GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

LESSON PLAN

FOR

TRAINING OF MATE

[Promotional Course from Gangman/Keyman to Keyman/Mate]

CAMTECH/2004/TTID/C/MATE/1.0

March - 2004

Centre
for
Advanced
Maintenance
TECHnology

Excellence in Maintenance

Maharajpur, GWALIOR - 474 020
Lesson Plan for Training of Mate
Foreword

Mate is the person who remains all the time with P.Way unit carries out all the track work directly in his supervision and ensures safety of trains as well as safety of trackmen working in his unit daily. The object of this book, is to educate the mate in track works.

This book contains detail information regarding track works, maintenance of track & track protection rules etc.

T.T.I.D (Training Technique and Instructional Design) branch of Civil Engineering,.CAMTECH has made appreciable efforts to bring out the book for training of Mate based on the modules issued by Railway Board.

I am sure that this book will certainly prove to be extremely useful to the Instructor in Training Centres to train the Mate.
Preface

The railway track is the important and vital part of the Indian Railway. Mate is the most important person amongst the permanent way staff. The Mate is the person who carries out/supervises track work daily and directly involves in the maintenance of track. He plays a vital role of safety of track. The Mate needs to be educated thoroughly in his job.

To have uniform syllabus all over Indian Railway, this lesson plan has been prepared based on the modules, published by Railway Board. This book on lesson plan will be of immense use to the Instructors of all training schools for giving training to the Mate.

This lesson plan does not supersede any existing instruction from Railway Board, IRPWM and RDSO on the subject.

I am very much thankful for the guidance given to me by Shri Manoj Agarwal, Director (Civil) and grateful for the assistance given by Shri K.C.Shakya,CTA (Civil) who went through the complete text and done editing work. Nice data entry has been done by Shri Ramesh Bhojwani, Console Operator, CAMTECH.

We welcome any suggestion for addition and improvements from our readers.

CAMTECH/Gwalior
Date : 30.03.2004

R.L.Jatav
AEN/TTID
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<td>142-145</td>
<td>01</td>
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<td>01</td>
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<td></td>
</tr>
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</table>
ISSUE OF CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows:

CAMTECH/2004/TTID/C/MATE/1.0/CS. # XX date .........................

Where “XX” is the serial number of the concerned correction slip (starting from 01 onwards).

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<th>Page no. and Item No. modified</th>
<th>Remarks</th>
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<td></td>
</tr>
</tbody>
</table>
1.0 TRACK COMPONENTS INCLUDING BALLAST & FORMATION

CE/021

Duration : 3 Day

1.1 Formation

1.1.1 Function of formation

The prepared flat surface, which is ready to receive ballast of the track, is called the formation or sub-grade. It is an important constituent of the track as it supports the entire track structure.

1.1.2 The formation has the following functions

- To provide a smooth and uniform bed on which the track can be laid.
- To bear the load transmitted to it from the moving loads through the section of ballast.
- To facilitate drainage.
- To provide stability to the track.

1.1.3 Formation width for concrete sleeper track

The Railway Board has recently decided that minimum formation width of all new construction and during relaying of open line where concrete sleepers are planned to be provided will be as given in figure.

Diagram - 1
Note:

1. All dimensions shown in the diagram are in millimetres.
2. On B.G. and M.G. double lines, the minimum formation on width is based on track centres of 5.300 m and 3.96 m respectively.
3. In flat terrain the height of bank/depth of cuttings should preferably be not less than 1 m ensuring good drainage, formation stability and to avoid trespassing.
4. These dimensions are based on a ballast cushion of 30 cm.
5. These dimensions are also applicable in case of all new lines because of the possibility of use of concrete sleepers at a later date.
6. On curves the following increase in formation widths shall be made.
Table: Formation width for concrete sleeper track for B.G. & M.G.

<table>
<thead>
<tr>
<th>Gauge</th>
<th>Single line section</th>
<th>Double line section</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In Bank</td>
<td>In Cutting</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>Ft</td>
</tr>
<tr>
<td>B.G.</td>
<td>6.85</td>
<td>22.6</td>
</tr>
<tr>
<td>M.G.</td>
<td>5.85</td>
<td>19.1</td>
</tr>
</tbody>
</table>

1.1.4 Remedial measures suggested

Based on the site investigations and soil testing, the relevant remedial measures should be formulated.

Some of the remedial measures suggested for the formation troubles, generally encountered, are listed under:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Nature of problem</th>
<th>Suggested remedial measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inadequate drainage due to high cess, dirty ballast.</td>
<td>Improve side drainage by lowering the cess and screening of ballast.</td>
</tr>
<tr>
<td>2</td>
<td>Weakening of soil at formation top on contact with rain water.</td>
<td>a. Cationic bituminous emulsion below ballast resulting in ‘mud pumping’. Or b. Provision of a rammed moorum or sand blanket of 20 to 30 cm. depth below ballast. Or c. Laying of Geo-textile.</td>
</tr>
<tr>
<td>3</td>
<td>Strength failure below ballast causing heaving up for cess or heaving up between sleepers.</td>
<td>a. Provision of 30 to 60 cm. deep blanket below ballast. Or b. Provision of sub-ballast.</td>
</tr>
<tr>
<td>4</td>
<td>Seasonal variation in moisture in formation top in expensive soils causing alternate heaving, shrinkage of formation.</td>
<td>a. Treatment with lime slurry pressure injection. Or b. Moorum blanket 30 to 45 cm. with moorum lining.</td>
</tr>
<tr>
<td>5</td>
<td>Gradual subsidence of the bank under live loads due to inadequate initial compaction/consolidation of embankment.</td>
<td>a. Cement grouting of ballast pockets, if ballast pockets are permeable. b. Sand or boulder drains.</td>
</tr>
<tr>
<td>7</td>
<td>Creep of formation soil.</td>
<td>Easing of side slopes.</td>
</tr>
<tr>
<td>8</td>
<td>Coal ash pockets due to treatment of previous slips of coal ash.</td>
<td>a. Sand drains below deepest level of coal ash. b. Cement pressure grouting.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>Hydraulic pressure built up under live loads in ballast pockets containing water causing bank slips.</td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>Creep of soil</td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>Swelling of over-consolidated clay side slopes in cutting causing loss of shear strength and slipping.</td>
<td></td>
</tr>
<tr>
<td>f.</td>
<td>Erosion of banks.</td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Drainage out of ballast pocket by sand or boulder drains.</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>Cement-sand pressure grouting of ballast pockets.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reducing stresses by provision of side berms or flattening of slopes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flattening side slopes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Provision of turfing, mats, etc.</td>
<td></td>
</tr>
</tbody>
</table>

### 1.1.5 For Side drain & catch water drain

1. For efficient drainage of cutting, side and catch water drains of suitable type and size should be provided. The bottom of side drains should be at least 30 cm. below the formation level.

2. Adequate openings to take the full flow of side drains should be provided under level crossings.

3. In cutting of black cotton soil and similar soils, catch water drain should be provided sufficiently away from the top of the cutting to avoid any danger of a breach occurring between the drain and the cutting itself. The excavated spoil should be used to form a ‘bund’ between the drain and the top of the cutting.

4. Ballast walls, where provided in cuttings, should be regularly inspected. The efficient maintenance of ballast walls includes regular cleaning of weep holes, the provision of weep holes where non exist and rebuilding where necessary.

5. The permanent way staff shall carry out cleaning of side and catch water drains, clearing of obstructions from out falls and cleaning water-ways of bridges and culverts methodically and complete the work before the monsoon sets in. the spoil from cleaning drains or cutting should not be deposited at a place from where it is likely to be washed back into the drains.

6. In the Municipal areas, where the out fall of Railway drains is in the municipal drains, close co-ordination should be maintained with the municipal authorities to ensure free flow from Railway drains.

**Drainage in station yards**: The network of cross and longitudinal drains in yards whether earthen or masonry, should be so planned that storm water is led away in least possible time. The system of surface drains of water columns carriage-water of carriage washing hydrants should be efficiently maintained.
1.2 Functions of Ballast

- To transfer and distribute the load from sleepers to a larger area of formation.
- To provide elasticity and resilience to track for getting proper riding comfort.
- To provide necessary resistance to track for longitudinal and lateral stability.
- To provide effective drainage to track.
- To provide effective means of maintaining evenness and alignment of the track.

1.2.1 Requirements of good ballast

- It should be tough and wear resistant.
- It should be hard without getting crushed under the moving loads.
- It should be generally angular having sharp edges.
- It should be non-porous and non-absorbent of water.
- It should resist attrition.
- It should be durable and should not get pulverised under the weather condition.
- It should provide good drainage of water.
- It should be cheap and economical in price.

1.2.2 Type of Ballast in use

Stone ballast should be used on all running lines including points and crossings. Other types of inferior ballast such as moorum, sand, shingle etc. may be used on sidings, yards, non-running lines and sub-ballast.

1.2.3 Size of ballast: The gauge of stone ballast shall be as follows:

With all types of sleepers 65-mm. gauge on square mesh sieve. Under points and crossings 40-mm. gauge on square mesh sieve. Or as per specifications issued from time to time.

1.2.4 Ballast profiles/Sections/Depths of Cushion

Ballast profiles/sections to be adopted – The following ballast profiles shall be provided for the various groups of track in B.G., M.G. and N.G.:

For LWR/CWR

![Ballast Profile for LWR Track (Single Line B.G.)](image-url)
<table>
<thead>
<tr>
<th>G Gauge</th>
<th>Type of sleeper</th>
<th>A</th>
<th>B</th>
<th>C*</th>
<th>D</th>
<th>E*</th>
<th>F</th>
<th>F1</th>
<th>H</th>
<th>Quantity of ballast per meter in</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1676 mm</td>
<td>Wooden</td>
<td></td>
<td></td>
<td>350</td>
<td>500</td>
<td>2270</td>
<td>2420</td>
<td>6850</td>
<td>6250</td>
<td>1.682 m^3 1.782 m^3 1.853 m^3</td>
<td>1.646 m^3 1.782 m^3 2.060 m^3</td>
</tr>
<tr>
<td></td>
<td>Steel trough</td>
<td></td>
<td></td>
<td>350</td>
<td>500</td>
<td>2280</td>
<td>2430</td>
<td>6850</td>
<td>6250</td>
<td>1.682 m^3 1.782 m^3 1.854 m^3</td>
<td>1.646 m^3 1.782 m^3 2.060 m^3</td>
</tr>
<tr>
<td></td>
<td>PRC</td>
<td></td>
<td></td>
<td>350</td>
<td>500</td>
<td>2360</td>
<td>2510</td>
<td>6850</td>
<td>6250</td>
<td>1.682 m^3 1.782 m^3 1.855 m^3</td>
<td>1.646 m^3 1.782 m^3 2.060 m^3</td>
</tr>
<tr>
<td></td>
<td>2 Block</td>
<td></td>
<td></td>
<td>350</td>
<td>500</td>
<td>2360</td>
<td>2510</td>
<td>6850</td>
<td>6250</td>
<td>1.682 m^3 1.782 m^3 1.856 m^3</td>
<td>1.646 m^3 1.782 m^3 2.060 m^3</td>
</tr>
</tbody>
</table>

1. The minimum clean stone ballast cushion below the bottom of sleeper i.e. A-250 mm.
2. For routes where increase in speeds are to be more than 130 km.p.h A-300 mm or 200 mm along with 150 mm of sub-ballast.
3. Suitable dwarf walls shall be provided in case of cuttings, if necessary for retaining ballast.
4. *On outer side of curves only.
5. Cess may be widened where required depending on local conditions and outside of curves.
6. All dimensions are in mm.
7. #200 over 150 Sub-Ballast.
1. **Recommended depths of Ballast Cushion**

   **A. Standard ballast profile for B.G. (Other than LWR/CWR)**

<table>
<thead>
<tr>
<th>G Gauge</th>
<th>Type of sleeper</th>
<th>A</th>
<th>B</th>
<th>C*</th>
<th>D*</th>
<th>E*</th>
<th>F</th>
<th>F1</th>
<th>H</th>
<th>Quantity of ballast per meter in</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 mm</td>
<td>Wooden</td>
<td>250</td>
<td>350</td>
<td>500</td>
<td>1760</td>
<td>1930</td>
<td>5850</td>
<td>5250</td>
<td>520</td>
<td>1.179 m³</td>
<td>1.284 m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>300</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>5250</td>
<td>560</td>
<td>1.331 m³</td>
<td>1.407 m³</td>
</tr>
<tr>
<td></td>
<td>Steel trough</td>
<td>250</td>
<td>350</td>
<td>500</td>
<td>1790</td>
<td>1940</td>
<td>5850</td>
<td>5250</td>
<td>520</td>
<td>1.290 m³</td>
<td>1.335 m³</td>
</tr>
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<td></td>
<td></td>
<td>300</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>5250</td>
<td>570</td>
<td>1.443 m³</td>
<td>1.514 m³</td>
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<tr>
<td></td>
<td>CST-9</td>
<td>250</td>
<td>350</td>
<td>500</td>
<td>1730</td>
<td>1880</td>
<td>5850</td>
<td>5250</td>
<td>510</td>
<td>1.235 m³</td>
<td>1.295 m³</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>5250</td>
<td>560</td>
<td>1.385 m³</td>
<td>1.453 m³</td>
</tr>
<tr>
<td></td>
<td>PRC</td>
<td>250</td>
<td>350</td>
<td>500</td>
<td>1940</td>
<td>2100</td>
<td>5850</td>
<td>5250</td>
<td>590</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td>300</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td></td>
<td>690</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

2. **Suitable dwarf walls shall be provided in case of cuttings, if necessary for retaining ballast.**

3. **On outer side of curves only.**

4. **Cess may be widened where required depending on local conditions and outside of curves.**

5. **All dimensions are in mm.**

6. **#200 over 150 Sub-Ballast.**

---

**RECOMMENDED DEPTHS OF BALLAST AND BALLAST REQUIREMENTS**

**FISH-PLATED TRACK**

<table>
<thead>
<tr>
<th>Group</th>
<th>Recommended depth of Ballast Cushion (Y)</th>
<th>Quantity of Ballast Required/Metre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On straight and curves of radius flatter than 600 M</td>
<td>Curves of radius sharper than 600 M</td>
</tr>
<tr>
<td>A</td>
<td>300 mm</td>
<td>1.588 M³</td>
</tr>
<tr>
<td>B &amp; C</td>
<td>250 mm</td>
<td>1.375 M³</td>
</tr>
<tr>
<td>D</td>
<td>200 mm</td>
<td>1.167 M³</td>
</tr>
<tr>
<td>E</td>
<td>150 mm</td>
<td>0.964 M³</td>
</tr>
</tbody>
</table>

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**Lesson Plan for Training of Mate**

March - 2004
Note:

1. In case of ordinary fish-plated track: *To be increased on the outside of curves to 400 mm in case of curves sharper than 600 M radius.
2. In short welded panel Track: *To be increased to 400 mm on outside of all curves, flatter than 875 m radius and to 450 mm. In case of curves sharper than 875 m radius.
3. *To be increased to 550 mm on the outside of turn in curves of turn-outs in passenger yards.
4. In the case of S.W.R. track, the minimum depth of cushion shall be 200 mm.

B. Standard ballast profile for M.G. (Other than LWR/CWR)

<table>
<thead>
<tr>
<th>Routes</th>
<th>Recommended depth of Ballast Cushion</th>
<th>Quantity of Ballast Required/Metre On straight and curves of radius flatter than 600 M</th>
<th>Curves of radius sharper than 600 M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q routes 100 km.p.h.</td>
<td>300 mm</td>
<td>1.070 M³</td>
<td>1.145 M³</td>
</tr>
<tr>
<td>Q routes of less than 100 km.p.h.</td>
<td>250 mm</td>
<td>0.965 M³</td>
<td>1.033 M³</td>
</tr>
<tr>
<td>R-1 Routes</td>
<td>250 mm</td>
<td>0.965 M³</td>
<td>1.033 M³</td>
</tr>
<tr>
<td>R-2 Routes where LWR is contemplated.</td>
<td>250 mm</td>
<td>0.965 M³</td>
<td>1.033 M³</td>
</tr>
<tr>
<td>R-2 Routes where LWR is not contemplated.</td>
<td>200 mm</td>
<td>0.817 M³</td>
<td>0.905 M³</td>
</tr>
<tr>
<td>R-3 Routes</td>
<td>200 mm</td>
<td>0.817 M³</td>
<td>0.905 M³</td>
</tr>
<tr>
<td>S Routes</td>
<td>150 mm</td>
<td>0.673 M³</td>
<td>0.725 M³</td>
</tr>
</tbody>
</table>

Note:

1. In case of ordinary fish-plated track : *To be increased on the outside of curves to 400 mm in case of curves sharper than 600 M radius.
2. In short welded panel: *To be increased to 330 mm on outside of all curves, flatter than 600 M radius, and to 380 mm. In case of curves sharper than 600 M. radius.
3. *To be increased to 550 mm on the outside of turn in curves of turn-outs in passenger yards.
4. In the case of S.W.R. track, the minimum depth of cushion shall be 200 mm.
C. Standard ballast profile for N.G. (Other than LWR/CWR)

<table>
<thead>
<tr>
<th>Recommended depth of ballast cushion</th>
<th>Quantity of Ballast required per Metre of Track</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On Straight</td>
</tr>
<tr>
<td>150 mm</td>
<td>0.543 M³</td>
</tr>
<tr>
<td></td>
<td>Curves of Track Sharper than 300 m radius.</td>
</tr>
<tr>
<td>150 mm</td>
<td>0.584 M³</td>
</tr>
</tbody>
</table>

**Note:**

1. *To be increased on the outside of curves, to 300 mm in the case of curves sharper than 300 M radius.

2. *To be increase to 450 mm in case of turn in curves of turn-outs in passenger yards.

In case of conversion to CWR/LWR in both B.G. and M.G. the ballast profiles should be made up as per the manual. The approximate quantity of ballast required per metre run of track for each of these standard ballast sections has been worked out and shown in the sketch itself.

2. Minimum depths of ballast cushion

(a) The recommended minimum depth of the ballast below the bottom of the sleepers at the rail seat should be as under:

<table>
<thead>
<tr>
<th>Groups</th>
<th>Recommended depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.G. Group ‘A’</td>
<td>300 mm</td>
</tr>
<tr>
<td>B.G. Group ‘B’ and ‘C’</td>
<td>250 mm</td>
</tr>
<tr>
<td>B.G. Group ‘D’</td>
<td>200 mm</td>
</tr>
<tr>
<td>B.G. Group ‘E’</td>
<td>150 mm</td>
</tr>
<tr>
<td>M.G. ‘Q’ routes</td>
<td>250 mm (300 mm when speed is 100 kmph)</td>
</tr>
<tr>
<td>‘R1’ routes</td>
<td>250 mm</td>
</tr>
<tr>
<td>‘R2’ &amp; ‘R3’ routes</td>
<td>200 mm</td>
</tr>
<tr>
<td>‘S’ routes</td>
<td>150 mm</td>
</tr>
<tr>
<td>Narrow gauge</td>
<td>150 mm</td>
</tr>
</tbody>
</table>
Note:
1. In the case of SWR, the recommended depth is 200 mm.

2. Wherever primary renewals are carried out even of ‘E’ route, the minimum depth of ballast of 200 mm shall be provided.

3. Minimum depth of ballast under the rail seat of the sleeper shall be 150 mm except under PSC sleepers, it shall be 250 mm.

4. Wherever 22.1 t axle load rolling stock is nominated to run, minimum depth of ballast shall be 350 mm.

5. On wooden sleeper road, for a distance of 50 m outside to stop signals and at every place where steam engines are likely to stop, it is a good practice to cover the central portion of the sleepers with ballast to reduce the risk of fire.

6. At locations where there is a change in the type of sleepers, special precaution should be taken and six rail lengths on either side of the junction should be fully boxed. Similar action should be taken for bridge and level crossing approaches.

1.3 Sleepers

Sleepers are transverse ties on which rails are laid.

1.3.1 Function of sleepers:

Sleepers are transverse ties on which the rails are laid. The main functions of sleepers are as follows:

- Holding rails to correct gauge and alignment.
- Giving a firm and even support to rails.
- Transferring the load evenly from the rails to widen area of the ballast.
- Acting as an elastic medium between the rails and the ballast to absorb the blows and vibrations of moving loads.
- Providing longitudinal and lateral stability.
- Providing means to rectify the track geometry during its service life.

1.3.2 Different types of Sleepers:

The sleepers, which are mostly in use on Indian Railways, are:

- Wooden sleepers
- Steel sleepers
- Cast iron sleepers
- Concrete sleepers
I. Wooden sleepers

Wooden sleeper is the most ideal type of sleeper and its utility has not decreased with the passage of time. It is laid in lines, bridge, points and crossing. The sleepers laid in bridge and point and crossings are of Sal (hard) wood. For oil treated sleeper the hard portions shall be laid on top and for un-treated sleepers hard portion shall be laid on bottom. Where bearing plates are not provided sleepers shall be adzed before laying. While laying of new wooden sleeper on track the year of laying shall be marked at the centre of sleeper.

Inter mixing of ‘U’ category and ‘T’ category sleepers shall be provided. Adzing and drilling of holes in ‘T’ category shall not be done at field. Sleepers shall be provided with end binding. These sleepers are flat bottom types.

The wooden sleeper has the following main advantages and disadvantages:

Advantages

(a) Cheap and easy to manufacture.
(b) Absorbs shocks and has got good capacity to dampen the vibrations thereby retains packing well.
(c) Easy handling without damage.
(d) Suitable for track circuited sections.
(e) Suitable for areas having yielding formations.
(f) Alignment can be easily corrected.
(g) More suitable for modern methods of maintenance.
(h) Can be used with or without stone ballast.
(i) Can be used on bridges and ash pits also.
(j) Can be used for gaunteretted track.

Disadvantages

(a) Lesser life due to wear decays and attach by vermin.
(b) Liable to mechanical wear with beater packing.
(c) Difficult to maintain gauge.
(d) Susceptible to fire hazards.
(e) Scrap value is negligible.

II. Metal Sleeper

A. Steel Trough sleepers

These sleepers essentially consist of rolled plate and in the form of trough shape placed inverted on the ballast section. Rails are provided on the top of trough. These are laid in lines and points and crossings. These sleepers are not laid in ash pits, platforms and corrosions prone area.

B. Steel Channel sleepers

These sleepers consist of two rolled steel channel connected with back to back by necessary fittings with a gap between them. These sleepers are laid in Girder Bridge only as a replacement of wooden sleeper.

About 27% of track on Indian Railways are laid on steel sleepers. The increasing shortage of timber in the country and other economical factors are mainly responsible for the use of steel sleepers in India. The steel sleepers have the following main advantages/disadvantages over the wooden sleepers:
Advantages

(a) Longer life
(b) Easy to maintain gauge and lesser maintenance problems.
(c) Better lateral rigidity.
(d) Lesser damage during handling and transport.
(e) Manufacturing process is simple
(f) Very good scrap value
(g) Free from decay and attack by vermin.
(h) Not susceptible to fire hazards.

Disadvantages

(a) Liable for corrosion
(b) Unsuitable for track circuiting areas.
(c) Liable to become centre bound because of slopes at two ends.
(d) Develops cracks at rail seats during service.
(e) Can only be used for rails for which it is manufactured.

III. Cast Iron Sleepers

Cast iron sleepers are being extensively used on Indian Railways a 45% track at present consists of C.I.Sleepers, which may be either of or plate type.

A. CST-9 sleepers – These sleepers are widely used in Indian Railways. These sleepers consist of two triangular inverted pots on side; a central plate with projected key and a box on top of the plate and a tie bar. Before laying the sleepers, the sleepers shall be painted with anti-corrosive paints. These sleepers shall not be laid in corrosion prone areas. Care should be taken to see that the plate is packed evenly. Tilting will disturb the gauge and will not give proper bearing. These sleepers are laid in lines only.

B. C.I.Pot sleepers – These sleepers consist of two hollow bowls or pots of circular or elliptical shape placed inverted on the ballast section. These two are connected by a tie bar. The rails are provided on the top of pot. The maintenance of this type of sleeper is very difficult and has become obsolete now.

The main advantages and disadvantages of C.I.Sleepers of trough sleepers are as follows.

Advantages

(a) Lesser corrosion
(b) Lesser liable to crack at rail seat
(c) Easier to manufacture
(d) Higher scrap value
Disadvantages

(a) Gauge maintenance is difficult as tie bars get bent  
(b) Provides lesser lateral stability  
(c) Unsuitable for track circuited lines  
(d) Not very suitable for mechanical maintenance and or M.S.P. be rounded bottom.  
(e) More susceptible to breakage.

IV. Concrete Sleepers

A. Mono Block PSC Sleeper – These sleepers are made from concrete. These sleepers are of trapezoidal shape. It is heavy and flat bottom. Now days it is widely used in Indian Railways. It is laid in lines and point and crossings.

B. RCC Twin Block sleepers – These sleepers consist of two reinforced cement concrete blocks joined by an angular tie bar. These sleepers are used in line only.

Advantages

(a) Concrete sleepers, being heavy, lend strength and stability to track and are specially suited to L.W.R. due to the great resistance they offer to the buckling of track.  
(b) Concrete sleepers with elastic fastening provide a track which can maintain better gauge, cross-level and alignment. It retains packing also very well.  
(c) The concrete sleepers, because of their flat bottom, are best suited for modern methods of track maintenance like M.S.P. and mechanical maintenance, which have their own advantages.  
(d) Concrete sleepers can be used in track circuited areas, being poor conductor of electricity.  
(e) They are neither in flammable nor subjected to damage by pests or corrosion in normal circumstances.  
(f) The life of concrete sleeper is very long, probably 40 to 50 years. Rails and sleeper renewals as such can be matched, which is a very big economic advantage.  
(g) The concrete sleepers can generally be mass produced from local resources.

Disadvantages

(a) Handling and laying of concrete sleepers is difficult due to their being heavy. Mechanical methods have to be normally adopted for handling which involve considerable initial expenditure.  
(b) The damage to concrete sleepers is very heavy at the time of derailment.  
(c) There is no scrap value for the concrete sleeper.  
(d) The sleepers are not suitable for beater packing.  
(e) The concrete sleepers are preferably to be maintained by heavy “On Track” tampers.
1.3.3 Sleeper Fastenings

A. **For wooden sleepers** – Below the rail foot and top of sleeper mild steel bearing plate (MSBP), anti-crip bearing plate (ACBP) cast iron bearing plate (CIBP) are provided. Bearing plates should be provided invariably on ‘T’ category sleepers, girder bridges, points and crossings, ash pits and examination pits, joint sleepers and sharp curves. These shall be painted with black oil before fixing to the sleepers. These are fixed to the sleeper by dog spike, rail screw and plate screw. All joints, bridge, turn out and ash pits should have four numbers of plate/rail screws. On curves in intermediate sleepers should have two spikes/screws outside and one inside. The spikes/screws should be dipped in coal tar before driving. Plate/rail screw should always be screwed by box spanners not driven by hammers.

B. **For CST-9 sleepers**- The fittings of CST-9 sleepers are tie bars, cotters and two-way keys. Before putting in track the tie bars should be coal tarred. These sleepers should be evenly packed otherwise the pots may break due to tiltness and disturb the gauge. When due to wear the keys exceed the limit of key driving, the keys should be used with appropriate size of liners or replaced by over sized keys. While fixing cotters for CST-9 plates it should be seen that the tapered side of the cotter is in contact with the sloped face of the CST-9 plate and the cotters are split sufficiently so that they remain tightly. When there is wear in rail seat saddle plates of suitable thickness should be tried for arresting the crip. Standard keying hammer (1.8 kg) should be used.

C. **For steel Trough sleepers** – The fittings of Steel Trough sleepers are loose jaw and keys, modified loose jaws and elastic rail clip (ERC). When holes of the sleepers get elongated half moon tapered washers should be used to make up for the wear on the holes. Standard keying hammer (1.8 kg) should be used. Old Steel Trough Sleepers having worn out rail seats can be reconditioned by strengthening the rail seats with mild steel pads.

D. **For Steel Channel sleepers** – The fittings for the Steel Channel Sleepers are M.S. canted bearing plate, grooved rubber pad, M.S.clip, annular cap, ‘T’ head bolts and nuts, tapered washers, bolts and nuts, single coil spring washers, M.S. packing plates, tapered split pin, plain washers, elastometric pad and hook bolts. The hook bolts should be checked for its tightness. All bolts and nuts should be checked for tightness.

E. **For Mono Block PSC Sleepers** – The fitting of Mono Block PSC sleepers are grooved rubber pad, liners and elastic rail clip (ERC). The liners are of two types – one is nylon (GFN) used for track circuit area and other is metal used for non-track circuit area. Before driving the ERC its center leg and hole of the insert should be cleaned off any dust and greased. The ERC should be driven/taken out by clip applicator/extractor and not by hammer. During driving it should be seen that the leg of the clip is flush with the end face of the insert.

F. **For RCC Twin Block Sleepers** – The fittings of RCC Twin Block sleepers are tie bar angle, rubber pad, plate screw or bolts.
G. Other fittings

(i) Hook bolts required in bridges.
(ii) Chair plate, stud bolts, stop, heel, block, distance block, spherical washers, stretcher bars, split pins, bolts and washers, spring washers, check blocks required in points and crossings. Creep anchors required in line, points and crossings and bridges to arrest creep.

1.4 Rails

Rails are like steel beam which are laid over the sleepers and which directly support the wheels and distribute the load to the formation through sleepers and ballast.

1.4.1 Different type of rail

(i) Double headed rail
(ii) Bull headed rail
(iii) Flat footed rail

Flat-footed rails are used in Indian Railways.

1.4.2 Standard sections of Rails

A. General

1. Rail sections are normally selected to suit standard of loading and the speeds. The other important factor which must govern the choice of a rail section is the traffic carried so that adequate service life could be obtained.

2. Recommended Rail sections:

Broad Gauge

The following minimum rail sections are recommended for various routes as follows:

<table>
<thead>
<tr>
<th>Routes</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D Spl.</th>
<th>D</th>
<th>E Spl.</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic density in G.M.T. More than 20</td>
<td>60 kg.</td>
<td>60 kg.</td>
<td>60 kg.</td>
<td>60 kg.</td>
<td>60 kg.</td>
<td>60 kg.</td>
<td>52/72</td>
</tr>
<tr>
<td>0–20</td>
<td>52/90</td>
<td>52/90</td>
<td>52/90</td>
<td>60</td>
<td>52/90</td>
<td>60</td>
<td>52/72</td>
</tr>
<tr>
<td>5–10</td>
<td>52/90</td>
<td>52/72</td>
<td>52/72</td>
<td>60</td>
<td>52/72</td>
<td>60</td>
<td>52/72</td>
</tr>
<tr>
<td>Under 5</td>
<td>52/90</td>
<td>52/72</td>
<td>52/72</td>
<td>60</td>
<td>52/72</td>
<td>60</td>
<td>52/72</td>
</tr>
<tr>
<td>Loop line</td>
<td>90 R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pvt. siding</td>
<td>52 kg/90 R</td>
<td>T-12 quality second hand rails</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Note:

1. Existing 90 R rails may be allowed to remain for speeds not exceeding 130 kmph.

2. Wherever Box ‘N’ wagons are plying, 52 kg 90 UTS rails shall be irrespective of GMT of section.

3. On routes identified for running of 22.1 t axle load wagons, 60 kg rails of approved specifications shall be used on all routes except on ‘E’ routes with GMT less than 5, where 52 kg 90 UTS rails may be used at the discretion of Chief Engineer.

4. On private sidings where BOX ‘N’ or 22.1 t axle load wagons ply, the rail section should be 52 kg. In case of operating speeds exceeding 30 kmph and going upto 50 kmph, as also where BOX ‘N’ for 22.1 t axle load wagons ply.

5. Head hardened rails should be used for local lines where (a) EMU stock is running (b) Ghat section with gradients steeper than 1 in 150 and / or curves sharper than 2° (c ) Location where rate of wear of rails necessitates rail renewal at frequency of 10 years or so. Head hardened rails should be laid on continuous & long stretches.

Metre Gauge

The following rail sections are recommended on M.G.routes:

<table>
<thead>
<tr>
<th>Route</th>
<th>Rail section recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Q’ and ‘R1’</td>
<td>90-R new</td>
</tr>
<tr>
<td>‘R2’ and ‘R3’</td>
<td>90-R II hand</td>
</tr>
<tr>
<td>‘S’</td>
<td>75-R new</td>
</tr>
<tr>
<td></td>
<td>60-R II hand</td>
</tr>
</tbody>
</table>

Narrow gauge (762 mm)

Suitable new or second hand rails 50 lbs. and above.

B. Grade/quality of rail

There are two grade of rail (i) 720 grade commonly known as 72 UTS (ii) 880 grade commonly known as 90 UTS.

C. Branding/identification mark of rails

Rails are marked at least in three places in one full length of rail with the following notations–

IRS - 52 KG - 710 - SAIL - II/2001 → OB

(i) IRS denotes Indian Railway Standard.

(ii) 52 KG denotes weight of rail.

(iii) 710 denote grade of rail.
(iv) SAIL denotes Steel Authority of India Limited.
(v) II/2001 denotes Month and Year.
(vi) → Denotes rolling direction.
(vii) OB (Open Hearth) denotes manufacturing process of rail.

D. Quality of rail

There are two quality of rail (i) Class I quality or IRS T-12 quality (ii) Class II quality or IRS T-12 quality.

E. Colour code

(i) For 710 grade – No colour in web surface.
(ii) For 880 grade – Yellow colour of about 4 m lengths on both side web surface and both the ends.
(iii) For T-18 rail – Red colour of about 4 m lengths on both sides web surface and both the ends.

F. Rail to Rail joining

One rail is joined with other by means of fish plates and fish bolts. When two rails of different sections are required to be joined, it is joined by combination fish-plates.

1.4.3 Rails and fastenings

I. Elastic Fastenings

Necessity for Elastic Fastenings

The primary purpose of a fastening is to connect or fix the rail with the sleeper. The fixing of the rail to the sleeper may be done directly or indirectly with the help of the fastenings, but in the process of fastening the rail is subjected to be severe vertical, lateral, and longitudinal forces. The forces, which is predominantly dynamic increase rapidly with the increasing loads and speeds in addition, vibrations are generated by moving loads mainly on account of geometrical irregularities of track and due to forces set of by the imbalance in the rolling stock. The traditional rigid fastening, which has to certain extent full filled its task for quite some time, is not able to meet the challenge of the heavy dynamic forces effectively and, therefore, works out loose under the high frequency vibrations of the order of 800-1000 cycles/second even at a moderate speed of 100 km/h. This type of fastening in fact is unable to hold the rail to sleeper firmly and with a constant pressure for a good length of time. Due to shocks and vibrations caused by moving loads, the rigid fastenings get loose, interplay between the components the track develops, track parameters get affected and rapid deterioration of the track starts. There is a need, as such, of a fastening, which can safeguard the track parameter and dampen the vibrations. An elastic fastening is possibly an answer for the problem.
Requirements of an elastic fastening an ideal elastic fastening should be able to meet the following requirements:

1. It should hold gauge well.
2. It should have adequate toe load, which should not reduce under service.
3. It should provide sufficient elasticity to absorb the vibrations and shocks caused by moving load.
4. It should keep the track parameters well mentioned.
5. It should offer adequate resistance to lateral forces for maintaining the stability of track.
6. It should provide the adequate resistance to longitudinal forces caused due to acceleration of moving loads and other miscellaneous factors. These longitudinal forces tend to developed creep in the track.
7. It should be of fit and forget type to require the least maintenance.
8. It should be of the type that it can be used and reused without losing its properties.
9. It should have as few parts as possible, which are easy to manufactured, laid and maintained.
10. It should be of the type that it can not be taken out and as such is free from sabotage or theft.
11. It should be of universal type so that it can be used on wooden, steel or concrete sleepers.
12. It should be cheap and have a long life.

II. Type of Elastic Fastenings

A. Pandrol Clip Or Elastic Rail Clip

Pandrol PR 401 clip (Also called elastic rail clip) is a standard type of elastic fastening on Indian Railways and was earlier manufactured by M/s Guest, Keens & Williams.

![Pandrol clip or Elastic rail clip](image)

It is a fit and forget type fastening and very little attention is required to maintain the same. The clip is made from silicon Manganese spring steel bar of 20.6mm dia (13/16”) and heat-treated. It exerts a toe load of 710 kg. (0.710 Tones) for a nominal deflection of 11.4 mm (7/16”). The toe load is quite adequate to ensure that the no relative movement between rail and sleeper is possible. The pandrol clips can be driven with the help of an ordinary 4 pounds hammer and requires no special tools. In order to ensure that correct toe load is exerted, The pandrol clip should be driven to
such an extent that the outer leg of the clip flushes with the outer face of the C.I. insert. The clip fixed on the rail is shown in an isometric view in figure

Pandrol clip fixed to Rail seat

The pandrol clip can be fixed on wooden, steel cast iron or concrete sleepers with the following arrangements:

(a) Wooden sleepers

In case of wooden sleepers, a steel or cast iron base plate is provided with the help of dog spikes or preferably with screw spikes. The base plate has grooves on both sides on which pandrol clip can be fixed by driving it with ordinary hammer. A rubber pad is also provided to give necessary cushioning.

Pandrol clip with wooden sleeper
(b) Steel Sleepers

In case of steel sleepers, a steel plate is normally welded on the sleepers having groove on both sides, where pandrol clip can be provided. Certain difficulties have been experienced with this arrangement as tolerance are not easily maintained and sleepers already laid are required to be taken out from the track to the workshop for alteration. Recently, a design for a modified loose jaw, which can be used with existing holes on steel trough sleepers, has been developed to accommodate the pandrol clips.

(c) Cast Iron Sleepers

In case of CST-9 sleepers the design of sleeper has been slightly modified to suit pandrol clip and new type of sleeper CST-11 sleepers has been evolved.

(d) Concrete Sleeper

In case of concrete sleepers, malleable cast iron inserts are inserted directly in to the sleepers during their manufacture. The pandrol clip is fixed in the hole of C.I. insert. A
4.5mm thick grooved rubber pad has been provided under the rail sheet to make it double elastic. Insulated liners have also been provided for the purpose of insulation.

![Pandrol clip with concrete sleeper](image)

**Draw backs of pandrol clips:** The pandrol clips suffer from the following drawbacks.

1. No adjustment of gauge is possible.
2. The pandrol clip has a point of contact and causes indentation on the foot of the rail due to heavy toe load and small contact area.
3. It does not provide enough safeguards for theft or sabotage because it can be taken out by ordinary hammer.
4. It gets seized in the M.C.I. insert during service.

**B. Elastic Rail Clip MK-III**

RDSO has developed a design of elastic rail clip known as ERC-MKIII, which can suit both 52-kg. Rails as well as 60 kg UIC rail and 6mm thick rubber pad by putting suitable thickness of liners. For 60 kg. Rails, 2 liners of 6mm thickness are used where as for 52kg rail, 1liner of 16mm on non-gauge side and another liner of10mm thickness on gauge side is used. The clip can also be used on existing 52 kg PRC sleepers with 6mm thick rubber pads in place of 4mm thick rubber pads.
Elastic Rail clip MK III

ERC MKIII a clip has modification from the standard elastic rail clip to the extent that in the new clip the distance of toe of clip with respect to Centre leg has increased. The space curves of the clip have also been modified to achieve higher toe load. The dia. of the clip has been kept the same as of the existing ERC clip i.e. 20.64mm.

The ERC clip MK III has got a toe load of 900kg to 1100 kg with toe deflection of 15.5 mm. The clip is a still under trial.

C. M.C.I. Inserts

Malleable Cast Iron (M.C.I.) inserts are fixed directly into the concrete sleepers during manufactured. M.C.I. inserts are manufactured to IRS Specification T-32-76. The material for the inserts conforms to the requirement of IS2640-64 “Specifications for Pearlitic malleable iron castings”.

The inserts are of two types.

(1) **Stem types M.C.I. Insert:** For use in normal pretension concrete sleepers. This insert is required for concrete sleepers being manufactured in all the concrete sleeper factory in India except that at Allahabad. The weight of stem type insert is about 1.6kg/piece.

(2) **Gate types M.C.I. Insert:** For use in post tension concrete sleepers. This insert is used in post tension type concrete sleeper, which are being manufactured at Allhabad. The approximate weight of the Gate type M.C.I. insert is 1.7kg/piece.
D. Rubber Pad

A rubber pad is an integral part of an elastic fastening. It is provided between rails and sleepers to perform the following duties;

(1) It absorbs the shocks.
(2) It dampens and absorbs the vibrations.
(3) It resists lateral movement of the rail.
(4) It prevents abrasion of the bottom surface of the rail, which otherwise comes in direct contact with the sleepers.
(5) It provides electrical insulation between rails in the electrified area.

Various pads have been used with different types of sleeper on the European Railways. The pad normally used are of rubber, but rubber bonded cork pads have also been used on the British Railways. On Indian Railways grooved type rubber pad of 4.5 mm thickness, made of special quality rubber, are used. The grooves provide uniform distribution of the load on the sleepers and help in limiting lateral expansion of the rubber under dynamic loads.

6mm Thick Grooved Rubber Pad.

A design of 6mm thick grooved rubber pad with horns has been developed by RDSO (Drg. No.RDSO/T371) for use on 60 kg UIC rails. It was being experienced that normal rubber pads of 4.5 mm thick (IRST-37-1982) were getting crushed in 6 to 7 year time and therefore thicker grooved rubber pads particularly for 60 kg UIC rail were designed which can give better service life 15 to 20 years.
Nylon insulating liners are being mostly used on Indian Railways. They are, however, getting crushed under the toe load exerted by pandrol clips. To eliminate such premature failure, the following two types of composite liners have been evolved by RDSO.

(I) Composite liner with malleable cast iron and nylon components (Drg. No.RDSO/T653/1)
(II) Composite liner with M.S. and nylon components (Drg. No.RDSO/T1895)

These liners have been evolved on the basis of the design adopted on British Railways, where these are reported to have given trouble free service for the last few years.

The composite liners have been used on Indian Railways for about last 5 years and they are reported to have given good service.

F. Glass Filled Nylon Liners

RDSO has developed some time back glass filled nylon liners (GFN-66) of 4mm thickness particularly for track-circulated areas and sections, subjected to severe corrosion. These glass filled nylon liners are considered to be technically superior because these are in single piece, have longer life and are free from corrosion. These liners are on extensive use on Indian railways particularly with ERC clip assembly on 60 kg and 52kg rails and PRC sleeper. That is saline atmosphere of coastal belts and areas subjected to industrial fumes etc. where corrosion is prominent, only GFN –66 liners should be used.

The 6mm thick grooved rubber pad is still under trial.

E. Composite Liners

Lesson Plan for Training of Mate

March - 2004
Glass filled nylon liner

The experience has shown that GFN-66 liners are breaking particularly in yards where these liners have been fitted in ERC clip assembly on concrete sleepers due to rusting of the rail surface and uneven seating. To avoid breakage of GFN-66 liners, it is necessary that while initial laying, proper precautions should be taken to ensure that rail surfaces are cleared of rust etc. and the liners are made to sit evenly on the 1 in 6 sloping surface of the rail flange.

A design of GFN-66 liners having 6mm thickness (Drg. No. RDSO/T2505 Alt II) has been developed which will possibly be more study and give better service life.

G. Pilfer proof Elastic fastenings for concrete sleepers.

The present design of elastic fattening (pandrol clips) is such that the same can be removed easily by single stroke of hammer. These are therefore susceptible for pilferage and theft by miscreants. A new design of elastic rail clip, which is pilfer proof has been under the consideration of the track standard committee for quite some time.

A pilfer proof elastic fastening may be defined as an elastic fastening system which is easily to fit in the assembly but provides some difficulty for its removal without damage to the system.

A design of a pilfer proof elastic rail fastening consist of an elastic clip of almost the same design and introduction of new fitting called pilfer proof circlip. The circlip is a standard mechanical component manufactured to IS specification and is generally use for rest training the axial movement of components mounted on shafts.

The design of the pilfer proof elastic rail clip is very much similar to the design of standard rail clip (Drg No. RDSO/T-1892) in respect of the properties of the clip, material specification and the methodology of production except for the change in length of central leg, which has been lengthened by 13mm compare to the central of the existing elastic rail clip. The toe load of the clip will remain the same as the existing elastic rail clip. The central leg has been provided with a grove 2.82 m deep at 11.25mm from its free end, which hoes the circlip. The grove in the rod of the clip shall be made before forming the clip. The clip will be driven in the assembly in the normal way like the elastic rail clip and the circlip will be applied on the groove through a plane inclined at 45 degree from the vertical with a light stroke of the hammer. The two free ends of the circlip spread out elastically till it is fully engaged.
and attain normal shape inside the groove of the central leg of chip. The dia of the circlip being larger (28mm) then the dia of hole in the insert (22mm). The circlip prevents the elastic rail clip to the driven out or simple stroke of a light hammer or by similar means. For removal of the circlip, a special tool similar to a nose pliers will be required. The nose of the pliers shall engaged itself into 2mm dia. Holes near the free ends of the circlip. On pressure application on the hand grid of the special tool, the circlip can be taken put (or even broken) with difficulty but without damage to the main clip.

The Railway Board have accepted the recommendations of Track standard and committee that the above pilfer-proof Elastic Rail clip should be used on trial basis on Eastern and South Eastern Railways.

III. Correct method of driving keys for different type of sleepers

RDSO has recommended the following method of driving keys for different type of sleepers. (Table)

Table : CORRECT METHOD OF DRIVING KEYS

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Type of sleeper and track</th>
<th>Direction of driving.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>SINGLE LINE</td>
<td>All the keys in one sleeper should be driven in the same direction. Keys should be</td>
</tr>
<tr>
<td></td>
<td>CST –9 sleeper (Fish plated ,SWR &amp;LWR track)</td>
<td>driven in reverse direction on alternate sleepers.</td>
</tr>
<tr>
<td></td>
<td>Steel trough sleeper (all type of track)</td>
<td>The outer keys on a sleeper should be in one direction and the inner keys in opposite</td>
</tr>
<tr>
<td></td>
<td></td>
<td>direction. The pattern of driving keys in alternate sleepers should be reversed.</td>
</tr>
<tr>
<td></td>
<td>Wooden sleeper</td>
<td>All keys should be driven in the same direction. Key should be driven in reverse</td>
</tr>
<tr>
<td></td>
<td>(i) ACB. With single key configuration.</td>
<td>direction in alternate sleepers.</td>
</tr>
<tr>
<td></td>
<td>(ii) A.C.B. with double key configuration</td>
<td>The outer key on a sleeper should be in one direction and the inner keys in the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>opposite direction. The pattern if driving keys in alternate sleepers should be</td>
</tr>
<tr>
<td></td>
<td></td>
<td>reversed.</td>
</tr>
</tbody>
</table>
B DOUBLE LINE
CST-9 sleeper
(a) Fish plated & SWR track
Direction of 75% keys should be in the
direction of traffic and 25% in opposite
direction.
(b) LWR track in non breathing length
75% keys should be driven in the
direction of traffic and 25% in the
opposite direction.
(c) LWR in breathing length
All keys should be driven in one
direction on one sleeper and in opposite
direction in the next sleeper and then
the scheme followed up in subsequent
sleepers.

ST sleeper
(a) Fish plated &SWR track
75% sleepers should have all four keys
driven in the direction of traffic and
25% sleepers should have all four
driven keys in reverse direction.
(b) LWR track in non breathing length
75% sleepers should have all four keys
driven in the direction of the traffic and
25% sleepers should have all four
driven keys in reverse direction of
traffic.
(c) LWR track in breathing length
Two inner key should be driven in one
direction and the other keys in the other
direction. Also direction of keys should
be reverse in alternate sleepers, so as to
prevent relative movement between
the rail and sleepers.

IV. Fastening per sleeper

The number of various fittings and fastenings per sleeper for deferent type of sleepers
for ordinary or conventional fastening as well as elastic fastening are summarized in
the table:

<table>
<thead>
<tr>
<th>Type of sleeper</th>
<th>Ordinary fastening per sleeper</th>
<th>Nos.</th>
<th>Elastic fastening per sleeper</th>
<th>Nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wooden</td>
<td>Bearing plates</td>
<td>2</td>
<td>C.I. bearing plates</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Dog spikes</td>
<td>8</td>
<td>Plate screws</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Or screws</td>
<td>8</td>
<td>Pandrol clips</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Keys for C.I. anti-creep</td>
<td>4</td>
<td>Rubber pads</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>bearing plate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td>No ordinary fastenings</td>
<td>-</td>
<td>Pandrol clips</td>
<td>4</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------</td>
<td>---</td>
<td>---------------</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Nylon Liners</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rubber pads</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>M.C.I. insert</td>
<td>4</td>
</tr>
<tr>
<td>Steel trough</td>
<td>Keys</td>
<td>4</td>
<td>Modified loose jaws</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Loose jaws</td>
<td>4</td>
<td>Pandrol clips</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rubber pads</td>
<td>2</td>
</tr>
<tr>
<td>CST/9</td>
<td>Plates</td>
<td>2</td>
<td>Pandrol clips</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Tie bar</td>
<td>1</td>
<td>Rubber pads</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Cotters</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Keys</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 1.4.4 Stacking of Rails

In stacking rails, care shall be taken that:

- The ground is level;
- Free rails are supported at least at four points, evenly in their length; and
- Each stack of the rail should be of the same section and class.

### 1.4.5 Handling of rails

1. Any carelessness loading, unloading, handling and laying is liable to use damage which will not only contribute towards bad running but also result in irreparable damage to, or incipient failures of rails. During loading and unloading, ramps of unserviceable rails should be made and the rails slid over them, intermediate supports being given to prevent excessive sagging.

2. When conveyed in bolster-wagons, the rails should be loaded to obtain equal over hang at each end beyond the bolsters and securely chained.

3. Carrying rails, on the head or shoulders should be avoided. For handling rails, slings or tongs should be used. When hauled into position, prior to linking otherwise, rails should be so spread as to rest evenly along their entire length or on supports closed placed. Flat-footed rails should lie on the pot. Those that are found with kinks should be straightened.

4. When housing rails into metal sleepers or chairs, the sleepers should be properly aligned and levelled. Forced insertion of rails with hammer blows should be avoided.

5. During yard surveys, curve adjustments and realigning operations, chisel or punch marking of rails should be avoided.

### 1.4.6 Inspection of rails in service

**General:** Rails should be inspected for flaws specially, when the rails show signs of fatigue and the rail wear is excessive. The detection of rail flaws is done either by visual examination of the rail or by ultrasonic rail flaw detection.
**Visual examination of rails:** Most of the rail flaws develop at the rail ends. Rails ends should be examined for cracks during the lubrication of rail joints by cleaning the surface of the rail by wire brushes and using a magnifying glass. A small mirror is of assistance in examining the underside of rails.

### 1.4.7 Ultrasonic Rail Flaw Detection

(a) **Description of instrument:** Manually operated portable, ultrasonic flaw detectors are used in Indian Railways and they are fully transistorised and battery operated. Three probes are used for rail testing, one normal and two angle probes 70° and 37.5° fitted to the trolley and one 80° probe for hand probing of welds.

(b) **Actual operation:** The operator should mark the defects on the rail itself. To reduce human error to the minimum, the operator should be well trained and should be able to concentrate on reading the information on the oscilloscope screen of USFD machine.

(c) **Peesting:** Testing before relaying-While carrying out primary renewals initial testing of rails is preferably done ultrasonically at the flash butt welding plant before the rails are welded. If it is not possible to do so in the plant, the rails should be tested ultrasonically, as early as possible, after laying the track.

(d) **Classification of flaws detected by Ultrasonic flaw detection:** Depending on the nature and extent of internal flaws and the traffic density and speed on the section, the defects have been classified into two categories i.e. I.M.R. and O.B.S.

(e) **Marking defective rails and remedial action:**

i) **I.M.R. (immediate removal):** The flaw which is serious in nature and can lead to sudden failure is classified as I.M.R. immediately after detection, such portions shall be marked with red paint (three stars) on the web of the rail on both faces. Such portions shall require urgent action and shall be replaced by sound tested rail piece of not less than 6m. in length. The defective rails are to be replaced within three days after detection. Till such portions are removed, speed restriction of 30 km.p.h. on B.G. and M.G. shall be imposed after detection. Clamped fishplates are to be provided at defective portions. Wherever clamped fishplates are provided, at such locations posting of a watchman is not considered necessary. Till clamped fishplates are provided a watchman should be posted.

ii) **O.B.S. under observation:** If the defect is such that it is not expected to result in fracture till re-scanning is done in a year’s time it is classified as O.B.S. Such defects shall be marked by red paint (one star) on both faces of the web and need only be kept under observation occasionally and when convenient.
The action to be taken in respect of the above classification is summarised below

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Classification</th>
<th>Painting on both faces of web</th>
<th>Action to be taken</th>
<th>Interim Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I.M.R.</td>
<td>Red – 3 – star</td>
<td>Replacement by a sound tested rail piece of not less than 6 m. within 3 days of detection.</td>
<td>Post a watchman till clamped fishplates are provided. Impose speed restriction of 30 kmph. till the fractured rail is replaced.</td>
</tr>
<tr>
<td>2</td>
<td>O.B.S.</td>
<td>Red – 1 – star</td>
<td>Re-scanning once a year</td>
<td>To be kept under observation occasionally and when convenient.</td>
</tr>
</tbody>
</table>

**Action to be taken in the case of Rail fractures/Weld failures**

1. It is of paramount importance that whenever a fracture of a rail/welded joint is noticed, immediate action is taken to restore the track, if necessary with restricted speed, with the least possible delay.

2. The mate/Mate/gangman, as soon as he notices the rail fracture/weld failure should first protect the track, while the repairs are being carried out. He should also send information to the P.W.I. and the Station Master of the nearest station.

3. If the fracture is with a gap of less than 30 mm. in the case of fish-plated/SWR track, the fractured portion should be supported on wooden block or by shifting the nearest sleepers on both sides. In the case of LWR the fractured rail should also be clamped.

**1.5 Requirement of Rail Joint**

An ideal rail joint should be able to perform the following functions:

1. It should hold the rail ends in the correct position, both in horizontal and vertical planes.
2. It should provide elasticity equal to that of the rail.
3. It should allow free expansion and contraction of the rail.
4. As the contact surfaces get worn out under traffic, necessary adjustment in the joint should be possible to retain level and line.
5. The joint component, i.e. fishplates, bolts and nuts, should not be very heavy or costly.
6. It should be easy to maintain and the cost of maintenance should be minimal. The maintenance cost should be viewed in the light of the fact that about 25 percent of the track maintenance cost is for the joints alone.
7. It should permit easy replacement of any single rail from the track.

Some of the above mentioned requirements are conflicting with each other. Efforts are therefore made to arrive at the best possible design.
1.5.1 **Standard fish-plated joints:** The standard fish-plated joints are discussed below:

Fish-plates

There as the “Revised British Standard” rail sections have been adopted for use in the Indian Railways, the British Standard Fish-plates designed for these sections have not been considered sufficiently strong for adoption as standard in India. For this reason stronger and heavier fishplates have been designed and standardised. Extra metal has been provided at the top and bottom of the plates to lend additional stiffness and strength to them. For 90 R and heavier rail section, 610-mm long fishplates are used. Longer fishplates give added strength to the joint and reduce bolt hole stresses.
M-37 carbon steel billets, with a minimum UTS of 57 kg. per square mm, are used for re-rolling into fishplates. The bolt holes in the fishplates can be either drilled or hot punched. The holes should be clean and without burrs on either side. The following tolerances are permitted in the positioning and diameter of the bolt holes.

1. Position of the holes  
   - 0.4 mm  
   + 0.4 mm
2. Diameter of the holes  
   + 0.8 mm  
   - 0.0 mm

1.5.2 Lubrication of Rail Joints

The purpose of lubricating rail joints is not only to facilitate expansion of rail but also to retard wear on the fishing planes of the rail and fish-plate. Reduced wear on fishing planes is one of the preventives for low joints.

A stiff paste of plumbago (graphite) and kerosene oil, in the proportion of 3:2 is used as a lubricant. Black oil or reclaimed oil is used for oiling fish-bolts and nuts.

Rail joints are lubricated once a year during the cold weather months. The procedure to be followed is as follows:

1. Unscrew the nuts and remove the fish-bolts and fish-plates.
2. Clean the fishing surfaces of the fishplates and rail with a wire brush.
3. Inspect the rail ends for cracks, and fishing surfaces of rails and fish-plates for wear. Select appropriate size of shims if it is readily available and considered necessary.
4. Lubricate the fishing surfaces of the rails and fish-plates and replace the latter with shims in case shims are to be provided.
5. Oil the fish-bolts and nuts and put them back in the reverse position. Tighten them using a standard fish-bolt spanner; the inner two bolts being tightening first.

If the traffic conditions so warrant, an alternate procedure of lubrication is adopted. In it, at no time during the operation, there are less than one fish-plate and three fish-bolts, without nuts connecting the two rails.
1.5.3 **Suspended or supported joints:** In respect to the sleeper spacing adopted at the joints, rail joints are classified into the following categories.

**A. Supported joint**

In this type the rail ends are supported directly on a single sleeper or on two sleepers bolted together. On some railway systems a common bearing plate for the two joints sleepers is used.

![Supported Joint Diagram](image)

**B. Suspended joint**

In this type rail ends project beyond the joint sleepers. Usually enough space is available for packing the joint sleepers from both sides.

![Suspended Joint Diagram](image)

**C. Bridging joint**

In this type, a bridging plate is placed between the rail and the joint sleepers. The joint is similar to the suspended joint in all other aspects.

![Bridging Joint Diagram](image)

1.5.4 **Semi-supported/suspended joint**

In this type, the joint sleepers are brought closer to each other, but the rail ends remain suspended between the bearings.
This type of joint has been adopted as a standard in the Indian Railways. On BG wooden joint sleepers, the suspended length of rail with and without bearing plates is 45 mm and 25 mm respectively.

Which type of joint gives better maintenance remains a debatable issue. While supported joints can stand more maintenance neglect, they slow down the output of tamping machines, and cause greater incidence of rail end batter. Suspended joints provide greater elasticity to the track and cause less disturbance to the wave motion of the track, but they require more maintenance. Perhaps the semi-supported joints adopted in the Indian Railways provide a good workable via-media.

1.5.5 Avoidance of joints:

In order to obtain better running surfaces, rail joints are avoided in (a) a level crossing, (b) within 3 m of the approach of a bridge abutment, and (c) on bridge spans of 6 m and below. Rail joints on ash pits are provided without any expansion gaps.

1.5.6 Combination fish-plates

When rails of different sections have to be joined together, special fish-plates are used. These are known as combination, junction or compound fish-plates.

The Indian Railway Standard (IRS) combination fish-plates have been designed with an adequate thickening up of the section in the middle portion, where the change in rail section taken place. Another feature of these designs is the elimination of the expansion gap, i.e. the rail ends are made to butt, which help in making the joint considerably stronger than would be the case with ordinary joints.

A uniform system of marking the right or left hand and the inner or outer fish-plates has been adopted. This is illustrated in the key plan.
The IRS design of combination fish-plates comprises two main groups of section:

**Group I**: Where the rails to be joined have the same head width. The combination fish-plates in this group have identical IL or OL and IR fish-plates. These are: 90 R-90 BS, 75 R-75 BS, 60R-60 BS, 52 kg.-90R, 52 kg.-90 BS.

**Group II**: Where the rails to be joined have different head width. All the plates i.e. IL, OL and IR in this group, are different. These are 90 R-75R, 90 R-75 BS, 75R-60 R, 75R-60 BS, 60 R-50 R.

### 1.5.7 Combination welded Rail Joints

Combination welded rail joints provide a good substitute to combination fish-plates. For a combination weld, it is desirable to have rail pieces of 4 metre length each, of the two rail sections. Thermit welding process is usually employed for making the combination weld. The mould and the portion used for the thermit weld are specially designed. Special moulds ensure the continuity of gauge face and evenness at the rail table. The 8 metre long combination rail so formed can be thermit welded to normal rails at either end.

It is preferable to have a longer combination rail of standard rail length, half rail length pieces welded together, particularly, when the rail ends are to be fish-plated. The longer length helps in minimising the effect of rail end disturbances on the rail stress, at the combination weld, which are usually high on account of the change of modules.

When the rail sections to be joined are not much different, combination welds can also be made using the flash butt welding process. These welds possess better strength and durability as compared to thermit welds.
1.5.8 **Joggled fish-plates**

Joggled fish-plates are usually made out of old/released standard fish-plates by providing a suitable bulge in the central part of the plates. This helps in avoiding interference with the weld collars of thermit welds. Elongated holes are provided in the fish plates to take care of varying degrees of gaps that may exist at the weld fractures. A full complement of four clamps are provided to have a firm grip at the rail ends.

1. New thermit weld, till they are ultrasonically tested; additional support of wooden blocks is given at the welded joint. If weld is categorised as ‘good’, the joggled fish-plates and wooden blocks are removed. In case of the weld is declared defective and placed in D1 or D2 category, the joggled fish-plates are left permanently in the track to ensure safety in train operation in the event of sudden fracture of the weld.

2. Old welds, when declared defective and placed in D1 or D2 category after ultrasonic testing.

3. Weld fractures, where joggled fish-plates are used to hold the rail ends together and pass the traffic at restricted speed, till proper repair work is carried out.

1.5.9 **Mitred Rail Joints**

These are used as rail expansion joints at bridges.

To avoid the thermal stresses of the bridge girders coming over the rails and vice-versa, rails on bridges are generally laid with rail free fastenings. The rails are also welded into span lengths. Mitred rail joints are provided on such bridges at the abutments and piers, to accommodate wider expansion gaps of rails. Two types of mitred joints have been designed.

1. With the rail end mitred.
2. With the rail ends mitred, but with a central rail piece in between.
Type (1) is used for short span bridges upto 30.5 and type (2) on long spans above 30.5 and upto 76.2 m. In both the types, the outer fish-plate is of special section, the top face of which is level with the rail table, so as to support the wheel tread over the expansion gaps. This gap is 26 mm in type (1) and 33 mm between the rail end and the central piece making a total of 66 mm in type (2). Alternate types have been prepared to suit canted or un-canted rails.

1.5.10 Insulated Rail Joints

Modern signalling system depends heavily on track circuits. In track circuits a portion of the track is electrically insulated from the adjoining track. This is done with the help of insulated rail joints. Various types of insulating joints in use in Indian Railways are described here.

A. Conventional insulated joint

For such insulated rail joints, standard fish-plates have to be planted on the fishing planes to accommodate channel type insulation between the rail and the fish-plates. Other insulating features are an end post between the rail ends and bushes around the fish-bolts. Nylon/fibre glass is used as an insulating material.

One important design feature of these insulation joints is that there is no allowance for expansion/contraction of rail.
B. Insulated joints with rubber coated fish-plates

In these joints, special type fish-plates fully coated with rubber are used. Trials with these joints are going on in the Indian Railways. Depending upon local factors, these joints have a service life of 1 to 1 ½ years in track, as compared to 6 to 9 months of the conventional insulated joints.

Both the conventional insulated joint and the rubber coated insulated joints require considerable care in respect to their track maintenance during service. Joint packing and creep has to be specially looked after. These joints should not butt against on SWR, but have at least one rail length on either side, which should be box anchored.

C. Glued insulated joints

Glued insulated joints essentially consist of special web fitting fish-plates, glued to the rails by high strength adhesive. High tensile steel bolts are used to ensure that rail and fish-plates behave as one monolithic mass under high frequency vibrations. Although glue itself gives sufficient insulation, separate fibreglass insulating liners are used to give additional safety margin. Suitably designed fibreglass end post is used between the rail ends. Fishbolts are provided with fibreglass insulating sleeves. After the glue is fully set, no relation movement between the rail and other components is possible and thus for all practical purposes, the joint behaves like a welded joint. The life of such a joint is equal to that of the rail.

Two types of glued joints meant for different locations are in use:

a) G3(L) for use with LWR/CWR track

One metre long fish-plates with 6 HTS bolts are used on this joint. It has a pull-out strength of more than 160 tonnes and can safely carry high thermal forces of LWR/CWR through the joint.
b) G3(S)

This is similar to G3(L) but has a smaller fish-plate with only 4 HTS bolts. It has a pull-out strength of about 100 tonnes and is best suited for fish-plated and SWR track.

Great care is required to be exercised in the preparation of glued joints. Detailed guidelines issued for the selection of rails, sand blasting, chemical cleaning and proper assembling of joint should be scrupulously followed, otherwise the joint may give trouble in service.

1.5.11 Maintainability of Rail Joints

For this purpose, rail joints have been classified into:

1. Fish-plated joints
2. Welded joints
3. Glued joints

The following guidelines have been issued for achieving better maintainability of these joints on BG tracks.

1. Fish-plated joints will have wooden and concrete sleepers. The spacing of joint sleepers will be 300 mm for wooden and 340 mm for concrete sleepers. Wooden sleepers will be provided with rail free fastenings usually of canted bearing plates with a full complement of four rail screws. Concrete sleepers at joints can have pandrol clips fixed in the reverse direction to avoid their interference with the fish-plates till a design of a special clip suitable for use with these sleepers is finalised.

2. Welded joints will have normal sleeper spacing, i.e. the same as at mid rail.

3. Defective welds, both of D1 and D2 category, will be provided with joggled fish-plates.

4. Glued joints will have normal sleeper spacing, but the joint should be symmetrical to the adjoining sleepers.

1.5.12 Switch Expansion Joint:

Switch Expansion Joint is an expansion joint installed at each end of LWR/CWR to permit expansion/contraction of the adjoining breathing lengths due to temperature variations.

Movements at SEJ i.e. of tongue & stock rail are observed periodically as laid down in LWR manual to access the behaviour of LWR/CWR on either side for planning the rectification/attention accordingly.

To ensure that the SEJ fulfills its functional and structural requirements without damage with smooth riding quality during service, it is essential to maintain the SEJ to desired standard.
• SEJ shall be checked daily by keyman, observing that the gap is not exceeding the maximum permissible & that the stock rail & tongue rails are not butting against each other.
• Keyman will also observe the conditions of fittings & will arrange to tighten them wherever required.
• Once in a fortnight, oiling and greasing of tongue & stock rails of SEJ shall be carried out by keyman along with tightening of fastenings.
• Once in a fortnight the alignment, unevenness & the packing of SEJ shall be checked. Alignment & unevenness shall be preferably checked by measuring the same on 14.4/7.2 meter chord at 3.6 meter station spacing, and to be attended as required.
• Gap at SEJ shall be measured as prescribed in para above. Whenever the gap at SEJ exceeds the max. permissible or tongue & stock rails butts against each other the SEJ shall be adjusted along with de-stressing of LWR/CWR.
• SEJ shall be adjusted to initial gap whenever the observed gap at SEJ indicates the abnormal behavior of LWR/CWR. Adjustment should always be carried out alongwith de-stressing of LWR/CWR.
• In service it shall be ensured that the rubber pad under the special chairs are in good and serviceable condition.
• It shall be ensure that the SEJ bolts are properly fixed i.e. the TEE head of the bolt is perpendicular to the track.
During machine tamping, the SEJ sleepers laid with special chairs should be tamped by machine itself. However, if not tampered by the machine then they should be manually packed immediately after tamping.

1.5.13 Precautions to be taken while working in track circuited area

1. The permanent way inspector should instruct the staff not to place across or touching two rails in the track, any tool or metal object, which may causes short-circuiting.

2. All gauges, levels, trolleys and lorries used on the track-circuited length should be insulated.

3. Steel or C.I. pipes used for carrying water/gas under the track should be run sufficiently below the rails to prevent any short-circuiting.

4. While carrying out track maintenance, care should be taken to see that no damage of track circuit fittings like rail bonding wires, lead wires to rails, bolt legs, jumper wires etc., takes place.

5. Use of steel tapes should be avoided in track circuited section.

6. Pulling back of rails should be done in track circuited areas in the presence of S&T staff, where signalling connections are involved.

7. Proper drainage should be ensured so as to avoid flooding of track, during rains, particularly in yards, where watering of coaches is done and in water columns and ash pits. It would be desirable to provided washable concrete aprons on platform lines at originating stations, in track circuited areas.

8. Ballast must be kept clean throughout the track-circuited section and care should be taken to see that the ballast is kept clear of the rails and rail fastenings. The clearance from the foot of the rail should not be less than 50 mm. during every packing this point should be taken note of.

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2.0  - TRACK PROTECTION RULES INCLUDING WORKING OF MATERIAL TROLLEY/LORRY

CE/022

Duration : 1 Day

2.1 Different types of Engineering Works

Various types of Engineering works, which are normally executed and the method by which track is protected for the same are given below in a tabulated statement.

**Categories of engineering works**

<table>
<thead>
<tr>
<th>Category &amp; type of work</th>
<th>Details of Works</th>
<th>Speed restriction and Engg. indicator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 1 : Works of routine maintenance.</td>
<td>Through packing, over hauling of track, picking up of slacks etc.</td>
<td>No restriction to speed is necessary; No hand signals are required as no danger to traffic exists.</td>
</tr>
<tr>
<td>Category 2 : Works of short duration, which is completed by the sunset.</td>
<td>Casual renewal of rails and sleepers adjustment of creep, lubrication of rail joints etc.</td>
<td>No restriction to speed is necessary; hand signals and banner flags and fog signals are used at specified distance to afford protection to trains.</td>
</tr>
<tr>
<td>Category 3: Works of long duration, which is carried for a few days or weeks as per programme.</td>
<td>Relaying, deep screening, bridge construction temporary diversion etc.</td>
<td>Speed restriction is necessary; Temporary engineering fixed signals is used at specified distances to give protection to trains.</td>
</tr>
</tbody>
</table>

2.2 Works of Short duration :

These are the Engineering works, which involve the safety of trains and are required to be completed by the sunset. Before commencing any work of this type, the J/E/P.Way should issue a notice to the Station Master in-charge at each end of the block section and obtain their acknowledgement. No Engineering work involving the danger to trains should be commenced unless the site has been protected by hand signals, banner flags and detonators. Depending as to whether the train is to be passed through the work site after stopping or at a restricted speed, the line should be protected in the following manner :
Case I: When a train is required to pass at a restricted speed in block section
(work to be completed before sunset)
The position of flagmen with hand flags and banner flag will be as follows:

![Diagram showing flagmen positions for single line train](image1)

(i) **Two flagmen with hand signals**: A flagman exhibiting caution hand signals at a distance of 30 metres from the place of obstruction. Another flagman exhibiting caution hand signals at a distance of 1200 metres for B.G. and 800 metres for M.G. from the place of obstruction.

(ii) **One Gangman with banner flag and intermediate hand signals**: An intermediate Gangman with hand signals at a distance of 600 metres for B.G. and 400 metres for M.G. from the place of obstruction. He will also place a banner flag across the track. The intermediate banner flag must be kept across the line until the speed of the train has been reduced, after which the banner flag shall be removed and the train hand signalled forward.

Case II: When the train is required to stop at site of work in block section
(work to be completed before sunset)
The position of hand flags, banner flags and detonators will be as follows:

![Diagram showing flagmen positions for double line train](image2)

Figure: Protection of track for works of short duration for double line
(Trains to stop – Case II)
(i) **One flagman with hand signals:** A flagman with hand signals at a distance of 30 metres in rear of the place of obstruction, to show stop hand signals.

(ii) **One flagman with banner flag & hand signals:** A flagman with hand signals and a banner flag across the track at a distance of 600 metres on Broad Gauge and 400 metres on Metre Gauge and Narrow Gauge in rear of the work. The flagman will show stop hand signals.

(iii) **One flagman with hand signals and 3 detonators:** A flagman with hand signals and detonators at a distance at 1200 metres in the case of Broad Gauge and 800 metres in the case of metre and narrow Gauge in rear of the work. The flagman shall fix three detonators on the line 10 metres apart and take/stand at a place not less than 45 metres from the three detonators, from where he can obtain a clear view of the approaching train. He will show stop hand signals.

The following points should be kept in view while protecting the track in the above two cases:

(i) On single line, the line must be protected on both sides of the work.

(ii) At places where there are curves or falling gradients and at times of poor visibility, the distances laid down above may be suitably increased wherever necessary and intermediate flagman posted to relay hand signals.

(iii) The location of the banner flag, detonators and hand signals should be so selected as to avoid stopping of trains as far as possible on continuous steep rising gradients.

(iv) If in an emergency, it becomes necessary to carry out such works in night, red light must be exhibited in the direction of approaching trains in place of red hand flags.

(v) In M.G. sections, with trains running at maximum speed of more than 75 Kmph. The distances specified for M.G. will be suitably increased.

(vi) The following special precautions should be taken when the work is to be carried out in station limits:

   a) The relevant signals are placed in ‘ON’ position.

   b) The line on which work is to be done should normally be isolated from running lines and the key held in the personal possession of the PWI. Wherever isolation is effected by the setting of points, these should be locked by means of clamps or bolts & cotters.

(vii) In case of works in automatic territory, if the distance from the place of works/obstruction to the automatic signal controlling entry of a train into the signalling section is less than 1200 metres on BG and 800 metres on MG/NG and the automatic signal is secured at ‘ON’, the banner flag and three detonators may be provided at 90 and 180 metres respectively.

2.3 **Works of long duration:**

These are the planned track works like deep screening track renewal works, rebuilding of bridges etc. and the speed restriction is to last for more than a day.
Preliminary arrangements:

1. A draft circular (green) notice showing the details of restrictions and the block to be granted is issued by the operating department in consultation with the Engineering branch for execution of the above work in advance.

2. Sanction of Commissioner of Railway Safety is obtained wherever required for execution of the work.

3. After getting confirmation of the sanction of block, on specified day, the line is blocked by the PWI in consultation with the section controller.

4. Caution orders are issued by the Station Masters concerned, as necessary.

5. The necessary temporary Engineering fixed signals as prescribed are provided.

6. In an emergency when it is necessary on consideration of safety, the Permanent Way Inspector, or Authorised railway servant may commence such work before issuing the notice under the protection of hand signals and banner flags. As soon as possible, he should issue the notice and replace the hand signals and banner flags by temporary Engineering fixed signals.

Case III : Protection of line for works of long duration – Train to stop dead.

In case where stop dead restrictions is to be imposed and the restriction is likely to last for more than a day, the following temporary Engineering indicators should be exhibited.

![Figure: Protection of track for works of long duration. (Trains to stop- Case III)](image)

i) Stop Indicator : 30 metres from the place of obstruction.

ii) Caution indicator : 1200 metres on B.G. and 800 metres on MG and NG from the stop indicator.

iii) Termination indicator : A place where the driver may resume normal speed, which is the length of the longest passenger/goods train.
If the distance between the place of obstruction and the automatic signal in rear of the site of obstruction is less than 1200 metres and provided that the automatic signal has been secured in ‘On position’, the banner flag and 3 detonators may be provided at 90 and 180 metres respectively and provision of caution indicator may be dispensed with in such territories.

Case IV – Protection of line for works of long duration:
(train to pass at a restricted speed)

In the case where the train is not required to stop (Train to pass at a restricted speed) and restriction is to last for more than a day, the following temporary Engineering indicators should be exhibited.

i) Speed Indicator : 30 metres from the place of obstruction.

ii) Caution indicator : 800 metres from the place of obstruction.

iii) Termination indicator : A place where the driver may resume normal speed, which is the length of the longest passenger/goods train.

Note: Two Termination Indicator i.e. one for passenger trains (T/P) and other for goods trains (T/G) should be provided on all trunk and main line routes.

Figure: Protection if track for works of long duration.
(Trains to pass at a restricted speed – Case IV)

Protection of track for Engineering works at times of poor visibility.

In thick foggy or tempestuous weather impairing visibility, no rail shall be displaced and no other works which is likely to cause obstruction to the passage of trains shall be performed except in case of an emergency.

When such work has to be undertaken and the site is protected by temporary engineering fixed signals, 2 detonators on the line 10 metres apart should be fixed not
less than 270 metres in rear of the caution indicator and a caution hand signal exhibited to approaching trains.

**Case V & VI – : Multi Speed restriction: (Train to pass at a restricted speed)**

Existence of two or more then two speed restrictions in continuation, when work of deep screening or sleeper renewal is in progress, there is situation of having two or more then two speed restrictions in continuation. In such situation of having two or more then two speed restrictions in continuation. In such situation, placement of speed board for following speed restriction shall be as under:-

(i) In case of following speed restriction being more restriction, a minimum of 200m track should be under earlier speed restriction zone. If not, then only one SR board should be provided considering that the previous speed restrictions is at par with the following SR, which is more restrictions.

(ii) In case of following speed restriction being less restrictive, corresponding speed indicator board for following speed restrictive shall be placed at a distance equal to the length of the longest goods train operating on the section after termination point of previous speed restriction Zone.

**Note :** Minimum length of speed restriction zone of S1 kmph should be 200 m otherwise speed indicator board S2 shall be provided at the place of S1.
2.4 **Conveyance of Trollies/Motor Trollies/Lorries by Trains:**

1. No trolley, motor trolley/lorry should be loaded in a train without the consent of the Guard in-charge of the train, who will direct where it is to be placed.

2. In the case of an accident/emergency, trollies/motor trollies may be carried by Mail/Express trains on which there are restrictions normally for loading of trolley motor trolley.

3. When loading a motor trolley with petrol in the tank, the following rule extracted from para 1106 of the I.R.C.A. Coaching Tariff No.21, Part I/1972 as applicable to carriage, motor-cars, boats etc. should be adhered to.
   
   “.......a quantity of petrol not exceeding 9.00 litres may be left in the tank provided that.

4. The flow of petrol in the carburettor has been cut off;

5. Any pressure has been released from the tanks;

6. The tank is in sound condition and closed by a well fitting cap;

7. The engine has been run by the official-in-charge until the carburettor has become exhausted and the engine stops automatically.
2.5 Trollies, Motor Trollies and Lorries not in use:

1. A trolley, motor trolley or lorry, when not in use shall be placed clear of the line, and wheels thereof secured with a chain and padlock.

2. When a trolley/motor trolley is placed on a platform to be loaded into a train, it should be under the charge of a trolleyman and placed where it will not be in the way of passengers or working staff.

3. Whenever possible, motor trollies, should be placed in a shed, the key of which, shall be in the possession of the official-in-charge.

2.6 Equipment for Trolley/Motor Trolley/Lorry

Each Trolley/Motor Trolley/Lorry shall have the following equipment

(a) Two hand signal lamps

(b) Two red and one green hand signal flags.

(c) Detonators 10 nos.

(d) A chain and a padlock.

(e) A copy of the working time table and all correction slips and appendices, if any, in force on at section of the railway over which the trolley, lorry and motor trolley is to run;

(f) A motor horn and a search light (for motor trolley only);

(g) Two banner flags and additional detonators (for lorry only); and

(h) Such other articles as may be prescribed by Railway Administration in this behalf.

(i) Portable field telephone.

Note: The official – in – charge of the Trolley/Motor Trolley/Lorry shall also be in possession of a watch in addition to the prescribed equipment.

2.7 Signals for Trolley/Motor Trolley/Lorry:

1. Day Signal: Every Trolley/Motor Trolley or Lorry when on the line shall show a red flag by day, fixed to a staff which will be placed on a socket and conspicuously visible in both directions.

2. Night Signal: On a double line the night signal shall be red light in the direction from which trains are expected and white in the other direction and on a single line, red in both directions. Where on double line, single line working is introduced, the night signal should be as per a single line. When working within the station limits, the light displayed at night shall be red in both directions.
3. **Signals within long tunnels**: On sections where there are long and dark tunnels, the night signals prescribed must be displayed during the day in addition to the red flag, in the case of Trolley/Motor Trolley and Lorries. In the case of thick foggy or tempestuous weather impairing visibility, light signals must be displayed in addition to the red flag.

4. **Removal of Trolley/Motor Trolley/Lorry**: As soon as a Trolley/Motor Trolley/Lorry is removed from the track and placed clear of it, the red flag or light signal shall be removed, but care should be taken to see that this signal is not taken off before the lines have been cleared of all the obstructions.

2.8 **Working of Trolleys**:

1. **Manning of trolleys**: Trolleys in all cases shall be manned by four men.

2. **Mode of working of trolley**: Trolleys in all cases should be pushed and not pulled.

3. **Working under Block protection** –

   (a) Trolley may be worked under block protection wherever it is possible to do so without interference to train service.

   (b) Trolleys should be worked under block protection in the night.

   (c) During day time in foggy weather and during dust storm, when the visibility is poor, a trolley should be worked under block protection.

   (d) Sections with restricted visibility due to curves, cuttings or due to other local conditions specified by Railway administration, wherever practicable, should be traversed under block protection.

   (e) When working under block protection trolleys will be worked in the same manner as trains.

4. **Working without block protection** –

   (a) During the day time in sections with normal visibility the official – in – charge shall before leaving a station/block post, ascertain the whereabouts of the trains likely to be met and set off on trolley.

   (b) In sections with restricted visibility [specified sections, ref. – para 1118 (3) (d) of IRPWM] when the official – in – charge is not able to block the section and work under block protection, he will follow the following procedure –

   (i) The Station/ Master/Signalman will on receipt of advice from official – in – charge in triplicate giving his trolley programme ascertain and fill in particulars of trains running on the section, retain one copy of return the order two to the official – in – charge of the trolley.
(II) As a reminder that the block section is occupied by the trolley and caution orders must be issued, a small placard with words “Trolley on line”, will be hung in front of the block instrument, until advice of the removal of the trolley is received.

(III) If telegraph and telephone communications are interrupted and the station master/signal man is unable to communicate with the station at the other end of the block section, the official – in – charge of the trolley will be advised of this fact and endorsed accordingly. When communication ensure that they are kept at least 100 m apart to safeguard the trolley in rear from colliding with the front one, in case the front trolley has to be stopped suddenly for any reason.

5. Protection In Block Section –

(a) When a trolley is worked other than under the rules for working of trains i.e., without block protection and when a clear view is not obtainable for an adequate distance of 1200 M. on Broad Gauge and 800 M. on Meter Gauge / Narrow Gauge, following precautions should be taken:

(i) On a double line, he must depute a Flagman with detonators to precede or follow the trolley, and to exhibit a hand danger signal at a distance of not less than 1200 M. on Broad Gauge and 800 M. on Meter Gauge / Narrow Gauge in the direction from which trains may approach.

(ii) On single line, depute a Flagman with detonators to precede and another to follow the trolley and to exhibit hand danger signals at a distance of not less than 1200 M. on Broad Gauge and 800 M. on Meter Gauge and Narrow Gauge.

(iii) Where necessary, intermediate Flag man should be posted to relay signals.

(b) The distance at which the signals are to be exhibited may be suitably increased in the case of Meter Gauge High speed routes where the speeds are more than 75 km.p.h, under special instructions by the Railway Administration.

(c) The flag man should only be withdrawn when a clear view of at least 1200 M. on Broad Gauge and 800 M. on Meter Gauge and Narrow Gauge can be obtained in the direction from which trains may approach.

(d) When a train is sighted, the Flagman should have the red flag vigorously to warn the official-in-charge of the trolley of the approach of the train, and at the same time place three detonators 10 M. apart on the line to protect the trolley. The detonators should be removed only on the receipts of hand signals from the official-in-charge by waving of a green flag to withdraw the danger signal indicating that the trolley has been removed. When conditions are such that the Flagman can not be seen by the official-in-charge of trolley, the latter must arrange before entering the section to take with him sufficient men with hand signals who will be placed in suitable positions between the trolley and the Flag man so that the signals from the Flag man can be repeated to the person-in-charge of the trolley and vice versa.
(e) On sighting an approaching train or the Flag man's signal, the trolley must be removed clear of the line and kept in such a manner that it can not roll towards the line.

6. Trollies travelling together - When two or more trollies are running together in the same direction in the same line, care should be taken to ensure that they are kept at least 100 M. apart to safeguard the trolley in rear from colliding with the front one, in the case the front trolley has to be stopped suddenly for any reason.

2.9 Working of Motor Trollies:

1. A motor trolley may be worked under block protection or without block protection, as may be prescribed by the Railway Administration.

2. Working under block protection –

(a) A motor trolley should be run only under block protection:

- During night
- During day time, when the visibility is poor due to fog or dust storm.

(b) Sections of restricted visibility should invariably be traversed under block protection. A list of “sections of restricted visibility” may be specified for the guidance of all concerned, either in the subsidiary rules or in the working time table.

(c) When a motor trolley that is worked under block protection breaks down in the block section, the official – in – charge should remove it clear of the line and send a written advice to the nearest station master/block hut – in - charge returning the line clear ticket or token or in the case of a motor trolley when the token or in the case of motor
trolley when the token has been clamped for a preceding train the key of the padlock. He should not replace the motor trolley on the line without the written permission of either station master/ block hut – in – charge at the end of block section concerned. On arrival at the other end, the official – in - charge will deliver the authority to the Station Master after the trolley has arrived complete.

(d) Following a Train/Motor Trolley – Motor trolley may follow a fully vacuum brake train or another motor trolley in the same block section during day light hours and in clear weather under special instructions issued by the Railway Administration.

(e) Working without block protection – when a motor trolley is worked without block protection, it should be manned by atleast four men.

(f) In case a motor trolley is worked without block protection, the procedure for trolleys shall be followed for working of the motor trolleys.

(g) When a motor trolley is worked without block protection, as per special instructions, the procedure should be followed for the protection of trolley in block section.

2.10 Working of Lorries:

1. Mode of working of lorry – Lorries in all cases should be pushed and never pulled. Riding of persons on the same is prohibited.

2. Manning of Lorries – When running under block, a lorry must be accompanied on foot by not less than four men in addition to the number of men required for expeditiously loading and unloading materials being conveyed on the lorry.

When running without block protection a lorry should be accompanied on foot by an adequate number of men required to remove the lorry and its contents readily off the line in addition to Flagman should invariably be entrusted to trained men experienced in the working of lorries and who have passed the vision test.

2.11 Working under block protection:

(a) Whenever it is possible to block the line without interference to trains, the lorry shall be worked under block protection, after blocking the line.

(b) A lorry shall be worked only under block protection when –

   ■ It is necessary during an emergency to run it at night.

   ■ The visibility is restricted due to sharp curves/cuttings etc., as on certain specified sections.

   ■ It is loaded with rails, girders or specially heavy materials which will cause delay in unloading.

(c) Actual working of lorry :
Before obtaining line clear, the official – in charge of a lorry should advised the Station Master / Block Hut in – Charge, whether it is his intention to return to that station, to run to the other end of block section, or to remove the lorry in mid-section.

The official – in – charge, after getting the authority to proceed in the form of line clear ticket/token, double line certificate or shunting key, as the case may be, would work his lorry.

He should, after completion of his work hand over the authority to proceed to the concerned Station Master/ Block Hut- in – charge and remove his lorry.

In case the lorry is off loaded in the mid section, the authority to proceed should be returned by a special messenger to the nearest station after ensuring that the lorry is kept clear off the line.

On the double line the official – in – charge should run the lorry on the proper road. The lorry should be taken along the line in the direction in which the trains will run; except when returning to the original starting station/ Block hut.

2.12 Working without block protection –

(a) A lorry shall ordinarily be run only by day and when the weather is sufficiently clear for a signal to be distinctly seen from an adequate distance, which shall never be less than 1200 metres on Broad Gauge and 800 metres on Metre Gauge and Narrow Gauge. Distance may be specified by administration in Metre Gauge high speed routes where the maximum speed is more than 75 km.p.h. In such cases the lorry can be worked without block protection when it is not possible to block the line without interference to train service.

(b) Procedure for working : When a lorry is to enter a block section without line clear, memo should be prepared by the official-in-charge in triplicate and necessary particulars filled in by the Station Master/Signalman who will retain one copy and return the other two to the official – in – charge.

(c) Until the “lorry removed from section” signal has been despatched and received, both Station Master/Signalman shall issue caution orders to the Drivers of all trains entering the section on which the lorry is working. All trains booked to run through and extra special and other out of schedule trains should be stopped at the station in order that this advice may be given.

(d) Lorries should be removed clear of the main line or if within station limits, of the line on which a train is to run at least 15 minutes before the train is due.

(e) On completion of work, the lorry removal report memo (Form IRPWM annexure 11/3) should be completed and handed over to the Station Master/Signalman concerned and his acknowledgement obtained.
Protection of lorry in Block Section – When the line has not been blocked and lorry whether loaded or empty is placed on the line without block protection the lorry shall be protected as detailed below.

- On double line, by one or two men as required at a distance of 600 metres on the Broad Gauge and 400 metres on the Metre Gauge and the Narrow Gauge, carrying a Banner flag across the track and another man plainly showing a stop hand signal at a distance of not less than 1200 metres on the Broad Gauge and 800 metres on the Metre Gauge and the Narrow Gauge from the lorry in the direction from which trains may approach, or

- On single line, by one or two men as required, following and preceding the lorry at a distance of 600 metres on the Broad Gauge and 400 metres on the Metre Gauge and Narrow Gauge carrying a banner flag across the track and another man plainly showing stop hand signal at a distance of not less than 1200 metres on Broad Gauge and 800 metres on Metre gauge and Narrow gauge from the lorry on either side.

- Each man so following or preceding the lorry at a distance of 1200 metres on Broad Gauge and 800 metres on Metre Gauge and Narrow gauge shall be provided with detonators and placed three on the line 10 metres apart, immediately the lorry comes to a stand for the purpose of either loading or unloading and continue to display the stop hand signal.

- The man or men carrying the banner flag shall immediately fix the banner flag across the track immediately the lorry comes to a halt or a train is seen approaching, and continue to display the stop hand signal.

- In all cases, where the flagman in advance or in rear can not be kept in view from the lorry, additional intermediate signalman as required should be posted to relay the signals.

- The stop signals and detonators shall not be removed until the flagman, receives the orders to withdraw them from the official – in – charge of lorry.
Note: In M.G. section high speed routes where the maximum speed is more than 75 kmph the distances should be specified by the administration.

Working in Station limits: When a lorry is required to work within station limits, the permission of the Station Master shall be obtained in writing before working the lorry and the lorry should be worked as per the approved special instructions.

Protection in Station limits: When a lorry works in a station yard the flagman must exhibit danger signals at such a distance on both sides as will ensure safety. When the lorry is required to remain stationary for more than 15 minutes, it must be protected by banner flags placed at an adequate distance supplemented by three detonators on both sides.

When a lorry has to work on a section with a steep down gradient (gradients steeper than 1/100), the same should not only be controlled by hand brakes, but by a rope tied in the rear and held in tension by men following a lorry.

2.13 Rail Dolleys

(1) Rail dolley is a device with two or more wheels which in balanced condition can be moved manually on one rail of track and can carry one rail/sleeper in suspended condition. When necessary, the suspended material can be dropped and rail dolley cleared off the track.

(2) Manning of Rail Dolley: Every rail dolley shall be manned by not less than two able bodied persons. The person in-charge for the working of rail dolleys shall be a railway servant not lower in rank than a keyman. The official in-charge should have passed in medical category A-3 and must hold a valid certificate of competency for working rail dolleys. Certificate of competency shall be issued by a PWI of the section who must satisfy himself that the person to whom competency certificate is being issued is fully aware of the rules for the working of rail dolleys and is also well acquainted with the concerned section.

(3) Working of rail dolleys

♦ The railway servant in-charge of rail dolleys must inspect the section in advance particularly in reference to heaping of ballast, girder bridges and any other special features which make it difficult to drop the material and remove the rail dolley in the event of an approaching train. He shall get the ballast heaps cleared and work the dolley(s) only when the visibility is clear for at least 1200 metre on Broad gauge and 800 metre on MG/NG and the rails/sleepers can be dropped off safely without affecting the safety of trains and workers both.

♦ Rail dolley shall not be worked on sections having gradients steeper than 1 in 200.

♦ Not more than 6 rail dolleys should be worked in a group in any one block section.

♦ Normally, not longer than 3 rail welded panels should be carried by rail dolleys. The rail dolleys must not be worked after sunset and before sunrise and in bad weather.
when the visibility is poor. Rail dolleys should not be worked in deep cuttings, steep grades, sharp curves and heavily built up areas where the visibility is not clear for 1200 meters on BG and 800 metre on MG/NG. In such locations, the rail dolleys should be worked under block protection.

♦ In case, a rail dolley is to carry rails longer than 3 rail panel or it is required to move over crossovers in yard crossing more than one line in deep cuttings and curves then it should work under block protection.

- No traffic block or caution order is normally necessary for working of rail dolleys except as indicated in above.
- Every rail dolley/group of rail dolley when on line shall exhibit a red flag.
- On single line, depute a Flagman with detonators to exhibit hand danger signal at a distance of not less than 1200 metre on BG and 800 metre on MG/NG each end and on double line section in the direction of approaching train.
- Where necessary intermediate Flagman should be posted to relay signals.
- When a train is sighted, the Flagman should wave the red flag vigorously to warn the official-in-charge of the dolley of the train and at the same time place three detonators 10 M apart on the line to protect the rail dolley(s). The detonators should be removed only on receipt of hand signals from the official-in-charge by waving of a green signal to withdraw the danger signals from indicating that rail dolleys have been removed.
- The official in-charge of the rail dolley shall keep a look out for approaching trains and will get the rail dolley(s) and materials cleared off the track as soon as an approaching train is sighted.
- While approaching level crossings, the official in-charge shall look out for road vehicles and ensure safe passage of rail dolleys.
- The official in-charge shall be fully responsible for the safe working of rail dolleys.

2.14 Engineering Indicators: These consists of -

1. Caution indicator.
2. Speed indicator
3. Stop indicator
4. Termination indicators (T/P & T/G)
5. Whistle indicator for level crossings.
6. Whistle indicator.
2.15 Procedure for blocking line for Engineering purposes—

(1) Arrangements for block.-

♦ Except in very urgent cases arrangements for Blocking the lines between stations shall be made by the Divisional Engineer in consultation with the Divisional Operating Superintendent, sometime before the block is imposed.

♦ The Divisional Operating Superintendent will issue instructions to the Station Masters on either side of the section to be blocked and Station Masters /Yard Masters of train ordering stations concerned about the last train to pass over the section before the block is imposed, the trains to be cancelled because of the block and any other particulars and will conclude by stating which official of the Engineering Department will impose and remove the block. The instructions will be acknowledged by those to whom issued.

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♦ In an emergency when there is no time to refer to Divisional Operating Superintendent or where block will not interfere appreciably with the traffic the Station Master (after consulting control on controlled section) will arrange directly with the Engineering Official requiring the block.

(2) **Imposition of Engineering Block :-**

♦ The Inspector or authorised railway servant who blocks the line should transmit a message to the Station Master on either side of the block section to be blocked, copy to the Divisional Engineer, Assistant Engineer, Loco Foreman, Controller on controlled sections and Divisional Operating Superintendent, advising them of the time from which the block is to be imposed and the kilometrage and asking for acknowledgement from the concerned Station Masters.

♦ The Station Master receiving the message for transmission will sign for it, noting the time of receipt and shall transmit the message to the Station Master on the other side of the block section, which is to be blocked, and to the Controller. The Station Master on the other side will acknowledge receipt by a message addressed to Permanent Way Inspector or authorised railway servant and the Station Master of the transmitting station.

♦ On receipt of this message the Station Master of the station from which the message was transmitted will block the line in the manner prescribed and hand over a signed copy to the Inspector.

♦ Field telephone should be used for liaison with the Control during the block.

(3) **Removal of Engineering Block:**

♦ When removing a block the Inspector or authorised railway servant responsible will transmit a message to the Station Master on either side of the block section blocked, copy to the Divisional Engineer, Assistant Engineer, Loco Foreman, Controller, Divisional Operating Superintendent etc., advising them that the block has been removed and asking for acknowledgement from Station Masters. Particulars of kilometrage, restriction of speed and position of Engineering Indicators should be given in the telegram.

♦ The Station Master who receives the message for transmission will sign for it, noting the time of receipt and transmit the message to the Station Master of the other station. The message must be acknowledged by the latter, addressed to the Inspector and Station Master of the transmitting station.

♦ On receipt of this acknowledgement the Station Master who originally imposed the block, will remove it in the manner prescribed.

♦ The Control or the Divisional Operating Superintendent, will advise the Station Masters on the train ordering stations when a block is finally removed.

**1.16 Issue of Caution Orders to Drivers** - Caution order to Drivers of all trains will be issued by the Station Masters for temporary engineering restrictions. Caution order will indicate the exact kilometrage, speed restrictions, stops, as the case may be, but will not include permanent restrictions that are notified in the working time-table.
2.17 Hand signals

A. Exhibition of hand signals:

(a) All hand signals shall be exhibited by day by showing a flag or hand and by night by showing a light as prescribed in these rules.

(b) During day a flag or flags shall normally be used as hand signals. Hands shall be used in emergencies only when flags are not available.

(c) During night a hand signal shall normally be given by showing a red or green light. A white light waved violently shall be used as a stop signal only when the red light is not available.

Stop hand signal:

<table>
<thead>
<tr>
<th>Indication</th>
<th>Stop dead</th>
</tr>
</thead>
</table>

How given by day: By showing a red flag or by raising both arms with hands above the head as illustrated below:

How given by night: By showing a red light or by violently waving a white light or horizontally across the body of the person showing the signal as illustrated below:
Proceed hand signal:

Indication Proceed

**How given by day**: By holding a green flag or by raising one arm steadily as illustrated below:

**How given by night**: By holding a green steadily as illustrated below:

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Proceed with caution hand signal:

Indication: Proceed slowly reducing speed further if the signal is given at a progressively slower rate.

How given by day: By waving a green flag vertically up and down or by waving one arm in a similar manner as illustrated below:
**How given by night**: By waving a green light vertically up and down as illustrated below:

![Diagram of hand signal]

**Note**: When the speed is to be reduced further, this signal shall be given at a slower and slower rate and when a stop is desired, the stop hand signal shall be shown.

**Hand signals for shunting**: The following hand signals shall be used in shunting in addition to the stop hand signal:

| Indication       | Move away from the person signalling. |

**How given by day**: By a green flag or one arm moved slowly up and down as illustrated below:

![Diagram of hand signal]
How given by night: By a green light moved slowly up and down as illustrated below:

Indication: Move towards the person signalling.

How given by day: By a green flag or one arm moved from side to siding across the body as illustrated below:

How given by night: By a green light moved from side to side across the body as illustrated below:
Note: The hand signals for “Move away from the person signalling” and “Move towards the person signalling” shall be displayed slower and slower, until the stop hand signal is given if it is desired to stop.

| Indication | Moving slowly for coupling |

**How given by day:** By a Green and a flag held above the head or both hands raised over the head and moved towards and away from each other as illustrated below:

![Illustration of hand signals](image1)

**How given by night:** By a green light held above the head and moved by twisting the wrist as illustrated below:

![Illustration of hand signals](image2)
Banner flags: A banner flag is a temporary fixed danger signal, consisting of a red cloth supported at each end on a post and stretched across the line to which it refers.

B. Knowledge and possession of hand signals:

(1) Every railway servant connected with the movement of trains, shunting operations maintenance of installations and works of any nature affecting safety of trains shall have.

   (a) A correct knowledge of hand signals; and

   (b) The requisite hand signals with him while on duty and keep them in good working order and ready for immediate use.

(2) Every railway servant shall see that the staff under him concerned with use of hand signals are adequately supplied with all necessary equipment for hand signalling and have a correct knowledge of their use.

(3) A red flag and a green flag by day or lamp, which is capable of showing red, green and white lights by night, shall constitute the requisite equipment for hand signalling.

2.17.1 Detonating Signals

Detonating signals, otherwise known as detonators or fog signals, are appliances which are fixed on the rails and when an engine, a vehicle passes over them, they explode with a loud report so as to attract the attention of the Driver.

(A) Method of using detonators:

   (1) A detonator when required to be used shall be placed on the rail with the level or brand facing upwards and shall be fixed to the rail by bending the clasps around the head of the rail.

   (2) In the case of a mixed gauge, detonators shall be placed on the common rail or on one rail of each gauge.

(B) Placing of detonators in case of obstruction:

   (1) Whenever in consequences of an obstruction of a line, it is necessary for a railway servant to stop approaching trains, he shall proceed, plainly showing his stop hand signal, to a point 400 metres from the obstruction and place on the line one detonator and then proceed to a point 800 metres from the obstruction and place on the line three detonators, about 10 metres apart, at such place:

   Provided that on the broad gauge be first detonator shall be placed at 600 metres and three detonators at 1200 metres from the obstruction about 10 metres part from each other.
(2) If the said railway servant is recalled before the obstruction is removed, he shall leave down three detonators and, on his way back, pickup the intermediate detonator.

- The railway servants deputed to place detonators in accordance with G.R. 3.62 (1) shall, after placing the detonators take his stand at a place from where he can obtain a good view of an approaching train and display a stop hand signal until he is recalled.

- Placing of detonators on single and double lines – On single lines, the lines shall be protected vide. G.R. 3.62 (1) on each side of the obstruction. On double line, both tracks will be similarly protected whenever necessary stop approaching trains.

- Replacement of detonators on the line : Every railway servant placing detonators on the line shall see that they are when necessary, replaced immediately after a train has passed over them.

- On single line sections for trains leaving a station, the fog signalman deputed to place detonator shall show to the Driver Proceed (Green) hand signal in accordance.

(C) Use of detonators

For use of detonators shall be placed on the centre of the head of the rail with the label or brand of the detonator upwards, and shall be securely fastened to the rail by bending the clasps, attached with the detonators, round the upper flange of the rail.

2.17.2 Flare signals

(A) Description of flare signals : A flare signal, which includes a fusee, emits a bright red flame when lighted and is used for warming the Driver of an approaching train of any obstruction.

(B) Use of flare signals : When it becomes necessary to protect on obstruction in a block section, a flare signal may be used as prescribed by special instructions while the railway servant proceeds to place detonators.

(C) Mode of lighting fuses : A quick and intelligent survey must be made to select a site in the vicinity of the obstruction for fixing the fuse so that the signal flame could be clearly seen by the Driver of the approaching train from the maximum distance possible. The fuse can be very conveniently lighted even in heavy rain, provided the striker is not made damp before it is rubbed against match composition. If possible the fuse should be lit under a cover i.e. an umbrella but once having lit, it could be exposed head down to the rain.

Directions for lighting the fuse are indicated on the printed label pasted on each fuse, as under :
(a) Expose friction composition and scratch surface of cap by pulling up tape.

(b) Hold fuse near base and rub/scratch surface of strike card against the head of fuse.

(c) If flame is not immediately visible pause before striking again.

(d) Always point fuse away from face and body while igniting and burning.

(e) After igniting hold for 5 seconds but not more than 10 seconds before dropping of fixing in position.

***
3.0 - MAINTENANCE OF TRACK

CE/023
Duration : 3 Days

3.1 Through Packing : Conventional Maintenance by beater packing :

**General** : Through packing shall consist of the following operations in sequence. The length of track opened out on any one day shall not be more than that can be efficiently tackled before the end of the day.

(a) Opening of the road.
(b) Examination of rails, sleepers and fastenings.
(c) Squaring of sleepers.
(d) Slewing of track to correct alignment.
(e) Gauging.
(f) Packing of sleepers.
(g) Re-packing of joint sleepers.
(h) Boxing of ballast section and tidying.

Through packing is best done continuously from one end of a gang length towards the other. Each of the above operations should be carried out as detailed below :

(a) **Opening of Road** : Ballast should be opened out on either side of the rail seats to the extent shown hereunder to a depth of 50 mm. below the packing surface without disturbing the cores under the sleepers.

- Broad Gauge : End of sleepers to 450 mm inside of the rail seat.
- Metre Gauge : End of sleepers to 350 mm, inside of the rail seat.
- Narrow Gauge : (762 mm) : End of sleepers to 250 mm. inside of the rail seat.

In case of cast iron plate or pot sleepers, the opening out should be to the extent of the plates or pots to enable packing being done conveniently.

The ballast should be drawn by powrahs/ shovel out wards and inwards i.e. that portion of the ballast on the outside of the rail should be drawn outwards, the portions between the rails being drawn towards the centre, care however, should be taken to see that the ridge between the rails does not project more than 50 mm above rail level.

(b) **Examination of Rails, Sleepers and Fastenings** :

- Rails should be examined, the underside for corrosion, the ends for cracks, the head for top and side wear, rail joint for wear on the fishing planes, fish bolts for tightness. If rails on curves wear at an unusually rapid rate, lubrication of the gauge face should be done. Rust and dust must be removed from the corroded rails by using wire brushes; kinks in rails should be removed by Jim crowing.
Sleeper should be inspected for their condition and soundness particularly at the rail seats. In case of wooden sleepers, plate screws, spikes and fang-bolts should be examined for their firm grip. Sleeper should be checked for split and decay.

In case of cast iron sleepers, the condition and firmness of cotters and keys should be examined. Loose keys should be tightened by providing liners or replaced by appropriate oversized keys. In the case of wear in the rail seat of CST-9 plates, suitable pad/saddle plates may be provided. Fastenings and fittings should be examined to ensure that they are in good order, appropriately tightened so that they firmly hold the rails. Broken ones should be replaced immediately.

(c) **Squaring of sleepers**: Gauge variations and kinks inevitably result from sleepers getting out of square.

(I) The spacing of sleepers on the sighting rail should first be checked and correctly chalk marked. Corresponding marks should then be made on the other rail using the square at every point. The core of sleepers that are out of square should then be ‘picked’ with the pick ends of beaters, the fastenings loosened and the sleepers levered and squared to correct position.

(II) Squaring should be done by planting the crowbars firmly against the sleeper and pushing it. Under no circumstances should sleepers be hammered. Sleepers that are squared should be re-gauged immediately, the fastening tightened and repacked.

(d) **Slewing of track to correct alignment**:

- Heavy slewing will only be required during realignment of curves when it will be necessary to loosen the rail, joints and in case of steel sleepers and cast iron sleepers to loosen the fastenings, the packing cores being broken with the pick-ends of beaters. Slewing for normal maintenance will be of a small order and should be done after opening out the road, loosening the cores at ends and drawing out sufficient ballast at the ends of the sleepers.

- Slewing of track shall be directed by the Mate who on straight should sight the rail from a distance of 30 to 60 metres. On curves, he should sight the outer rail. Slewing is best done in the morning unless it is cloudy, as later on, sighting conditions become unfavourable.

When slewing, the crowbars should be planted well into the ballast at an angle not more than 30 degrees from the vertical; otherwise lifting of the track may result.

(e) **Gauging**: Preservation of gauge is an important part of track maintenance especially through points and crossing. 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.

- 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.
The track gauge should be adjusted to correct gauge on the rail opposite to the base rail. The required slackness on sharp curves should be attained by using liners of the requisite thickness against the lug of the gauge in the case of ordinary track iron gauge.

While it is desirable to maintain correct gauge, where due to age and condition of the sleepers, it is not possible to maintain correct gauge, 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  
(b) On curves with radius 350 m or more  
(c) On curves with radius less than 350 m  

-6 mm to +6 mm  
-6 mm to +15 mm  
upto +20 mm  

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

**Metre Gauge :**

(a) On straight  
(b) On curves with radius  
(ii) 290 m or more  
(ii) Less than 290 m  

-3 mm to +15 mm  
upto +20 mm  

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

**Narrow Gauge :**

(a) On straight  
(b) On curves with radius 175 m  
(c) On curves with radius less than 175 m  

-3 mm to +6 mm  
-3 mm to +15 mm  
upto +20 mm  

**Note :** These tolerances are with respect to nominal gauge to 762 mm

(f) **Packing of sleepers :**

i) The aim of packing is to have each sleeper firmly and uniformly packed to ensure that the rails are at their correct relative levels i.e. level on the straight track and to the required cant on curves and that no sleeper has any void between it and its bed.

ii) Before packing is commenced, it is necessary to ensure that the chairs/bearing plates are firmly fixed to the sleepers and the rails are bearing on the chairs/bearing plates. In case of rails resting directly on sleepers it should be ensured that there is no gap between the bottom of the rail and top the sleeper.

iii) The base rail shall be sighted by the Mate with eye along the lower edge of the head of rail and any dip or low joint lifted correctly. The adjacent sleepers should then be
packed and the top checked. After two rail lengths have been attended to, the rail on the other side should be brought to the correct level by checking cross level with the straight edge and spirit level or gauge-cum level at every rail joint and at every fourth sleeper. The next two rail lengths should then be taken up and the process continued.

iv) No joint or dip should be lifted higher than the proper level in the expectation that it will settle to the correct level. Instead it will settle more under traffic as a result of being high and cause rough running.

v) Having aligned the track and adjusted the ‘top’ the Gangmen should distributed in batches of two for packing all sleepers in a systematic manner, commencing from one end. Four men should deal with every sleeper successively, two at each rail seat. The ballast under the sleeper should be packed by the men standing back-to-back and working their beaters diagonally under the rail seat at the same time to ensure firm packing.

vi) It is important that men should thoroughly ‘break’ the cores with the pick-ends and then use the blunt-ends (head-ones) as otherwise, uniform packing will not be achieved and elasticity of the road bed affected. After packing the rail seat the packing should be continued outwards and inwards to the requisite extent on each side of the rail seat i.e. end of the sleeper to 450 mm, inside on the BG and end of sleeper to 350 mm inside on the MG and end of sleepers to 250 mm inside on the NG (762mm). The beaters should not be lifted above the chest level, the strokes being kept as nearly horizontal as possible. Care must be taken to avoid forcing under the sleeper any stones so large as to cause uneven bearing and to avoid striking the edges of the sleepers and timbers. All men should aim to work the beater from the same height (chest level) so that the sleepers are uniformly packed. Higher or lower lifting of the beater results in uneven compactness.

vii) In case of steel trough and wooden sleepers, packing under the rail seat causes the ballast to work towards the center. Before final dressing is done, it should be ensured that no sleeper is centre-bound by working the pick-ends over the central range. Centre bound sleepers cause vehicles to roll from side to side.

viii) In the case of CST- 9 sleepers it should be ensured that the end pockets or bowls are filled with ballast and the main packing should be done at corners. The central flat portion of the plate should not be packed hard but only tamped lightly. On pot sleepers the ballast should punned through the holes provided at the top of the pot and rammed in with crow-bars.

ix) Care must also be taken while packing to ensure that the work does not result in the sleepers adjoining those being packed, lifted off their bed, thus creating artificial voids under them.

x) The packing on the inside and outside at every rail seat should, before boxing the track, be checked by the Mate by tapping with a wooden mallet or a canne-a boule. A hollow sound would indicate defective packing which should be attended to again.
xi) As soon as the packing is completed, slight distortions in alignment and top should be checked and corrected by the Mate, the sleeper disturbed for this purpose being finally repacked.

(g) **Re-packing of joints sleepers**: The joint and ‘shoulder’ sleepers should be repacked, before boxing is done and the cross-levels at joints checked. The rail joint being the weakest portion, firmness of its support is essential.

(h) **Boxing to Ballast section and Tidying**: After completing the preceding operations in sequence, clean ballast should be worked in with ballast forks or rakes. The ballast section should be dressed to the specified dimensions, a template being used for the purpose. Hemp cords 6 mm dia. of sufficient length should be used for lining the top and bottom edges of the ballast section. Where the quantity of ballast is inadequate, full section of ballast should be provided near the rail seat, the deficiency being reflected along the centre of the track and not under the rails or in the shoulders.

The cess should then be tidied up. Where earth ridging is existing at the edge of the bank, this should be removed. Cess should maintained to the correct depth below rail level according to the ballast section and formation profile. Too high a cess affects drainage; too low a cess results in ballast spread and wastage.

**3.2 Pre-tamping and Post tamping attention of track for machine packing:**

**3.2.1 Pre-tamping attention**: To achieve good results the PWI should carry out the following preparatory work before taking up the tamping:

(a) Ballasting where there is shortage of ballast.

(b) Heaping up of ballast in the tamping zone, to ensure effective packing.

(c) Making up of low cess.

(d) Cleaning of pumping joints and providing additional clean ballast, where necessary.

(e) Attending to Hogged joints before tamping.

(f) Tightening of all fittings and fastening like fish bolts and keys, splitting of cotters and replacement of worn out fittings.

(g) Renewing broken and damaged sleepers.

(h) Squaring of sleepers and spacing adjustment; re-gauging to be done as necessary.

(i) Adjusting creep and expansion gap in rails.

(j) Examination of rails for cracks etc.

(k) Re-alignment of curves which are badly out of alignment.

(l) Clearing of ballast on sleepers to make them visible to the operator.
(m) All obstructions such as signal rods, cables, pipes, level crossing check rails etc., likely to be damaged by the tampers should be clearly marked and make known to the tamping operator before he starts work. Tight overhead clearance should also be brought to his notice; the beginning and end of transitions should be marked. Super elevation should marked on every second sleeper so that it can guide the operator for levelling up correctly.

3.2.2 Post-tamping attention: The permanent Way Inspector shall pay attention to the following points:

(a) As some of the rigid fastenings might get loose, tightening of fittings should be done immediately after tamping.

(b) Any broken fitting should be replaced.

(c) It is preferable to check gauge and do gauging, wherever necessary, after tamping.

(d) Proper quality check of work done by tamping machine is important. Immediately after the tamping work, the track should be checked, in respect of cross levels and alignment, and action taken as considered necessary.

(e) The ballast should be dressed neatly and proper consolidation of ballast between the sleepers should be done.

3.2.3 Systematic Overhauling:

(1) Sequence of operations: Overhauling as described briefly in Para 203 (2) of IRPWM should consist of the following operations in sequence:

(a) Shallow screening and making up of ballast.

(b) All items attended to, while doing through packing as detailed in Para 224 (1) of IRPWM.

(c) Making up the cess.

(2) Shallow screening and making up of Ballast.

(a) For good drainage periodical screening of ballast is essential.

(b) In the case of manual maintenance, the crib ballast between sleepers is opened out to a depth of 50 to 75 mm below the bottom of sleepers, sloping from the centre towards sleeper end. For machine maintained section, the crib ballast in the shoulders should be opened out to a depth of 75 to 100 mm below the bottom sleepers, sloping from the centre towards sleeper end. The ballast in the shoulders opposite to the crib as well as the sleepers is removed to the full depth. A slope is given at the bottom sloping away from the sleeper end. The ballast is then screened and put back. Care should be taken to see that the packing under the sleepers is not disturbed and the muck removed is not allowed to raise the cess above the correct level.
(c) Two continuous spaces between sleepers should not be worked at the same time.

(d) Screening should be progressed in alternate panels of one rail length. In no circumstances should several rail lengths of track be stripped of ballast.

(e) Where drains across the track exist, they should be cleaned and filled with boulders or ballast to prevent packing from working out and forming slacks.

(f) After screening, full ballast section should be provided, extra ballast being run out previously for the purpose. Work should be commenced after making sure that the ballast will not be seriously deficient. Deficiency, if any, should be shown in the central portion of sleeper and this also should be made up soon.

(g) Through packing of track: The detailed operations are described in Para 224 of IRPWM. Through packing may be done either by conventional beater packing or measured shovel packing or by using machines.

(h) Making up of cess: Cess when high should be cut alongwith overhauling and when low should be made up. A template should be used for this purpose.

(i) General: Overhauling should be completed before the end of March. In the case of L.W.R. territory, the provisions in L.W.R. Manual should be followed.

(j) Screening in Welded Area: In the case of S.W.R. area screening may be carried out at rail temperatures and conditions.

3.3 Directed Track Maintenance:

One of the two systems of maintenance mentioned in Para 203 (1) of IRPWM, is the Directed Track Maintenance. The directed Track maintenance conforms to the basic Engineering Philosophy to conserve inputs in a selective manner only at stretches where attention is necessary. The features of the Directed Track maintenance are as follows:

(a) Systematic recording of track geometry from one end of the maintenance unit to the other including inspection of track to record defects which can be noticed visually.

(b) Analysis of these records and identification of stretches which need attention during periodic maintenance and spots needing immediate attention.

(c) Rectification of defects and checking quality of work done.

3.3.1 Picking up Slacks: Slacks usually occur on stretches of yielding formation on high banks and cutting, on approaches of bridges, on badly aligned curves, where ballast is poor in quality or quantity or where drainage is defective. Attention to slacks should be need based, need for the same being determined by inspection and results of track recording. Picking up slacks shall be done where the alignment is kinky or top level is uneven and the track has to be restored to normal condition quickly. The quantum of
work turned out by a gang during the day will depend on the extent of slacks. In all cases sighting is done, the defects assessed and mark made on sleepers to be dealt with in chalk. The marked sleepers should then be dealt with as in through packing care being taken to see that the packing of adjacent sleepers does not get disturbed. In case a large percentage of sleepers need attention in a rail length, the entire rail length should be attended to.

**To marking of defects shall be as indicated below:**

<table>
<thead>
<tr>
<th>Defects</th>
<th>Symbol</th>
<th>Place of indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross levels</td>
<td>C-2</td>
<td>On the sleeper inside gauge face.</td>
</tr>
<tr>
<td>Loose packing</td>
<td>H or P</td>
<td>On the sleeper outside the gauge face.</td>
</tr>
<tr>
<td>Gauge</td>
<td>O ±</td>
<td>On the sleeper inside gauge face.</td>
</tr>
<tr>
<td>Unevenness</td>
<td>→ ←</td>
<td>On the rail web on gauge face side.</td>
</tr>
<tr>
<td>Alignment</td>
<td>↓ →</td>
<td>On the foot of rail inside the gauge face.</td>
</tr>
</tbody>
</table>

It is imperative that when joints are picked up, at least sleepers on either side of the joints are packed. Picking up slacks may be done, by conventional method or by measured shovel packing or by off-track tampers. In the case of a low joint, the fish plates should be slightly loosened and the joint tapped, so that the rail ends are, rendered free and are capable of being lifted. After the joint is thoroughly packed the fish- plates should be tightened again.

### 3.3 Annual Programme of Track Maintenance:

The annual programme of regular track maintenance and works incidental thereto shall be based on the programme given below, with such variations to suit local conditions, as may be specified by Chief Engineer. This applies to any system of maintenance.

<table>
<thead>
<tr>
<th>Period</th>
<th>Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Post monsoon attention:</td>
<td>(a) Attention to run down lengths in the entire gang beat to restore the section to good shape</td>
</tr>
<tr>
<td>For about six months after</td>
<td>(b) One cycle of conventional systematic through packing/systematic directed track maintenance from, one end of the gang length to the others including overhauling of nominated sections.</td>
</tr>
<tr>
<td>end of monsoon</td>
<td>(c) Normally 4 to 5 days per week should be allotted for works under item (b) and the remaining days for picking up of slacks, attention to bridge approaches, level crossings and points and crossings over the entire beat. Works such as lubrication of rail joints, joint gap adjustments as required and realignment of curves should be done during this period.</td>
</tr>
</tbody>
</table>
2. Pre monsoon attention for about 2 months prior to break of monsoon. Normally 2 to 4 days in a week should be devoted to clearing of sides and catch water drains, earthwork repair to cess, clearing water ways and picking up slacks. In the rest of the days normal systematic maintenance will be carried out.

3. Attention during monsoon for about four months. Attention to track as required. This will consist primarily of picking up slacks and attention to side and catch water drains and water ways. During abnormally heavy rains, patrolling of the line by gangs should be carried out in addition to regular monsoon patrolling.

Note: Scattered or casual renewals, creep adjustments and earth work repairs should be done as necessary.

3.4 3-Tier system of track maintenance. —

3-tier System of track maintenance shall be adopted on sections nominated for mechanized maintenance. This shall consist of the following 3 tiers of track maintenance:

- On-track machines (OMU)
- Mobile Maintenance Units (MMU)
- Sectional Gangs

3.4.1 On-track machines (OMU)

Large track machines for track maintenance include Tie tamping machines for plain track and points and crossings, shoulder ballast cleaning machines, ballast cleaning machines, ballast regulating machines and dynamic track stabilizers. These machines shall be used as per the various instructions issued in Indian Railways Track Machines Manual. These machines shall be deployed to carry out the following jobs:

- Systematic tamping of plain track as well as points and crossings.
- Intermediate tamping of plain track as well as points and crossings.
- Shoulder ballast cleaning.
- Ballast profiling/redistribution.
- Track stabilization.
- Periodical deep screening.

3.4.2 Mobile Maintenance Units:

The mobile maintenance units (MMU) shall consist of two groups:

- MMU-I: One for each PWI's section.
- MMU-II: One for each sub-division.

MMU-I: Rail cum-Road Vehicle based (one with each PWI incharge with a jurisdiction of 40 - 50 Kms. double line or 90-100 Kms. single line):

- Need based spot tamping.
- In-SITU. rail welding.
Casual Renewal and repairs except planned renewals.
Overhauling of Level Xings.
Replacement of glued joints.
Rail cutting/drilling and chamfering.
Permanent repairs to fractures.
Creep or gap adjustments involving use of machines.
Distressing of LWR/CWR.
Loading Unloading of materials.
Any other functions assigned.

MMU-II (Road Vehicle based) one with each sub division:

- Reconditioning of Turnouts.
- Minor repairs to the equipment of MMU.

**List of Equipment for MMU-I**

<table>
<thead>
<tr>
<th>A. Communication Equipment.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Walkie Talkie)</td>
<td>4 sets</td>
</tr>
<tr>
<td>2. Portable field telephones)</td>
<td>4 sets</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Rail Cutting /Drilling Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Disc Cutter</td>
<td>1</td>
</tr>
<tr>
<td>4. Rail Cutting Machine</td>
<td>1</td>
</tr>
<tr>
<td>5. Rail Drilling Machine</td>
<td>1</td>
</tr>
<tr>
<td>6. Chamfering Kit</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. Rail Welding Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Rail Welding Equipment</td>
<td>2 sets</td>
</tr>
<tr>
<td>8. Weld Trimmer</td>
<td>1 set</td>
</tr>
<tr>
<td>9. Rail Profile Grinder for Welded Joints</td>
<td>1 set</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>D. Spot Tamping with Lifting Lining</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Off Track Hand Held Tamper With Generators</td>
<td>1 set</td>
</tr>
<tr>
<td>11. Lifting Jack - hydraulic/Mechanical</td>
<td>4 sets</td>
</tr>
<tr>
<td>12. Lifting -cum-Slewing Device</td>
<td>2 sets</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>E. De-stressing Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Rail Tensors - Hydraulic/Mechanical</td>
<td>2 sets</td>
</tr>
<tr>
<td>14. Rollers, wooden mallets</td>
<td>1 complete set for Distressing 3 Kms. LWR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F. Inspection Gadgets</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>15. Inspection Kit</td>
<td>1 No</td>
</tr>
<tr>
<td>16. Gauge cum Level.</td>
<td>1 No.</td>
</tr>
<tr>
<td>17. Rail Thermometer</td>
<td>1 No.</td>
</tr>
<tr>
<td>18. Vernier Calipers</td>
<td>1 No.</td>
</tr>
<tr>
<td>19. Micrometer</td>
<td>1 No.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>G. Material Handling Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>20. Rail Dolly</td>
<td>6 No.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>H. Safety and Protection Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>22. Warning System</td>
<td></td>
</tr>
</tbody>
</table>
23. Red Banner Flag
24. Red Hand Signal Flag
25. Green and Signals
26. Detonators

I. Gas Cutting Equipment with Accessories 1 Set

List of Equipment for MMU-2

<table>
<thead>
<tr>
<th>A. Points and Crossing Recording Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Welding Generator</td>
<td>1 Set</td>
</tr>
<tr>
<td>2. Arc Welding Equipment</td>
<td>1 Set</td>
</tr>
<tr>
<td>3. Hand Held Rail Grinder</td>
<td>2 Sets</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. For Minor Repairs to Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Spanner of Sizes</td>
<td>2 sets</td>
</tr>
<tr>
<td>5. Trifer</td>
<td>2</td>
</tr>
<tr>
<td>6. Files of Sorts</td>
<td>2 sets</td>
</tr>
<tr>
<td>7. Bench Drill</td>
<td>2</td>
</tr>
<tr>
<td>8. Vice Bench</td>
<td>2</td>
</tr>
<tr>
<td>9. Bench Grinder</td>
<td>2</td>
</tr>
</tbody>
</table>

2.4.3 Sectional Gangs

The sectional gangs, under 3-tier system of track maintenance shall perform the following functions:

- Keyman's daily patrol
- Hot/cold weather patrolling
- Monsoon patrolling
- Watching vulnerable locations
- Attention of emergencies viz. temporary repairs of fractures.
- Need-based attention to bridges, turnouts, SEJs and approaches of level crossings.
- Greasing of ERCs, lubrication of joints, casual changing of rubber pads and other fittings.
- Minor cess repairs
- Cleaning of drains and boxing of ballast
- Attention to loops.
- Creep and gap adjustment not involving use of machines
- Cleaning of crib ballast for effective cross-drainage
- Pre & post tamping attention
- Assistance to MMU & OMU as required
- Any other functions assignee.

3.5 Maintenance of Rail Joints.

1) Special care is needed for maintenance of fish plated joint to get better rail life as well as improved running.
(2) The efficient maintenance of joints depends on:-

- Efficiency of fastenings
- The efficiency of packing and correct spacing of sleepers.
- The provision and maintenance of correct expansion gaps.
- The proper lubrication and fishing of the joints.
- The correct maintenance of gauge and cross-levels and proper packing.
- Efficient drainage.

(3) **Defects in rail joints** - Some of the major defects, noticed at the rail joints and preventive measures suggested to rectify or minimize the deficiencies /defects noticed are detailed below:

- **Slack sleepers.** - Maintenance of joints by measured shovel packing in case of flat-bottomed sleepers improves the condition of the joints. In the case of conventional maintenance by beater packing it should be ensured that the sleepers do not get tilted.
- **Loose Fish-Plates.** - Fish bolts must be kept tight, but not so tight as to prevent expansion or contraction of the rails, by using standard spanners.
- **Wear of FishPlate and Rails at fishing surfaces.** - When wear takes place on the fishing planes of rails and fish plates, the joints dips down. The wear is generally greatest at the centre of the top of the fishplates and least at the ends.

  Two types of devices are used for compensating the wear of the fishing planes-

- **Repressed Fish-Plates.** - The repressed fish-plates are those which are hot forged so as to form a bulge in the middle part of the fish plates conforming to the wear most prevalent.

- **Tapered shims.** - Tapered shims are pieces of steel, shaped to fit the usual pattern of wear between the top fishing surfaces. They are made in varying thicknesses, each size being designated by the wear in mm. between the fishing surfaces multiplied by 10. Thickness of shim is varied in steps of 0.5 mm. from 1.5 mm. to 3.8 mm. Length of the shims should be determined on the basis of actual wear pattern of different sections of rails. Shims are tapered in thickness from one to the other to conform to the wear.

- **Battering of Rail ends.** - Battering can be avoided by packing the joint sleepers firmly and by maintaining correct expansion gaps. Battering of rail ends can be repaired by in situ welding. It can also be improved by end cropping.

- **Hogged Rail Joints.** - De-hogging can be done by de-hogging machines. De-hogging of rail ends can be done by Measured Shovel packing. In this method the joint sleepers are normally packed to a specified height above the normal, taking into consideration the dip at the joint and voids below the sleepers, leaving the shoulder sleepers without packing. After allowing traffic for about two days, the shoulder sleepers are packed without lifting them. De-hogging is effected by traffic passing over the joints. Use of repressed fishplates helps in improving the hogged joints. Hogging can also be eliminated by cropping the rail ends.
- **Broken Fish-plates.-** Broken or cracked fishplates must be replaced with new or reconditioned fishplates.

- **Cracked or Broken Rail ends.-** The fish bolts and bond holes at rail ends weaken the rails. When maintenance is poor, rail end fractures occur, the fracture almost always starting as a fine crack from the fish bolt or bond holes. During lubrication of rail joints, opportunity should be taken to observe the rail end carefully for any fine cracks. If cracks are noticed rails should be replaced. Chamfering of bolt holes and bond holes should be done. Ultrasonic testing of rails helps in detecting the cracks, which are difficult to detect by visual examination.

- **Pumping of Joints.-** Immediately after the monsoon, the ballast at such joints should be removed. Sand blanketing should be provided on the top layer of the formation, which will prevent upward rise of clay slurry. On top of this blanket clean and adequate ballast should be put. Cross drains should be provided between first and second shoulder sleepers. Geo-textiles can also be advantageously used.

(4) **Other important points regarding joint maintenance.-**

- Gap survey should be undertaken periodically and gap adjusted.
- Use of wooden sleepers at fish-plated joints, on a metal sleepered road, is desirable.
- Ordinary fish plated track could be converted into three-rail panel, wherever all other conditions for S.W.R. are satisfied.

### 3.6 Chamfering of bolt holes in rails:

- Chamfering of bolt holes work hardens the periphery of holes and thereby delays the formation of star cracks. The chamfering of hole takes 5 minutes per hole. Each drilled hole shall be chamfered.
- Existing bolt holes in fracture prone zones should be chamfered if not elongated. In case of elongated holes, the chamfering bit will not be in contact with the full edge of the bolt holes and there will be uneven hardening of the metal resulting in stress concentration in weaker-zones. Therefore, such portion of rail should be removed, holes should be drilled and chamfered.
- Chamfering of bolt holes in the welded 0rail panels should be done before dispatch in the Flash Butt Welding Plants, if situation so warrants.
- When rails in track are end-cropped, new bolt holes should be chamfered at site.
- Bolt holes in new rails received directly from steel plant should be chamfered before rails are laid in track.

#### 3.6.1 Equipment for chamfering of bolt holes: Work hardening of bolt holes should be done with chamfering kit of approval make. The chamfering kit consists of the following equipment:

<table>
<thead>
<tr>
<th>Equipment Description</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) High tensik bolt M-20</td>
<td>1 No.</td>
</tr>
<tr>
<td>(ii) High tensile nut for M-20 bolt</td>
<td>1 No.</td>
</tr>
<tr>
<td>(iii) Sets of 2 H.S. S. chamfering bits</td>
<td>1 Set</td>
</tr>
<tr>
<td>(iv) 19 mm sq. drive sockets size 32 mm</td>
<td>8 Nos.</td>
</tr>
<tr>
<td>(v) Set of 2 packing pieces (Sleeves)</td>
<td>1 Set.</td>
</tr>
<tr>
<td>(vi) T-400 torque-wrench with built-in rachet mechanism 1.25 m length</td>
<td>1 No.</td>
</tr>
</tbody>
</table>
3.6.2 Procedure for chamfering of bolt holes:

- The nut of high tensile steel bolt is removed and one packing piece is inserted in the shank followed by one side of the H.S.S chamfering bit.
- The high tensile steel bolt is inserted with 2 pieces in the rail hole.
- On the other face of the rail hole, the second half of the HSS chamfering bit is inserted over the shank followed by the second packing piece.
- The nut on the high tensile steel bolt is replaced.
- Pre-set torque-wrench on nut at torque value of 52 kg-m equivalent to an exile force of 12.5 tonnes, is applied. The nut is tightened with the torque wrench. As soon as the pre-set torque is attained, the torque wrench will automatically trip indicating complete tightening to pre-set torque value.
- The nut by reversing the top wrench is unscrewed and HTS bolt is removed. The process is repeated on other rail holes.
- Chamfering of each hole should be done under the supervision of Mate/Keyman.
4.0 - DEEP SCREENING AND SHALLOW SCREENING INCLUDING DRAINAGE

Duration: ½ Day

4.1 Deep Screening

4.1.1 Detailed procedure: A day’s length will be deep screened as the procedure detailed below:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Procedure Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>The ballast should be removed from space ‘A’ and ‘B’ on either side of the sleeper ‘1’ down to final formation level and wooden blocks provided to support the rail for passing trains.</td>
</tr>
<tr>
<td>II</td>
<td>The ballast is removed from under sleeper ‘1’ down to final formation level/sub-ballast level.</td>
</tr>
<tr>
<td>III</td>
<td>The ballast should then be screened and placed back under sleeper ‘1’ which should then be packed.</td>
</tr>
<tr>
<td>IV</td>
<td>The wooden blocks from space ‘A’ should then be removed.</td>
</tr>
<tr>
<td>V</td>
<td>The ballast from space ‘C’ down to formation level should be removed and after screening be placed in space ‘A’ up to bottom of sleeper. The balance may be taken outside the track and screened. The rail in space ‘C’ should be supported with wooden blocks.</td>
</tr>
<tr>
<td>VI</td>
<td>The ballast should be removed from under sleeper ‘2’ down to formation level.</td>
</tr>
<tr>
<td>VII</td>
<td>Screened ballast should be provided under sleeper ‘2’ and sleeper well packed.</td>
</tr>
<tr>
<td>VIII</td>
<td>The ballast from space ‘D’ down to formation level should be removed and after screening be placed in space ‘B’ up to bottom of sleeper; the balance may be taken outside the track and screened. The wooden blocks should be removed from space ‘B’ and placed to support the rail in space ‘D’.</td>
</tr>
<tr>
<td>IX</td>
<td>The ballast from under sleeper ‘3’ should be removed and so on till the whole rail length is provided with screened ballast up to level of the bottom of sleepers.</td>
</tr>
<tr>
<td>Final Stage</td>
<td>The track should be lifted to provide additional cushion where required. The track should be packed in the final position and then boxed.</td>
</tr>
</tbody>
</table>

4.1.2 Sequence of the operations is shown in the sketches.

The following points should be kept in view while doing the work –

1. No un-screened length should be left between screened lengths of the track at the same time.

2. It should be ensured, that when ballast is being removed from any sleeper, invariably, there are at least four fully supported sleepers between it and the next sleeper worked upon.

3. Lifting should be limited to 50 mm at a time.
(4) It should be ensured that packing, cross levels and grade run off are satisfactory before closing the day’s work.

(5) The work should be done under a speed restriction of 20 kmph.

(6) The speed should be gradually raised as in para below which will vary depending on the type of maintenance in the section.

4.1.2 Schedule for working and speed restriction to be observed, in deep screening works:

- With manual packing: The details of the work to be carried out in stages on various days, after the starting of the screening operation and the speed restriction recommended to be imposed are shown in table 1. According to the above schedule normal sectional speed can be resorted on the 21st day.
### TABLE - PROPOSED SCHEDULES FOR DEEP SCREENING (MANUAL PACKING)

<table>
<thead>
<tr>
<th>Details of work</th>
<th>Day of work</th>
<th>Speed restrictions and their length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Broad Gauge</td>
</tr>
<tr>
<td>Deep screening and initial packing</td>
<td>1</td>
<td>20 km.p.h.</td>
</tr>
<tr>
<td>First through packing</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Second through packing</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>20 km.p.h.</td>
</tr>
<tr>
<td>Picking up slacks are required………</td>
<td>5</td>
<td>45 km.p.h.</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td></td>
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<tr>
<td></td>
<td>9</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Third through packing………</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>75 km.p.h.</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Fourth through packing …….</td>
<td>21 onwards</td>
<td>Normal sectional speed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Normal sectional speed</td>
</tr>
</tbody>
</table>

The period mentioned in the schedules shown above is the minimum and can be suitably increased to suit local condition of the track consolidation.

### 4.2 Requirement of Track Drainage Systems.

1. The surface and under ground waters should be well away from a track, the banks and cutting, over or through which they run.
2. The surface water from adjoining land should be prevented from entering the track formation.
3. The side drains should have sufficient capacity and longitudinal slope to carry away all the possible surface water going to be collected.
4. Flow of surface water across the track and along the slope should not cause erosion of the banks and slopes of embankment.
5. Sub-surface water should be efficiently drained off by the sub surface drainage system.
6. The highest level of the ground water table should be well below the level of the sub-grade.
7. Track alignment should be made on pervious, naturally drained and suitable soils. Coarse textured soils are more permeable, retain less capillary moisture and respond more readily to drainage system.
8. In water logged areas, special precaution should be taken specially if detrimental salts are present or if floods are common in the area.
Special measures should be taken in the following cases:

- Existence of an underground water pocket due to hollow basin over thick impervious layer.
- Existence of an underground water pocket over a thin impervious stratum. Which lies on fissured strata (i.e. good pervious soil).
- Presence of water bearing strata on sides of cuttings and banks i.e. seepage flow.
- In case of black-cotton soils or expansive soils.
- In case of track drainage problems where either (I) wets earth and gets into the ballast or (ii) ballast sinks into the wet earth.

The drains or pipes should be kept at closer spacing to keep the water table well below the formation to prevent capillary rise of water.

4.3 Drainage systems. The efficiency of a modern track carrying heavy and dynamic loads depends entirely on preservation and retention of its stability and elasticity by proper drainage.

The construction engineers should provide properly designed drainage system or alternatively, the bank and formation structures must be strengthened and made proof against weakening by damp and by the use of a better bank material. The method of drainage is adopted on the basis of economic considerations.

4.3.1 Surface drainage - Due to rain, dew and snowfalls, the moisture moves into the embankment under the action of gravity. This movement of water is resisted by the permeability of soils. So it is desirable that the good soils should be used for bank and formation. The best soil would be a well graded material of high internal friction having high cohesion without any characteristic of detrimental shrinkage i.e. when it dries without any expansive tendencies, when it gets damp with small capillary and of good elasticity and even with fairly large water content not of too much plasticity, when compacted, such an ideal material must remain stable both when wet and dry i.e. under all whether conditions. However, such soils are very rare in actual practice.

So the surface water is first collected in good side drains and cross drains which is further disposed of at the nearest stream or any water course which is connected to side drains. Cross drainage structure, like culverts and bridges may be necessary for disposing of the surface water. When warranted the use of perforated pipes, pipes with loose joints, boulder drains etc. can be made.

The only method to prevent the entry of water in to provide turfing on the side slopes of embankment or cutting and on the cess.

Surface water from the embankment can also be drained by use of sand piles.

4.3.2 Sub-surface Drainage - Changes in moisture content of sub grade or formation in embankment or cutting are caused mainly due to fluctuations in movement of capillary water, seepage water from adjacent area, ground water table and percolation of rain water. The object of sub-drainage is to keep these fluctuations of moisture as minimum as possible. The different sub-surface drainage systems used under different conditions in the following paragraphs.
Inverted filter blanket

Filter details
1. Graded gravel 20 mm to 2 mm, 2. Graded coarse sand 2 mm to 0.2 mm, 3. Graded fine sand 0.2 mm to 0.07 mm, 4. Graded silt 0.07 mm to 0.002 mm.

- Drainage of capillary water. The best method of preventing the capillary rise to provide pervious layer in the embankment. The rise can also be prevented by providing a blanket or inverted filter of pervious material below the ballast.

- Drainage of seepage water. In case of track in cuttings, the water weeps from adjacent area to sub grade.

A water bearing strata impounds its water because it has no escape in such cases, the construction engineer should determine the source which feeds this water bearing strata and should divert it at the surface of interception. This water is further collected and carried away to some point of out fall where it can have no further adverse effect on the track.

Seepage water due to bearing strata
The surface water entering the sub grade is prevented by providing catch water drains at the top of cutting and side drain. Further to check seepage through catch water drains, the drains should be paved. The water from catch water drains is finally disposed of in natural river or water coarse.

In case of formation in cutting, the side drains are also provided with perforated pipes underneath to lower the ground water table.

4.3.3 Blind drains for lowering ground water table (Treatment of bad formation)

Under ground drains also proposed below the sub-grade for lowering the ground water table. Blinds drains with inverted filter provide under ground drainage, which improves the stability of formation by lowering the water table.

However, the rise of capillary water can also be controlled by this method because for particular soils, there is limit up to which such capillary rise can take place.

4.4 Track drainage under special cases:

Special situations may arise in any one of the following cases:

- Existence of an under ground water pocket due to hollow basin over thick impervious layer.
- Existence of an under ground water over a thin impervious stratum which lies over a fissured strata (i.e. good pervious soil).
- Presence of water bearing strata on side long cuttings and banks that is seepage flow.
- In case of black cotton soils or expansive soils.
- The following remedial measures are suggested for special cases:
Case I - The water pocket has been formed because of the presence of ridges on all the sides and moisture cannot escape. Moreover, it is too deeply located to evaporate quickly. This type of soft soil with impounded water in a pocket seriously affected the stability of the track and embankment above.

A simple remedy to this problem is to provide a cut or pipe or channel for draining away the water pocket. This cut or pipe can be taken to the nearest outfall which further can not adversely affect the track and the embankment.

Case II - In such cases when the water pocket is held up by a thin impervious layer which lies a good pervious soil of fissured strata.

A simple remedy for this is, by drilling or puncturing through the thin impervious stratum and to provide an easy escape for impounded water. This will stabilise the whole sub grade.
Case III - In case of presence of water bearing strata on side long cutting and banks, when seepage flow take place.

A remedy to this is to take due precaution during construction. The source of water bearing strata should be located and water should be diverted to out fall and taken away to have no Adverse effect.

Case IV - The problem of drainage in case of black cotton soils is very acute as they swell with excess of water and shrink and crack when they have shortage of water.

A remedy to this is to improve the quality of sub-grade soil. Quick line can be mixed with soil to make the soil granular in structure which will improve the undesirable property of swelling and shrinkage. This mixed granular should be used in the top layer of sub grade and the banks should be laid to proper slope.

4.5 Cross drainage

Whenever streams or watercourses have to cross the track, facilities of cross drainage have to be provided. The water form the side drains is taken across by these cross drain in order to divert the water away from the track. Generally the cross drainage structures consists of pipe, culvert or bridges.

The choice of the type of a bridge will depend upon several factors like span, loads etc. However the cross drainage system can be designed and used depending upon the requirements and economic consideration.

4.6 Track drainage problems:

The bad drainage results in either of the following two problems:

- Wet earth clogs (or gets into) the ballast.
- Ballast sinks into the wet earth.
4.6.1 Wet earth clogs (or gets into) the ballast.

Due to bad drainage, it is observed that wet earth gets into the ballast which causes mud pumping around the sleeper and also causes the formation of ridges along the cess and in between the track. The rise of wet earth may also checked the existing drainage system on the track. This finally results in constant lifting of the track, which is evident from mud pumping. This mud pumping is clear indication of the entry of sub-grade soil into the ballast.

Only remedy to this defect is to improve the formation. The formation can be improved by two ways:

(a) By providing an interposing layer of sand between the ballast and the formation or an inverted filter between the ballast and formation.

(b) The formation is also improved by lowering the ground water table.

4.6.2 Ballast sinks into the wet earth.

This happens due to rupturing of bad formation under heavy loads and goes on increasing in size under repetition of loads. Finally these ruptures (cracks) become wide enough to give way to the ballast. Thus ballast goes on sinking into wet earth formation and results in formation of water pockets along with the lifting of the track. Due to loss of ballast and formation of water pockets, trouble gets aggravated and may result in the failure of formation if not properly curbed at the right time.

Problem – Ballast getting into the formation

Pervious cess to drain water pocket
Perforated pipe and trench drains to drain water pocket

Inverted filter blanket to prevent ballast penetration
The following remedial measures are recommended to prevent sinking of ballast into wet soil:

- Use of pervious cess
- Use of perforated pipes and trench drains
- Use of inverted filter blanket
- Cement grouting
- Combination of pervious cess and inverted filter
- Use of sand piles
- Use of counter fort drains
- Use of capillary break

***
5.0 - CREEP CAUSES AND PREVENTION

CE/025

Duration : ½ Day

5.1 Creep:

5.1.1 General:

Rails have a tendency to move gradually in the direction of the dominant traffic. It is believed to be caused by the ‘ironing out’ of yielding track by the moving load augmented by braking loads, and by the impact of the wheels on the running on ends of the rails, particularly at times when they are in a state of expansion or contraction. Among the troubles caused by ‘creep’ are:

1. Sleepers getting out of square.
2. Distortion of gauge.
3. Loosening of joints.
4. Shearing and breaking of spikes, bolts and fishplates.
5. Buckling, in extreme cases.

Causes:

The following are some of the avoidable causes to which creep is attributed.

1. Inadequate toe loads of the rail to sleeper fastening and rails not secured properly to sleeper.
2. Inadequate ballast resistance to the movement of sleepers due to poor or insufficient ballast or other causes.
3. Inefficient or badly maintained rail joints.
4. Rails too light for the traffic they carry.
5. Improper expansion gaps.
6. Decaying sleepers, uneven spacing of sleepers.
7. Lack of proper drainage.
8. Yielding formation resulting in uneven cross-levels.
9. Loose/uneven packing.
10. Rail seat wear in metal sleeper road.

Precautions:

1. For reducing creep, it must be ensured that the rails are held firmly to the sleepers and adequate ballast resistance is available. All spikes screws and keys should be driven home, the sleepers properly packed, and crib and shoulder ballast compacted. Rail anchors should be provided, wherever necessary.
2. With steel trough and cast iron plate sleepers and in the case of sleepers where elastic fastenings and other fastenings with adequate toe-load are used, no trouble is normally experienced. Careful watch should be kept for a series of jammed joints. Not more than six jammed joints continuously should be permitted in the case of single rail joints. In case of SWP not more two consecutive jammed joints should be permitted at rail temperatures lower than \( t_m \) in the case of Zone I and II, \( t_m -5 \) in the case of Zone III and IV. One girder bridge, adjustment may be necessitated at regular intervals. Anti-creep devices should be provided on the approaches of girder bridges for adequate length.

5.1.2 Creep indication posts:

Creep indication posts square to the track should be erected on either side of the track on the cess at intervals of about on km. These may be un-serviceable rail posts with chisel mark square to the joints. The top of the post should be about 25 mm. above the rail level and the amount of creep one way or the other measured with a fishing cord stretched over the chisel marks.

**Permissible amount of creep:** Creep in excess of 150 mm. shall not be permitted.

5.1.3 Adjustment of creep:

Adjustments of creep should be carried out in the following manner:

(a) Careful measurement of expansion gaps as existing, would be done and appropriate length which can be dealt with in one operation should be chosen. The total amount of gap in the length should be equal to the standard expansion gap required for the temperature at the time, multiplied by the number of joints in the length.

(b) Work should start at the running-on end of the length, commonly just beyond the points and crossings or level crossings. The work of creep adjustments should be carried out under the protection of Engineering signals by the permanent way inspector as envisaged in para 806 (2). Before pulling back is commenced the keys are knocked out and fish-plates removed or eased. Correct expansion liners should be used and the rails should be pulled back with bars. If the fish-plates are removed, the bars can pull against a Tommy bar thrust through a bolt hole. Next, the rail is keyed up, the bolts of joints correctly tightened up, and the expansion liner moved to the next joint, whereupon the process is repeated.

(c) It is a good practice to adjust creep before the commencement of summer. It is desirable to pull back the rails during the cool hours of the day.

(d) Mechanical and hydraulic devices are available for adjustment of creep. Such a device can be set with the wide joints behind it and the tight joints ahead of it. Expansion liners are put in all the wide joints, all keys, spikes and fish bolts are loosened.
The adjuster then closes up the rails behind it by pushing, leaving a gap of some centimetres between the rail ends opposite the machine. The corrected rails are then fastened up.

(c) The machine is next attached to the rail ahead of it, keys, spikes and fish bolts loosened for that rail and those beyond it. These rails are then pulled until only the normal expansion gap is left opposite the machine. The operation leaves some of the gaps wide and it is then necessary to fix the machines further ahead in order to close them up to normal by pulling against expansion liners.

(f) When the value of total gap required for the temperature at the time of adjustment multiplied by the number of joints, it is necessary to provide closure rails. When closure rails are put in, a speed restriction of 30 km.p.h. should be imposed, which should be removed, when closure rail is changed.

(g) During adjustment of creep, the sleeper spacing should be adjusted if necessary, special attention being given to the joint and shoulder sleeper spacing.

5.1.4 Provision of Anchors to arrest Creep:

To arrest excessive creep on wooden sleeper road, not provided with anti-creep fastenings, adequate numbers of anchors of approved design should be provided; no anchors being provided at the joint sleepers. Both rail seats of the sleepers should be anchored on the same side. In addition to sufficient directional anchors being provided if considered necessary.

5.1.5 Prevention of creep on metal sleeper road: Creep on cast iron plate sleepers should be counteracted as follows:

(a) On C.I. plate sleepers all keys should be driven in the direction of traffic on the double line and alternately in the opposite direction on single line.

(b) On steel trough road normally keys are driven as indicated in S.S.I. sheet 3 to 4 of Indian Rail Standard Track Manual. However, where heavy creep is experienced on double line, all the four keys may be driven in the direction of the creep (generally in the direction of traffic). On single line keys may be driven in the opposite direction on alternate sleepers.

***
6.0 - LIFTING AND LOWERING OF TRACK

CE/026

Duration : ½ Day

6.1 Lifting of Track :

1. Lifting of track will become necessary during re-grading and for elimination of minor sags, which develop through improper maintenance or yielding soil, to keep a good top.

2. Correct level pegs should be fixed at suitable intervals, before lifting is commenced.

3. Heavy lifting should always be carried out under suitable speed restriction and under the protection of corresponding engineering signals. Lifting should not exceed 75 mm. at a time so as to allow proper consolidation. The easement gradient for the passage of trains should not be steeper than 25 mm. in one rail length of 13 metres. The operation should be repeated until the required level is attained when the track should be finally ballasted, through packed and boxed, the cess being made up to proper level.

4. Lifting should commence from the down hill end carried out in the direction of rising grade in case of single line. It should proceed in the opposite direction to traffic, in case of double line, care being taken not the exceed the easement grade.

5. While lifting track under bridges and overhead structures and in tunnels it should be ensured that there is no infringement of standard dimensions.

6. In case of curves, it is usual to set the inner rail to the correct level and grade and to raise the outer rail to give the required super-elevation, care being taken to see that the cant gradient is within the permissible limit.

6.2 Lowering of Track :

1. Lowering of the track should not be resorted to except where it can not be avoided and if resorted to, it should be done under suitable speed restriction and under the protection of engineering signals.

2. When lowering is to be done, trenches should be made across the track at every 30 M to the final level in order to give continuous indication, while the work is in progress. The ballast should be removed sufficiently far away from the track to prevent is getting mixed up with excavated material.

3. The procedure is to clear the spaces between the sleepers, then slightly lift the track, break the packing beneath and level it into the space between sleepers. This material is then removed and the operation repeated until the final level is reached. The road
should then be ballasted, through packed and boxed, the cess being cut down to proper level.

4. Lowering as in the case of lifting, should be restricted to a maximum of 75 mm at a time and the grade for passage of trains should not exceed 25 mm in rail length of 13 M. As opposed to lifting, lowering should be carried out in the direction of the falling grade.

5. Work of lifting or lowering of track should be carried out in the presence of Permanent Way Inspector.

***
7.0 - POINT AND CROSSING, LEVEL CROSSING

CE/028

Duration : 1½ Day

7.1 Inspection and Maintenance of Points and Crossings :

(I) Maintenance :

General :

(a) Point and Crossings should be laid without 1 in 20 cant.

(b) Where large number of Points and Crossings are being maintained within a specific area such as marshalling yards, large lay-outs of sidings, terminal stations etc., regular cycle of maintenance covering all Points and Crossings should be organised.

(c) Cess should be low enough to permit efficient drainage and adequate depth of ballast cushion should be provided.

(d) Correct spacing of sleepers should be ensured according to the standard lay out drawings.

(e) There should be no junction fish plates at stock rail joints or at the heel of crossings. Atleast one rail on either side of the Points and Crossings should have the same section as the Points and Crossings assembly rail section.

(f) Use of spherical/taper washer at appropriate places in a Points and Crossings assembly is very important. A spherical/taper washer is used to obtain flush fit of the head of the nut of the bolt with the web of the rail, in the switch and crossing assembly. The use of spherical/taper washer is necessary where the shank of the bolt is not at right angles to the axis of the rail. Spherical/taper washers are used on skew side. In I.R.S. turnouts with straight switches, these should be provided on the left hand side invariably in the switch assembly.

(g) The gauge and cross level measurements shall be done at the nominated stations. The track geometry at the turnout should not be inferior to that applicable to the route. However, gauge just ahead of actual toe of switch shall be as follows :

(I) All BG turnouts of 1:12 BG 60 kg with 10125 mm O.R. curved switches (on wooden, steel or PSC sleepers), 1:12 BG52 Kg with 10125 mm O.R. curved switches on PSC sleepers and all thick web switches (52 kg/60 kg) on wooden/PSC sleepers i.e. all turnouts with switches having switch entry angle ≤ 0°20'00"= Nominal gauge 1676/1673.

(II) All other excluding those (I) above i.e. turnouts with switches having switch entry angle > 0°20'00"= Nominal gauge 1676/1673 + 6 mm.
(h) The clearance, at the toe, heel of switch, at check rail and wing rail must be maintained within the tolerances prescribed in the schedule of dimensions.

(i) Packing under the sleepers must not be loose/defective especially under at toe and nose of crossing and the switch.

(j) The chair and fastenings and all other fittings must be properly secured.

(k) The Points and Crossings assembly should be in good condition and alignment with the rest of the track without kinks.

(l) Adequate creep anchors should be provided to arrest creep. Box anchoring of at least one rail length ahead of stock rail is recommended. Creep posts should be erected at all interlocked facing points opposite the toe of the switch and creep should not allowed to exceed permissible limits.

(m) It is desirable to weld stock and lead joints on the Points and Crossings assembly.

**2) Interlocked Points:**

Before interlocking work is taken in hand, the permanent Way Inspector should:

(a) Bring the rails to correct level and alignment.

(b) Fully pack and ballast the points to be interlocked.

(c) Provide creep indicators if required.

(d) Mark places where the rods and wires have to cross the lines.

(e) To avoid future adjustments of gear, see that the Permanent Way at points, is laid to correct gauge so that switches, fittings and locks may be correctly put together.

(f) Clear formation and bring it to the correct level and section where rods and wires have to be run.

(g) Make the road at level crossings, if any to correct level and section to allow casing pipes for wires to be put in their final position.

(h) Provide and fix special timbers as may be required.

(i) Provide sufficient anchors of an approved type ahead of switches.

(j) Fit gauge ties correctly to all switches.

As interlocked points should be disturbed as little as possible, it is of the utmost importance that these instructions should be rigidly adhered to.

In the case of interlocked points, to Signal Inspector will be responsible for keeping in working order, the interlocking parts and apparatus. As the slewing of the track at
points is likely to throw them out of adjustment, such work should not be undertaken except in the presence of the signal staff.

On the advice of track defects from Signal Inspector, Permanent Way Inspector should promptly attend to them.

7.2 Classification of Level Crossings:

The classification of Level Crossings should be settled in consultation with the road authorities concerned keeping in view the class of the road, visibility conditions, the volume of the road traffic and the number of trains passing over the level crossing.

The classification of Level Crossings shall be as under:

a) Special : for roads
b) A Class : for roads
c) B Class : for roads
d) C Class : for roads
e) D Class : for cattle crossing

7.2.1 For the purpose of this standard, Roads shall be categorised as under:

a) Class I roads –
   i) National Highways
   ii) State Highways
   iii) Important roads within towns and
   iv) Roads in and around towns where road and rail traffic is heavy.

b) Class II roads –
   i) Major and other District roads
   ii) Un-important roads within municipal towns.
   iii) Roads within non-Municipal towns including those within shunting limits of Railways stations, and
   iv) Other surfaced roads.

c) Class III road –
   i) Earth roads, and
   ii) Cart tracks.
   iii) Class IV roads –

d) Cattle crossings and foot-path.
7.3 **Equipment at Level Crossings:**

The equipment for a manned level crossing shall be as follows; in addition to such others as may be prescribed by special instructions:

a) 2 hand signal lamps, tri-colour provided with bright reflectors,

b) 1 hand signal flag, green.

c) 2 hand signal flags, red + 2 banner flags.

d) 1 staff suitable for exhibition of red lamp or red flag.

e) 2 long spare chains with “stop” marked disc attachment at the center to cover the full width of the gate, for use in case the gates/barriers are damaged.

f) 2 spare small chains and padlocks for locking gates, in case locking arrangements of gates become defective.

g) 10 detonators.

h) 1 tin case for flags.

i) 1 tin case for detonators.

j) 1 canister for muster sheet.

k) 1 can for oil.

l) 1 Tommy bar

m) 1 water pot or bucket.

n) 1 mortar pan.

o) 1 powrah.

p) 1 rammer.

q) 1 pick-axe.

r) 1 tool list (with columns drawn for checking of tools).

s) 1 book of safety rules in Hindi or regional language.

t) Duty roster.

u) Complaint book for road users.

v) Inspection register

w) Level crossing working instructions (in local language) where applicable.

x) Two gate lamps.

y) 3 flare signals (fuses) in Ghats, Suburban, automatic and absolute permissible block territories and double and multiple lines in other than Suburban sections;

z) Diagram indicating the method of protection to be adopted, in case of obstruction in the level crossing.

7.4 **Duties of Gateman:**

1) **Alertness:** The Gateman should be on the alert and be prepared to take immediate action should danger be apprehended. The keys of the gates shall be on his person.

2) **Position during passage of trains:** The Gateman should stand facing the track on the gate lodge side of the approaching train. He should observe all passing trains and be prepared to take such action as may be necessary to ensure safety of trains.
7.4.1  **Action in emergency :**

In case of an obstruction at the level crossing the Gateman should maintain the gate signals, if any, in the “ON” position and if unable to remove it, protect the line as under:

(a) On double line, if both lines are obstructed during day, he shall plant a banner flag at a distance of 5 meters on the line on which a train is expected to arrive first, then attach another red flag to the staff and fix it on the other line at site of obstruction. He shall then pick up the first danger signal and showing it, proceed on that line towards the direction of an approaching train to a point 600 meters on Broad Gauge and 400 meters on Meter Gauge and Narrow Gauge from the level crossing and place one detonator on the line, after which proceed further to not less than 1200 meters from the level crossing on Broad Gauge and 800 meters on Metre and Narrow Gauge and place 3 detonators on the line about 10 meters apart. Having thus protected the line on which a train is expected to approach first, he should return to the level crossing, picking up the intermediate detonators on his way back and remove from the other line the staff with red flag and plant it on the line towards the direction protected with detonators. He shall then proceed on the other line showing the danger signal, place detonators similarly and return to the site of obstruction to warn the Driver of an approaching train.

(b) Provided that on those Metre Gauge sections where trains run at more than 75 Kmph. the detonators shall be placed at distance to be specified under special instructions by the Administration. (Annexure -A)

(c) On single line, if the line is obstructed during day, he shall plant a banner flag towards the direction from which a train is expected to arrive first, then attach another red flag to the staff and fix it towards the opposite direction at the site of obstruction. He shall then pick up the first danger signal and as in sub-para (a) above, protect the line in direction from which a train is expected to approach first, return to the site of obstruction, re-fix the staff to show the danger signal on the side the line is protected and proceed with all haste in the other direction to protect the line. Having protected the line on both sides he should station himself at the place of obstruction to warn the Driver of an approaching train. (Annexure – B)

(d) At night the Gateman should light the two hand signal lamps and take action to exhibit red light and protect the lines as in sub-paras (a) and (b) above.

(e) Gateman should take immediate action to inform the Mate, JE/SE (P.Way) and the nearest Station Master about the obstruction at the level crossing through messenger or other means available.
7.4.2 Parting of a Train:

If a Gateman notices that a train has parted he shall not show a stop hand signal to the Driver, but shall endeavour to attract the attention of the Driver and the Guard by shouting, gesticulation or by showing green flag slowly from his head to toe during day & H.S. Lamp during night with yellow light and back from toe to head repeatedly.
1) The Gateman should ensure that the gate lamps and lamps of all gate signals are lighted and kept burning continuously from sunset to sunrise.

2) No Gateman shall leave his gate unless other Gateman has taken charge of it. If it is necessary to leave his gate in an emergency, before doing so, he should close and lock the gates against the public road.

3) The Gateman should see that the channel for the flange of the wheel is kept clear.

4) The Gateman should keep the road surface well watered and rammed.

5) At level crossings, if any gate or barrier gets damaged/out of order the Gateman should use the spare chain and disc, for closing against the road traffic.

6) As soon as possible, the Gateman should report to the nearest Station Master, Gang Mate or Permanent Way Inspector any defect in his gate or the apparatus pertaining to it.

7) At gates the signal or signals of which have become defective, the Gateman should close and lock the gates on sighting of train and hand signal or pilot the train past the defective signal. In such case he should inform the Driver to report about the defective signal or signals to the Station Master at the next station.

8) In the event of a gate signal becoming defective the Gateman should maintain the signal in the ‘ON’ position by disconnecting the signal or the wire if necessary.

9) The Gateman should ensure that the equipment supplied to the gate is in good order and ready for immediate use.

10) Every Gateman shall as far as possible prevent trespassing by persons or cattle.

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8.0 - MAINTENANCE OF SWR, LWR/CWR

8.1 Short Welded Rails

8.1.1 Introduction:

The fish plated joints are the weak links in the continuity of track structure. The state of maintenance of track and the quality of running depends largely on how the joints are maintained. It has been estimated that 40% of the maintenance efforts in maintaining fish plated track is towards maintenance of joints. The best way to maintain rail joint is to get rid of fish plated joint and replace it by a welded joint.

This can be achieved by having long length of LWRs/CWRs. However where LWRs are not feasible due to constraints (permitted locations etc.) SWRs is being adopted wherever feasible. Thus on Indian Railways have very long lengths of track as short welded panels.

SWRs do undergo large thermal forces throughout its length due to variation in temperature and hence the laying and maintenance instructions on SWRs have to be specified.

I. Definitions:

Short welded rails (SWR) is a welded rail which contracts and expands throughout its length.

OR

Short welded rails are the rails formed by welding standard lengths of rails (generally 3 rails) which contracts (in winter) and expands (in summer) throughout its length due to the temperature variations.

II. Length of short welded rails: Normally the length of SWR as

In BG – 3 X 13M = 39 M
In MG – 3 X 12M = 36 M

III. Rail temperature zones

The Indian Railways have been divided into for rail temp. zones.

<table>
<thead>
<tr>
<th>Temp. Zones</th>
<th>Limits of rail temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone – I</td>
<td>40° C to 50° C</td>
</tr>
<tr>
<td>Zone – II</td>
<td>51° C to 60° C</td>
</tr>
<tr>
<td>Zone – III</td>
<td>61° C to 70° C</td>
</tr>
<tr>
<td>Zone – IV</td>
<td>71° C to 76° C</td>
</tr>
</tbody>
</table>
IV. Mean Annual Rail Temperature: Mean annual rail temperature \( (t_m) \) is the average of maximum rail temperature recorded during the year.

V. Installation Temperature \( (t_i) \): It is the average rail temperature during the process of fastening the rails to the sleepers at the time of installations of SWR.

8.1.2 Role of Mate in SWR

As the Mate is directly related to the maintenance of track his role is quite important in maintaining the SWRs. Therefore he should be conversant with the behaviour of SWR due to temperature variation and maintenance of the same following the specific instructions of carrying out the work in SWRs within the specified temp. limits, maintenance of gaps and observance of the behaviour of SWRs.

8.1.3 Conditions of laying of SWR

Alignment: SWR shall not be laid on curves sharper than 500 M radius (Curves having degree of curve more than 3.50\(^{th}\)) in both BG & MG.

Junction of SWR with insulated joints and point and crossings:

- SWR shall not butt against insulated joints, heel of crossing and stock rail joints.
- Two standard length rails (13M/12M) shall be laid between the SWR and these locations.
- These standard length rails shall be anchored effectively by providing creep anchors, anti creep fastening and sufficient quantity (well profiled) of well compacted ballast to restrict the movement in either direction.

Junction with track laid with free rails on wooden sleepers: When SWR track butts against track laid with free rail (13M for BG and 12 M for MG) on wooden sleepers, the later shall be adequately anchored for at least six rail lengths to check the creep of rails. These six rail lengths shall have a sleeper density of M+7. Additional shoulder ballast should also be provided.

SWR on Level Crossing:

SWR may be continued through the level crossing but no fish plated joint should fall on the level crossing and within six (6) meters from the edge of level crossing on either approach.

SWR on Bridges:

- SWR may be continued over girders bridges with unballast decks up to 13.3 m opening if length of SWR is symmetrical to the centre line of bridge and up to 6.1 m opening if the length of SWR is unsymmetrical to the centre line of bridge.
- No fish plated joint should be located on the girder or within 6 m from either side abutment.
Rail free fastenings such as rail screws, dog spikes or rail free clips shall be used in such cases over the bridge.

8.2 Maintenance of short welded rails:

8.2.1 General:

a) Ensuring of correct gaps at the fish plated joints appropriate to the rail temperature.

b) Availability of sufficient and well compacted ballast at all times.

c) Maintenance operations of SWR should be confined to the temperatures as close to the mean rail temperature as possible.

d) Creep should be checked and necessary action should be taken to arrest the creep.

e) Watch on abnormal contraction in winter to guard against bending or shearing of fish bolts and expansion in summer to guard against buckling of track.

f) Special attention should be given to the location vulnerable to buckling like short stretches of wooden sleepers between SWR.

g) Lubrication of rail joints should be done at the time when the temperature is moderate or near the mean rail temperature.

h) While doing lubrication of rail joints, one plate should be tackled at a time and it should be ensured that at no time during the operation there is less than one fish plate and three fish bolts connecting the two rails.

8.2.2 Regular Maintenance Operations:

Regular track maintenance including all operations involving packing, lifting, aligning, local adjustment of curves, screening of ballast other than deep screening and scattered renewal of sleepers may be carried out without restriction when the rail temp. is below $t_{m} + 20^0C$ in case of zone III and IV.

On curves of less than 875 m radius (more than $2^0$) on BG and less than 600 m radius (more than $3^0$) in MG or yielding formation. The above work shall be carried out when the temperature is less than $t_{m} + 15^0C$ in case of zone I and II and $t_{m} + 10^0C$ in case of zone III and IV.

If the above maintenance operations have to be undertaken at temperature more than $t_{m} + 25^0C$ in case of zone I and II and $t_{m} + 20^0C$ in case of zone III and IV then not more than 30 sleeper spaces in one continuous stretch shall be opened, leaving at least 30 fully boxed sleeper spaces between adjacent lengths which are opened out.

Before the end of day’s work it shall be ensured that the ballast is boxed up properly.

During the months of extreme summer for attention to the run down track even if the temperature is less than $t_{m} + 25^0C$ in zone I and II and $t_{m} + 20^0C$ in zone III and IV
then more than 30 sleeper spaces in one continuous stretches shall be opened, leaving at least 30 fully boxed sleeper spaces between adjacent lengths which are opened up.

If joint gaps are not available at time of opening of the track even when the rail temperature is less than $t_{m} + 25^0C$ in zone I and II and $t_{m} + 20^0C$ in zone III and IV, nor more than 30 sleepers in one continuous stretch should be opened leaving at least 30 boxed sleeper spaces between adjacent lengths which are opened up.

8.2.3 Special maintenance in SWR:

Major lifting, major alignment of track, deep screening and renewal of sleepers in continuous length: These work shall be done under suitable precautions and normally when rail temperature is below $t_{m} + 15^0C$ in case of zone I and II and $t_{m} + 10^0C$ in the case of zone III and IV. If it becomes necessary to undertake such work at rail temperature exceeding the above values then adequate speed restriction shall be imposed.

8.3 Use of Joggled Fish Plates and Clamps:

Adequate no. of joggled fish plates with special clamps shall be provided to the gangs for use in case any rail or welded joint fails.

If any rail/weld fracture is noticed by gangman he should protect the track and the fractured rail/weld should be supported by providing a wooden block and then same shall be fastened by using joggled fish plates and clamps. Then only the traffic may be passed at restricted speed from the failure spot. He should then immediately inform about the same to the nearest SM, gangman and JE/SE (P.Way) of the section.

In case of any fracture in the weld or in the rail, the portion of rail with fracture is cut, and removed for a length of not less than 4 m to carry out the re-welding duly introducing a rail piece of equivalent length. This should also be ensured that no weld lies closer than 4 m from the fish plated joint.

8.3.1 Causes of Buckling in SWR

1) In adequate resistance due to deficiency of ballast
2) In effective and missing fastenings.
3) Carrying out work of laying and maintenance at a temperature out side the specified range specially in summer.
4) Excessive creep, jammed joints, sum kinks in track.
5) Failure to lubricate the joints in time.

8.3.2 Vulnerable locations: Track prone to buckling in SWR

1) Wooden sleeper stretches between metal sleepers, approaches of LC, bridges and yards etc.
2) Old track butting with new track.
3) Junction point of free rail track and SWR track.

4) Location of deficient specially on shoulders.

   Symptoms of Buckling :

   1) Sun kinks in track

   2) Absence of gaps in joints in the morning hours in hot weather.

   3) High percentage of hollow/loose sleepers in continuous length.

   Precautions to avoid buckling :

   1) Provide proper expansion gaps in joints.

   2) Mate should inspect during extreme hot and cold by adjusting his duty hours.

   3) No track work beyond specified temperature range.

   4) Strengthening of track where it is weak by provision of extra ballast over the shoulders, increasing the sleeper density, provision of anti creep fastenings replacement and tightening of missing and loose fittings.

8.3.3 Action in case of buckling :

   When tendency of buckling or actual buckling is detected, suspend the traffic and protect the track. Inform the nearest Station Master and Mate of the gang. Do not leave the site unmanned and unprotected.

   1) Temperature of rail brought by pouring the water.

   2) In case of fish plated & SWR Track, a gentle reverse curve may be given in the rear of the buckled track to ease out the stresses.

   3) Buckled rail then cut from two places not less than 6.5 m apart, rectify the misalignment occurred due to buckling and close the gap by correct closure.

   Gap Survey in SWR and rectification : Gap survey and rectification of gaps is carried out once in a year before end of February i.e. before on set of summer by the PWI. The role of gangmen in this case is not significant and hence not described here.

8.4 Long Welded Rail (LWR)

8.4.1 Definitions

   Long Welded Rail (LWR) is a welded rail, the central part of which does not undergo any longitudinal movement due to temperature variations. A length greater than 250metre on Broad Gauge (BG) and 500 metre on Metre Gauge (MG) will normally function as LWR.
Continuous Welded Rail (CWR) is an LWR, Distressing of, which may be required to be carried out in parts. Maximum length of CWR under Indian conditions shall normally be restricted to one black section.

Breathing Length is that length at each end of LWR/CWR, which is subjected to expansion/contraction on account of temperature variations.

Switch Expansion, Joint (SEJ) is an expansion joint installed at each end of LWR/CWR to permit expansion/contraction of the adjoining breathing lengths due to temperature variations.

Buffer Rails are a set of rails provided in lieu of SEJ at the ends of LWR/CWR to allow expansion / contraction of adjoining breathing lengths due to temperature variations. These will be laid with prior approval of Chief Engineer at locations where provision of SEJ is not permitted. Buffer rails may also be temporarily laid to facilitate maintenance/renewal operations.

Rail Temperature is the temperature of the rail at site as recorded by an approved type of rail thermometer. This is different from ambient temperature, which is the temperature of air in shade at the same place.

Note: Tacks on Indian Railways have been divided into four rail temperature zones.

Mean sail Temperatures (tm) for a section is the average of the maximum and minimum rail temperatures recorded for the section.

Distressing is the operation undertaken with or without rail tenser to secure stress-free conditions in the LWR/CWR at the desired/specified rail temperature.

Installation Temperatures (ti) is the average rail temperature during the process of fastening the rails to the sleepers at the time of installation of the LWR/CWR.

Distressing Temps re tars (td) is the average rail temperature during the period of fastening the rails to the sleepers after Distressing LWR without the use of rail tenser. If rail tenser is used, td for all practical purposes is equal to to. Range of td or to shall be within the limits of rail temperature shown below:

<table>
<thead>
<tr>
<th>Rail Section</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>52 kg &amp; heavier</td>
<td>tm +50°C to tm +100°C.</td>
</tr>
<tr>
<td>Others</td>
<td>tm to tm +50°C</td>
</tr>
</tbody>
</table>

Prevailing Rail Temperature (tp) is the rail temperature prevailing at the time when any operation connected with Distressing is carried out.

Stress-free Temperature (to) is the rail temperature at which the rail is free of thermal stress. When tensors are utilised for the Distressing operation the work has to be carried out at tp which shall be lower than stress free temperature. The extension to be applied by the tensor shall be calculated from the following formula:

\[ \text{Expansion} = L \alpha (t_o - t_p) \]

Where 'L' is the length of segment of the rail to which the extension is applied and \( \alpha \) is the coefficient of linear expansion of rail steel.
**Rail Tensor** is a hydraulic or mechanical device used for stretching the rail physically.

**Anchor Length (la)** is the length of track required to resist the pull exerted on rails by the rail tensor at temperature $t_p$. For practical purposes, this may be taken as equal to 2.5 metre per degree Celsius of $(t_0 - t_p)$ for MG.

**Hot Weather Patrol** is the patrol carried out when the rail temperature exceeds $t_d + 200C$.

**Cold Weather Patrol** is the patrol carried out during cold months of the year in specified sections as per instructions of Chief Engineer.

**Consolidation of track** is the process of building up ballast resistance to the tendency of movement of sleeper either initially before laying LWR or making up subsequent loss of resistance by anyone of the following:

i) For track structures consisting of sleepers other than concrete sleepers -

- Passage of at least 3,00,000 gross tonnes of traffic on BG or at least 1,00,000 gross tonnes of traffic on MG when compaction of ballast is done using hand operated compactors/consolidators or rammers.
- Passage of at least 50,000 gross tonnes of traffic on BG or at least 20,000 gross tonnes of traffic on MG or a period of two days, whichever is later, when compaction is done by means of mechanised shoulder and crib compactor.

ii) For the track structure consisting of concrete sleepers, passage of atleast 50,000 gross tonnes of traffic on BG or atleast 20,000 gross tonnes of traffic on MG or a period of two days whichever is later.

iii) Atleast one round of stabilisation by Dynamic Track Stabiliser (DTS).

iv) For newly laid LWR / CWR, atleast three rounds of packing, last two of which should be with on-track tamping machines

### 8.4.2 PERMITTED LOCATIONS FOR LWR/CWR

**A. General considerations for laying LWR/CWR**

- As a rule, complete track renewals (primary) shall provide for LWR/CWR wherever permissible by the provisions of this Manual. Also existing rails on permitted locations may be converted in to LWR/CWR, provided they meet the requirements laid down in the Manuals for Welding of Rail Joints by Alumino Thermic (SKV process)/ Gas Pressure/ Flash putt Process, as the case may be.

- New constructions/doublings/gauge conversions/retired alignment/permanent diversion shall be opened with LWR/CWR, wherever permissible by the provisions of this Manual.

- In goods running lines, goods yards, reception yards and classification yards, rail joints may be welded to form LWR if the condition of all the components of track is
generally sound and without any deficiency, subject to such relaxation as may be approved by Chief Engineer, in each specific case.

8.4.3 ALIGNMENT

- LWR/CWR shall not be laid on curves sharper than 440 metre radius both for BG and MG.
- LWR/CWR may be continued through reverse curves not sharper than 875 metre radius. For reverse curves sharper than 1500 metre radius, shoulder ballast of 600 mm over a length of 100 metre on either side of the common point should be provided.

8.4.4 GRADIENTS

- The steepest permitted grade shall be 1:100.
- A vertical curve shall be provided at the junction of the grade when the algebraic difference between the grades is equal to or -more-than 4 mm per metre or 0.4 percent.

The minimum radius of the vertical curve shall be kept as under:

<table>
<thead>
<tr>
<th>Broad Gauge</th>
<th>Metre Gauge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>Minimum radius</td>
</tr>
<tr>
<td>A</td>
<td>4000 metre</td>
</tr>
<tr>
<td>B</td>
<td>3000 metre</td>
</tr>
<tr>
<td>C, D &amp; E</td>
<td>2500 metre routes</td>
</tr>
</tbody>
</table>

8.4.5 TRACK STRUCTURE FOR LWR/CWR

A. Formation: LWR / CWR shall be laid on stable formation.

B. Ballast cushion and section:

The minimum clean stone ballast cushion (below the bottom of the sleeper) of 250 mm shall be provided at the time of installation of LWR/CWR. Where speeds in excess of 130 km/h on BG or 100 km/h on MG are to be introduced, at least 300 mm ballast cushion or 200 mm ballast cushion over 150 mm of sub-ballast shall be provided. The ballast section and cushion provided for LWR/CWR shall be continued over SEJ and up to 3 rails beyond it wherever it is followed by SWR/ fish plated track.

C. Sleepers & fastenings

Following types of sleepers and fastenings are approved for use in LWR/CWR:

- Concrete sleepers with elastic fastenings.
Steel trough sleepers with elastic fastenings for speeds not exceeding 130 km/h. (as an interim measure speed up to 160 km/h may be allowed)

Note:

LWR/CWR already existing on steel trough sleepers and CST-9 sleepers with key fastenings for speeds up to 130 km/h, on BG, if behaving satisfactorily, may be continued.

On steel trough sleepers with key fastenings, the breathing lengths' shall preferably be provided with elastic fastenings.

In case of CST - 9 sleepers, special precautions shall be adhered to. Existing LWRs/CWR on wooden sleepers with anticreep bearing (ACB) plates & two way keys or elastic fastenings, if behaving satisfactorily, may be continued for maximum speed of 130 km/h on BG and T00 km/h on MG.

On metre Gauge

| i) | Concrete sleepers with elastic fastenings | Preferably for speeds above 75 km/h but a must for speeds above 100 km/h |
| ii) | Steel trough sleepers with elastic fastenings.) | For speeds not exceeding 100 km/h. |
| iii) | ST sleepers with) keys | |
| iv) | CST-9 sleepers with keys | |

D. Sleeper density

The minimum sleeper density (number of sleepers laid) in LWR/CWR shall be as follows:

<table>
<thead>
<tr>
<th>Types of sleeper</th>
<th>Sleeper density BG/MG</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) PRC Sleepers</td>
<td>1310 in temperature Zone I &amp; II</td>
</tr>
<tr>
<td>(ii) PRC Sleeper</td>
<td>1540 in temperature Zones III &amp; IV</td>
</tr>
<tr>
<td>(iii) Other sleepers</td>
<td>1540 in all temperature Zones</td>
</tr>
</tbody>
</table>

E. Rails

Rails of the following sections shall be welded into LWR/CWR.

<table>
<thead>
<tr>
<th>Gauge</th>
<th>Rail section</th>
</tr>
</thead>
<tbody>
<tr>
<td>BG</td>
<td>90R / 52k9 / 60 kg</td>
</tr>
<tr>
<td>MG</td>
<td>75R / 90R</td>
</tr>
</tbody>
</table>

LWR/CWR already laid with 60R rails on MG may be allowed to continue.

8.5 While converting existing fish plated /SWR track Into LWR/CWR, following precautions shall be taken: -

In one LWR, two different rail sections are not permitted. In case of any change in rail section, LWR should be isolated by providing SEJ".
Rail ends, which are bent, hogged, battered, or having history of bolt hole cracks shall be cropped before welding for conversion into LWR/CWR.

New rails used in LWR/CWR shall, as far as possible be without fish-bolt holes. Joining of rail ends temporarily during installation of LWR/CWR shall be done by 1 metre long fish plates with special screw clamps /joggled fish plates having slotted grooves & bolted clamps with speed restrictions. Fish bolt: holes, if any, shall be chamfered.

8.6 Miscellaneous

Continuity of track structures: Wherever LWR/CWR is followed by fish plated track SWR the same track structure as that of LWR/CWR shall be continued for three rail lengths beyond SEJ.

Level crossings: Level crossings situated in LWR/CWR territory shall not fall within the breathing lengths.

Points and Crossings: LWR/CWR shall not normally be taken through points and crossings. Three normal rail lengths shall be provided between stock rail joint (SEJ) and SEJ as well as between the crossing and SEJ. These normal rail lengths shall be provided with elastic rail clips /anchors to arrest creep. LWR/CWR shall not be taken through points & crossings. For any exceptions in these regards, special-arrangements shall have the prior approval of RDSO.

Glued Joints: All insulation for track circuiting in LWR/CWR shall be done by providing glued joints G3(L) type.

Location of SEJ: The exact location of SEJ shall be fixed taking into account the location of various obligatory paints such as level crossings, girder bridges, points and crossings gradients, curves and insulated joints. SEJ with straight tongue and stock shall not be located on curves sharper than 0.5 degree (3500 m radius) as far as possible. SEJ shall not be located on transition of curves.

Bridges with ballasted deck (without bearing): LWR/CWR can be continued over bridges without bearings like slabs, box culverts and arches.

Bridges with/without ballasted deck

LWR/CWR shall not be continued over bridges with overall length as specified in next paras for BG and. not: more than 20 metre for MG.

Bridges on which LWR/CWR is not permitted/ provided shall be isolated by a minimum length of 36 metre well anchored track on either sides

Bridges provided with rail free fastenings : (single span not exceeding 30.5 metre and having sliding bearings on both ends.) Overall length of the bridge should not exceed the maximum as provided with following stipulations.

Rail free fastenings shall be provided throughout the length of the bridge between abutments;
The approach track upto 50 m on both sides shall be well anchored by providing any one of the following:-

- ST sleepers with elastic fastenings.
- PRC sleepers with elastic rail clips with fair T or similar type creep anchors.

The ballast section of approach track upto 50 metre shall be heaped upto the foot of the rail on the shoulders and kept in well-consolidated & completed condition during the months of extreme summer and winter.

**Bridges provided with rail free fastenings and partly box anchored** (with single span not exceeding 30.5 metre and having sliding bearings at both ends.)

Overall length of the bridge should not exceed the maximum as provided in Table- with following stipulations.

- On each span, 4 central sleepers shall be box anchored with fair V or similar type creep anchors and the remaining sleepers shall be provided with rail-free fastenings.
- The bridge timbers laid on girders shall not be provided with through notch but shall be notched to accommodate individual rivet heads.
- The track structure in the approaches shall be laid and maintained to the standards as above para.
- The girders shall be centralised with reference to the location strips on the bearing, before laying LWR/CWR.
- The sliding bearings shall be inspected during the months of March and October each year and cleared of all foreign material. Lubrication of the bearings shall be done once in two years.

### Maximum overall length of bridges permitted on LWR / CWR on B.G. (in metre).

<table>
<thead>
<tr>
<th>Temperature zones</th>
<th>Rail section used</th>
<th>Rail free fastenings on bridges partly box anchored.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Type of sleeper used in approaches</td>
</tr>
<tr>
<td>I</td>
<td>60 kg</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>52 kg / 90R</td>
<td>45</td>
</tr>
<tr>
<td>II</td>
<td>60 kg</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>52 kg / 90R</td>
<td>27</td>
</tr>
<tr>
<td>III</td>
<td>60 kg</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>52 kg / 90R</td>
<td>27</td>
</tr>
<tr>
<td>IV</td>
<td>60 kg</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>52 kg / 90R</td>
<td>27</td>
</tr>
</tbody>
</table>

**Welded rails may be provided from pier to pier with rail-free fastenings and with SEJ on each pier** : The rail shall be box anchored on four sleepers at the fixed end of the; girder if the girder is supported on one side and rockers on other side. In case of girder supported on sliding. Bearings on both sides, the central portion of the welded rails over each span shall be box anchored on four sleepers.

Lesson Plan for Training of Mate

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LWR/CWR may also be continued over a bridge with the provision of SEJ at the far end approach of the bridge using rail-free fastenings overt the bridge. The length of the bridge in this case, however, will be restricted by the capacity of the SEJ to absorb expansion, contraction and creep, if any, of the rails. The length of the bridges with the above arrangement that can be permitted in various rail temperature zones for LWR/CWR with SEJs having maximum movement of 120 mm and 190 mm are as follows:

<table>
<thead>
<tr>
<th>Rail Temp. Zone</th>
<th>Max. movement of SEJ used (mm)</th>
<th>Max. length of bridge with SEJ</th>
<th>Initial gap to be provided at td</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>With ST/PRC approach sleepers</td>
<td>With CST-9 approach sleepers</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>190</td>
<td>55 m</td>
<td>45 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.0 cm</td>
<td>6.0 cm</td>
</tr>
<tr>
<td>III</td>
<td>190</td>
<td>70 m</td>
<td>70 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.0 cm</td>
<td>6.5 cm</td>
</tr>
<tr>
<td>II</td>
<td>190</td>
<td>110 m</td>
<td>100 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>605 cm</td>
<td>6.5 cm</td>
</tr>
<tr>
<td>I</td>
<td>190</td>
<td>160 m</td>
<td>150 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>II</td>
<td>120</td>
<td>20 m</td>
<td>15 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 cm</td>
<td>4.5 cm</td>
</tr>
<tr>
<td>I</td>
<td>120</td>
<td>50 m</td>
<td>50 m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.5 cm</td>
<td>4.0 cm</td>
</tr>
</tbody>
</table>

Note: SEJ is to be installed 10 metre away from the abutment.

8.7 GAPS AT SEJ

- Gaps at SEJ shall be adjusted at the time of laying/subsequent destressing of LWR/CWR.

<table>
<thead>
<tr>
<th>Rail section laid</th>
<th>Gag to be provided at ’td’</th>
</tr>
</thead>
<tbody>
<tr>
<td>52 kg/60 kg</td>
<td>40 mm</td>
</tr>
<tr>
<td>others</td>
<td>60 mm</td>
</tr>
</tbody>
</table>

- The gaps between the reference mark and tongue rail tip/stock rail corner at various rail temperatures shall not differ by more than 10 mm from the theoretical range.

- Where fish-plated or SWP track is joined on one side of SEJ, the gap between the reference mark and tongue rail tip/stock rail corner on LWR/CWR side shall not differ by more than 10mm from half the theoretical range.

8.8 Regular track maintenance in LWR/CWR includes following operations

- Tamping/packing
- Lifting
- Aligning including minor realignment of curves
- Shallow screening/shoulder cleaning
- Renewal of fastening requiring lifting
- Maintenance of buffer rails

8.8.1 General

- Track Structure consisting of other than concrete sleepers in LWR/CWR
The regular track maintenance in LWR/CWR shall be confined to hours when rail temperature is between \( t_d +10°C \) and \( t_d -30°C \) and shall be completed well before onset of summer. If rail temperature after maintenance operation exceeds \( t_d +20°C \) during the period of consolidation, the speed restriction of 50 kmph on BG and 40 kmph on MG shall be imposed when shoulder and crib compaction has been done and 50 kmph and 40 kmph respectively when shoulder and crib compaction has not been done in addition to posting mobile watchman.

- **Track structure consisting of concrete sleepers (not other than concrete sleepers)**
  The regular track maintenance in LWR/CWR shall be confined to hours when the rail temperature is between \( t_d +10°C \) and \( t_d -30°C \) and shall be completed well before onset of summer. If rail temperature after the maintenance operation exceeds \( t_d +20°C \) during the period of consolidation, then the speed restriction of 50 kmph on BG and 40 kmph on MG shall be imposed.

### 8.8.2 Mechanised Maintenance

- **Maintenance tamping**: Tamping in LWR/CWR with general lift not exceeding 50 mm in case of concrete sleeper and 25 mm in case of other sleepers including correction of alignment shall be carried out during the period when prevailing rail temperatures are within specified limit together with precautions.

- **Lifting of track**: Lifting where needed, in excess of 50 mm in case of concrete sleepers/25mm in case of other types of sleepers shall be carried out in stages with adequate time gap in between successive stages such that full consolidation of the previous stage is achieved prior to taking up the subsequent lift.

- **Cleaning of shoulder ballast**: Mechanised cleaning of shoulder ballast shall be undertaken when prevailing rail temperatures are within the limits prescribed, together with the precautions mentioned therein.

### 8.8.3 Manual maintenance

- At no time, not more than 30 sleepers spaces in a continuous stretch shall be opened for manual maintenance or shallow screening with atleast 30 fully boxed sleeper spaces left in between adjacent openings. Maintenance of in between lengths shall not be undertaken till passage of traffic for atleast 24 hours in case of BG carrying more than 10 GMT or 2 days in case of other BG and MG routes.

- For correction of alignment, the shoulder ballast shall be opened out to the minimum extent necessary and that too, just opposite the sleeper end. The ballast in shoulders shall then be put back before opening out crib ballast for packing.

- In exceptional circumstances when more than 30 sleeper spaces have to be opened for any specific work, like through screening of ballast etc. during the period of the year when minimum daily rail temperature is not below \( t_d -30°C \) maximum does not go beyond \( t_d +10°C \), up to 100 sleeper spaces may be opened under the direct supervision of PWI. It should however, be ensured that rail to sleeper fastenings on the entire length of LWR are functioning satisfactorily and SEJs do not indicate any unusual behaviour."
8.8.4 Casual Renewal of Sleepers

Not more than one sleeper in 30 consecutive sleepers shall be replaced at a time. Should it be necessary to renew two or more consecutive sleepers in the same length, they may be renewed one at a time after packing the sleepers renewed earlier duly observing the temperature limits specified with precautions.

8.8.5 Renewal of fastenings

The work of renewal of fastenings shall be carried out when rail temperature is within the limits specified, with following additional precautions.

- Renewal of fastenings not requiring lifting:- Fastenings not requiring lifting of rails, shall be renewed on not more than 'one sleeper at a time. In case fastenings of more than one sleepers are required to be renewed at a time, then atleast 15 sleepers in between shall be kept intact. Work shall be done under supervision of keyman.

- Renewal of fastenings requiring lifting:- Fastenings requiring lifting of rails i.e. grooved rubber pads, etc. shall be renewed on not -more than one sleeper at a time. In case fastenings of more than one sleepers are required to be renewed at a time, then at least 30 sleepers in between shall be kept intact. Work shall be done under supervision of Gangmate.

8.8.6 Maintenance of SEJs

- Once in a fortnight SEJs shall be checked packed and aligned if necessary. Oiling greasing of tongue and stock rails of SEJ and tightening of fastenings shall be done simultaneously. Movement of SEJs shall be checked and action taken for de-stressing if necessary.

- During his daily patrolling, keyman shall keep special watch on the SEJs falling in his beat

8.8.7 Maintenance of buffer rails

1. Type of sleepers under buffer rails
   - PRC sleepers with – J clips
   - Wooden sleepers with – M.S. canted bearing plates and rail screws.

2. Expansion gap in each buffer rail joints 7.5 mm at ‘td’ range.

3. All fish bolts holes in buffer rails should be chamfered.

4. If buffer rails are provided between track and LWR, then conventional track for three rail length should be box anchored.

5. Fish bolts of buffer rails should be kept tight at all times.

6. Buffer rails are laid with rail free fastenings.
7. Extra shoulder ballast width of 500 mm & heaping of ballast up to 100 mm should be provided in buffer rail lengths.

8. Maintenance of rails shall be of high standards.

9. Lubrication of buffer rail joints should be done in temperature range between ‘t_d’ - 15°C to ‘t_d’ + 15°C and average gap value 3 to 12 mm.

8.8.8 Renewal of defective rails/welds

The procedure for repairs to track after rail fracture shall be followed.

A. Special track maintenance

Special track maintenance in LWR/CWR includes following operations:

- Through fittings renewal
- Deep screening/mechanised cleaning of ballast
- Lowering / Lifting of track
- Major realignment of curves
- Sleeper renewal, other than casual renewals
- Rehabilitation of bridges and formation causing disturbance to track

B. Through fittings renewal: Whenever it is decided to carry out through renewal of fittings so as to ensure proper functioning of LWR, the LWR shall be destressed along with the through fittings renewal.

C. Deep screening / mechanised cleaning of ballast

- Provisions laid down in para 238 of IRPWM will also apply mutatis- mutandis to LWR/CWR with further provisions as mentioned hereafter in this para. Wherever mechanised cleaning of ballast is resorted, the detailed procedure, deep screening shall stand replaced by the sequence of operations of Ballast Cleaning Machine (BCM).

- Ballast Cleaning Machine (BCM), tamping machine and Dynamic Track Stabilizer (DTS) shall, as far as possible, be deployed in one consist.

- Temperature records of the sections where deep screening is to be undertaken, shall be studied for the previous and the current year. The maximum and minimum rail temperature attainable during the period of deep screening and during the period of consolidation shall be estimated. Any of the following three methods may be adopted for Carrying out the work of deep screening/mechanised cleaning:
  - If range of rail temperature falls within td + 10°C to td + 20°C. Deep screening may be done without cutting or temporary de-stressing.
  - If range of rail temperature falls outside (a) above, Temporary de-stressing shall be carried out 10oC below the maximum rail temperature likely to be attained during the period of work. CWR shall be cut into LWRs of about 1 km length with two temporary buffer rails of 6.5 metre long clamped.
Wherever rail renewals are being carried out, LWR/CWR may be converted into three rail panels and deep screening done.

Constant monitoring of rail temperature shall be done during the progress of work. Should the temperature rise more than 10°C above td/temporary destressing temperature, adequate precautions shall be taken including another round of temporary destressing.

**Note:** Deep screening shall be undertaken within 15 days of temporary destressing failing which temporary destressing may become due again, if the range of rail temperature varies appreciably.

During the period of deep screening, if there is any possibility of minimum temperature falling 30°C below td/temporary destressing temperature, cold weather patrol should be introduced to detect/guard against rail fractures.

**D. Sequence of operation:**

- Deep screening of LWR may be done from one end of LWR to other end.
- After deep screening and consolidation, destressing of LWR shall be undertaken.

**8.8.9 Other Special Maintenance**

- Other types of special track maintenance constitute jobs like lowering of track, major realignment of curves, renewal of large number of sleepers or rehabilitation of formation/bridges causing disturbance to track. For carrying out such maintenance, the affected length of track may be isolated from LWR/CWR by introducing SEJs or buffer rails as needed.
- Temperature records of the section shall be studied and action taken in accordance.
- After completion of work, the affected length of track shall be destressed at the required destressing temperature and joined with: rest of the SWR/CWR in accordance.

**8.8.10 Special equipment for maintenance of LWR/CWR**

Staff responsible for maintenance of LWR/CWR shall be trained in using and equipped with additional equipment detailed below:

- A pair of joggled fish-plate with bolted clamps
- Rail thermometer with markings for temperature ranges for maintenance.
- special 1 metre long fish-plates with screw clamps
- Rail closure pieces.

**8.9 Unusual occurrences**
Unusual occurrences in LWR/CWR comprise of the following:-

- Rail fractures or replacement of defective rail/glued, joint.
- Damage to SEJ/buffer rails.
- Buckling or tendency towards buckling.
- Factors causing disturbance to LWR/CWR such as accidents, breaches etc.

### 8.9.1 RECTIFICATION OF RAIL FRACTURES

#### (a) Equipment required

- Special 1 metre long fishplates with screw clamps and Joggled fishplates with bolted clamps (for fractures at welded joints) as per arrangement
- Steel tape capable of reading up to one mm.
- Alumino-thermic welding and finishing equipment.
- Equipment for destressing.
- 6.5 metre long sawn rail cut piece of the same section as LWR duly tested by USFD.
- Rail closures of suitable lengths.
- Equipment for protection of track.
- Equipment for night working.

#### (b) Procedure for repairs

If any fracture takes place on LWR/CWR, immediate action shall be taken by the official who detected the fracture to suspend the traffic and to protect the line. He shall report the fracture to the Gangmate, Keyman/PWI, who shall arrange for making emergency repairs to pass the traffic immediately. Repairs shall be carried out in four stages as described below.

- Emergency repairs to pass the traffic immediately.
- Temporary repairs.
- Permanent repairs.
- Destressing.

#### (c) Emergency Repairs

The fractured rails shall be joined by using special fishplates and screw clamps. If the gap at fracture does not exceed 30 mm, insertion of any closure rail piece is not necessary. The traffic may then be resumed at a speed of stop dead and 10 kmph for the first train and 20 km/h for subsequent trains.

#### (d) Temporary Repairs

If a welding party is not readily available, the fracture shall be repaired by using a cut-rail (not less than 4 metre long) and clamped/bolted as per arrangement.

- A traffic block shall be taken as soon as possible preferably when the rail temperature is within the range specified for td
Two points on either side of the fracture shall be marked on the rail such that the length of closure rail (not less than 4 metres) to be inserted is equal to the total length of the rail pieces removed from the track minus allowances for two welds and saw cut (normally 51 mm).

Alternately two points on either side of the fracture shall be marked on the rail at a distance equal to the length of the available closure rail. The length of closure rail should not become less than 4 metres at the time of permanent repairs.

The rails shall then be cut through at these points simultaneously, if possible. The closure rail shall then be inserted joined. After joining the traffic shall then be resumed at restricted speed.

(e) Permanent Repairs

If the fracture is such that, wide gap A T welding ban be adopted, then the total length of fractured ends to-be cut shall be equal to the gap required for wide gap welding. Once the two ends are cut, a gap required for wide gap welding will be created by using rail tensors and joint welded by wide-gap Alumino Thermit welding technique.

In case rail closure has been provided for temporary repairs as mentioned above, one joint of the closure rail shall be welded without rail tensor after setting correct gap for welding. However to ensure correct gap during welding of the other joint, tensor shall be used.

In case rail closure has been provided at the time of temporary repairs as mentioned above, the rail closure shall be suitably cut such that the length of the rail to be final inserted in track is equal to length of rail remove from track after fracture minus allowances for two welds i.e. 50 mm. Once the closure rail is cut, the closure rail will be welded.

After welding of joints, a length of track equal to breathing length or about 125 metres on either side be unfastened and tapped to ensure equalisation of stress and then refastened.

8.9.2 Action in case of rail fracture :

1. In case of rail weld fracture in LWR track, emergency repairs should be carried out by the gang staff.
2. Suspend traffic and protect the track as per rules.
3. Clamp the fractured rail by using one meter long fish plates or juggled fish plates as required and restore traffic with stop dead and 10 kmph for first train and 20 kmph for subsequent trains.
4. Use rail piece of suitable size, if gap at fracture is more than 30 mm.
5. Manned the site by deputing the flagman till the permanent repairs carried out by JE/SE (P.Way).

8.9.3 Damage to switch expansion joint
The damaged/broken SEJ shall be replaced and gap adjusted. Traffic may be allowed if necessary at a restricted speed and thereafter restriction relaxed progressively.

If another SEJ is not available for replacement, both the damaged SEJ and the undamaged SEJ on the opposite rail at the same location, shall be replaced by a closure rail and connected to LWR/CWR with special clamps and fish-plates. The traffic over the clamped joints may be permitted at a restricted speed. The restriction may be relaxed only after the new SEJ has been inserted in the correct position and the clamped joint has been replaced with in-situ weld.

8.9.4 Buckling of track

Buckling or a tendency towards buckling may occur, among others, in the following circumstances:-

- Failure to adhere to the temperature ranges specified for operation on LWR/CWR.
- Inadequate resistance to longitudinal, lateral and vertical movement of track due to deficiencies in ballast section or/and inadequate ballast consolidation.
- Use of ineffective fastenings or missing fastenings resulting in loss of creep resistance and torsional resistance.
- Excessive settlement of formation.
- Improper functioning of SEJ.

Repairs to buckled Track

- When the track actually buckles, the traffic shall be suspended and the cause of buckling ascertained. The position of tongue and stock rails of the SEJ shall be checked. The methods for rectification are explained below.
- The rectification shall normally be carried out in the following stages under the supervision of PWI :-
  - Emergency repairs.
  - Permanent repairs.
  - Destressing.

Emergency Repairs

The buckled rails shall preferably be as cut adequately apart not less than 6.5 metre. The track shall then be slewed to the correct alignment and cut rails of the required lengths shall be inserted to close the gaps making due provision for welding of joints on both sides. The cut rails shall then be connected by use of special fishplates and screw clamps and the line opened to traffic with speed restriction.

Permanent Repairs

- As soon as possible the clamped joints shall be welded adopting the same procedure as in case of rail fracture. Additional pair of cut rails and rail cutting equipment shall also be required to adjust the gaps in case they have been disturbed in the intervening period. The speed restriction shall be removed after welding.
The entire panel shall be destressed as soon as possible.

8.9.5 Action in case of buckling / Tendency towards buckling

1. If abnormal kinks are noticed in the track, check the track sleepers by canne-o-boule for loose packing.

2. If tendency of buckling or buckling of track get established, suspend traffic and protect the track and inform to the concerned staff.

3. In case of tendency of buckling, stabilize the track by heaping the ballast on the shoulders up to the bottom of rail head, taking the ballast from the inter sleepers spaces between the rails.

Manned the site, till the permanent repairs is carried out by the JE/SE (P.Way).

8.9.6 Breaches, temporary girders and diversions

- The affected portion shall be isolated by insertion of SEJs preferably within the temperature range specified for td. The track thus isolated shall be replaced by fishplated track which shall be box anchored, if necessary.
- In the breached sections where the new banks are constructed, the formation shall be fully consolidated before laying LWR/CWR again.
- In case of diversions and insertion of temporary girders, SEJ shall be inserted to isolate the portion where such work is required to be done.
- LWR/CWR panels in the affected portion shall be destressed immediately after the LWR/CWR are restored.

Schedule of speed restrictions

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Conditions of track</th>
<th>Restriction imposed in km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>When 1 metre long fishplates with special clamps or joggled fishplates with bolted clamps are used at a temporary rail joint and there is 24 hrs. watch (Both BG &amp; MG).</td>
<td>30</td>
</tr>
<tr>
<td>2.</td>
<td>When other clamps are used at a temporary rail joint (both BG and MG).</td>
<td>20</td>
</tr>
<tr>
<td>3.</td>
<td>When sleeper fastenings on alternate sleepers are loosened before destressing (both BG &amp; MG).</td>
<td>30</td>
</tr>
<tr>
<td>4.</td>
<td>At fracture after emergency repairs are completed (i) First train (ii) Subsequent trains</td>
<td>STOP DEAD &amp; 10 20</td>
</tr>
<tr>
<td>5.</td>
<td>After emergency repairs to track after buckling (i) First train (ii) Subsequent trains</td>
<td>STOP DEAD &amp; 10 20</td>
</tr>
</tbody>
</table>

8.10 Concrete sleeper track
a) 50 Kmph for BG/40 Kmph for MG- if shoulder & crib ballast compaction has been done.

b) 30 Kmph for BG/20 Kmph for MG – if ballast compaction has not been done. Other than concrete sleeper track.

50 Kmph for BG/40 Kmph for MG.

8.10.1 Ballast

a) Maintain well compacted proper ballast section at all times.

b) Keep special watch on Pedestrian & cattle crossing, curves, approach of LC & bridges.

c) Deficiency of shoulder ballast from the center of track between the rails over a width not exceeding 600/350 mm & depth not more than 100/75 m in BG & MG respectively.

8.10.2 Correction of alignment

Maintain well compacted proper ballast section at all times.

8.10.3 Lifting of track

Lifting of track shall be done in stages, not more than 50 mm in concrete sleepers & 25 mm in other sleepers track in one stage with the adequate time gap between two stages for proper consolidation.

8.11 Working hour

a) All regular maintenance works should be completed well before the onset of summer i.e. before 31st March of every year and should be confined to the hours when rail temperature is in between of ‘t_d’ + 10°C to ‘t_d-30°C.

b) When during the work rail temperature exceeds ‘t_d’ + 10°C stop the work and put back the ballast by boxing and try to compact the ballast by the hand rammer.

c) If rail temperature further exceeds ‘t_d’ + 20°C, then the following speed restriction should be imposed for the period of consolidation.

8.12 Do's of LWR for PWM, Mates & Keyman

8.12.1 Do's

1. Check and carry LWR/CWR equipment daily. Each Gangmate/ PWS should keep two Sets of joggled fishplates, 2 clamps, one rail thermometer, special 1m long fish-plates, rail closure pieces, one straight edge and one feeler gauge. The thermometer should be regularly checked with that of standard thermometer kept in PWI's office.

2. Know the td of your section/panels.
3. Keep the ballast section full and in compacted condition particularly in cribs and shoulders. Deficiency in ballast shall be brought to the notice of PWI.

4. Keep close watch on pedestrian and cattle crossings, where the ballast is always disturbed. Make up ballast deficiency promptly.

5. Get your SEJs oiled and greased once in a fortnight.

6. Check the gaps of SEJ at extremes of temperatures.

7. Train men in detecting buckling, rail fractures etc. and protection of the trains in such cases.

8. Keep the patrolling equipment always handy and start patrolling of track as soon as temperature exceeds td + 20oC. which is marked on the thermometer in red.

9. Commence patrolling as per laid down schedule for the prescribed periods.

10. Keep sharp look out for severe alignment defects in summer. Protect the trains and report to supervisors.

11. Keep the anchors wherever provided always butting against the sleepers.

12. Renew fittings only on one sleeper at a time.

13. Ensure that fittings are tightly fitted at proper places at all times.

14. Pack loose sleepers without lifting or opening track in summer.

15. Attend only one or two sleepers at a time for adjusting fittings while removing a kink.

16. Confine essential maintenance to period when the temperature is below td + 10oC.

17. Impose speed restriction if temperature exceeds td + 20oC during consolidation period.

18. Pay special attention to SEJs, breathing lengths, curves, approaches to level crossings, unballasted bridges, horizontal and vertical curves.

19. Keep the rail thermometer with proper markings with limiting temperature ranges thereon in proper working order. Learn the limits of temperature restrictions as marked on thermometers for various operations.

20. Check that reference posts at SEJ and at centre of LWR/CWR are correctly maintained.

21. Pay special attention for crib and shoulder packing of ballast on CST-9 road.

22. Learn the six items (i) missing and loose fastenings, (ii) shortage of ballast,
(iii) misalignment (iv) slewing (v) Lifting (vi) improper packing, about which you should be very careful to avoid buckling.

23. Learn what to do when there is buckling or fracture in the track.

24. Ensure that all bridges and its approaches have all fittings at all times and are regularly tightened.

8.12.2 Don'ts of LWR for PWS, Mates & Keyman.

1. Do not touch the track unnecessarily unless specially instructed by PWI.

2. Do not undertake through packing after, the onset of summer months.

3. Do not open shoulder and crib ballast at one and the same time.

4. Do not try to lift the track while packing sleepers for replacement of fastenings and slewing with crow bars.

5. Do not open the track for more than 30 sleepers in a stretch. Keep at least 30 fully boxed sleeper between adjacent lengths opened out.

6. Do not open the adjacent length till the passage of 20,000 tonnes of traffic or two days, whichever is later.

7. Do not renew more than one sleeper within 30 sleepers at a time.

8. Do not renew fastenings not requiring lifting on more than one sleeper within 15 sleepers at a time.

9. Do not renew fastenings requiring lifting on more-than one sleeper within 30 sleepers at a time.

10. Do not allow loose, missing or ineffective fastenings to remain in track.

11. Do not neglect checking and attending to the breathing lengths of LWR/CWR in a fortnight.

12. Do not lift track by more than 50 mm even if temperature is within td.

***
9.0 - PATROLLING

CE/030

Duration: ½ Day

9.1 General

9.1.1 Patrolling in track:

a) Keyman's daily patrol.
b) Gang patrol during abnormal rainfall or storm.
c) Night patrolling during monsoon.
d) Security patrolling during civil disturbances and for movement of VIP specials.
e) Hot weather patrolling for long welded rails/continuous welded rails.
f) Watchmen at vulnerable locations.

g) Each patrolman shall be provided with the following equipment and such other, as may be prescribed by special instructions:

a) One staff
b) Number plate 15 cm. Square (to be numbered consecutively from the beginning of each Permanent Way Inspector’s length in white letters on black background.
c) 10 fog signals in a tin case.
d) Two tricolour hands signal lamps, and 3 nos if pair of patrol men is working.
e) Protective clothing according to local dress regulations.
f) One match box.
g) Two red flags and one green flag (day patrol only).
h) Patrol book in a tin case.
i) One three cell Electric torch.
j) Whistle thunderer.
k) One haversack.
l) 3 flare signals - in Ghat automatic and absolute permissive block territories, double and multiple lines in other than suburban sections.

9.1.2 Equipment of Patrolmen:

The duties of patrolmen shall be as follows:

a) Walk to and fro the beat in accordance with the chart pertaining to his “patrol-section” looking out for subsidence, slips, signs of erosion, trees blown across the track during storms or any other causes likely to endanger the safety of line. Bridges and their approaches should be especially watched.

b) Apprehend damage to line when

i) The flood exceeds danger level at any of the bridges.
ii) When there is damage to the protection work or on approaches even before
danger level is reached.

iii) The water on one side of the embankment is at much higher level than on the
other side.

iv) When any obstruction such as a fallen tree is blocking the water-way of
bridge.

v) The track shows signs of settlement.

c) Take immediate steps in accordance with Para 1011 E to stop trains when any
portion of the line is likely to be rendered unsafe due to abnormal rain or flood or
any other cause.

d) When no danger is apprehended, stand on the cess on the left hand side facing the
train and exhibit his number plate, turning the light of his lamp on to it, so that the
number can be seen from the passing train. He should also blow the whistle, when
the engine and the brake-van of the train pass him.

e) Obtain the signature of the Station Master/Block Hut- in-charge on duty at the
Station/Block Hut concerned for his arrival and departure and exchange patrol
books with adjacent patro lmen.

f) Exchange the reports as to the conditions on their beats with adjacent patrol
men and stationary watchmen on the way.

g) Need instructions from drivers who may report a condition of danger at a kilo-
meterage and proceed to the place indicated and take necessary measures.

9.2  Action when damage is observed :

In the event of any portion of the line being breached or otherwise rendered unsafe for
traffic the following procedure shall be observed.

A. In the case where two patrolmen are employed –

Protecting the line :

a) The second lamp should be lit and danger signals shown at once in both the
directions.

b) The two patrolmen shall then proceed in opposite directions showing the danger
signals (red flag by day and red light by night) and when at 600 M. on Broad
Gauge and 400 M. on Metre Gauge and Narrow Gauge from the point of danger,
each should place one detonator on to the rail; they shall then proceed to a
distance of 1200 M. one Broad Gauge and 800 M. on Metre Gauge/Narrow Gauge
from the point of danger where they should place three detonators on the rail
about 10 metres apart.
On the double line the detonators must be placed on the line, in the direction on which the trains will approach. On metre gauge sections where trains run at maximum permissible speed of more than 75 kmph the distance at which the detonators are to be placed shall be specified by the administration.

c) Should the nature of obstruction be such as to render it impossible for either of patrolmen to get across the gap, as for instance a wash away with strong flood, one of the men should show the danger signal and endeavour to stop trains approaching the proceed towards the station on his side of the gap fix the detonators and act as in (b).

B. In case when one patrol man is employed

Protection of line –

a) When damage is detected on single line –

i) Place a red lamp during the night and a red flag during the day in a prominent position to warn a train, which may approach from one direction. Then run in the opposite direction from which direction train is likely to come, with a danger signal (red flag by day and red light by night) and place one detonator at 600 M. on Broad Gauge and 400 M. On Metre Gauge and Narrow Gauge and three detonators at 10 meters apart at 1200 M. on Broad Gauge and 800 M. on Metre Gauge/Narrow Gauge from the site of obstruction/damage.

Provided that on those Metre gauge sections where trains run at maximum speed of more than 75 Kmph, the distances at which the detonators are to be placed shall be specified by the administration.

ii) Return to the site of obstruction/damage and protect the other side with detonators similarly.

iii) In the event of it being impossible to get the other side of the obstruction/damage (as in a washaway) place the red lamp so that it can be seen from as great distance as possible by a train approaching from that direction and protect the other side with the detonators etc. as detailed in sub para (a) (i).

b) When damage is detected on double line –

i) Place the red flag/lamp in prominent position so as to warn an approaching train on one track. Then run along the other track on which train is expected first and place the detonators as shown in chapter in sub para (a) (i).

ii) Run back and protect with detonators the line one which the lamp/flag was prominently placed earlier.
9.3 Hot weather patrolling

1. Hot weather patrolling should be done when rail temperature exceeds ‘\(T_a\) + 20^0C’.

2. Regular hot weather patrolling should also be done during the period specified by the Chief Engg. as per the patrol chart.

3. The beat of one patrolman should be restricted to 2 km only i.e. 2 km in single line and 1 km on double line track.

4. He should carry all the equipment as necessary during patrolling i.e. H.S.flag red-2 nos. staff for flag – 1 no., detonators – 10 nos., Canne-e-boule – 1 no.

5. Patrolman during his inspection should keep vigilant watch to detect the tendency of buckling/buckling by way of observing any abnormal kinks and continuous loose sleepers in the track. In case of any un-usal occurrence, he should stop the trains, protect the track & inform to the concerned staff.

9.4 Cold Weather patrolling

1. Cold Weather patrolling is introduced when rail temp. falls below ‘\(T_d\) - 30^0C’.

2. Period & section notified by the Chief Engineer should also be covered by cold weather patrolling as the petrol charts specified.

3. Patrolman should carry the equipment as prescribed in the LWR manual.

4. Patrolman shall be vigilant while on work & look out for any rail weld failure and take immediate action of stopping the trains and protection of track, in case of any such occurrences.

5. Patrolman shall also notice the gap of SEJ in his beat and if he noticed the gap at SEJ more than the designed max. gap, he will suspend the traffic and protect the track till the emergency repairs is carried out.

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10.0 - ACCIDENTS AND BREACHES

CE/031

Duration : ½ Day

10.1 Action during accidents including breaches and pre-monsoon precautionary measure :

10.1.1 Every Railway servant who observes :

(a) that any signal is defective;
(b) any obstruction, failure, or threatened failure of any part of the way or works;
(c) anything wrong with a train; or
(d) any unusual circumstance likely to interfere with the safe running of trains or the safety of the public.

Shall take immediate steps, such as the circumstances of the case may demand, to prevent accident; and where necessary, advise the nearest Station Master by the quickest possible means:

Provided that in the case of train having parted, he shall not show a stop hand signal but shall endeavour to attract the attention of the Driver or Guard by shouting, gesticulating or other means.

10.1.2 Action at site :

By Permanent Way and other Engineering Officials –

(a) Protect Train : Any engineering staff available at the site of the accident shall assist the Guard and Driver to protect the train in accordance with the General Rule 6.03 and 9.10 (1976). The Inspector should ensure that protection has been afforded to the train in front and in the rear, in accordance with the rules. In case of double line, if the other line is also affected by the accident, steps shall be taken to protect both the lines. If no infringement exists, trains must be controlled and passed cautiously on the unaffected track.

(b) First aid and Rescue : The Inspector should arrange for first aid to injured passengers and Railway staff and rescue of trapped persons. If there is any Medical Practitioner on the train, his assistance should be obtained.

(c) Advice to nearest Station Master – After a rapid survey of the position, particulars should be sent to the nearest Station Master. In case of controlled sections, a field telephone should be got commissioned at once.

(d) Line Clear Examination : If the Engineering official has reached the site and no traffic official is available he should carefully secure the line clear token or ticket and any caution order, where necessary. If the accident has occurred in a station yard, the train register book must be seized and if necessary, statement of staff concerned recorded; if line badges are in use, it should be recorded as to in whose possession
each line badge was. The position of block instruments, signals, points, point levers, indicators, keys, etc. should be noted and recorded, jointly with the inspectors of the other concerned departments, available at site.

(e) Preliminary Clearing operation and preservation of clues –

In all instances in which the means taken for the restoration of communication are likely to obliterate marks on the road and other evidence needed at a joint enquiry, the senior official who arrives first on the spot should carefully examine the track, train or vehicle and as soon as possible make notes, sketches etc. and hand over the same to his superior or produce them at the enquiry. He will, when the nature of the accident is such as will involve the question of eye-sight of any of the staff, verify (in case of those permitted to wear glasses) that they had worn glasses at the time of the accident and had carried a spare pair of glasses with them.

In all cases of accidents, the cause of which might possibly due to sabotage, it is essential that the clearance and restoration operations are not commenced till the Police officials arrive at the site and intimate their agreement to the commencement of clearance and restoration work, after making thorough investigations.

A factual note of the conditions obtaining at the site prior to restoration work should be prepared and signed by the senior-most Police and Railway officials at the site. In the event of any difference of opinion between the Police and the Railway officials, such difference of opinion may be recorded on the joint factual note.

This should not, however, be allowed to interfere with rendering of first aid to the injured, which is the first essential in all accidents.

In other cases, clearance and restoration operations can commence even before the arrival of the Police and it is not necessary that all the rails, sleepers and fastenings involved in an accident should be preserved, but only those, whether serviceable or otherwise, which bear wheel marks, etc., specially between the points of mount and drop. In all cases of serious derailments, these are essential for a later reconstruction of the scene and should be preserved and/or recorded by the first responsible official to reach the site of the accident. As these would be valuable evidence to ascertain the cause of the accident.

After the injured persons have been attended to and arrangements made for the onward journey of the stranded passengers, the railway officers at the site of the accident should arrange to record the preliminary statements of the staff concerned, as any delay in doing so, might result in some facts being suppressed or some evidence being fabricated during subsequent enquiries.

In case sabotage is suspected, the procedure as outlined in clause above should be followed. In addition it should be ascertained promptly from the C.R.S. if he would like to inspect the site etc. before the commencement of clearance and restoration work and then action should be taken in accordance with his wishes. Before clearance and restoration operations are commenced all relevant clues, materials and damages and the deficiencies on Rolling Stock, etc. must be noted and preserved. In other
serious accidents, however, the same procedure as outlined in clause above should be strictly followed.

- **Contacting higher officials** – The Inspector should get in touch with the Assistant Engineer or Divisional Engineer, explain the position on telephone, wherever possible; if not, he should himself organise the restoration of through running including ordering of ballast trains, requisitioning of required materials and tools and send information to Assistant Engineer and Divisional Engineer of the preliminary measures undertaken, by the quickest possible means.

- **Recording of details and advice regarding restoration time** – He should arrange to record the details of the accident and prepare notes on any special features bearing on its cause, which may be of help in the enquiry. He should send by any means available and relay a concise report of the accident to the nearest Station Master to enable him to issue all concerned message.

- **Preservation of clues** – He should arrange to preserve all clues to enable reconstruction of the scene of the accident.

- **Photographs showing the details of damage to permanent way and rolling stock at the site of accident** should be taken wherever necessary; in case of suspected sabotage, the photographs of the site of the accident showing the damage and possible clues should invariably be taken.

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11.0 - TRACK RENEWALS

CE/032

Duration : 1 Day

11.1 General :

a) **Complete Track Renewal (C.T.R.)** – It implies renewal of all the components of the track over a particular length. Necessary recouping of ballast and provision of full ballast cushion is also done alongwith C.T.R.

b) **Through Rail Renewal (T.R.R.)** – It implies renewal of entire lengths of rail from point to point. Necessary recouping of ballast and provision of full ballast cushion is also done alongwith T.R.R.

c) **Through Sleeper Renewal (T.S.R.)** – It implies renewal of entire lot of sleepers from point to point. Necessary recouping of ballast and provision of full ballast cushion is also done along with T.S.R.

d) **Through-cum-Casual Renewal** – It implies through renewal of a certain length of track and carrying out casual renewal in the remaining length to be renewed.

e) **Casual Renewal** – It implies the renewal of some of the unserviceable rails or sleepers or both with generally serviceable released rails and sleepers of similar type and age.

f) **Spot Renewals** – It implies the renewal of some of the unserviceable rails or sleepers or both with generally with new materials in a specified length, Spot renewal of rail should be avoided as far as possible.

g) **Primary Renewals** - It implies the renewal where new P.Way materials are used. Primary renewals may be of the following type :

<table>
<thead>
<tr>
<th>I</th>
<th>Complete track renewal (primary) abbreviated as CTR (P)</th>
<th>Complete track renewals with all new track materials.</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Through rail renewal (primary) abbreviated as TRR (P)</td>
<td>Rail renewals with new rail and fittings.</td>
</tr>
<tr>
<td>III</td>
<td>Through sleeper renewal (primary) abbreviated as TSR (P)</td>
<td>Sleeper renewals with new sleepers and fastenings.</td>
</tr>
</tbody>
</table>

h) **Secondary renewals** - It implies the renewals where released serviceable P.Way materials are used. Secondary renewals may be of the following type :

<table>
<thead>
<tr>
<th>I</th>
<th>Complete track renewal (secondary) abbreviated as CTR (S)</th>
<th>Complete track renewal with all second-hand serviceable (S.S.) P.Way materials.</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>Through rail renewal (secondary) abbreviated as TRR (S)</td>
<td>Rail renewals with S.S. rails.</td>
</tr>
<tr>
<td>III</td>
<td>Through sleeper renewal (secondary) abbreviated as TSR (S)</td>
<td>Sleeper renewal with S.S. sleepers.</td>
</tr>
</tbody>
</table>
11.2  Track Renewals – General Guide Lines:

1) Normally complete track renewal should be programmed on the trunk routes and main lines. Separate rail renewals and sleeper renewals should be avoided unless inescapable.

2) Primary renewals are generally carried out on important high density traffic routes viz. Group A, B, C & D routes on B.G. and trunk routes on M.G., whereas secondary renewals are done on E routes on B.G. and unimportant main lines, branch lines, and sidings etc. as also, on M.G. having comparatively lesser traffic density and low speeds.

3) Track renewal should be planned with an objective that maximum benefits are derived out of it, such as removal of speed restrictions permission of heavier axle loads, introduction of higher speeds and cutting down maintenance cost etc.

4) It is desirable to plan track renewals in reasonable long length preferably in a continuous block section.

5) No track renewal should normally be planned purely on the basis that the existing track is below the prescribed standard.

6) The rail section should be so adopted that renewal on the basis of GMT carried should not be earlier than once in 20 years.

7) Along with complete Track Renewal and Through Sleeper Renewal, deep screening of ballast should also be done and full ballast cushion provided as per standard specified for that section.

Track renewal should be planned in a systematic way with an objective of long term planning in mind.

11.2.1 Speed restrictions for track renewals

**TABLE – 1**

<table>
<thead>
<tr>
<th>Broad and Metre Gauge – Manual Packing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>1st</td>
</tr>
<tr>
<td>2nd</td>
</tr>
<tr>
<td>3rd</td>
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<tr>
<td>4th to 9th</td>
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<tr>
<td>10th</td>
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<tr>
<td>11th to 19th</td>
</tr>
<tr>
<td>20th</td>
</tr>
</tbody>
</table>
### TABLE – 2
**Broad Gauge – Machine Packing**

<table>
<thead>
<tr>
<th>Day</th>
<th>Sequence of events</th>
<th>Speed in Km.p.h</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Opening, relaying and packing.</td>
<td>20</td>
</tr>
<tr>
<td>2nd</td>
<td>1st tamping.</td>
<td>20</td>
</tr>
<tr>
<td>3rd to 5th</td>
<td>Attention to track as required.</td>
<td>45 (after completion of 1st tamping)</td>
</tr>
<tr>
<td>6th</td>
<td>2nd tamping.</td>
<td>45</td>
</tr>
<tr>
<td>7th to 8th</td>
<td>Attention to track as required.</td>
<td>75 (after completion of 2nd tamping)</td>
</tr>
<tr>
<td>9th</td>
<td>3rd tamping.</td>
<td>-</td>
</tr>
<tr>
<td>10th</td>
<td>---</td>
<td>Normal sectional speed.</td>
</tr>
</tbody>
</table>

**Note:** The work of Track renewals on double line should normally proceed in the direction opposite to Traffic.

**11.3 Classification and disposal/use of released material:**

(a) After a section of track has been renewed, the released materials should be carefully sorted out so that the greatest possible use may be made of them. They should then be classified by the Assistant Engineer. Tools and plants left over should also be classified and action taken on their disposal.

(b) The rails should be graded according to their weight and condition into groups suitable for re-use in running lines and for conversion into posts or structural members for various purposes or for sale as scrap. Where rail ends are worn or hogged, the feasibility of “Cropping” the ends should be considered if the condition of the rail is otherwise satisfactory.

(c) The sleepers should be sorted into various grades suitable for re-use in the track or as unserviceable material not fit for use in track works. The possibility of converting unserviceable Broad Gauge wooden sleepers to Metre Gauge or Narrow Gauge (762 mm.) should be considered before their classification as scrap. The unserviceable wooden sleepers may be used for temporary road-ways and other sundry purposes.

(d) Fish-plates, fish bolts, keys and dog spikes should be sorted into those suitable for re-use and the rest as scrap.

(e) If the switches and crossings themselves are too badly worn to be re-used, the small fittings such as stretcher bars, switch anchors, stud-bolts and blocks can generally be used. Crossings should be reconditioned by welding, if the wear is not too severe, as also the switches.

(f) The timbers should be carefully inspected to decide the best use that can be made of them. If they are not too severely worn, the holes can be filled with a suitable compound or plugged and the timbers re-used in less important positions. It often happens that long timber is not decayed throughout its length and it is frequently possible to cut short lengths. If cut lengths so obtained are not long enough for use. Two such pieces may be spliced and bolted together to form a composite sleeper for use in important sidings, interlaced with through sleepers.

**Lesson Plan for Training of Mate**

*March - 2004*
11.3.1 Basis of classification

For the purpose of classification, Permanent Way materials should be divided into three classes depending upon the section and condition as detailed below –

(a) Class I material is that which is new and of standard section. New items of obsolescent sections which are interchangeable with standard materials and are purchased from time to time to prevent wastage of other serviceable material, should be brought on to the stock account as Class I material. These items should be included in the price lists for the miscellaneous and common items. No other material of an obsolescent section is to be treated, as Class I, even through it may never have been put in the road.

(b) Class II material includes all new material obsolescent sections other than those included under Class I and all standard and obsolete material released from the road and fit for further use on track.

Class II released rails should be classified and sub-divided as under –

Class II (a) rails fit for use in running lines.
Class II (b) rails fit for use in non-running lines.

(c) Class III materials shall include all materials that has become unserviceable. This is either metal scrap or unserviceable timber. This class will include all rails which are neither Class I nor Class II.

Class III sleepers, wooden or steel should be further sub-divided as follows :

- Wooden sleepers – Class III – A not fit for use in track but fit for walling of enclosures or for paving.
  
  Class III- B - not fit in track but fit for scantling or manufacturing keys or plugs.
  Class III-C - fit for fire-wood only.

- Steel sleepers – Class III – A - unserviceable, suitable for reconditioning or conversion to smaller gauge. Class III – B - unserviceable scrap.

(d) Valuation of released material – This value of Class I, II and III materials should be fixed in consultation with the Financial Adviser and Chief Accounts Officer and shown in the price list for D.I. class material.

11.3.2 Marking of Permanent Way Material –

All permanent way material should be distinguished as follows or as otherwise directed :

(a) Class I – No marks.

(I) Class II (a) Second hand rail fit to be re-laid in running lines – Ends to be painted with a daub of white.
(II) Class II (b) Second hand rail fit for use in non-running lines – Ends to be painted with daub of yellow.

(III) Unserviceable rails not fit for use - Ends to be painted with daub of red.

(b) For other track materials like sleepers etc. -

(I) Class II i.e. Second hand fit for use in track works to be painted with a daub of white.

(II) Unserviceable material not fit for use - Ends to be painted with daub of red.

It should be ensured by the Assistant Engineer and Permanent Way Inspector that the materials of each class including fittings, are separately stacked for convenience of accounting and despatch and indication plates erected there at.

11.4 Identification of different qualities of Rails in the Field (Class I Rails) –

(1) First Quality Rails (T/12) : Indian Railway Specification IRS. T. 12/96 gives the detailed specification of flat bottom rails 60 Kg, 52 Kg of grade 880 MFa, 1000 MFa and 1080 MFa. 52 kg/m and 60 kg/m rails shall be classified as Class A and Class B rails based on tolerance in end straightness. The rails shall have rolled on it, the rail section, the grade of steel, identification marks of manufacturer, month and last two digits of the year of manufacture, process of steel making and the direction of rolling of rail.

(2) Second Quality Rails : These are rails with relaxation in sectional tolerance as provided in amendments to I.R.S. T-12/96 but otherwise confirming to T-12/96 in all other respects. The identification of such rails will be one hole of 6 mm dia, chamfered at both ends, drilled at the centre length of the rail and at the middle of the web. These rails should be used only on loop lines/sidings with speed restriction of 50 kmph. These rails shall be painted with orange colour on both sides of the web for a distance of one meter from each end for easy identification.

(3) Third Quality Rails : In addition to above two qualities, third quality rails supplied by steel plants are arising, particularly during the inspection of rails while producing first quality rails as per IRS-T-12 specification. There is no deviation in chemical composition or mechanical property in ‘industrial use’ rails from that of IRS-T-12. The deviations exit only in tolerance in surface defects, dimensions and straightness. These can be used in industrial sidings where speeds are limited to 30 kmph in B.G. and 25 kmph in M.G.

The identification of such rails will be one hole of 12 mm dia., chamfered at both ends, drilled at the centre length of the rail and at the middle of the web. A marking “I.U.” in 18 mm size shall be stamped on both end faces of rail. The third quality rail shall be painted with white paint on end face of flange and on both sides of flange for a distance of 500 mm, from each end for identification.

***
12.0 - BRIDGES

Duration : 1 Day

12.1   Track structure on Bridges

12.1.1 Rail and rail joints on Bridges

1.  **Longitudinal profile of Rails** – In standard plate girders no camber is provided. Open web girders of span 30.5 and above are provided with camber. Track on these bridges are laid correctly following the camber of the girders. While re-timbering is done it should be ensured that the longitudinal level of rails follows the camber of girders.

2.  **Rail Cant** – On bridges the rail should be laid with an inward cant of 1 in 20 by continuing the same cant as on the approaches.

3.  **Rail joints over the bridges** – In the case of small bridge opening less than 6.1 m rail joints should be avoided. For other spans, the preferred position of the rail joint is at 1/3 the span from either end.

4.  **SWR on Bridges** : SWR may be continued over girder bridges with un-ballasted decks upto 13.3 m opening if the length of SWR is symmetrical to the centre line of bridge and upto 6.1 m opening if the length of SWR is unsymmetrical to the centre line of the bridge. No fish-plated joint should be located on the girder or within six metres from either abutment. In all such cases rail free fastenings, such as rail screws, dog spikes or rail free clips shall be used, so that relative movement between rail and sleepers may take place.

5.  **LWR/CWR on Bridges** – In the case of laying LWR/CWR, provisions of LWR Manual should be followed.

   (a) In the case of girders (unballasted deck) LWR can be continued over bridges where overall length is not more than 20 m. In case of bridges where the overall length is between 20 and 43 m. LWR can be continued on B.G., in case of the track is laid with 52 kgs. and 90-R rails under certain conditions as laid down in LWR Manual.

   (b) LWR with rail free fastenings can be provided from pier with SEJs on each pier over the free end in the case of rollers on one side and rockers on other side. Box anchoring for a few sleepers should be done at the fixed end. In case of roller bearings on both sides, the central portion of the welded rails shall be box anchored on a few sleepers.

   (c) LWR can be continued over a girder bridge with the provision of S.E.J. at the far end of the approach of the bridge using rail free fastenings over girder bridge. The length of the girder bridge will be restricted as per the table given in LWR Manual.
6. **Precautions for arresting Creep** – Track on girder bridges with un-ballasted deck is always laid with rail free fastenings in all cases. Track on girder bridges laid with standard single rails and fish-plated joints be isolated from the SWR if existing, on approaches on either side by providing atleast two well anchored Standard rail lengths. Similarly the track on the girder bridges not laid with LWR/CWR shall be isolated from LWR/CWR by a minimum length of 36 metres of well anchored SWR on either side.

<table>
<thead>
<tr>
<th>Gauge</th>
<th>Clear distance between consecutive sleepers not to exceed.</th>
<th>Depth of sleepers (exclusive of notching) not less than</th>
<th>Length of sleepers</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.G.</td>
<td>510 mm</td>
<td>150 mm</td>
<td>Outside to outside of girder flanges plus 305 mm. but not less than 2440 mm.</td>
</tr>
<tr>
<td>M.G.</td>
<td>305 mm</td>
<td>125 mm</td>
<td>Outside to outside of girder flanges plus 305 mm. but not less than 1675 mm.</td>
</tr>
<tr>
<td>N.G.</td>
<td>125 mm</td>
<td>125 mm</td>
<td>Outside to outside of girder flanges plus 305 mm. but not less than 1525 mm.</td>
</tr>
</tbody>
</table>

12.1.2 ** Provision of Guard Rails on Bridges** –

(1) **Location**: Guard rail should be provided on all girder bridges (including pre-stressed concrete girder bridges without deck slab) whether major or minor. Guardrail should also be provided on all major and important ballasted bridges and also on such other minor bridges where derailment may cause serious damages.

On all flat top, arch and prestressed concrete girder bridges with deck slab, where guard rails are not provided the whole width of the bridge between the parapet walls shall be filled with ballast upto the top of the sleeper level.

(2) **Design of Guard rails** – The typical arrangement of a guard rail, with the important dimensions for B.G., M.G. and N.G. are shown in the sketch and table.
<table>
<thead>
<tr>
<th>Particulars</th>
<th>Sketch no. ref.</th>
<th>B.G.</th>
<th>M.G.</th>
<th>N.G.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clearance between guard rail and running rail</td>
<td>“a”</td>
<td>250±50 mm</td>
<td>200±25 mm</td>
<td>150±25 mm</td>
</tr>
<tr>
<td>Length of guard rail outside ballast wall and maintained to clearances mentioned in item – 1</td>
<td>L1</td>
<td>1825 mm</td>
<td>1825 mm</td>
<td>1825 mm</td>
</tr>
<tr>
<td>Length of guard rails to be sent so as to be brought together at the middle of the track</td>
<td>L2</td>
<td>4875 mm</td>
<td>3655 mm</td>
<td>3200 mm</td>
</tr>
</tbody>
</table>

The top table of the guard rail should not be lower than that of the running rail, by more than 25 mm. In the case of bridges on curves with canted track the difference should be measured with reference to a straight line connecting the running tables of inner and outer rails.

(3) **Fixing of Guard Rails** – The ends of guard rails should be bent vertically and buried and a block of timber fixed at the end of prevent entanglement of hanging loose couplings. To ensure that guard rails are effective, they should be spiked down systematically to every sleeper with two spikes towards the centre of the track and one spike on the opposite side. Notching of the rail foot for spikes fixing the guard rails should be done on every alternate sleeper.

(4) **Splaying of Guard rails** : In the case of through girder bridges on double lines, the guard rails should be splayed on both ends on both lines. In the case of bridges other than through bridges on double lines, the splaying need be done only on the facing direction of particular line. However, the non-splayed end should be bent downwards after it is stopped at the end of the abutment and wooden block provided.

**12.2 Inspection and maintenance of Track on Bridge proper :**

1. **Condition of Track** : It should be ascertained whether it is central on the rail bearers and the main girders and in good line and level.

   Departure from line is caused by incorrect seating of girders, shifting of girders laterally or length wise, incorrect seating of sleepers on girders or rails on sleepers, varying gauge or creep.

   Departure from level is caused by errors in level of bed blocks or careless sleepering. The adequacy of clearances of running rails over ballast walls or ballast girders at the abutments and condition of timbers and fastening on the run off and skew spans should be inspected.

2. **Sleepers** : The condition of sleepers and fastening should be checked. The spacing of sleepers should not exceed the limits laid down in para 273 (1) and 273 (3) of IRPWM. Squareness of sleepers shall be ensured. Sleepers requiring renewals should be marked with paint, and renewals carried out. End bolts should be provided on sleepers which have developed end splits.
3. **Hook Bolts**: Hook bolts should be checked for their firm grip. Position of arrows on top of the bolts should be at right angles to the rails pointing towards the rail. Hook bolts should be oiled periodically to prevent rusting.

4. **Creep and joint gap**: It should be checked and rails pulled back wherever necessary. Rail fastenings should be tight. Defective rails should be replaced. Where switch expansion joints are provided on the girder bridge, it should be ensured that free movement of the switch is not hindered.

5. **Guard rails**: Adequacy of guard rail arrangements should be checked. Correct distance between the running rail and guard rail should be maintained as per the prescribed dimensions.

6. Camber packing where provided should be in sound condition.

7. On girder bridges adequacy of pathways for inspection should be checked.

8. Sand bins which are provided for putting out fires should be filled with dry and loose sand.

***
13.0 - CURVES

Definitions:

1. Cant or super-elevation is the amount by which one rail is raised above the other rail. It is positive when the outer rail on a curved track is raised above inner rail and the negative when the inner rail on a curved track is raised above the outer rail.

2. Equilibrium speed is the speed at which the centrifugal developed during the movement by the vehicle on a curved track is exactly balanced by the cant provided.

3. Cant deficiency: Cant deficiency occurs when a train travel around a curve at a speed higher than the equilibrium speed. It is the difference between the theoretical cant required for such higher speed and actual cant provided.

4. Cant excess: Cant excess occurs when a train travels around a curve at a speed lower than the equilibrium speed. It is the difference between the actual cant and the theoretical cant required for a such a lower speed.

5. Maximum permissible speed of the curve: It is the highest speed which may be permitted on a curve taking into consideration the radius of the curvature, actual cant, cant deficiency, cant excess and the length of transition. When the maximum permissible speed on a curve is less than the maximum sectional speed of the section of a line, permanent speed restriction becomes necessary.

6. Cant gradient and cant deficiency gradient indicate the amount by which cant or deficiency of cant is increased or reduced in a given length of transition e.g., 1 in 1000 means that cant or deficiency of cant of 1 mm. if gained or lost in every 1000 mm. of transition length.

7. Rate of change of cant or rate of change of cant deficiency is the rate at which cant or cant deficiency is increased or reduced per second, at the maximum permissible speed of the vehicle passing over the transition curve, e.g. 35 mm per second means that a vehicle when travelling at a maximum speed permitted will experience a change in cant or deficiency of cant of 35 mm. in each second of travel over the transition.

8. Transition curve is an easement curve, in which the change of radius is progressive throughout its length and is usually provided in a shape of a cubic parabola at each of the curve. It affords a gradual increase of curvature from zero at the tangent point to the specified radius of circular arc and permits a gradual increase of super-elevation, so that the full super-elevation is attained simultaneously with the curvature of the circular arc.
13.2 Joints on curves:

Rail joints on curves normally be laid square. On the sharp curves less than 400 metres on the broad gauge and 300 meters on the metre gauge the rail joints may be staggered, where elbow and kinks are likely to develop if rail joints are laid square.

13.2.1 Check rails on curves: Check rails should be provided on the inside of the inner rail of the curves as stipulated in the schedule of dimensions.

Appropriate clearances should be provided between the check rail and the running rail as stipulated in the schedule of dimensions. Check rails reduce the risk of derailment on the sharp curves.

Location where check rails should be provided shall be decided by the Chief Engineer taking into consideration the negotiability of the rolling stock and the curve geometry.

Wear on outer rail of curves:

1. This can be reduced effectively.
   - By lubricating the gauge face of outer rails on the curves.
   - By maintaining correct curve geometry and super-elevation.

2. Provision of rail lubricator.

Rail flange lubricators should be provided on curves of radius 600 meters and less on Broad Gauge and of radius 300 metres and less at Metre Gauge to avoid rail face wear, the first lubricator being provided a little ahead of the curve.

13.2.2 Measurement of rail wear on sharp curves: The wear of rails of curves having radius of 600 M or less on B.G. and 300 M or less on M.G. shall be periodically recorded. Railways should prescribe the periodicity of measurement of wear on those sharp curves. The lateral, vertical and total loss of section should be recorded. Proper record of the measurement should also be maintained.

13.3 Negative Super-elevation

When the main line is on a curve and has a turnout of contrary flexure leading to a branch line, the super-elevation necessary for average speeds to trains running over the main line curve can not be given. The branch line curve has a negative super-elevation and therefore speeds on both track must be restricted, particularly on the branch line.

13.4 Transition Curve

13.4.1 Purpose of transition curve

As soon as a vehicle enter a circular curve taking off from a straight, it is subjected to a sudden centrifugal force, which not only causes discomfort to passengers but distorts track alignment and affects the stability of rolling stock. In order to provide
smooth entry to the curve, transition curves are provided on either side of a circular curve so that the centrifugal force is built up gradually by running out the super-elevation slowly at a uniform rate. A transition curve is, therefore, an easement curve in which the degree of curvature and gain of super-elevation are uniform throughout its length, starting from zero at the tangent point to the specified value at the circular curve.

13.4.2 The following are the objective of transition curve:

(I) To decrease the radius of curvature gradually in planned way from infinity at the straight to that of the circular curve to help the vehicle to negotiate a curve smoothly.

(II) To provide a gradual increase of the super-elevation starting from zero at the straight to the desired super-elevation at the circular curve.

(III) To enable the vehicles to negotiate a curve smoothly ensuring a gradual increase or decrease of centrifugal forces.

13.5 Widening of gauge or curves

A vehicle normally assumes the central position on a straight track and the flanges of the wheels are clear of rails. The position is however, different on a curved track. As soon as the vehicle enters a curve, the flange of the outside wheel of leading axle continues to travel in a straight line till it rubs against the rail. Due to coning of wheel, the outside wheel travels a longer distance compared to the inner wheel. This is, however, not possible for the vehicle as a whole because due to rigidity of the wheel base, the trailing axle occupies a different position. In an effort to make up the difference of travel between outer wheel and inner wheel, the inside wheels slip backward and outer wheel skid forward. A close study of vehicles on curves indicate that wear of flanges eases the passage of a vehicle round curves as it has the effect of increasing the play. Widening of gauge on a curve has in face the same effect and it tends to decrease wear and tear on both vehicles and track (see para 403 of IRPWM-1999).

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14.0 - RAIL FRACTURE AND WELD FAILURES

CE/035

Duration : 1 Day

14.1 Rail failures :

A rail is said to have failed if it has fractured in track or it is considered necessary to remove from track on account of defects other than those due to accidental damages due to buckling, kinking, derailments, abnormal wheel burns etc.

14.1.1 Action to be taken in case of rail fractures/weld failures :

1. As soon as rail fracture/weld failure is noticed, the track should immediately be protected.

2. It is of paramount importance that whenever a fracture of a rail/welded joint is noticed, immediate action is taken to restore the track, if necessary.

3. The Mate/Mate/Gangman, as soon as he notices the rail fracture/weld failure should first protect the track, while the repairs are being carried out. He should also send information to the PWI & the Station Master of the nearest station.

4. If the fracture is with a gap of less than 30 mm in the case of fish plated/S.W.R. track, the fractured portion should be supported on wooden block or by shifting the nearest sleepers on both sides. In case of LWR the fractured rail should also be clamped.

5. When the fracture gap is more than 30 mm. A closure of appropriate length should be used with a clamp & further action taken as in sub para (4) above.

6. In cases where a small portion or piece of rail has come off or in the case of multiple fracture, the rail has to be changed.

7. In the case of weld failure, joggled fish plates & clamps should be used.

8. After doing the emergency repairs the trains may be passed at 20 kmph by a Mate/Mate, until the permanent way official replaced the rail & restores full speed.

9. If there is a spate of rail fractures, additional Keyman's patrol should be introduced in the early hours of the morning.

14.2 Causes of Rail Fractures :

a. Inherent defects in the rail :

There are the failures occurring due to manufacturing defects of the rail such as faulty chemical composition, harmful segregation, piping, seams, laps and guide marks etc.
b. Defects due to fault of the rolling stock and abnormal traffic effects:

These are the rail failure occurring due to flat spots in tyres, engine burns, skidding of wheels, severe braking etc.

c. Excessive corrosion of rails:

Excessive corrosion in the rail takes place generally due to weather condition, subsoil containing corrosive salts like chlorides etc.

d. Badly maintained joints:

These are the rail failures caused due to poor maintenance of joints such as improper packing of sleeper and loose fitting etc.

e. Defects in welding in joints:

These are the failures occurring due to defects in the welding of joints.

f. Improper maintenance of track:

These are the failure, which develop as a result of ineffective or careless maintenance of track or due to delayed renewal of track.

g. Derailments:

These are the failures, which develops as a result of derailment.

14.3 Defects in Rails:

1. Corrosion
2. Wear on rails.
3. Flattening of table.
5. Battering of rail ends.
6. Wheel burns.
7. Corrugation.
9. Shelling

***
15.0 – FIRST AID

Duration : ½ Day

15.1 First Aid:

First aid is an immediate help rendered by trained person to a victim who met with sudden illness or accident before medical aid is obtained.

i) Preserved life
ii) Promote recovery
iii) Prevent further worsening
iv) Arrange transport for further medical aid

15.1.1 Scopes of first aid:

(a) The first aider should examine the casualty to know the details of injuries and their nature. This known as diagnosis.
(b) The diagnosis will give an idea of the treatment to be given till the doctor takes charge.
(c) Send the casualty to his house or to a hospital, as the case may be in a suitable manner. This is known as disposal.

15.1.2 Diagnosis: Diagnosis of a case is based on its history, sign and symptoms.

a) History of the case is the story of the accident, namely how the accident actually occurred. The casualty will give the history, if he is unconscious, then some one who saw the accident would give the history. The surroundings will add to the information.
b) Symptoms are what the casualty tell the first aider like pain, shivering, faintness etc. which will lead to the first aider to the reason of injury without waste of time.
c) Signs are what the first aider feels and finds out for himself like paleness swelling of parts injured, bleeding, deformity of limbs etc.

15.1.3 Treatment: If the cause of the accident is still there, it should be removed, e.g. a live electric wire pillars or logs on the body etc. or remove the casualty from the danger, e.g. a burning house, a room with poisonous gases etc.

See the casualty is comfortable, promote recovery and see that the condition does not become worse. First aiders prompt attention requires when failure of bleeding, stoppage of heart sever bleeding and shocks, poisoning major burns, head injuries and fractures. Continue treatment until the doctor takes charge.

15.1.4 Disposal: The earlier the doctor takes charge the greater chances of recovery. Take the casualty to the nearest shelter or hospital by quickest means of transport.
15.2 Dressing and stings :

15.2.1 Dressing : A dressing is a protecting covering applied to a wound to prevent infection, absorb discharge, control bleeding and to avoid further injury. An efficient dressing should be sterile (germ free) and have a high degree of porosity to allow oozing and sweating.

Dressing are of different types :

1. Adhesive dressing : It consists of a pad of absorbent gauge of cellulose, held in place by a layer of adhesive material.
2. Non-adhesive dressing : It consists of layers of gauge covered by a pad of cotton wool with an attach roller bandage to hold in position.
3. Gauze dressing : Gauze in layers in commonly used as a dressing for large wounds as it is very absorbent, soft and pliable.
4. Improvised dressing : This can be from any clean, soft absorbent material.

Application of dressing : Great care must be taken in handling and applying dressing. Therefore, hands should be washed thoroughly. Avoid touching any part of the wound with the finger or any part of the dressing, which will be in contact with wound. Dressing must be covered with adequate pads of cotton extending well beyond them and retain in position by a bandage or strapping. If a dressing adheres to wounds do not try to remove it. Covers it with sterile dressing after cutting away whatever can be removed .

15.2.2 Stings : Stings are used to immobilise and support the fractured limbs and to prevent pull by upper limb of injuries to chest, solders and neck.

Different type of stings :

1. Arm sting : Used for fractured rib, injured arm, wrist and hand.
2. Collar and cuff sting : Used as support for wrist only.
3. Triangular sting : Used for treating a collarbone.
4. Improvised sting

Applying the stings :

1. Face the casualty, put one end of the spread triangular bandage over the injured solder with point on the injured side.
2. Pass the end around the neck and bring it over the injured side solder. The other end will now be hanging down over the chest.
3. Place the forearm horizontally across the chest the bring the hanging end up. The forearm is now covered by bandage.
4. Tie the two ends in such a way that the forearm is horizontal or slightly tilted upward and the knot is placed in the pit above the collarbone.
5. Take the part of sting that is loose at he elbow behind the elbow end and bring the fold to the front and pin it up to the front of the bandage.
6. Place the free base of the bandage in such a way that its margin is just at the base of the nail of the little finger. The nails of all the fingers should be exposed.
7. Inspect the nails to see if there is any bluish Colour. A bluish Colour shows that there is a dangerous tightening of splints or plasters and therefore free flow of blood is not possible.
8. If the casualty is not wearing a coat, place a soft pad under the neck portion of the sting to prevent rubbing of skin at that place.

15.3 Wounds and bleeding (Hemorrhage):

When any tissue of the body e.g. skin, muscle, bone etc. is torn or cut by injury, a wound is caused. The depth of a wound is often more important then the area. Small deep wound caused by knives, bullets etc. are often be more dangerous.

15.3.1 Types of wounds:

(I) Incised wounds: Caused by sharp instruments like knife, razor etc. these wounds bleed very much.
(II) Confused wounds: Caused by blows by blunt instruments or by crushing the tissues are bruised.
(III) Lacerated wounds: Caused by machinery, falls on rough surfaces, pieces of shells, claw of animals etc.
(IV) Punctured wounds: Caused by stabs by any sharp instruments like a knife or a dagger. They have small openings, but may be very deep.

Wounds cause two great dangers: (a) Bleeding (b) Infection

Bleeding (Haemorrhage) is a common cause of death in accident. It is caused by the rupture of the blood vessels due to severity of the injury.

15.3.2 Types of bleeding: Bleeding may occur from arteries, veins, capillaries or from the combination of the three.

A. Sign and symptom of bleeding:

1. The casualty feels pain and may even collapse.
2. Skin becomes pale, cold and clammy.
3. Pulse gets rapid but very weak.
4. Bleeding becomes shallow, casualty grasp for bleed and signs deeply.
5. There is profuse sweating.
6. The casualty feels thirsty.

B. Bleeding are of two natures:

1. External bleeding – It is from the surface of the body.
2. Internal bleeding – It is within chest, skull or abdomen etc.

15.4 Sign and symptoms of shock:

a) Giddiness
b) Pale Colour of face
c) Coldness
Cold clammy skin  
Rapid and weak pulse  
Nausea (Vomiting sensation)  
Vomiting  
Unconsciousness

15.4.1 General treatment:

a) Reassure the casualty, if he is unconscious.
b) Keep the casualty on his back comfortably (except in case of injury of head, chest or abdomen), lower the head slightly and turn it to a side.
c) Loosen the clothing but do not remove it.
d) Wrap in light bed sheet or thin rug. (Note: Do not use hot water bottles. Do not apply massage and never give alcoholic drinks. If there is no chest or abdominal injury, hot tea, coffee or milk can be given.
e) Give pain relievers and arrest bleeding if necessary.
f) Arrange medical aid.

15.4.2 Electric shock: If any part of the body comes in contact with live electric wires, which is either exposed or not covered with insulators, or with a cable or rail in which current is leaking, a person gets an electric shock.

15.4.3 The effect of electric shock:

1. There may be fatal paralysis of heart.
2. There may be sudden stoppage of breathing due to paralysis of muscles used in breathing.
3. Heart may continue to beat, while breathing has stopped.
4. There may be burns, either superficial or deep. They depend on the strength of the electric current causing the injuries.

15.5 Management:

Intelligent and prompt action is required. If the first aider is not cautious, he may also receive electric shock or even die along with the casualty.

If the casualty is still in contact with the conductor, switch off the current. If the switch is not available, remove the plug or break the wire to cut off the current.

1. Place the casualty in a comfortable position and raise the injured part (if no bone fracture is suspected).
2. Press on the pressure point firmly for 10 to 15 minutes.
3. Apply a clean pad larger than the wound and press it firmly with the palm until bleeding becomes less and less and finally stops.
4. If bleeding continues, do not take to the original dressing, but add more pads.
5. Finally, bandage firmly but not too tightly.
6. Treat for shock.
7. Get the casualty to hospital as soon as possible.
15.5.1 Management in the case of severe external bleeding :

1. Bring the sides of the wound together and press firmly.
2. Established shock (True shock) : This kind of shock is mainly due to loss of blood body or loss of body fluids other than blood in case of severe vomiting etc.

15.5.2 Management in the case of internal bleeding :

1. Lay the casualty down with head low, raise his legs by use of pillow etc.
2. Keep him calm and relaxed. Re-assure him. Do not allow him to move.
3. Keep up the body heat with thin blankets, rugs or coats.
4. Do not give anything to eat or drink because he may have to be given an anesthetic later.
5. Do not apply hot water bottles or ice bags to chest or abdomen. This might only make thing worse.
6. Take him to a hospital as quickly as possible. Transport gently.

15.5.3 Bleeding from the nose :

1. Place the victim near a window or against current of air in sitting position with the head slightly bent forward.
2. Pinch the junction of the nose just below the hard part, if available put ice piece over the nose.
3. Advice him to use his mouth to breath and avoid breathing from nose.
4. Warn him not to blow the nose.
5. Do not block the nostril.
6. Arrange medical aid.

15.5.4 Bleeding from the ear :

1. Place the victim on suitable place on side-ways, and see that the affected ear is down. (If both ears bleeding keep face upward and head little bit low for free drainage of blood.)
2. do not block the ear.
3. Arrange medical aid.

15.6 Internal heart compression (If there are two trained persons)

1. This should be going with artificial respiration. Therefore ask the first aider giving mouth to mouth breathing to set to the right of the victim and placed you on the left side.
2. Feel and mark the lower part of the sternum.
3. Place the heel of your hand on the marked part.
4. Place the heel of the other hand over it.
5. With your right arm, press the sternum backwards towards the spine.
6. If the treatment is effective.
   a) Colour becomes normal.
   b) Pupils will contract as improvement begins.
   c) Carotid pulse begins with each pressure.
   When the pulse is restored, continue compression till the victim reaches hospital.
15.7 Poisons, gases and acids:

A by substances (liquid, solid or gas) when enters into body in sufficient quantity, which has power to injure health or destroy life is called poisons.

15.7.1 Methods of poisoning:

a) By swallowing
b) By breathing or by injection

Poisoning by swallowing – Acids, alkalies, disinfectants etc. are swallowed by mistake.

Poisoning by gases: Poisons get into the body through injection bites of poisonous snakes, rigid dogs or stings by scorpions and insects.

First aid in gas poisons: Take the victim to a safe place and start artificial respiration.

First aid in swallowed poison: Check whether the victim is conscious or not. If unconscious, check breathing and pulse. If there is no breathing, start artificial respiration and if there is no pulse, start cardiac message except corrosive chemicals like alkalies. Aid vomiting by tickling the back of the throat or make him drink tepid water mixed with two tablespoons of common salt for a tumbler of water. If proper antidote is not available immediately, give soft drink like mild, white part of an egg/barley/wheat flour mixed with water.

First aid in case of injected poisons: Put rubber bandage if the bite took place on legs or hands.

Note: Before cutting off the current ensure that you stand on a dry piece of insulated board. Do not use scissors or knife.

If casualty is not breathing normally or heart has stopped beating, give artificial respiration and external cardiac message for a long time. Treat for shock and burns. Transfer to a hospital or seek the help of a medical practitioner.

15.8 Artificial respiration

15.8.1 Respiration: Respiration means breathing in and breathing out of air. This function is necessary supply oxygen to all the organs in the body. Stoppage of oxygen supply to the organs results in death sooner or latter.

There have been several methods of artificial respiration practices. Out of which Sylvester’s method is felt the best. Mouth to mouth method has discovered and found to be best and easiest method to be used under normal condition.
15.8.2 Mouth to mouth artificial respiration:

1. Place the casualty on his back and hold his head tilted back.
2. Take a deep breath with mouth open widely.
4. Cover the mouth of the victim with your mouth snugly.
5. Watching the chest, blow into his lungs until the chest is falls back. (Note: It is hygienic to cover the mouth of casualty with your handkerchief or some clean cloth).
6. Repeat the above for 15 to 20 times permute.
7. If the chest does not rise look for an obstruction.
8. Turn the victim to a side and thump his back. This will make obstructing material come to the front of the throat. Open the mouth and remove it with your fingers covered with a piece of a cloth.
9. Use mouth to nose respiration if mouth to mouth respiration is not possible where the thumb of the first aider should close mouth of the victim.
10. If the heart is working, continue artificial respiration until normal breathing occurs, if the heart is not working, it will be notice that
   (a) The face is blue or pale.
   (b) Pupils are dilated.
   (c) Heart beat and pulse are not felt.
11. Call an ambulance.

15.8.3 Management:

1. Place the victim flat on his back on a herd surface (bench, table etc.)
2. Give a smart hit with the edge of your hand on the lower and left angle of the sternum. This usually stimulates the heart to work.
3. In case of heart does not work, persist the striking for 10 to 15 seconds, at the rate of one stroke per second. Feel for the pulse regular and continuous-stop breathing.
4. All the while artificial respiration has to go on.
5. Even if the victim is breathing, but the breathing is not normal it is wise to start artificial respiration.
6. Do not begin thumping the heart until your are sure that the heart is stop beating.

- Wash the area immediately, if readily available with potassium permanganate solution or other antiseptic solution.
- Do encourage bleeding and do not cover the wounds.
- Arrange medical aid.

15.9 Knowledge about respiration, storing of consumables, perishables, inflammables and fragile stores:

All the stores should be transported from one place to another very carefully. While transporting, care should be taken to avoid any damages. No material should thrown. They have to be taken physically to the appropriate place. Heavy material should be carried out on trolleys or carts. Care should be taken while loading and unloading into trolleys or carts.
While storing the materials, care should be taken to avoid any damages to the materials. Materials like consumables, perishables, inflammable and fragile should be stored separately.

Inflammable material such as oil, spirit and petrol should be stored separately and away from cotton waste, stationary and furniture. Bags of cement must be stored in a dry go-down with a masonry floor.

Transportation and storing of fragile store should have proper dry grass packing and handle with utmost care.

15.10 **Prevention of damage due to storm, rain, corrosion and fire:**

- All the stores and tools should be in proper condition and protecting them from deterioration.
- All materials must be kept clean, duly oiled where necessary and fit for immediate use.
- Materials must not be allowed to rust or otherwise deteriorate.
- Stores enclosures should be paved with stone or brick so as to keep material away from dust protection from weather.
- Bags of cement must not be stored in too large quantity.
- Naked light and smoking should not be allowed inside such go-down.

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16.0 – Basic Supervisory skill

16.1 Basic Supervisory skill

16.1.1 Knowledge of Rules and Signals

1. Every mate shall have the correct knowledge of hand and detonating signals and shall be conversant with the following rules:

   (a) Protecting the line in an emergency and during work affecting the track.
   (b) Method of fixing and safety range of detonators.
   (c) Action to be taken when a train is noticed to have parted.
   (d) “Safety first” rules.
   (e) Action to be taken where sabotage is suspected and patrolling in emergencies.

2. Every mate shall see that the signals, supplied to the gangs are kept in good order and ready for use and that every man in his gang has a correct knowledge of all the signals.

3. Mate shall keep in his charge in the tool box other tools and equipment as may be prescribed.

16.1.2 Safety of the line: Every mate shall see that his length of line is kept safe for the passage of trains. Kilometrage needing urgent attention shall be picked up without waiting for orders from the Permanent Way Inspectors.

   (a) Level-cum-gauge, square, hemp cord, metre stick, keying and/OT spiking hammer, fish-bolt spanner, 2 sets of H.S. flag, 10 detonators, marking chalk and Rail thermometer (2 H.S. Lamp in the night).
   (b) Sufficient number of shovels or phowrahs, beater, crow-bars, ballast forks or rakes, mortar pans or baskets and wooden mallet.

16.1.3 Muster and gang charts/diary books:

1. The muster and gang chart/diary shall be in the possession of each mate. The gang chart should be carefully kept in a container provided for the purpose.

2. The muster should normally be marked by the Mate, checked and initialled by the Permanent Way Inspector.

3. The Mate shall see that the prescribed system of track maintenance is adhered to and the tasks allotted, according to verbal instructions or entries made in his gang chart/diary, and explained to him, are efficiently carried out. If capable of entering details of work done in his gang diary, the Mate should do so.
16.2 Observance of sleeper packing during passage of train:

During the passage of the first and last train in working hours, the mate and his men should stand on the cess, each about one rail length apart, and observe the effect on the sleepers.

Passing over a track other than that on which the gangmen are working. It is worsened when trains are crossing each other. The noise of a train passing over one track prevents hearing the noise or whistle of another train approaching the work site.

When working at a place from which an approaching train cannot be seen, at least 600 metres away in the case of BG and 400 metres in the case of MG and NG, a gangmen with hand signals should be sent out by the Mate:

(a) On double line in the direction of approaching trains.
(b) On a single line in the direction the view is obstructed (in both directions if view is obstructed on both sides).

It will be the duty of such Flagman to warn the Mate by means of signals when a train is approaching. The mate will be responsible for warning the gang in good time to enable them to get clear off the track. It may be deemed expedient, as an additional precaution, to issue portable whistle boards of the type indicated in para 815(2) to the Mates, who should fix them at least 600 metres on BG and 400 metres on MG and NG from the work site, in the direction the view obstructed to less than this distance. In the case of MG high speed routes, the distance may be increased suitably as per the directives of the administration.

16.2.1 Tidiness of section: The Mate shall see that the whole of his gang length is kept neat and tidy and that all loose materials are collected and brought to stations, gangs quarters or gate lodges.

16.2.2 Safe custody of tools: The Mate shall be responsible for the safe custody of tools used by him, the Keymen and Gangmen. He should see that Gangmen on work remove their tools clear of the track on the approach of a train. After the day’s work the Mate should secure the tools in the toolbox. In no case should Gangmen be permitted to take tools consequence of any defect in the Permanent Way or works, or abnormal rain or flood or any other occurrence, he shall take immediate steps to secure the safety of trains by using the prescribed signals to “Proceed with Caution” or to “Stop” as necessity may require, and shall, as soon as possible, report the circumstances to the nearest Station Master and the Permanent Way Inspector.

In the event of an accident, the Mate, Keyman and Gangmen should lookout for broken fittings of wagons and track components and see that these are not disturbed until they have been seen and recorded by a responsible official.

16.2.3 Patrolling during abnormal rain fall: during abnormal rainfall, the Mate should organise patrolling on the gang-length, whether or not Patrolmen are on duty. In the event of damage being detected, action should be taken to safe-guard traffic by protecting the line.
16.2.4 **Commencing work affecting safety of trains**: No work which may involve danger to trains should be under taken by the Mate except under the personal supervision of the Permanent Way Inspector, or a competent railway servant authorised by special instructions, unless it is an emergency where the requirements of safety warrant the commencement of the work. In such cases the Mate shall ensure that Engineering Signals are exhibited at the specified distances according to rules and Flagmen are posted with necessary equipment to man them before commencing the work.

16.2.5 **Weekly inspection of gang length by Mate**: The Mate shall inspect the whole gauge length once a week, on which day he will carry out the Keyman’s work and duties and the Keyman will remain in-charge of the Gang.

16.2.6 **Prevent trespass and theft of Permanent Way Fittings**: Every Mate and his men shall endeavour to prevent trespass in railway limits by persons or noticed. He along with Gang, should also attempt to prevent theft of P.Way fittings and report any attempt to steal, to his Permanent Way Inspector.

16.2.7 **Relief arrangement in emergencies**: The Mate shall arrange immediate relief for Keymen, Gangmen, Patrolmen and Watchmen when, due to sickness, they are unable to perform their duties.

16.2.8 **Assistance of P. and T. staff**: Where interruption to the telegraph line has occurred through obviously visible causes, the Permanent Way staff should render all possible assistance. The staff must for example, remove trees or branches of trees which after a storm, are seen to foul the wires. Where wires are seen to be broken or entangled, the occurrence should be reported to the nearest Station Master.

16.2.9 **Assistance in protection of trains**: The Mate and his men should render assistance to guards and drivers of the trains for the protection of the trains in the event of an accident between stations, when called upon to do so.

16.2.10 **Assistance in placing fog signals**: On requisition from the Station Master, the Mate of a yard gang may depute, if available, two Gangmen for placing of detonators, during time of poor visibility, in the rear of approach signals of the station.

16.3 **Gangmate**:

   (a) They shall carry out maintenance work under their personal supervision only if they are in possession of valid competency certificate issued by Zonal/Divisional Training Centre to work on LWR/CWR section.

   (b) They shall undertake only those works of train maintenance for which they are authorised as per Annexure – VI.

   (c) They shall maintain additional/special equipment issued to them in good condition and bring to the notice of Permanent Way Inspector defective equipment requiring repairs.
(d) They shall ensure that hot weather patrolmen turn out on duty during the specified patrol period and carry out the patrolling duties correctly. They shall be vigilant during hot weather and order patrol if the temperature is like to reach $t_d + 20^\circ C$ and report to their supervisors any unusual occurrences which take place on the LWR/CWR in their beat.

(e) They shall take prompt action to protect the track in case of rail/weld fractures and carry out emergency repairs to permit the restoration of traffic promptly and report to nearest Station Master/ Permanent Way Inspector.

(f) They shall take immediate steps to secure the safety of the trains, if they consider that the track is likely to be rendered unsafe.

(g) They shall impose the specified speed restriction and post watchman if the temperature exceeds $t_d + 20^\circ C$ during the period of consolidation after the maintenance work had been completed.

(h) They shall make up the shortage of ballast at isolated/vulnerable locations and report any ballast deficiency or disturbance of track to the PWI.

(i) They shall inspect SEJ and LWR/CWR under their jurisdiction frequently, specially during the hottest part of the afternoons in summer and report any unusual occurrence on LWR/CWR to PWI and obtain his order.

(j) They shall ensure that men working under them have knowledge of working on LWR/CWR.

(k) They shall introduce cold weather patrolling when instructed by their supervisors.

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OUR OBJECTIVE

To upgrade Maintenance
Technologies and Methodologies
and achieve improvement in
productivity and performance
of all Railway assets and manpower
which inter-alia would cover
Reliability, Availability,
and Utilisation.

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