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GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

RDSO GUIDELINES FOR CONSTRUCTION OF LIMITED HEIGHT SUBWAY (LHS) BY CUT AND COVER METHOD

REPORT NO. BS – 120

APRIL - 2015

**BRIDGE & STRUCTURES DIRECTORATE
RESEARCH DESIGNS AND STANDARDS ORGANISATION
LUCKNOW-226011**

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FOREWORD

Indian Railway is engaged in the construction of large number of Limited Height Subway (LHS). The work is mainly executed by "cut and cover" method. RDSO has issued typical drawings for LHS. However, no guidelines for execution of work have been issued.

The "cut and cover" method for construction of LHS/Box culverts is one of the most frequently used method in the field. If, properly planned the work of insertion of RCC Box segments under track can be completed in a block of approximately 5 hours, for single line track.

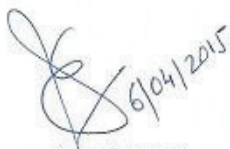
In order to maintain the uniformity and safe working in the field, Railway Board directed RDSO vide letter No. 2014/CE-IV/ROB/250 dated 16.01.2015 to issue guidelines on construction of LHS/Box culverts by "cut and cover" method, keeping the following issues in view:

- i. Adequate slope with berms with suitable interval for different soil conditions.
- ii. The deployment of machinery during excavation.
- iii. Backfill material with mechanical compaction.
- iv. Provision of return/wing walls so that backfill material can be retained properly.
- v. Wrapping up of box from outside by suitable Geo-Textile and water proofing arrangement from inside the box.
- vi. Adequate block.

Based on the practices and instructions issued on the subject by Zonal Railways and comments received from Railways on draft guidelines on the subject, RDSO Guidelines For Construction of LIMITED HEIGHT SUBWAY (LHS) by CUT AND COVER Method have been prepared. It is expected that these guidelines will serve as a technical guidance for officials of Engineering Department of Indian Railways working in the field.

Lucknow

Dated: 06.04.2015


(H.L. Suthar)
Executive Director/Structures
B&S Directorate
RDSO

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GUIDELINES FOR CONSTRUCTION OF LIMITED HEIGHT SUBWAY (LHS) BY CUT AND COVER METHOD

For executing work of construction for subway (Limited Height) by “Cut n Cover” method following guidelines shall be adopted. RDSO be advised in case any modifications in these guidelines are needed, based on Railways experience and/or any difficult is faced in adopting these guidelines in the field.

1. Site Survey and Planning

- 1.1. Detail site survey to be carried out for each LHS work separately. Modus operandi giving details of activities to be undertaken Before Block, During Block and After Block should be outlined.
- 1.2. Detailed soil investigation shall be conducted. Extra care shall be taken while taking samples of soil so that a realistic picture of soil stratum is obtained. It will be essential to take soil samples in close proximity of the tracks. As guidance at least two bore, one on either side of outer tracks, in the middle of Cess, be done. Boring to be done from formation to 500 mm below bottom of proposed precast RCC slab (below RCC Box segments).
- 1.3. Machinery, tools and plants and other equipment for excavation should be arranged as per soil stratum observed in soil investigation. Follow, relevant rules & regulations of concerned State/Central Govt. Authorities, especially where blasting is envisaged.
- 1.4. Side slope for excavation or cutting of embankment shall be decided based on the type of soil strata observed in the soil investigation indicated in clause 1.2 above. As a guidance side slope shall be kept 1: 0.5 (V:H). In case of dominantly non-cohesive soil, a flatter slope may be provided.
- 1.5. The width at bottom shall be kept at least 1.2 m more than width of RCC Box. At 3m depth from formation level or at Natural Ground Level (whichever is less) a berm of 0.75 m wide be provided, on either side. Width of cutting at formation level shall accordingly be worked out. Typical sketch for 4m X 4.5m internal box size is enclosed as annexure-1. Alternatively, flatter single slope of cutting be adopted.
- 1.6. S & T cable, electrical cable or any other cable or OHE wire coming in the way of execution of LHS should be surveyed and planning for their shifting/diversion, through concerned department be made.
- 1.7. Approach road for movement of road Crane & other heavy machineries be planned in advance.

2. Pre-Block Activities

- 2.1. RCC Box segments and base slab segments shall be casted as per approved drawing, outside the track, near proposed site. All RCC surfaces coming in contact with soil should be painted with bitumen or Coal Tar of approved quality @ 1.464 kg/sqm.
- 2.2. Reference lines are to be marked on the track and levels are to be fixed by using leveling instrument with reference to rail level. Centre line is to be marked on all the precast box segments. Central line of Subway shall be transferred on ground.
- 2.3. In case LHS is constructed on the same alignment of Level Crossing, existing CC paver blocks, lifting barrier etc should be removed.
- 2.4. Arrangement of Materials, manpower and machinery, as per requirement at site for single line or double line work.
 - 2.4.1. Sufficient quantity of ballast, sand, boulders and back filling material (as per clause 7.5 of foundations and sub-structure code), preferably, loaded in tractor-trolley during block.
 - 2.4.2. Sufficient empty cement bags filled with sand
 - 2.4.3. Arrangement of skilled labour, Engineering Black-Smith with rail cutting and drilling machine.
 - 2.4.4. Minimum equipments to be arranged for line block are given below.
 - a) Two Road cranes of suitable capacity (based on segment weight and length from where these are to be placed) with one additional as stand by crane. (capacity of crane required at 8m radius will at least be 50t)
 - b) At least two poclain (having bucket capacity of 1.0 to 1.5 cum) and 2 JCBs.
 - c) One Hydra of 14T capacity.
 - d) Six dumper/tractor-trolley with hydraulic system for unloading.
 - e) Wire ropes/slings (steel rope dia suitable as per total load to be lifted) and clips for each RCC Box segment.
 - f) Jack hammer along with compressors and tools and plants for blasting purpose, if required as per soil investigation, also additional poclain for Jack hammer.
 - g) Gas cutter and other T&P for track works
 - h) Leveling instrument with staff
 - i) Unserviceable Rail piling & sheet piling with proper lagging be arranged to protect the slopes of proposed cutting & embankment at the time of excavation. Alternatively, safety net and protective screen be used to safeguard workmen (being used by WCR). Details enclosed as annexure-2.
 - j) One suitable length RH girder with all accessories.
 - 2.4.5. Skilled & semiskilled staff for crane working, excavation of earth, sand filling, placement of slab & RCC Box, sand bag placement, back filling & P way work should be arranged for the Block working.

- 2.4.6. In case, due to any unforeseen eventuality which may affect the successful execution of planned work, RH Girders of suitable length along with ancillary arrangements should be kept ready to restore traffic expeditiously.
- 2.5. Caution of 20 KMPH may be imposed 24 hours before the proposed line block for a length of approximately 60 m.
- 2.6. LWR track should be converted in to Single rail, two gaps of 25 mm width to be made at a spacing of 13m (to be decided as per width of cutting at formation level), at equal distance from centre of proposed alignment of LHS and fish plates are to be provided. LWR to be destressed as per LWR manual.
- 2.7. Precast RCC Boxes to be placed in vertical position, along the track, on both sides, at a distance of at least 8m from the proposed centre of LHS. Precast slabs should also be kept ready near the LHS site or they can be put on precast RCC boxes. Efforts to be made to keep them in such a way that from one side launching of precast slab as well as RCC boxes can be done from one single position of crane. Crane shifting during block be avoided.
- 2.8. OHE to be lowered (in case of electrified section) with the help of tower wagon.
- 2.9. Notice to public for traffic block and train cancellation/diversion, if any, be given.
- 2.10. In case the LHS is required to be placed partially or fully below the Ground level, excavation on both the sides of the Railway bank should be done in advance with suitable ramps. This will facilitate easy access of machineries from sides and also in minimizing the requirement of excavation efforts during the block period. Stability of the side slopes must be ensured while doing this excavation.
- 2.11. Approach road for movement of road Crane & other heavy machineries be made.



Cutting of slope prior to block



Pre cast slabs and RCC box segments

3. Works during Block

- 3.1. The block shall not be planned during rainy season. Even in case of fair weather, the block work shall be avoided, if there is forecast of rain during block hours. The movement of machinery becomes difficult and work duration also gets prolonged, in case it rains.
- 3.2. Disconnect the track and track assembly including sleepers. Lift the disconnected track panel by crane and place at suitable location. Ballast is to be removed upto formation level and to be stacked away from working area.
- 3.3. Excavation of earth should be started simultaneously from both ends of formation by separate Poclain. While deploying two Poclain during excavation, care should be taken to commence excavation from diagonally opposite side (Up & DN) so that vibration effect on soil is not compounded. Slope and width be as per design as indicated in clause 1.4 and 1.5 above. The earth arising out of the excavation should be dumped away from the working area either transported through dumper/ tractor-trolley or space is created to temporary store the excavated earth. This excavated earth should not be used for backfill material unless specified otherwise.
- 3.4. Water may be sprinkled on cut slopes depending on type of soils.
- 3.5. Watchman should be posted to watch stability of cut slope and control traffic movement at site. Necessary plastic sheet to be kept at site to protect cut surface in case of unusual rain etc.
- 3.6. No materials should be kept or men are allowed to stand within 2 m from cut edge.
- 3.7. Precaution and safety
 - 3.7.1. Concerned staff from S&T and OHE shall be available at site.
 - 3.7.2. All the skilled, semi skilled staff working at LHS location should use safety helmet.
 - 3.7.3. Man should enter into trench only after stability of cut slope is ensured by SSE/Works in charge at site. Only bare minimum required persons to be allowed for entering the area between cut slopes.
 - 3.7.4. One staff at each side should be vigilant and he should alert staff working inside the trench in case of any collapse of side earth etc.
 - 3.7.5. Medical personnel with First Aid Box etc. should be available at site.
 - 3.7.6. Sufficient number of RPF personnel should be deployed to protect the site from local people during Block.
 - 3.7.7. Sectional Traffic Inspector (TI) should be deputed for co-ordination with Divisional Control.
- 3.8. To check the level for bottom of cutting, bamboo or staff can be used, having pre-marked level, for quicker idea. One string to be stretched at rail level. From the same string three plum bob be fixed one on either outer ends of RCC Boxes and one at centre. Thereafter, edges and centre line be transferred at bottom of cutting. Track centre shall also be transferred.



Approximate depth check by bamboo



First RCC box segment being placed (to be placed with one edge at centre of track)

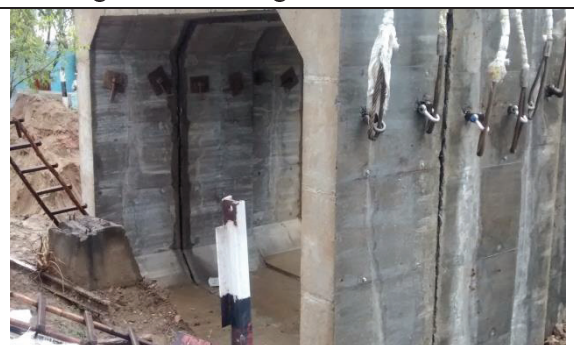
3.9. Bottom of bed is to be prepared with sand. Sand to be unloaded directly from dumpers/ tractor trolly, minimum 200 mm thick layer or as designed to achieve required SBC and leveled manually or with the help of poclain. Level of top of sand be checked with the help of levelling instrument with respect to designed level.

3.10. Precast base slabs should be placed in position by cranes, starting from centre of formation towards both ends. Centre line of precast slab shall be placed at the centre line of track (for single line). Hook on slabs top should be cut by disc cutter or gas cutting arrangement and epoxy mortar to be applied.

3.11. The pre-cast box segments are to be placed over base slabs, by cranes, edge of box segment be placed at centre of track (especially in case of single track) i.e. track will be supported on two segments. After that segments are placed towards both ends. The pre-cast box segments should be at perfect alignment with centre line of LHS. The joints between base slab and segmental boxes should be staggered. Segments should perfectly flush with each other. Hook on box top should be cut by disc cutter or gas cutting arrangement and epoxy mortar to be applied Alternatively holes can be kept in precast Box segment for lifting.



Alignment being adjusted prior to final placement



Holes in RCC box segments (instead of hooks) along with wire rope and steel bracket, fixed prior to block

- 3.12. Geo-textile to be wrapped on the entire outer surface of the box to prevent seepage and leaching of earth. All joints to be sealed with suitable sealant/waterproofing compound.
- 3.13. Insertion of RCC Box for LHS should be done in presence of Sr. DEN/DEN as per instructions of Railway Board.
- 3.14. Construction of wing walls after launching of boxes require a considerable period and also require speed restriction during this period. Hence, suitably designed U-shape or L-shape precast RCC retainers be launched, along with launching of RCC boxes. In such cases suitable weep holes shall be provided in the RCC box/U or L shaped retainers.
- 3.15. Boulders to be filled behind the RCC box. Remaining space (between cut formation and boulders) should be filled with suitable back fill material and to be compacted properly, preferably by use of hand held pneumatic vibrators.
- 3.16. Backfill material may slip easily (being granular material), therefore, in outer 1.0m -1.5m thickness (bank slope) excavated soil or cohesive soil be used.
- 3.17. Ballast should be spread and track panel to be placed over ballast and fish plates be fixed on either end. Manual, packing and alignment should be done.
- 3.18. Pilot the first train with Stop Dead and proceed caution and subsequent train at a speed restriction of 20 KMPH, till post block activities are completed.

4. Post Block Works

- 4.1. Mark sleeper nos on either side of the proposed LHS for a length of 15 m for monitoring Track parameters i.e. Cross Level measurements. The cross level of track should be measured after passage of train and track should be attended as per requirement.
- 4.2. After allowing initial settlement of boxes (if any), the gaps between two segments be sealed by use of Cement mortar or epoxy, by pressure grouting, to make joints water tight.
- 4.3. Making of ballast profile and through packing of track. Welding of fish plated joints to convert it to LWR and distressing.
- 4.4. Construction of Wing/Return walls. Sal Balli Pilling /Rail Pilling for the foundation of wing/return wall should be provided to facilitate construction of wing wall, as per requirement.
- 4.5. Provide height gauges on either side, as per the requirement and standard specifications.
- 4.6. Repair of embankment to proper profile.
- 4.7. Temporary speed restriction should be relaxed depending on site condition and consolidation of track.
- 4.8. Construction of approach road to LHS on either side and drainage system.
- 4.9. Commissioning of LHS.
- 4.10. Closing of Level Crossing.
- 4.11. As soon as first rainfall occurs after completion of the work. SSE/SE (P-way) should visit the site and inspect for any unusual occurrence like settlement, loose packing, cross-level variation etc.

5. Traffic Block-

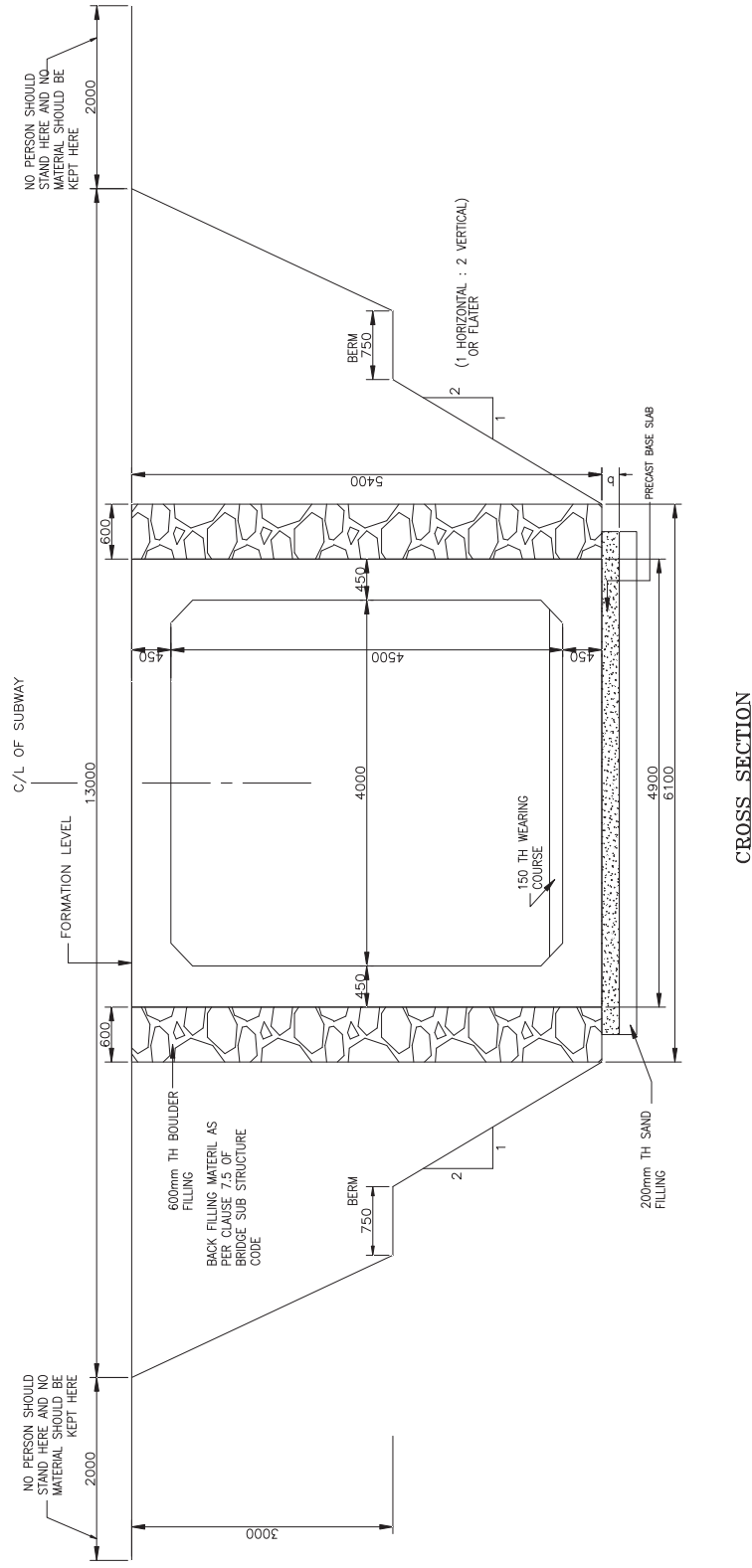
- 5.1. Site Engineers should carefully assess the quantum of work and evaluate the execution time based on capacity of equipments and other resources deployed. Some additional time should be considered for any exigencies. As a guidance following time log are given in Table-1 for Single line.

Table-1 Time Log for Single Line

SN.	Activity	Time (min)
1	Dismantling and Removal of track panel from track	5
2	Excavation of earth/embankment by two poclain (one from each side) and dumping of cut material about 30m away from embankment (approximate 400 cum)	90
3	Laying of sand below the base slab & preparation of bed including levelling	20
4	Laying of Precast slab- laying (about 10 slabs) leveling and aligning (cutting of hooks and applying epoxy) (by crane from both side)	30
5	Placing of precast boxes (9 box segments)- placement in proper level & alignment and placing geotextile/GI sheets	60
6	Boulder back filling (started after placement of two segments)- (Boulders placed at site by Dumpers) and placement of sand bags in four corners in between cutting & RCC boxes, Filling of back fill material in between boulders and existing formation along with compaction (work to be done parallel with boulder filling)	60
7	Placement of track panels, linking on either side of track and manual packing.	20
8	Exigencies	25
	Total	320



TYPICAL ARRANGEMENT FOR CONSTRUCTION OF LIMITED HEIGHT SUBWAY (LHS)
BY CUT AND COVER METHOD (FOR LHS SIZE 4.0MX4.5M)

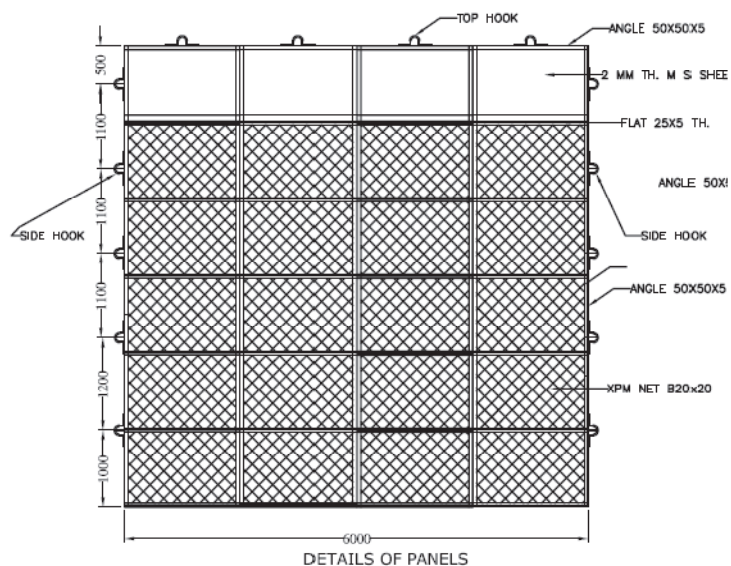


Protection screen for retaining the earth during construction of LHS:

For safety of workmen at LHS work site, protective steel mesh screen has been developed, designed and fabricated. Use of this at work sites has increased the confidence of Staff, Supervisor and Officers.



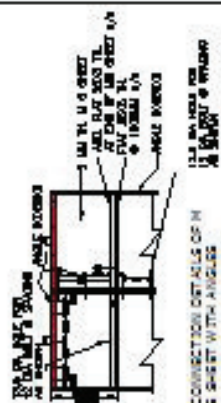
Protection screen being inserted during construction of LHS



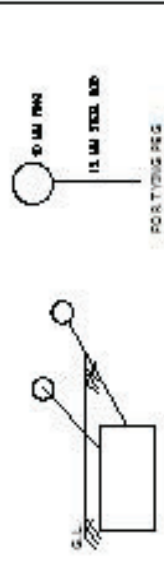
(All dimensions are in mm)



1. ALL MATERIALS ARE IN UNCLASSIFIED CONDITION.



CONNECTION DETAILS OF
SHEET WITH ANGLE



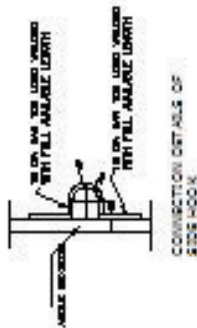
1000



CONNECTION OF VERTICES



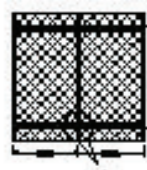
CONNECTION DETAILS OF STEEL WOOD

CONNECTION DETAIL OF
BEE HOOK

CONTAINS AT A



DETAILS OF BOLTS FOR BOLTS

DETAILS OF TOP HOOK
AND SIDE HOOK[illegible]

WEST CENTRAL RAILWAY	
APPROVAL AUTHORITY	
CSS	-25- R.N. SINGH (IAS)
JOINT (S&O)EN	-25- (JYOTI SINGH M. DASHBOROI)
S&O(S&O)EN	-25- (S. P. DASGUPTA)
TITLE :	
SCHEDULING ARRANGEMENT TO PREVENT S&O CUTTING DURING WORKING FOR PROVISION OF S.C. BOX	
DETAILS OF PANELS	
SCALE : NOT TO SCALE	
PAGE NO.	