



**Government of India  
Ministry of Railways**

**GUIDELINES  
FOR  
CONSTRUCTION OF BALLASTLESS TRACK  
WITH INDIGENOUS FASTENING SYSTEM  
(BLT-IFS)  
For Washable Apron on Loop Line  
(for Speed upto 50 kmph)**

**Document No. CT- 31B  
July, 2019**

*(Based on Report No. CT-31 of 2013 updated for loop line washable apron for 50 kmph)*

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## **PREFACE**

***(of BLT-IFS Construction Guidelines, CT-31 Dec.,2013)***

As the intermediate maintenance may not be economically feasible for a number of locations e.g. tunnels, viaducts, heavy suburban sections, platform lines, etc., need of Ballastless track is given. In high density suburban areas need of track form that is able to attenuate noise and vibrations is also growing due to environmental considerations. BLT offers options of pre-design of components which can result into desired levels of noise and vibrations. A suitable design of ballastless track (BLT), therefore, has been a long quest on Indian Railways.

IR so far has constructed BLT mostly in the form of washable aprons on platform lines; on Kolkata Metro and in few cases, in tunnels. A number of designs used on platform lines so far have provided only limited success. BLT constructed based of propriety designs obtained from advance railway systems are not only costly but also pose problems due to poor availability of fastenings and design alteration alternatives.

Using basics of civil engineering, an RCC design of BLT was done on Central Railway in 2005 and drawing no. G.M. (W) BB/10176/TRIAL/ALT.0 of 2005 was developed. Based on the experience gained from the trial of this design of BLT laid on Pune station, platform no. 5 in 2005-06; and on Mumbai CST station, platform no. 18 in 2007, RDSO has modified the design incorporating the observations made during the trial and issued document no. CT-31 in October 2013 - "Guidelines for Construction of Ballastless track with indigenous fastening system (BLT-IFS). The design and guidelines were issued in limited manner as further improvement work on the design was in hand for extending it's use as washable apron for platform lines. This has been possible with the development of a partly casted rail seat beam (PCRSB) having an in-built cant along with development of a flat SGCI bearing plate instead of fabricated MS canted bearing plate, as used earlier on Pune and Mumbai trials lengths. The design now stands modified and can also be used as washable apron on platform lines.

This modified version of Ballastless Track with indigenous fastening system (BLT-IFS) has been designed for trial for 'at-formation' tracks and for platform lines as washable apron for speeds upto 110 kmph. This design of BLT-IFS can also be used for tunnels and bridges with suitable modifications in pad stiffness, work on which is in progress at RDSO. Railway Board have approved earlier Guidelines and Drawings for issuance to zonal railways vide letter no. 2011/Proj./9/2 dated 07.10.2013. The subject was also deliberated in 84<sup>th</sup> TSC in Shimla in Oct. '13 and the august body recommended for the trial with modifications of PCRSB and bearing plate as proposed by RDSO. The revised version has also been approved vide letter no. 2011/Proj./9/2 dtd. 13.12.2013

This work could be completed in a very short time due to continuous support, motivation and guidance of honorable Member Engineering Shri Subodh Jain and dedicated efforts put in by Sleeper and Elastic Fastening Cells of RDSO. It is hoped that after successful trial, BLT-IFS will prove to be a significant development for Indian Railway tracks and serve the future BLT needs as a durable and cost effective solution.

Dec.16, 2013

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## **PREFACE**

***(of BLT-IFS Washable Apron Construction Guidelines, CT-31B, June, 2019)***

Railway Board vide letter No. ME/Misc./2013 dated 09.8.2013 instructed RDSO to develop design of ballastless track using indigenous fastening system to overcome the problems being faced on foreign based patented design such as problem in availability of fastening components, costly fastening components and high initial cost of construction etc.

Based on the experience gained from the earlier constructed ballastless track washable apron at Pune & Mumbai station in year 2006, RDSO in year 2013 had designed a Ballastless Track with indigenous fastening system (BLT-IFS) for trial for 'at-formation' tracks and for platform lines as washable apron for speeds upto 110 kmph. This design of BLT-IFS can also be used for tunnels and bridges with suitable modifications in pad stiffness.

The detail design of BLT-IFS was developed along with relevant drawings and Guidelines for Construction (Report No. CT-31 of Dec.2013) of BLT-IFS in 2013. This BLT-IFS design had been approved by Railway Board for trial in Zonal Railways & PSUs vide letter no. 2011/Proj./9/2 dtd. 13.12.2013. Railway Board vide letter No. letter no. 2011/Proj./9/2 dtd. 17.10.2013 had approved to lay BLT-IFS in 100m track on mainline at RVNL project.

Based on this design, a 100m trial section of BLT-IFS and transitions have been constructed by RVNL in WCR on 3<sup>rd</sup> line at km 862/160-292 on Bina – Bhopal section in June 2016. The trial section is under monitoring by WCR & RDSO. Based on site observations, some modifications in the BLT-IFS design have been carried out by RDSO.

This modified design has been further simplified for use as loop line washable aprons for speed upto 50 kmph and axle load of 25t by using easily available fastening components of wider PSC Sleeper (RDSO/T-8527) based on satisfactory performance of washable aprons constructed by Northern Railway at New Delhi station which is also based on BLT-IFS design of 2013 version.

It is expected that, this modified BLT-IFS design for loop line washable aprons for speed upto 50 kmph will overcome the problems faced in old design of washable apron and will serve the need of a durable and cost effective solution.

July 12, 2019

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# **GUIDELINES FOR CONSTRUCTION OF BALLASTLESS TRACK WITH INDIGENOUS FASTENING SYSTEM (BLT-IFS) FOR WASHABLE APRON ON LOOP LINE UPTO SPEED OF 50 KMPH**

## **1. Introduction:**

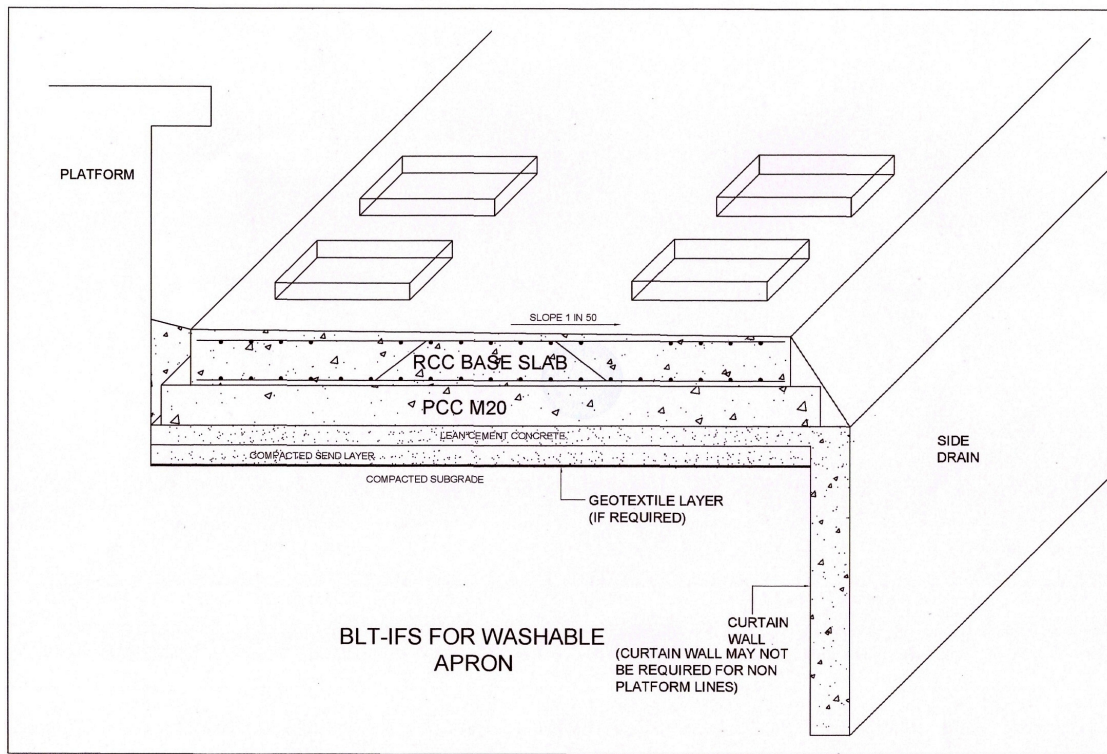
A number of ballastless tracks (BLT) have been tried and used on Indian Railways in the past. Some of the early forms include typical BLT on concrete pedestals on washing lines followed by washable aprons on platforms lines, initially with the use of wooden blocks and later with PSC sleepers.

A large number of BLT forms primarily with the focus to develop a robust and durable design to serve as washable apron have been tried on different parts of Indian Railways and the process continues.

Railway Board vide letter No. ME/Misc./2013 dated 09.8.2013 instructed RDSO to develop design of ballastless track using indigenous fastening system to overcome the problems being faced on foreign based patented design such as problem in availability of fastening components, costly fastening components and high initial cost of construction etc.

Concept of combination of beams & slab was used for designing of Ballastless Track with indigenous fastening system, (abbreviated as BLT-IFS) where rail is supported on equally distant beams and loads are transferred to subgrade through slab monolithically casted at site along with beams. The beam spacing of 750 mm as used on earlier ballastless track washable apron provided in central railway has been modified to standard spacing of 600 mm to control rail deflection. For improving the rail seat area quality for the perspective of dimensional accuracy and required pull out strength of SGCI insert, it was decided to go for partly casted full RCC beam in rail seat portion to be casted in concrete sleeper plant with M-55/M60 grade concrete. The arrangement is available in drawing no. RDSO/T-8777. These partly casted rail seat beams (PCRSB) are joined with RCC base slab by reinforcement and in-situ second pour concreting after track is assembled to required line and level and supported with the help of jigs and fixtures (considered necessary for required quality of finished BLT) to act as monolithic structure. The modified new design has been named as '**Ballastless Track with Indigenous Fastening System (BLT- IFS)**'.

In BLT-IFS, the slab has one directional cross-slope towards drain side (away from platform wall, in case of washable apron) to facilitate drainage. Depth of beams (PCRSB) & slab is kept same to have shuttering less construction. PCRSB is casted in concrete sleeper plant with raised rail seat area, which projects out of final level concrete top of the BLT/Washable apron in order to facilitate non-submergence of rail seat and cleaning. Typical BLT-IFS as washable apron arrangement is shown in following schematic sketch:



The detail design of BLT-IFS was developed along with relevant drawings and Guidelines for Construction (Report No. CT-31 of Dec. 2013) of BLT-IFS in 2013. This BLT-IFS design had been approved by Railway Board for trial in Zonal Railways & PSUs vide letter no. 2011/Proj./9/2 dtd. 13.12.2013. Railway Board vide letter No. 2011/Proj./9/2 dtd. 17.10.2013 had approved to lay BLT-IFS in 100m track on mainline at RVNL project.

Based on this design, a 100m trial section of BLT-IFS and transitions have been constructed by RVNL in WCR on 3<sup>rd</sup> line at km 862/160-292 on Bina – Bhopal section in June 2016. The trial section is under monitoring by WCR & RDSO. Based on site observations, some modifications in the BLT-IFS design have been carried out by RDSO. Further, Northern Railway has constructed washable aprons at New Delhi station based on 2013 version of RDSO design of BLT-IFS by removing the SGCI bearing plate & 10mm Beam/Base pad and using 10mm rail pad. Moreover, in the CTEs' Seminar held in May 2019, RDSO was asked to carry out design modification in BLT-IFS considering changes made by Northern Railways for washable apron at New Delhi station for use in loop line washable apron for speed upto 50 kmph. The performance of washable aprons constructed by Northern Railway at New Delhi station has been found satisfactory by RDSO. Accordingly, drawings of canted PCRSB, General Arrangement drawing have been prepared along with this Construction Guidelines CT-31B- July 2019.

Following modifications have been carried out in the design of BLT-IFS over the 2013 version of the BLT-IFS design to make it suitable for the loop line washable apron for speed upto 50kmph:

#### **A. Improvements in Fastening part and in PCRSB:**

1. Removal of SGCI bearing plate & 10mm CGRSP Beam/Base pad
2. Provision of fastening components of wider PSC sleeper to Drg. RDSO/T-8527 i.e use of RDSO/T-6901 SGCI inserts, 10mm CGRSP to RT-8528, GFN Liners to RDSO/T-6938 & 6939 and ERC Mk-V to RDSO/T-5919
3. Use of phosphate treated ERC for minimizing corrosion
4. PCRSB strengthening by providing cross-members & welding of shear ties with main reinforced bars instead of fastening with wires to control its bending during transportation & handling

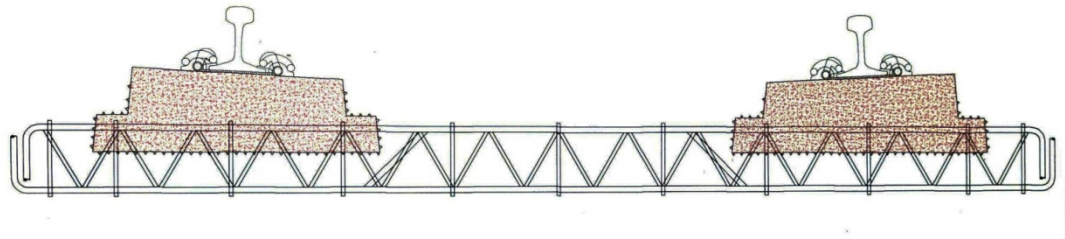
#### **B. Change in RCC part & others**

1. Change in shape of rail seat block with recess to have more anchorage with RCC slab resting over bottom half of rail seat block
2. Provision of 4 no. of cross reinforcement bars (in track direction) per rail seat block for better bonding between pre-cast rail seat blocks & slab to avoid cracks at their joints
3. Use of M55/M60 grade concrete in PCRSB and Fe500 grade deformed bar as reinforcement instead of Fe415 due to better availability and better quality
4. Camber slope in RCC to be increased to 1 in 50 to have better top surface drainage. Further, rail seat block has been raised by 40mm to have more clearance between rail bottom & slab top to facilitate better drainage.
5. Provision of clear gap of 100mm in transverse direction in RCC slab @ 6000mm c/c (without continuation of reinforcement) filled with extruded polystyrene rigid board with proper sealing at top to eliminate requirement of expansion / contraction joint etc.
6. Increase of min. clear cover in RCC slab upto 50mm
7. End face of RCC & PCC to be made vertical instead of sloping for easy in-situ casting
8. Construction of temporary concrete pedestals at suitable intervals on non-platform side, if required to provide lateral support to assembled track during construction of BLT on washable apron
9. Provision of concrete bonding agents between PCRSB and new in-situ concrete for better bonding between old and new concrete
10. Provision of sealant over the junction of PCRSBs with RCC slab after curing to avoid ingress of water during service
11. Provision of geo-textile over the formation top in case of weak subgrade or high water table condition or if the site is having history of formation problems

Instructions for manufacturing of canted partly casted rail seat beam at concrete sleeper plant and assembling the whole structure with steel reinforcement along with in-situ concreting for RCC base slab & PCC base at site has been spelt out in the present document. As the actual construction conditions may vary from site to site, the instructions in the present document shall be taken as guidelines only and modification in the construction methodology can be done in consultation with RDSO. Before planning & execution of actual construction of BLT-IFS, these guidelines should be studied carefully in conjunction with relevant drawings. RDSO shall be consulted for any clarification / suggestions.

## 2. Various components of BLT-IFS:

- a) **Canted Partly Casted Rail Seat Beam (PCRSB):** This beam has been designed by RDSO which can accommodate rail seat assembly for BLT-IFS as per drg. No. RDSO/T-8777. These beams are to be manufactured in concrete sleeper plants with M-55/M-60 grade concrete as per RDSO drawing no. RDSO/T-8777. Canted PCRSBs shall be procured from existing concrete sleeper manufacturers that have already been cleared for supply of PSC sleepers to RDSO design. Concrete Sleeper Plants shall need to prepare suitable moulds in their plants for casting of canted PCRSBs. During the period of supply of BLT-IFS, it would be imperative on part of concrete sleeper plants to get the moulds inspected by Zonal Railway officials attached to the sleeper plants before commencing casting of canted PCRSB. For guidance purpose, Zonal Railways viz. WCR & NR etc. which have prior experience of construction of BLT-IFS may be contacted. RDSO may also be contacted for any clarifications, if required.



*(Typical Canted PCRSB Sketch along with rails & fastenings)*

Acceptance criteria for canted PCRSBs would be dimensional conformity as per the drawing, testing of concrete cubes after steam curing & 14 days water curing for M-55/M-60 grade of concrete, as per 'Specification of PSC sleeper', IRS-T:39, latest version. Achieving proper rail seat dimensions would require special attention on part of CSPs and inspecting officials and shall be ensured.

For supply of canted PCRSBs, inspection of canted PCRSBs of BLT-IFS would be carried out by Zonal Railway officials attached to the sleeper plants during which SGCI insert on the canted PCRSB would also be tested (1 canted PCRSB per shift) for pull out strength which should be minimum of 6 ton per SGCI insert.

Pull out strength of SGCI insert shall be measured for 1 canted PCRSB per shift for initial 10% of ordered quantity of canted PCRSBs until the regular production of canted PCRSB is cleared by the Inspecting agency of Zonal Railway. Later on, pull out test is to be conducted on 1 canted PCRSB per 100 by the inspecting agency. Cost of the canted PCRSBs failed in pull out test is to be borne by the concrete sleeper manufacturer, as major part of canted PCRSB cost is that of reinforcement which is largely reusable.



- b) **Inserts:** It is important to understand that the quality and dimensional accuracy of inserts is of paramount importance for achieving the rail seat dimensions and designated toe load. The inserts used in canted PCRSB should be as per drawing no. RDSO/T-6901 duly inspected and approved as per the provisions of IRS T-46. The inserts supplied shall be re-checked and it must be ensured by concrete sleeper plant before using them that the toe gap of inserts checked using three pin gauge made as per drawing no. RDSO/T-8206 is in order.
- c) **Rail:** Standard 60 Kg (UIC) rail section has been used in the assembly.
- d) **Elastic Rail Clips:** ERC Mk-V (drg no. RDSO/T-5919) conforming to updated specification no. IRS-T-31 can be used. The ERCs is to be procured from existing RDSO approved / developmental vendors of ERC Mk-V, the list of which is available in the 'Vendor Directory' of Quality Assurance/Civil Directorate, on RDSO's website [www.rdso.indianrailways.gov.in](http://www.rdso.indianrailways.gov.in). Inspection is to be carried out by the nominated inspecting agency for the product for the zonal railway.
- e) **Rail Pad:** 10mm thick CGRSP (drg no. RDSO/T- 8528) conforming to updated IRS specification RDSO/M&C/RP-200/2007(Provisional) between canted PCRSB and Rail shall be used and procured from existing approved / developmental vendors of 10mm CGRSP to RDSO/T- 8528, the list of which is available in the 'Vendor Directory' of QA/Civil Dte., on RDSO's website [www.rdso.indianrailways.gov.in](http://www.rdso.indianrailways.gov.in). Inspection for this item shall be arranged by RDSO or the nominated inspecting agency for the product for the Zonal Railway.
- f) **GFN-66 Insulating Liners:** Liners (drg. no. RDSO/T- 6938 & 6939) conforming to updated specification no. IRS-T-44-1995 shall be used for holding the rails. These liners can be procured from existing approved / developmental vendors of RDSO/T- 6938 & 6939 or any GFN liners or as per extant procurement instructions, the list of which is available in the 'Vendor Directory' of QA/Civil Dte., on RDSO's website [www.rdso.indianrailways.gov.in](http://www.rdso.indianrailways.gov.in). Inspection for this item shall be arranged by RDSO/RITES.
- g) **Jigs & fixtures:** For holding and making fine adjustment of rails / track in vertical & horizontal directions during the in-situ casting, Jigs & fixtures shall be manufactured & used as per typical arrangement shown in the drawing no. EDO/T-2263. Such jigs and fixtures can be got fabricated through Railway workshops or trade and may also be available with working agencies having undertaken construction of ballastless track in past. Alternatively, for holding and adjusting track, commercially available 'Track supporting & adjusting frames' (also called as 'Gauge Supporting Frames') being used in construction of ballastless track in Metro Rail projects can preferably be used.
- h) **Reinforcement Steel:** Reinforcement bars for use in canted PCRSB & RCC slab shall be of Fe-500 (FE500D is preferable) grade (High yield strength TMT deformed bars) conforming to IS:1786 – 2008. The

reinforcement bars shall be procured from reputed manufacturers along with test certificates. In case, Fe- 500/500D rebars are not available then rebars of Fe-550 grade may be used. The rebars shall be cut or bent as per the relevant drawing and splicing & lap lengths shall be as per drawing or IS:456-2000.

**3. Construction Stages:** Following are the stages of construction of BLT-IFS washable apron in brief, listing various aspects to be ensured:

- 1) After removal of existing track & ballast from old existing washable apron and after water removal from site & drainage improvement as per site condition, formation shall be ensured for a minimum bearing capacity of 10 t/m<sup>2</sup>.
- 2) RCC curtain wall of 1.5 m height should be constructed for platform lines on drain side as per drawing no. RDSO/T-8778.
- 3) Lean concrete/M15 grade concrete base of 100 mm shall be provided over formation.
- 4) Levels to be fixed as per drawing No. RDSO/T-8778.
- 5) Provision of geo-textile, if required in case of weak subgrade or high water table conditions or if the site is having history of formation problems
- 6) 150 mm PCC layer with M20 shall be used.
- 7) Bottom reinforcement of RCC slab (distribution and longitudinal steel) will be laid and canted PCRSBs shall be placed at c/c spacing of 600mm.
- 8) The rail pad to be placed and rails to be laid and fastened with GFN liners and ERCs. ERCs used shall neither be under driven nor over driven.
- 9) After fastening the track, it is to be aligned and leveled to the target line and check the gauge & cross level. In this position, track is to be secured in this position with the help of Jigs & fixtures. (Refer typical jigs and fixtures RDSO drawing no. EDO/T-2263) or commercially available track supporting & adjustment systems in Metros.
- 10) Application of concrete bonding agent on PCRSB circumference between old concrete & new in-situ concrete
- 11) Necessary shuttering arrangement to render required profile and shape to the concrete to be fixed and after final round of checking only, concreting is to be commenced. The design is so conceived that it may require shuttering only at sides of the BLT.
- 12) M40 concrete, as per approved mix (mixed design to be approved at the minimum level of Dy.CE/ Sr.DEN) to be used for concreting. However, use of RMC (ready mix concrete) is preferred.
- 13) Slab shall be casted in panels of length 5900 mm leaving clear panel gap of 100 mm at centre of space between two canted PCRSB from top of RCC slab to top of PCC without continuation of longitudinal reinforcement.
- 14) Construction of temporary pedestal may be considered for providing lateral support to track during construction for exact alignment, if required as per site and weather condition.
- 15) The BLT-IFS concrete must be cured for a minimum period of 21 days after concreting, preferably through ponding.
- 16) Filling of panel gap with closed cell extruded polystyrene rigid board and polyurethane sealant & coating at top
- 17) Application of suitable sealant around PCRSB at junction with slab

#### **4. Detailed construction procedure for BLT-IFS:**

The construction of BLT-IFS mainly consists of four steps, which have been described in detail in following paragraphs –

- a) Manufacturing of canted partly casted rail seat beam (canted PCRSB) in a Concrete Sleeper Plant and procurement of other fittings including jigs & fixtures.
- b) Construction of foundation base layers for BLT-IFS
- c) Assembling of track on canted Partly casted rail seat beam at site and holding track with Jigs & Fixtures in exact position after ensuring gauge, level and alignment.
- d) Construction of RCC slab and beam by in-situ concreting.

Construction of BLT-IFS washable apron should be executed by the agency having adequate prior experience & expertise in construction of ballastless track e.g. in Metro Railways projects or for similar works having proper equipments & machinery for construction of BLT and with detail planning and preparatory works. The firm/JV who have already constructed ballastless track or washable apron either over World railway system or over Metro projects should be preferred. Selection of construction agency should be preferably done keeping in view of the eligibility criteria specified for Prime Contractor (Construction Agency) in 'Technical Eligibility Criteria & special condition of contract for design & construction of ballastless track for washable apron vide letter dated 25.05.2018 or with latest instructions of Railway Board on eligibility for Prime Contractor/Construction agency for ballastless track.

#### **4.1 Manufacturing of Canted Partly casted rail seat beam (PCRSB) in Concrete Sleeper Plant –**

- i) Canted PCRSB is basically an RCC part beam having two rail seat blocks with 1 in 20 slope partly casted along with 2 no. of SGCI inserts to Drg. RDSO/T-6901 on each rail seat block along with beam reinforcement. This is to be casted in concrete sleeper plant as per RDSO drawing no. RDSO/T-8777, using M55/M60 grade of concrete conforming to updated IRS:T-39 specification and Fe-500 / Fe-550 ( if Fe-500 is not available) grade of steel, conforming to IS:1786-2008 for TMT deformed reinforcement bars and stirrups, anchorage bars and 6/8mm plain/deformed bars frame.
- ii) Canted PCRSBs are to be casted at plant in the specially prepared moulds having internal dimensions same as RCC block dimensions within specified tolerances. Mould box dimensions shall be checked with precision for conformity to the dimensions given in drawing RDSO/T-8777. The each of two mould boxes shall have two pockets for placing SGCI inserts in inverted position. Distance between inserts shall be checked for conformity to the distance between holes given in the drawing RDSO/T-8777.
- iii) First, joining reinforcement bars and stirrups frame is to be prepared using the given numbers and diameters of reinforcement bars duly tied with steel

wires at junctions and keeping the spacing of stirrups as per RDSO drawing RDSO/T-8777. Middle one bent/cranked bars may be left at this stage, if required, to have working space, which must be placed at their indicated position & tied to stirrups after completion of curing. Length of reinforcement bars and its bends and its relative position shall be as per drawing. Stirrups shall be tied with reinforcement bars using steel wire pieces to keep them in position while casting of concrete. Cross-bracings shall be welded to main reinforcement as per the drawings RDSO/T-8777 and position of stirrups can be slightly adjusted to avoid infringement. Weld flux shall be removed from reinforcement joints before casting of canted PCRSB. Frames of 6/8mm mm dia bars (cradle) to reinforce concrete around rail seat shall be prepared as per drawing no. RDSO/T-8777 and these should be tied with main reinforcement frame as per drawing. Four number of 12mm dia. anchorage bars shall also be provided to have bond between canted PCRSB and RCC slab in longitudinal direction & tied to main reinforcement / cradle on the both rail seat block. This frame of reinforcement bars, anchorage bars & stirrups along with cradle is to be placed inside moulds and fixed to its position.

- iv) Next, 4 no. SGCI inserts duly conforming to drawing RDSO/T-6901 shall be placed in the pockets for SGCI inserts in the mould. The SGCI inserts should be duly inspected as per drawing RDSO/T-6901 and updated specification IRS T-46 and approved by RDSO/RITES. Distance between outer to outer inserts of two rail seat blocks and two inserts of same rail seat blocks shall be checked for correctness within tolerances, as given in drawing RDSO/T-8777.
- v) The two mould boxes shall be joined by the steel bars / plates to have exact distance between outer to outer insert pockets as per drawing within tolerance. The mould shall have inside corners and edges round to have round edges in canted PCRSB as per drawing and shall have a grooved mark line showing top level of slab casting as per drawing. Cant of 1 in 20 in between two insert pockets shall be checked for entire rail seat area with the Gauge similar to the gauge used for checking the seat slope in moulds of PSC sleeper having steel plate of exact cant of 1 in 20 but width of 150 mm instead of 120 mm used for normal sleeper.



***Sample mould for casting of PCRSB (for guidance only)***



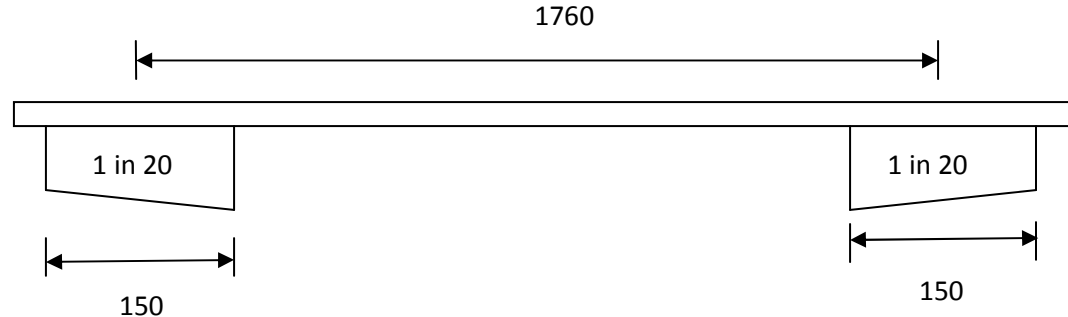
***Offset kept in side plates in mould for producing concrete level guiding streak on the PCRSB ( for guidance only)***

Moulds are so fabricated that it produces a streak on the sides of casted canted PCRSB at a slope of 1 in 50 as per drawing as a result of offset given through plates inside the mould box. This streak/line guides the field staff at the time of concreting for the level at which concrete is to be finished ensuring the cross drainage.

- vi) Reinforcement frame shall be placed inside the mould box. Mould box may be divided into two halves having half circle cuts for reinforcement bars to facilitate demoulding of canted partly casted rail seat beam along with reinforcement after steam curing. Reinforcement frame is to be supported over rich mortar blocks of height equal to clear cover for main reinforcement bars. Reinforcement frame shall be placed in such a way to ensure that sufficient clearance is available around SGCI inserts from reinforcement bars and stirrups. Frame shall be fixed against movement so that it does not move relative to the mould during concreting operation.
- vii) Concrete mix of M55/M60 grade shall be prepared using already approved mix design for the plant for manufacturing of PSC sleepers. Concrete shall be poured inside the moulds in layers and compacted using steel rods in the corners and around the reinforcement bars & stirrups. Needle vibrators & mould vibrations shall also be used for uniform compactions of concrete at about 9000 rpm. Concrete in canted PCRSB's bottom surface and four side faces along its length shall be rough finished to the extent feasible for better bonding with in-situ concrete later. Overall concrete quality and rail seat finish must be the same that used for manufacturing of PSC sleepers.
- viii) Only machine handling of canted PCRSBs is to be done after concreting both in sleeper plant, while handling during transportation, loading and unloading and laying in track upto the stage of concreting for construction of BLT at site. Sling used for lifting / lowering must be tied at three points, two at ends / rail seat portion and one in the middle, to prevent development of any bend in canted PCRSB.
- ix) Canted PCRSB along with moulds shall be left for initial setting time or two hours whichever is later. Reinforcement bars, cross-bracings, anchor bars

and stirrups shall be coated with anti-corrosive paints before taking the same to steam curing chambers. Canted PCRSB along with Mould shall be kept in steam chambers and shall be steam cured as per approved steam curing cycle for the M55/M60 grade concrete for the plant.

- x) Canted PCRSB shall be demoulded from moulds and kept submerged in water tanks for 14 days. A paint mark 'D' with arrow will be painted on one side (down side) of canted PCRSB after water curing of the canted PCRSB showing incline of drainage streak and direction of side drain. Three concrete cubes shall also be casted from concrete mix per shift of casting canted PCRSB and shall be steam cured and water cured and shall be tested for desired compressive strength as per IRS:T-39. Compressive strength of all 3 cubes shall be more than 55/60 MPa.
- xi) Canted PCRSB shall finally be checked for dimensions viz. length, width and height, insert to insert distance, outer to outer inserts distance, rail seat slope of 1 in 20 (with tolerance of  $\pm 0.25$ ) using wider rail seat slope gauge (indicative sketch shown below), toe gap using three pin gauge as per drawing RDSO/T-8206, spacing of stirrups, distances between reinforcement bars, concrete cover etc. Pull out strength of inserts shall be measured for 1 canted PCRSB per shift until the regular production of canted PCRSB is cleared by Inspecting officials of Zonal Railway. Later on, pull out test is to be conducted on 1 canted PCRSB per 100 by the zonal railways or nominated inspecting agency. Minimum Pull out strength of insert should be 6 tons without any breakage of SGCI insert & appearance of cracks in concrete around SGCI inserts.



- xii) Passed canted PCRSBs shall be stored to ensure that no damage is done to SGCI inserts and concrete or bending of reinforcement. The canted Partly casted rail seat beam shall be dispatched and transported to the depot / site in safe manner to avoid bending of reinforcement and damage to anchor bolts and concrete blocks, handling it only with mechanical means. Proper handling and transportation of canted PCRSB to the site of work is one of the most important aspect of this design and needs due attention from the executing agency.
- xiii) Procurement of required quantity of fastening components including jigs & fixtures/ available track supporting & adjusting frames used for construction of track in any Metro Rail project to be done in advance as per clause 2.

## 4.2 Construction of foundation base layers for BLT-IFS Washable Apron :

### i) Removal of Existing Track & Preparation of Ground

In case of existing old washable apron, track shall be removed and existing caked up ballast / old concrete along with soil shall be removed upto 300 mm level below desired bottom level of lean concrete as per drawing RDSO/T-8778. The existing muck etc., if any, shall be removed and the top layer of soil should be compacted upto the density as per RDSO guidelines of Earthwork. A coarse sand layer of 300 mm is to be provided and compacted before providing lean concrete. A layer of geo-textile covering full width is to be provided in between sand layer and subgrade, if required as per site conditions i.e. in case of weak subgrade or high water table condition or if the site is having history of formation problems

Minimum bearing capacity of 10 ton/m<sup>2</sup> is to be ensured at the top of sand layer / formation (calculated for a 3.5 m width of strip footings), measured by Plate Load Test or otherwise. RCC curtain wall of 1.5 m height shall be constructed for washable apron on platform lines towards drain side as per drawing RDSO/T-8778.

### (ii) De-watering and Base preparation for washable apron

The washable apron, if constructed over weak sub grade (having bearing capacity less than 10 tonne/m<sup>2</sup>) without dewatering and complete drying of surrounding area and ground improvement, will not function effectively and may not be durable. Following steps for ground improvements are recommended to achieve better results:-

1. In order to have trouble free performance of washable apron over long service life, it is mandatory that before casting of base concrete and formation for washable aprons, dewatering of accumulated water and ground water for complete drying of the area to be ensured.  
Good drainage arrangement is the basic requirement for washable aprons to function properly during service. In case, the natural ground slope is not favourable and / or the yard is located in low lying area, sump & pump arrangement or some alternative arrangement for effective drainage shall be required.
2. Dismantle the existing ballasted track / old washable apron, debris and caked up ballast should be removed completely.
3. Scum/muck/soil of poor bearing capacity should be removed completely over the entire construction area.
4. Remove the sub soil layer below the base concrete layer of washable apron at least by 500 mm and carry out ground improvement measures given under steps 5, 6, 7, 8 & 9 so as to achieve minimum bearing capacity of 10 tonne/m<sup>2</sup>.
5. Provide a layer of non-woven geo-textile over the subgrade complying the specification No. RDSO/2018/GE: IRS-0004 part-I, issued by Geotechnical Engineering Directorate, RDSO in March 2019 in case of weak subgrade or high water table condition or if the site is having history of formation problems.
6. Provide well compacted gravel base of 200mm thickness.



7. Over this compacted base, provide 300 mm thick coarse sand/ quarry dust layer and rolling/compacting should be done of the same.
8. In case the depth of scum/poor soil is more than 500 mm which cannot be easily removed, bearing capacity improvement through other economical methods e.g. Sand/Gravel/Stone piles may be suitably done.
9. Minimum bearing capacity of compacted formation specified to lay the washable apron (say 10 tonne/m<sup>2</sup>) should be ensured before construction of base concrete of washable apron. Plate load tests should be carried out at one or two locations (as considered appropriate by field engineers) to determine the bearing capacity.

### iii) **Construction of Base slab for BLT-IFS –**

Base of BLT-IFS will consist of two layers viz. Lean concrete and plain cement concrete. Lean concrete/M15 grade concrete of 3.5 meter width or from platform wall to curtain wall / drain wall of thickness 100 mm is to be provided over the top layer of subgrade to have a level surface for concreting and to prevent loss of cement slurry from upper layers of concrete into soil. Lean concrete shall be prepared from brick aggregate or residual ballast layer, cement in low quantity and water. Lean concrete shall be of same quality that provided under building foundation. Layer of lean concrete shall be well compacted using vibratory rollers and shall be leveled well.

Plain cement concrete of grade M 20 (in approximate ratio of 1: 1½: 3 of Cement : Fine aggregate : Course aggregate) of depth 150 mm shall be provided over lean concrete on entire width from platform wall to curtain wall/drain wall. PCC base shall be compacted using vibratory plate compactor and leveled horizontal accurately. PCC base shall be water cured for 7 days by covering with jute bags & sprinkling the water or ponding the water over it.

## 4.3 **Assembling of track on Canted Partly Casted Rail Seat Beam at site:**

### i) **Placing of Base slab reinforcement –**

Longitudinal reinforcement bars (along the track direction) of 16 mm dia TMT deformed bars of FE500/FE550 grade steel shall be laid at 200 mm centre to centre spacing over the entire width of PCC base. 25 mm clear cover to these bars at bottom shall be provided by rich mortar/cover blocks of required size of same grade of concrete. Cover blocks should be placed at about 1.5m spacing longitudinally and at 3 no. for each bar but the spacing and no. may vary as per site condition. 12mm dia deformed bars shall be placed in cross direction over longitudinal reinforcement bars at 200 mm & 400mm spacing alternatively to accommodate canted PCRSB in between them as per drawing RDSO/T-8778. These two layers of reinforcement shall be tied with steel wire pieces to keep them in place forming a stable grid.



## **ii) Placement of Canted Partly casted Rail Seat beams –**

Canted PCRSBs along with reinforcement shall be placed over base slab reinforcement in between cross reinforcement bars of slab (having spacing 400 mm) centrally from both side and centrally on PCC slab width, taking reference from center line of track from both ends of proposed BLT stretch. Canted PCRSBs are to be placed with mark 'D' & arrow towards drain side. The center to center spacing between PCRSBs along the track shall be accurately adjusted as 600 mm, after properly squaring the canted PCRSBs with reference to center line of track. The main bottom reinforcement bars of canted PCRSB shall be tied with slab reinforcement with steel wires to keep these in proper position during concreting. Top longitudinal and cross reinforcement bars of RCC slab in between canted PCRSB and outside the blocks shall be placed at specified interval or in specified numbers as per drawing no. RDSO/T-8778. This top reinforcement of RCC slab shall be tied together and with beam reinforcement using steel wire pieces to form stable frame to place track over it before assembling & adjusting the track & concreting. 8 No. anchor bars of each canted PCRSB should also be tied with anchor bars of adjoining canted PCRSB using wire pieces after bending the overlaps of these bars horizontally. Cant of 1 in 20 in top surface of canted PCRSB's shall be checked during laying with the help of the gauge and maintained throughout during assembling of track and concreting. If required, suitable packing can be used under canted PCRSBs to achieve the desired rail seat slope of 1 in 20.

## **iii) Assembly of track over canted PCRSBs**

Track shall assembled as per Rail seat Assembly Drg. RDSO/T-8529 for 60 Kg UIC rail i.e. 10mm thick CGRSPs shall be placed on canted PCRSBs to its position in between two inserts,. 60 Kg (UIC) rails shall then be placed over these 10mm thick CGRSPs. GFN liners to RDSO/T-6938 & 6939 (RT-6938 for gauge side and RT-6939 for non-gauge side) shall be placed in between rail and inserts in proper position on either side of rails. Rails shall be fastened to inserts using ERCs Mk-V, as done in case of normal ballasted track.

## **iv) Holding of track in position using Jigs & Fixtures/Track supporting Frames**

The track assembled so far shall be in an approximate position. Both rails shall be separately held vertically & horizontally in between every third canted PCRSBs (at approximately 1.8 m intervals) using specially designed Jigs and fixtures (Refer typical arrangement as per RDSO drawing no. EDO/T-2263), supported on PCC slab base. Jigs and fixtures have suitable arrangement for making fine adjustments to move rails in both horizontal and vertical directions. Alternatively, for holding and adjusting track, commercially available 'Track supporting & adjusting frames' being used in construction of ballastless track in Metro Rail projects can preferably be used. Gauge, cross levels, longitudinal alignment of rails, Cant of 1 in 20 shall be checked, adjusted and achieved to exact position by fine movement

of rails in vertical and horizontal directions using fine adjustment screws for this purpose. Now, rails shall be held firmly in accurate position achieved securing track in this position.

**v) Fixing of shuttering**

The design is such that it should need no shuttering for construction except in side drain and curtain wall portion. Shuttering, wherever used should preferably of steel plates or well finished plywood surface and shall be placed & fixed, on side faces of BLT or wherever needed, for getting required dimensions as per drawing and to facilitate drainage.

**4.4 Construction of RCC slab and beam by in-situ concreting:**

- i) Concrete of M40 grade shall be prepared by weigh batching at site as per designed mix as per IS:10262-2009 using 20 mm down coarse aggregates, fine aggregate, 53 grade cement, super plasticizer, if needed, to improve its workability. Workability of concrete shall be high having slump of 75 to 100mm and 100mm to 150mm, if pumped concrete is proposed to be used. Ready Mix Concrete (RMC) should be used preferably, if available. Concrete cubes shall also be casted from prepared mix for testing and verification of concrete strength later in a laboratory.

For proper functioning of washable apron and longer life, use of high quality concrete in RCC & PCC is pre-requisite as washable aprons are exposed to extreme weather conditions, cleaning with water jets and highly corrosive environment. For production of high quality and durable concrete, it is advised to use preferably non-reactive aggregates only and low-alkali cement & low-heat cement so that chances of cracks in concrete is minimized for longer service life of RCC & PCC. It is advised that 'Alkali resistant glass fibers' (Grade HD-12) of 12mm length can be mixed in concrete in quantity of about 600 gm/cum for controlling surface cracks.

- ii) Before concreting, track gauge, levels & alignment, cant of 1 in 20 shall be checked once again and shall be corrected with the help of Jigs & Fixtures/Track supporting and adjusting frames, wherever required. For better bonding between old concrete of PCRSBs and new in-situ concrete, suitable high performance epoxy based concrete bonding agent shall be applied on the side faces of PCRSB's upto the slab mark level prior to concreting. Two such products for concrete bonding are 'Masterbrace1414 of M/s BASF' or 'Nitobond EP' of M/s Fosroc. Similar product of assured quality can be used. The concrete bonding agent should be applied with the precautions mentioned in their product application guidelines.
- iii) Concrete mix shall be poured in layers in base slab and beam area around reinforcement and shall be compacted thoroughly around reinforcement using needle vibrators. Special care should be taken to compact concrete fully without any voids or with entrapped air in the space below the both rail seat blocks of canted PCRSB and top of PCC slab. Rails and fastenings shall be covered with inverted U-shaped thin metal sheets during concreting

to avoid fouling of these with wet concrete. Concreting shall be done in a manner so that correct profile of beam and slab including cross slope in slab portion of 1 in 50 are achieved. Mark lines have been provided in canted PCRSBs indicating top level of slab to facilitate concreting and getting desired level of slab thickness and cross-slope. All precautions to be taken that the track does not get disturbed during the process of concreting. Concreting in between BLT slab and platform wall and BLT slab and side drain shall also be done giving slopes / steps as per drawing RDSO/T-8778.

- iv) Slab shall be casted in panels of length 5900mm leaving clear panel gap of 100mm at centre of space between two canted PCRSB from top of RCC slab to top of PCC. Longitudinal reinforcement of slab shall be cut before the panel gap so that a clear concrete cover of 50mm is available. At the each panel joints, anchor bars in canted PCRSB shall be cut / bent and transverse reinforcement of RCC slab at top & bottom shall be shifted suitably to have clear cover of 50mm at this panel gap. Suitable slope (say 1 in 50) to be provided at panel gap towards drain in PCC top surface. The panel length can be modified suitably at either the end of washable apron, if required as per site condition with approval of CE/CTE.
- v) Cross-slope in slab area should be ensured as per drawing for proper drainage. Top surface of slab must be well-finished as plain without any local depressions so that no retention of rain water takes place during service. Corners & edges between slab & canted PCRSBs shall be manually rounded off using trowel & extra concrete to facilitate drainage.
- vi) Remove the jigs/Track frames from track after 8-12 hours when concrete becomes sufficiently hard. Fill the cavities using cement mortar made preferably from non-shrinkable cement.
- vii) Remove the shuttering after 8-12 hours or when concrete becomes sufficiently hard.
- viii) At end of day, concrete should be left in rough slope in slab portion (between two beams). Before starting further concreting, this rough slope may be chipped off. It is important that any part concreting work should only be terminated in slab portion and not in beam portion.
- ix) Concrete shall be water cured after 24 hours of placement. Wet curing shall be done for 21 days by ponding water over beam and slab.
- x) A 6-10 mm thick epoxy treated wearing coat would be preferable to be provided on top of the finished concrete on BLT washable apron where cleaning is anticipated with the use of pressure water jet.
- xi) Suitable sealing compound viz. 'Silicone sealant' 'Dowsil 991' or similar shall be provided over the groove of 10mm size made at the corner / junction of PCRSBs and RCC slab all around to avoid ingress of water at these locations during service. It is also suggested to check & recoup the

sealant, if required at suitable time interval or on condition basis. One such sealant is 'Silicone sealant' 'Dowsil 991' which or similar item can be used. Primer coat is also need to be provided before application of the silicon sealant (as shown in Drawing No. RDSO/T-8778).

- xii) 100mm panel gap shall be filled with 'Closed cell Extruded Polystyrene rigid board of high compressive strength (Minimum 60 psi) of 100mm thickness and width varying from 300mm from one end to 250mm at other end and length of 3 meter or as per site condition. Over this rigid board, 2mm thick Polyurethane Aliphatic coating shall be provided to form U-shaped channel from top level of RCC to top of rigid board. Polyurethane sealant shall also be provided at the corners in between U-shaped PU coating and rigid board to fill the hollow space in between. Details of panel gap & its filling is shown in Drawing No. RDSO/T-8778.

## **5.0 Construction of Side drains and curtain wall**

Side drain and curtain wall should be constructed on one side of BLT-IFS as per site requirement to facilitate drainage and prevent water seepage under BLT-IFS washable apron to reduce upward pore water pressure. The construction of curtain wall (as per Drg. RT-8778) and side drain may also be done before undertaking construction of BLT-IFS washable apron if considered suitable as decided by Dy chief engineer/Sr DEN in-charge. Water collection ditches may also be constructed at suitable interval as per site requirement to drain out track area efficiently. Size of drain can be decided depending upon the local requirement. Top level of drain should be kept at the level or below top level of PCC.

## **6. Opening of BLT-IFS & Monitoring:**

- 6.1 All track parameters shall be checked carefully before opening the section for traffic, which is to be done only after 21 days of proper curing. Initially, traffic shall be opened at restricted speed of 30 kmph for passenger / empty trains & 15 kmph for loaded goods trains. BLT-IFS for washable apron shall be monitored for its performance in respect of track settlement, track parameters variations, crack development in beams, slab, etc. Separation of joints of precast beams and in-situ casted slab and beams shall specially be monitored carefully.
- 6.2 After observation of no adverse performance for a period of 10 days, speed can be raised in stages as suggested in para 6.3 however BLT-IFS washable apron shall be continuously monitored for above mentioned parameters for any adverse observations. Detail report of performance of BLT-IFS shall be sent to RDSO for further analysis and any modification in design.

## **6.3 Speed Restrictions for opening of track:**

Initially open at 30 kmph for passenger / empty goods trains & 15 kmph for loaded goods trains after 21 days of curing. After 10 days of opening, necessary inspection shall be done for checking the integrity of fastening system as well as concrete.

After no structural issues are observed and track parameters are found to be within limits, speed can be raised to 50 kmph for passenger / empty goods trains & 30 kmph for loaded goods trains (keeping in view the speed restriction(s) imposed due to other reasons). BTL-IFS is to be monitored further for period of 30 days or passage of sufficient number of loaded goods train followed by another inspection only after satisfactory performance of BLT-IFS speed for loaded goods train can be relaxed to 50 kmph and monitored for a period of 10 days followed by another inspection. Zonal Railways may impose suitable speed restrictions if required as per site conditions.

After the section is opened to the sectional speed as mentioned above, a regular inspection on monthly basis or suitable frequency specified by Chief Track Engineer be done for keeping the record.

#### **6.4 LWR: Laying of trial LWR on BLT-IFS can be done with following stipulations:**

- (i) Laying of LWR shall be done as per the provisions of Manual for Instructions on Long Welded Rail – 1996 with up-to-date correction slips.
- (ii) Creep shall be limited to 50 mm per km of LWR track after which distressing shall be done and creep is adjusted.
- (iii) All the welded joints in ballastless track shall be supported with joggled fish plates.
- (iv) Proper drainage should be ensured over BLT-IFS.
- (v) Zero missing fittings should be ensured throughout the LWR on BLT-IFS portion. Regular monitoring of toe load shall also be done and remedial measures be taken in case toe load is found to be less than 600 kg.
- (vi) Behaviour of trial LWR on BLT shall be kept under strict observation and performance be evaluated as per the provisions of the LWR Manual. Suitable action be taken immediately on observing unusual behaviour, if any and the same shall be reported to RDSO subsequently for necessary action.

#### **7. Tolerances & Design level for BLT-IFS Construction:**

Following are the design levels and tolerances (for general guidance during construction) of various elements which can be followed for achieving / finishing their top level (w.r.t. top level of 60 kg UIC rail) during construction of BLT-IFS washable apron:

- i) Design level of formation top : 840 mm below rail top level
- ii) Design level of top of LCC base : 740 mm below rail top level
- iii) Design level of top of PCC base : 590 mm below rail top level
- iv) Design level of centre of rail seat in PCRSB: 182 mm below rail top level

Tolerance for finishing /achieving the following level:

- i) Subgrade top : within  $\pm 20$  mm from the designed level
- ii) Top level of LCC base : within  $\pm 10$  mm from the designed level
- iii) Top level of PCC Base: within  $+0/-5$  mm from the designed level
- iv) Top level of centre of canted PCRSB: within  $\pm 1$  mm from the designed level
- v) Top level of Rail : to be the reference point

## 8. Maintenance and Performance Monitoring of BLT:

After construction of BLT-IFS washable apron, Zonal Railway will monitor the performance on quarterly basis. The performance monitoring will be based broadly upon following parameters:

- i) Efficacy of Fastening: Fastening system should be able to maintain track geometry (gauge, cross-level, loss fittings etc.) at all times within track tolerances during service without any component breakage, excessive wear and tear.
- ii) Track tolerances to be maintained at the time of construction and during trial / service should be as per laid down in following table:

S.No.	Parameter	Installation	Service
1	Gauge (with reference to 1673mm, measured below 14 mm rail top) for straight track and for curve upto the radius of 350m.	$\pm 1$ mm	$\pm 3$ mm
2	Variation in versine on curved track (20 m chord with half overlapping).	$\pm 3$ mm	$\pm 6$ mm
3	Vertical alignment over a 3.6m chord.	$\pm 1$ mm	$\pm 6$ mm
4	Lateral alignment over a 7.2 m chord on straight track.	$\pm 1$ mm	$\pm 3$ mm
5	Twist on 3.6 m base.	$\pm 1$ mm	$\pm 5$ mm

- iii) Any track settlement which impairs the functionality of track.
- iv) Any visible crack of width more than as stipulated in IRS concrete bridge code para 10.2.1 in concrete / RCC portion of slab which impair the functionality of track.
- v) Efficacy of drainage system : e.g. the slope of BLT-IFS slab & beams and drains constructed, if any along the track should function properly even during Monsoon period.
- vi) Any special observation.

**Annexure-I****LIST OF DRAWINGS USED IN MODIFIED BLT-IFS**

<b>S. No.</b>	<b>Title of Drawing</b>	<b>Drawing No.</b>
1.	Canted Partly casted rail seat beam for Ballastless track with indigenous fastening system (BLT-IFS) for loop line washable apron for speed upto 50 kmph	RDSO/T-8777 (enclosed)
2.	Ballastless track with indigenous fastening system (BLT-IFS) for loop line washable apron for speed upto 50 kmph	RDSO/T-8778 (enclosed)
3.	Rail Seat Assembly with 60 kg (UIC) rail for Wider PSC Sleeper to RDSO/T-8528	RDSO/T-8529 (Existing RDSO drg.)
4.	Jigs & Fixtures for holding the track for BLT-IFS in position	EDO/T- 2263 (enclosed)
5.	Elastic Rail Clip Mk-V	RDSO/T-5919 (Existing RDSO drg.)
6.	GFN-66 Insulating Liners	RDSO/T-6938 & 6939 (Existing RDSO drg.)
7.	10 mm thick Composite grooved rubber sole plate	RDSO/T-8528 (Existing RDSO drg.)