GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

2015/Proj./MMRC/SoD/30/13 New Delhi dated 20.03.2018

Managing Director,
Mumbai Metro Rail Corporation Ltd.,
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Sub: Approval to the Schedule of Dimensions for Mumbai Metro Line 3 corridor.
Ref: MMRCL's letter No. MMRC/ML-3/CBS49/TD/SOD/VOL-II/608 dated 05.03.2018

The Schedule of Dimensions (SoD) for Standard Gauge, (1435 mm) for 3200mm wide rolling stock, January, 2018 of Mumbai Metro Line 3 corridor has been examined in consultation with RDSO and approval of Railway Board is hereby conveyed.

Accordingly, approved copy of SoD is enclosed.

Encl: As above

20-03-2018

(Ruth Changsan)
Director/MTP
Railway Board
☎ 011-23097061

Copy to: **Executive Director/UTHS**, RDSO, Manak Nagar, Lucknow w.r.t their letter No. UTHS/107/MMRCL/Civil dated 13.03.2018.

SCHEDULE OF DIMENSIONS

FOR

STANDARD GAUGE
(1435 mm)

(FOR 3200 mm WIDE STOCK)

JANUARY 2018



MUMBAI METRO RAIL CORPORATION LTD

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PREAMBLE

The schedule of dimensions for Standard Gauge Mumbai Metro Line 3 Corridor has been prepared based on following factors:

1. The Kinematic Envelope has been adopted for the 3200 mm wide rolling stock and 4048 mm (pantograph in locked down condition) high rolling stock. The track and vehicle maintenance shall conform to the clearances indicated therein during the period these stocks are in operation.

2. The clearances are based on the assumption that windows are sealed and doors are closed during movement/operation.

3. Track shall be maintained to the tolerances taken for calculation of kinematic envelope.

4. The Structure Gauge indicated in SOD shall not be violated under any circumstances except for platform coping, Platform Screen Doors (PSD) and hand railing in back of house of platform edge.

5. The Kinematic Envelope(s) indicated in SOD shall not be violated under any circumstances.

6. The vehicle Kinematic Envelope at a speed of 70 Kmph for the platform area shall be applied within confines of stations. At all other locations, the kinematic envelope corresponding at85kmph operation speed shall be used for determining the Structure Gauge. The Design speed is set with 95 Kmph.

7. The maximum operating speed through station platforms shall be limited to 70 Kmph and at all other locations 85 Kmph, subject to speed restriction.

8. No vertical curve shall be provided in platform area.

9. The SOD is applicable for ballastless track on main line and Ballasted/Ballastless track in the Depots.

10. No work/work men are allowed during operations of trains.

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MUMBAI METRO LINE 3

SCHEDULE OF DIMENSIONS

STANDARD GAUGE (1435 mm GAUGE)

(FOR 3200 mm WIDE STOCK)

INTRODUCTION

The dimensions given in this are to be observed in all new works and alterations to existing works on 1435 mm gauge (STANDARD GAUGE)and 3200 mm wide Rolling Stock, unless prior sanction has been obtained from the Railway Board through the Commissioner of Railway Safety to execute works which infringe this Schedule Of Dimensions.

This Schedule of Dimensions is applicable to Underground, At-grade and Elevated Sections of Mumbai Metro Line 3 (MML3) which shall be with 25 kV, AC Traction system and Over Head current collection. The rolling stock shall be 3200 mm wide with sealed windows and doors closed while in motion.

The Underground system may be with a Circular Tunnel or Rectangular Box or of any other suitable shape while elevated system may be with suitable over ground structure such as viaducts. Both Underground and Elevated system shall have suitably designed ballastless track. For At-Grade and Depot tracks may be ballasted track /ballastless track.

The Schedule of Dimensions (SOD) has been divided into five chapters as under

CHAPTER 1----------	GENERAL
CHAPTER 2 ----------	STATION
CHAPTER 3----------	ROLLING STOCK
CHAPTER 4----------	ELECTRIC TRACTION
CHAPTER 5 ----------	PLATFORM SCREEN DOORS

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CHAPTER 1
GENERAL

1.1. SPACING OF TRACKS

1.1.1. Minimum distance, centre to centre of tracks without any structure between tracks for tangent (straight) track for:

(a) Under Ground sections..... 3800 mm
(b) Elevated sections.....3900mm
(c) At-grade sections.....3900mm

Note:

See Appendix 1 for minimum track centres on curves.

1.2. CURVES

1.2.1. Minimum radius of curves (horizontal)

On main running lines:	
a) Underground sections	200 m
b) Elevated and at-grade sections	120 m
Depot and other lines	100 m
At passenger platforms	1000 m

1.2.2. Check rail / Restraining rail

Check rail /Restraining rail shall be provided on curves on main line in the case that the radius is 190 m or less duly considering the limits given in 1.2.1. Check rail/ Restraining rail shall not be mandatory for curves in depots, yards and non-passenger lines where speed is less than 25 kmph. The clearance between the check/restraining rail and running rail shall be suitably decided by the Metro Authority.

1.2.3. Minimum radius of vertical curve

Minimum radius of vertical curve: 1500m

1.3. GRADIENT

1.3.1 Maximum gradient shall be 4%. This maximum value has to be compensated according to Notes (ii) below.

Notes:

(i) There will be no change of gradient in transition portion of curves.

(ii) The gradient will be compensated for curvature at the rate of 0.04% per degree of curve.

1.3.2 Maximum permissible gradient on turnouts

i) On ballasted track	0.25%
ii) On ballastless track	3.0 %

Notes:

(i) There shall be no change of gradient (i.e. vertical curve) on and within 15.0 m (desirable)/3.0 m (minimum) of any turnout on Ballastless track. In case of Ballasted track, there shall be no change of gradient on and within 30 m of any turnout.

(ii) There shall be no horizontal curve within 15.0 m (desirable)/3.0 m (minimum) of any turnout on Ballsated Track and 30 meters of any Turnout on Ballasted Track.

(iii) Turnout shall normally be installed on straight track. In exceptional situations, turnout may take off from curve provided that the radius of lead curve (main line as well as diverging line) is not less than 190 m. The negotiability of rolling stocks on such turnout must be certified by

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rolling stock supplier and confirmed through oscillation trial and a suitable speed restriction should be imposed on main and/or diverging line based on track geometry and other considerations, if required. In case of turnout installed on curved track, the minimum distance for commencement of vertical curve or another horizontal curve shall be 15 m for Ballastless Track. Turnout shall not be laid on transition curve.

(iv) The limit of turnout for above purposes shall be taken from Stock Rail Joint (SRJ) to end (i.e. heel) of crossing for Ballastless Track. For Ballasted track, it shall be from SRJ to last common sleeper behind end of crossing.

(v) The maximum permissible gradient on turnout and the location of turnout with respect to vertical/horizontal curves in vicinity shall be confirmed from rolling stock supplier for the negotiability of rolling stock.

(vi) The above stipulations shall also be applicable for turnout to be laid outside station limit, if any.

1.4. BUILDINGS AND STRUCTURES

1.4.1 Minimum horizontal distance from centre of track to any structure for heights above rail level on level/constant grade tangent track shall be as below:

(a) ELEVATED and AT-GRADE SECTIONS

Height from rail level		Horizontal distance from centre line of track
(i)	Up to 25 mm (*)	0 mm vert. clearance from 577.5 mm to 946.5 mm
(ii)	25 mm to 65 mm	1450 mm increasing to 1585 mm
(iii)	65 mm to 200 mm	1585 mm increasing to 1745 mm
(iv)	200 mm to 880 mm	1745 mm increasing to 1903 mm
(v)	880 mm to 1095 mm	1903 mm
(vi)	1095 mm to 1130 mm	1903 mm increasing to 1938 mm
(vii)	1130 mm to 2030 mm	1938 mm
(viii)	2030 mm to 3300 mm	1938 mm decreasing to 1875 mm
(ix)	3300 mm to 3736 mm	1875 mm decreasing to 1540 mm
(x)	3736 mm to 6250 mm	1540 mm

(*) No clearance is allowed in the wheel/rail contact area.
Also refer to FIG. MMRC-2

(b) UNDER GROUND SECTIONS

(i) CIRCULAR TUNNELS

Height from rail level		Horizontal distance from centre line of track
(i)	Up to 25 mm (*)	0 mm vert. clearance from 577.5 mm to 946.5 mm
(ii)	25 mm to 65 mm	1450 mm increasing to 1585 mm
(iii)	65 mm to 200 mm	1585 mm increasing to 1720
(iv)	200 mm to 305 mm	1720 mm
(v)	305 mm to 880 mm	1720 mm increasing to 1849 mm
(vi)	880 mm to 1095 mm	1849 mm
(vii)	1095 mm to 1130 mm	1849 mm increasing to 1875 mm
(viii)	1130 mm to 2030 mm	1875 mm
(ix)	2030 mm to 3346 mm	1875 mm decreasing to 1815 mm
(x)	3346 mm to 3738 mm	1815 mm decreasing to 1390 mm
(xi)	3738 mm to 4620 mm	1390 mm
(xii)	4620 mm to 4970 mm	1390 mm decreasing to 0 mm along arc R=2800 mm

(*) No clearance is allowed in the wheel/rail contact area.
Also refer to FIG. MMRC-2 (CIRCULAR TNL)

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(ii) RECTANGULAR BOX TUNNELS

Height from rail level		Horizontal distance from centre line of track
(i)	Up to 25 mm (*)	0 mm vert. clearance from 577.5 mm to 946.5 mm
(ii)	25 mm to 65 mm	1450 mm increasing to 1585 mm
(iii)	65 mm to 200 mm	1585 mm increasing to 1720 mm
(iv)	200 mm to 305 mm	1720 mm
(v)	305 mm to 880 mm	1720 mm increasing to 1849 mm
(vi)	880 mm to 1095 mm	1849 mm
(vii)	1095 mm to 1130 mm	1849 increasing to 1875 mm
(viii)	1130 mm to 2030 mm	1875 mm
(ix)	2030 mm to 3346 mm	1875 mm decreasing to 1815 mm
(x)	3346 mm to 3738 mm	1815 mm decreasing to 1390 mm
(xi)	3738 mm to 4838 mm (min.)	1390 mm

(*) No clearance is allowed in the wheel/rail contact area.
Also refer to FIG. MMRC-2 (BOX TNL)

Notes for (a) and (b) above:

i) Extra clearance shall be provided for curves as laid down at Para 1.7.
ii) The term 'structure' covers any item including light ones like ladders, isolated posts, cables etc. erected alongside the track.
iii) Minimum lateral clearance for OHE masts for tangent track shall be2150 mm from centre line of nearest track.
iv) For passenger platform & PSD refer to Para 2.2.1 to 2.2.3 of Chapter 2.

1.5. KINEMATIC ENVELOPE

The kinematic envelope for level or constant grade tangent track, refer to:
a) FIG. MMRC-1 and MMRC -1A for At-grade and Elevated Sections
b) FIG. MMRC-1(TNL) and MMRC-1A (TNL) for Underground Sections

1.6. STRUCTURE GAUGE

1.6.1 Underground Sections

The Structure Gauge (Fixed Structure Line) has been arrived at by allowing a minimum clearance of 100 mm to kinematic envelope and minimum electrical clearance of 270 mm from 25 kV live parts conforming to the stipulations in Chapter 4 of this SOD.

Refer to FIG. MMRC-2 (BOX TNL) and FIG. MMRC-2 (CIRCULAR TNL) for structure gauge for underground sections (outside station) with Ballastless track for level or constant grade tangent track.

Note:

Extra clearance shall be provided for curves as laid down at Para 1.7.

1.6.2 Elevated Sections

The Structure Gauge (fixed structure line) has been arrived at by allowing minimum clearance of 150 mm to kinematic envelope and minimum electrical clearance of 270mm from 25 KV live parts conforming to the stipulations in Chapter 4 of this SOD.

For Structure Gauge on Elevated sections (outside station) with Ballastless track for level or constant grade tangent track, refer to FIG. MMRC-2.

Note:

Extra clearance shall be provided for curves as laid down at Para 1.7.

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1.6.3 At-Grade Sections

The Structure Gauge (Fixed Structure Line) has been arrived at by allowing minimum clearance of 150 mm to kinematic envelope and minimum electrical clearance of 270mm from 25 kV live parts, conforming to stipulations in Chapter 4 of this SOD.

For Structure Gauge on At-grade sections (outside stations) on level or constant grade tangent track, refer to FIG. MMRC-2.

Note:

Extra clearance shall be provided for curves as laid down at Para 1.7.

1.7. EXTRA CLEARANCES ON CURVES

Following are the extra clearances considered for curves.

Abbreviations used in Para 1.7:

C is the distance between centres of bogies in meters,
C_1 is the coach (vehicle) length in meters,
R is the radius of curve in meters,
Ca is the cant applied in mm,
h is the height from rail level in mm and
g is the distance between centres of rails in mm

1.7.1 Inside of Curve

(A) CURVATURE EFFECT

i) Mid throw at the centre of the vehicle = V (in mm) = $125 \times C^2/R$
ii) Clearance due to gauge widening on curves

For values of items i) and ii) above, refer to Appendix 2.

Note:

Lateral shift of 32mm due to nosing is included in kinematic envelope for tangent track (and as a result included in Structure Gauge also) shall be subtracted from the total extra clearance worked out as at Para 1.7.1(A) i) & ii) above for inside of a curve in case the value of mid throw (V) is equal to or greater than 32mm. In case the value of mid throw (V) is less than 32mm, the curvature effect shall be due to widening of the gauge only. (The Mid throw minus 32.0 mm shall be taken as zero). Refer please also to Appendix 2.

(B) CLEARANCE FOR SUPER ELEVATION

(a) Under Ground (Box Structures), At-Grade and Elevated Sections

The lean 'L' due to cant at any point at height 'h' above rail level is given by:

$L = Ca \times h/g$ (all in mm)

For values of structure gauge (E_1) for inside of a curve with cant effect only, refer to:

(i) Appendix 4 (BOXTNL) & FIG. MMRC 4 (BOX TNL) for box structures of underground sections;
(ii) Appendix 4 & FIG. MMRC 4 for At-Grade and Elevated sections.

(b) Circular Tunnels

In the case of circular tunnel, the cant is provided by raising the outer rail and suitably shifting the centre of the circular tunnel towards inside of curve and upwards. This has same effect as assuming rotation of the circular tunnel about mid-point of top of inner rail resulting in shift of Tunnel centre laterally towards inside of curve and also vertically upwards.

The Rigid OCS shall also be rotated with the tunnel so as to be along the centre line of canted track.

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For values of horizontal and vertical shifts of centre of circular tunnel for different values of cant, refer to Appendix 3 & FIG. MMRC-3.

(C) CLEARANCE FOR VERTICAL CURVE (VERTICAL THROW):

Vertical throw V_1 and V_2 (in mm) for vertical curve shall be calculated as under:

V_1 (with vehicle centre in sag or vehicle end on summit) = $125 \times C^2/R$
V_2 (with vehicle centre on summit or vehicle end in sag)
= $(125 \times C_1^2/R)-(125 \times C^2/R)$
Values of vertical throw due to vertical curves of different radii are given in Appendix 6 & FIG. MMRC- 6.

1.7.2 Outside of Curve

(A) CURVATURE EFFECT

i) End throw at the end of vehicle = V_O (in mm)
= $[125 \times C_1^2/R]-[125 \times C^2/R]$

ii) Clearance due to gauge widening on curves

iii) Additional nosing due to gauge widening on curves

The values of items i) to iii) are shown in Appendix 2

(B) CLEARANCE FOR SUPER ELEVATION

(a) Under Ground (Box Structures), At-grade and Elevated Sections
The lean 'L' due to cant at any point at height 'h' above rail level is given by:
L = (-) Ca x h/g (all in mm)
-Ve sign indicates relief due to cant or reduction in clearance required.

Note:

Full relief for lean due to cant (Ca) is to be taken into account only for calculation of track spacing without any structure between tracks. In case there is a structure adjacent to track, relief for lean is to be taken into account only if the cant provided is greater than 50 mm and shall be limited to a value = (Ca - 50) X h/g.

Values of Structure Gauge (F_1) on outside of curve with cant effect only, refer to:

I) Appendix 4 (TNL) & FIG. MMRC-4 (TNL) for underground sections (RECTANGULAR BOX)
II) Appendix 4 & FIG. MMRC- 4 for At-Grade and Elevated sections

(b) Circular tunnels

In the case of circular tunnel, the cant is provided by raising the outer rail and suitably shifting the centre of the circular tunnel towards inside of curve and upwards. This has same effect as assuming rotation of the circular tunnel about mid-point of top of inner rail resulting in shift of tunnel centre laterally towards inside of curve and also vertically upwards.

The Rigid OCS shall also be rotated with the tunnel so as to be along the centre line of canted track.

For values of horizontal and vertical shifts of centre of circular tunnel for different values of cant, refer to Appendix 3 & FIG. MMRC-3.

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(C) CLEARANCE FOR VERTICAL CURVE (VERTICAL THROW)

The provisions at Para1.7.1 (C) above shall be applicable in this case also.

1.8 MINIMUM TRACK SPACING ON CURVES

Underground, At-grade and Elevated Sections:

The worst case will be when the end of a bogie carriage on the inner track is opposite the Centre of a similar carriage on the outer track.

1.8.1 Without any structure between tracks.

The minimum track spacing on curves without any structure between tracks shall be the sum of the following:

i) (E + F),
ii) T_1 (extra lateral clearance due to curvature on inside of curve)
iii) T_2 (extra lateral clearance due to curvature on outside of curve)
iv) Minimum clearance between adjacent kinematic envelopes stipulated is as under:
   a) 200 mm for under-ground sections
   b) 300 mm for At-Grade and Elevated sections

Where:

'E' is the distance from vertical axis of Centre line of canted track to canted kinematic envelope on inside of curve at a height 'h' (from rail level) for a given cant (Appendix 5 & FIG. MMRC-5 for At-Grade and Elevated and Appendix 5 (TNL) & FIG. MMRC -5 (TNL) for underground tunnels) and

'F' is the distance from vertical axis of Centre line of canted track to canted kinematic envelope on outside of curve at a height 'h'(from rail level) for a given cant (refer to Appendix 5 & FIG. MMRC -5 & Appendix 5 (TNL) & FIG. MMRC-5 (TNL).

Notes:

i) The value of 'F', calculated from the formula at Appendix 5&FIG. MMRC-5and Appendix 5 (TNL) & FIG. MMRC 5 (TNL) includes full relief due to cant.

ii) The sum of 'E' and 'F' for same height (which are with cant effect only), shall be the maximum of values calculated for various heights from rail level.

For values of E, F, $T_1$and T_2, refer to the Appendices as shown below:

SECTIONS		FOR E & F APPENDIX	FOR T_1&T_2 APPENDIX
I)	Underground	5 (TNL)	2
II)	At-grade and Elevated	5	2

1.8.2 With a structure between adjacent tracks

The minimum track spacing on curves with a structure between tracks shall be the sum of the following:

i) (E_1 +T_1) Minimum clearance to the structure from centre line of track on inside of curve (for outer track)
ii) (F_1 +T_2) Minimum clearance to the structure from centre line of track on outside of curve (for inner track)
iii) Width of structure between adjacent tracks (measured across the tracks).

Where:

E_1 is the horizontal distance from vertical axis of centre line of track to canted Structure Gauge on inside of curve for a given cant,

F_1 is the horizontal distance from vertical axis of centre line of track to canted Structure Gauge on outside of curve for a given cant,

T_1 is extra lateral clearance due to curvature on inside of curve and

T_2 is extra lateral clearance due to curvature on outside of curve

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Notes:

a) The values of 'E_1'and 'F_1'for a given cant Ca, shall each be the maximum of values at different heights of structure from rail level. In case the cant provided is greater than 50 mm on inner track, the value of F_1 shall be for the cant of (Ca-50) mm. In case the cant provided is 50 mm or less on inner track, the value of F_1shall be for zero cant.

b) Minimum track spacing, so worked out with a structure between the adjacent tracks as per Para 1.8.2 shall not be less than that calculated as per Para 1.8.1 for tracks without any structure between adjacent tracks.

For values of E_1, F_1, T_1 AND T_2, refer to the Appendices as shown in table below:

SECTIONS	FOR E_1 & F_1 APPENDIX	FOR T_1&T_2 APPENDIX
I) Underground	4 (Box TNL)	2
II) At-grade and Elevated	4	2

1.9 CANT AND CANT DEFICIENCY

A) Maximum cant on curves = 125 mm
B) Maximum cant deficiency = 100 mm

1.10 PATHWAY/WALKWAYS

(i) Minimum width of Pathway/walkways 552mm
(ii) Minimum height of Pathway/walkways 1000mm
(iii) Maximum height of Pathway/walkways 1200mm
FIG. MMRC-2, MMRC-2 (BOX TNL) & MMRC-2 (CIRCULAR TNL)

Note:

Extra clearances shall be provided for curves as laid down at Para 1.7:

(i) Maximum and minimum heights of pathway/walkway on curves are meant above inner rail.
(ii) No structure, other than signalling and minor signalling equipment post, shall be permitted within the minimum width of pathway/walkway.
(iii) Minimum clearance to pathway/walkway at the nearest edge from kinematic envelope shall be 100 mm for underground sections and 150mm for At-Grade and Elevated sections.
(iv) Pathway/Walkway could be used by metro inspection group only in non-operation periods and for evacuation of passengers in emergency.

1.11 DERAILMENT GUARD

a) Derailment guard shall be provided inside/outside of running rail on elevated as well as in tunnel having multiple tracks and at-grade section at locations specified by the Metro railway. For single track tunnel, location for providing derailment guard is given in note. In tunnels, the derailment guard should preferably be provided inside the track, so that it permits less sway of coach towards tunnel wall in case of derailment.

Notes:

In case of single track tunnel, the derailment guards shall be provided:

1. Entry of tunnel: 200 m from tunnel portal outside the tunnel to 50 m inside the tunnel.

2. Exit of tunnel: 50 m from inside of tunnel portal to 200 m outside the tunnel.

3. In curved track having radius 500 m or less including transition portion but excluding locations where check rail is provided.

4. Covering locations of all important installations e.g. location of any sub-station or hazardous structures inside the tunnel, etc. damage to which in the assessment of metro rail administration can result into serious loss of life or/and infrastructure as a result of derailment in tunnel.

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The above is subject to the condition that metro railway shall carry out the risk assessment analysis for derailment in tunnels and ensure that the maintenance practices in the maintenance manual are as per the risk assessment mitigation plan.

b) The lateral clearance between the running rail and the derailment guard shall be 210 ±30 mm. In case of Double Resilient Base Plate Assembly Fastening System as approved by MoR, the lateral clearance between running rail and the derailment guard shall be 250 ± 20 mm. It shall not be lower than 25 mm below the top of the running rail and should be clear of the rail fastenings to permit installation, replacement and maintenance.

c) Derailment guard shall be designed such that in case of derailment:

   (i) The wheels of a derailed vehicle under crash load, moving at maximum speed are retained on the viaduct or tunnel.

   (ii) Damage to track and supporting structures is minimum.

The detailed design calculations of derailment guards along with detailed structural drawings shall be furnished for record.

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CHAPTER 2
STATION

2.1 SPACING OF TRACKS AT STATIONS

Minimum spacing of tracks at station on straight and on curve of radius of 1000 m and flatter, without any structure between tracks

At-grade, elevated and under-ground stations.....4100 mm

2.2 PLATFORMS

2.2.1. Maximum horizontal distance from centre of track to face of passenger platform coping for tangent track

(i) For At grade and elevated: 1680 mm vide FIG. MMRC-1A

(ii) For Underground: 1670 mm vide FIG. MMRC-1A (TNL)

2.2.2. Minimum horizontal distance from centre of track to face of passenger platform coping for tangent track

(i) For At grade and elevated: 1670 mm vide FIG.MMRC-1A

(ii) For Underground: 1660 mm vide FIG. MMRC-1A (TNL)

Notes:

(i) Platform faces shall be flared away smoothly from the centre line of the track at either end for a distance of 1500 mm so as to give from centre of track area/at platform end so as to give from centre of track a minimum dimension :

Dimension:

- 1795 $\pm$ 5 mm for Under Ground stations
- 1785 $\pm$ 5 mm for At-Grade and Elevated stations

(ii) For additional clearance for platforms on curves, refer to Para 2.7.

2.2.3. Height above rail level for passenger platform:

	Maximum	**Minimum**
(a) At-Grade	1085 mm	1075 mm
(b) Elevated/Under Ground	1095 mm	1085 mm

2.2.4. (i) Minimum horizontal distance of any isolated structure on a passenger platform from the edge of coping except PSD:

At-grade/Elevated.....2500 mm

Underground.....2000 mm

(ii) Minimum horizontal distance of any continuous structure on a passenger platform from the edge of coping except PSD:

At-grade/Elevated .....3000 mm

Underground.....2500 mm

NOTES:

a) The Platform Screen Door (PSD) may be installed at platform as per design of PSD but shall have a minimum clearance of 10mm from kinematic envelope.

b) The structure on the platform is treated as isolated if the length along the platform length is 2000 mm or less. Any structure having a length exceeding 2000 mm is treated as continuous structure. The clocks/mirrors/CCTV/signage/screens etc. shall not be

considered structures and shall be located at a minimum horizontal distance 1000 mm from platform edge /coping with minimum height of 2000mmfrom top of platform.

c) For platform structure setting-out dimensions at stations, refer to FIG. MMRC-7 and FIG. MMRC-9 for At-Grade /elevated station and FIG. MMRC-8 and FIG.MMRC-10 for underground station. No fixed structures should infringe the Structure Gauge except for designated railway operational structures. Designated railway operational structures include platform coping, platform screed door, hand railing in back-of-house platform edge, track access gates. Such designated railway operational structures should not infringe the kinematic envelope under any circumstances.

2.2.5. For Structure Gauge at stations, refer to following appendices:

a.	For Under Ground Station (Tunnel)	FIG. MMRC-8 & FIG. MMRC-10
b.	For At-Grade with One Side Platform	FIG. MMRC-7
c.	For Elevated Station with Island Platform	FIG. MMRC-9
d.	For Structure Gauge At-Grade and Elevated Station	FIG. MMRC-11

2.3 TRACK GRADIENT IN PLATFORM

(a)Maximum Gradient	1 In 400
(b) Desirable	Level

Note: There shall be no change of gradient in platform line.

2.4 INTERLOCKING AND SIGNAL GEAR

Maximum height above rail level of any part of interlocking or signal gear on either side of centre of track subject to the restrictions embodied in note below shall be as under:

For At-Grade And Elevated Stations:

• From 577.5 mm to 946.5 mm from C. L. of Track	0 mm
• From C.L. of Track to 577.5 mm and from 946.5 mm to1450 mm	25 mm
• From 1450 mm to 1585 mm	25 mm rising to 65 mm
• From 1585 mm to 1745 mm	65 mm rising to 200 mm

For Under Ground Stations:

• From 577.5 mm to 946.5 mm from C. L. of Track	0 mm
• From C.L. of Track to 577.5 mm and from 946.5 mm to1450 mm	25 mm
• From 1450 mm to 1585 mm	25 mm rising to 65 mm
• From 1585 mm to 1720 mm	65 mm rising to 200 mm

Note:

Except for check rails of ordinary and diamond crossings, or wing rails and point rails of crossings leading to snag dead ends, or such parts of signaling gear as are required to be actuated by the wheels, no gear or track fittings shall project above rail level for a distance of 229 mm outside and 140 mm inside the gauge face of the rails.

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2.5 POINTS & CROSSINGS

2.5.1.	Maximum clearance of check rail opposite nose of crossing	44 mm
2.5.2.	Minimum clearance of check rail opposite nose of crossings	41mm
2.5.3.	Minimumclearance between switch rail and stock rail at heel of switch rail.	52 mm
2.5.4.	Maximum clearance of wing rail at nose of crossing	44 mm
2.5.5.	Minimum clearance of wing rail at nose of crossings	41mm
2.5.6.	Minimum clearance between toe of open switch and stock rail	160mm
2.5.7.	Minimum radius of curvature for slip points, turnouts and crossover roads (mainline)	190 m
2.5.8.	On depot lines, the turnouts and diamond crossings shall be of the following types or flatter	140 m radius

(a) 1 in 7 type Turnout
(b) Scissor cross-over of 1 in 7 type consisting of 4 turnouts and 1 diamond crossing
(c) 1 in 7 derailing switches / 1 in 7 type symmetrical split turnout

2.5.9.	Diamond crossings not to be flatter than	1 in 4.5

Notes:

a) The above restrictions shall not apply to moveable diamond crossings
b) There must be no change of superelevation (of outer over inner rail), between points 18 metres outside toe of switch rail and nose of crossings respectively, except in the case of special crossing leading to snag dead-ends or under circumstances as provided for in item 2.6 below.

2.5.10. Minimum length of tongue rail: 9000mm

2.6 SUPERELEVATION AND SPEED ON CURVES WITH TURNOUTS OF CONTRARY AND SIMILAR FLEXURE

2.6.1. Main line:

Subject to the permissible run through speed based on the standard of interlocking, the equilibrium super elevation, calculated for the speed of the fastest train may be reduced by a maximum amount of 100mm without reducing speed on the main line.

2.6.2. Turnouts

i) Curves Of Contrary Flexure
The equilibrium super elevation(S) in mm should be = $(1510/127)*(V^2 / R)$
Where, R = radius of turnout in meters and V is speed on turnout in Kmph.
The permissible negative super elevation on the turnout is specified with 100 mm.

ii) Curves of Similar Flexure
The question of reduction or otherwise of super elevation on the main line must necessarily be determined by the administration concerned. In the case of a reverse curve close behind

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the crossing of a turnout, the super elevation may be run out at the maximum of 1 mm in 440 mm.

2.7 ADDITIONAL CLEARANCE FOR PLATFORMS ON CURVES

The additional clearance for platforms on curves is shown At Appendix 7.

Notes:

(i) As the minimum radius of curve for stations is 1000 meters, there will be no gauge widening at stations on passenger platform line.

(ii) Platforms located in curves shall be filled with a gap filler to reduce safety risk at the Platform Train Interface (PTI). The maximal stepping distance of 75 mm has to be maintained by way of fillers of material elastic in nature and flexible to allow train contact without any adverse effect on passenger safety and stability of trains.

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CHAPTER 3
ROLLING STOCK

3.1 PASSENGER ELECTRIC MULTIPLE UNITS

1.	(a)	length of the coach body: (Maximum including end fairings)	22010 mm
	(b)	The maximum width of the vehicle	3200 mm
	(c)	Height of coach body (maximum with pantograph in lock down position)	4048 mm
2.	(a)	Distance between bogie centers	14750±350mm
	(b)	Maximum distance apart between any two adjacent axles	12900 mm

Note:

Fittings on the end of a vehicle, such as step iron, brake/drainage pipes, electrical connection, cables or boxes, vestibule or gangway, fairings etc. Need not be kept within the prescribed maximum permissible length of the car body, but may project beyond the end of body to a reasonable extent.

3. Kinematic Envelope for level tangent track

(i)	For Underground Sections	FIG. MMRC-1 (TNL)
(ii)	For At-Grade and Elevated Sections	FIG. MMRC-1
(iii)	For Underground Section at platform	FIG. MMRC-1 A (TNL)
(iv)	For At-Grade and Elevated Sections at Platform	FIG. MMRC-1A
(v)	Same Pantograph Shall Be Used For Underground and Elevated Corridors.	

4. (a) Minimum clearance from rail level with fully worn wheel and under fully loaded condition for bogie mounted equipment in worst condition*. 75 mm
   * Worst condition means wheels with maximum tread wear and primary springs with maximum deflection in static condition.

   (b) Minimum clearance from rail level under fully loaded condition for body mounted equipment in worst condition*. 102 mm
   * Worst condition means deflated secondary air spring, wheels with maximum tread wear and primary spring with maximum deflection in static condition.

   (c) Minimum clearance from rail level, under dynamic conditions of fully loaded vehicle, with maximum tread wear and primary spring with maximum deflection, with the exception of wheels and their attachments to (vide note below). 50 mm

Note:

A tyre or an attachment to a wheel or sand pipes or wheel/track lubrication nozzle in line with the wheel may project below the minimum height of 50 mm from a distance of 51 mm inside to 216 mm outside of the gauge face of the wheel.

5. Incline of Tread / Wheel Profile FIG. MMRC-12 (RDSO Sk-91146)
6. Wheel

a)	Maximum wheel gauge back to back distance	1360 mm
b)	Minimum wheel gauge back to back distance	1358mm

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7.	a)	Maximum diameter on the tread measured at 63.5mmfrom the wheel gauge face	860 mm
	b)	Minimum diameter on the tread measured at 63.5mm from the wheel gauge face	780mm
8.	a)	Minimum projection for flange of new wheel measured from tread at 63.5 mm from the wheel gauge face	28.5 mm
		For profile as per Sk-91146	
	b)	Maximum projection for flange of worn wheel measured from tread at 63.5 mm from the wheel gauge face	34 mm
9.	a)	Maximum thickness of flange of wheel measured from wheel gauge face at 13 mm from outer edge of flange	29.4mm
	b)	Minimum thickness of flange of wheel Measured from wheel gauge face at 13 mm from outer edge of flange.	25 mm
10.	Minimum width of wheel		127 mm
11.	Floor Height		
	a)	Maximum height above rail level for floor of any unloaded vehicle	1130mm
	b)	Minimum height above rail level for floor of fully loaded normal vehicle	1100mm
12.	a)	Maximum height of centre coupler above rail level for unloaded vehicle	815mm
	b)	Minimum height of centre coupler above rail level for fully loaded vehicle	740mm
13.	Maximum length over couplers		23000mm
14.	Length of rigid wheel base for single bogie		2200mm to 2600m

3.2 LOCOMOTIVES AND ENGINEERING SERVICE VEHICLES

Other items of rolling stock, viz. shunting locomotives, OHE maintenance and inspection cars, emergency re-railing van, track machines, etc., used on MML3 Metro System(where these cars would be plying)will conform with the Kinematic Envelope of the Passenger Electric Multiple Units as shown in FIG. MMRC- 1(TNL) and FIG. MMRC- 1A (TNL) for Underground sections and FIG. MMRC-1 and FIG. MMRC-1A for At-grade and Elevated sections.

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CHAPTER 4
OVERHEAD ELECTRIC TRACTION 25 KV/AC 50 CYCLES PER SECOND

Note:

Wherever electric traction is in use, special precautions must be taken to maintain following clearances:

4.1 ELECTRICAL CLEARANCES FOR UNDER GROUND

4.1.1 Minimum height from rail level to the underside of wearing copper / metal conductor of rigid OCS (Overhead Contact System):

In Tunnel .....4318 mm

Note:

(a) Location of level crossing from the exit point of the tunnel will take into consideration the OHE height of 4318 mm at the tunnel exit and the permissible contact wire gradient.

(b) In the depot deck portion, if rigid OCS is provided and the track is ballastless, the electrical clearances laid down at Para 4.1.1 to 4.1.4 shall be applicable.

(c) For location of rigid OCS in circular tunnel with canted track, refer to para1.7.1 (B)-b and 1.7.2 (B)-b.

(d) It shall be ensured that environment level inside the tunnel is controlled suitably so that no extra air clearance, over and above the minimum separation prescribed in Para 4.1.3 and 4.1.4 on account of pollution, fog etc. is required.

4.1.2 Stagger of Rigid OCS Conductor in Tunnels shall not be more than

(a) On Straight .....±200 mm
(b) On Curves .....±300 mm

4.1.3 Prescribed minimum clearance between live parts of contact lines and the earthed bodies of structures.

Air clearance between bodies of the earthed structures and live un-insulated parts of contact lines, feeders and current collectors for 25 KV shall be as per IEC 60913 as below:

	Condition	Minimum Clearance Between Live Parts And Structures	Absolute Minimum Dynamic Clearance Between Live Parts And Structures
A)	Long Duration (Static)	270 mm	-
B)	Short Duration (Dynamic)	170 mm	150 mm*

*in exceptional cases and considering operating in climatic conditions (Ref: IEC 60913)

4.1.4 Prescribed minimum clearance between live parts of contact lines and the earthed bodies of vehicles.

Minimum air clearance between bodies of vehicles and the live un-insulated parts of the contact line or feeders for 25 KV shall be as below:

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	Condition	Clearance (mm)
A)	Long Duration (Static)	290 mm
B)	Short Duration (Dynamic)	190 mm

4.1.5 Maximum width of pantograph under dynamic condition.

The Kinematic Envelope for the underground system with ballastless track is shown in FIG. MMRC-1(TNL). The pantograph adopted should be such that its actual half KE width does not exceed 820 mm and 980 mm at the top and bottom respectively in pantograph raised condition for a contact wire height of 4318 mm to fulfil electrical clearance as per item 4.1.3.

Note:

These limits would not apply to special locations like insulated overlaps and out of run wires.

4.2 ELECTRICAL CLEARANCES FOR AT-GRADE AND ELEVATED SECTIONS

4.2.1 Minimum vertical clearance (under worst condition of temperature, wind etc.) between any live part of the Overhead Equipment or Pantograph and parts of any fixed structure (earthed or otherwise) or moving loads:

	Condition	For Flexible OHE
(I)	Long Duration (Static)	320 mm
(Ii)	Short Duration (Dynamic)	270 mm

Note:

A minimum vertical distance of 340 mm shall normally be provided between rolling stock and contact wire to allow for a 20 mm temporary rising of the tracks during maintenance for ballasted track . Wherever the clearance required for track maintenance exceeds 20 mm, the vertical distance between rolling stock and contact wire shall correspondingly be increased.

4.2.2 Minimum lateral clearance (under worst condition of temperature, wind etc.) between any live part of the Overhead Equipment or Pantograph and parts of any fixed structure (earthed or otherwise) or moving loads:

	Condition	For Flexible OHE
(I)	Long Duration (Static)	320 mm
(Ii)	Short Duration (Dynamic)	220 mm

4.2.3 Height of contact wire:

Minimum height from rail level to the underside of live conductor wire:

i. In tunnel portal to Ramp area..... .....4388 mm
ii. Under the bridges.....4640mm(approx)
iii. In the open (Elevated & At-grade sections) 5000mm
iv. At Level Crossings.....5500 mm
v. In Running and carriage sheds wherever staffs are expected to work on the roof of rolling stock..... 5500 mm
vi. In depot.....P5500 mm

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Note:

On curves, all vertical distances specified in items 4.2.3 above, shall be measured above level of the inner rail, increased by half the super-elevation.

4.2.4 Maximum variation of the live conductor wire on either side of the centreline of the track under static conditions:

i. On Straight .....±200 mm
ii. On Curves.....±300 mm

Note:

These limits would not apply to special locations like insulated overlaps and out of run wires.

4.2.5 Maximum Width of Pantograph Collector :

The kinematic envelope with the size of pantograph adopted shall be within the kinematic envelope shown at FIG. MMRC-1

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CHAPTER 5
PLATFORM SCREEN DOORS

5.1 PLATFORM SCREEN DOORS SETTING OUT DIMENSIONS

Minimum Platform Screen Door Width	Min 2000 mm
Minimum Platform Screen Door Height From Platform Level	Min 1500mm (Partial Height) Min 2100 mm(Full Height)
Minimum Platform Threshold offset from track centreline—straight track (Underground)	1660 mm
Minimum Platform Threshold Offset From Track Centreline – Straight Track (At Grade/ Elevated)	1670 mm
Minimum Platform Screen Door Panel Offset From Track Centreline – Straight Track (a) For Underground (b) For At Grade /Elevated	 1695 mm 1705 mm

Note:

(a) Assumed plus/minus 300 mm stopping accuracy.
(b) Curve track through station to be considered separately.
(c) Platform Screen Doors are considered as designated railway operational structures. Therefore, PDS may infringe the Structure Gauge, but does not infringe the station Kinematic Envelope and having minimum clearance of 10 mm from Kinematic Envelope to Platform Screen Door.

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APPENDIX 1

PERMISSIBLE SPEED, CANT AND MINIMUM TRACK SPACING ON CURVES.

UNDER GROUND (TUNNELS), AT-GRADE AND ELEVATED SECTIONS

(REFERENCE: PARA 1.1)

RADIUS OF CURVE	CANT	MAXIMUM PERMISSIBLE SPEED	MINIMUM DISTANCE BETWEEN ADJACENT TRACKS See note (a)	
			UNDER GROUND	AT-GRADE AND ELEVATED
meters	mm	kmph	mm	Mm
3000	15	85	3800	3900
2800	15	85	3800	3900
2400	20	85	3800	3900
2000	20	85	3800	3900
1600	25	85	3800	3900
1500	30	85	3800	3900
1200	35	85	3800	3950
1000	45	85	3800	3950
800	55	85	3850	4000
600	70	85	3850	4000
500	85	85	3850	4000
450	100	85	3900	4000
400	115	85	3900	4050
350	125	80	3950	4050
300	125	75	4000	4100
260	125	70	4000	4100
230	125	65	4050	4150
200	125	60	4100	4200
150*	0	35	4200	4300
120*	0	30	4300	4400
100*	0	25	4300	4400

Notes:

(a) The track spacing shown in the table above is without any column/structure between two tracks and is with equal cant for both outer and inner tracks.
(b) Track spacing shown in Table above is not applicable to stations which should be calculated depending on specific requirement.
(c) Figures for any intermediate radius of curvature may be obtained adopting value of sharper curve.
(d) Cant provided is limited to desirable value of 125 mm
(e) Maximum cant deficiency is 100 mm.
(f) * The curves of100 to 150 meters radii are used in depot and depot connections.

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APPENDIX 2

EXTRA HORIZONTAL SHIFT ON CURVES (CURVATURE EFFECT]
INSIDE OF CURVE

REFERENCE PARA 1.7.1

RADIUS (meters)	MID-THROW (28500/R) (mm)	NOSING INCLUDED IN K.E/STRUCTURE GAUGE FOR TANGENT TRACK (mm)	EXTRA GAUGE TOLERANCE ON CURVES (mm)	EXTRA HORIZONTAL SHIFT'ON CURVE (mm)	REMARKS
R	(V)	(N)	(G)	(T_1)	G), EXTRA GAUGE TOLERANCE ON CURVES SHARPER THAN 1000 M RADIUS: 9 mm FOR CURVES WITH RADIUS SHARPER THAN 500 M AND 5mm FOR CURVES WITH RADIUS OF 500 M TO LESS THAN 1000M. T_1=V-N+G V EQUAL TO OR GREATER THAN (N) **T_1 = G for V<(N)**
100	285	32.0	9.0	262	
120	237.5	32.0	9.0	215	
150	190.0	32.0	9.0	167	
175	162.9	32.0	9.0	140	
200	142.5	320	9.0	120	
230	123.91	32.0	9.0	101	
260	109.61	32.0	9.0	87	
300	95.0	32.0	9.0	72	
350	81.4	32.0	9.0	58	
400	71.3	32.0	9.0	48	
450	63.3	32.0	9.0	40	
500	57.0	32.0	5.0	30	
600	47.5	32.0	5.0	21	
700	40.7	32.0	5.0	14	
800	35.6	32.0	5.0	9	
900	31.7	32.0	5.0	5	
1000	28.5	32.0	0.0	0	
1200	23.8	32.0	0.0	0	
1500	19.0	32.0	0.0	0	
1600	17.8	32.0	0.0	0	
2000	14.3	32.0	0.0	0	
2400	11.9	32.0	0.0	0	
2600	10.2	32.0	0.0	0	
3000	9.5	32.0	0.0	0	

Mid Throw (in mm) Vo= $(125xC^2)/R$ = 28500/R, where 'C' is the distance between bogie centres = 14.750+0.350=15.100 m OR 14.750-350=14.400m. Worst Case will be with C=15.100 m; R is the radius of curve

OUTSIDE OF CURVE

REFERENCE PARA 1.7.2

RADIUS (meters)	END-THROW (34635/R) (mm)	EXTRA GAUGE TOLERANCE ON CURVES (mm)	EXTRA NOSING DUE TO EXTRA GAUGE TOLERANCE (mm)	EXTRA HORIZONTAL SHIFT'ON CURVE (mm)	REMARKS
R	Vo	G	(EN)	T2	(G), EXTRA GAUGE TOLERANCE ON CURVES SHARPER THAN 1000 M RADIUS: 9 mm FOR CURVES WITH RADIUS SHARPER THAN 500 M AND 5mm FOR CURVES WITH RADIUS OF 500 M TO LESS THAN 1000M. **T_2=Vo +G+EN EN=G x 0.2555555**
100	346.4	9.0	2.3	358	
120	288.6	9.0	2.3	300	
150	230.6	9.0	2.3	242	
175	197.9	9.0	2.3	209	
200	173.2	9.0	2.3	184	
230	150.58	9.0	2.3	162	
260	133.21	9.0	2.3	145	
300	115.5	9.0	2.3	127	
350	99.0	9.0	2.3	110	
400	86.6	9.0	2.3	98	
450	77.0	9.0	2.3	88	
500	69.3	5.0	1.3	76	
600	57.7	5.0	1.3	64	
700	49.5	5.0	1.3	56	
800	43.3	5.0	1.3	50	
900	38.5	5.0	1.3	45	
1000	34.6	0.0	0.0	35	
1200	28.9	0.0	0.0	29	
1500	23.1	0.0	0.0	23	
1600	21.6	0.0	0.0	22	
2000	17.3	0.0	0.0	17	
2400	14.4	0.0	0.0	14	
2800	12.4	0.0	0.0	12	
3000	11.5	0.0	0.0	12	

End Throw (in mm) Vo= $(125 \times C1^2)$ /R - $(125xC^2)/R$ = 34635/R, where 'C' is the distance between bogie centres = 14.750 + 0.350=15.100 m OR 14.750 - 0.350 = 14.400 m.
Worst case will be with C=14.400 m, 'C1' is length of coach in meters: 22.010 m and 'R' radius of curve in meters.

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APPENDIX 3

Shift of the Centre of Circular Tunnel Due To Rotation of Tunnel to provide for cant

(WITH D_1 =630mm)

REFER TO FIG. MMRC-3 AND PARA No. 1.7.1 (B)(b)

Cant	sin α= cant/1510	Angle α	tan θ= (r-D1)/(g/2)	Angle θ	Lateral Shift of Tunnel centre=X	Vertical Shift of Tunnel centre=Y
mm		Degrees		Degrees	mm	mm
125	0.08278	4.74846	2.87417	70.8159	182	55
120	0.07947	4.55811	2.87417	70.8159	175	53
115	0.07616	4.36782	2.87417	70.8159	167	51
110	0.07285	4.17757	2.87417	70.8159	160	49
105	0.06954	3.98736	2.87417	70.8159	153	47
100	0.06623	3.79720	2.87417	70.8159	145	45
95	0.06291	3.60708	2.87417	70.8159	138	43
90	0.05960	3.41701	2.87417	70.8159	131	41
85	0.05629	3.22696	2.87417	70.8159	123	39
80	0.05298	3.03696	2.87417	70.8159	116	37
75	0.04967	2.84699	2.87417	70.8159	109	35
70	0.04636	2.65705	2.87417	70.8159	101	33
65	0.04305	2.46714	2.87417	70.8159	94	30
60	0.03974	2.27725	2.87417	70.8159	87	28
55	0.03642	2.08739	2.87417	70.8159	80	26
50	0.03311	1.89756	2.87417	70.8159	72	24
45	0.02980	1.70774	2.87417	70.8159	65	22
40	0.02649	1.51795	2.87417	70.8159	58	19
35	0.02318	1.32817	2.87417	70.8159	51	17
30	0.01987	1.13840	2.87417	70.8159	43	15
25	0.01656	0.94865	2.87417	70.8159	36	12
20	0.01325	0.75891	2.87417	70.8159	29	10
15	0.00993	0.56917	2.87417	70.8159	22	7
10	0.00662	0.37945	2.87417	70.8159	14	5
5	0.00331	0.18972	2.87417	70.8159	7	2
0	0	0.00000	2.87417	70.8159	0	0

Remarks

a. The cant is provided by rotating the outer rail which will mean, rotating the tunnel about the midpoint of the top of inner rail.

b. Lateral shift of the centre of tunnel (X) towards the inside of tunnel = X

$$X = \left[2 \times (r - D_1) \div (\sin\theta) \times \sin\frac{\alpha}{2}\right] \times \cos(90 - \theta - \alpha/2)$$

c. The vertical shift of the centre of the tunnel Upwards = Y

$$Y = \left[2 \times (r - D_1) \div (\sin\theta) \times \sin\frac{\alpha}{2}\right] \times \sin(90 - \theta - \alpha/2)$$

- 'r' is Internal Radius of Circular Tunnel =2800 mm
- D_1 =Depth from Invert of Circular Tunnel to Rail Top Level =630 mm
- α = Angle of Rotation $\alpha=\sin^{-1}(\text{cant}/g)$
- θ= Angle Subtended by line joining top of two rails and the line joining midpoint of top of inner rail and the centre of circular Tunnel

$\theta=\tan^{-1}[(r\text{-}D1)/(g/2)]=70.8159$

Distance between Centre to Centre of Rails (g) = 1510mm

Project Directorate Approved on 20/3/18 Railway Board

Mumbai Metro Rail Corporation Ltd. MUMBAI

APPENDIX 4

CANT EFFECT ON STRUCTURE GAUGE
AT-GRADE OR ELEVATED SECTIONS

REFER TO FIG. MMRC-4 AND PARA No. 1.7.1 (B) (a) &1.8.2 (b)

Cant	Alpha Degree	Alpha Radians	Sin Alpha	Cos Alpha	Tan Alpha	h= 200		ab= 1745		h= 880		ab= 1903		h= 1130		ab= 1938		h= 2030		ab= 1938		h= 3300		ab= 1875		h= 3736		ab= 1540		h= 6250		ab= 1540	
						E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2
125	4.7485	0.0829	0.0828	0.9966	0.0831	1756	1722	406	117	1969	1824	1097	782	2025	1838	1349	1028	2099	1763	2246	1925	2142	1595	3506	3196	1844	1225	3913	3658	2052	1017	6419	6164
120	4.5581	0.0796	0.0795	0.9968	0.0797	1755	1724	398	121	1967	1827	1088	786	2022	1842	1340	1032	2093	1771	2238	1930	2131	1607	3499	3201	1832	1238	3907	3662	2032	1038	6413	6168
115	4.3678	0.0762	0.0762	0.9971	0.0764	1755	1725	390	124	1964	1830	1080	790	2018	1846	1332	1037	2087	1778	2229	1934	2121	1618	3491	3205	1820	1251	3900	3665	2012	1060	6407	6172
110	4.1776	0.0729	0.0728	0.9973	0.0730	1755	1726	382	127	1962	1834	1071	794	2015	1851	1323	1041	2081	1785	2221	1938	2110	1630	3483	3210	1808	1264	3893	3669	1991	1081	6401	6176
105	3.9874	0.0696	0.0695	0.9976	0.0697	1755	1727	373	131	1960	1837	1063	798	2012	1855	1315	1045	2074	1792	2212	1943	2100	1641	3475	3214	1796	1276	3887	3672	1971	1102	6394	6180
100	3.7972	0.0663	0.0662	0.9978	0.0664	1754	1728	365	134	1957	1841	1054	802	2009	1859	1306	1049	2068	1799	2204	1947	2089	1652	3467	3219	1784	1289	3880	3676	1951	1123	6388	6184
97	3.6831	0.0643	0.0642	0.9979	0.0644	1754	1729	360	136	1956	1843	1049	804	2007	1861	1301	1052	2064	1804	2199	1950	2083	1659	3462	3221	1777	1297	3876	3678	1938	1135	6385	6187
95	3.6071	0.0630	0.0629	0.9980	0.0630	1754	1729	357	137	1955	1844	1045	806	2005	1863	1297	1053	2062	1806	2195	1952	2079	1664	3459	3223	1772	1302	3873	3679	1930	1144	6382	6188
90	3.4170	0.0596	0.0596	0.9982	0.0597	1754	1730	349	141	1952	1847	1037	810	2002	1867	1289	1057	2056	1814	2187	1956	2068	1675	3451	3227	1760	1315	3866	3683	1910	1165	6376	6192
85	3.2270	0.0563	0.0563	0.9984	0.0564	1753	1731	340	144	1950	1850	1028	814	1999	1871	1280	1062	2049	1821	2178	1960	2058	1686	3443	3232	1748	1327	3859	3686	1889	1186	6369	6196
80	3.0370	0.0530	0.0530	0.9986	0.0531	1753	1732	332	147	1947	1854	1020	818	1995	1875	1271	1066	2043	1828	2170	1964	2047	1698	3435	3236	1736	1340	3852	3689	1869	1207	6363	6200
75	2.8470	0.0497	0.0497	0.9988	0.0497	1753	1733	324	151	1944	1857	1011	822	1992	1879	1262	1070	2036	1835	2161	1969	2037	1709	3427	3240	1724	1353	3845	3692	1849	1228	6356	6203
70	2.6570	0.0464	0.0464	0.9989	0.0464	1752	1734	316	154	1942	1860	1002	826	1988	1884	1254	1074	2030	1842	2153	1973	2026	1720	3418	3245	1712	1365	3838	3696	1828	1249	6350	6207
60	2.2773	0.0397	0.0397	0.9992	0.0398	1752	1736	299	161	1936	1867	985	834	1981	1892	1236	1082	2017	1856	2135	1981	2005	1742	3402	3253	1687	1390	3824	3702	1787	1290	6336	6214
55	2.0874	0.0364	0.0364	0.9993	0.0364	1751	1737	291	164	1934	1870	976	838	1978	1896	1227	1086	2011	1863	2127	1986	1994	1754	3394	3257	1675	1403	3817	3705	1767	1311	6329	6217
50	1.8976	0.0331	0.0331	0.9995	0.0331	1751	1737	283	167	1931	1873	968	842	1974	1900	1219	1090	2004	1870	2118	1990	1983	1765	3385	3261	1663	1415	3810	3708	1746	1332	6323	6221
45	1.7077	0.0298	0.0298	0.9996	0.0298	1750	1738	274	170	1928	1876	959	845	1971	1903	1210	1094	1998	1877	2109	1994	1973	1776	3377	3265	1651	1428	3803	3711	1726	1353	6316	6224
40	1.5179	0.0265	0.0265	0.9996	0.0265	1750	1739	266	174	1926	1879	950	849	1967	1907	1201	1098	1991	1884	2101	1998	1962	1787	3369	3269	1638	1440	3795	3714	1705	1374	6309	6227
35	1.3282	0.0232	0.0232	0.9997	0.0232	1749	1740	258	177	1923	1882	941	853	1964	1911	1192	1102	1985	1890	2092	2002	1951	1798	3360	3273	1626	1453	3788	3717	1684	1395	6302	6230
30	1.1384	0.0199	0.0199	0.9998	0.0199	1749	1741	250	180	1920	1885	933	857	1960	1915	1183	1106	1978	1897	2083	2006	1940	1809	3352	3277	1614	1465	3781	3720	1664	1416	6294	6233
25	0.9486	0.0166	0.0166	0.9999	0.0166	1748	1741	241	184	1917	1888	924	861	1956	1919	1174	1110	1971	1904	2074	2010	1929	1820	3343	3281	1602	1478	3773	3722	1643	1436	6287	6236
20	0.7589	0.0132	0.0132	0.9999	0.0132	1747	1742	233	187	1914	1891	915	865	1953	1923	1166	1114	1965	1911	2065	2014	1919	1831	3335	3285	1589	1490	3766	3725	1623	1457	6280	6239
15	0.5692	0.0099	0.0099	1.0000	0.0099	1747	1743	225	190	1912	1894	906	869	1949	1927	1157	1118	1958	1918	2057	2018	1908	1842	3326	3289	1577	1503	3759	3728	1602	1478	6272	6242
10	0.3794	0.0066	0.0066	1.0000	0.0066	1746	1744	217	193	1909	1897	898	872	1945	1930	1148	1122	1951	1925	2048	2022	1897	1853	3317	3293	1565	1515	3751	3731	1581	1499	6265	6245
5	0.1897	0.0033	0.0033	1.0000	0.0033	1746	1744	208	197	1906	1900	889	876	1942	1934	1139	1126	1945	1931	2039	2026	1886	1864	3309	3296	1552	1528	3744	3733	1561	1519	6258	6247
0	0.0000	0.0000	0.0000	1.0000	0.0000	1745	1745	200	200	1903	1903	880	880	1938	1938	1130	1130	1938	1938	2030	2030	1875	1875	3300	3300	1540	1540	3736	3736	1540	1540	6250	6250

REFER TO FIG. MMRC-4
All dimensions are in mm
Where:

g= 1510
h= Height above rail level measured perpendicular to plane of track.
$E_1 = [ab + (h \times \text{Tan } \alpha)] \times \text{Cos } \alpha$
$F_1 = [Ab - (h \times \text{Tan } \alpha)] \times \text{Cos } \alpha$
$H_1 = (Ca / 2) + (h / \text{Cos } \alpha) + (Ab - h \times \text{Tan } \alpha) \times \text{Sin } \alpha$
$H_2 = (Ca / 2) + (h / \text{Cos } \alpha) - (ab + h \times \text{Tan } \alpha) \times \text{Sin } \alpha$
ab=Ab = Distance from centre line of vehicle to Structure Gauge for Tangent track at height "h" from rail level.

Mumbai Rail Corporation Ltd. MUMBAI

Project Directorate Approved on 20/3/18 Railway Board

APPENDIX 4 (BOX TNL)

CANT EFFECT ON STRUCTURE GAUGE
UNDERGROUND SECTIONS (RECTANGULAR BOX TUNNEL)

REFER TO FIG. MMRC-4 (BOX TNL) AND PARA No. 1.7.1 (B) (a) &1.8.2 (b)

Cant	Alpha Degree	Alpha Radians	Sin Alpha	Cos Alpha	Tan Alpha	h= 305		ab= 1720		h= 880		ab= 1851		h= 1130		ab= 1875		h= 2030		ab= 1741		h= 3346		ab= 1818		h= 3738		ab= 1390		h= 4838		ab= 1390	
						E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2
125	4.7485	0.0829	0.0828	0.9966	0.0831	1739	1689	509	224	1917	1772	1093	786	1962	1775	1344	1033	2037	1701	2241	1930	2086	1532	3547	3247	1695	1076	3903	3673	1786	985	4999	4769
120	4.5581	0.0796	0.0795	0.9968	0.0797	1739	1690	501	227	1915	1775	1084	790	1959	1779	1335	1037	2030	1708	2233	1935	2075	1543	3540	3251	1683	1089	3897	3676	1770	1001	4993	4772
115	4.3678	0.0762	0.0762	0.9971	0.0764	1738	1692	493	231	1913	1779	1076	794	1956	1783	1327	1041	2024	1715	2224	1939	2065	1555	3532	3256	1671	1101	3891	3679	1754	1018	4987	4776
110	4.1776	0.0729	0.0728	0.9973	0.0730	1738	1693	484	234	1910	1782	1068	798	1952	1788	1319	1045	2018	1722	2216	1943	2054	1566	3524	3260	1659	1114	3884	3682	1739	1034	4981	4779
100	3.7972	0.0663	0.0662	0.9978	0.0664	1736	1696	468	240	1905	1789	1051	805	1946	1796	1302	1053	2005	1736	2200	1951	2033	1589	3509	3268	1634	1139	3872	3688	1707	1067	4969	4785
105	3.9874	0.0696	0.0695	0.9976	0.0697	1737	1695	476	237	1908	1785	1059	802	1949	1792	1310	1049	2012	1729	2208	1947	2043	1578	3517	3264	1647	1127	3878	3685	1723	1050	4975	4782
95	3.6071	0.0630	0.0629	0.9980	0.0630	1736	1697	460	244	1903	1792	1042	809	1942	1800	1293	1057	1999	1744	2191	1956	2022	1601	3501	3273	1622	1152	3866	3691	1692	1083	4963	4788
90	3.4170	0.0596	0.0596	0.9982	0.0597	1735	1699	452	247	1900	1795	1034	813	1939	1804	1285	1061	1993	1751	2183	1960	2011	1612	3493	3277	1610	1165	3859	3694	1676	1099	4957	4792
85	3.2270	0.0563	0.0563	0.9984	0.0564	1734	1700	444	250	1898	1799	1025	817	1936	1808	1276	1065	1986	1758	2175	1964	2000	1624	3485	3281	1598	1177	3853	3696	1660	1115	4951	4795
80	3.0370	0.0530	0.0530	0.9986	0.0531	1734	1701	436	253	1895	1802	1017	821	1932	1812	1268	1069	1980	1765	2166	1968	1990	1635	3477	3285	1586	1190	3846	3699	1644	1132	4945	4798
75	2.8470	0.0497	0.0497	0.9988	0.0497	1733	1703	428	257	1892	1805	1008	824	1929	1817	1259	1073	1974	1772	2158	1972	1979	1647	3470	3289	1574	1203	3840	3702	1629	1148	4939	4800
70	2.6570	0.0464	0.0464	0.9989	0.0464	1732	1704	419	260	1890	1808	1000	828	1925	1821	1251	1077	1967	1779	2150	1976	1968	1658	3462	3293	1562	1215	3833	3705	1613	1164	4932	4803
65	2.4671	0.0431	0.0430	0.9991	0.0431	1732	1705	411	263	1887	1811	991	832	1922	1825	1242	1081	1961	1786	2141	1980	1957	1669	3454	3297	1550	1228	3827	3707	1597	1180	4926	4806
50	1.8976	0.0331	0.0331	0.9995	0.0331	1729	1709	387	273	1879	1821	966	843	1911	1837	1216	1092	1941	1807	2116	1992	1925	1703	3429	3309	1513	1265	3807	3715	1549	1229	4906	4814
45	1.7077	0.0298	0.0298	0.9996	0.0298	1728	1710	379	276	1876	1824	957	847	1908	1840	1208	1096	1935	1814	2107	1996	1914	1714	3421	3313	1501	1278	3800	3717	1534	1245	4900	4817
40	1.5179	0.0265	0.0265	0.9996	0.0265	1727	1711	370	279	1874	1827	949	851	1904	1844	1199	1100	1928	1821	2099	2000	1903	1726	3413	3317	1489	1290	3794	3720	1518	1261	4893	4819
35	1.3282	0.0232	0.0232	0.9997	0.0232	1727	1712	362	283	1871	1830	940	854	1901	1848	1191	1104	1922	1827	2090	2003	1892	1737	3405	3321	1476	1303	3787	3722	1502	1277	4886	4822
30	1.1384	0.0199	0.0199	0.9998	0.0199	1726	1714	354	286	1868	1833	932	858	1897	1852	1182	1108	1915	1834	2082	2007	1881	1748	3396	3324	1464	1315	3780	3725	1486	1294	4880	4824
25	0.9486	0.0166	0.0166	0.9999	0.0166	1725	1715	346	289	1865	1836	923	862	1893	1856	1173	1111	1908	1841	2073	2011	1870	1759	3388	3328	1452	1328	3773	3727	1470	1310	4873	4827
20	0.7589	0.0132	0.0132	0.9999	0.0132	1724	1716	338	292	1862	1839	914	865	1890	1860	1165	1115	1902	1848	2065	2015	1859	1771	3380	3332	1439	1340	3766	3729	1454	1326	4866	4829
15	0.5692	0.0099	0.0099	1.0000	0.0099	1723	1717	330	295	1860	1842	906	869	1886	1864	1156	1119	1895	1855	2056	2019	1848	1782	3371	3335	1427	1353	3759	3732	1438	1342	4859	4831
10	0.3794	0.0066	0.0066	1.0000	0.0066	1722	1718	321	299	1857	1845	897	873	1882	1867	1147	1123	1888	1862	2047	2023	1837	1793	3363	3339	1415	1365	3752	3734	1422	1358	4852	4834
5	0.1897	0.0033	0.0033	1.0000	0.0033	1721	1719	313	302	1854	1848	889	876	1879	1871	1139	1126	1882	1868	2039	2026	1826	1804	3354	3342	1402	1378	3745	3736	1406	1374	4845	4836
0	0.0000	0.0000	0.0000	1.0000	0.0000	1720	1720	305	305	1851	1851	880	880	1875	1875	1130	1130	1875	1875	2030	2030	1815	1815	3346	3346	1390	1390	3738	3738	1390	1390	4838	4838

REFER TO FIG. MMRC-4 (BOX TNL)
All dimensions are in mm

Where:

g= 1510
h= Height above rail level measured perpendicular to plane of track.
$E_1 = [ab + (h \times \text{Tan } \alpha)] \times \text{Cos } \alpha$
$F_1 = [Ab - (h \times \text{Tan } \alpha)] \times \text{Cos } \alpha$
$H_1 = (Ca / 2) + (h / \text{Cos } \alpha) + (Ab - h \times \text{Tan } \alpha) \times \text{Sin } \alpha$
$H_2 = (Ca / 2) + (h / \text{Cos } \alpha) - (ab + h \times \text{Tan } \alpha) \times \text{Sin } \alpha$
Ab=Ab = Distance from centre line of vehicle to Structure Gauge for Tangent track at height "h" from rail level.

Project Directorate Approved on 20/3/18 Railway Board

Mumbai Metro Rail Corporation Ltd. MUMBAI

APPENDIX 5

CANT EFFECT ON KINEMATIC ENVELOPE AT-GRADE OR ELEVATED SECTIONS

REFER TO FIG. MMRC-5 AND PARA No. 1.8.1

Cant	Alpha Degree	Alpha Radians	Sin Alpha	Cos Alpha	Tan Alpha	h= 165		ab= 1585		h= 880		ab= 1749		h= 1130		ab= 1788		h= 2030		ab= 1788		h= 3300		ab= 1774		h= 3736		ab= 1285		h= 4115		ab= 1220		h= 4833		ab= 1220		h= 5018		ab= 880	
						E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2
125	4.7485	0.0829	0.0828	0.9966	0.0831	1593	1566	358	96	1816	1670	1084	795	1875	1688	1337	1041	1950	1614	2234	1938	1992	1446	3494	3208	1590	971	3892	3679	1556	875	4264	4062	1616	816	4980	4778	1292	462	5136	4990
120	4.5581	0.0796	0.0795	0.9968	0.0797	1593	1567	350	99	1813	1674	1076	798	1872	1693	1329	1044	1944	1621	2226	1941	1982	1457	3487	3212	1578	984	3886	3682	1543	889	4259	4065	1600	832	4975	4781	1276	478	5132	4992
115	4.3678	0.0762	0.0762	0.9971	0.0764	1593	1568	343	101	1811	1677	1068	802	1869	1697	1320	1048	1937	1628	2218	1945	1971	1469	3479	3217	1566	997	3881	3685	1530	903	4253	4068	1585	848	4969	4784	1260	495	5128	4994
110	4.1776	0.0729	0.0728	0.9973	0.0730	1593	1569	335	104	1808	1680	1060	805	1866	1701	1312	1052	1931	1635	2210	1949	1961	1480	3472	3221	1554	1009	3875	3687	1517	917	4248	4070	1569	865	4964	4786	1243	512	5124	4996
105	3.9874	0.0696	0.0695	0.9976	0.0697	1593	1570	327	107	1806	1684	1052	809	1862	1705	1304	1055	1925	1643	2202	1953	1950	1491	3464	3225	1542	1022	3869	3690	1503	931	4242	4073	1553	881	4959	4789	1227	529	5120	4997
100	3.7972	0.0663	0.0662	0.9978	0.0664	1592	1571	320	110	1803	1687	1044	812	1859	1709	1296	1059	1919	1650	2194	1957	1940	1503	3457	3229	1530	1035	3863	3693	1490	945	4237	4075	1537	897	4953	4792	1210	546	5115	4999
95	3.6071	0.0630	0.0629	0.9980	0.0630	1592	1571	312	112	1801	1690	1036	816	1856	1713	1288	1063	1912	1657	2186	1961	1929	1514	3449	3232	1518	1047	3857	3695	1476	959	4231	4078	1522	914	4948	4794	1194	563	5111	5000
90	3.4170	0.0596	0.0596	0.9982	0.0597	1592	1572	304	115	1798	1693	1028	819	1852	1717	1280	1066	1906	1664	2178	1965	1919	1525	3442	3236	1505	1060	3851	3698	1463	973	4225	4080	1506	930	4942	4797	1178	579	5107	5002
85	3.2270	0.0563	0.0563	0.9984	0.0564	1592	1573	296	118	1796	1697	1020	823	1849	1722	1271	1070	1899	1671	2170	1969	1908	1537	3434	3240	1493	1073	3845	3700	1450	986	4220	4082	1490	946	4937	4799	1161	596	5102	5003
80	3.0370	0.0530	0.0530	0.9986	0.0531	1592	1574	289	121	1793	1700	1011	826	1845	1726	1263	1074	1893	1678	2162	1972	1897	1548	3427	3244	1481	1085	3839	3703	1436	1000	4214	4085	1474	962	4931	4802	1145	613	5098	5004
75	2.8470	0.0497	0.0497	0.9988	0.0497	1591	1575	281	124	1791	1703	1003	830	1842	1730	1255	1077	1887	1685	2154	1976	1887	1559	3419	3248	1469	1098	3833	3705	1423	1014	4208	4087	1459	978	4925	4804	1128	630	5093	5006
70	2.6570	0.0464	0.0464	0.9989	0.0464	1591	1576	273	126	1788	1706	995	833	1838	1734	1247	1081	1880	1692	2146	1980	1876	1570	3411	3251	1457	1110	3827	3707	1409	1028	4202	4089	1443	995	4919	4806	1112	646	5088	5007
65	2.4671	0.0431	0.0430	0.9991	0.0431	1591	1576	266	129	1785	1709	987	836	1835	1738	1238	1084	1874	1699	2138	1984	1865	1581	3404	3255	1445	1123	3820	3710	1396	1042	4196	4091	1427	1011	4914	4809	1095	663	5084	5008
55	2.0874	0.0364	0.0364	0.9993	0.0364	1590	1578	250	135	1780	1716	971	843	1828	1746	1222	1092	1861	1713	2121	1991	1844	1604	3388	3262	1420	1148	3808	3714	1369	1069	4184	4095	1395	1043	4902	4813	1062	697	5074	5010
45	1.7077	0.0298	0.0298	0.9996	0.0298	1589	1579	235	140	1774	1722	954	850	1821	1754	1205	1099	1848	1727	2105	1998	1823	1626	3372	3270	1396	1173	3795	3719	1342	1097	4172	4099	1363	1075	4890	4817	1029	730	5064	5012
40	1.5179	0.0265	0.0265	0.9996	0.0265	1589	1580	227	143	1772	1725	946	853	1817	1757	1197	1102	1841	1734	2097	2002	1812	1637	3365	3273	1384	1186	3789	3721	1329	1111	4166	4101	1348	1092	4884	4819	1013	747	5060	5013
35	1.3282	0.0232	0.0232	0.9997	0.0232	1588	1581	219	146	1769	1728	938	857	1814	1761	1189	1106	1835	1740	2088	2006	1801	1648	3357	3277	1371	1198	3782	3723	1315	1124	4160	4103	1332	1108	4877	4821	996	763	5055	5014
30	1.1384	0.0199	0.0199	0.9998	0.0199	1588	1581	211	148	1766	1731	930	860	1810	1765	1180	1109	1828	1747	2080	2009	1790	1659	3349	3280	1359	1211	3776	3725	1302	1138	4153	4105	1316	1124	4871	4823	980	780	5049	5015
25	0.9486	0.0166	0.0166	0.9999	0.0166	1588	1582	204	151	1763	1734	921	863	1806	1769	1172	1113	1821	1754	2072	2013	1779	1670	3341	3283	1347	1223	3769	3727	1288	1152	4147	4107	1300	1140	4865	4825	963	797	5044	5015
20	0.7589	0.0132	0.0132	0.9999	0.0132	1587	1583	196	154	1761	1737	913	867	1803	1773	1164	1116	1815	1761	2064	2016	1769	1681	3333	3287	1334	1235	3763	3729	1274	1165	4141	4108	1284	1156	4859	4826	946	813	5039	5016
15	0.5692	0.0099	0.0099	1.0000	0.0099	1587	1583	188	157	1758	1740	905	870	1799	1777	1155	1120	1808	1768	2055	2020	1758	1692	3324	3290	1322	1248	3756	3731	1261	1179	4134	4110	1268	1172	4852	4828	930	830	5034	5017
10	0.3794	0.0066	0.0066	1.0000	0.0066	1586	1584	180	159	1755	1743	897	873	1795	1780	1147	1123	1801	1775	2047	2023	1747	1703	3316	3294	1310	1260	3749	3732	1247	1193	4128	4112	1252	1188	4846	4830	913	847	5029	5017
5	0.1897	0.0033	0.0033	1.0000	0.0033	1586	1584	173	162	1752	1746	888	877	1792	1784	1138	1127	1795	1781	2038	2027	1736	1714	3308	3297	1297	1273	3743	3734	1234	1206	4122	4113	1236	1204	4840	4831	897	863	5023	5018
0	0.0000	0.0000	0.0000	1.0000	0.0000	1585	1585	165	165	1749	1749	880	880	1788	1788	1130	1130	1788	1788	2030	2030	1725	1725	3300	3300	1285	1285	3736	3736	1220	1220	4115	4115	1220	1220	4833	4833	880	880	5018	5018

REFER TO FIG. MMRC-5
All dimensions are in mm

Where:
g = 1510 Rail centre to centre distance
h= Height above rail level measured perpendicular to plane of track.

E = [ab + (h x Tan α)] x Cos α
F = [Ab - (h x Tan α)] x Cos α
H1 = (Ca / 2) + (h / Cos α) + (Ab - h x Tan α) x Sin α
H2 = (Ca / 2) + (h / Cos α) - (ab + h x Tan α) x Sin α
ab=Ab =Distance from centre line of vehicle to Kinematic Envelope for Tangent track at height "h" from rail level.

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APPENDIX 5 (TNL)

CANT EFFECT ON KINEMATIC ENVELOPE
UNDERGROUND SECTIONS

REFER TO FIG. MMRC-5 (TNL) AND PARA No. 1.8.1

Alpha Radians	Sin Alpha	Cos Alpha	Tan Alpha	h= 165		ab= 1585		h= 880		ab= 1749		h= 1130		ab= 1775		h= 2030		ab= 1775		h= 3300		ab= 1715		h= 3727		ab= 1255		h= 4048		ab= 980		h= 4145		ab= 1097		h= 4318		ab= 820	
				E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2	E	F	H1	H2
0.0829	0.0828	0.9966	0.0831	1593	1566	358	96	1816	1670	1084	795	1862	1675	1336	1042	1937	1601	2232	1939	1982	1436	3493	3209	1559	942	3881	3673	1312	642	4178	4015	1436	750	4284	4102	1175	460	4434	4298
0.0796	0.0795	0.9968	0.0797	1593	1567	350	99	1813	1674	1076	798	1859	1680	1327	1045	1931	1608	2225	1943	1972	1447	3486	3213	1547	955	3875	3675	1299	655	4173	4017	1423	764	4279	4105	1161	474	4430	4299
0.0762	0.0762	0.9971	0.0764	1593	1568	343	101	1811	1677	1068	802	1856	1684	1319	1049	1924	1615	2217	1946	1961	1459	3479	3217	1535	968	3869	3678	1285	669	4168	4019	1409	778	4274	4107	1146	489	4425	4301
0.0729	0.0728	0.9973	0.0730	1593	1569	335	104	1808	1680	1060	805	1853	1688	1311	1053	1918	1622	2209	1950	1951	1470	3471	3221	1523	980	3864	3681	1272	683	4164	4021	1396	792	4269	4109	1132	503	4421	4302
0.0696	0.0695	0.9976	0.0697	1593	1570	327	107	1806	1684	1052	809	1849	1692	1303	1056	1912	1630	2201	1954	1940	1481	3464	3225	1511	993	3858	3683	1259	696	4159	4023	1383	806	4264	4111	1118	518	4417	4303
0.0663	0.0662	0.9978	0.0664	1592	1571	320	110	1803	1687	1044	812	1846	1696	1295	1060	1906	1637	2193	1958	1930	1493	3456	3229	1499	1005	3852	3686	1246	710	4154	4024	1369	820	4259	4113	1104	532	4413	4304
0.0630	0.0629	0.9980	0.0630	1592	1571	312	112	1801	1690	1036	816	1843	1700	1287	1064	1899	1644	2185	1962	1919	1504	3449	3233	1487	1018	3846	3688	1233	723	4149	4026	1356	834	4253	4115	1090	547	4409	4305
0.0596	0.0596	0.9982	0.0597	1592	1572	304	115	1798	1693	1028	819	1839	1704	1279	1067	1893	1651	2177	1966	1909	1515	3441	3237	1475	1031	3840	3691	1220	737	4144	4027	1342	848	4248	4117	1076	561	4404	4306
0.0563	0.0563	0.9984	0.0564	1592	1573	296	118	1796	1697	1020	823	1836	1709	1271	1071	1886	1658	2169	1969	1898	1527	3434	3241	1463	1043	3834	3693	1206	751	4139	4029	1329	862	4243	4119	1062	576	4400	4307
0.0530	0.0530	0.9986	0.0531	1592	1574	289	121	1793	1700	1011	826	1832	1713	1262	1074	1880	1665	2161	1973	1887	1538	3426	3245	1451	1056	3828	3695	1193	764	4134	4030	1315	876	4237	4121	1048	590	4395	4308
0.0497	0.0497	0.9988	0.0497	1591	1575	281	124	1791	1703	1003	830	1829	1717	1254	1078	1874	1672	2153	1977	1877	1549	3419	3248	1439	1068	3822	3698	1180	778	4129	4032	1302	890	4232	4123	1033	605	4391	4309
0.0464	0.0464	0.9989	0.0464	1591	1576	273	126	1788	1706	995	833	1825	1721	1246	1082	1867	1679	2145	1981	1866	1560	3411	3252	1426	1081	3816	3700	1167	791	4124	4033	1288	904	4226	4125	1019	619	4386	4310
0.0431	0.0430	0.9991	0.0431	1591	1576	266	129	1785	1709	987	836	1822	1725	1238	1085	1861	1686	2137	1984	1855	1571	3403	3256	1414	1093	3810	3702	1153	805	4119	4035	1274	918	4221	4126	1005	633	4382	4311
0.0364	0.0364	0.9993	0.0364	1590	1578	250	135	1780	1716	971	843	1815	1733	1221	1092	1848	1700	2121	1992	1834	1594	3388	3263	1390	1118	3798	3706	1127	832	4109	4037	1247	945	4210	4130	977	662	4373	4313
0.0298	0.0298	0.9996	0.0298	1589	1579	235	140	1774	1722	954	850	1808	1741	1205	1099	1835	1714	2104	1999	1813	1616	3372	3270	1366	1143	3785	3710	1100	859	4098	4039	1220	973	4198	4133	948	691	4363	4314
0.0265	0.0265	0.9996	0.0265	1589	1580	227	143	1772	1725	946	853	1804	1744	1197	1103	1828	1721	2096	2002	1802	1627	3364	3273	1353	1156	3779	3712	1087	872	4093	4041	1206	987	4193	4134	934	705	4358	4315
0.0232	0.0232	0.9997	0.0232	1588	1581	219	146	1769	1728	938	857	1801	1748	1188	1106	1822	1727	2088	2006	1791	1638	3356	3277	1341	1168	3773	3714	1074	886	4087	4042	1193	1001	4187	4136	920	720	4353	4315
0.0199	0.0199	0.9998	0.0199	1588	1581	211	148	1766	1731	930	860	1797	1752	1180	1110	1815	1734	2080	2009	1780	1649	3348	3280	1329	1181	3766	3716	1060	899	4082	4043	1179	1014	4181	4137	906	734	4348	4316
0.0166	0.0166	0.9999	0.0166	1588	1582	204	151	1763	1734	921	863	1793	1756	1172	1113	1808	1741	2072	2013	1769	1660	3340	3284	1317	1193	3760	3718	1047	913	4076	4044	1165	1028	4175	4139	891	748	4343	4316
0.0132	0.0132	0.9999	0.0132	1587	1583	196	154	1761	1737	913	867	1790	1760	1163	1116	1802	1748	2063	2016	1759	1671	3332	3287	1304	1206	3753	3720	1034	926	4071	4045	1152	1042	4169	4140	877	763	4338	4317
0.0099	0.0099	1.0000	0.0099	1587	1583	188	157	1758	1740	905	870	1786	1764	1155	1120	1795	1755	2055	2020	1748	1682	3324	3290	1292	1218	3747	3722	1020	940	4065	4046	1138	1056	4163	4141	863	777	4333	4317
0.0066	0.0066	1.0000	0.0066	1586	1584	180	159	1755	1743	897	873	1782	1767	1147	1123	1788	1762	2047	2023	1737	1693	3316	3294	1280	1230	3740	3724	1007	953	4059	4046	1124	1070	4157	4143	849	791	4328	4317
0.0033	0.0033	1.0000	0.0033	1586	1584	173	162	1752	1746	888	877	1779	1771	1138	1127	1782	1768	2038	2027	1726	1704	3308	3297	1267	1243	3734	3725	993	967	4054	4047	1111	1083	4151	4144	834	806	4323	4318
0.0000	0.0000	1.0000	0.0000	1585	1585	165	165	1749	1749	880	880	1775	1775	1130	1130	1775	1775	2030	2030	1715	1715	3300	3300	1255	1255	3727	3727	980	980	4048	4048	1097	1097	4145	4145	820	820	4318	4318

REFER TO FIG. No MMRC-5 (TNL)
All dimensions are in mm
Where:
g = 1510 Rail centre to centre distance
h= Height above rail level measured perpendicular to plane of track.

E = [ab + (h x Tan α)] x Cos α
F = [Ab - (h x Tan α)] x Cos α
H1 = (Ca / 2) + (h / Cos α) + (Ab - h x Tan α) x Sin α
H2 = (Ca / 2) + (h / Cos α) - (ab + h x Tan α) x Sin α
ab=Ab = Distance from centre line of vehicle to Kinematic Envelope for Tangent track at height "h" from rail level.

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APPENDIX 6

EFFECT OF VERTICAL CURVES ON STRUCTURAL GAUGE

REFER TO FIG. MMRC-6) AND PARA No. 1.7.1 (B) (c)

Radius of Vertical Curve (Meter)	Vehicle End on Summit V_2 (mm)	Vehicle Centre on Summit or Vehicle End in S.g. V_1 (mm)
1500	19	23
1600	18	22
1700	17	20
1800	16	19
1900	15	18
2000	14	17
2100	14	16
2200	13	16
2300	12	15
2400	12	14
2500	11	14
2600	11	13
2700	11	13
2800	10	12
2900	10	12
3000	10	12
3100	9	11
3200	9	11
3300	9	10
3400	8	10
3500	8	10
3600	8	10
3700	8	9
3800	8	9
3900	7	9
4000	7	9

- **Mid throw (in mm) $V1 = (125 \times C^2) /R = 28500/R$**

  Where 'C' is the distance between bogie centres = 14.750+0.350=15.100m OR 14.750 - 0.350=14.400 m..

  The worst case will be with C=15.100 m

  R is the radius of curve in metres.

- **End Throw (in mm) $V2 = (125 \times C1^2) /R - (125xC^2)/R = 34635/R$**

  Where 'C' is the distance between bogie centres = 14.750+0.350=15.100m OR 14.750-0.350=14.400m.

  Worst case will be with C=14.400 m

  'C1' is length of coach in meters = 22.010 m and 'R' is radius of curve in meters.

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APPENDIX 7

ADDITIONAL CLEARANCE FOR PLATFORMS ON CURVES UNDERGROUND, AT-GRADE & ELEVATED STATIONS EXTRA CLEARANCE

REFER TO PARA No. 2.7

INSIDE OF CURVE									OUTSIDE OF CURVE					
AT CENTRELINE OF BOGIES					AT EDGE OF OPEN COACH DOOR NEAREST TO C.L. OF BOGIES				AT END OF COACH	AT EDGE OF OPEN COACH DOOR FARTHEST FROM C.L. OF BOGIES				
RADIUS	MID THROW (28500/R)	NOSING	Additional Clearance on CURVES (mm) (Rounded off to nearest 1mm)	Additional Clearance (Rounded off to nearest 5mm)	THROW (28498/R)	NOSING =(15.85*0.873/10.97)	Additional Clearance on CURVES	Additional Clearance (Rounded off to nearest 5mm)	End throw (34635/R)	THROW (19340/R)	NOSING =(15.85*9.59/10.97) rounded to next 1mm	Difference between N and N2	Additional Clearance on CURVES	Additional Clearance (Rounded off to nearest 5mm)
R	V	N	(V-N)	(V-N)	V3	N1	V3-(N-N1)	V3-(N-N1)	V0	V4	N2	N-N2	V4-(N-N2)	V4-(N-N2)
Metres	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
1	2.0	3	4a	4	5	6	7a	7	8	9	10	11	12a	12
3000	9.5	15.85	-6	0.0	9.5	1.3	-5.1	0.0	11.3	6.4	13.9	2	4.4	5
2000	14.3	15.85	-2	0.0	14.2	1.3	-0.3	0.0	17.0	9.7	13.9	2	7.7	10
1600	17.8	15.85	2	5.0	17.8	1.3	3.3	5.0	21.3	12.1	13.9	2	10.1	10
1500	19.0	15.85	3	5.0	19.0	1.3	4.4	5.0	21.1	12.9	13.9	2	10.9	15
1200	23.8	15.85	8	10.0	23.7	1.3	9.2	10.0	28.3	16.1	13.9	2	14.1	15
1000	28.5	15.85	13	15.0	28.5	1.3	13.9	15.0	33.9	19.3	13.9	2	17.3	20

NOTES:

1 For outside of curve, the difference between clearance required at coach end that at the farthest door edge is less than 25mm.As half width of coach at ends i.e. at least 25mm less than that at door locations, additional clearance to be provided is additional clearance required at the farthest door edge (column 12)

2 Values of additional clearances (columns 4,7 and 12) are rounded off to the nearest 5mm

3 Negative values of additional clearance are taken as Zero in the columns 4 and 7 with rounded off Figures.

4 Extra clearance for curve:

- Inside of curve :

$V = (125C^2 / R) = 28500/ R$ with C = 15.10m for the worst case.

$V_3 = [(125) * (15.1^2 - 4 * 0.873^2) / R] = 28498/R$

$N_1 = N * (x) / (C_1 / 2) = 13 * 0.873/10.97 = 1.03$ mm

Minimum distance (X) for the nearest edge of an open door from centre line of Bogies is 0.873 metre.

Higher of (i) columns 4 and (ii) column 7 shall be adopted

- Outside of curve

$V_0 = (125C_1^2/ R- (125C^2 / R) = 34635/R$ for coach and with C = 14.4 metres and C1 = 2 * 10.97 m

$V_4 =125 * (19.18 * 19.18 - 14.4 * 14.4) / R = 20064/R$ for farthest edge of end door in open position with

$C_1 = 2 * 9.590 = 19.18$ meters and C = 14.40 meters for the worst case.

N_2 = Nosing at the farthest edge of an open door = $N * 9.59/(C_1) = 13 * 9.59 / 10.97$ mm = 11.3 mm

R = Radius of curve in metres

Maximum distance (X) for the farthest edge of open door from centre line of two Bogies = 9.590 m

5 There will be no super elevation on curves in platform Portions.

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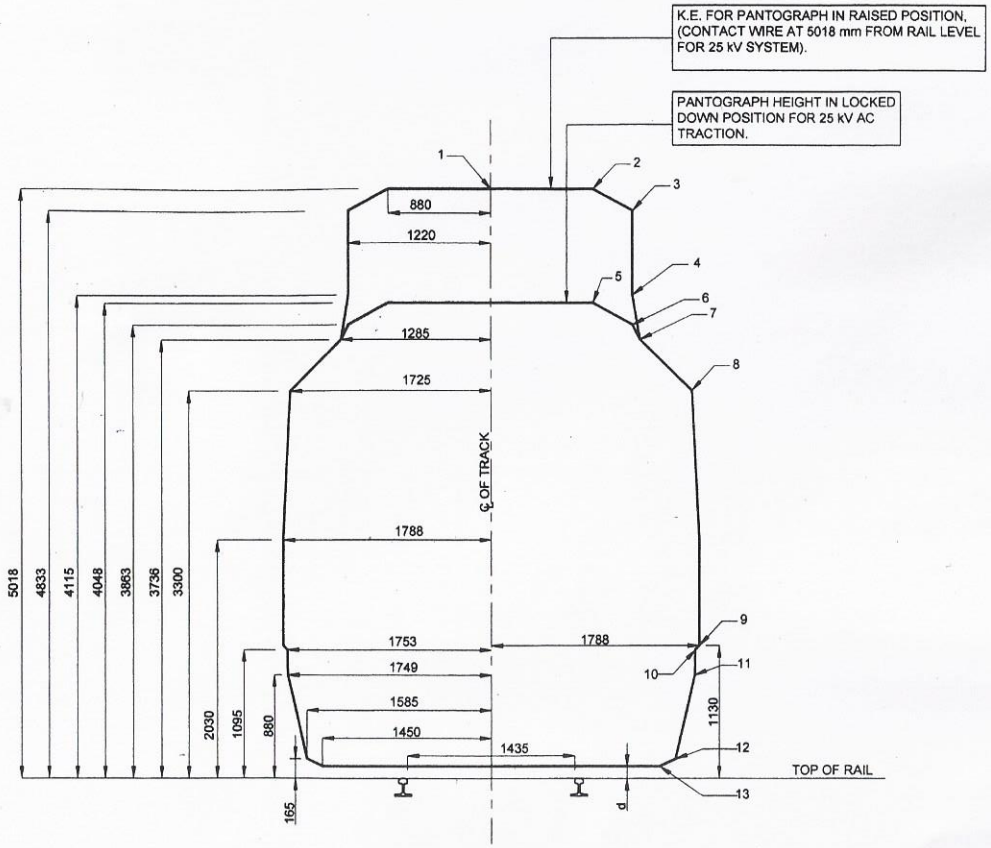


FIG. MMRC-1
Ref. SOD Para 1.5 (a) & 3.1.3 (II)

CO-ORDINATES OF K.E		
	X	Y
1	0	5018
2	880	5018
3	1220	4833
4	1220	4115
5	880	4048
6	1220	3863
7	1285	3736
8	1725	3300
9	1788	1130
10	1753	1095
11	1749	880
12	1585	165
13	1450	d

NOTES :

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. THE KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. CONDUCTOR HEIGHT ABOVE RAIL LEVEL SHALL ALSO TAKE INTO CONSIDERATION PRESCRIBED ELECTRICAL CLEARANCES BETWEEN ALL LIVE OVERHEAD EQUIPMENT AND PANTOGRAPH / VEHICLE AND PARTS THEREOF.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT IS OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUT SIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 6 ABOVE,AND 50mm UNDER DYNAMIC CONDITION. REFERENCE : SOD PARA 1.5 AND SOD PARA 3.1.3(II)
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

Project Directorate Approved on 20/3/18 Railway Board

Mumbai Metro Rail Corporation Ltd. MUMBAI

MMRC

maple MUMBAI METRO LINE-3 GENERAL CONSULTANT

GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

REV.	DATE	PREP.	APPR.	DESCRIPTION
C	16.01.2018	NKV	RJM	COMMENT RDSO 08.12.17 INCORPORATED
B	02.06.2017	HRM	RJM	COMMENT RDSO 23.05.17 INCORPORATED
A	11-01-2017	KCB	RJM	FIRST ISSUE

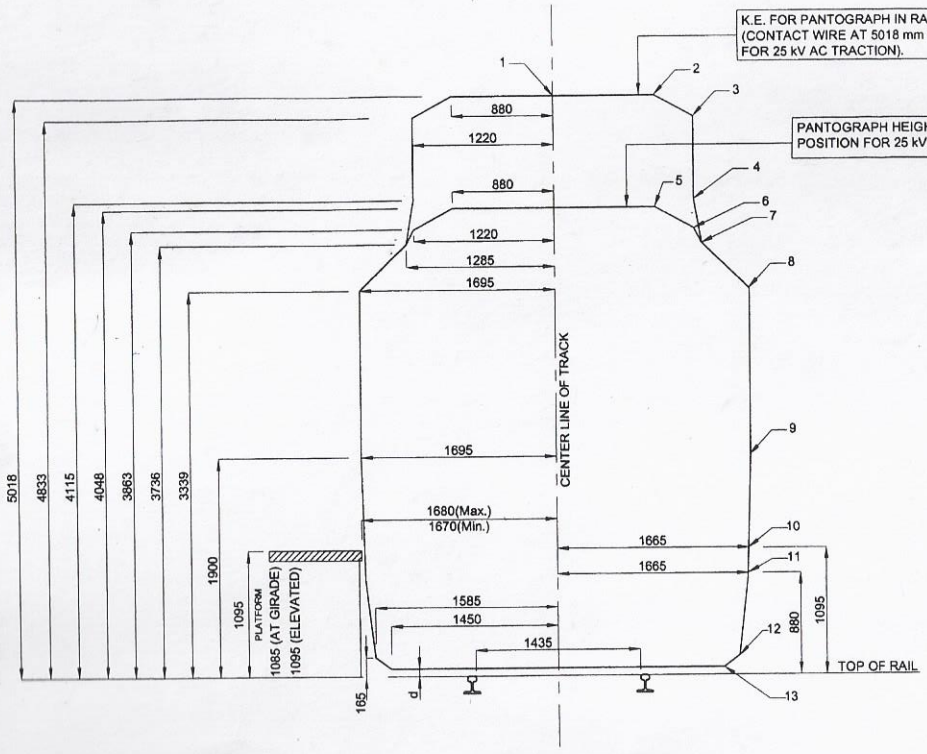
	NAME	SIGN	DATE
DRAWN BY	NKV		16-01-2018
FOR RS	ISAO		SCALE 1:40 (A3 SIZE)
APPROVED BY	RJM		

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: KINEMATIC ENVELOPE:AT - GRADE AND ELEVATEDSECTION ON LEVEL OR CONSTANT GRADE TANGENT TRACK

DRAWING NO: MM3-GC-SOD-GD-0161001

PRINTED ON 02-JUN-17



CO-ORDINATES OF K.E		
	X	Y
1	0	5018
2	880	5018
3	1220	4833
4	1220	4115
5	880	4048
6	1220	3863
7	1285	3736
8	1695	3329
9	1695	1900
10	1665	1095
11	1665	880
12	1585	165
13	1450	d

FIG. MMRC-1A
Ref. SOD Para 3.1.3 (iv)

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. THE KINEMATICS ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE MOTION.
4. KINEMATICS ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED AND WIND SPEED OF 70 KMPH MAXIMUM.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE, AND 50mm UNDER DYNAMIC CONDITION.
7. THE MAXIMUM AND MINIMUM DISTANCE OF PLATFORM EDGE FROM CENTER LINE OF TRACK SHALL BE AS PER SOD PARA 2.2.1 AND SOD PARA 2.2.2 RESPECTIVELY.
8. THE MAXIMUM AND MINIMUM HEIGHT OF PLATFORM RAIL LEVEL SHALL BE AS PER SOD PARA 2.2.3 .

Project Directorate Approved on 20/3/18 Railway Board

Mumbai Metro Rail Corporation Ltd. MUMBAI

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

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CHECKED BY	MVD		SCALE 1:40 (A3 SIZE)
APPROVED BY	RJM		

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: KINEMATIC ENVELOPE:3.2m WIDE CAR, STANDARD GAUGE, AT GRADE AND ELEVATED SECTIONS ON LEVEL OR CONSTANT GRADE TANGENT TRACK AT PLATFORM

DRAWING NO: MM3-GC-SOD-GD-0163001

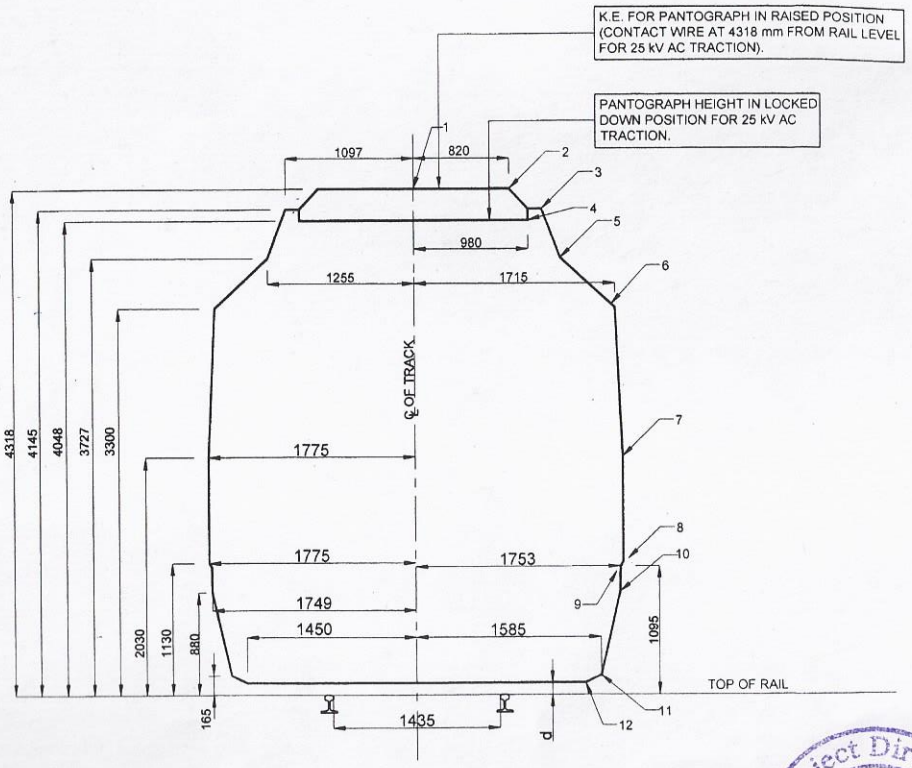


FIG. MMRC-1 (TNL)
Ref. SOD Para 1.5 (b) & 3.1.3 (i)

CO-ORDINATES OF K.E		
	X	Y
1	0	4318
2	820	4318
3	1097	4145
4	980	4048
5	1255	3727
6	1715	3300
7	1775	2030
8	1775	1130
9	1753	1095
10	1749	880
11	1585	165
12	1450	d

NOTES :

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLERANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. THE KINEMATICS ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE MOTION.
4. KINEMATICS ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE, AND 50mm UNDER DYNAMIC CONDITION.
7. THE MAXIMUM AND MINIMUM DISTANCE OF PLATFORM EDGE FROM CENTER LINE OF TRACK SHALL BE AS PER SOD PARA 2.2.1 AND SOD PARA 2.2.2 RESPECTIVELY.
8. THE MAXIMUM AND MINIMUM HEIGHT OF PLATFORM RAIL LEVEL SHALL BE AS PER SOD PARA 3.1.3 (i)
9. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM
10. VERTICAL ALLOWANCES AND EXTRA CANT ON CURVED TRACKS SHALL BE ADDED.
11. CONDUCTOR HEIGHT ABOVE RAIL LEVEL SHALL ALSO TAKE INTO CONSIDERATION THE PRESCRIBED ELECTRICAL CLEARANCE BETWEEN ALL LINE OVERHEAD EQUIPMENT AND PANTOGRAPH/VEHICLE AND PARTS THEREOF.

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

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DRAWN BY	HRM		28-02-2018
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FOR TRACK	VKS		SCALE 1:40 (A3 SIZE)
APPROVED BY	RJM		

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: KINEMATIC ENVELOPE : UNDERGROUND SECTIONS (TUNNELS) ON LEVEL OR CONSTANT GRADE TANGENT TRACK

DRAWING NO: MM3-GC-SOD-GD-0161002

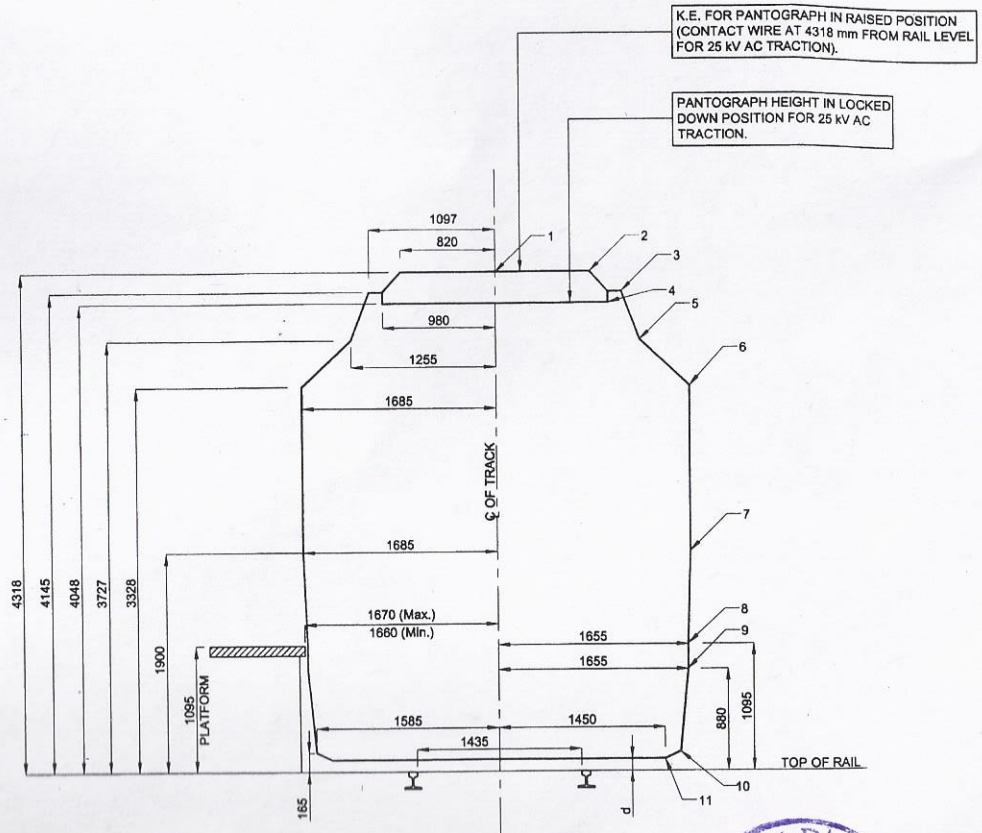


FIG. MMRC-1A (TNL)
Ref. SOD Para 3.1.3(v)

CO-ORDINATES OF K.E		
	X	Y
1	0	4318
2	820	4318
3	1097	4145
4	980	4048
5	1255	3727
6	1685	3328
7	1685	1900
8	1655	1095
9	1655	880
10	1585	165
11	1450	d

NOTES :

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. THE KINEMATICS ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE MOTION.
4. KINEMATICS ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE, AND 50mm UNDER DYNAMIC CONDITION.
7. THE MAXIMUM AND MINIMUM DISTANCE OF PLATFORM EDGE FROM CENTER LINE OF TRACK SHALL BE AS PER SOD PARA 2.2.1 AND SOD PARA 2.2.2 RESPECTIVELY.
8. THE MAXIMUM AND MINIMUM HEIGHT OF PLATFORM RAIL LEVEL SHALL BE AS PER SOD PARA 2.2.3

Project Directorate Approved on 20/3/18 Railway Board

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

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APPROVED BY	RJM		

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: KINEMATIC ENVELOPE:3.2m WIDE CAR, STANDARD GAUGE UNDERGROUND SECTIONS ON LEVEL OR CONSTANT GRADE TANGENT TRACK AT PLATFORM

DRAWING NO: MM3-GC-SOD-GD-0161002

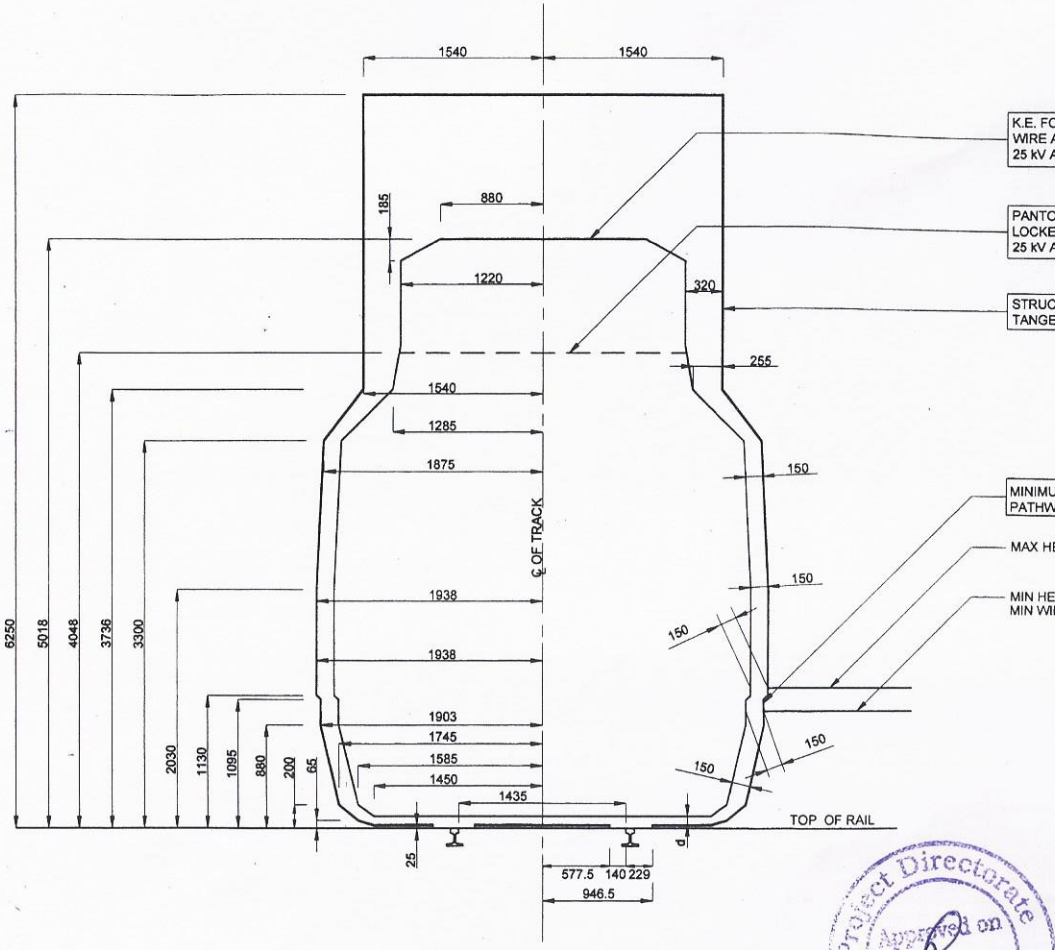


FIG. MMRC-2
Ref. SOD Para 1.4.1(a) & Para 1.10

NOTES :

1. THIS STRUCTURE GAUGE WILL ALSO BE APPLICABLE FOR ROBs /FOBs AT STATIONS WITHOUT THE MAST UNDER THE STRUCTURES.
2. WHERE IT IS NECESSARY TO PROVIDE MAST UNDER THE ROB/FOB, THE HEIGHT SHALL BE INCREASED FROM 6250mm TO 6290mm. INCASE THE CONTACT WIRE IS HIGHER, THE HEIGHT OF THE ROB/FOB SHALL BE INCREASED ACCORDINGLY.
3. MINIMUM CLEARANCE BETWEEN KINEMATIC ENVELOPE AND STRUCTURE GAUGE WILL BE 150mm. MINIMUM ELECTRICAL CLEARANCE OF 320mm. SHALL BE MAINTA INED BETWEEN 25 KV LIVE PARTS AND THE EARTHED STRUCTURES.
4. MINIMUM CLEARANCE FOR OHE MAST WILL BE 2150 mm FROM THE CENTRE OF TRACK.
5. THE KINEMATIC ENVELOPE AND STRUCTURE GAUGE ARE VALID FOR ROLLING STOCK WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
6. HORIZONTAL AND VERTICAL CLEARANCE DUE TO CURVES INCLUDING VERTICAL CURVE AND CANT SHALL BE EXTRA.
7. FOR KINEMATIC ENVELOPE, REFER TO FIG. MMRC-1
8. ALL DIMENSION ARE IN mm.
9. FOR ELEVATED SECTION, ONE METER WIDE PATH WAY / WALK WAY WITH PARAPETS IS TO BE PROVIDE AT COACH FLOOR HEIGHT.
10. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
11. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 10 ABOVE,AND 50mm UNDER DYNAMIC CONDITION.
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

Project Directorate Approved on 20/3/18 Railway Board

Mumbai Metro Rail Corporation Ltd. MUMBAI

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

REV.	DATE	PREP.	APPR.	DESCRIPTION
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PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: STRUCTURE GAUGE : AT - GRADE AND ELEVATED SECTIONS ON LEVEL OR CONSTANT GRADE TANGENT TRACK

DRAWING NO: MM3-GC-SOD-GD-0163001

MMRC-2 (BOX TNL)

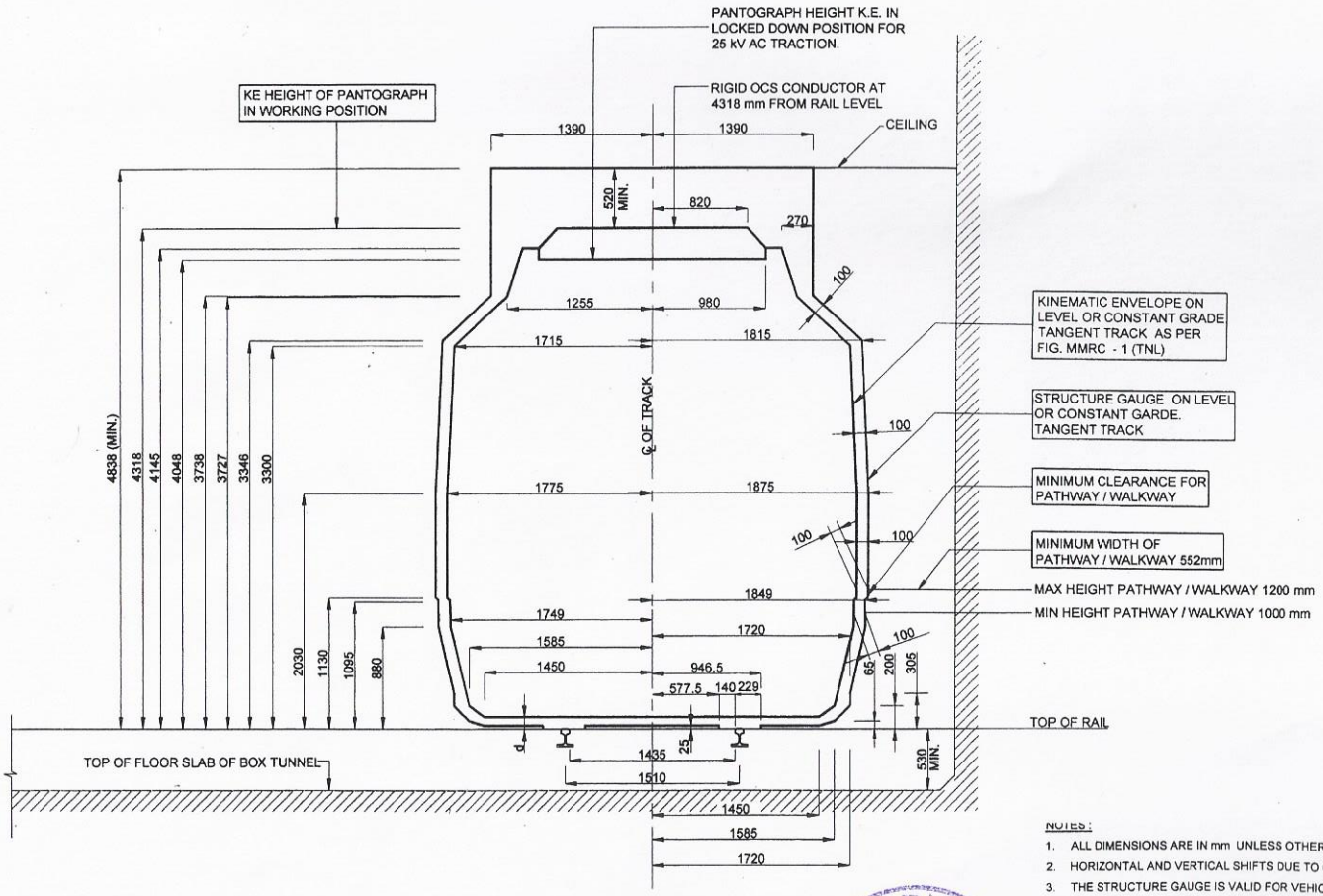


FIG. MMRC-2 (BOX TNL)
Ref. SOD Para 1.4.1(b) (ii) & Para 1.10

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL AND VERTICAL SHIFTS DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE ADDED.
3. THE STRUCTURE GAUGE IS VALID FOR VEHICALS WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. STRUCTURE GAUGE FOR CURVE DOES NOT INCLUDE LATERAL SHIFT (Lean) DUE TO CANT.
5. MINIMUM CLEARANCE BETWEEN KINEMATIC ENVELOPE AND STRUCTURE GAUGE = 100 mm. THE ELECTRICAL CLEARANCE FROM 25 KV LIVE PARTS AND EARTHED STRUCTURE SHALL BE 270 mm.
6. VERTICAL THROW DUE TO VERTICAL CURVE HAS NOT BEEN SHOWN IN THE FIGURE AND SHALL BE EXTRA.
7. FOR DETAILS OF KINEMATIC ENVELOPE REFER TO FIG. MMRC - 1 (TNL)
8. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
9. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 9 ABOVE,AND 50mm UNDER DYNAMIC CONDITION.
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

Project Directorate Approved on 20/3/18 Railway Board

Mumbai Metro Rail Corporation Ltd. MUMBAI

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

REV.	DATE	PREP.	APPR.	DESCRIPTION
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APPROVED BY	RJM		

SCALE 1:40 (A3 SIZE)

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: STRUCTURE GAUGE: UNDERGROUND SECTIONS (RECTANGULAR BOX STRUCTURE) ON LEVEL OR CONSTANT GRADE TANGENT TRACK

DRAWING NO: MM3-GC-SOD-GD-0163002

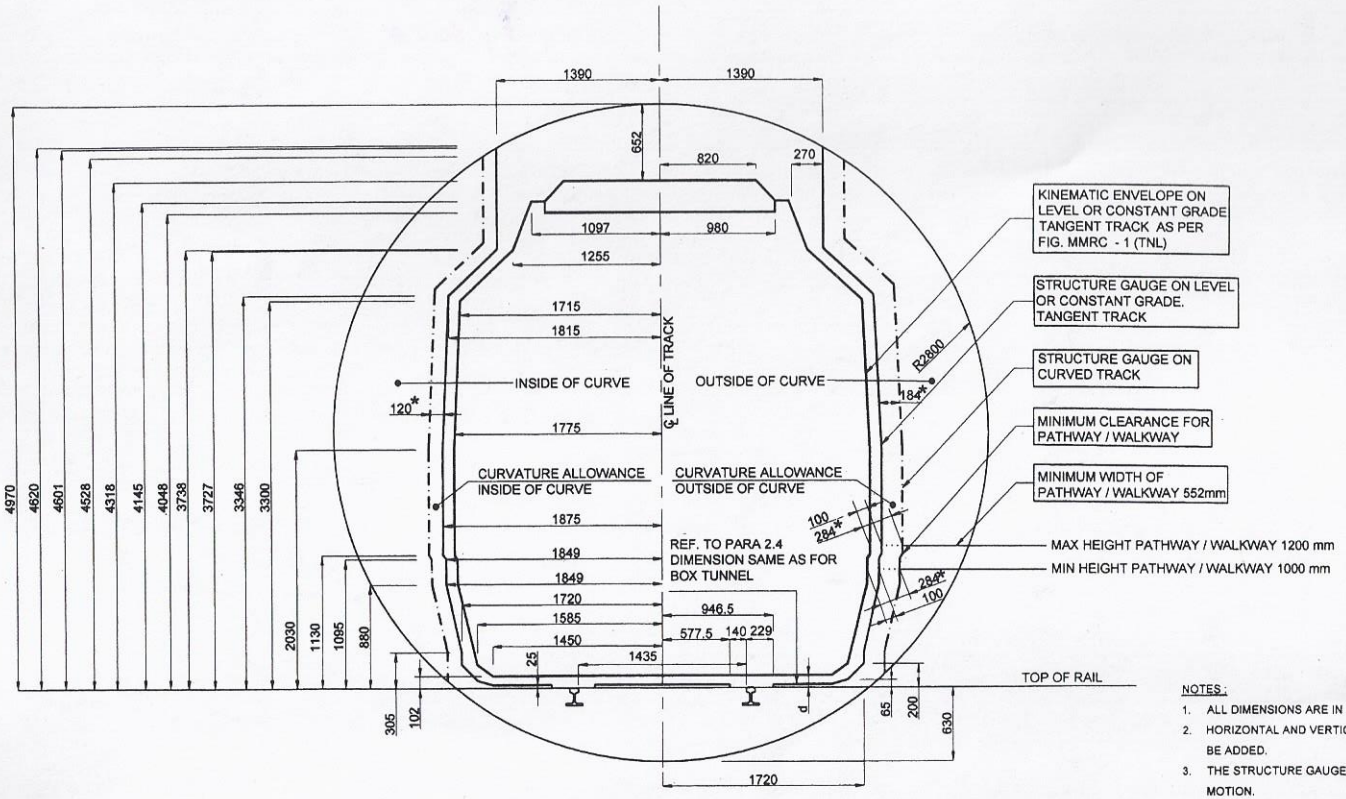


FIG. MMRC-2 (CIRCULAR TNL)
Ref. SOD Para 1.4.1(b) (i) & Para 1.10

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL AND VERTICAL SHIFTS DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE ADDED.
3. THE STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. STRUCTURE GAUGE FOR CURVE DOES NOT INCLUDE LATERAL SHIFT (Lean) DUE TO CANT.
5. CANT SHALL BE PROVIDED BY RISING OUTER RAIL ONLY AND SHIFTING OF THE CIRCULAR TUNNEL TOWARDS INSIDE OF THE CURVE AND UPWARDS. THIS WILL BE SAME AS ROTATING THE CIRCULAR TUNNEL ABOUT THE MID POINT OF TOP OF INNER RAIL.
6. MINIMUM CLEARANCE BETWEEN KINEMATIC ENVELOPE AND STRUCTURE GAUGE = 100 mm. THE ELECTRICAL CLEARANCE FROM 25 KV LIVE PARTS AND EARTHED STRUCTURE SHALL BE 270 mm.
7. VERTICAL THROW DUE TO VERTICAL CURVE HAS NOT BEEN SHOWN IN THE FIGURE AND SHALL BE EXTRA.
8. FOR DETAILS OF KINEMATIC ENVELOPE REFER TO FIG No. MMRC - 1 (TNL)
9. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
10. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 10 ABOVE AND 50 mm UNDER DYNAMIC CONDITION.
11. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

*Structure gauge / KE on inside or outside of curve, here as an example R = 200 m (outside)

Project Directorate Approved on 20/3/18 Railway Board

Mumbai Metro Rail Corporation

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

REV.	DATE	PREP.	APPR.	DESCRIPTION
D	16.01.2018	NKV	RJM	COMMENT RDSO 08.12.17 INCORPORATED
C	23.10.2017	HRM	RJM	COMMENT RDSO 05.09.17 INCORPORATED
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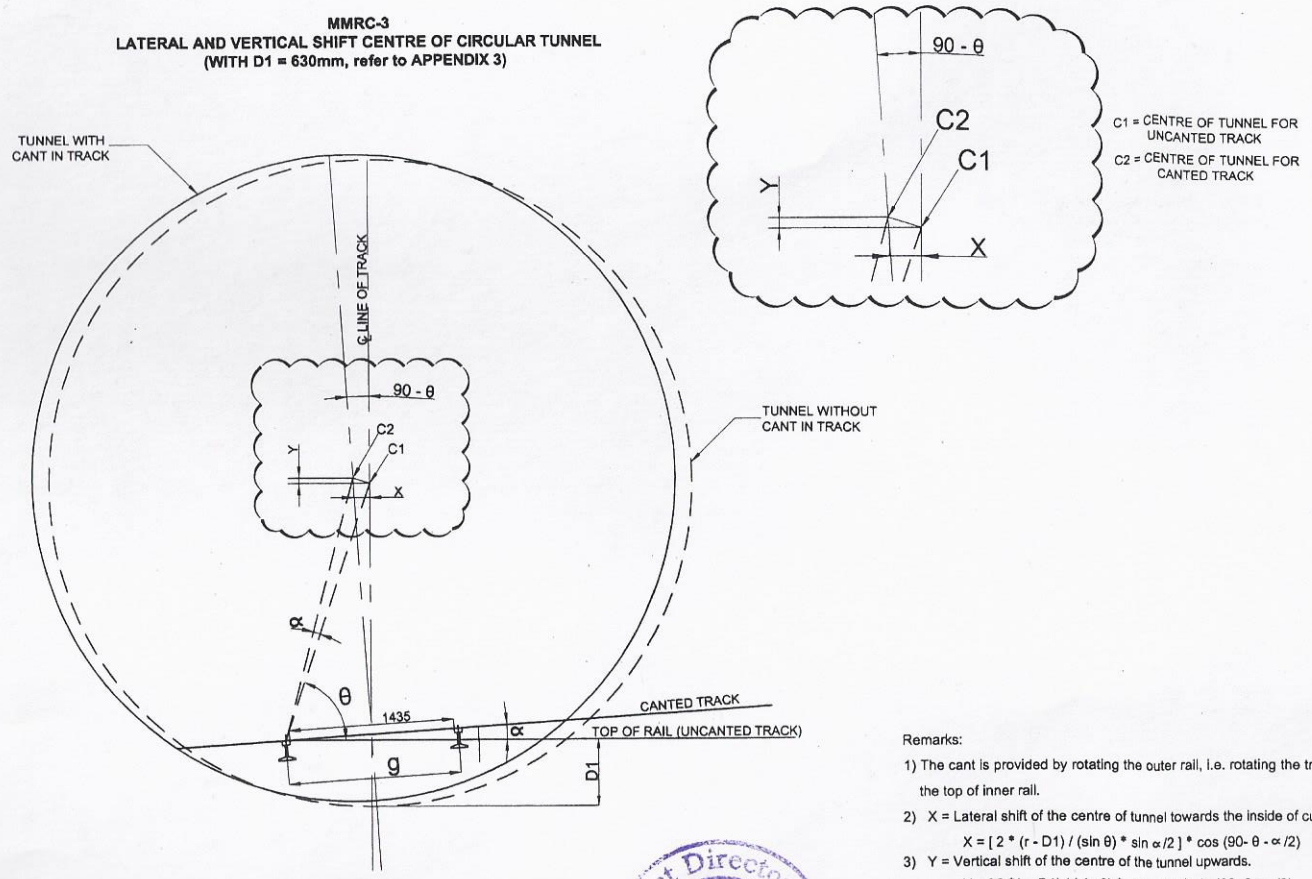
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DRAWN BY	NKV		16-01-2018
FOR RS	I&AO		SCALE 1:40 (A3 SIZE)
APPROVED BY	RJM		

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: STRUCTURE GAUGE: UNDERGROUND SECTIONS (CIRCULAR TUNNEL) ON LEVEL OR CONSTANT GRADE TANGENT TRACK

DRAWING NO: MM3-GC-SOD-GD-0163003

MMRC-3
LATERAL AND VERTICAL SHIFT CENTRE OF CIRCULAR TUNNEL
(WITH D1 = 630mm, refer to APPENDIX 3)



C1 = CENTRE OF TUNNEL FOR UNCANTED TRACK

C2 = CENTRE OF TUNNEL FOR CANTED TRACK

FIG. MMRC-3
Ref. SOD Para 1.7.1(B)(b)

Remarks:

1) The cant is provided by rotating the outer rail, i.e. rotating the track around the mid point of the top of inner rail.
2) X = Lateral shift of the centre of tunnel towards the inside of curvature.
   $X = [\,2 * (r - D1) / (\sin\theta) * \sin\alpha/2\,] * \cos(90 - \theta - \alpha/2)$
3) Y = Vertical shift of the centre of the tunnel upwards.
   $Y = [\,2 * (r - D1) / (\sin\theta) * \sin\alpha/2\,] * \sin(90 - \theta \alpha/2)$

$\tan\theta = (r-D1)/(g/2)$
$\theta = \tan^{-1}[(r-D1)/(g/2)]$
$\sin\alpha = \text{cant}/g$
$\alpha = \sin^{-1}(\text{cant}/g)$
g= distance center to center of the rails

Project Directorate Approved on 20/3/18 Railway Board

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GENERAL CONSULTANCY SERVICES FOR MUMBAI METRO RAIL PROJECT, LINE 3 COLABA- BANDRA-SEEPZ

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SCALE 1:40 (A3 SIZE)

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: SHIFT OF THE CENTRE OF CIRCULAR TUNNEL DUE TO ROTATION OF TUNNEL FOR CANT

DRAWING NO: MM3-GC-SOD-GD-0165001

CANT EFFECT ON STRUCTURE GAUGE
AT - GRADE OR ELEVATED SECTIONS
(REFER TO APPENDIX 4)

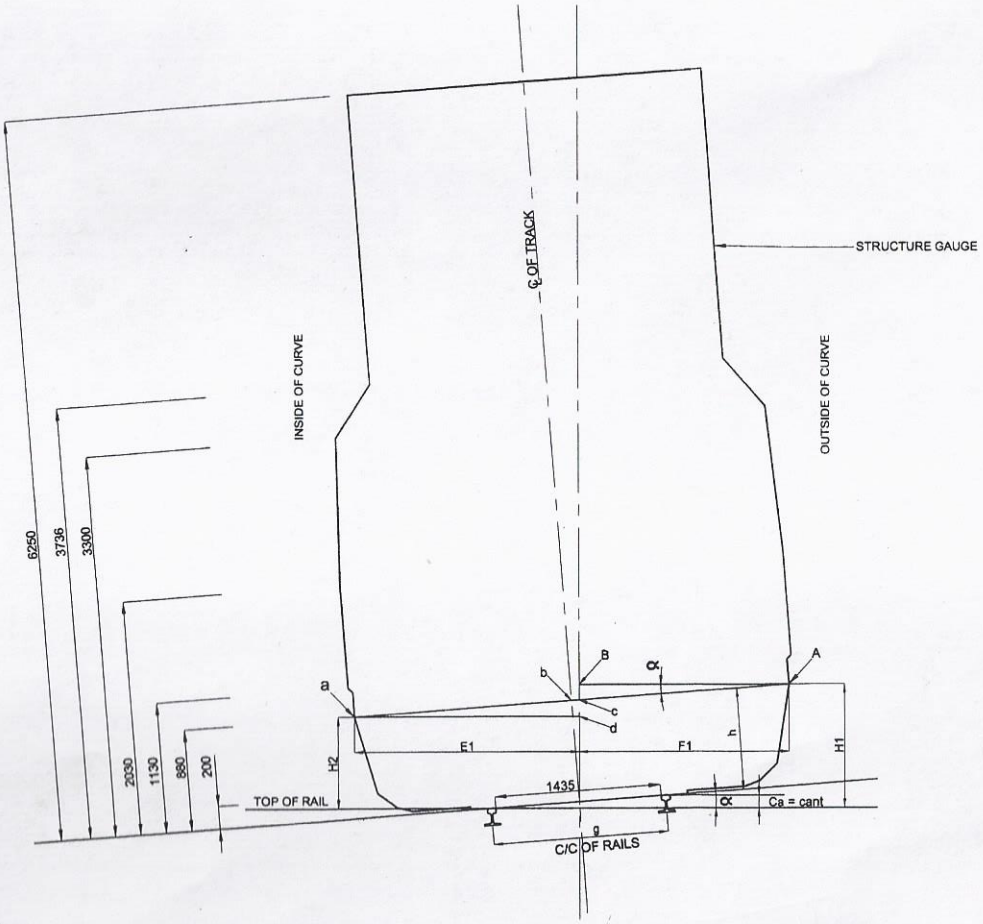


FIG. MMRC-4
Ref. SOD Para 1.7.1(B) & 1.8.2 (b)

Where:

g = 1510 mm

h = Height above rail level measured perpendicular to plane of track.

E1 = [ab + (h x tan α)] x cos α

F1 = [Ab - (h x tan α)] x cos α

H1 = (Ca / 2) + (h / cos α) + (Ab - h x tan α) x sin α

H2 = (Ca / 2) + (h / cos α) - (ab + h x tan α) x sin α

ab = Ab = Distance from center line of vehicle to Kinematic Envelope for Tangent track at height "h" from rail level.

Project Directorate
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20/3/18
Railway Board

Metro Rail Corporation Ltd. MUMBAI

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MUMBAI METRO LINE-3
GENERAL CONSULTANT

GENERAL CONSULTANCY SERVICES
FOR MUMBAI METRO RAIL PROJECT, LINE 3
COLABA- BANDRA-SEEPZ

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SCALE 1:40 (A3 SIZE)

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: CANT EFFECT ON STRUCTURE GAUGE: AT- GRADE OR ELEVATED SECTIONS

DRAWING NO: MM3-GC-SOD-GD-0164001

MMRC - 4 (BOX TNL)
CANT EFFECT ON STRUCTURE GAUGE
UNDERGROUND SECTIONS (RECTANGULAR BOX TUNNEL)
REFER TO APPENDIX 4 (BOX TNL)

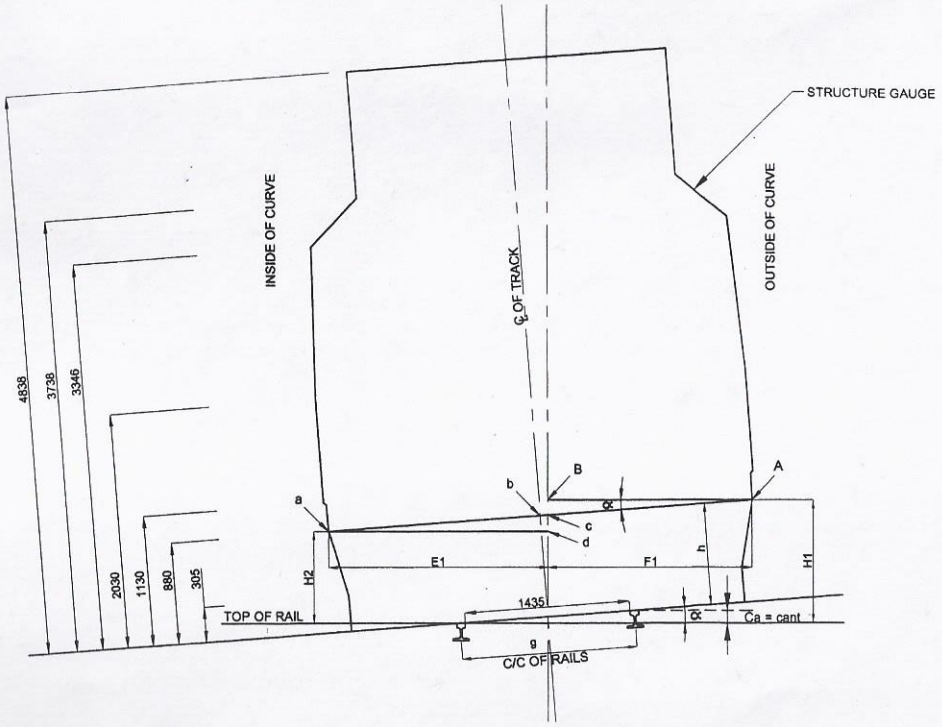


FIG. MMRC-4 (BOX TNL)
Ref. SOD Para 1.7.1(B) (a) & 1.8.2 (b)

Where:

g = 1510 mm Rail centre to centre distance

h = Height above rail level measured perpendicular to plane of track.

E1 = [ab + (h x tan α)] x cos α

F1 = [Ab - (h x tan α)] x cos α

H1 = (Ca / 2) + (h / cos α) + (Ab - h x tan α) x sin α

H2 = (Ca / 2) + (h / cos α) - (ab + h x tan α) x sin α

ab=Ab = Distance from center line of vehicle to Structure Gauge for Tangent track at height "h" from rail level.

NOTE:

ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.

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COLABA- BANDRA-SEEPZ

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SCALE 1:40 (A3 SIZE)

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: CANT EFFECT ON STRUCTURE GAUGE: UNDERGROUND SECTIONS (RECTANGULAR BOX TUNNEL)

DRAWING NO: MM3-GC-SOD-GD-0164002

MMRC - 5
CANT EFFECT ON KINEMATIC ENVELOPE
AT-GRADE OR ELEVATED SECTIONS
(REFER TO APPENDIX 5)

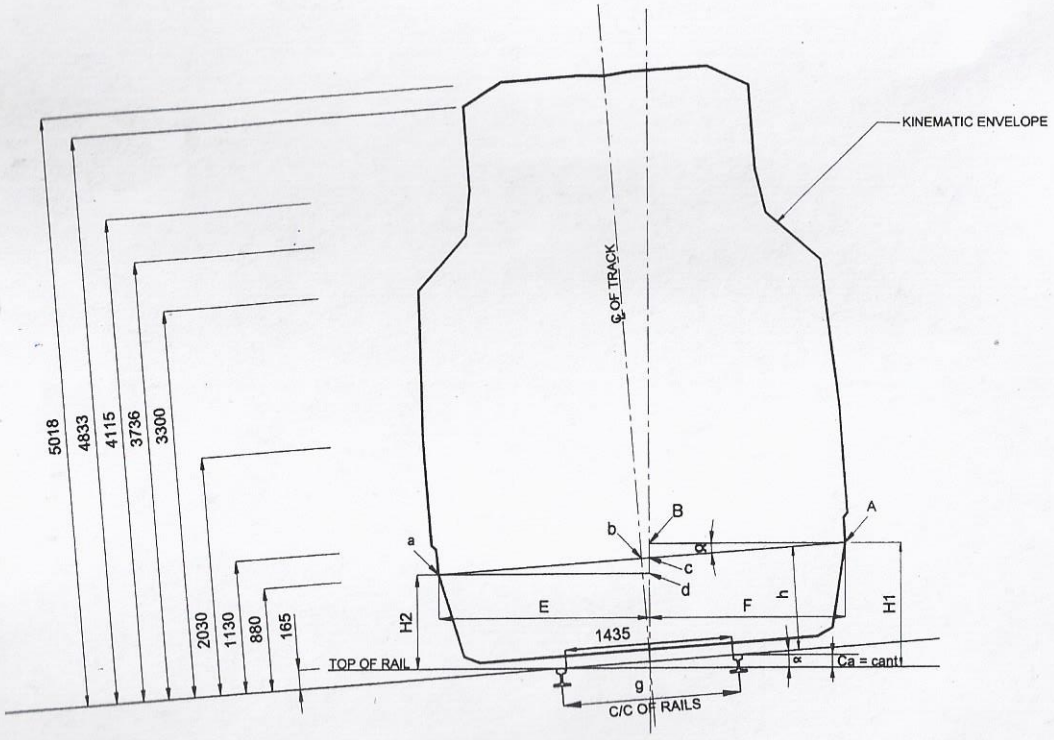


FIG. MMRC-5
Ref.SOD Para 1.8.1

Where:
g =1510 mm Rail centre to centre distance
h = Height above rail level measured perpendicular to plane of track.
E = [ab + (h x tan α)] x cos α

F = [Ab - (h x tan α)] x cos α

H1 = (Ca / 2) + (h / cos α) + (Ab - h x tan α) x sin α

H2 = (Ca / 2) + (h / cos α) - (ab + h x tan α) x sin α
ab=Ab = Distance from center line of vehicle to Kinematic Envelope for Tangent track at height "h" from rail level.

NOTE:

1. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

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PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ
DRAWING TITLE: CANT EFFECT ON KINEMATIC ENVELOPE: AT-GRADE OR ELEVATED SECTIONS
DRAWING NO: MM3-GC-SOD-GD-0162001

MMRC-5 (TNL)
CANT EFFECT ON KINEMATIC ENVELOPE
UNDERGROUND SECTIONS
REFER TO APPENDIX 5 (TNL)

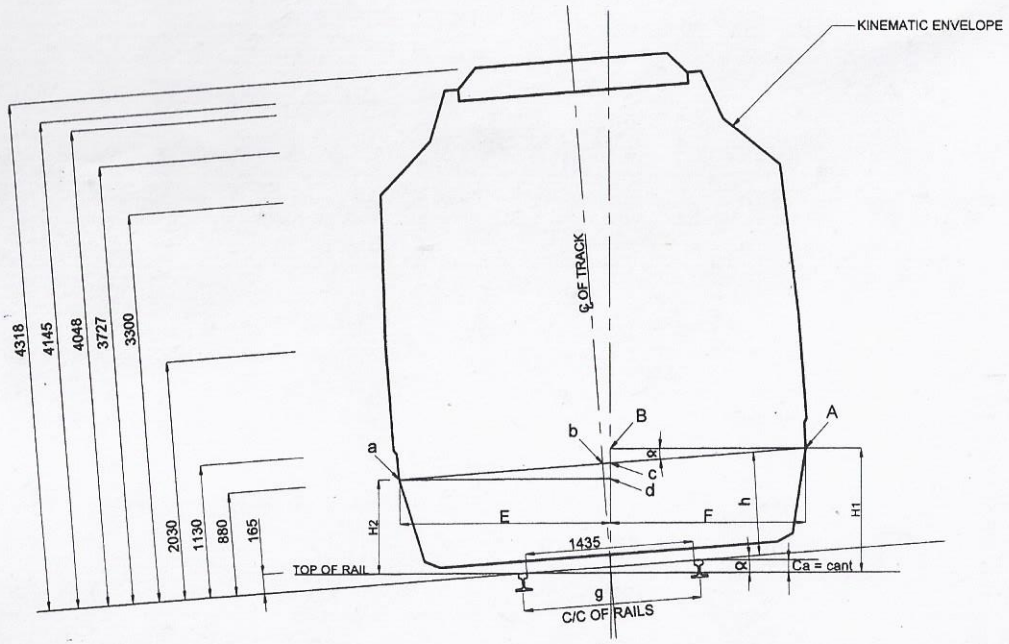


FIG. MMRC-5(TNL)
Ref. SOD Para 1.8.1

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Where:

g = 1510 mm Rail centre to centre distance

h = Height above rail level measured perpendicular to plane of track.

E = [ab + (h x tan α)] x cos α

F = [Ab - (h x tan α)] x cos α

H1 = (Ca / 2) + (h / cos α) + (Ab - h x tan α) x sin α

H2 = (Ca / 2) + (h / cos α) - (ab + h x tan α) x sin α

ab = Ab = Distance from center line of vehicle to Kinematic Envelope for Tangent track at height "h" from rail level.

NOTE:

1. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 95KMPH DESIGN SPEED AND UPTO 85KMPH OPERATING SPEED MAXIMUM

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PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: CANT EFFECT ON KINEMATIC ENVELOPE: UNDERGROUND SECTIONS

DRAWING NO: MM3-GC-SOD-GD-0162002

MMRC - 6
EFFECT OF VERTICAL CURVES ON STRUCTURAL GAUGE
REFER TO APPENDIX 6

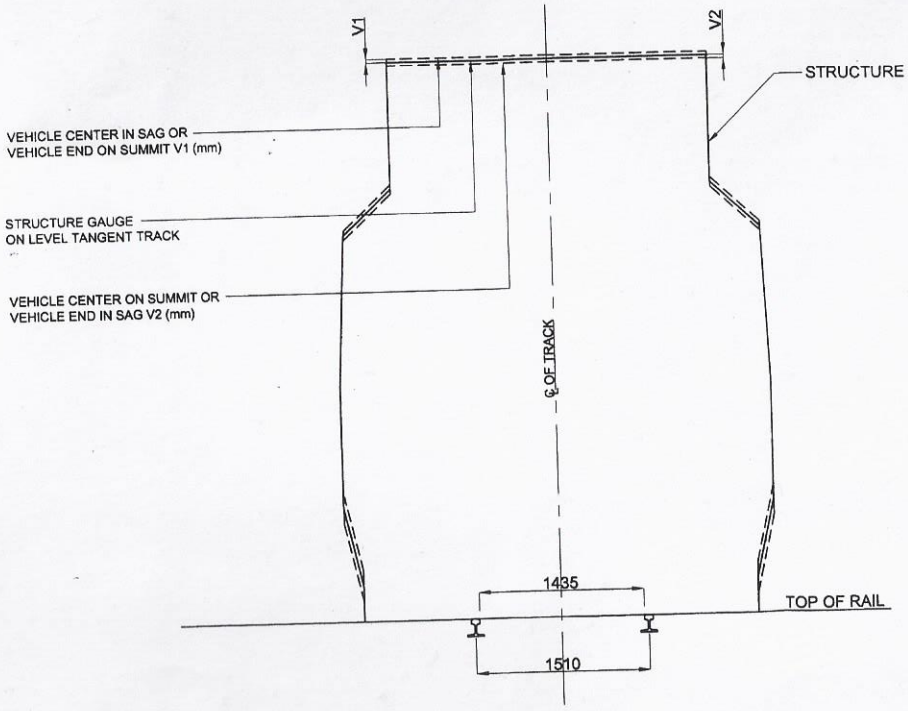


FIG. MMRC-6
Ref. SOD Para 1.7.1 (B) (c)

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Mid throw (In mm) V1 = (125 x C²) /R= 28500/R
Where 'C' is the distance between bogie centers = 14.750+0.350=15.100m OR 14.750 - 0.350=14.400 m. .
The worst case will be with C=15.100 m
R is the radius of curve in metres.

End Throw (In mm) V2 = (125 x C1²) /R - (125xC²)/R = 34635/R
Where 'C' is the distance between bogie centers = 14.750+0.350=15.100m OR 14.750-0.350=14.400m .
Worst case will be with C=14.400
'C1' is length of coach in meters = 22.010 m and 'R' is radius of curve in meters.

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SCALE 1:40 (A3 SIZE)

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ
DRAWING TITLE: EFFECT OF VERTICAL CURVES ON STRUCTURAL GAUGE
DRAWING NO: MM3-GC-SOD-GD-0166001

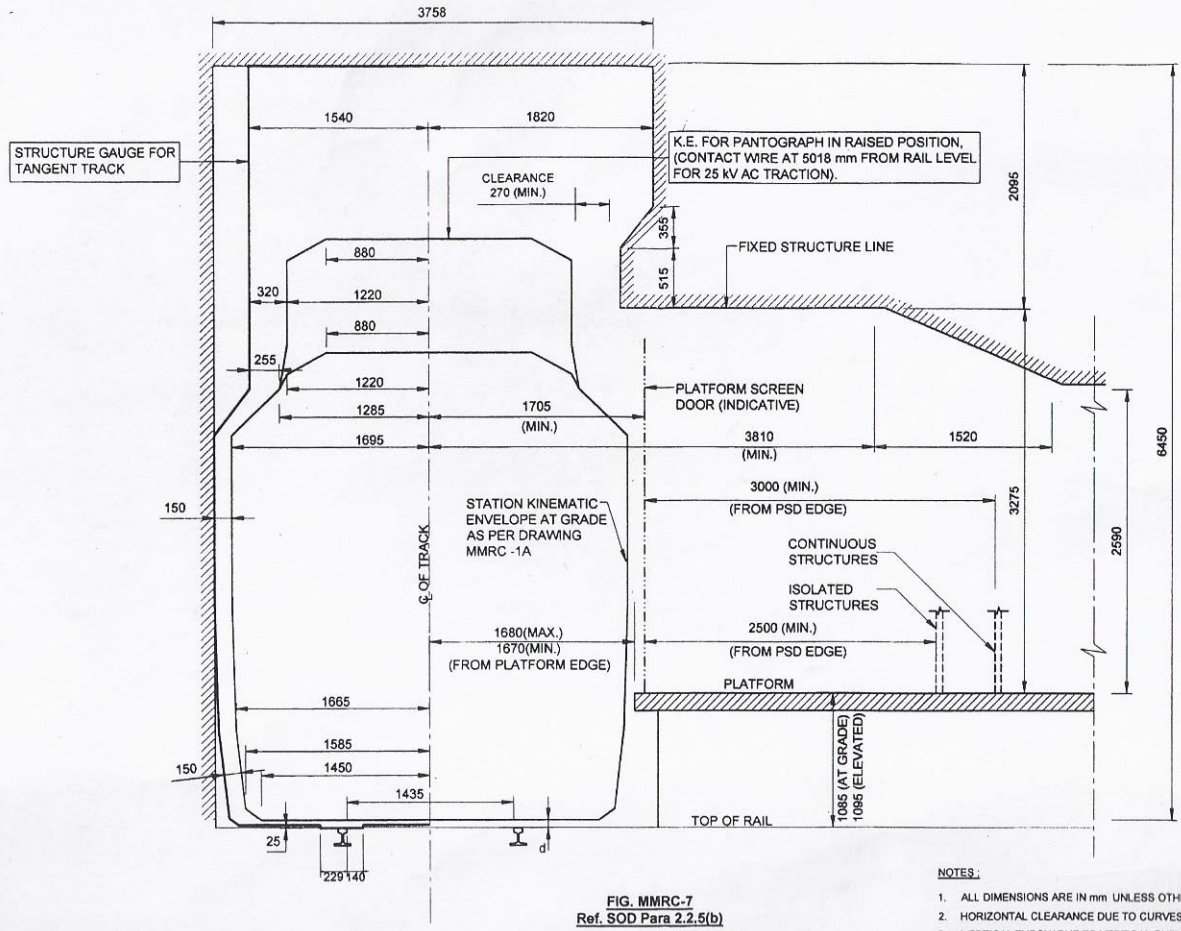


FIG. MMRC-7
Ref. SOD Para 2.2.5(b)

NOTES :

1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. VERTICAL THROW DUE TO VERTICAL CURVE, IF ANY, SHALL BE ADDED.
4. THE STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE,AND 50mm UNDER DYNAMIC CONDITION.
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED MAXIMUM

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APPROVED BY	RJM		

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: STRUCTURE GAUGE:AT-GRADE STATION WITH ONE SIDE PLATFORM ON LEVEL OR CONSTANT GRADE TANGENT TRACK

DRAWING NO: MM3-GC-SOD-GD-0169001

MMRC-8

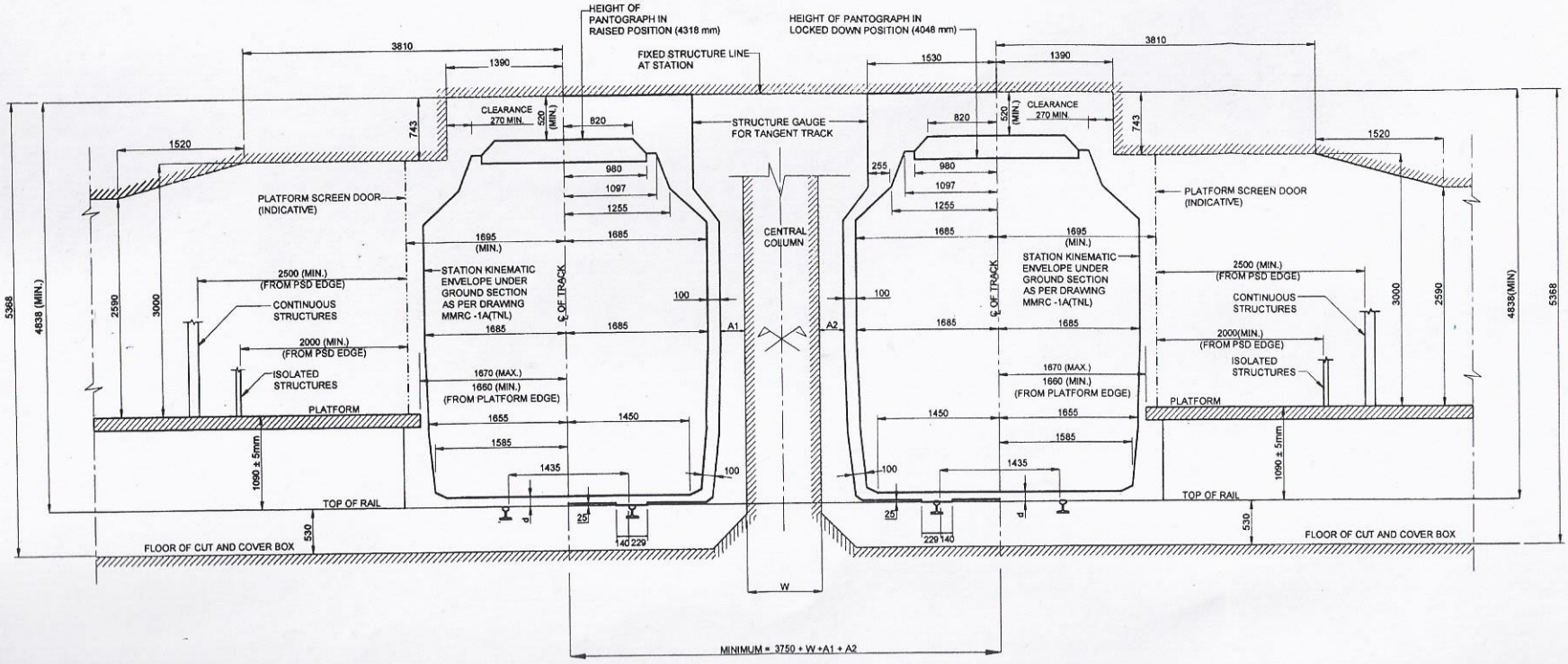


FIG. MMRC-8
Ref. SOD Para 2.2.5(a)

Project Directorate
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NOTES :

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. VERTICAL THROW DUE TO VERTICAL CURVE, IF ANY, SHALL BE ADDED.
4. THE STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOW S AND DOORS CLOSED WHILE IN MOTION.
5. CLEARANCES 'A1' AND 'A2' ARE MEANT FOR SERVICE PURPOSES AND SHALL BE DIMENSIONED AS PER REQUIREMENT.
6. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
7. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 6 ABOVE,AND 50 mm UNDER DYNAMIC CONDITION
8. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED MAXIMUM

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FOR RS	ISAO	
APPROVED BY	RJM	

DATE 16-01-2018
SCALE 1:50 (A3 SIZE)

PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ
DRAWING TITLE: STRUCTURE GAUGE:UNDERGROUND STATION (TUNNEL) WITH SIDE PLATFORMS ON LEVEL OR CONSTANT GRADE TANGENT TRACK
DRAWING NO: MM3-GC-SOD-GD-0167001

TYPICAL FOR 8.0 m WIDE ISLAND PLATFORM.

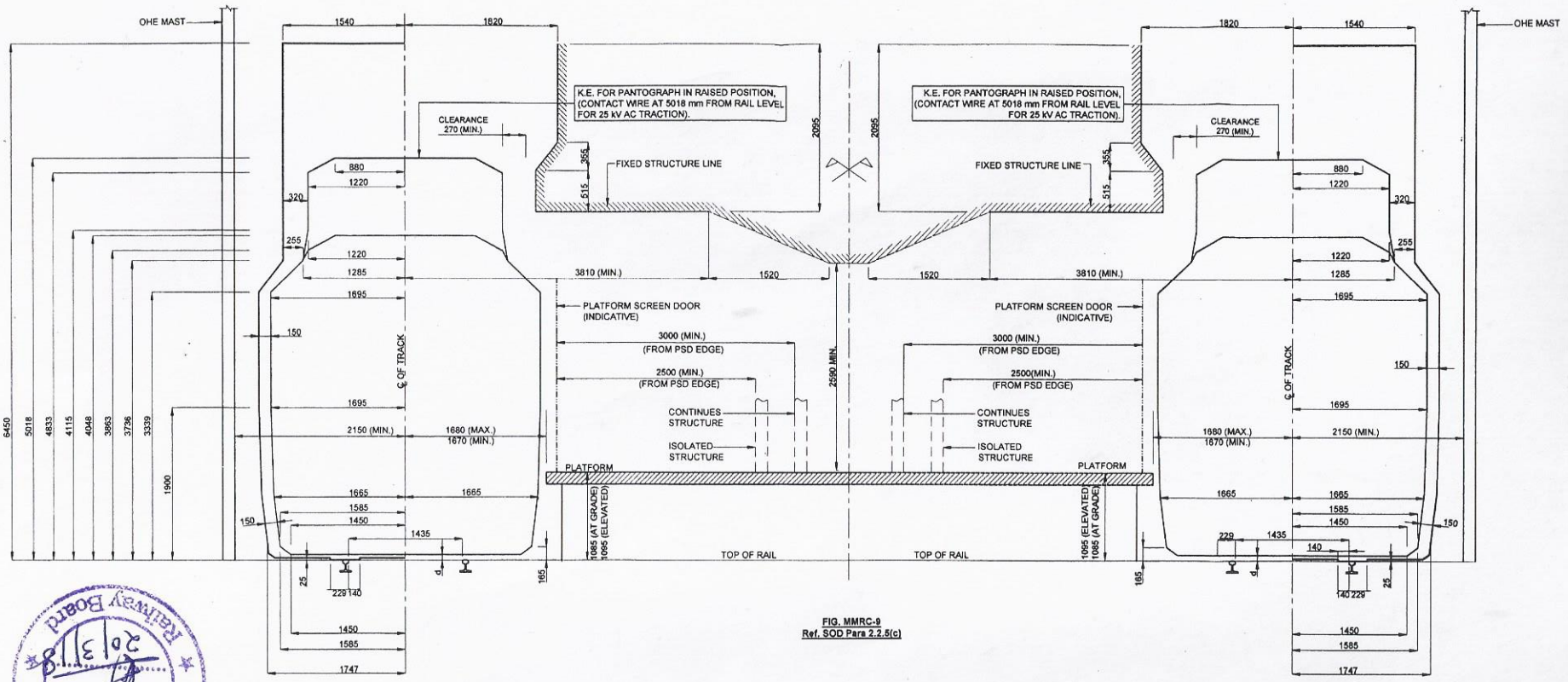


FIG. MMRC-9
Ref. SOD Para 2.2.5(c)

NOTES :

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. THE STRUCTURE GAUGE IS VALID FOR VEHICLE WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. MINIMUM CLEARANCE FOR OHE MAST WILL BE 2150 mm FROM THE CENTRE OF TRACK.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE,AND 50mm UNDER DYNAMIC CONDITION.
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED MAXIMUM

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PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: STRUCTURE GAUGE ELEVATED STATION WITH ISLAND PLATFORM ON LEVEL OR CONSTANT GRADE TANGENT TRACK

DRAWING NO: MM3-GC-SOD-GD-01610001

MMRC-10

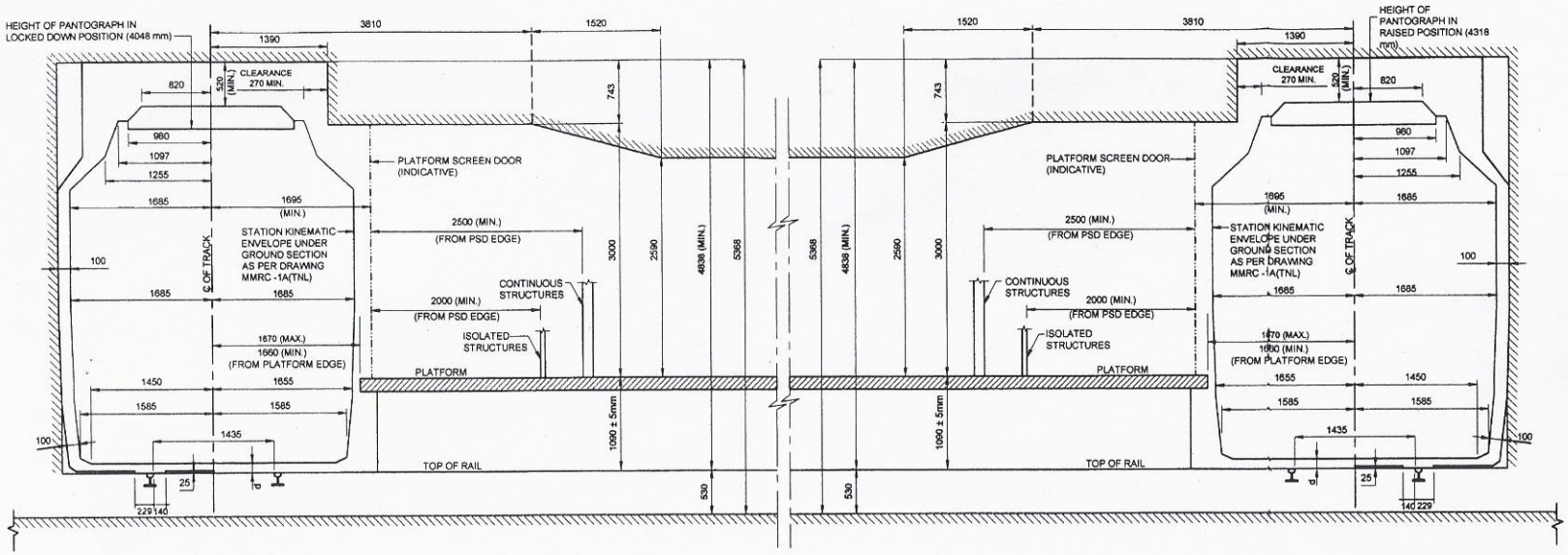


FIG. MMRC-10
Ref. SOD Para 2.2.5(a)

NOTES :

1. ALL DIMENSIONS ARE IN MM.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. VERTICAL THROW DUE TO VERTICAL CURVE IF ANY SHALL BE EXTRA.
4. THE STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOW AND DOORS CLOSED WHILE IN MOTION.
5. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
6. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 5 ABOVE,AND 50 mm UNDER DYNAMIC CONDITION.
7. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED MAXIMUM

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PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: STRUCTURE GAUGE : UNDERGROUND STATION (TUNNEL) WITH ISLAND PLATFORMS ON LEVEL ORCONSTANT GRADE TANGENT TRACK

DRAWING NO: MM3-GC-SOD-GD-0168001

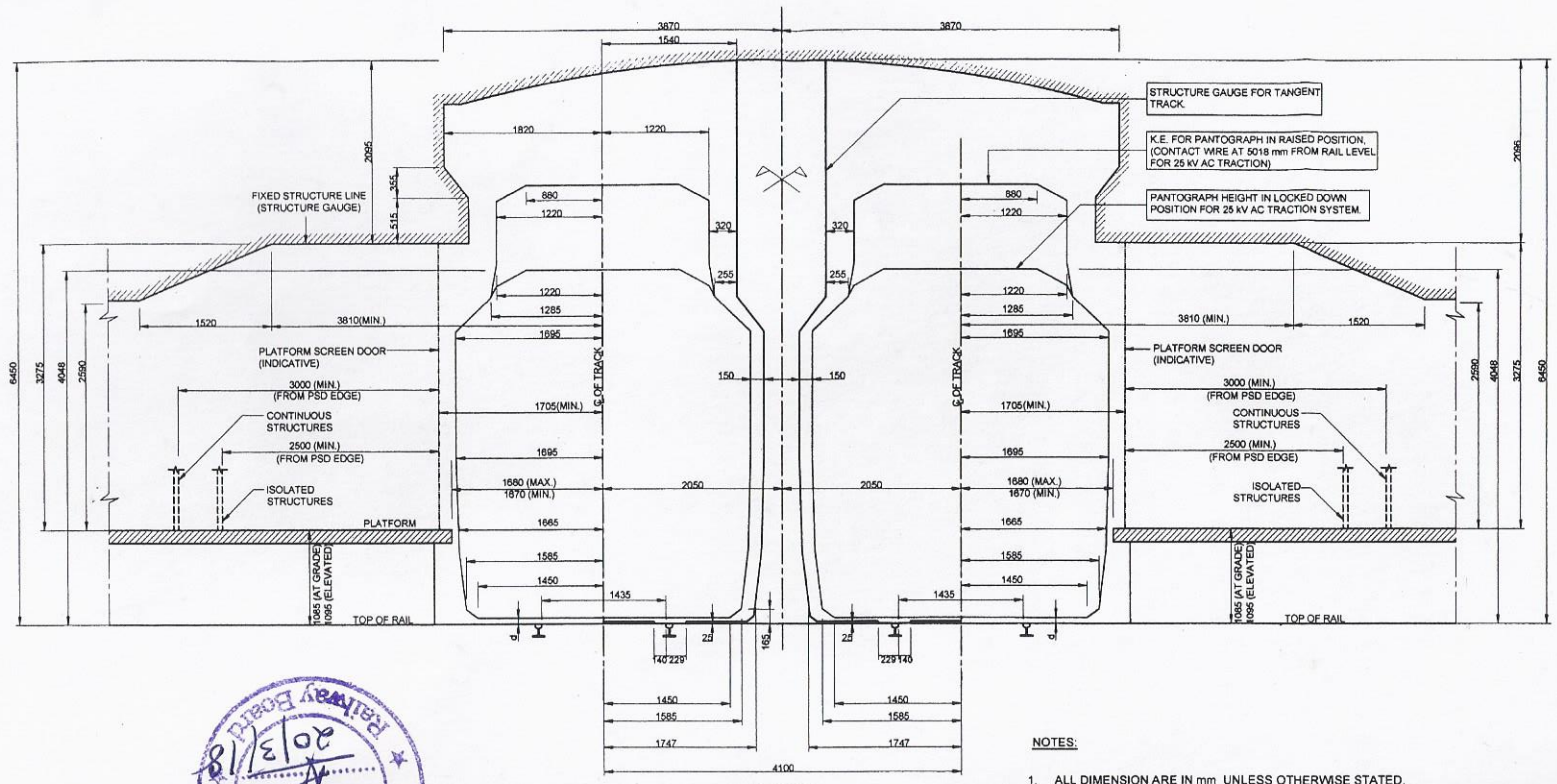


FIG. MMRC-11
Ref. SOD Para 2.2.5(d)

NOTES:

1. ALL DIMENSION ARE IN mm UNLESS OTHERWISE STATED.
2. HORIZONTAL CLEARANCE DUE TO CURVES SHALL BE ADDED IF PLATFORM IN CURVE.
3. VERTICAL THROW DUE TO VERTICAL CURVES SHALL BE ADDED.
4. STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
5. OHE IS SUSPENDED FROM CEILING BY DROP ARM.
6. A TYRE OR AN ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR DISTANCE OF 51 mm INSIDE AND 216 mm OUTSIDE THE WHEEL GAUGE FACE.
7. DIMENSION 'd' SHALL BE 75 mm (MINIMUM) FOR BOGIE MOUNTED EQUIPMENT FOR FULLY LOADED STATIC VEHICLE AND 102 mm (MINIMUM) IN FULLY LOADED CONDITION FOR BODY MOUNTED EQUIPMENT EXCEPT AS LAID DOWN AT ITEM 6 ABOVE,AND 50 mm UNDER DYNAMIC CONDITION.
8. KINEMATIC ENVELOPE IS VALID FOR SPEED UPTO 70 KMPH OPERATING SPEED MAXIMUM

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PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: STRUCTURE GAUGE : AT - GRADE AND ELEVATEDSTATION ON LEVEL OR CONSTANT GRADE TANGENT TRACK

DRAWING NO: MM3-GC-SOD-GD-01611001

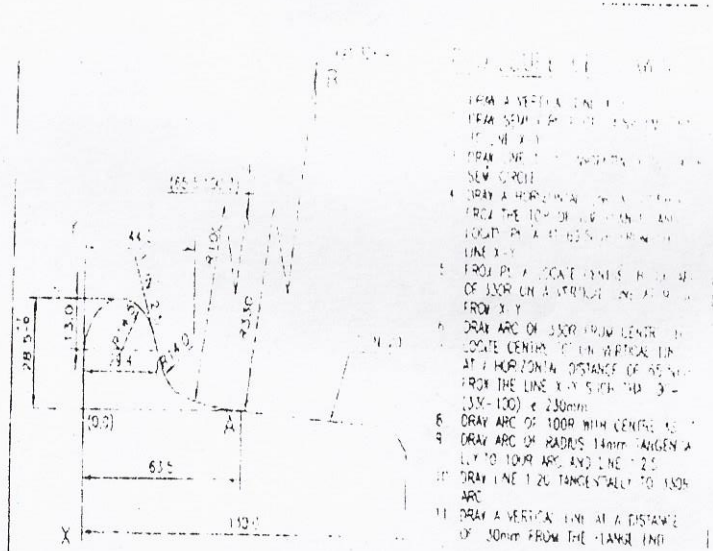


FIG. MMRC-12
Ref. SOD Para 3.1 (5)

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PROJECT: MUMBAI METRO LINE 3 COLABA-BANDRA-SEEPZ

DRAWING TITLE: RDSO SK - 91146 WORN WHEEL PROFILE

DRAWING NO: MM3-GC-SOD-GD-01612001