Steel Channel Sleepers

In view of the great shortage of wooden sleepers, steel channel sleepers have been developed by Indian Railways particularly for use on girder bridges. Steel channel sleepers can be used for welded plates, riveted plates, as well as open web girders.

Composite sleepers have been developed indigenously in India as a replacement for wooden sleepers. These are made from waste products such as used rubber tyres, and the manufacturers claim a lifespan of about 40 years for these sleepers. The Patel Group of Industries is one such firm that has developed these composite sleepers. Composite sleepers are similar to wooden sleepers and use similar fittings. These sleepers are under trial and the results so far have been quite encouraging.

Steel Trough Sleeper

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

Fig. Steel trough sleeper (BG 90 R)
 **Advantages**

(a) Long life
(b) Easy to maintain gauge and less maintenance problems
(c) Good lateral rigidity
(d) Less damage during handling and transport
(e) Simple manufacturing process
(f) Very good scrap value
(g) Free from decay and attack by vermin
(h) Not susceptible to fire hazards

 **Disadvantages**

(a) Liable to corrode
(b) Unsuitable for track-circuited areas
(c) Liable to become centre-bound because of slopes at the two ends
(d) Develops cracks on rail seats during service
(e) Design is rail specific

 **Design Features**

The steel trough sleeper essentially consists of a rolled steel plate of about 2 mm thickness pressed into a suitable trough shape and the rail seat canted to 1 in 20. The ends of the rolled section are flattened out in the shape of a spade to retain the ballast. Two alternative types of sleepers have been designed for each rail section as per the following details.

1. In one type, the lugs or jaws are pressed out of the plate itself to accommodate the foot of the rail and the key (Fig.1). There are several maintenance problems with these pressed up lugs, as they give way due to the movement of the keys as well as due to the vibrations and impact of the moving loads.
2. In order to obviate this defect, another sleeper design has been adopted. In this design, two holes are punched into either side of the plate to accommodate specially designed ‘loose jaws’ (Fig. 2). The rails are held with the help of two standard keys driven either into the pressed up lugs or into the loose jaws.

The adjustment of the gauge to the extent of ± 3 mm is done by properly driving in the keys. In the double-line section, the keys are driven in the direction of the traffic. The approximate weight of a standard BG trough sleeper is 81 kg and that of an MG sleeper is 35 kg. The steel trough (ST) sleeper has an average life of about 50 years. It is an acceptable type of sleeper for use with long welded rails because of its lateral stability and its adaptability for use along with elastic fastenings.

➢ Classification
All steel sleepers conforming to Indian Railways specifications T-9 are classified as first quality sleepers. The sleepers not accepted as first quality but free from the following defects are termed second quality steel trough sleepers.

(a) Inward tilt at rail seat beyond the limits of 1 in 15 to 1 in 25
(b) Sleepers with a twist
(c) Heavy scale fitting or deep grooves or cuts
(d) Deep guide marks at heads, blisters, etc.

All first quality sleepers are normally marked by a green dot. Sleepers that have been rejected as first quality sleepers on account of pipes, seams, and laps but are free from the defects indicated above are marked with a cross (×) in yellow paint at the centre. All other second quality steel trough sleepers are marked distinctly with a 15-cm-wide strip of yellow paint at one end. Sleepers that are unfit as second quality are given a distinct red paint mark to avoid mixing them up with first and second quality sleepers during loading.

➤ Maintenance Problems

It has been noticed that the keys used to fix rails on steel sleepers tend to become loose due to the bending of the pressed up lugs or due to wear at the rail seat. The holes also get elongated during service. Special types of shims and liners are provided in these cases to hold the gauge well. Mota Singh Liner is a very effective type of liner used for holding the correct gauge for oblong holes with loose jaws. Another maintenance problem with steel trough sleepers is that these tend to become centre-bound if due care is not taken while packing. The ballast is normally removed from the centre of the sleepers after packing so as to ensure that centre binding of the sleepers does not take place. Sometimes the alignment of steel sleeper tracks also gets affected by the overdriving of the keys.

➤ Cast Iron Sleepers

Cast iron sleepers are being extensively used on Indian Railways and about 45% of the track at present consists of CI sleepers, which may be either pot type or plate type. The main advantages and disadvantages of CI sleepers over steel trough sleepers are the following.

ציflammable Advantages

(a) Less corrosion
(b) Easy to manufacture
(c) Higher scrap value

**Disadvantages**

- a. Gauge maintenance is difficult as tie bars get bent
- b. Provides less lateral stability
- c. Unsuitable for track-circuited lines
- d. Not very suitable for mechanical maintenance and/or MSP because of rounded bottom
- e. Susceptible to breakage

**CI pot sleepers**

Cast iron pot sleepers (Fig. ) consist of two hollow bowls or pots of circular or elliptical shape placed inverted on the ballast section. The two pots are connected by a tie bar with the help of cotters and gibbs; the gauge can be adjusted slightly [± 3 mm (1/8”)] by changing their positions. The rail is placed on top of the pots in a rail seat provided with a cant of 1 in 20 and is held in position with the help of a key. The pot sleeper suffers from the drawback that it cannot be used on curves sharper than 4° on BG. Most of the fittings are hidden and their inspection and maintenance is quite difficult. These sleepers have become obsolete now and are not being procured by the Indian Railways any more.

![Diagram of CI pot sleeper](image-url)

**CST-9 sleepers**
The CST-9 sleeper is a standard sleeper and is being most extensively used on Indian Railways (IR). It is called CST-9 (Central Standard Trial-9) (Fig.) because it is the ninth of the series produced by the Central Standard Office. The sleeper is a combination of pot, plate, and box sleepers. It consists of two triangular inverted pots on either side of the rail seat, a central plate with a projected keel, and a box on top of the plate. The two CI plates are connected by a tie bar with the help of four coters. The rails are held to the sleeper by two-way keys provided at each rail seat on the side of the gauge face. The gauge is adjusted to a value of ± 5 mm by altering the relative positions of the four coters.

<table>
<thead>
<tr>
<th>Rail</th>
<th>Gauge</th>
<th>RDSO drawing number</th>
<th>Wt (kg)</th>
<th>A (mm)</th>
<th>B (mm)</th>
<th>C (mm)</th>
<th>D (mm)</th>
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<tbody>
<tr>
<td>52 kg</td>
<td>BG</td>
<td>T-478 (M)</td>
<td>43.55</td>
<td>800</td>
<td>330</td>
<td>140</td>
<td>89</td>
</tr>
<tr>
<td>90 R</td>
<td>BG</td>
<td>T-478 (M)</td>
<td>43.55</td>
<td>800</td>
<td>330</td>
<td>140</td>
<td>89</td>
</tr>
<tr>
<td>90 R</td>
<td>MG</td>
<td>T-2366</td>
<td>-</td>
<td>700</td>
<td>300</td>
<td>132</td>
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<tr>
<td>75 R</td>
<td>MG</td>
<td>T-498 (M)</td>
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<td>650</td>
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<td>60 R</td>
<td>MG</td>
<td>T-10257</td>
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<td>270</td>
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<tr>
<td>50 R</td>
<td>NG</td>
<td>T-438</td>
<td>-</td>
<td>533</td>
<td>228</td>
<td>108</td>
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</tbody>
</table>
The rail seat of a CST-9 sleeper is 115 mm wide along the length, and this narrow bearing tends to reduce the rocking of the sleeper under the wave motion of the rail. The sleeper is designed to provide a firm support to the rail and provides fairly good lateral and longitudinal stability to the rails. The dimensions of CST sleepers in use on IR are given in Table 7.5. The sleeper provides a bearing area approximately equal to the effective bearing area of a standard BG wooden sleeper, i.e., 5 sq. ft, for both the plates. CST-9 plates are also available with reverse jaws (T-443 type) to serve as an anti-sabotage measure; a few of these are provided in each rail length. Normally, three reverse jaw CST-9 sleepers are provided per rail to serve anti-sabotage purposes. The weight of a CST-9 sleeper assembly along with fastenings for BG is 102 kg and for MG is 58 kg.

The CST-9 sleeper is one of the most popular sleepers on Indian Railways at present. The sleeper has, however, certain limitations when combined with the modern track as mentioned in the following.
(a) As the sleeper does not have a flat bottom, it is not quite suitable for MSP and mechanical maintenance with tie tamers.
(b) The suitability of a CST-9 sleeper on LWRs, particularly on the breathing lengths, is doubtful because of rigid fastenings and the inability of the fastenings to hold the rail with a constant toe load.
(c) The rail seat wears out quickly causing the keys to come loose.
(d) The sleeper has only limited longitudinal and lateral strength to hold LWRs, particularly in the breathing length.
(e) Due to the use of less metal under rail seat, the shocks and vibrations are directly transmitted to the ballast, resulting in poor retention of packing (loose packing) and hence an increased frequency of attention.

**CST-9 sleeper for MG**

A new design of the CST-9 sleeper has recently been developed by Indian Railways for 90 R rails on MG lines as shown in Fig. A

![CST-9 sleeper for MG](image)

**CST-10 sleepers**

The CST-10 sleeper is an improvement on the design of the CST-9 sleeper to suit the requirements of a modern track. The basic design feature of this sleeper is the same as that of a CST-9 sleeper except the following improvements.

(a) The rail is held with clips and double-coil spring washers instead of a fixed lug and key.
(b) An insulating liner is provided between the rail and the sleeper.
(c) A rubber pad is provided below the rail seat.

A CST-10 sleeper gives certain amount of elasticity to the track by virtue of its double-coil spring washer. The sleeper, however, has the limitation that it cannot be used with elastic fastenings.

**CST-11 sleepers**
The CST-11 sleeper is an improvement over the CST-10 sleeper. A special shoulder is provided to accommodate the Pandrol clip instead of clips and double-coil spring washers. An elastic rubber pad is provided between the sleeper and the rail seat instead of the rail resting directly on the sleeper. The CST-11 sleeper has the potential of being used on the modern track. The sleeper, however, is still in the experimental stage and the results are not very encouraging at present. Its design details are shown in Fig. B

![CST-11 sleeper diagram](image)

**CST-12 sleepers**
CST-12 sleepers are designed to suit the IRN-202 clip, instead of the Pandrol clip. In this case the casting is quite complicated due to the shape of the clip. No firm has undertaken the manufacture of this sleeper as yet.
CST-13 Sleepers

The purpose of the CST-13 sleeper is to use the existing CST-9 sleeper with certain additions and alternations made in the local workshop. It consists of the CST-9 plate with the rubber pad under the rail and an additional rubber head to fill the gap occupied by the key. The rail is fastened to the sleeper by a sigma clip, similar to the ‘fist fastening’ used on Swedish Railways. To reduce the cost of the sleeper, the inner cotter is dispensed with. No adjustment of gauge is possible in this sleeper. The CST-13 sleeper is still under trial.

Concrete Sleepers

The need for concrete sleepers has been felt mainly due to economic considerations coupled with changing traffic patterns. In the early days of Indian Railways, wood was the only material used for making sleepers in Europe. Even in those days, the occasional shortage of wooden sleepers and their increasing price posed certain problems and this gave a fillip to the quest for an alternative material for sleepers. With the development of concrete technology in the nineteenth century, cement concrete had established its place as a versatile building material and could be adopted suitably to meet the requirements of a railway sleeper. In the year 1877, Mr Monnier, a French gardener and inventor of reinforced concrete, suggested that cement concrete could be used for making sleepers for railway tracks. Monnier in fact designed a concrete sleeper and obtained a patent for it, but his design did not work successfully. The design was further developed and the railways of Austria and Italy produced the first concrete sleepers with a promising design around the turn of the nineteenth century. This was closely followed by other European railways, where large-scale trials of concrete sleepers were done mostly due to economic considerations.

However, not much progress could not be achieved till the second world war, when wooden sleepers practically disappeared from the European market and their prices shot up. Almost at the same time, as a result of extensive research carried out by French Railways and other European railways, the modern track was born. Heavier rail sections and long welded rails came into existence. The necessity of a heavier and better type of sleeper that could fit the modern track...
was felt. These conditions gave a spurt to the development of concrete sleepers and countries such as France, Germany, and Britain went a long way in developing concrete sleepers to perfection.

**Development**

The development of concrete sleepers that took place on various railway systems was mainly based on the following concepts of design.

(a) RCC or prestressed sleepers similar in shape and size to wooden sleepers
(b) Block-type RCC sleepers connected by a steel tie bar
(c) Prestressed concrete blocks and a steel or an articulated concrete tie bar
(d) Prestressed (pre-tensioned or post-tensioned) type of concrete sleepers

These four concepts of design are the basis of the development of present-day concrete sleepers.

**Advantages and disadvantages**

Concrete sleepers have the following advantages and disadvantages.

**Advantages**

a. Concrete sleepers, being heavy, lend more strength and stability to the track and are specially suited to LWR due to their great resistance to buckling of the track.

b. Concrete sleepers with elastic fastenings allow a track to maintain better gauge, cross level, and alignment. They also retain packing very well.

c. Concrete sleepers, because of their flat bottom, are best suited for modern methods of track maintenance such as MSP and mechanical maintenance, which have their own advantages.

d. Concrete sleepers can be used in track-circuited areas, as they are poor conductors of electricity.

e. Concrete sleepers are neither inflammable nor subjected to damage by pests or corrosion under normal circumstances.

f. Concrete sleepers have a very long lifespan, probably 40–50 years. As such rail and sleeper renewals can be matched, this is a major economic advantage.

g. Concrete sleepers can generally be mass produced using local resources.
**Disadvantages**

(a) Handling and laying concrete sleepers is difficult due to their large weights. Mechanical methods, which involve considerable initial expenditure, have to be adopted for handling them.

(b) Concrete sleepers are heavily damaged at the time of derailment.

(c) Concrete sleepers have no scrap value.

(d) Concrete sleepers are not suitable for beater packing.

(f) Concrete sleepers should preferably be maintained by heavy ‘on track’ tampers.