

Development of Special PSC Sleeper Assembly Using SEJ Sleepers For Special Turnout (Diamond & Scissors Crossing)

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SYNOPSIS

After introduction of fan shaped turnouts on PSC sleeper track maintenance has improved manifolds and a probable cause for derailment has been eliminated apart from lesser maintenance input requirement from manual labour. This leaves only special turnout like diamond crossings with higher crossing angle and scissors crossings on wooden sleepers. There is lot of efforts to provide alternate assemblies on these spots by using P&C sleepers but problem remains for the locations requiring longer sleepers (Length > 4.9m) as same is not available even in 1 in 20 Fan shaped Turnout.

In view of above situation a possibility was explored to use SEJ sleepers to develop this type of sleepers by using existing rail assembly and fixing it on special sleepers prepared by using 2 or more SEJ sleeper and fixing rail assembly by ERC at every sleeper, thereby making a robust, sturdy and maintainable structure. This concept was developed and successfully used on Bhatinda bypass BG- BG diamond crossing having crossing angle of 75°.

This method is flexible enough to be utilized at any special turnout by replacing wooden sleeper with special PSC sleepers. There is a possibility to manufacture special sleepers by concrete sleeper plant.

1.0 Introduction

Introduction of PSC sleeper was a watershed after which track maintenance standards has changed significantly and track structure has become sturdy and reliable. Subsequently, introduction of fan shaped turnouts on PSC sleeper has further improved track structure on turnouts and this has resulted in consistent reliable track which was fit for higher speed. This shift from wooden/ metal sleepers to PSC sleepers leads to significantly improved track structure and a probable cause for derailment has been eliminated apart from lesser maintenance input requirement from manual labour.

This leaves only special turnout like diamond crossings with higher crossing angle and scissors crossings still on wooden sleeper's layout. There is lot of efforts to provide alternate to these wooden sleeper assemblies by various methods like use of P&C sleepers but problem remains for the locations requiring sleepers longer than 4.9m length as same is not available even in set of 1 in 20 T/o set.



75° diamond crossing on wooden sleepers at Bhatinda Bypass

Further, drilling of holes and removal of inserts on P & C sleepers is also required to house diamond/ scissors assembly and it has been noticed that retentively of these holes drilled on site is not lasting more than six months, therefore not resulting in long term solution. Change of alignment to reduce angle of diamond crossing to utilize standard RDSO drawing is also not possible as most of these locations are situated in old busy congested yard

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and due to space constraints and other obligatory points, it is not feasible to use standard RDSO drawing.

These special turnouts laid on wooden sleepers are very difficult to maintain due to non availability of long wooden sleepers. High crossing angle on these turnouts leads to their non standard design which includes longer wooden sleepers, special type of check rails, built up crossings, distance blocks and different size nut and bolts. In absence of standard design, these fittings are very difficult to catch hold of for maintenance. These turnouts are spread over Indian Railways and invariably located in old busy and congested junction yards and due to constraints of land and obligatory points, modification in their approaches to reduce crossing angle is also not possible.



Adjoining Diamond crossings in Krishna Canal Junction



Scissors crossing in Kazipet

These special turnouts are having special design and layout at different locations as per local requirement and solution to their maintenance problem is being dealt by local level by sectional P. way engineers. Large number of trackman, blacksmith along with continuous attention by PWI is used to maintain track safe on these turnouts. In maintenance of these turnouts problem of availability of suitable wooden sleeper and fittings is faced.

In view of above situation a possibility was explored to use 2 or more SEJ sleepers (side by side and adjacent to each other) to develop long PSC sleeper required to house these special turnout. It was also decided that time tested existing rail assembly on wooden sleepers will be retained and same assembly is to be fixed on Specially designed PSC sleepers assembly by using elastic fastenings (ERC with GR pad). This concept was successfully used for development of special PSC sleeper assembly (Bikaner Assembly) for diamond crossing on Bhatinda bypass where Bikaner- Delhi BG line crosses the Bhatinda – Hisar BG line on 75° crossing angle.

2.0 Possible options for special Turnouts

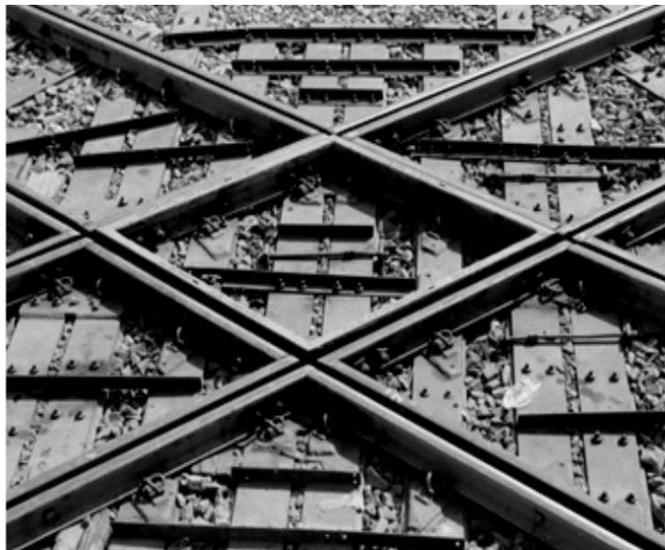
Maintenance of these special turnouts is very difficult and given any opportunity, all P. way engineers will try to avoid these non standard layouts but still on some of the locations these special non standard turnouts become necessary for operational requirement. Possible options to replace wooden sleepers by PSC sleeper are listed as below-

- A. Change in approach alignment to reduce crossing angle –If crossing angle is reduced to such an level that standard 1 in 8.5 or 1 in 12 crossings can be used then maintenance becomes quite easy and sleepers of P&C fan shape layout may be used with standard layout is used. Availability of land is prerequisite for easing the crossing angle. This is difficult in existing yards but on new locations of special turnouts may be governed by this criterion for better maintainability.
- B. Possibility of grade separator – Provision of grade separator in case of diamond crossing is an option that not only solves the problem of track maintenance but provides higher unrestricted speed on both the directions. This option is most effective long term solution but requires large fund and adequate space, which is difficult in existing yards. Grade separator shall be planned in all new line and doubling projects as planned in Dungarpur – Ratlam New BG line (190 Km) work for providing connectivity of new line to existing Ratlam yard.
- C. Use of P & C PSC sleepers- PSC sleepers are easily

available and can be used to replace existing wooden sleepers of special turnouts. Longest length of of 1 in 20 turnout sleeper is 4.9m and wooden sleepers of this length can be replaced. In this method holes are to be drilled in existing sleepers to hold the rail assembly of special turnout and all the obstructive inserts are required to be removed to house the special turnout assembly. This method was used in Secunderabad division of South Central Railways, but it is observed that holes drilled at site get loosened and rail screw started getting worked out from these holes after three to four months. It can be tried out initially on trial basis and subsequently set of special sleepers can be developed from sleeper plants and same is successfully carried out in South Central Railways.



P&C sleepers with Rail screw used on diamond crossing



SEJ sleeper with ERC on diamond crossing

- D. Use of 2 & more SEJ sleepers- SEJ sleepers provides good replacement option for wooden sleepers of special turnouts if 2 or more SEJ PSC sleepers are used side by side and adjacent to each other. This method is useful for the turnouts having larger crossing angle with sleeper's length more than 4.9m. In this concept, one combined special sleeper is prepared by using 2 or more SEJ sleepers as per required length. Rail assembly of special turnout is fixed to these combined special sleepers by GR pad & ERC and making it an effective solution for maintenance problems of special turnouts.

As discussed above, use of SEJ sleepers to prepare special PSC sleeper for special turnouts gives an effective, economical and maintainable solution which can be used to all the special turnouts for which standard design is not available.

This concept was used in Bikaner division of N. W. Railways on Bhatinda bypass for 75° diamond crossing. The detailed use of this method is discussed in next chapter as a case study.

3.0 Use of SEJ sleepers & its advantages

Points and crossing sleepers has been tried to replace wooden sleepers from special turnout and this concept has been used at some of the locations as discussed earlier. But there is a limitation of length as longest available sleeper of 1 in 20 P&C sleeper set is 4.9m and there are some diamond crossings where longer sleeper is required, therefore, there was no option but to join two sleepers to obtain longer length was prerequisite. Here SEJ sleeper provides better alternative to P & C sleepers. Since SEJ sleeper have 8 nos. holes without any projections and has larger bearing area without any cant which is favorable qualities for use in Special turnouts.

Following advantage makes combined SEJ sleepers for use in special turn out to replace wooden sleepers better than P & C sleepers.

1. No projected fittings as compared to inserts projected above of P & C sleeper.
2. Wider bearing area make these sleeper better option as it will give more stability to the turnout assembly. This factor enhanced because combined sleeper acts as a single sleeper after it has been prepared by joining two or more SEJ sleepers by using 6 mm thick rubber pad and 25 mm MS plate with standard SEJ fittings.
3. Inbuilt holes of SEJ sleepers are more effective in holding the sleeper assembly in comparison to s holes

driven in field through P&C sleepers. As per experience of the field engineers of Kazipet and Krishna Canal (Secunderabad division of S. C. Railways) these holes driven subsequently can't withstand the impact forces generated and tend to loosen after 3 to 4 months of life in the track. Further accuracy of driving the holes by avoiding the strands of PSC sleeper is also very difficult and lot of sleepers get wasted in the process due to lack of accurate driving methodology.

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4.0 Case study of 75°Diamond crossing at BTI Bypass

There is a non standard diamond crossing, where two BG lines namely Bhatinda bypass line (Bhatinda A cabin to Kartarsinghpura) and Bhatinda – Hisar lines crosses at 75°. This diamond crossing was laid on 25.01.1999 with wooden sleepers. This diamond crossing is situated on nominated CC+8+2 route and about 30 trains (including 20 loaded goods train) passes through daily. Length of wooden sleepers used on this diamond was varying from 4.10 m to 5.5 m. In diamond crossing assembly especially bended 1 m long fish plates, special check rails and distance blocks of built up crossings were used. With passage of traffic, maintenance of this diamond assembly becomes difficult due to non availability of wooden sleepers of required length. Old wooden sleepers were not able to withstand increased impact force of goods train and packing of whole diamond crossing assembly along with approach rails was regularly getting disturbed and day by day incidents of snapping of bended fish plate is also got increased. This situation reaches to this extent that tightening of bolts was required after passing of 2-3 goods trains and snapping of bended fish plate was occurring on average every week. All the options were tried in last three four years to replace wooden sleepers by PSC sleeper but no viable option could be worked out. Possibility of reduction of crossing angle was also not possible due to heavy built up area on all the four approaches and cost of grade separator was estimated at Rs 44 crore in year 2010, therefore dropped due to very high cost.



Old Diamond assembly on wooden sleeper



Bikaner Diamond assembly on special PSC

4.1 Design/development of Bikaner diamond assembly-

Due to above discussed maintenance difficulties it was decided that wooden sleepers have to be replaced by PSC sleepers. After going through fan shaped P & C sleepers design drawing it was clear that four sleepers of diamond crossing has length more than 4.9 m and there is no other option but to use two sleepers putting them side by side to increase the length. Further it was also observed that inserts of existing P&C sleepers are to be removed and holes are to be driven through these P & C sleepers. It was observed that holes drilled in P & C sleepers has effective life span of three to four months under traffic and after that they tend to get loosen up.

SEJ sleeper with flat surface without any projection, larger bearing area, eight factory made holes and easy availability was considered as a suitable option and it was decided to use 2 SEJ sleepers side by side for preparation of PSC sleeper layout to house the existing time tested

diamond rail assembly and it was also decided that rail assembly will be fixed at every point by ERC for better functioning.

By using above guiding principles, a prototype of special PSC sleeper was prepared. For its preparation, a skeleton Assembly of SEJ sleeper was prepared by putting them side by side and marking of existing diamond assembly was taken on a template and this marking was transferred on the skeleton assembly. In this prototype two problems were observed,

1. Firstly, joint of SEJ sleeper was coming exactly under the nose of crossing which was not a desirable situation and it was feared that both the sleeper will act independently to each other if joined in this manner.
2. Secondly, under the diamond crossing bearing area was not enough for placing a bearing plate to fix the assembly by ERC.

After contemplating with all the available option it was decided that use of three sleepers side by side will give sleeper of such length where joint will not be located directly under nose of crossing and by placing sleepers side by side will give much larger bearing area enough to fix the assembly by ERC.

After deciding these guiding rules prototype consists of seven special sleepers (D-1 to D-7) was prepared. 6 approach sleepers A-1 to A-6 is also prepared in similar manner. Every special sleeper is prepared by Joining SEJ sleepers as tabulated below.

Sr. No.	Special Sleeper number	No. of RDSO/ T-6253 sleepers used	Length of special sleeper in mm
1	A-1 to A-6	1	2700
2	D-1 & D-7	1	2700
3	D-2 & D-6	4	6980
4	D-3 & D-5	2	5400
5	D-4	4	5400

After preparation of prototype assembly as per above detailed specifications, drawing was prepared and approval of CTE was sought for using this new assembly on trial basis and CTE, NWR had accorded the approval for use of this special PSC sleeper assembly on the diamond crossing vide his letter dated 28.06.12 and this assembly was inserted into track on 30.06.12.

4.2 Material requirement

Material required for preparation of special PSC sleeper assembly is as below-

- i. SEJ (RDSO/T-6253) sleepers with fittings.
- ii. 16/20/25 mm thick MS plate.
- iii. Conveyer belt rubber pad (6 mm thick & 10 inch wide).
- iv. Special bearing plate of switch portion of Fan shaped turnouts.
- v. ERC & Liners
- vi. G R pad.
- vii. 4 mm dia, 450 mm long A-1/ER 4212 Pt2 (RDSO approved) Electrode for welding the special bearing plate and MS plate.

Apart from the above listed material, welding set generator for welding work and drilling machine for drilling holes through MS plate and rubber pad is also required. Welding work is preferably shall be done near the location of special turnout as after all preparation complete diamond assembly was fixed at site.

4.3 Fabrication & preparation of Bikaner diamond assembly

After collecting all the required material, plates were cut into required shape with local C & W workshop and holes were driven through the plates and rubber pad in PWI workshop. All the special sleepers prepared and placed as per drawing near the site with diamond rail assembly.



Holes Drawn In MS Plate

For preparation of these special sleepers, SEJ sleepers are placed as per drawing shown above and fixed by plate screw and angle by placing 6 mm thick rubber pad and 20 mm MS plate over the SEJ sleepers exactly in alignment of holes of individual sleeper, so that complete unit can act as a single special sleeper.



Arrangement for Drilling of Holes in MS Plate

For this rubber pad and MS plate is carved out of the size of the combined sleepers and holes are drawn in both the rubber pad and MS plate exactly in alignment of holes in SEJ sleepers. Finally connecting angle and plate screw tightened through MS plate, rubber pad and SEJ sleeper to prepare one special sleeper. Subsequently, special bearing plate is also welded as per marking to hold diamond rail assembly with ERC and liner on GR pad, to make this effective elastic connection

4.4 Insertion in track & precautions-

Complete diamond assembly was fabricated near to special turnout. This place shall be selected on a level ground with approach available for working of Hydra and road cranes. Road approach to this location is essentially required and suitable earthen platform was prepared beforehand for placing and propping of crane. Clean ballast cushion is essential requirement for smooth working of turnouts on PSC sleepers. Therefore, 200 bags of clean ballast was kept ready at nominated place near the turnout, A place is also required to be identified for placing of existing diamond assembly.

(A) Pre Block activities-

- I. Replace the approach sleepers with PSC sleepers if there is any wooden/ metal sleeper in the track.
- II. Rousing of fish bolts of existing diamond assembly.
- III. Ensuring availability of suitable capacity of road crane/ hydra. We have used two hydras simultaneously, as total weight of diamond assembly was about 16 MT.

One back up hydra was also kept apart from one JCB. It is advisable that crane/ hydra shall be checked by lifting the new assembly.

- IV. Levels shall be taken from all approaches and final level of diamond crossing with proper ballast cushion is decided.
- V. Removal of any obstruction for movement of machinery for removal of existing assembly as well as insertion of new assembly.
- VI. S & T and Electrical staff shall be kept in co-ordination for the work so that no problem occurs during and after the block.
- VII. 3 to 6 hours before the traffic block all shoulder and crib ballast is removed for ease of removal of existing assembly.



- VIII. All the machinery is placed in readiness before taking the traffic block.
- IX. Four separate teams shall be kept ready for opening of fish bolts from all four approaching tracks.

(B) Activities during the block-

- i. Adequate traffic block is required for insertion of new turnout assembly. We have taken five hour blocks for both of the lines.
- ii. During the block all the eight fish plate joints is opened and fish plates removed. Simultaneously, slings had been placed at nominated locations to lift the existing diamond assembly. (15 min.)
- iii. Deep screening of diamond crossing by removal of existing caked ballast and earth to provide 200 mm clean ballast cushion. Simultaneously, positioning of new assembly at nearest possible location by Crane/Hydras. (75 min.)
- iv. Placement of new assembly into track- new assembly is lifted and placed at the required location by Hydras/ crane, slings attached to new assembly shall be kept tight by both the Hydras till proper alignment is not achieved in all four approaching directions. Fish plates shall be fixed and bolted and katcha packing is required to be provided before releasing the pressure from Hydras. (150 min).
- v. Traffic block opened after checking gauge and cross level of track in both the direction including approaches to pass first train at stop dead and 10 kmph.
- vi. Further another round of packing shall be done after passing of one train from both the directions. After that speed may be relaxed to 20 Kmph.
- vii. Two rounds of packing shall be done after third and seventh day from insertion of new assembly.



- viii. Finally after one month consolidation, diamond assembly was tamped by UNIMAT machine also.

(C) Precautions during the block-

- i. It is also important to note that situation arises when whole of new assembly is lifted and moved through only one point by both the hydras causing lot of stresses at one point. Therefore, role of MS plate becomes very important as it helps in such a situation. This situation also indicative of high erection stresses.
- ii. It is also important to notice that after replacement the new assembly has new rail profile and there is misalignment because of old worn out rails in approaches, therefore it is essentially important that all the rails/ Glued joints shall be replaced with new one to match the rail profile for better alignment.
- iii. After that ballast deficiency in and approaches of diamond is recouped before packing.

5.0 Conclusion

Performance of this diamond crossing is termed as excellent after passing of approximately four months. After providing 200 mm ballast cushion and tamping by UNIMAT machine riding has been improved significantly. No tightening of bolts is required in this period and required maintenance input has reduced significantly. We have spent approximately Rs 4 lac for the complete job of fabrication and erection of new diamond assembly including removal of old assembly. Further, these special sleepers may be produced by concrete sleeper plants also.

As discussed above, use of SEJ sleepers to prepare special PSC sleeper for special turnouts gives an effective, economical and maintainable solution which can be used to all the special turnouts for which standard design is not available. This successful experiment paves way for development of PSC sleeper assembly for special turnouts with existing rail assembly by utilizing SEJ sleepers, which will go long way in creating safe and maintainable track structure with lesser inputs. ■ ■ ■

