Caked Cushion.		
<b>Percentage of Poor Drained Lines =</b>	0%	2 Mark
Total No .of Loop lines/ Sidings/ Pt Lines/ Washable Apron Lines/ Stabling Lines having poor drainage or Ballast Cushion < 150 mm	0-20%	1.4 Mark
<hr/>	20-50%	1.0 Mark
Total No. of Lines in the Yard	50-90%	0.6 Mark
	>90%	Nil Mark

**Based on the Criteria Above, DBCI is calculated.**

### 3.3 DAMAGED SLEEPERS INDEX. (DSI)

Sleepers form an integral part of the Track Structure and require proper maintenance so that the same survives up to its Codal Life or near. However, there are various issues such as Deep Screening, Jammed ERC's, Improper Packing and Poor Drainage which increases the dynamic Load and thereby causes mid-life deterioration of Sleepers.

In case of PSC Turnout Sleepers in Crossing area gets damaged due to vibration and high impact load on crossing due to presence of gap at fore leg and back leg of crossing. Vibration in crossing portion displaces rubber pads and subsequently due to continuous impact groove forms on sleeper or sleeper gets cracked.

With less number of Broken Sleepers in Yard, the Maintenance shall be better and shall require lesser effort. Further, the parameters shall be maintained properly.

The Weightage of 01 Marks shall be distributed to Drainage and Ballast Cushion.

Remedial measures suggested for eliminating Broken Sleepers are as Providing gapless joint at crossing, Using 10mm thick GRSP in place of 6mm, Trying elastomeric pad in place of GRSP. Need based packing of sleepers, Replacement of damaged sleepers and Regular Greasing of ERC's of Sleepers.

<b>Number of Damaged Sleepers</b>		
<b>Percentage of Broken Sleepers =</b>	0%	1 Mark
$\frac{\text{Total No. of Broken Sleepers}}{\text{Total No. of Sleepers in Yard}} \times 100$	0-20%	0.7 Mark
	20-50%	0.5 Mark
	50-90%	0.3 Mark
	>90%	Nil Mark

Based on the Criteria Above, DSI is calculated.



### **3.4 LOOP LINE and JUNCTION JOINT INDEX (LLJI)**

Today the LWR is synonymous with modern track. The conversion of Loop Lines into LWR tracks shall eliminate fish plated joints leading to safety. Fish plated joints are a source of large no. of dynamic forces. As a result fish plated joints exhibit large scale rail wear and development of cracks from fish bolt holes and fractures and reduce the maintenance.

In some instances premature rail renewal may have to be carried out due to excessive fractures. Due to development of large dynamic forces at the rail joints the track geometry at the rail joint gets disturbed frequently resulting in an increment in the track maintenance effort. It has been estimated that there is as much as 25% to 33% savings in the track repair and maintenance costs due to elimination of rail joints.

Due to impact at rail joints there is an added wear and tear of rolling stock wheels to an extent of 5% and as the wheel has to negotiate the gap there is added fuel consumption to an extent of 7%.

Due to elimination of noise and vibrations at the rail joints passenger comfort is substantially increased.

The above issues can be addressed if all the Joints in Loop Lines can be converted to Welded Joints so that the efforts for its maintenance are reduced. Further, there are various Rail Sections which are being used in Yards.

Owing to several types of Rail Components being used in Yards such as SEJ's, Turnouts etc; different kinds of Rail Section exist in the Yard. Due to this, Heavy Forces are generated at Junction Joints which several times cause failure of Fish Plates and rendering the track as unusable. Hence, it is ideal that such Joints are eliminated from the system.

The Weightage of 01 Mark shall be given to Continuity of Rail Section and 01 Mark shall be given to Track Structure of Loop lines.

<p><b>Number of Junction Joints</b></p> <p><b>Percentage of Junction Joints =</b></p> $\frac{\text{Total No. of Junction Joints and Block Joints}}{\text{Total No. of Fish Plated Joints}} \times 100$	<p>0%</p> <p>0-20%</p> <p>20-50%</p> <p>50-90%</p> <p>&gt;90%</p>	<p>1 Mark</p> <p>0.7 Mark</p> <p>0.5 Mark</p> <p>0.3 Mark</p> <p>Nil Mark</p>
<p><b>Number of Non-LWR Loop Lines</b></p> <p><b>Percentage of Non-LWR Loop Lines =</b></p> $\frac{\text{Total No. of Non-LWR Loop Lines}}{\text{Total No. of Loop Lines}} \times 100$	<p>0%</p> <p>0-20%</p> <p>20-50%</p> <p>50-90%</p> <p>&gt;90%</p>	<p>1 Mark</p> <p>0.7 Mark</p> <p>0.5 Mark</p> <p>0.3 Mark</p> <p>Nil Mark</p>

**Based on the Criteria Above, LLJI is calculated.**

### **3.5 COMPUTATION OF YMI and ANALYSIS**

From the above Discussion wherein all the Parameters which largely affect the Maintenance of Yards have been discussed the following Parameters shall be calculated:

- |                                       |      |
|---------------------------------------|------|
| a. Turnout Index                      | TI   |
| b. Drainage and Ballast Cushion Index | DBCI |
| c. Damaged Sleepers Index             | DSI  |
| d. Loop Line and Junction Joint Index | LLJI |

#### **A. J Factor**

The above parameters shall constitute a major part of "YMI". However, there are some deficiencies such as Jammed/ Broken ERC's and Jammed/ Broken Plate Screws which also

cause trouble in maintaining Yards. For the same, a Factor of Jammed ERC's and Plate Screws have been introduced as "J" Factor which shall be used as follows:

J Factor	Percentage	Multiplying Factor
Jammed/ Broken ERC's and Screws	0-10	1.0
	10-20	0.9
	25-50	0.8
	>50	0.5

*Hence, "J" Factor is of importance and should be considered while planning for Maintenance Activities of Yard. However, if the Percentage of Broken/ Jammed/ Missing ERC's is > 50 %, then irrespective of YMI or J-Factor, Urgent Maintenance of the Yard is required.*

#### **B. T Factor**

TGI of the Yard (Average TGI of All Blocks from the Location of Outermost SEJ/ Turnout to Outermost SEJ/Turnout) is an indication of Track geometry of Main Lines through the Yards. Depending upon the TGI Index, the maintenance of Main Lines in Yard can be sought after. In Case there is no current TGI available, the Last TGI shall be utilized for computation of this factor.

In Yards where speed of 15 KMPH is allowed due to Interlocking Conditions/ Special Layouts, TGI can be calculated manually by measurement of parameters.

T Factor	Percentage	Multiplying Factor
TGI Value of Yard	>80	1.0
	50-80	0.9
	36-50	0.7
	<36	0.5

#### **C. S Factor**

There are certain Safety Items which may affect directly or indirectly Track Maintenance at large. These also have to be given due importance. In order to account for these items "S" factor has been introduced.

Condition	S-Factor
If there are > 50% Missing ERC's in the entire population of Yard or on Any Individual Turnout OR If there are More than 05 Nos. of P-Way Failures such as rail Failure, Weld Failure, Stock Rail or Tongue Rail Failure or SEJ Failure etc; in Last 06 Months OR If there are more Than 05 Unattended USFD Defects(except IMR, IMRW or DFWR) or Any IMR, IMRW or DFWR OR If there is any Derailment/Accident an Account of Engineering in Yard	0.5 (If Neither of the Condition Exists, Then S= 1.0)

After computing the above factor, the YMI shall be calculated based on the formula given below:

$$\text{YARD MAINTENANCE INDEX (YMI)} = (\text{TI} + \text{DBCI} + \text{DSI} + \text{LLJI}) \times \text{J} \times \text{T} \times \text{S}$$

Based on the YMI Calculated Above, the Maintenance shall be judged and more or less efforts as required for that above Yard shall be known to the Open Line Officers and Staff who shall in turn plan for the Maintenance and Attention required and the Area which requires attention shall be judged from the Indexes that are calculated while computing the entire YMI.

However, all Yards in Indian Railways are not comparable. Hence, in Order to have a system of Comparison for Judging/Analyzing the type of Attention and Input required for up gradation of YMI the Yards have been classfied as Three Types:

**a. BIG YARD**

All Yards which have More than 100 Turnouts which comprise of (Turnouts 1 in 8.5, 1 in 12, and 1 in 16; Special Layouts Single Slip Diamond, Double Slip Diamond, Diamond and Scissor; And Derailing Switches)

**b. MEDIUM YARD**

All Yards which have More than 50 Turnouts but Less than 100 Turnouts which comprise of (Turnouts 1 in 8.5, 1 in 12, and 1 in 16; Special Layouts Single Slip Diamond, Double Slip Diamond, Diamond and Scissor; And Derailing Switches)

**c. SMALL YARD**

All Yards which have Less than 50 Turnouts which comprise of (Turnouts 1 in 8.5, 1 in 12, and 1 in 16; Special Layouts Single Slip Diamond, Double Slip Diamond, Diamond and Scissor; And Derailing Switches)

Sl. No.	Type of Yard	YMI	Attention Required
1	BIG YARD	> 9.0	No Attention
		> 7.0 and $\leq$ 9.0	Need Based Maintenance
		> 5.0 and $\leq$ 7.0	Planned Maintenance
		$\leq$ 5.0	Urgent Attention
2	MEDIUM YARD	> 9.25	No Attention
		> 7.5 and $\leq$ 9.25	Need Based Maintenance
		> 5.5 and $\leq$ 7.5	Planned Maintenance
		$\leq$ 5.5	Urgent Attention
3	SMALL YARD	> 9.5	No Attention
		> 8.0 and $\leq$ 9.5	Need Based Maintenance
		> 6.0 and $\leq$ 8.0	Planned Maintenance
		$\leq$ 6.0	Urgent Attention

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