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Government of India - Ministry of Railways
Research Designs & Standards Organisation, Manak Nagar, Lucknow – 226011

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संख्या/No. TI/OHE/IRSDCL/2017 दिनांक/Dated, the 31st October, 2017

To,

The Principal Chief Electrical Engineer,

(i) Central Railway, Station Building, Mumbai CST – 400 001.
(ii) Eastern Railway, Fairlie Place, Kolkata-700 001.
(iii) East Central Railway, Hajipur-844 101.
(iv) East Coast Railway, Bhubaneshwar-751 023.
(v) Northern Railway, Baroda House, New Delhi - 110 001.
(vi) North Central Railway, Allahabad-211 015.
(vii) North Eastern Railway, Gorakhpur-273 012.
(viii) North Frontier Railway, Mailgaon - 781 011.
(ix) North Western Railway, Jaipur – 302 017.
(x) Southern Railway, Park Town, Chennai- 600 003.
(xi) South Central Railway, Railnilayam, Secunderabad-500 371
(xii) South Eastern Railway,Garden Reach, Kolkata-700 043.
(xiii) South East Central, Railway, Bilaspur-495 004.
(xiv) South West Railway, DRM's Office, Hubli-580 028.
(xv) Western Railway, Churchgate, Mumbai-400 020.
(xvi) West Central Railway, Jabalpur- 482 001.
(xvii) Central Organisation for Railway Electrification, Nawab Yusuf Road, Allahabad-211000.
(xviii) Konkan Railway, Belapur Bhavan, Navi Mumbai – 400614

विषय/Sub: Modification in OHE in connection with Redevelopment of Railway Station.

संदर्भ/Ref: (i) Railway Board letter No. 2003/RE/161/1Vol.III/Pt. dated18/22.08.2017.
(ii) Railway Board letter No. 2003/RE/161/1Vol.III/Pt. dated19/27.09.2017.
(iii) IRSDCL letter no. IRSDC/HQ/Civil/01/RB/4487 dated 24.10.2017.

Vide subject and reference (i) above, Railway Board sent the revised Report on "Modification of OHE in connection with the Redevelopment of Railway Stations" prepared by IRSDCL based on the discussion held at Railway Board along with RDSO and IRSDCL for examination of RDSO.

2. The report was examined by RDSO and recommendations were sent to Railway Board for acceptance. Vide reference (ii) above, Railway Board has issued the following directives:

(i) Last Para of item no. 2(d) of RDSO letter shall be revised as below:
"Encumbrance in OHE shall be kept in such a way that the clearance between the lowest beam of station concourse and rail level does not exceed beyond 7000mm".
(ii) Other recommendations of RDSO on the OHE modification in connection with station re-development are approved.
(iii) Accordingly IRSDCL shall submit the revised report incorporating the changes suggested by RDSO and RDSO shall issue the report for implementation over Indian Railways.

3. Accordingly IRSDCL submitted the report "Modification in OHE in connection with redevelopment of Railway Stations-Version 6 dated 23.10.2017" duly incorporating the changes suggested by RDSO vide reference (iii) above. RDSO recommendations incorporating the Railway Board directives are reproduced below:

(a) Standard height of contact wire shall be 5.6m.

(b) In order to reduce the height of Overline structure (station concourse), Cantilever position under the Station Concourse as shown in Case II under para 4.3 of the report, have been recommended by IRSDCL. It is acceptable. However, along the track distance between the Cantilever and beam (distance named as B) should be minimum of 1000mm and not 750mm for considering rotation of Cantilever due to temperature variation.

(c) Overall proposed vertical clearance of approximately 770 mm mentioned in the report is considered acceptable (It includes 20mm track maintenance allowance, 250mm minimum Electrical Clearance and 500 mm additional clearance; civil structure tolerance, conductor diameter is included in it).

(d) Encumbrance in OHE shall be kept in such a way that the clearance between the lowest beam of station concourse and rail level does not exceed beyond 7000mm.

(e) OHE gradient & Relative gradient, outside the overhead structure, shall be 2mm/m and 1mm/m respectively. Level OHE gradient should be maintained under overhead structure.

(f) Minimum dropper length shall not be less than 200mm.

(g) Rail level shall not be raised (other than 20mm for track maintenance allowance) and permanent bench mark shall be provided to indicate the maximum level of track to be maintained.

(h) OHE spans under concourse area may be selected in line with civil structure design and may not be standard spans.

(i) The design load for each support of OHE cantilevers shall consider two OHEs of higher cross section (125 sq. mm catenary wire and 150 sq. mm contact wire). The design shall have the following features:

(i) The insulated dowels shall be used for connecting the fittings to the structure.

(ii) Locations, where drilling of new holes can be done for providing any new support, shall be indicated in the document submitted to the concern division.

(j) Anchor load of 2400 kgf, on beam structure as well as on the face of the station concourse shall be considered in design of concourse.

(k) To prevent bird menace, appropriate measures such as closed sections, RSJ/BFB drop arms etc. are recommended so as not to provide any space for birds to make nests. Suitable arrangement for the cantilever support should be done.

(l) To prevent monkey menace, the walls towards the trackside shall have no windows and ledges etc. which can be used by monkey.

(m) Concourse design should not permit any possibilities of physical contact with live parts (in line with EN 50122-1) and which eliminates possibility of throwing any object on live OHE shall be adopted.

4. All the latest directives of Railway Board & RDSO for installations of OHE shall be ensured.

As directed by Railway Board, IRSDCL report is hereby issued for implementation regarding modification in OHE in connection with Redevelopment of Railway Station over Indian Railway.

This is issued with the approval of PED/TI/RDSO.

31/10/17

(नीरज कुमार वर्मा /Neeraj Kumar Verma)

निदेशक(ओएचई-डी)/Director(OHE-D)

[कृतेमहानिदेशक(कर्षणसंस्थापन)/ForDirector General(TI)]

Encl: Approved Final Report of IRSDCL -Version 6 dated 23.10.2017

Copy to : 1. CPM/Civil, Indian Railway Station Development Corporation Limited, 4th floor, Palika Bhawan, Sector-XIII, R.K.Puram, New Delhi-110066

2. The Executive Director, Electrical Energy (Management), Railway Board, Rail Bhawan, New Delhi-110001

Modification in OHE in connection with the Redevelopment of Railway Stations
Final Report

Ref: LOA no. LEAP/HQ/Tender/06/2017/LEAP/3962 dated 22.05.2017

Submitted to

Indian Railway Stations Development Corporation Ltd.
(A JV of IRCON and Rail Land Development Authority)
4th Floor, Palika Bhavan, Sector XIII
RK Puram, New Delhi 110066
INDIA

Submitted by

LEAP Infraasys Pvt. Ltd.
SCO#25, HUDA Market, Sector 21A
Faridabad 121002
Haryana, INDIA

Submitted on

23/10/2017

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31/10/17
For Director General/T.I./R.D.S.O./LKO

GM/civil/IRSDC

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For Director General/T.I./R.D.S.O./LKO

GM(Civil) IRSDC

Quality Assurance

Document Name: Modification in OHE in connection with the Redevelopment of Railway Stations

Document Ref: LIPL/IRSDC/001

	Name	Signature	Date
Drafted by	Anil Jangid		Sept 03, 2017
Reviewed by	Sudesh Kumar		Sept XX, 2017

Version	Date	Subject of Revision
0	May 29, 2017	
1	July 12, 2017	Incorporation of RDSO comments
2	July 14, 2017	Incorporation of DMRC comments
3	Aug 08, 2017	Incorporation of RDSO additional comments
4	Sept XX, 2017	Incorporation of RDSO final comments
5	Sept 27, 2017	Incorporation of Railway Board orders
5.1	Oct 6, 2017	Minor Typographical errors corrected as pointed out by RDSO.
6	Oct 23, 2017	Minor Typographical errors corrected and changes done as pointed out by RDSO.

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Abbreviations

AC	Alternating Current
ACS	Addendum & Corrigendum Slip
ACSR	Aluminium conductor steel-reinforced cable
ACTM	AC Traction Manual
ATD	Automatic Tensioning Device
DFCCIL	Dedicated Freight Corridor Corporation of India Limited
DMRC	Delhi Metro Rail Corporation
EN	Euro Norms (European Standards)
FOB	Foot Over Bridge
FTA	Fixed Termination Assembly
IEC	International Electro-technical Commission
IR	Indian Railways
IRIEEN	Indian Railway Institute of Electrical Engineering, Nasik
IRSDC	Indian Railway Station Development Corporation
LC	Level Crossing
LOA	Letter of Acceptance
OHE	Overhead Equipment
RCC	Reinforced Concrete
RDSO	Research, Design and Standards Organization
ROB	Road Over Bridge
SOD	Schedule of Dimensions

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1 Introduction

Indian Railway Stations Development Corporation Limited (IRSDC) is a Special Purpose Vehicle (SPV) under the Ministry of Railways and was incorporated under the Companies Act, 1956 in 2012.

IRSDC is mandated to develop / redevelop railway stations into world-class stations. As land and floor spaces become scarce with the growth of operational and commercial activities, and with a view to relieve congestion prevailing on the platforms, the IRSDC has prepared this concept of development of air spaces above the railway platforms, including track area, for commercial / institutional / recreational purposes.

The 25kV OHE will be required to be installed on the ceiling / soffit of the structure built over the track space. A study is required to be carried out covering the following aspects:

(a) Minimum height of the bottom of the beam, which will comply with all the extant regulations.

(b) Openings in the concourse on sides: Any special requirements for the design of concourse, which will ensure protection of OHE (so that nothing can be thrown on the OHE / tracks).

(c) Addressing bird menace: The bottom of beams and other arrangements shall be such as not to provide any space for the birds to sit and/or nest as this can create safety issues with OHE. If this cannot be ensured, protection measures required for catenary wires under the concourse.

(d) Earthing of concourse structure: If the OHE is hung from the concourse structure, proper earthing requirement for steel / concrete structures.

(e) Arrangement for providing OHE: The concourse structure shall be designed such as to allow the standard OHE equipment to be used. The holes / plates etc. shall be provided suitably in the concourse structure. General arrangement only to be suggested.

(f) Flexibility in providing OHE: The standard OHE portals / masts are provided with spacing at 4.5m intervals. How this aspect will be tackled while designing the concourse structure and it shall be possible to provide OHE even at locations where the main beams of concourse structure are not there. Arrangement shall be there for future tracks.

(g) OHE loads for design of concourse structure: The concourse structure shall be designed keeping the present and future planned OHE loads in mind. There are several different types of arrangements including single set of wires, double set of wires, anchored wires and ATD arrangement etc. The absolute loads for these arrangements in all three directions need to be considered in design. It is desirable that the maximum spans / maximum wind loads be considered so that flexibility for future modification of OHE is there.

Vide LOA no. LOA no. LEAP/HQ/Tender/06/2017/LEAP/3962 dated 22.05.2017, IRSDC engaged LEAP Infraasys Pvt. Ltd. for carrying out the above study. Following professionals worked on this report:

- Sudesh Kumar
- Anil Jangid

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This document has been prepared for guidance and cross reference to other standards that would be attracted while developing additional spaces above the existing stations electrified with 25kV OHE for traction. The additional floor space created above the railway tracks / platforms may be on RCC structures or supported on fabricated steel structures. Where RCC structures are contemplated for the purpose, the drop arms to support the OHE will be required to be grouted in and suspended from the concrete ceiling / soffit of the structure built over the track space.

This revised version (Version-01) of the report has considered the RDSO comments communicated vide letter no. TI/OHE/IRDSCL/2017 dated 29.06.2017. The key comment of RDSO is regarding height of contact wire, which has been suggested to be kept at normal 5.6m instead of reduced height of 4.8m-5.1m considered in Version-0 of report.

Further, RDSO has suggested the following other issues:

- Clearance between overhead structure and OHE conductor shall be 340mm instead of 270mm (as per IR SOD, IEC, ACTM)
- Contact wire gradient should be considered 2mm/m instead of 3mm/m. Though with contact wire height at normal 5.6m, the contact wire gradient will not be encountered at most places.

IRSDC referred the study report to Delhi Metro Rail Corporation (DMRC) for proof-checking. Vide letter no. DMRC/CEE/RC2/Misc/8/4139 dated 14.07.2017; DMRC has provided their comments and in-principally agreed with the design proposed in the Report. DMRC have suggested to go for 500mm electrical clearance in view of civil construction tolerances.

Version 2 of the Report incorporated suggestions of DMRC and was submitted to RDSO. RDSO vide letter no. TI/OHE/IRSDC/2017 dated 28.07.2017 issued further comments. Following these comments of RDSO, meeting was held in Railway Board on 04.08.2017 and the following was in-principally agreed:

- Normal encumbrance of 1.4m shall be attempted with max span permissible
- Reduced encumbrance of 0.9m is fine with span not more than 58.5m
- Further reduced encumbrance of 0.6m may be resorted with lesser spans (not more than 40.5m) if site conditions so warrant
- A track maintenance allowance of 20mm is to be considered
- An additional electrical clearance of 500mm over and above the minimum prescribed (as per ACTM, IR SOD and IEC) 250mm; hence the overall vertical electrical clearance of 770mm (including track maintenance allowance) to be planned. The additional 500mm clearance will also take care of civil structure tolerances and conductors width / diameter.

Considering the above, this Verion-03 of the report was submitted. Typical design has been proposed in this report to keep the minimum height of overline structure duly complying with RDSO and DMRC comments regarding contact wire height and electrical clearances.

Vide letter no. TI/OHE/GA/2017 dated 31.08.2017, RDSO has accepted the Report but suggested to perform certain corrections. Version 4 of the report has incorporated the suggestions of RDSO.

The report has been finally accepted by Board (MTR) vide letter no 2003/RE/161/1 Vol-III/Pt. Dated 19/27.09.2017 with one change over RDSO suggestions. Version 5 (i.e. current version) of the report has incorporated the Board orders.

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2 Indian Railway SOD Requirements

2.1 Context

2.1.1 Indian Railways Schedule of Dimensions (SOD) 1676mm BG was revised and issued in 2004. Since then 19 revision slips (ACSs) have been issued from time to time. Recently (after 17 ACSs in Aug 2015), Railway Board consolidated the then 17 ACSs and issued a document "Technical Aid to Indian Railways Schedule of Dimensions 1676mm Board Gauge". This Technical Aid and later ACSs (no. 18 and 19) have been considered for analyzing the relevant requirements for the instant case. In fact, the ACS no. 18 and 19 does not deal with vertical height / clearance matters.

2.1.2 The Schedule-I of the SOD, which is applicable to New Works and Alteration to Existing Works, applies to station redevelopment projects.

The paragraph references mentioned in this report pertain to the Technical Aid.

2.2 Height of Structures above Tracks

2.2.1 Para 1.8: Height of Road Over Bridges and Foot Over Bridges

Para 1.8.3 (Item 10 (iii) of SOD 2004): Where 25kV AC traction is likely to be used, the minimum height above rail level for a distance of 1600mm on either side of the center of track shall be:

1.8.3.1	Light overhead structure such as foot over bridge:	6250mm
1.8.3.2	Heavy overhead structure such as ROB or flyover bridges:	5870mm

2.2.1.1 Para 1.8.4: Minimum height of such heavy structure in case of

(i)	Turnout or crossover located under a heavy overhead structure or within 40m from its nearest face or	6250mm
(ii)	Level crossing gate is within 520m from the nearest face of the overhead structure	

The height mentioned above shall be measured from the higher or super elevated rail.

2.2.2 Para 2.8 (Item 9 of SOD 2004): Height of Overhead Structures above rail level in a passenger station

2.2.2.1 Para 2.8.1: Of tie rods or any continuous covering

2.8.1.1	For a width of 1600mm on either side of the center of track	6250mm
2.8.1.2	For a width of 1370mm on either side of center of track on lines other than main lines where 25kV ac electric traction is not likely to be used or on the existing primary lines which are not likely to be electrified	6100mm

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2.2.2.2 Para 2.8.2: Of Signal Gantry or Foot Over Bridge for a width of 1600mm on either side of center of track

2.8.1.2	Height above rail level	6250mm

2.2.3 The above provisions require that the minimum height of structure above tracks (for a width of 1600mm on either side of center of tracks) in station areas shall be 6250mm for 25kV ac electrified territories, irrespective of any other provisions.

2.2.4 Extra vertical clearance

2.2.4.1 Extra allowance of 275mm of foreseen vide Note (3) under Para 2.8.1

"Extra vertical clearance of 275mm under overhead structures and overhead equipment in electrified section or proposed to be electrified on 25kV ac system shall be provided to allow for any raising of track to permit modern track structure, i.e. to cater for increased ballast cushion, larger sleeper thickness and deeper rail sections by using longer traction OHE mast."

2.3 Electrical Clearances

2.3.1 Para 8.1 (Item 1 of Chapter V-A of SOD 2004): Electrical Clearances

Vertical and lateral distance between 25kV live parts and earthed parts of fixed structures or moving loads / rolling stocks shall be as large as possible. The minimum vertical and lateral electrical clearances to be maintained under worst condition of temperature, wind etc. between any live part of the overhead equipment or pantograph and parts of any fixed structures (earthed or otherwise) or moving loads / rolling stocks shall be:

8.1.1	Long duration	250mm
8.1.2	Short duration	200mm

Note (b) to Para 8.1 further requires:

A minimum vertical distance of 270mm shall normally be provided between rolling stock and contact wire to allow for a 20mm temporary raising of track during maintenance. Wherever the allowance required for track maintenance exceed 20mm, vertical distance between rolling stock and contact wire shall correspondingly be increased.

2.4 Minimum Contact Wire Height

2.4.1 Para 8.2 (Item 2 of Chapter V-A of SOD 2004): Minimum Height from rail level to the underside of contact wire:

8.2.1	Under bridges and in tunnels	4800mm
8.2.2	In the Open	5500mm (5600mm normal height)
8.2.3	At Level Crossings	5500mm (5600mm normal height)
8.2.4	In Running and Carriage Sheds	5800mm

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2.4.2 Following notes under this Para 8.2 are provided in the Technical Aid / SOD:

(i) In cases, where it is proposed to allow Locomotives or Rolling Stocks not higher than 4.42m, the minimum height of Contact Wire, specified under Item 8.2.1 above many be reduced to 4.69m.

(ii) In cases, where it is proposed to allow only Locomotive or Rolling Stocks not higher than 4.27m the minimum height of contact wire, specified under Item 8.2.1 above may be reduced to 4.54m. A board showing this restriction and specifying "locomotives or Stocks not permitted to ply on such section", shall be exhibited at the entrance to the same.

(iii) For movement of Over Dimensional Consignments, the height specified under Item 8.2.1 above shall be increased by the difference between the height of the consignment contemplated and 4.42m. In case, such an over dimensional consignment is moved at speed not exceeding 15 kmph and is also specially escorted by authorized Railway Staff, the derived height of Contact Wire may be reduced by 50mm.

(iv) On curves, all vertical distances specified in Item 8.2 above shall be measured above the level of the inner rail, increased by half the super-elevation.

(v) Suitable prescribed gradient on the height of contact wire shall be provided for connecting these wires installed at different heights.

In the case of light structures such as foot-over bridges, it would be desirable to keep a standard height of contact wire of 5.50m. In case of heavy structures, such as flyover bridges or Road over bridges, it is desirable to keep height of contact wire as low as possible, consistent with the requirements of movement of Standard Class 'C Over Dimensional Consignments of height 4.80m.

2.5 Summary of Requirements

Minimum height of station concourse structure above tracks in station area for 25kV ac electrified territories	6250mm
Vertical electrical clearance (including 20mm track maintenance allowance)	270mm
Lateral electrical clearance	250mm
Minimum contact wire height (ignoring lower height stocks viz. 4.42m and 4.27m high) at mid span (i.e. with pre-sag)	4800mm*

*The IRSDC's proposed concourse structures over the railway tracks qualify as heavy structures (not light one akin to FOB) and, therefore the contact wire height of 4.80m is considered as applicable to these stations. The contact wire height will have to be increased at the supports to the extent of pre-sag in contact wire.

However, as per RDSO and DMRC comments, the minimum contact wire height and vertical electrical clearance shall be considered to be 5600mm and 770mm respectively. In view of this, the revised summary of requirement is as under:

Minimum height of station concourse structure above tracks in station area for 25kV ac electrified territories	7.0m (As per clause 4.5, Table 9)
Vertical electrical clearance (including 20mm track maintenance allowance)	770mm
Lateral electrical clearance	750mm
Minimum contact wire height at mid span (i.e. with pre-sag)	5600mm

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3 OHE System & Requirements

3.1 Main Features

3.1.1 The standard OHE System used in Indian Railways is having the following features:

Table 1: OHE features

SN	Description	Value / particular
1	Cu Contact wire area (cross section)	107 mm2
2	Contact wire weight per meter	0.952 kg/m
3	Contact wire diameter	12.24mm (107 mm2)
4	Messenger wire cross section	65 mm2
5	Messenger wire weight per meter	0.5973 kg/m
7	Messenger wire diameter	10.5 mm
8	Tension in contact and messenger wire	1100 kgf*
9	Automatic tensioning device	3-pulley type
10	Dead weight of ATD	735 kg
11	Cantilever assembly dead weight	60 kg
12	OHE Structure Spans (4.5m gaps)	27m to 67.5m*
13	Contact wire sag at the mid span	50mm* (67.5m span)
14	Encumbrance (generally)	1.4m
15	Contact wire stagger*	150mm (on tangent) 200mm (on curves)
16	RC wire (if used) type	
17	RC wire weight per meter (233 mm2 aluminum)	0.652 kg/m
18	Section insulator weight	50 kg

*The revised parameters as per Railway Board letter No. 2001/Elect(G)/170/1 dated 22.11.2016 considered (as pointed out by DMRC)

3.2 Speed potential

3.2.1 The standard OHE used in Indian Railways is considered fit for speeds upto 160 kmph. The speed potential of OHE system is determined using the empirical formula for wave propagation velocity 'c':

$$c = 3.6 * \sqrt{\frac{\sigma_{cw}}{\rho_{cw}}} = 3.6 * \sqrt{\frac{H_{cw}}{m_{cw}}}$$

Where:

σ_{cw}	Tensile stress in contact wire
ρ_{cw}	Specific density of contact wire material
H_{cw}	Tensile force in contact wire and
m_{cw}	Mass per unit length of contact wire

The maximum operating speed should not increase 70% of the wave propagation speed. For 1000kgf tension and 107mm2 contact wire (linear weight of 0.952kg/m), the operating speed works out to be above **200 kmph**. So long as the loop type dropper is used, the speed potential of OHE is not hampered. Minimum length of such dropper is 200mm.

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3.3 Contact wire gradient

3.3.1 The normal height of contact wire is 5.6m above rail level in the open and at level crossings (refer Para 2.4 above).

3.3.2 The minimum contact wire height under heavy structures (bridges and tunnels) is permitted upto 4.80m (Para 2.4 above). However, contact wire height of 5.6m is considered as the minimum height permissible for concourse structures envisaged over railway tracks.

3.3.3 The contact wire needs to be graded to allow smooth passage of locomotives through sections with different contact wire heights. The prescribed contact wire gradient is given under as Para 7.4 of "*Principles for Layout Plans and Sectioning Diagrams for 25kV ac Traction*" contained in IR ACTM Volume-II, Part II.

Any change in the height of the contact wire should be made gradually and the slope should not normally exceed 3mm/m on mainlines and 10mm/m on sidings. In no case, shall the relative gradient of the contact wire in two adjacent spans be greater than 1.5mm/m on mainlines and 5mm/m on sidings.

However, in view of RDSO comments and in line with Railway Board letter no. 2001/Elect(G)/170/1 dated 22.11.2016, the contact wire gradient and relative gradient over two adjacent spans have been revised to 2mm/m and 1mm/m respectively.

3.4 Encumbrance

3.4.1 The encumbrance is elaborated under Para 9.0 of "*Principles for Layout Plans and Sectioning Diagrams for 25kV ac Traction*" contained in IR ACTM Volume-II, Part II. It is reproduced hereunder:

3.4.2 Para 9.2 Normal Encumbrance

The encumbrance shall normally be 1.4m

3.4.3 Para 9.3 Reduced encumbrance

The preferred values of reduced encumbrance for erection of overhead equipment under over line structure are:

Table 2: Reduced encumbrance under over line structure

SN	Span under over line structure (m)	Recommended encumbrances for span under over line structure (m)	Largest permissible adjacent spans (m)
(1)	(2)	(3)	(4)
1	63.0	0.9	67.5
2	58.5	0.9	67.5
3	54.0	0.75	67.5#
4	49.5	0.6	63.0
5	45.0	0.6	63.0
6	40.5	0.5	58.5
7	36.0	0.4	54.0*
8	31.5	0.4	49.5
9	27.0	0.3	45.0

Applicable where the encumbrance cannot be increased to 1.40m in a single span

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from the value given in column 3. The normal encumbrance of 1.40m should be provided in subsequent spans. In such cases, the encumbrance may be adjusted in such a way that the lowest point of the catenary does not fall between first dropper and the support.
Note: (i) The above values are applicable only to regulated OHE with upto 10cm nominal pre-sag of contact wire (Note: Now the maximum pre-sag has been reduced to 50mm as per Railway Board letter no. 2001/Elect(G)/170/1 dated 22.11.2016) (ii) Special droppers may be required in spans under and adjacent to over line structures

3.4.4 Para 9.4 Minimum Encumbrance

Normally, the axial distance between the catenary and the contact wire at the minimum dropper should not be less than 150mm. Smaller droppers may be adopted in exceptional cases. If the shortest dropper is loop type and more than 150 mm, no speed restriction is called for. But if the dropper is without loop or of rigid type or less than 150 mm, the overhead equipment is deemed suitable up to 90 km/h speed.

Notwithstanding the above Para of ACTM, droppers of minimum 200mm length are proposed.

3.4.5 Para 9.5 If section insulators are to be installed in spans under over-line structures, special designs should be evolved.

3.5 Electrical clearance from over line structures

3.5.1 The clearance study of OHE from over line structure requires consideration of the following factors for determining the maximum height of contact wire or minimum height of over line structure from rail level (ref: Treatise on Electrical Traction Distribution, Part IV Overhead Equipment, Chapter 7 "Clearance Study"):

Table 3: Electrical clearance factors under over line structures

SN	Details	Value (meter)
1	Kinematic load gauge	u
2	Allowance for track maintenance	v
3	Vertical oscillations of contact wire	d
4	Short time clearance between Kinematic load gauge and contact wire	z
5	Minimum height of contact wire at mid span = 1 + 2 + 3 + 4 (Note: if the sum of SN 3 & 4 is less than long time clearance, the value for long time clearance shall be considered in place of sum of figures at SN 3 & 4)	$h = u + v + d + z$
6	Sag of contact wire at mid span	s
7	Height of contact wire at support	$H = h + s$
8	Thickness of conductor	t
9	Minimum or desirable construction depth (axial distance between contact and catenary wires)	d
10	Stationary height of catenary above rail level at mid span (5 + 8 + 9)	$h + t + d$
11	Rise of catenary from mid span to the point under consideration	y

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12	Erection tolerance	e
13	Allowance for push up	b
14	Height of catenary at point under consideration under push up conditions (10 + 11 + 12 + 13)	$h+t+d+y+e+b$
15	Short time clearance between over line structure and the catenary at the point under consideration	z
16	Minimum head room of over line structure required (14 + 15)	$h+t+d+y+e+b+z$

Normally, the most onerous scenario in case of clearance study is mid point of spans where the combined effects of contact wire sag, oscillation, axial distance (between contact and catenary wire) and allowance for messenger wire push are to be considered.

3.5.2 However, in case of station development / redevelopment projects, with the beam / slab structure of station concourse (and considering OHE cantilevers will be installed on beams), the onerous situation is that of support points and not mid spans. At support point the uplift is not prominent. The minimum axial distance between messenger and contact wire will depend on encumbrance, pre-sag and span length.

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4 Minimum height of over line station structure

4.1 General

The following situations could be encountered in station redevelopment projects:

(a) Simple situation with normal OHE without any special requirement under the concourse
(b) Two cantilevers OHE under the station concourse structure (with or without terminations of out of run OHE outside the covered zone); OHE anchor within the concourse region may not be avoidable in some cases
(c) A Section Insulator installed in OHE under the concourse area
(d) Level crossing within in close vicinity from the face of the station structure (requiring normal contact wire height of 5.5m)
(e) Concourse structure beams spaced at distance which is not multiple of 4.5 and/or less than 27m (necessitating non-standard span arrangement)

4.2 Case I

4.2.1 Refer to figure 1a, 1b, 1c below for schematic (cantilever suspended from concrete beam).

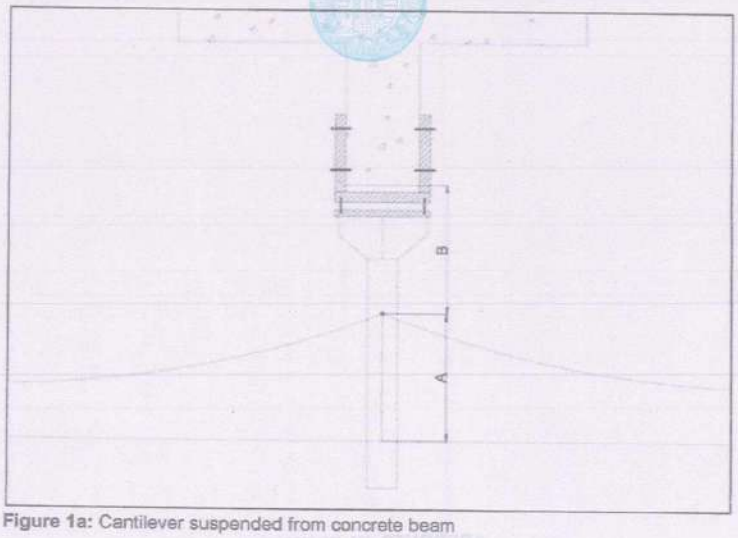

Figure 1a: Cantilever suspended from concrete beam

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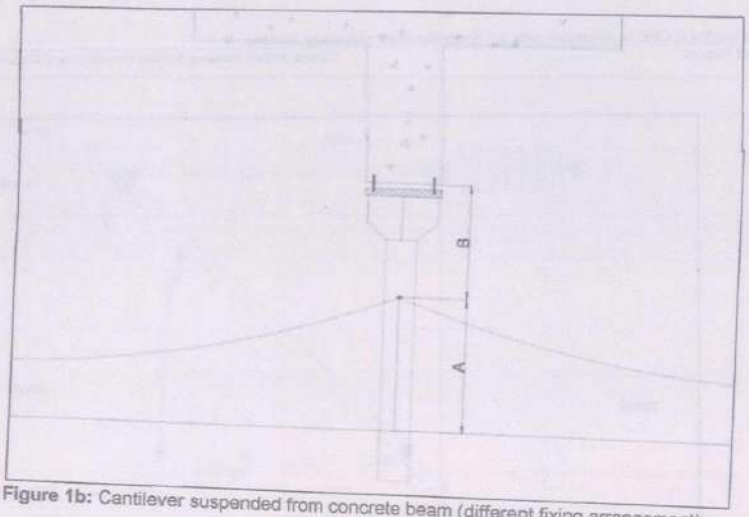

Figure 1b: Cantilever suspended from concrete beam (different fixing arrangement)

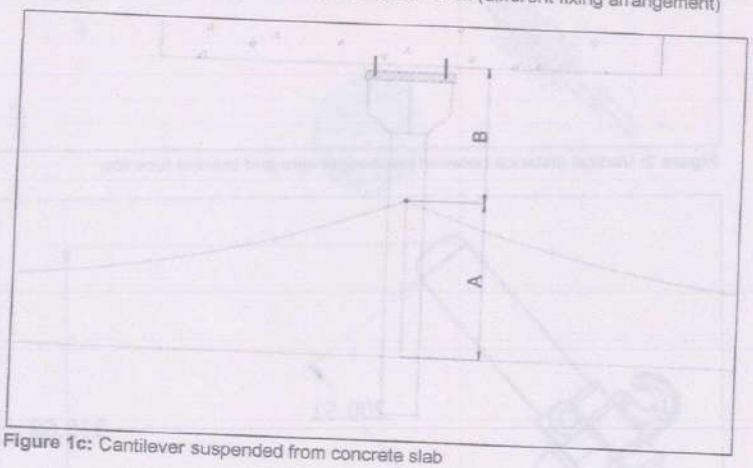

Figure 1c: Cantilever suspended from concrete slab

'A' is encumbrance in the above figures
'B' is minimum gap between bottom most point of beam and top most point of live parts i.e. top point of bracket tube (refer figure 2 ~~below~~ 1)

In figure 2 / 3, case of lower suspension distance (say 1.8m) (distance between mast face and messenger wire) is considered, which will be most onerous in this respect.

Hence B = 770mm (electrical clearance) + 310mm = 1080mm

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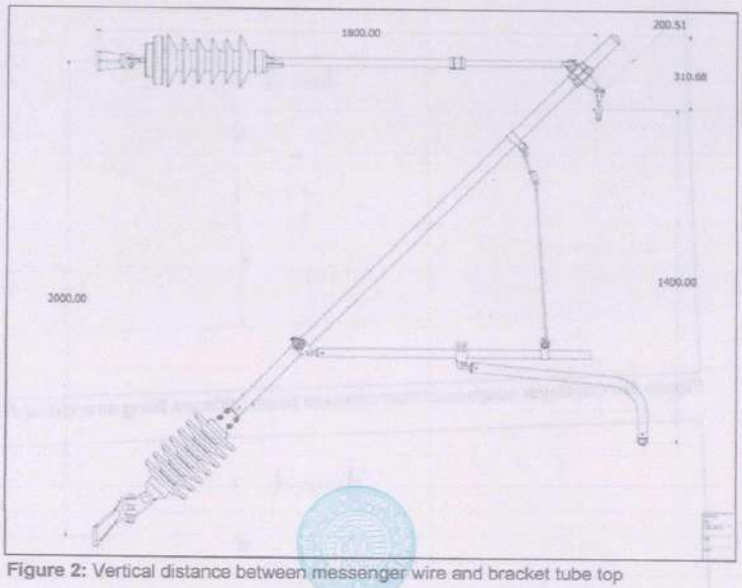

Figure 2: Vertical distance between messenger wire and bracket tube top

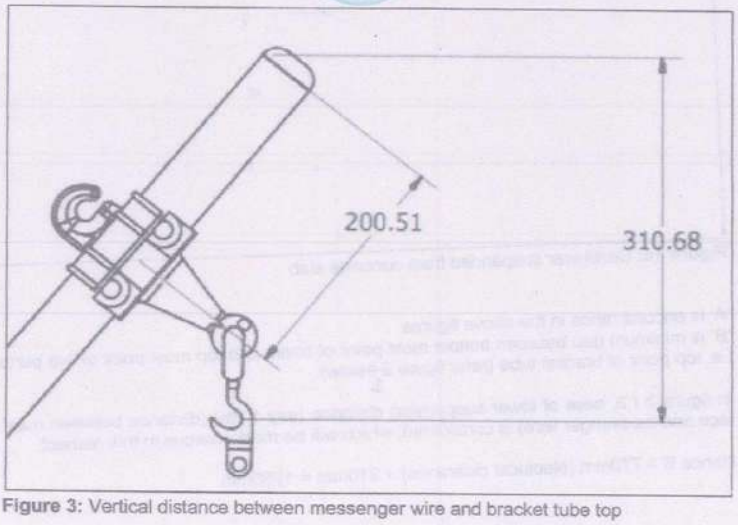

Figure 3: Vertical distance between messenger wire and bracket tube top

4.2.2 The situation is analyzed as under:

Minimum permissible contact wire height from rail level (refer Para 2.5 above)	= 5600mm

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Vertical distance between messenger wire and top point of bracket tube	= 1080mm
The minimum height of lowest portion of across the track beam from rail level	= 5600 + 1080mm + Encumbrance + pre-sag

4.2.3 The minimum dropper length for a span with different encumbrances (say 1.4m/0.75m or 1.4m/0.6m, 1.4/0.4m etc.) will always be more than 200mm. However, since the station concourse will be 100m or longer, there will be OHE spans within the over line structures requiring equal encumbrance on either side of the span. With the same encumbrance on either side of the span, the minimum dropper length will be more than 150mm in the following cases only:

Table 4: Minimum dropper lengths for various spans with minimum permissible encumbrances

Span (m)	Encumbrance (mm)	Axial distance (mm)	Dropper length (axial distance – 46mm)
22.5m	300mm	211mm	165mm
27.0m	300mm	187mm	141mm
31.5m	400mm	245mm	199mm
36.0m	400mm	182mm	136mm
40.5m	500mm	228mm	182mm
45.0m	600mm	279mm	233mm
49.5m	600mm	211mm	165mm
54m	750mm	275mm	229mm

***Note:** The above is derived from RDSO Drawing no. ETI/OHE/G/00173 "Dropper schedule for compensated OHE with equal encumbrance (14/1.4m) for speed upto 160 kmph"*

It is proposed to use encumbrance of 600mm and above only Hence, the minimum dropper length of 200mm will be ensured.

4.2.4 With the permissible encumbrance (Table 4 above), and pre-sag values (as per RDSO Drawing no. ETI/OHE/G/00173-1 titled "Dropper schedule for regulated OHE in worn out condition of 107 mm2 Contact wire (9.75mm thickness)", the minimum height of overline structure for 5600mm contact wire height from rail level is determined as under:

Table 5: Minimum overline structure height with various spans and encumbrances

Span (m)	Pre-sag (mm)	Minimum overline structure height (in mm) for 5600mm high contact wire for different encumbrances					
			400	500	600	750	900
22.5	7		7087	7187	7287	7437	7587
27.0	11		7091	7191	7291	7441	7591
31.5	16		~~7096~~	7196	7296	7446	7596
36.0	22		~~7102~~	~~7202~~	7302	7452	7602
40.5	29			~~7209~~	7309	7459	7609
45.0	37				7317	7467	7617
49.5	46				~~7326~~	7476	7626
54.0	55					7485	7635

Note 1: The above minimum height of overline structure is conservative to the extent of lower value of pre-sag (max 50mm instead of earlier 100mm) to be considered as per Railway Board letter no. 2001/Elect(G)/170/1 dated 22.11.2016.

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Note 2: Contact and catenary wire diameters (total 28mm for both, assuming 150mm2/125mm2 conductors as most onerous case) are assumed to be covered in additional 500mm electrical clearance.

4.3 Case II: Innovative designs

4.3.1 It is possible to innovatively design the OHE support under the concourse structure for reduction of over line structure height

Refer to figure 4 below

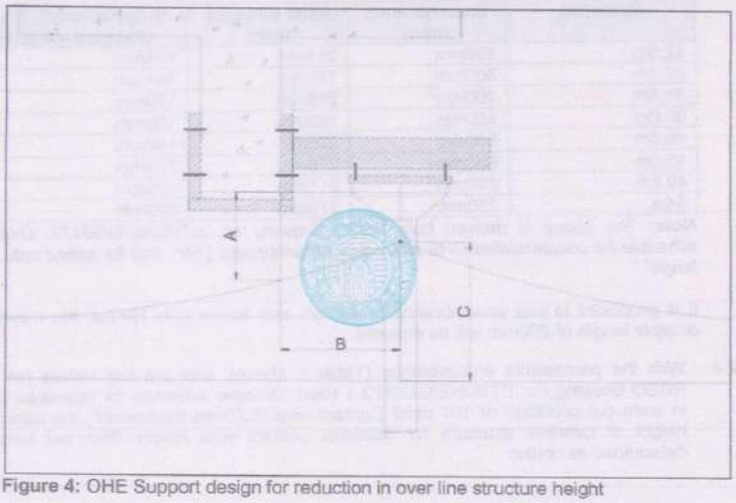

Figure 4: OHE Support design for reduction in over line structure height

This design will require consideration of additional bending moment on the OHE support structure, which shall be appropriately addressed by IRSDC during detailed design.

4.3.2 In this case, the cantilever support point is kept some distance away from beam. Since the additional vertical space (800-1000mm or so) is available in the non-beam region of the structure, the vertical distance (310mm) between messenger wire and bracket tube top (refer figure 2/3) need not be considered from bottom of the beam.

Further, the catenary will sag a bit away from its support point, and hence the 500mm clearance (between messenger wire and beam bottom – 'A' in above figure) will need to be measured from its actual position rather than suspension point location.

4.3.3 For B = 750mm and 1000mm, the sag of catenary for various spans (this is independent of encumbrance) and reduction of vertical distance required, will be as under:

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Table 6: Reduction in vertical clearance requirement for innovative design (B = 750mm)

SN	Span (m)	Messenger wire Sag at 750mm from suspension point	Hence reduction in height requirement or availability of additional headroom (mm)
1	22.5	14mm	324mm
2	27.0	16mm	326mm
3	31.5	19mm	329mm
4	36.0	22mm	332mm
5	40.5	25mm	335mm
6	45.0	27mm	337mm
7	49.5	30mm	340mm
8	54.0	33mm	343mm

Table 7: Reduction in vertical clearance requirement for innovative design (B = 1000mm)

SN	Span (m)	Messenger wire Sag at 1000mm from suspension point	Hence reduction in height requirement or availability of additional headroom (mm)
1	22.5	19mm	329mm
2	27.0	23mm	333mm
3	31.5	26mm	336mm
4	36.0	30mm	340mm
5	40.5	34mm	344mm
6	45.0	37mm	347mm
7	49.5	42mm	352mm
8	54.0	45mm	355mm

The above sag of messenger wire has been worked out using the methodology and formulae as provided in Chapter 2 (Dropper Schedule), Part IV (Over head Equipment) of Treatise on Electric Traction Distribution issued by IRIEEN.

4.3.4 With the permissible encumbrance (Table 4 above), and pre-sag values, the minimum height of overline structure for 5600mm contact wire height from rail level is determined as under (considering electrical clearance of 770mm between messenger wire top and beam bottom):

Table 8: Minimum overline structure height with various spans and encumbrances (Case II Design)

Span (m)	Pre-sag (mm)	Minimum overline structure height for 5600mm high contact wire for different encumbrances and with 200mm or more dropper length					
			400	500	600	750	900
22.5	7		6777	6877	6977	7127	7277
27.0	11		6781	6881	6981	7131	7281
31.5	16			6886	6986	7136	7286
36.0	22			6892	6992	7142	7292
40.5	29				6999	7149	7299
45.0	37				7007	7157	7307
49.5	46					7166	7316
54.0	55					7175	7325

Note 1: The above minimum height of overline structure is conservative to the extent of lower value of pre-sag (max 50mm instead of earlier 100mm) to be considered as per Railway Board letter no. 2001/Elect(G)/170/1 dated 22.11.2016.
Note 2: Contact and catenary wire diameters (total 28mm for both, assuming 150mm2/125mm2 conductors as most onerous case) are assumed to be covered in additional 500mm electrical clearance.

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The above minimum overline structure height will be reduced to the extent of sag of messenger wire (Table 6 or Table 7 above).

4.4 Track raising

As per the discussion with IRSDC officials, raising of tracks in future is not foreseen for the station redevelopment projects as these are located in yards where the tracks are interlinked through crossovers, platform heights are fixed and raising of lines is generally not possible in view of stiff requirements of gradients etc.; therefore the extra vertical clearance of 275mm need not be considered for the OHE design purpose.

However, a track maintenance allowance of 20mm is considered.

4.5 Conclusion

4.5.1 Based on the above elaboration, the Case II design may be adopted for station redevelopment projects with the intent of keeping the minimum height of overline structure possible (whenever situation demands) and duly meeting the electrical clearance required. The minimum encumbrance of 600mm is proposed (instead of upto 300mm permitted as per ACTM). The table shows the various scenarios:

Table 9: Concourse structure height for station redevelopment (for 5600mm contact wire height)

SN	Span	Encum-brance	Min Concourse height (beam bottom) from rail level		Min axial distance available (for 1100 kgf tension)	Min elect clearance ('A' of figure 4) (B=1m)*	Min Dropper Length (Axial distance - 46 mm)
			Min.	Rounded#			
1	22.5m	600mm	6977mm	7000mm	525mm	812mm	479mm
2	27.0m	600mm	6981mm	7000mm	492mm	812mm	446mm
3	31.5m	600mm	6986mm	7000mm	442mm	810mm	396mm
4	36.0m	600mm	6992mm	7000mm	369mm	808mm	323mm
5	40.5m	600mm	6999mm	7000mm	299mm	805mm	253mm
6	45.0m	900mm	7307mm	7325mm	533mm	825mm	487mm
7	49.5m	900mm	7316mm	7325mm	444mm	821mm	398mm
8	54.0m	900mm	7325mm	7325mm	331mm	815mm	285mm

*This is determined by addition of 770mm (min electrical clearance), messenger wire sag from Table 7 and difference of rounded concourse height from minimum required (as per above table)

Note: The electrical clearance shown above is in respect of messenger wire from beam bottom corner (refer figure 4, dimension A). The electrical clearance of cantilever assembly from slab will be more than 800m (depth of beam) in vertical direction and 1000mm in lateral direction (dimension B in figure 4).

4.5.2 **Case I arrangement will normally not be required in stations, however the same is discussed here since IRSDC is of the view that these might be required at some stations as per local requirements. Computations for case I have not been given here and wherever case I is to be used, the computations may be done following the principles given herein.**

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5 OHE span design

5.1 Standard designs for OHE spans

Indian Railways follow a standardized OHE span lengths from 22.5m to 67.5m with increment of 4.5m.

For the above spans, a standardized dropper schedule has also been developed and issued by RDSO vide drawing no. ETI/OHE/G/00173 titled "*Dropper Schedule for Compensated OHE with equal encumbrance (1.40/1.40)*". (now revised drawing to be referred).

The same revised drawing also contains dropper schedule for spans other the standardized ones (for all values between 67m to 18m in decrement of 0.5m).

5.2 OHE Spans for station area

For the station being developed / redeveloped, the OHE spans need to be kept in line with the civil structure. For example, if beams are spaced @20m, the OHE span may be selected as 20m or 40m.

Dropper schedule for any span can be worked out as per the methodology provided in Chapter 2 (Dropper Schedule), Part IV (Over head Equipment) of Treatise on Electric Traction Distribution issued by IRIEEN or directly derived from RDSO drawing no. ETI/OHE/G/00173 mentioned above.

Example: Dropper spacing for 20m, 30m, 40 and 50m spans:

Span	Droppers and their spacing (m)						
	1	2	3	4	5	6	7
20m	2.25	7.75	7.75	2.25			
30m	2.25	8.25	9	8.25	2.25		
40m	2.25	8.75	9	9	8.75	2.25	
50m	2.25	4.75	9	9	9	4.55	2.25

The overall OHE layout can be developed considering the station (concourse) OHE support locations being obligatory ones.

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6 Earthing / Grounding arrangements

6.1 Structure Earthing

The station structure will need to be earthed as per usual practice of building grounding, irrespective of traction system. The codes to be followed in this respect are IS 3043, IS 2309 etc.

6.2 OHE support earthing

6.2.1 Normally, the OHE masts are bonded to rails (return circuit) and hence any insulator puncture will lead to completion of circuit and tripping of relevant circuit breaker.

6.2.2 In the instant case, the structure bonds between suspended OHE structure (drop arm etc.) is not feasible. Therefore, an earth wire of appropriate section may have to be run connecting masts / portals nearest to the concourse and all the OHE support structure (drop arms) suspended from the concourse. See the schematic below:

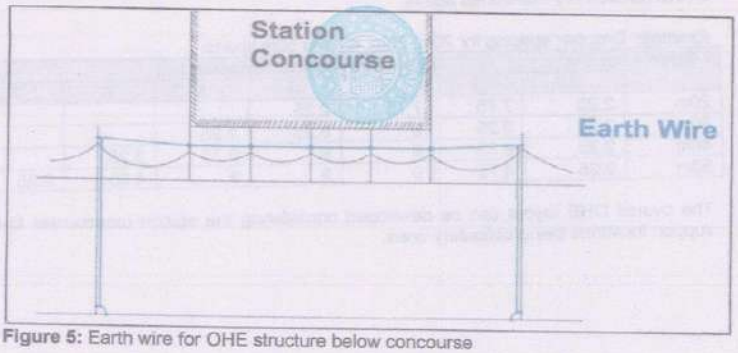

Figure 5: Earth wire for OHE structure below concourse

6.2.3 Further, the earth wires of different tracks can be cross-connected to ensure adequate redundancy of earth connections. See the schematic below:

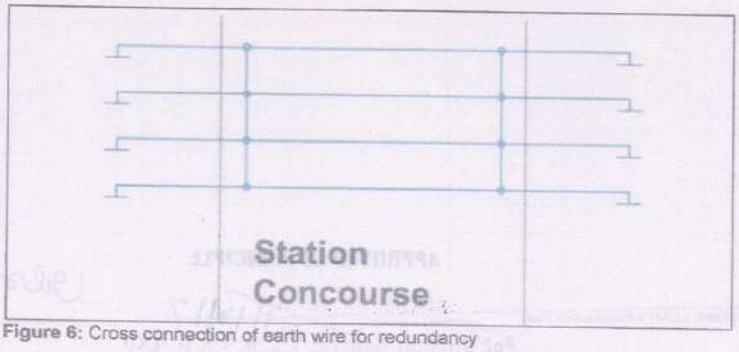

Figure 6: Cross connection of earth wire for redundancy

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The cross connection can also be effected with embedded earth strips in the roof slab with earth terminals brought out in either side for construction to structures.

6.2.4 As for the bonding method and sizing of the earth wire, reference is drawn to Para 3.6.7 and Para 4.0 of RDSO Code No. ETI/OHE/71 (11/90) "Code for Bonding and Earthing for 25kV ac, 50Hz, Single Phase Traction System":

Para 3.6: Mode of Connection of Bond
Para 3.6.7: The cross section of an earth wire used for bonding traction masts or structures or supports or the metallic parts supporting the traction overhead equipment in a tunnel or in double rail-track-circuited section shall be not less than 50 mm2 copper equivalent.

Para 4.0: Bonding of metallic parts inside a tunnel
An earth wire connecting all non-current metallic parts, which form parts of the supports for the overhead equipment, shall be run inside the tunnel. The earth wire shall be connected to an earth as well as to the traction rails at both ends just outside the tunnel. In case, all the rails are track circuited, the earth wire shall be connected to an earth at both ends just outside the tunnel. If the length of the earth wire exceeds 1000m, the stipulation in regard to making it electrically discontinuous as contained in clause 3.8 shall be followed.

6.2.5 The OHE under a 100-200m long concourse structure is a situation similar to tunnel in respect of earthing of OHE support structures.

Capacity of 93.3 sqmm AAC (All Aluminium Alloy Conductor) conductor is similar to 50 sqmm of copper. Hence 93.3 sqmm AAC (or equivalent ACSR) conductor may be used for this purpose.

6.2.6 The following are the salient features of the this 93.3 sqmm AAC conductor:

Conformance to IS standard	IS 398 (Part II) (latest revision)
Composition	19 aluminium wires also of 2.5 mm diameter each
Overall diameter	12.5mm
Linear weight	0.257 kg/meter
Breaking load	2657 kgf
Coefficient of linear expansion	$\alpha = 18 * 10^{-6}\ per\ ℃$
Elongation factor	$\lambda = 132 * 10^{-6}$
Resistivity	2.8264 μΩ.cm

6.2.7 The FTA anchor body structure in the concourse area (if used) shall also be earthed by bonding it through the ACSR earthing conductor as above.

6.3 Steel girder concourse structure

6.3.1 In case the concourse is built with steel structures, appropriate measures are required for bonding of the steel structures. In this connection, reference is drawn to Para 4.1 and 4.2 of RDSO Code No. ETI/OHE/71 (11/90) "Code for Bonding and Earthing for 25kV ac, 50Hz, Single Phase Traction System":

Para 4.1: Bonding of Overline structure

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7 OHE loading for structure design

7.1 OHE system weight data

The following are the OHE weight data:

SN	Description	Particular	Remarks
1	Contact wire (107 mm2)	0.952kg/m	If 150 mm2, then the weight is 1.34 kg/m
2	Messenger wire (65 mm2)	0.5973 kg/m	If 125 mm2, then the weight is 1.191 kg/m
3	OHE weight kg per meter	1.6 kg/m	With some allowance for dropper weights; If higher capacity OHE (150mm2/125mm2), then the weight is 2.6 kg/m
4	Earth wire weight	0.437 kg/m	
5	Cantilever assembly weight	60 kg	
6	Weight of maintainer with tools	100 kg	May not be relevant in the instant case, but still conservatively considered
7	Section insulator weight	50 kg	
8	Cut in insulator weight	15 kg	
9	Drop arm bracket assembly weight with SPS	146 kg	DA length of 2375mm with RSJ (8x6"), having unit weight of 53.39kg/m considered
10	Spreader bar weight with SPS (each)	18 kg	1250m length, C channel 150mm x 75mm

7.2 Cases considered

The onerous case could be installing two OHEs on support (one normal and other out-of-run) and running through the length of covered area and one OHE having cut-in insulator.

The situation of OHE termination with ATD inside covered area is not foreseen.

However, OHE termination with FTA arrangement either on face of station structure or at any intermediate concrete beam may be possible and hence considered (though it is not recommended).

7.3 Loads for 40.5m span

7.3.1 Vertical loads

OHE weight (2 nos.) = 2 x [40.5 x (1.6 + 0.437)]	= 165kg
Cantilever weight (2 nos.) = 2 x 60 kg	= 120 kg
Maintainer weight	= 100 kg
Cut-in insulator weight = 2 x 15	= 30kg
Drop Arm / Spreader arm (2 nos.) / SPS weight	= 182 kg
Total vertical load	= 165 + 120 + 100 + 30

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	+ 182 = 597 kg
Total vertical load with high capacity OHE (150mm2 / 125mm2)	597+81 = 678kg
Add extra for unforeseen	25 kg

The case with one OHE and section insulator installed in that span will be less onerous than the above one.

Section insulator possibility in station area will require high encumbrance (450mm axial distance), which is possible with 600mm and above encumbrance.

7.3.2 Transverse loads

Radial load due to stagger (200mm) of both catenary and contact wire = 1000/40.5 x (2*0.2 + 2*0.2) = 19.75 (for each)	= 39.5kg
Radial load due to stagger of out-of-run OHE is not considered as that OHE can be taken terminated in straight line on concrete beam	= 0
Wind load (considering wind pressure of 178 kg/m2, high capacity OHE, contact wire diameter 14.5mm and catenary wire diameter 14mm) = 1.05*0.75*(0.0145 + 0.014)*178*Span	= 4*Span Kg

Note: In Indian Railway OHEs, the messenger wire is not staggered normally, but in many systems (such DFCCIL) the messenger wire is also staggered. For future considerations, the messenger wire is also considered staggered for loading purpose.

7.3.3 FTA load on beam

FTA load on beam structure (directly installed on concrete beam) = 2400 kgf (in longitudinal direction). This considers 1200 kgf tension in each contact and catenary wire with use of 150mm2/125mm2 contact/catenary wires. The tension used by IR with 107mm2/65mm2 combination is 1000 kgf each i.e. 2000 kgf total.

Additionally, the jerk load of OHE breaking shall also be considered.

7.4 Loads for 54m span

7.4.1 Vertical loads

OHE weight (2 nos.) = 2 x [54 x (1.6 + 0.437)]	= 220kg
Cantilever weight (2 nos.) = 2 x 60 kg	= 120 kg
Maintainer weight	= 100 kg
Cut-in insulator weight = 2 x 15	= 30kg
Drop Arm / Spreader arm (2 nos.) / SPS weight	= 182
Total vertical load	= 220 + 120 + 100 + 30 + 182 = 652 kg
Total vertical load with high capacity OHE (150mm2 / 125mm2)	652+108 = 760kg
Add extra for unforeseen	25 kg

The case with one OHE and section insulator installed in that span will be less onerous than the above one.

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7.4.2 Transverse loads

Radial load due to stagger (200mm) of both catenary and contact wire = 1000/54 x (2*0.2 + 2*0.2) = 14.8 (for each)	= 30kg (approx.)
Radial load due to stagger of out-of-run OHE is not considered as that OHE can be taken terminated in straight line on concrete beam	= 0
Wind load (considering wind pressure of 178 kg/m2, high capacity OHE, contact wire diameter 14.5mm and catenary wire diameter 14mm) = 1.05*0.75*(0.0145 + 0.014)*178*Span	= 4*Span Kg

Note: In Indian Railway OHEs, the messenger wire is not staggered normally, but in many systems (such DFCCIL) the messenger wire is also staggered. For future considerations, the messenger wire is also considered staggered for loading purpose.

7.4.3 FTA load on beam

Same as in Para 7.3.3 above.

7.5 General note

7.5.1 Other than the OHE loading described above, the station planning shall consider loads for future proposals, alterations, augmentation etc.

7.5.2 The loads shall be considered as follows:

(a) High capacity OHE with 2 OHEs shall be considered for all locations, whether or not the same is currently having 2 OHEs;
(b) For every 5 tracks or part thereof, FTA load for one track shall be considered in design of concourse, which can be in any of the tracks;

7.5.3 The design of support brackets shall be got done by IRSDC and duly proof checked. The design shall have the following features:

(c) The dowels shall be insulated
(d) Maintenance instructions shall be given i.e. how the repairs / replacement work shall be done. This shall be essential feature of design and a maintenance manual shall be prepared and handed over to TRD Department in Division responsible for maintaining the OHE
(e) Locations where drilling of new holes can be done for providing any new support is allowed shall be clearly indicated in the maintenance manual

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8 Bird menace

Various provisions available regarding bird nesting and mitigation measures are as under:

Ref: ACTM Volume II, Part II, Appendix 1 "Principles for layout plans and sectioning diagrams for 25kV ac traction
Para 21.0 Over line Structure
Para 21.2 Where adequate clearance is available, the catenary should be erected so as to have maximum clearance from the overline structure to reduce the possibility of birds perching on the catenary wire and coming in contact with earthed parts.

All other provisions regarding bird nesting in ACTM are in respect of maintenance / inspection and mitigation measures (e.g. removing the bird nests etc.) only.

The following measures are recommended for avoiding bird menace:

(a) If the structure consists of closed sections which don't permit birds to sit or make nests, such as concrete beams / slab system no special precautions are required

(b) For structures which permit birds to sit or make nests such as in case of steel plate girders / trusses etc. following measures may be applied:

   a. The structure shall be covered by suitable sheet to make it a closed section

(c) Drop arms of RSJ/BFB sections only shall be used and the fabricated / laced drop arms shall not be used.

(d) Some manufacturers have developed anti-bird nesting device (e.g. RIBE and Siemens), which may be considered for installing on stay and bracket insulators.

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9 Concourse design

9.1 Safety regulations

9.1.1 EN 50122-1 (Jan 2011) or IEC 62128-1 (2013) "Railway applications – Fixed installations – Electrical safety, earthing and the return circuit – Part 1: Protective provisions against electric shock" elaborates the requirements from the safety perspective.

9.1.2 The basic safety clearances are described in figure 4 of EN 50122-1, which is produced below as figure 8:

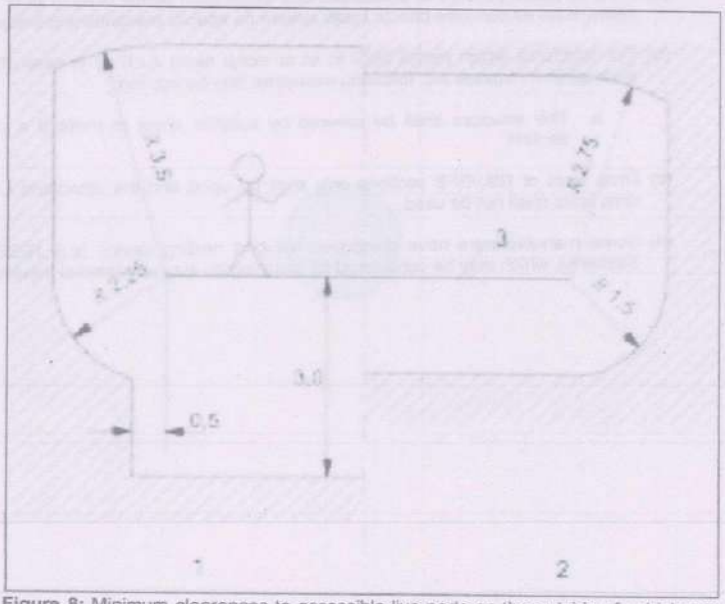

Figure 8: Minimum clearances to accessible live parts on the outside of vehicles as well as to live parts of overhead contact line systems from standing surfaces accessible to persons for high voltages (figure 4 of EN 50122-1)
[1 – public areas; 2 – restricted areas; 3 – standing surface]

The instant case of station development relates to public area (1).

9.1.3 The above-referred EN/IEC further provides for designs of obstacles in case the above clearances are not possible to be achieved (ref Para 5.3.2.2 "Obstacles and standing surfaces above live parts"). Such provisions for 25kV ac traction system is provided in figure A.2 of EN 50122-1, which is produced below as figure 9.

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9.1.4 IR ACTM basically derives the safety clearance of 2m from live parts and safety screens (on FOBs, ROBs etc.) from the above EN/IEC only. All the regulations basically relates to elimination of possibility of accessing live parts from the standing / working surfaces.

9.2 Design for station concourse

9.2.1 In case, the concourses are designed with a corridor on side, then the EN 50122-1 design as per figure 10 above can be adopted. Refer the figure below for more comprehension.

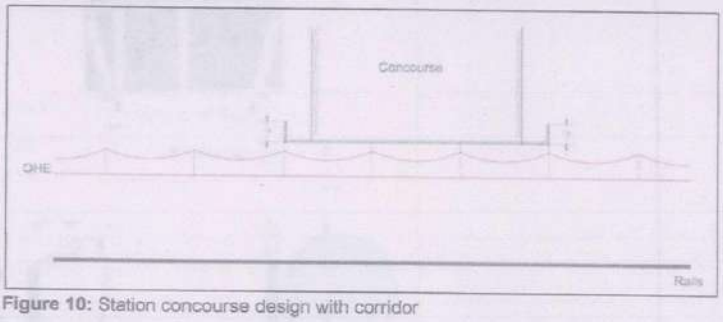

Figure 10: Station concourse design with corridor

9.2.2 However, it is recommended that concourses be designed in such manner that no window is planned on the two faces of the building directly above the tracks. This will eliminate any possibility of throwing any object on OHE. Or if window / opening is provided, it should be protected with a mesh / grill. Refer the figure below:

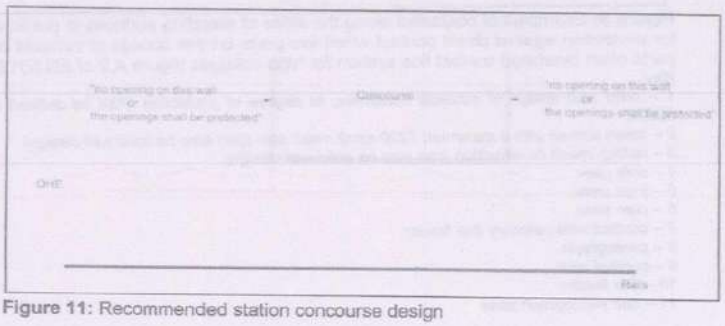

Figure 11: Recommended station concourse design

9.2.3 Examples of DMRC's Pragati Maidan station and UK's Birmingham railway station is shown in below pictures, which does not have openings on the sides above tracks.

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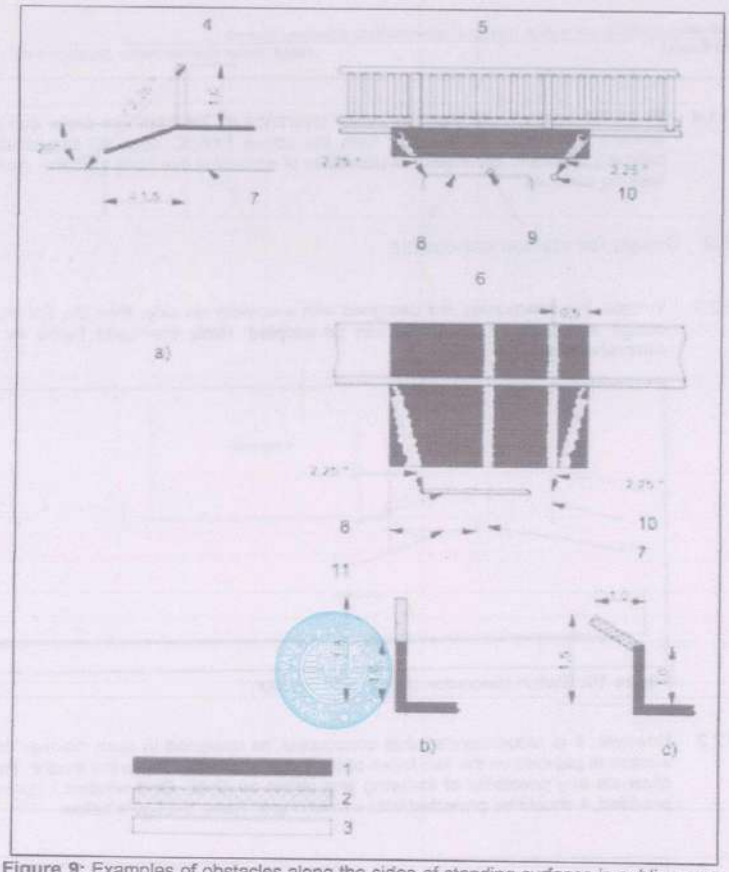

Figure 9: Examples of obstacles along the sides of standing surfaces in public areas for protection against direct contact when live parts on the outside of vehicles or live parts of an overhead contact line system for high voltages (figure A.2 of EN 50122-1)

Key

1 – solid wall design or obstacle confirming to degree of protection IP3X as defined in EN 60529
2 – mesh screen with a maximum 1200 mm2 mesh size (can also be solid wall design)
3 – railing, mesh construction (can also be solid wall design)
4 – side view
5 – front view
6 – plan view
7 – contact wire catenary line feeder
8 – pantograph
9 – contact wire
10 – line feeder
11 – half pantograph zone

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Figure 12: Pragati Maidan Metro station

Figure 13a: Birmingham Railway Station

Figure 13b: Birmingham Railway Station

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10 DMRC and IR practices

10.1 Tughlakabad Station Example of DMRC

10.1.1 Tughlakabad station is an elevated station with commercial development over the tracks. Figures 14, 15 and 16 show the actual photographs of cantilever / OHE suspended from the structure above the tracks:

Figure 14: OHE suspension arrangement at DMRC's Tuglakabad station (1)

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Figure 15: OHE suspension arrangement at DMRC's Tuglakabad station (2)

Figure 16: OHE suspension arrangement at DMRC's Tuglakabad station (3)

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10.1.2 The earth wire in the above station is not visible; however for IR's station development / redevelopment projects, accessible earthing wire is recommended from the point of view of maintainability.

10.2 Over line structure clearance guidelines of DMRC

The DMRC SOD envisage the following contact wire height:

(i)	Under bridges, in tunnels and in ramp area	4388mm
(ii)	In the open	5000mm*

*It is understood that this is being revised to 4500mm

The station roof height (overline structure) with the revised contact wire height in the open is as under:

1	Contact wire height	4388mm
2	Minimum encumbrance	900mm
3	Maximum design electrical clearance	500mm
	Total height	**5788mm** **Say 5800mm**

10.3 Some Indian Railways example (Mumbai Suburban)

OHE suspended from overline concourse structure has been used extensively in Mumbai suburban section. Few photographs are provided hereunder for dereference:

Figure 17: Nerul Station of Central Railway (1)

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Figure 18: Nerul Station of Central Railway (2)

Figure 19: Khargar Station of Central Railway

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Figure 20: Belapur Station of Central Railway

Figure 21: Churchgate Station of Western Railway

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11 Recommendations

Minimum height of station concourse structure above rail level may be kept as 7000mm (which exceed the IR SOD requirement of 6250mm) for spans upto 40.5m and within the height; the OHE will be possible to be installed as per the extant guidelines following the Case-II design (Para 4.3). This minimum height shall be suitably increased for normal design (Case-I) and for different spans.

If return conductor is used, then the applicable clearance as per extant guidelines of 400mm from OHE, 150mm from earthed metallic parts and 80m from structure shall be adhered to.

Protective screens as per ACTM guidelines (refer DMRC photos above also) may be required to be used where maintenance staff has to go (such as for maintenance of signals or any civil installation etc.) and which is within 2m of OHE.

All other relevant guidelines as contained in SOD, ACTM etc. regarding OHE system will need to be followed.

The summary of recommendations is as follows:

(a) Height of concourse structure: The height of concourse shall be such that with Case II design, the following nominal clearances are available at the bottom of the lowest beam:

Span (m)	Encumbrance* (mm)	Clearance (mm)
Upto 40.5m	Minimum 600mm	7000mm
40.5 < Span < 58.5	Minimum 900mm	7325mm
More than 58.5m	1400mm	7850mm

For Case-I design, the following are the nominal clearances from the bottom of the lowest beam:

Span (m)	Encumbrance* (mm)	Clearance (mm)
Upto 40.5m	Minimum 600mm	7310mm
40.5 < Span < 58.5	Minimum 900mm	7635mm
More than 58.5m	1400mm	8165mm

* Encumberance in OHE shall be kept in such a way that the clearance between lowest beam of station concourse and rail level does not exceed beyond 7000 mm.

The various issues related to this height are elaborated in Section 4 of this report.

(b) Design of OHE support structure: Case II design (as elaborated in Para 4.4) may be adopted in order to optimize / minimize the civil structure height.

(c) OHE spans in concourse area may be selected in line with civil structure design and need not necessarily be standard spans only.

(d) Earthing of OHE support structures and bonding of overline concourse structures shall be done as elaborated in Section 6 of this report; the anchor fasteners used for fixing the OHE support structure shall be non-conducting ones (i.e. use of insulated dowels)

(e) The loads for civil structure design shall be considered as follows:

a. High capacity OHE with 2 OHEs shall be considered for all locations, whether or not the same is currently having 2 OHEs;

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b. For every 5 tracks or part thereof, FTA load for one track shall be considered in design of concourse, which can be in any of the tracks;

(f) The design of support brackets shall be got done by IRSDC and duly proof checked. The design shall have the following features:

a. The dowels shall be insulated
b. Maintenance instructions shall be given i.e. how the repairs / replacement work shall be done. This shall be essential feature of design and a maintenance manual shall be prepared and handed over to TRD Department in Division responsible for maintaining the OHE
c. Locations where drilling of new holes can be done for providing any new support is allowed shall be clearly indicated in the maintenance manual

(g) Bird menace: Appropriate measures such as closed sections, RSJ/BFB drop arms etc. are recommended such as not to provide any space for birds to make their nests or to sit as far as practicable

(h) Monkey menace: The walls towards the tracksides shall have no windows and shall not have any ledges etc. that can be used by monkeys to move.

(i) Concourse design which do not permit any possibilities of physical contact with live parts (in line with EN 50122-1) and which eliminates possibilities of throwing any object on live OHE shall be adopted, as elaborated in Section 9 of this report.

(j) Option of modular cantilever may be explored to reduce the overall vertical height of OHE.

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