

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

2019/Proj./MPMRCL/SoD/Bhopal-Indore/30/14

New Delhi, dated 23.02.2023

Managing Director,
Madhya Pradesh Metro Rail Corporation Limited, (MPMRCL),
2nd Floor, Smart City Development Corporation Office Building,
Kalibadi Road, BHEL, Sector-A, Berkheda,
Bhopal-462 022 (Madhya Pradesh)

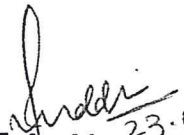
Sub: Approval of Schedule of Dimension (SoD) for Bhopal and Indore Metro Rail Projects of Madhya Pradesh Metro Rail Corporation Limited (MPMRCL).

Ref: SoD uploaded on RDSO's online portal by MPMRCL on 03.01.2023

The Schedule of Dimensions (SoD), Standard Gauge (1435mm) for At-Grade, Elevated and Underground Sections (December, 2022) for Bhopal and Indore Metro Rail Projects of Madhya Pradesh Metro Rail Corporation Limited (MPMRCL) has been examined in consultation with RDSO and approval of Railway Board is hereby conveyed for the same.

Accordingly, approved copy of SoD is enclosed.

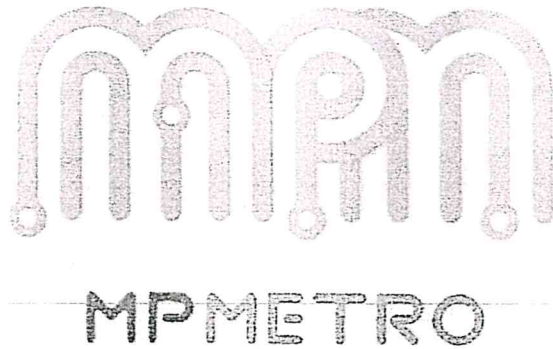
Encl: As above


(F.A. Ahmad) 23.02.23

Director/Gati Shakti (Civil)-IV
Railway Board
Ph. 011-47845480

Copy to:

1. **Executive Director/UTHS**, RDSO, Manak Nagar, Lucknow-226011 w.r.t RDSO's letter No. UTHS/MPMRCL/BMRC/P01/112020 dated 24.01.2023
2. **OSD/UT & Ex-Officio Joint Secretary**, Ministry of Housing & Urban Affairs (MoHUA), Nirman Bhawan, New Delhi-110011



SCHEDULE OF DIMENSIONS (SOD)
FOR
STANDARD GAUGE (1435 mm)
FOR AT-GRADE, ELEVATED AND UNDERGROUND SECTIONS
BHOPAL AND INDORE METRO RAIL SYSTEM

December 2022



Examined & Found in order
Date

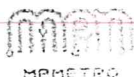
Auth. Sign. : Director (Civil) / MPMRCL

Madhya Pradesh Metro Rail Corporation Limited (MPMRCL)

2nd Floor, Bhopal Smart City Development Corp. Ltd.,
Sector A, Berkheda, Bhopal – 462023,

Madhya Pradesh, India.





Document Control

Document Name: Schedule of Dimensions (SOD) for Standard Gauge (1435mm)
At-Grade, Elevated and Underground section
Document Reference: B001-BIG-GNS-RPT-00010
Release Date: 2022-12-23
Version: 08

Version	Issue Date	Details
01	2019-05-28	First issue
02	2021-01-21	Second issue
03	2021-06-23	Third issue
04	2021-11-08	Fourth issue
05	2022-01-19	Fifth issue
06	2022-09-15	Sixth issue
07	2022-11-17	Seventh issue
08	2022-12-23	Eight issue

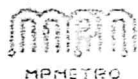
Version 08 is the current version of the document

Printed copy is uncontrolled and only valid at the time of printing

Examined & Found in order
Date

Auth. Sign. : Director Civil (IT&S) Bhopal





Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

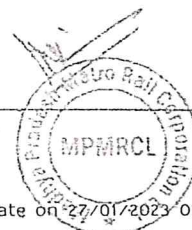
TABLE OF CONTENTS

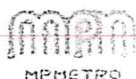
PREAMBLE	8
INTRODUCTION	10
1. CHAPTER-I: GENERAL	11
1.1 SPACING OF TRACKS:	11
1.2 CURVES:	11
1.3 GRADIENTS:	12
1.4 BUILDINGS AND STRUCTURES (OUTSIDE STATION AREA).....	12
1.5 KINEMATIC ENVELOPE (KE):	14
1.6 STRUCTURE GAUGE (EXCEPT FOR PASSENGER PLATFORMS):	14
1.7 EXTRA CLEARANCES ON CURVES:	15
1.8 MINIMUM TRACK SPACING ON CURVES:.....	17
1.9 WALKWAYS	19
1.10 DERAILMENT GUARDS:	20
2 CHAPTER – II: STATIONS	21
2.1 SPACING OF TRACKS AT STATIONS:.....	21
2.2 PLATFORMS:	21
2.3 TRACK GRADIENTS IN PLATFORMS:	23
2.4 INTERLOCKING AND SIGNAL GEAR:.....	24
2.5 POINTS AND CROSSING:	24
2.6 SUPER ELEVATION AND SPEED ON CURVES WITH TURNOUTS OF CONTRARY AND SIMILAR FLEXURE:	25
2.7 ADDITIONAL CLEARANCE FOR PLATFORMS ON CURVES:.....	26
3 CHAPTER - III: ROLLING STOCK	27
3.1 PASSENGER ELECTRIC MULTIPLE UNITS:.....	27
3.2 LOCOMOTIVES AND ENGINEERING SERVICE VEHICLES.....	29
4 CHAPTER - IV: ELECTRIC TRACTION	30
4.1 ELECTRIC TRACTION - 750 V DC THIRD RAIL WITH BOTTOM CURRENT COLLECTION:	30
5 CHAPTER – V: PLATFORM SCREEN DOORS / GATES	31
5.1 PLATFORM SCREEN DOORS AND GATES SETTING OUT:	31

Examined & Found in order
Date

Pradeep

Auth. Sign : Director/Civil/MPMRCL





LIST OF APPENDICES

Appendix no.	Description	Page no.
APPENDIX 1	PERMISSIBLE SPEED, CANT AND MINIMUM TRACK SPACING ON CURVES	32
APPENDIX 2A	EXTRA HORIZONTAL CLEARANCE ON CURVES (CURVATURE EFFECT) – AT GRADE (SURFACE) SECTIONS (BALLASTED TRACK) – INSIDE OF CURVE	33
APPENDIX 2B	EXTRA HORIZONTAL CLEARANCE ON CURVES (CURVATURE EFFECT) – AT-GRADE (SURFACE) SECTIONS (BALLASTED TRACK) – OUTSIDE OF CURVE	34
APPENDIX 2C	EXTRA HORIZONTAL CLEARANCE ON CURVES (CURVATURE EFFECT) – TUNNEL/ELEVATED/AT-GRADE (SURFACE) SECTIONS (BALLASTLESS TRACK) – INSIDE OF CURVE	35
APPENDIX 2D	EXTRA HORIZONTAL CLEARANCE ON CURVES (CURVATURE EFFECT) – TUNNEL/ELEVATED/AT-GRADE (SURFACE) SECTIONS (BALLASTLESS TRACK) – OUTSIDE OF CURVE	36
APPENDIX 3A	CANT EFFECT ON STRUCTURE GAUGE – AT-GRADE (SURFACE) SECTION (BALLASTED TRACK)	37
APPENDIX 3B	CANT EFFECT ON STRUCTURE GAUGE – ELEVATED AND AT-GRADE (SURFACE) SECTION (BALLASTLESS TRACK)	38
APPENDIX 3C	CANT EFFECT ON STRUCTURE GAUGE – UNDERGROUND SECTION (RECTANGULAR BOX TUNNELS) BALLASTLESS TRACK	39
APPENDIX 3D	CANT EFFECT ON KINEMATIC ENVELOPE-HORIZONTAL AT-GRADE (SURFACE) SECTION - BALLASTED TRACK	40
APPENDIX 3E	CANT EFFECT ON KINEMATIC ENVELOPE – ELEVATED & AT-GRADE (SURFACE) SECTION BALLASTLESS TRACK	41
APPENDIX 3F	CANT EFFECT ON KINEMATIC ENVELOPE – UNDERGROUND SECTION (RECTANGULAR BOX (TUNNEL)-BALLASTLESS TRACK	42
APPENDIX 4	LATERAL AND VERTICAL SHIFT OF CENTRE OF CIRCULAR TUNNEL FOR DIFFERENT CANT VALUES	43
APPENDIX 5	ADDITIONAL CLEARANCE FOR PLATFORMS ON CURVES UNDERGROUND, ELEVATED AND SURFACE SECTIONS	44

Examined & Found in order

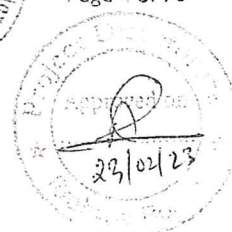
Date

Pratap

Auth. Sign. : Director/Civil (UTMS/PSO)



Page 4 of 70





Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

LIST OF FIGURES:

Sr. No	Drawing No.	Drawing Title	Page No.
1	MPMRCL/GEN/SOD/GEN-01	EFFECT OF CANT ON STRUCTURE GAUGE (TYPICAL)	45
2	MPMRCL/GEN/SOD/GEN-02	EFFECT OF VERTICAL CURVE ON STRUCTURE GAUGE	46
3	MPMRCL/GEN/SOD/GEN-03	EFFECT OF CANT ON KINEMATIC ENVELOPE (TYPICAL)	47
4	MPMRCL/GEN/SOD/ELE-01	KINEMATIC ENVELOPE FOR AT-GRADE & ELEVATED SECTION WITH BALLASTLESS TRACK ON LEVEL/CONSTANT GRADE (TANGENT TRACK) OUTSIDE STATION	48
5	MPMRCL/GEN/SOD/UND-02	KINEMATIC ENVELOPE FOR UNDERGROUND SECTION WITH BALLASTLESS TRACK ON LEVEL / CONSTANT GRADE (TANGENT TRACK) OUTSIDE STATION	49
6	MPMRCL/GEN/SOD/ATG-01	KINEMATIC ENVELOPE FOR SURFACE (AT—GRADE) SECTION BALLASTED TRACK ON LEVEL/CONSTANT GRADE (TANGENT TRACK) OUTSIDE STATION	50
7	MPMRCL/GEN/SOD/ELE	KINEMATIC ENVELOPE FOR UNDERGROUND & AT—GRADE SECTION AND ELEVATED SECTION WITH BALLASTLESS TRACK OVER PLATFORM LINE ON LEVEL/CONSTANT GRADE (TANGENT TRACK) — (SPEED — 70kmph)	51
8	MPMRCL/GEN/SOD/UND	KINEMATIC ENVELOPE FOR UNDERGROUND SECTION WITH BALLASTLESS TRACK OVER PLATFORM LINE ON LEVEL / CONSTANT GRADE (TANGENT TRACK) (SPEED – 70 KMPH)	52
9	MPMRCL/GEN/SOD/ELE-02	STRUCTURE GAUGE ON ELEVATED & AT—GRADE SECTION BALLASTLESS TRACK ON LEVEL/CONSTANT GRADE TRACK (TANGENT TRACK) OUTSIDE STATION	53
10	MPMRCL/GEN/SOD/UND-01	STRUCTURE GAUGE FOR UNDERGROUND SECTION (CIRCULAR TUNNELS) WITH	54

Examined & Found in order

Date

Pradeep

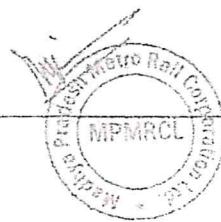
Auto. Sign : Director/Civil/1146/2023

6

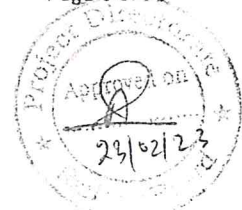
Page 5 of 70



Sr. No	Drawing No.	Drawing Title	Page No.
		BALLASTLESS TRACK ON LEVEL/CONSTANT GRADE (TANGENT TRACK)	
11	MPMRCL/GEN/SOD/UND-03	STRUCTURE GAUGE FOR UNDERGROUND SECTION (RECTANGULAR BOX TUNNELS) WITH BALLASTLESS TRACK ON LEVEL/CONSTANT GRADE (TANGENT TRACK)	55
12	MPMRCL/GEN/SOD/ATG-02	STRUCTURE GAUGE FOR AT-GRADE SECTION (BALLASTED) TRACK ON LEVEL/CONSTANT TRACK (TANGENT TRACK) OUTSIDE STATION	56
13	MPMRCL/GEN/SOD/UND-04	CLEARANCE OF THE CENTRE OF CIRCULAR TUNNEL DUE TO ROTATION OF TRACK FOR CANT	57
14	MPMRCL/GEN/SOD/ELE-03	STRUCTURE GAUGE FOR ELEVATED/AT— GRADE STATION WITH 4m WIDE (MINIMUM) SIDE PLATFORMS WITH BALLASTLESS TRACK ON LEVEL/CONSTANT GRADE TRACK WITHOUT PLATFORM SCREEN GATE	58
15	MPMRCL/GEN/SOD/ELE-04	STRUCTURE GAUGE FOR ELEVATED/AT— GRADE STATION WITH AN ISLAND PLATFORM ON LEVEL/CONSTANT GRADE (TANGENT TRACK) WITHOUT PLATFORM SCREEN GATE	59
16	MPMRCL/GEN/SOD/ELE-05	STRUCTURE GAUGE AT ELEVATED/AT— GRADE STATION WITH 4m WIDE (MIN.) SIDE PLATFORM WITH BALLASTLESS TRACK ON LEVEL / CONSTANT GRADE TRACK WITH PLATFORM SCREEN GATE	60
17	MPMRCL/GEN/SOD/ELE-06	STRUCTURE GAUGE FOR ELEVATED/AT— GRADE STATION WITH AN ISLAND PLATFORM ON LEVEL/CONSTANT GRADE (TANGENT TRACK) WITH PLATFORM SCREEN GATE	61
18	MPMRCL/GEN/SOD/UND-05	STRUCTURE GAUGE FOR UNDERGROUND STATION WITH SIDE PLATFORM ON LEVEL/CONSTANT GRADE (TANGENT TRACK) WITHOUT PLATFORM SCREEN DOOR	62



Page 6 of 70



Examined & Found in order
Date

Auth. Sign. & Designation

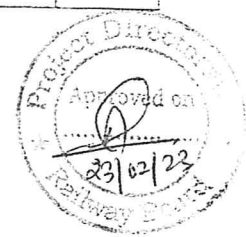


Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

Sr. No	Drawing No.	Drawing Title	Page No.
19	MPMRCL/GEN/SOD/UND-06	STRUCTURE GAUGE FOR UNDERGROUND STATION WITH AN ISLAND PLATFORM ON LEVEL/CONSTANT GRADE (TANGENT TRACK) WITHOUT PLATFORM SCREEN DOOR	63
20	MPMRCL/GEN/SOD/UND-07	STRUCTURE GAUGE FOR UNDERGROUND STATION WITH SIDE PLATFORM ON LEVEL/CONSTANT GRADE (TANGENT TRACK) WITH PLATFORM SCREEN DOOR	64
21	MPMRCL/GEN/SOD/UND-08	STRUCTURE GAUGE FOR UNDERGROUND STATION WITH AN ISLAND PLATFORM ON LEVEL/CONSTANT GRADE (TANGENT TRACK) WITH PLATFORM SCREEN DOOR	65
22	MPMRCL/GEN/SOD/PSD-01	STATIC AND KINEMATIC ENVELOPE FOR UNDERGROUND STATIONS WITH PLATFORM SCREEN DOOR	66
23	MPMRCL/GEN/SOD/PSD-02	PLATFORM GATE AT ELEVATED/AT-GRADE (STATION) ON LEVEL/CONSTANT GRADE (TANGENT TRACK)	67
24	MPMRCL/GEN/SOD/UND-DR-01A	DERAILMENT PROFILE FOR UNDERGROUND SECTION (CIRCULAR TUNNELS) WITH BALLASTLESS TRACK MAX. CANT & MIN. RADIUS OF CURVE	68
25	MPMRCL/GEN/SOD/UND-DR-01B	DERAILMENT PROFILE FOR UNDERGROUND SECTION (CIRCULAR TUNNELS) WITH BALLASTLESS TRACK MAX. CANT & MIN. RADIUS OF CURVE	69
26	MPMRCL/GEN/SOD/TR-01	THIRD RAIL CURRENT COLLECTION SYSTEM	70

Examined & Found in order
Date

Auth. Sign.: Director/Civil/UTMS/RDSO





SCHEDULE OF DIMENSIONS (SOD)
STANDARD GAUGE (1435 mm)

PREAMBLE

The Schedule of Dimensions (SOD) has been prepared for the Bhopal and Indore Metro Rail Projects having Standard Gauge (1435mm) with a third rail bottom current collection using 750V DC Traction system and end to end evacuation.

This SOD has been prepared based on following guidelines:

1. The SOD has been developed assuming certain coach dimensions and design characteristics, as well as track and coach maintenance tolerances. Whenever, a new stock is introduced the track and coach maintenance tolerances should be laid down. The suitability of the Rolling Stock for operation with these maintenance tolerances should be established and sanction shall be obtained from the competent authority before the operation of the Rolling Stock.
2. The Kinematic Envelope has been developed for 2900 mm wide and 4120 mm high Rolling Stock. The Kinematic Envelope has been developed taking into account the entire Track and the Rolling Stock Maintenance Tolerances.
3. The clearances are based on assumption that windows are sealed and doors are closed during movement.
4. Track and Rolling stock shall be maintained to the tolerances considered for calculation of Kinematic Envelope.
5. The Structure Gauge indicated in SOD shall not be violated under any circumstances except for platform coping, designated operational structures such as platform screen door/gate structures including structural support, hand railing in back-of-house, platform edge, track access gates, the third rail conductor with its feeding arrangement, and support structure for third rail and platform screen doors/gates etc.
6. The vehicle Kinematic Envelope at wind speed of 70 kmph shall be applied for the platform area on At-Grade, Elevated stations and 42 kmph* wind speed for Underground stations within the confines of stations. At all other locations, the Kinematic Envelope corresponding to 100 kmph wind speed shall be used for determining the Structure Gauge for Elevated and At-Grade sections (outside the station area) and 42 kmph wind speed for underground sections (outside the station area). (*42kmph side wind represents 100 Pa gauge pressure considered as buffeting effect.)
7. The speed of trains at platform on Elevated or At Grade Station shall be restricted to 40 KMPH when wind speed is more than 70 KMPH but less than 90 KMPH. Metro operation shall be stopped when wind speed reaches 90 KMPH or more. Continuous recording of wind speed shall be done at critical locations defined by the Metro administration.
8. Maximum design speed is 90 KMPH and operating speed shall be 80 KMPH (except at stations). Operating speed at stations shall be 70 KMPH. Operating speed in depot shall be 25 Kmph.

The operating speed on diversion lines at turnouts having:

- (i) Weldable CMS crossing (1 in 9) and thick web switch with 300 m radius of lead curve rail shall be 45 kmph.
- (ii) Weldable CMS crossing (1 in 9) and thick web switch with 190 m radius of lead curve

Examined & Found in order
Date

Auth. Sign : Director Civil Engineering





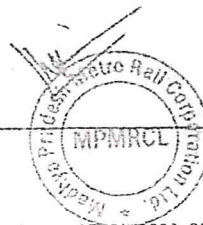
Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

- rail shall be 35 kmph.
- (iii) Weldable CMS crossing (1 in 7) and thick web switch with 190 m radius of lead curve rail shall be 35 kmph.
- (iv) Weldable CMS crossing (1 in 7) and thick web switch with 140 m radius of lead curve rail shall be 25 kmph."
9. The Kinematic Envelope of Rolling Stock should not infringe under any circumstance. And any infringement to SOD should be condoned by Railway Board.
10. No work/workmen/equipment are allowed between Vehicle and Structure gauge during operation of trains.
11. Electrical Clearances should be measured from Kinematic Envelope of rolling stock.
12. The train operation will be stopped in affected section by central control if any one of the trains in UP or DN direction derails. The operation will remain suspended till the clearance given by Accident site Manager from the site by exchange of private number with Central control.

Examined & Found in order
Date

Pradeep

Auth. Sign. : Director/Civil/UTHS/SOSG





SCHEDULE OF DIMENSIONS (1435 mm STANADARD GAUGE)

INTRODUCTION

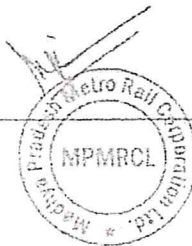
1. The dimensions given in this Schedule of Dimensions (SOD) are to be observed in all works on 1435 mm Standard Gauge unless prior sanction has been obtained from the Railway Board through the Commissioner of Metro Rail Safety (CMRS) to execute works which infringe this SOD.
2. Any condonation in SOD parameters will require approval by Railway Board through the Chief Commissioner of Railway Safety (CCRS).
3. The dimensions given in this SOD are applicable to At-grade, Elevated and Underground sections of the Bhopal and Indore Metro Rail Projects, which will have a 750Volts DC Traction system with Third rail bottom current collection and track rail return current. The Rolling Stock shall be 2900mm wide and 4120 mm maximum height with sealed windows and sliding doors, which shall all remain closed when the train is in motion.
4. The Underground sections may be with Circular Tunnel or Rectangular Box or open cut (at ramps) or of any other suitable shape. The Elevated sections shall be above ground structures such as Viaducts. Both Underground and Elevated sections shall have suitably designed ballastless track, Direct Fixation Fastening (DFF) type. The At-Grade section and the Depot area may be with ballasted or ballastless track.
5. The Schedule of Dimensions (SOD) has been divided into five chapters as under:

Sr. No	Description	Remarks
1	Chapter-1	General
2	Chapter-2	Stations
3	Chapter-3	Rolling Stock
4	Chapter-4	Electric Traction
5	Chapter-5	Platform Screen Doors / Gates

Examined & Found in order
Date

Pradip

Auth. Sign. : Director of Metro Rail



Page 10 of 70





1. CHAPTER-I: GENERAL

1.1 SPACING OF TRACKS:

1.1.1 Minimum distance, centre to centre of tracks without any structure in between, for Tangent (Straight) tracks for:

- | | | |
|----|---|---------|
| a) | Underground section | 3650 mm |
| b) | Elevated section | 3750 mm |
| c) | Surface (At-Grade) sections (Ballasted section) | 3800 mm |
| d) | Surface (At-Grade) sections (Ballastless section) | 3750 mm |

Note: For minimum track centres distance on curves, refer Appendix-1 at Page no. 32

1.2 CURVES:

1.2.1 Minimum radius of curvature (Horizontal)

- | | | |
|-----|---|--------|
| a) | On main running lines, other than stations: | |
| i) | Underground section: | 200 m |
| ii) | At-Grade and Elevated sections: | 120 m |
| b) | Depot, Yard and other non-passenger Lines: | 100 m |
| c) | At Station Passenger Platforms | 1000 m |

1.2.1.1 The minimum transition length - 15m

1.2.1.2 Length of straight between two transition curves should be minimum 25 m on passenger lines and at locations where 25 m is not possible, common tangent point shall be provided.

1.2.2 Check Rail / Restraining Rail:

- | | |
|----|---|
| a) | Check rail/Restraining Rail shall be provided on curves on main line where radius is 190 m (for SG) or less. Check rail/Restraining Rail shall not be mandatory for curves in depots, yards and non-passenger lines where speed is less than 25Kmph |
| b) | The clearance between check/restraining rail and running rail shall be suitably decided by metro depending upon study of track vehicle interaction. |

1.2.3 Cant & Cant Deficiency

- | | | |
|----|---|------------------------|
| a) | Maximum permissible Cant (Ca) | 125 mm |
| b) | Maximum desirable Cant (Ca) | 110 mm |
| c) | Maximum permissible Cant deficiency (Cd) | 100 mm |
| d) | Maximum desirable Cant deficiency (Cd) | 85 mm |
| e) | Maximum Cant Gradient | 1 in 440 |
| f) | Maximum Cant Excess (Ce) | 75mm |
| g) | Maximum rate of change of cant | 55mm/sec |
| h) | Maximum rate of change of cant deficiency | 55mm/sec |
| i) | Maximum lateral acceleration | 0.55m/sec ² |



Examined & Found in order
Date



1.2.4 Vertical Curve

- a) Minimum radius : 1500 m
b) Minimum length of vertical curve : 20m

Note: No Vertical curve shall be provided in Platform area

1.3 GRADIENTS:

- 1.3.1 Maximum Permissible Gradient on mid-section (compensated) shall be 4%

Notes:

- i) There shall be no change of gradient in transition portion of horizontal curves.
ii) The grade compensation for curvature shall be considered at the rate of 0.04% per Degree of curve.

1.4 BUILDINGS AND STRUCTURES

The minimum horizontal distance from the centre of the track to any structure (except for a passenger platform and the Third Rail) for heights above Rail Level on tangent track on level or constant grade shall be as below:

1.4.1 Underground Sections

1. Circular Tunnel

Sr.no.	Height from Rail Level	Horizontal Distance from C/L of track
i.	Up to Rail 348 mm	1680 mm
ii.	At 348 mm	1554 mm
iii.	348 mm to 679 mm	1554 mm increasing to 1638 mm
iv.	679 mm to 885 mm	1638 mm increasing to 1676 mm
v.	885 mm to 2884 mm	1676 mm increasing to 1729 mm
vi.	2884 mm to 3320 mm	1729 mm
vii.	3320 mm to 4064 mm	1729 mm decreasing to 1170mm
viii.	4064mm to 4246 mm	1170 mm decreasing to 1040mm
ix.	4246 mm to 4300 mm	1040 mm decreasing to 833 mm

Refer Drawing no. MPMRCL/GEN/SOD/UND-01 at Page no. 54

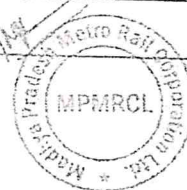
2. Rectangular Box Tunnel

Sr.no.	Height from Rail Level	Horizontal Distance from C/L of track
i.	Up to Rail 348 mm	1680 mm
ii.	At 348 mm	1554 mm
iii.	348 mm to 679 mm	1554 mm increasing to 1638 mm

Examined & Found in order
Date

Budh

Auth Sign: Bhopal/Indore Metro



Page 12 of 70





Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

Sr.no.	Height from Rail Level	Horizontal Distance from C/L of track
iv.	679 mm to 885 mm	1638 mm increasing to 1676 mm
v.	885 mm to 2884 mm	1676 mm increasing to 1729 mm
vi.	2884 mm to 3320 mm	1729 mm
vii.	3320 mm to 4064 mm	1729 mm decreasing to 1170mm
viii.	4064 mm to 4246 mm	1170 mm decreasing to 1040mm
ix.	4246 mm to 4300 mm	1040 mm decreasing to 833 mm

Refer Drawing no. MPMRCL/GEN/SOD/UND-03 at Page no. 55

1.4.2 Elevated and Surface (At-Grade) Sections (Ballastless Track)

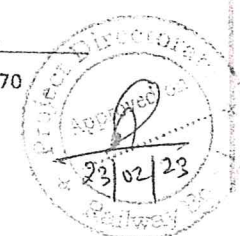
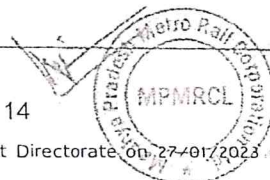
Sr. no.	Height from Rail Level	Horizontal Distance from C/L of track
i.	From Rail Level to 348 mm	1730 mm
ii.	At 348 mm	1730 mm decreasing to 1607 mm
iii.	348 mm to 666 mm	1607 mm increasing to 1696 mm
iv.	666 mm to 879 mm	1696 mm increasing to 1736 mm
v.	879 mm to 2874 mm	1736 mm increasing to 1808 mm
vi.	2874 mm to 3338 mm	1808 mm
vii.	3338 mm to 4058 mm	1808 mm decreasing to 1374 mm
viii.	4058 mm to 4350 mm	1374 mm decreasing to 1366 mm

Refer Drawing no. MPMRCL/GEN/SOD/ELE-02 at Page no. 53

1.4.3 Surface (At-Grade) Sections (Ballasted Track)

Sr. no.	Height from Rail Level	Horizontal Distance from C/L of track
i.	From Rail Level to 348 mm	1742 mm
ii.	348mm to 899 mm	1742 mm increasing to 1765 mm
iii.	899mm to 2031 mm	1765 mm increasing to 1833mm
iv.	2031mm to 3356 mm	1833 mm increasing to 1834 mm
v.	3356mm to 4060 mm	1834 mm decreasing to 1374 mm
vi.	4060mm to 4350mm	1374 mm decreasing to 1366 mm

Examined & Found in order
Date





Refer Drawing no. MPMRCL/GEN/SOD/ATG-02 at Page no. 56

Notes for 1.4.1, 1.4.2 and 1.4.3:

- 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, cable etc. erected alongside the track.
- iii) For passenger platform refer to para 2.2.1 to 2.2.3 of chapter 2

1.5 KINEMATIC ENVELOPE (KE):

- a) For a Kinematic Envelope for level or constant grade (tangent track) outside Platform area, refer to:
 - Drawing no. MPMRCL/GEN/SOD/ELE-01 at Page no. 48
 - Drawing no. MPMRCL/GEN/SOD/UND-02 at Page no. 49
 - Drawing no. MPMRCL/GEN/SOD/ATG-01 at Page no. 50
- b) For Kinematic Envelope for level or constant grade (tangent track) in Platform area for Elevated At-Grade, refer to - Drawing no. MPMRCL/GEN/SOD/ELE - 70 kmph at Page no. 51 and for Underground Platform, refer to Drawing no. MPMRCL/GEN/SOD/UND - 70 kmph at Page no. 52.

1.6 STRUCTURE GAUGE (Except for Passenger Platforms):

1.6.1 Underground sections:

The Structure Gauge (Fixed Structure Line) outside platform area has been arrived at by allowing minimum clearance of 100 mm to Kinematic Envelope for Underground sections.

- a) For Structure Gauge on Underground Sections (Circular Tunnel) with Ballastless track for level and constant grade (tangent track). Refer drawing no. MPMRCL/GEN/SOD/UND-01 at Page no. 54.
- b) For Structure Gauge on Underground Sections by cut and cover Tunnel or ramp with Ballastless Track for level and constant grade (tangent track) Refer drawing MPMRCL/GEN/SOD/UND-03 at Page no. 55.

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

1.6.2 Elevated and At-Grade sections with Ballastless Track.

The Structure Gauge (Fixed Structure Line) has been arrived at by allowing a minimum clearance of 150 mm to Kinematic Envelope for Elevated and At-Grade sections.

- a) For Structure Gauge on Elevated Sections and At-Grade sections outside stations with Ballastless Track for level or constant grade (tangent track) refer to drawing number MPMRCL/GEN/SOD/ELE-02 at Page no. 53.

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

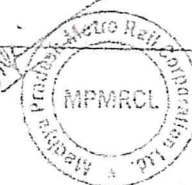
1.6.3 Surface (At-Grade) section with Ballasted Track.

The Structure Gauge (Fixed Structure Line) has been arrived at by allowing a minimum clearance of 150 mm to Kinematic Envelope.

For Structure Gauge on At-Grade sections (outside stations) with ballasted track for level and constant grade (tangent track). Refer to drawing no.

Examined & Found in order
Date

Auth. Sign:





MPMRCL/GEN/SOD/ATG - 02 at Page no. 56.

Note: Extra allowance shall be provided for curves as laid down at Para 1.7.

1.7 EXTRA CLEARANCES ON CURVES:

Following are the extra allowances considered for Curves.

Abbreviations used in Para 1.7 :

'C' is the distance between centres of bogies in metres.

'C₁' is the coach length in 'metres'

'R' is the radius of curve vertical or horizontal in metres

'C_a' is the Cant provided in 'mm'

'h' is the height from Rail Level in 'mm' and

'G' is the distance between centres of heads of rails in 'mm'. this value shall be taken as 1507 mm.

1.7.1 Inside of Curve:

A. Curvature effect:

- Mid throw at the centre of the Vehicle = V (in mm) = $125 C^2 / R$
- Lateral shift due to gauge widening on curves, is 9 mm for curves sharper than 500m radius and 5 mm for curves of radius 500m to 1000m.
- Lateral shift for nosing is 28mm for ballasted track and ballastless track.

For values of curvature effect,

- For At-Grade (Surface) Sections – Ballasted Track refer Appendix – 2A at Page no. 33 and Appendix – 2B at Page no. 34.
- For Tunnel, Elevated and At-Grade (Surface) Sections – Ballastless Track refer Appendix – 2C at Page no. 35 and Appendix – 2D at Page no. 36.

Notes:

- Underground, Elevated, At-Grade Ballastless and At-Grade Ballasted sections:

Lateral shift of 28 mm due to nosing is included in Kinematic Envelope for Underground, Elevated and At-Grade Sections with ballastless track for tangent track (and as a result, also included in Structure Gauge) which shall be subtracted from the total extra allowance worked out as at Para 1.7.1(A) above if the value of mid throw (V) is equal to or greater than 28 mm. However, if the value of mid throw (V) is less than 28 mm, the curvature effect shall be due to widening of the gauge only (mid throw minus 28 mm shall be taken as zero).

B. Clearance for Cant:

- Underground (box structures), Elevated and At-grade sections:

The lean 'L' due to Cant at any point at height 'h' above Rail Level is given by:

$$L = C_a \times h / G \text{ (all in mm),}$$

Examined & Found in order

Date

Pradip

Attn. Sign. : Director/Civil UTHS/DSO





Where, $G = 1435 + c = 1507 \text{ mm}$

'c' being the rail head width, and 'Ca' being the Cant.

Values of Cant effect on Structure Gauge for inside of a curve with only the Cant effect, as shown in MPMRCL/GEN/SOD/GEN-01 at Page no. 45 is as under:

- i) For At-Grade (Surface) Sections - Ballasted Track refer Appendix - 3A at Page no. 37.
- ii) For Elevated and At-Grade (Surface) Sections- Ballastless Track refer Appendix - 3B at Page no. 38.
- iii) For Box Structures of Underground Sections- Ballastless Track refer Appendix - 3C at Page no. 39.

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 the same effect as assuming rotation of the Circular Tunnel about midpoint of top inner rail resulting in shift of Tunnel centre laterally towards inside of curve and also vertically upwards.

For values of horizontal and vertical shifts of centre of Circular Tunnel for different values of Cant, refer to Appendix - 4 at Page no. 43 and drawing no. MPMRCL/GEN/SOD/UND-04 at Page no. 57.

c. Clearance for Vertical Curve (Vertical Throw):

- a) Vertical Throw V1 and V2 (in mm) for vertical curves shall be calculated as below:

V1 (with vehicle centre in sag or vehicle end on summit)

$$= 125 \times C^2 / R$$

V2 (with vehicle centre on summit or vehicle end in sag)

$$= [125 \times C_1^2 / R] - [125 \times C^2 / R]$$

- b) Values of Vertical Throw V1 and V2 due to vertical curves of different radii are shown in drawing no. MPMRCL/GEN/SOD/GEN-02 at Page no. 46.

1.7.2 Outside of Curve:

A. Curvature effect:

- a) End throw at the end of vehicle = V_o (in mm)
 $= [125 \times C_1^2 / R] - [125 \times C^2 / R]$
- b) Clearance due to gauge widening on curves is 9 mm for curves sharper than 500 m radius and 5 mm for curves of radius between 500 m up to 1000 m.
- c) Additional clearance due to nosing, due to gauge widening to be considered for curves sharper than 1000 m radius.
- d) For values of curvature effect, refer to:

Examiners Found in order
Date

Auth. Sign. Director





- i) For At-Grade (Surface) Sections – Ballasted Track refer Appendix – 2A at Page no. 33 and Appendix – 2B at Page no. 34
- ii) For Underground, Elevated and At-Grade (Surface) Sections – Ballastless Track refer Appendix – 2C at Page no. 35 and Appendix – 2D at Page no. 36.

B. Clearance for Cant:

a) Underground (Box Structure), Elevated and At-Grade (Surface) Sections

The lean 'L' due to Cant at any point at height 'h' above Rail Level is given by:

$L = (-) C_a \times h/G$ (all in mm), where $G = 1435 + c$, c being the rail head width (negative sign indicates relief due to Cant or reduction in clearance required)

Note:

Full relief for lean due to cant (C_a) 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 50mm and shall be limited to a value = $(C_a - 50) \times h/g$.

Values of cant effect on Structure Gauge on inside and outside of curve with only the cant effect as shown in drawing no. MPMRCL/GEN/SOD/GEN-01 at Page no. 45.

- i) For Ballasted Track sections refer Appendix – 3A at Page no. 37.
- ii) For Elevated and At-Grade (Surface) sections (Ballastless Track) refer Appendix – 3B at Page no. 38.
- iii) For Box structures of Underground sections (Ballastless Track) refer Appendix – 3C at Page no. 39.

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.

For values of horizontal and vertical shifts of centre of Circular Tunnel for different Values of cant, refer to Appendix - 4 at Page no. 43 and MPMRCL/GEN/SOD/UND-04 at Page no. 57.

C. Clearance for Vertical curve (Vertical Throw):

The provision at Para 1.7.1 (C) above shall be applicable in this case also.

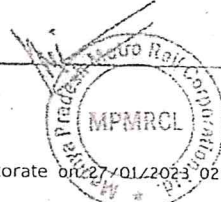
1.8 MINIMUM TRACK SPACING ON CURVES:

Underground, Elevated and At-Grade (Surface) 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.

Examined & Found in order
Date

Auth. Sign. : Director (Civil Engineering)





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:

a) $(E+F)$

Where, E is the horizontal 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

F is the horizontal 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 Drawing no. MPMRCL/GEN/SOD/GEN-03 at Page no. 47.

b) T1 (Extra lateral clearance due to curvature on inside of curve)

c) T2 (Extra lateral clearance due to curvature on Outside of curve)

Minimum clearance between adjacent Kinematic Envelopes is stipulated as below:

- i) 300 mm for Under-Ground Sections
- ii) 300 mm for Elevated Sections
- iii) 300 mm for Surface (At-Grade) sections

Notes:

- i) The value of 'F', calculated from the formula is at drawing no. MPMRCL/GEN/SOD/GEN-03 at Page no. 47 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, T1 and T2, refer to the Appendices as shown below.

Sr. no.	Sections	For E & F	For T1 & T2
1	Elevated, Underground & At-Grade (Ballastless)	Appendix 3E at Page no. 41	Appendix 2C at Page no. 35 Appendix 2D at Page no. 36
2	Surface (At-Grade) Ballasted Section	Appendix 3D at Page no. 40	Appendix 2A at Page no. 33 Appendix 2B at Page no. 34

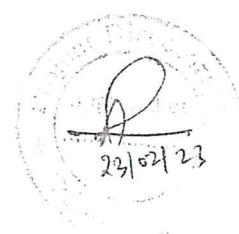
1.8.2 With a Structure between adjacent tracks

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

a) $(E1 + T1)$ Minimum clearance to the structure from centre line of track on inside of curve (for outer track)

Examined & Found in order
Date

Auth. Sign. [Signature]





Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

- b) $(F1 + T2)$ Minimum clearance to the structure from centre line of track on outside of curve (for inner track)
- c) Width of structure between adjacent tracks (measured across the tracks).

Where, E1 is the horizontal distance from vertical axis of centre line of canted track to canted Structure Gauge on inside of curve for a given Cant,

F1 is the horizontal distance from vertical axis of centre line of canted track to canted Structure Gauge on outside of curve for a given Cant,

T1 is extra lateral allowance due to curvature on inside of curve.

T2 is extra lateral allowance due to curvature on outside of curve.

Notes:

- The values of E1 and F1 for a given Cant C_a , shall each be the maximum of values at different heights of structure from Rail Level. In case the cant provided is greater than 50mm on inner track, the value of F1 shall be for the cant of $(C_a - 50)$ mm. In case the cant provided is 50mm or less on inner track, the value of F1 shall be for ZERO Cant.
- Minimum track spacing, so worked out with a structure between the adjacent tracks shall not be less than that calculated as per Para 1.8.1 for tracks without any structure between adjacent tracks.

For values of E1, F1, T1 and T2, refer to the Appendices as shown below.

Sr. no.	Sections	For E1 & F1	For T1 & T2
1	Underground Rectangular Box Tunnels (Ballastless)	Appendix 3C at Page no. 39	Appendix 2C at Page no. 35 Appendix 2D at Page no. 36
2	Elevated & At-Grade (Ballastless)	Appendix 3B at Page no. 38	Appendix 2C at Page no. 35 Appendix 2D at Page no. 36
3	Surface (At-Grade) Ballasted Section	Appendix 3A at Page no. 37	Appendix 2A at Page no. 33 Appendix 2B at Page no. 34

1.9 WALKWAYS (UG section)

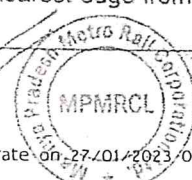
Minimum clear Width of Walkway	:	610 mm
Minimum Height of Walkway	:	1000 mm
Maximum Height of Walkway	:	1200 mm

Note: Extra clearance to walkway shall be provided for curves, as laid down at Para 1.7

- Walkway shall not infringe the Structure gauge.
- Maximum and minimum heights of walkway on curves are above inner rail.
- No structure, other than signalling and minor signalling telecom equipment post, shall be permitted within the minimum width of walkway.
- Minimum clearance to walkway at the nearest edge from kinetic envelope shall



Examined & Found in order
Date





be of 100 mm for underground section.

1.10 DERAILMENT GUARDS:

1.10.1 Derailment Guard should be provided on inside/outside of running rail on viaduct as well as in tunnel and at grade section at locations specified by the Metro Railway. In tunnel, 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

Note:

Location for providing Derailment Guard in single track tunnel;

- i) Entry of tunnel: 200 m from tunnel portal outside the tunnel to 50 m inside the tunnel.
- ii) Exit of tunnel: 50 m from inside of tunnel portal to 200 m outside the tunnel.
- iii) In curved track having radius of 500m or less including transition portion but excluding locations where check rail is provided.
- iv) 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.
- v) 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.

1.10.2 The lateral clearance between the running rail and the derailment guard shall be 210 ± 30 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.

Note:

In case of Double Resilient Base Plate Assembly fastening system as approved by Ministry of Railways (MoR), the lateral clearance between running rail and the derailment guard shall be 250 ± 20 mm. This fastening system, if used in tunnel having multiple tracks, KE of adjacent tracks is not to be infringed so long as the Wheels of any derailed vehicles are within the main rail and the derailment guard.

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

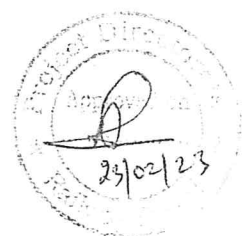
- i) The Wheels of a derailed vehicle under crush load, moving at maximum speed are retained on the viaduct or tunnel.
- ii) Damage to track and supporting structures is minimum.

Examined & Found in order
Date: 

Auto Sign: 



Page 20 of 70





2 CHAPTER – II: STATIONS

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 adjoining tracks for:

a) Under Ground Section	3650 mm
b) Elevated Section	3750 mm
c) At-Grade Section (Ballasted Track)	3800 mm
d) At-Grade Section (Ballastless Track)	3750 mm

2.2 PLATFORMS:

2.2.1 Minimum horizontal distance from centre of track to face of passenger Platform coping (ballastless track):

a) Under Ground Station	1516 mm	} (A)
b) Elevated Station/At-Grade	1530 mm	

2.2.2 Maximum horizontal distance from centre of track to face of passenger Platform coping (ballastless track):

a) Under Ground Station	1525 mm	} (B)
b) Elevated Station/At-Grade	1540 mm	

Notes:

- 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 a dimension:
 - 1575 ± 5 for Under Ground and Elevated Stations.
 - 1590 ± 5 for Surface (At-Grade) Stations.
- For additional clearance for platforms on curves, refer to Para 2.7.
- Minimum and Maximum distances specified at Para 2.2.1 and 2.2.2 are for 2900 mm wide Rolling Stock. The distances (A) and (B) shall be adjusted with the variation in width of Rolling Stock.

2.2.3 Height above Rail Level for passenger platform.:

	Maximum	Minimum
a) At Grade	1085 mm	1075 mm
b) Elevated/Underground	1095 mm	1085 mm

2.2.4 Horizontal distance

- Minimum horizontal distance of any 'isolated' structure on a passenger Platform from the edge of coping with/without platform screen door/gate. 2500 mm

Examined & Found in order

Date



- b) Minimum horizontal distance of any 'continuous' Structure on a passenger platform from the edge of coping with/without platform screen door/gate. : 3500 mm

Note:

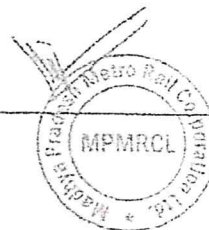
- i) The structure on the platform is treated as 'isolated' if the length of structure along the platform is 2000 mm or less. Any structure having a length exceeding 2000 mm is treated as 'continuous structure' except for platform screen doors and its supports.
- ii) The clocks/mirrors/ CCTV/ LED/LCD Screens/PIDS (passenger Information Display System) etc. shall not be considered structures and shall be located at a minimum horizontal distance of 1000 mm from platform edge/coping with minimum height of 2500 mm from top of platform. CCTV/LED/LCD, PIDS etc. suspended from the Roof of Station shall to be adequately secured and a safety loop is to be provided for taking care of incidences of failure of hanging arrangement.
- iii) No fixed structure should infringe the Structure Gauge except for designated railway operational structure. Designated railway operational structures include platform coping, platform gates, 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.
- iv) The Platform Screen Gates/Doors (PSG/PSD) may be installed at platform as per design of Original Equipment Manufacturer (OEM) of PSG/PSD but shall have a minimum clearance of 10 mm from Kinematic Envelope.
- v) For platform structure setting-out dimension at stations, refer to;
Figure No: MPMRCL/GEN/SOD/ELE-03 at Page no. 58 and MPMRCL/GEN/SOD/ELE-05 at Page no. 60 for Elevated/At-Grade Stations with side platform without and with Platform Screen Gates respectively.
Figure No: MPMRCL/GEN/SOD/ELE-04 at Page no. 59 and MPMRCL/GEN/SOD/ELE-06 at Page no. 61 for Elevated/At-Grade Stations with Island platform without and with Platform Screen Gates respectively.
Figure No: MPMRCL/GEN/SOD/UND-05 at Page no. 62 and MPMRCL/GEN/SOD/UND-07 at Page no. 64 for Underground Stations with side platform without and with Platform Screen Doors respectively.
Figure -No: MPMRCL/GEN/SOD/UND-06 at Page no. 63 and MPMRCL/GEN/SOD/UND-08 at Page no. 65 for Underground Stations with Island platform without and with Platform Screen Doors respectively.
- vi) There shall be no super elevation and gauge widening on passenger platform lines.

2.2.5 For Structure Gauge at stations, refer to Figures as under:

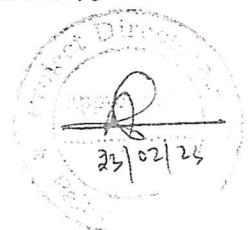
Budhup

Examined & Found in order
Date

/s/ A. S. G. / Director / MPMRCL



Page 22 of 70





Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

a)	For Elevated and At-Grade Stations (Side platform) with/without platform screen gate	Drawing no. MPMRCL/GEN/SOD/ELE-03 at Page no. 58 and ELE-05 at Page no. 60
b)	For Elevated and At-Grade Stations (Island platform) with/without platform screen gate	Drawing no. MPMRCL/GEN/SOD/ELE-04 at Page no. 59 and ELE-06 at Page no. 61
c)	For Underground Stations (Side platform) with/without platform screen door	Drawing no. MPMRCL/GEN/SOD/UND-05 at Page no. 62 and UND-07 at Page no. 64
d)	For Underground Stations (Island platform) with/without platform screen door	Drawing no. MPMRCL/GEN/SOD/UND-06 at Page no. 63 and UND-08 at Page no. 65

2.2.6 For Kinematic Envelope on platform at station, refer for Elevated / At-Grade, Drawing No. MPMRCL/GEN/SOD/ELE - 70 kmph at Page no. 51, for Underground drawing No. MPMRCL/GEN/SOD/UND - 70 kmph at Page no. 52.

2.3 TRACK GRADIENTS IN PLATFORMS:

2.3.1 Track gradient in platform

- | | | | |
|----|----------------------|---|-----------|
| a) | Maximum Gradient | : | 1 in 1200 |
| b) | Desirable | : | Level |
| c) | Exceptional Gradient | : | 1 in 400 |

Note:

- There shall be no change of grade in platform track.
- Any steeper gradient than 1 in 1200 and up to Exceptional gradient of 1 in 400 shall be proposed by the Civil Engineering Head and Approved by Managing Director in consultation with the Head of Safety Nominated by Metro Rail Authority.

2.3.2 Maximum permissible gradient on turnouts.

- | | | | |
|----|----------------------|---|-------|
| a) | On Ballasted Track | : | 0.25% |
| b) | On Ballastless Track | : | 3.00% |

Note:

- There shall be no change of gradient (i.e. vertical curve) on and within 15 m (desirable) and 3 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.
- There shall be no horizontal curve within 15 m (desirable) and 3 m (minimum) of any turnout on Ballastless Track and 30 m of any turnout on Ballasted Track.
- Turnouts shall normally be installed on straight track. In exceptional situations, turnout may take off from a curve provided that the radius of the



Examined & Found in order
Date



lead curve (main line as well as diverging line) is not less than 190 m. The negotiability of rolling stock on such turnouts must be certified by the rolling stock supplier and confirmed through oscillation trials, and a suitable speed restriction should be imposed on the 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 the above purposes shall be taken from the Stock Rail Joint (SRJ) to end (i.e. heel) of the crossing for Ballastless track. For Ballasted track, it shall be from the SRJ to the last common sleeper behind end of the crossing.
- v) The maximum permissible gradient on turnout and the location of turnout with respect to vertical/horizontal curves in vicinity shall be ensured by Metro Authority that the Rolling Stock is fit to negotiate these gradients.
- vi) The above stipulations shall also be applicable for the turnout to be laid outside station limit, if any.

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 falling within the structure gauge limits shall be as under, subject to the restrictions as per Note below:

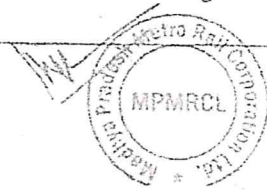
a)	<u>In Under Ground Stations</u>	
	From centre of track to 1610 mm	0 mm
	Beyond 1610 mm from centre of track up to 1705 mm	250 mm
b)	<u>In Elevated Stations</u>	
	From centre of track up to 1610 mm	0 mm
	Beyond 1610 mm from centre of track up to 1755 mm	250 mm
c)	<u>In At-Grade/ Surface Stations</u>	
	From centre of track up to 1610 mm	0 mm
	Beyond 1610 mm from centre of track up to 1880 mm	250 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 signalling gear as are required to be actuated by the wheels, no gear or track fittings shall project above rail level for a distance of 1150 mm on either side of centre of track.

2.5 Points and Crossing:

- 2.5.1 Maximum clearance of check rail opposite nose of crossing : 42 mm

Examined & Found in order





Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

- 2.5.2 Minimum clearance of check rail opposite nose of crossings : 36 mm
- 2.5.3 Maximum clearance of wing rail at nose of crossing : 43 mm
- 2.5.4 Minimum clearance of wing rail at nose of crossings : 41 mm
- 2.5.5 Minimum clearance between toe of open switch and stock rail : 160 mm
- 2.5.6 On passenger lines, minimum radius of lead curve for slip points, turnouts and diamond crossings shall be of the following types.
- 1 in 9 turnouts : 190 m radius
 - 1 in 7 turnouts : 140 m radius
 - Scissors cross-over of 1 in 9 type consisting of 4 turnouts and 1 diamond crossing
 - Scissors cross-over of 1 in 7 type consisting of 4 turnouts and 1 diamond crossing.
- 2.5.7 On Depot lines and other non-passenger lines the turnouts and diamond crossings shall be of the following types or flatter:
- Minimum angle of crossing (ordinary):
- 1 in 7 type turnouts : 140 m radius
 - Scissors cross-over of 1 in 7 type consisting of 4 turnouts and 1 diamond crossing
 - 1 in 7 derailing switches : 140 m radius
- 2.5.8 Diamond crossings not to be flatter than 1 in 4.5
- Note:** The above restrictions shall not apply to moveable diamond crossings
- 2.5.9 Minimum length of tongue rail : 10,000 mm.
- 2.6 SUPER ELEVATION 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 Cant Deficiency permitted without reducing speed on the main line.
- 2.6.2 Turnouts:
- Curves of contrary flexure:
The equilibrium super elevation (s) in mm should be $= \{(1435 + c) / 127\} (V^2 / R)$
Where, c = Rail head width, R = radius of turnout in metres and V is speed on turnout in kmph. The permissible negative super elevation on the turnout (which is also the actual super elevation of the main line) may then be = (Cant deficiency - 's') in mm.
 - Curves of Similar flexure:
The question of reduction or otherwise of super elevation on the main line in order to keep the cant deficiency on turnout track within limits for the speed



Examined & Found in order
Date



permitted on turnout track must be determined by the administration concerned.
In the case of a reverse curve close behind 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 to be provided as under:

On inside of curve : Mid Throw
On outside of curve : End Throw

The additional clearance for platforms on curves is shown in Appendix - 5 at Page no.
44.

Note:

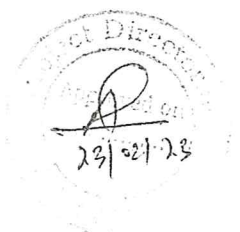
- (i) As the minimum radius of horizontal curves for station passenger platforms
line is 1000 metre, there will be no super elevation and gauge widening at
stations on passenger platform lines.
- (ii) Platforms located in curve shall be fitted with a gap filler wherever necessary
to maintain the Maximum stepping distance (between platform and car body
floor) at platform as 75 mm in Horizontal direction and 50 mm in Vertical
direction. The gap filler shall be of elastic nature and flexible to allow train
contact without any adverse effect on passenger safety and stability of trains.

Examined & Found in order
Date

Auth Sign: [Signature]



Page 26 of 70



3.1.1 Coach Dimensions:

- | | | |
|----|--|----------|
| a) | Maximum Length of Coach body (including end fairings): | 21965 mm |
| b) | Maximum length over couplers : | 22600 mm |
| c) | Maximum width of the vehicle : | 2900 mm |
| d) | Maximum Height of the Coach body : | 4120mm |

- | | | | |
|-------|--|---|-----------------|
| 3.1.2 | Distance between Bogie centres | : | 14800 ± 200 mm |
| | a) Length of rigid Wheel base for single bogie. | : | 2200 to 2600 mm |
| | b) Maximum distance between any two adjacent axles | : | 12800 mm |

3.1.3 Kinematic Envelope:

3.1.3.1 Kinematic Envelope for level tangent track except for passenger platform:

- For underground ballastless track, refer drawing no. MPMRCL/GEN/SOD/UND-02 at Page no. 49.
- For At- Grade & elevated sections, ballastless track, refer drawing no. MPMRCL/GEN/SOD/ELE-1 at Page no. 48.

- 3.1.3.2 Kinematic Envelope for level tangent track passenger platform (for Underground, At-Grade and Elevated sections, ballastless track) refer drawing no. MPMRCL/GEN/SOD/UND - 70 kmph at Page no. 52 and MPMRCL/GEN/SOD/ELE - 70 kmph at Page no. 51.

- 3.1.4 Net Minimum Clearance above Rail Level under dynamic condition of fully loaded vehicle under worst condition** for bogie and axle mounted equipment excluding Current Collection Device (CCD) and Obstacle Detection Device (ODD) after considering up to 25mm projection of Check rails, wing-rails and upstand above Rail Level.

:50 mm *

Note:

- * The Current Collection Device (CCD) in worst condition (with the deflection of primary springs and with maximum tread wear) in retracted position shall have a net minimum clearance of 25 mm above Rail Level.

- ** The 'worst condition' means that it is with maximum deflection of Primary suspension with Maximum tread wear.

- 3.1.5 Minimum Clearance above Rail Level under dynamic condition of fully loaded vehicle under

Examined & Found in order

1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580, 2581, 2582, 2583, 2584, 2585, 2586, 2587, 2588, 2589, 2590, 2591, 2592, 2593, 2594, 2595, 2596, 2597, 2598, 2599, 2600, 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2609, 2610, 2611, 2612, 2613, 2614, 2615, 2616, 2617, 2618, 2619, 2620, 2621, 2622, 2623, 2624, 2625, 2626, 2627, 2628, 2629, 2630, 2631, 2632, 2633, 2634, 2635, 2636, 2637, 2638, 2639, 2640, 2641, 2642, 2643, 2644, 2645, 2646, 2647, 2648, 2649, 2650, 2651, 2652, 2653, 2654, 2655, 2656, 2657, 2658, 2659, 2660, 2661, 2662, 2663, 2664, 2665, 2666, 2667, 2668, 2669, 2670, 2671, 2672, 2673, 2674, 2675, 2676, 2677, 2678, 2679, 26

Acta. Slov. 10 (1964) 2, 107-110, 120



worst condition*** for body mounted equipment.

: 102 mm

*** The 'worst condition' means that it is with maximum deflection of Primary suspension, deflated air spring and maximum tread wear.

3.1.6 Wheel

- a) Maximum Wheel Gauge back to back distance : 1360 mm
- b) Minimum Wheel Gauge back to back distance : 1358 mm

3.1.7

- a) Maximum diameter on the tread measured at 70 mm from the wheel gauge face. : 860 mm
- b) Minimum diameter on the tread measured at 70 mm from the Wheel Gauge face. : 780 mm

3.1.8

- a) Minimum projection for flange of new wheel (Wheel profile dimensions as per EN 13715/EN 15313 measured at 70 mm from the Wheel Gauge face). : 30 mm
- b) Maximum projection for flange of worn Wheel (wheel profile dimensions as per EN 13715/EN 15313 measured at 70 mm from the Wheel Gauge face.) : 36 mm

3.1.9

- a) Maximum thickness of flange of Wheel (Measured at a height of 10 mm from the wheel running circle diameter as per EN 13715/EN 15313). : 32.5 mm
- b) Minimum thickness of flange of Wheel (Measured at a height of 10 mm from the wheel running circle diameter as per EN 13715/EN 15313). : 25 mm

3.1.10 Width of Wheel

: 135 ± 1mm

3.1.11 Incline of tread/wheel Profile

As per EN 13715, wheel profile: EPS/h30/e30/with reverse slope 1 in 10.

3.1.12 Floor Height

- a) Maximum Height of floor above Rail Level, for an unloaded vehicle. : 1130 mm
- b) Minimum Height of floor above Rail Level, for a fully loaded normal vehicle. : 1100 mm



Page 28 of 70

Handwritten signature and date 24/02/23





3.1.13

- a) Maximum Height of coupler above Rail Level, for an unloaded vehicle. : 815 mm
- b) Minimum Height of coupler above Rail Level, for a loaded vehicle. : 740 mm

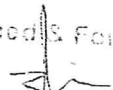
3.2 LOCOMOTIVES AND ENGINEERING SERVICE VEHICLES

Other items of rolling stock, viz. shunting locomotives, inspection cars, emergency re-railing van, track machines, etc., used on this Metro System (running lines) will conform at their maximum operational speed with the Kinematic Envelope of the Passenger Electric Multiple Units as shown in:

For Underground refer drawing no. MPMRCL/GEN/SOD/UND-02 at Page no. 49.

For At-Grade and elevated sections refer drawing no. MPMRCL/GEN/SOD/ELE-01 at Page no. 48.

For Surface (At-Grade) sections for ballasted track refer drawing no. MPMRCL/GEN/SOD/ATG - 01 at Page no. 50.

Examin'd & Found in order
Date 
Aut. Sign : Director CL/UTS-730





4 CHAPTER - IV: ELECTRIC TRACTION

- 4.1 Electric Traction - 750 V DC Third Rail with bottom current collection:
- 4.1.1 Electrical Clearances for At-grade, Elevated and Underground section:
- a) Minimum height from Rail Level to current collecting surface of the Conductor rail. : 148 mm
 - b) Maximum height from Rail Level to current collecting surface of the Conductor rail including worn-out condition. : 164 mm
- 4.1.2
- a) Distance of centre line of the Conductor rail from the track centre : 1445 - 1490 mm (Designed value ± 5 mm)
- 4.1.3 Minimum clearance between the bottom of the shroud and the bottom of the Conductor Rail. : 19 mm
- 4.1.4 Maximum distance between the centre line of the Conductor Rail and the outer edge of the shroud structure. : 91 mm
- 4.1.5
- a) Minimum clearance between live parts of third rail and the structure in static and dynamic conditions. : 25 mm
 - b) Minimum clearance between live parts of Conductor Rail and vehicle body. : 25 mm

Note: General arrangement drawing for 'Third Rail Current Collection arrangement' indicating all the clearances mentioned in Chapter-4 need to be attached for reference as shown in Fig No MPMRCL/GEN/SOD/TR-01 at Page no. 70 of 70.

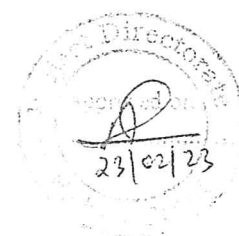
Examined & found in order
Date

Prady

Signature of Officer in Charge



Page 30 of 70



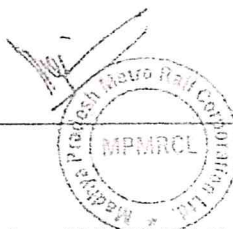
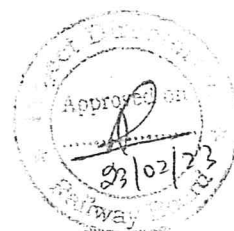


5 CHAPTER – V: PLATFORM SCREEN DOORS / GATES

5.1 Platform Screen Doors and Gates setting out:

- | | | |
|-------|---|---------------|
| 5.1.1 | Minimum Platform Screen Door width | : 2000 mm |
| 5.1.2 | Minimum Platform Screen Door height from Platform level | : 2150 mm |
| 5.1.3 | Minimum Platform Screen Gate height from Platform level | : 1500 mm |
| 5.1.4 | | |
| a) | Minimum Platform Screen Door/Gate panel offset from tangent track centre line | : 1600 mm |
| b) | Minimum Platform Screen Door/Gate threshold offset from track centre line | |
| i) | Underground station | : 1555 mm |
| ii) | Elevated Station/At-Grade | : 1570 mm |
| 5.1.5 | Station Platform (Finished Floor Level) height from Rail Level | |
| | Ballastless Track | : 1090 ± 5 mm |
- Note:
- Assumed +/- 300 mm Stopping accuracy
 - Platform Screen Doors at station on curves shall be considered separately taking into account the additional clearance as per Appendix-5.
 - Platform screen doors are considered as designated railway operational structures. Therefore, Platform Screen Doors may infringe the structure gauge, but does not infringe the kinematic envelope over platform line and having minimum clearance of 10 mm from Kinematic Envelope to Platform Screen Door.
 - The deflector (if provided) attached to the bottom of the sliding door shall be designed in order not to protrude beyond the door threshold.
- 5.1.6 For static and Kinematic Envelope for station in Underground section with Platform Screen Door, refer Drawing no. MPMRCL/GEN/SOD/PSD - 01 at Page no. 66.
- 5.1.7 For Static and Kinematic Envelope for Elevated and At-grade stations with Platform Screen Gate, refer Drawing no. MPMRCL/GEN/SOD/PSD - 02 at Page no. 67.

Examined & Found in order
Date 27/02/23
Pudap
Full Sign. Director Civil Engineering



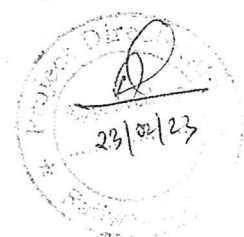


APPENDIX -1					
PERMISSIBLE SPEED, CANT AND MINIMUM SPACING ON CURVES BALLASTLESS TRACK ON UNDERGROUND (TUNNELS) & ELEVATED SECTIONS AND BALLASTED TRACK ON AT-GRADE SECTIONS (REFERENCE PARA 1.1)					
Radius of Curve	Cant	Max Perm Speed	Minimum distance between adjacent tracks		
			Ballastless		Ballasted
			Underground	Elevated & At-	At-Grade
m	mm	kmph	mm	mm	mm
≥ 3000	15	80	3700	3800	3850
2800	15	80	3700	3800	3850
2600	15	80	3700	3800	3850
2400	20	80	3700	3800	3850
2200	20	80	3700	3800	3850
2000	20	80	3700	3800	3850
1900	20	80	3700	3800	3850
1800	25	80	3700	3800	3850
1700	25	80	3700	3800	3850
1600	25	80	3700	3800	3850
1500	30	80	3700	3800	3850
1400	30	80	3700	3800	3850
1300	30	80	3700	3800	3850
1200	35	80	3700	3800	3850
1100	35	80	3700	3800	3850
1000	40	80	3700	3800	3850
950	40	80	3700	3800	3850
900	45	80	3700	3800	3850
850	45	80	3700	3800	3850
800	55	80	3700	3800	3850
750	55	80	3700	3800	3850
700	55	80	3700	3800	3850
650	85	80	3700	3800	3850
600	85	80	3700	3800	3850
550	85	80	3750	3800	3850
500	85	80	3750	3850	3900
450	95	80	3750	3900	3950
400	105	80	3800	3900	3950
350	125	80	3800	3900	3950
300	125	75	3850	3950	4000
250	125	65	3900	4000	4050
200	125	60	3950	4050	4100
175	125	55	NA	4100	4150
150	125	50	NA	4150	4150
120	125	45	NA	4150	4150
100	125	40	NA	4250	4250

Notes:

1. The track spacing shown in the table above is without any column/structure between two tracks and is with equal cant both for outer and inner tracks.
2. The table above is not applicable to Platform tracks
3. Figure for any intermediate radius of curvature may be obtained by adopting the value for sharper curve.

Examined & Found in order
Date
Auth. Sign. & Stamp





Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

APPENDIX -2A					
EXTRA HORIZONTAL CLEARANCE ON CURVES (CURVATURE EFFECT)					
AT-GRADE (SURFACE) SECTIONS (BALLASTED TRACK)					
INSIDE OF CURVE					
(REFERENCE PARAs 1.7.1A, 1.8.1 & 1.8.2)					
Radius	Mid throw	Nosing Included in	Gauge	Extra	Remarks
R	28125/R	KE/Structure Gauge	Widening	Horizontal	
		for Tangent Track	on curves	Clearance	
		N	G	T1	
m	mm	mm	mm	mm	
3000	9.4	28	0	0	GAUGE WIDENING ON CURVES: is 9 mm for Curves sharper than 500m radius is 5 mm for Curves of radius from 500m to 1000m and is 0 mm for Curves with radius 1000m and above.
2800	10.0	28	0	0	
2600	10.8	28	0	0	
2400	11.7	28	0	0	
2200	12.8	28	0	0	
2000	14.1	28	0	0	
1900	14.8	28	0	0	
1800	15.6	28	0	0	
1700	16.5	28	0	0	
1600	17.6	28	0	0	
1500	18.8	28	0	0	
1400	20.1	28	0	0	
1300	21.6	28	0	0	
1200	23.4	28	0	0	
1100	25.6	28	0	0	
1000	28.1	28	0	0	T1 = V-N+G For 'V' equal to or greater than 'N' T1 = G for V < N
950	29.6	28	5	7	
900	31.3	28	5	8	
850	33.1	28	5	10	
800	35.2	28	5	12	
750	37.5	28	5	15	
700	40.2	28	5	17	
650	43.3	28	5	20	
600	46.9	28	5	24	
550	51.1	28	5	28	
500	56.3	28	5	33	
450	62.5	28	9	44	
400	70.3	28	9	51	
350	80.4	28	9	61	
300	93.8	28	9	75	
250	112.5	28	9	94	
200	140.6	28	9	122	
175	160.7	28	9	142	
150	187.5	28	9	169	
120	234.4	28	9	215	
100	281.3	28	9	262	

Mid throw (in mm) $V = 125 C^2 / R = 28125 / R$

Where 'C' is the distance between bogies centres = 14800+200 = 15000 mm OR 14800-200 = 14600 mm

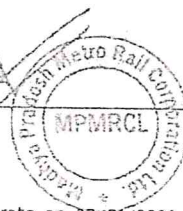
The worst case will be with C = 15000 mm

R is the radius of curve in metres



Prepared

2/



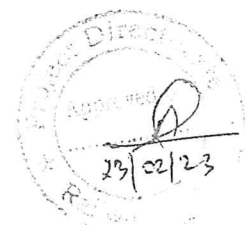


APPENDIX -2B					
EXTRA HORIZONTAL CLEARANCE ON CURVES (CURVATURE EFFECT)					
AT GRADE (SURFACE) SECTIONS (BALLASTED TRACK)					
OUTSIDE OF CURVE					
(REFERENCE PARAS 1.7.1A, 1.8.1 & 1.8.2)					
Radius R	End throw, V0 34020 / R	Gauge Widening on curves, G	Nosing due to Gauge widening, EN = Gx0.219723183	Extra Horizontal Clearance, TZ = V0+G+EN	Remarks
m	mm	mm	mm	mm	
3000	11.3	0	0.0	11	
2800	12.2	0	0.0	12	
2600	13.1	0	0.0	13	
2400	14.2	0	0.0	14	
2200	15.5	0	0.0	15	
2000	17.0	0	0.0	17	
1900	17.9	0	0.0	18	
1800	18.9	0	0.0	19	
1700	20.0	0	0.0	20	
1600	21.3	0	0.0	21	
1500	22.7	0	0.0	23	
1400	24.3	0	0.0	24	
1300	26.2	0	0.0	26	
1200	28.4	0	0.0	28	
1100	30.9	0	0.0	31	
1000	34.0	0	0.0	34	
950	35.8	5	1.1	42	
900	37.8	5	1.1	44	
850	40.0	5	1.1	46	
800	42.5	5	1.1	49	
750	45.4	5	1.1	51	
700	48.6	5	1.1	55	
650	52.3	5	1.1	58	
600	56.7	5	1.1	63	
550	61.9	5	1.1	68	
500	68.0	5	1.1	74	
450	75.6	9	2.0	87	
400	85.1	9	2.0	96	
350	97.2	9	2.0	109	
300	113.4	9	2.0	124	
250	136.1	9	2.0	147	
200	170.1	9	2.0	181	
175	194.4	9	2.0	205	
150	226.8	9	2.0	238	
120	283.5	9	2.0	294	
100	340.2	9	2.0	351	

GAUGE WIDENING ON CURVES:
is 9mm for Curves sharper than 500m radius.
is 5mm for Curves of radius from 500m to 1000m and
is 0mm for Curves with radius 1000m and above.

End throw (in mm) $V0 = (125 C^2) / R - (125 \times C^2) / R = 34020 / R$
Where 'C' is the distance between bogies centres = 14800+200 = 15000mm or 14800-200 = 14600 mm
The worst case will with C = 14600 mm
'C' is the length of coach in metres = 22.030 m and R is the radius of curve in metres
COACH LENGTH = 21900 mm
FOR DMC IT CAN INCREASE TO = 21965 mm
DIFFERENCE IN LENGTH = 65 mm: (THIS INCREASE WILL BE ON ONE SIDE FOR DRIVING CAB)
HALF LENGTH FROM CENTRE OF TWO BOGIES = ((21900 / 2)+65) = 11015 mm
LENGTH FOR CALCULATION OF END THROW = 22030 mm
(2 x HALF LENGTH FROM CENTRE OF 2 BOGIES)

Examined & found in order
Date
Auto Sign of the authority





Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

APPENDIX -2C					
EXTRA HORIZONTAL CLEARANCE ON CURVES (CURVATURE EFFECT)					
TUNNEL/ELEVATED/AT-GRADE (SURFACE) SECTIONS (BALLASTLESS TRACK)					
INSIDE OF CURVE					
(REFERENCE PARAs 1.7.1A, 1.8.1 & 1.8.2)					
Radius R	Mid throw 28125/R	Nosing Included in KE/Structure Gauge for Tangent Track N	Gauge Widening on curves G	Extra Horizontal Clearance T1	Remarks
m	mm	mm	mm	mm	
3000	9.4	28	0	0	GAUGE WIDENING ON CURVES: is 9mm for Curves sharper than 500m radius. is 5mm for Curves of radius from 500m to 1000m and is 0mm for Curves with radius 1000m and above.
2800	10.0	28	0	0	
2600	10.8	28	0	0	
2400	11.7	28	0	0	
2200	12.8	28	0	0	
2000	14.1	28	0	0	
1900	14.8	28	0	0	
1800	15.6	28	0	0	
1700	16.5	28	0	0	
1600	17.6	28	0	0	
1500	18.8	28	0	0	
1400	20.1	28	0	0	T1 = V-N+G For 'V' equal to or greater than 'N' T1 = G for V < N
1300	21.6	28	0	0	
1200	23.4	28	0	0	
1100	25.6	28	0	0	
1000	28.1	28	0	0	
950	29.6	28	5	7	
900	31.3	28	5	8	
850	33.1	28	5	10	
800	35.2	28	5	12	
750	37.5	28	5	15	
700	40.2	28	5	17	
650	43.3	28	5	20	
600	46.9	28	5	24	
550	51.1	28	5	28	
500	56.3	28	5	33	
450	62.5	28	9	44	
400	70.3	28	9	51	
350	80.4	28	9	61	
300	93.8	28	9	75	
250	112.5	28	9	94	
200	140.6	28	9	122	
175	160.7	28	9	142	
150	187.5	28	9	169	
120	234.4	28	9	215	
100	281.3	28	9	262	

Mid throw (in mm) $V = 125 C^2 / R = 28125 / R$

Where 'C' is the distance between bogies centres = 14800+200 = 15000 mm or 14800-200 = 14600 mm
The worst case will be with C = 15000 mm
R is the radius of curve in metres

Found in order

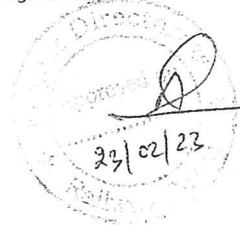
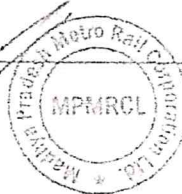


APPENDIX -2D					
EXTRA HORIZONTAL CLEARANCE ON CURVES (CURVATURE EFFECT)					
TUNNEL/ELEVATED/AT-GRADE (SURFACE) SECTIONS (BALLASTLESS TRACK)					
OUTSIDE OF CURVE					
(REFERENCE PARAS 1.7.1A, 1.8.1 & 1.8.2)					
Radius, R	End throw, 34020 / R	Gauge Widening on curves, G	Nosing due to Gauge widening, EN = Gx0.219723183	Extra Horizontal Clearance, T2 = V0+G+EN	Remarks
m	mm	mm	mm	mm	
3000	11.3	0	0.0	11	
2800	12.2	0	0.0	12	
2600	13.1	0	0.0	13	
2400	14.2	0	0.0	14	
2200	15.5	0	0.0	15	
2000	17.0	0	0.0	17	
1900	17.9	0	0.0	18	
1800	18.9	0	0.0	19	
1700	20.0	0	0.0	20	
1600	21.3	0	0.0	21	
1500	22.7	0	0.0	23	
1400	24.3	0	0.0	24	
1300	26.2	0	0.0	26	
1200	28.4	0	0.0	28	
1100	30.9	0	0.0	31	
1000	34.0	0	0.0	34	
950	35.8	5	1.1	42	
900	37.8	5	1.1	44	
850	40.0	5	1.1	46	
800	42.5	5	1.1	49	
750	45.4	5	1.1	51	
700	48.6	5	1.1	55	
650	52.3	5	1.1	58	
600	56.7	5	1.1	63	
550	61.9	5	1.1	68	
500	68.0	5	1.1	74	
450	75.6	9	2.0	87	
400	85.1	9	2.0	96	
350	97.2	9	2.0	108	
300	113.4	9	2.0	124	
250	136.1	9	2.0	147	
200	170.1	9	2.0	181	
175	194.4	9	2.0	205	
150	225.6	9	2.0	238	
120	283.5	9	2.0	294	
100	340.2	9	2.0	351	

GAUGE WIDENING ON CURVES
is 9mm for Curves sharper than 500m radius.
is 5mm for Curves of radius from 500m to 1000m and
is 0mm for Curves with radius 1000m and above.

End throw (In mm) $V0 = (125 C1^2) / R - (125x C^2) / R$; = 34020 / R
Where 'C' is the distance between bogies centres = 14800+200 = 15000mm or 14800-200 = 14600 mm
The worst case will with C = 14600 mm
'C1' is the length of coach in metres = 22.030 m and R is the radius of curve in metres
COACH LENGTH = 21900 mm
FOR DMC IT CAN INCREASE TO = 21965 mm
DIFFERENCE IN LENGTH = 65 mm (THIS INCREASE WILL BE ON ONE SIDE FOR DRIVING CAB)
HALF LENGTH FROM CENTRE OF TWO BOGIES = ((21900 / 2)+65) = 11015 mm
LENGTH FOR CALCULATION OF END THROW = 22030 mm
(2 x HALF LENGTH FROM CENTRE OF 2 BOGIES)

37



MPMRCL
Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

APPENDIX - 3A

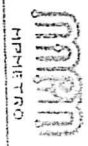
CANT EFFECT ON STRUCTURE GAUGE
AT-GRADE (SURFACE) SECTION (BALASTED TRACK)
REFERENCE DRAWING NUMBER: MPMRCL/GEN/SOD/ATG-02 & MPMRCL/GEN/SOD/CKEN-01 & PARA 1.7.1b, 1.7.2 B, and 1.8.2
All figures in mm

Height above rail level measured above perpendicular to track plane	346	695	2031	3368	4080	4360
Distance from centre line of track to Structure Gauge for tangent track	1742	1765	1833	1834	1374	1366
angle in radians	sin a	cos a	tan a	E1	F1	H1
125	0.003	0.997	0.003	1764.9	1767.1	1767.1
120	0.003	0.997	0.003	1764.2	1766.4	1766.4
115	0.003	0.997	0.003	1763.5	1765.7	1765.7
110	0.003	0.997	0.003	1762.8	1765.0	1765.0
105	0.003	0.997	0.003	1762.1	1764.3	1764.3
100	0.003	0.997	0.003	1761.4	1763.6	1763.6
95	0.003	0.997	0.003	1760.7	1762.9	1762.9
90	0.003	0.997	0.003	1760.0	1762.2	1762.2
85	0.003	0.997	0.003	1759.3	1761.5	1761.5
80	0.003	0.997	0.003	1758.6	1760.8	1760.8
75	0.003	0.997	0.003	1757.9	1760.1	1760.1
70	0.003	0.997	0.003	1757.2	1759.4	1759.4
65	0.003	0.997	0.003	1756.5	1758.7	1758.7
60	0.003	0.997	0.003	1755.8	1758.0	1758.0
55	0.003	0.997	0.003	1755.1	1757.3	1757.3
50	0.003	0.997	0.003	1754.4	1756.6	1756.6
45	0.003	0.997	0.003	1753.7	1755.9	1755.9
40	0.003	0.997	0.003	1753.0	1755.2	1755.2
35	0.003	0.997	0.003	1752.3	1754.5	1754.5
30	0.003	0.997	0.003	1751.6	1753.8	1753.8
25	0.003	0.997	0.003	1750.9	1753.1	1753.1
20	0.003	0.997	0.003	1750.2	1752.4	1752.4
15	0.003	0.997	0.003	1749.5	1751.7	1751.7
10	0.003	0.997	0.003	1748.8	1751.0	1751.0
5	0.003	0.997	0.003	1748.1	1750.3	1750.3
0	0.003	0.997	0.003	1747.4	1749.6	1749.6

E1 = (As + (h x tan a)) x cos a
F1 = (As - (h x tan a)) x cos a
H1 = (As + (h x tan a)) x cos a
H2 = (As - (h x tan a)) x cos a
Ab = Distance from levelled centre line of cant track to Structure Gauge for tangent track at height h from rail level in the direction parallel to the line joining the top of rails.
be = h x tan a = lateral increment due to cant (measured along the line parallel to the line joining the top of rails).

Examined & found in order
Date

Page 37 of 70



Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

APPENDIX - 3C

CANT EFFECT ON STRUCTURE GAUGE
UNDERGROUND SECTION (RECTANGULAR BOX TUNNELS) - BALLASTLESS TRACK

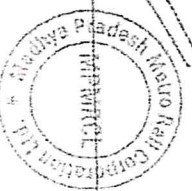
REFERENCE DRAWING NUMBER: BPH/CL/DESIGN/IND-03.3, IMPRCL/DESIGN/IND-03.3, IMPRCL/DESIGN/IND-03.3 AND PARAS 17.10, 17.20 AND 18.2

All figures in mm

Height above rail level measured above 100 mm to track plane 'H' =		Distance from centre line of track to Structure Gauge for tangent track 200 mm		1680		605		2684		3220		4246		4300	
Track 200 mm		Track 200 mm		E1		F1		H1		H2		E1		F1	
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
125	0.003	0.003	0.007	0.003	1702.1	1645.3	548.7	2710.0	1743.6	1595.0	1003.5	805.4	1967.3	1403.8	3060.0
120	0.000	0.000	0.000	0.000	1702.4	1645.7	2713.1	1744.1	1600.2	1076.6	808.7	1963.2	1403.9	3073.2	2719.2
115	0.006	0.006	0.007	0.007	1701.7	1645.0	537.7	2713.3	1738.6	1050.6	812.0	1944.0	1503.8	3085.0	2707.1
110	0.012	0.012	0.007	0.007	1700.9	1650.1	527.7	2714.3	1736.1	1028.0	815.3	1924.7	1513.9	3097.5	2695.1
105	0.018	0.018	0.007	0.007	1700.2	1655.2	517.7	2715.3	1733.6	1005.3	818.6	1905.4	1523.8	3110.0	2683.0
100	0.024	0.024	0.007	0.007	1699.4	1660.3	507.7	2716.3	1731.1	982.3	821.9	1886.1	1533.7	3122.5	2671.0
95	0.030	0.030	0.007	0.007	1698.6	1665.4	497.7	2717.3	1728.6	959.2	825.1	1866.8	1543.6	3135.0	2659.0
90	0.036	0.036	0.007	0.007	1697.8	1670.5	487.7	2718.3	1725.9	936.1	828.2	1847.5	1553.5	3147.5	2647.0
85	0.042	0.042	0.007	0.007	1697.0	1675.6	477.7	2719.3	1723.2	913.0	831.3	1828.2	1563.4	3160.0	2635.0
80	0.048	0.048	0.007	0.007	1696.2	1680.7	467.7	2720.3	1720.5	889.9	834.4	1808.9	1573.3	3172.5	2623.0
75	0.054	0.054	0.007	0.007	1695.4	1685.8	457.7	2721.3	1717.8	866.8	837.5	1789.6	1583.2	3185.0	2611.0
70	0.060	0.060	0.007	0.007	1694.6	1690.9	447.7	2722.3	1715.1	843.7	840.6	1770.3	1593.1	3197.5	2600.0
65	0.066	0.066	0.007	0.007	1693.8	1696.0	437.7	2723.3	1712.4	820.6	843.7	1751.0	1603.0	3210.0	2588.0
60	0.072	0.072	0.007	0.007	1693.0	1701.1	427.7	2724.3	1709.7	797.5	846.8	1731.7	1612.9	3222.5	2576.0
55	0.078	0.078	0.007	0.007	1692.2	1706.2	417.7	2725.3	1707.0	774.4	849.9	1712.4	1622.8	3235.0	2564.0
50	0.084	0.084	0.007	0.007	1691.4	1711.3	407.7	2726.3	1704.3	751.3	853.0	1693.1	1632.7	3247.5	2552.0
45	0.090	0.090	0.007	0.007	1690.6	1716.4	397.7	2727.3	1701.6	728.2	856.1	1673.8	1642.6	3260.0	2540.0
40	0.096	0.096	0.007	0.007	1689.8	1721.5	387.7	2728.3	1698.9	705.1	859.2	1654.5	1652.5	3272.5	2528.0
35	0.102	0.102	0.007	0.007	1689.0	1726.6	377.7	2729.3	1696.2	682.0	862.3	1635.2	1662.4	3285.0	2516.0
30	0.108	0.108	0.007	0.007	1688.2	1731.7	367.7	2730.3	1693.5	658.9	865.4	1615.9	1672.3	3297.5	2504.0
25	0.114	0.114	0.007	0.007	1687.4	1736.8	357.7	2731.3	1690.8	635.8	868.5	1596.6	1682.2	3310.0	2492.0
20	0.120	0.120	0.007	0.007	1686.6	1741.9	347.7	2732.3	1688.1	612.7	871.6	1577.3	1692.1	3322.5	2480.0
15	0.126	0.126	0.007	0.007	1685.8	1747.0	337.7	2733.3	1685.4	589.6	874.7	1558.0	1702.0	3335.0	2468.0
10	0.132	0.132	0.007	0.007	1685.0	1752.1	327.7	2734.3	1682.7	566.5	877.8	1538.7	1711.9	3347.5	2456.0
5	0.138	0.138	0.007	0.007	1684.2	1757.2	317.7	2735.3	1680.0	543.4	880.9	1519.4	1721.8	3360.0	2444.0
0	0.144	0.144	0.007	0.007	1683.4	1762.3	307.7	2736.3	1677.3	520.3	884.0	1500.1	1731.7	3372.5	2432.0

E1 = (H1 + H2) x Sin α + (H1 + H2) x Cos α
F1 = (H1 + H2) x Sin α + (H1 + H2) x Cos α
H1 = (G1/2) x Sin α + (G1/2) x Cos α
H2 = (G2/2) x Sin α + (G2/2) x Cos α
G1 = Distance from vertical centre line of structure to Structure Gauge for tangent track at height 'H' from rail level in the direction parallel to the line joining the top of rails
G2 = Distance from vertical centre line of structure to Structure Gauge for tangent track at height 'H' from rail level in the direction parallel to the line joining the top of rails
α = Angle of inclination of structure to the horizontal

Examined & found in order
Date: 20/07/23
Signature: [Signature]





Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

APPENDIX - 3D

CANT EFFECT ON KINEMATIC ENVELOPE - HORIZONTAL
AT-GRADE (SURFACE) SECTION (BALASTED TRACK)

REFERENCE DRAWING NUMBER: MPMRCL/ENSC/DOEN-01 & MPMRCL/ENSC/DOEN-01 AND PARA 10.1

All figures in mm

Height above rail level measured above as per to track plane 'y' =	Distance from centre line of track to kinematic Envelope for tangent track 'y' =	349				807				2006				3011				4014				4200			
		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	0.063 0.063 0.067 0.063 15.54	15.54	15.57	541.4	277.3	1604.7	1534.2	1100.3	932.4	1046.1	1500.3	220.1	1951.9	1922.8	1403.6	3501.0	3222.4	1553.7	857.8	4164.3	3961.1	1664.2	887.4	4245.2	4146.8
120	0.063 0.060 0.067 0.060 16.14	16.14	15.92	533.7	280.1	1602.1	1537.6	1092.7	935.5	1039.8	1515.5	222.3	1950.5	1942.3	1415.0	3494.0	3220.4	1540.7	901.5	4158.9	3963.7	1650.6	881.7	4243.8	4143.5
115	0.070 0.076 0.007 0.077 16.19	16.08	15.60	526.0	283.0	1609.2	1541.1	1095.1	930.0	1033.5	1522.7	221.0	1959.1	1931.0	1429.4	3487.4	3230.3	1527.2	915.1	4153.3	3960.3	1630.9	895.9	4236.4	4152.2
110	0.073 0.073 0.007 0.073 16.12	16.02	15.74	518.3	285.9	1616.9	1544.5	1077.5	941.7	1027.1	1529.9	220.4	1962.7	1921.2	1437.0	3480.1	3234.2	1514.7	920.7	4147.7	3960.9	1623.3	910.2	4233.8	4154.7
105	0.070 0.070 0.008 0.070 16.12	16.09	15.63	510.6	289.7	1614.3	1547.9	1060.0	944.0	1020.0	1537.1	220.0	1960.3	1910.6	1449.2	3472.0	3239.1	1501.7	942.3	4142.1	3971.4	1600.7	924.4	4227.3	4157.3
100	0.066 0.066 0.008 0.067 16.11	16.04	15.64	502.9	291.6	1617.8	1551.3	1052.2	947.0	1014.4	1544.2	219.2	1959.9	1900.0	1460.6	3465.4	3242.0	1484.7	955.9	4135.4	3972.9	1589.0	930.6	4221.7	4159.8
95	0.073 0.063 0.008 0.063 16.10	16.08	15.68	495.7	294.4	1625.0	1554.6	1054.5	950.9	1008.0	1551.3	218.5	1973.4	1009.4	1471.9	3459.1	3245.0	1475.6	969.5	4130.7	3976.7	1582.3	940.7	4216.1	4162.2
90	0.060 0.060 0.008 0.060 16.09	16.08	15.68	487.5	297.3	1635.3	1556.0	1046.8	953.9	1001.8	1558.4	217.9	1976.9	1007.7	1483.3	3450.7	3249.5	1462.5	983.1	4125.0	3982.0	1580.7	947.0	4210.4	4164.6
85	0.056 0.056 0.008 0.056 16.08	16.08	15.68	479.7	300.2	1646.8	1561.3	1038.1	957.0	1705.2	1565.5	217.0	1980.3	1000.1	1494.6	3443.2	3253.2	1449.5	993.1	4119.2	3987.0	1585.0	951.2	4204.6	4167.0
80	0.053 0.053 0.008 0.053 16.07	16.07	15.68	472.0	303.0	1656.0	1564.6	1031.5	960.0	1788.7	1572.5	216.2	1983.9	1004.8	1505.6	3435.7	3256.0	1436.4	1019.2	4113.4	3983.3	1581.2	955.3	4200.8	4169.3
75	0.050 0.050 0.008 0.050 16.07	16.07	15.68	464.3	305.0	1666.1	1567.9	1023.8	963.0	1782.2	1579.0	215.4	1987.2	1006.7	1517.1	3428.2	3260.0	1423.2	1023.7	4107.5	3980.8	1582.5	958.5	4196.5	4171.5
70	0.046 0.046 0.008 0.047 16.06	16.06	15.68	456.6	308.7	1676.5	1571.1	1016.0	966.0	1775.8	1586.6	214.0	1990.6	1006.0	1528.4	3420.2	3264.2	1410.1	1037.2	4101.6	3987.0	1583.8	961.2	4193.8	4173.8
65	0.043 0.043 0.008 0.043 16.05	16.05	15.68	448.9	311.6	1687.0	1574.4	1008.3	969.0	1769.3	1593.6	213.0	1994.0	1005.2	1539.6	3413.1	3267.0	1397.0	1050.7	4095.6	3988.8	1585.0	963.7	4191.1	4176.1
60	0.040 0.040 0.008 0.040 16.04	16.04	15.68	441.1	314.3	1697.4	1577.6	1000.6	972.0	1762.7	1600.8	211.4	1997.4	1004.4	1550.8	3405.4	3271.3	1383.0	1064.2	4089.6	3992.0	1586.3	966.3	4188.4	4178.4
55	0.037 0.037 0.008 0.037 16.03	16.03	15.68	433.4	317.2	1707.8	1580.8	992.8	975.0	1756.2	1607.8	210.6	2000.7	1003.7	1562.0	3397.8	3274.0	1369.7	1077.7	4083.5	3994.1	1587.5	968.9	4185.7	4180.7
50	0.033 0.033 0.008 0.033 16.02	16.02	15.68	425.6	320.0	1718.2	1584.0	995.1	977.9	1748.6	1614.5	211.7	2004.0	1792.9	1573.2	3390.0	3278.3	1357.5	1091.1	4077.4	3996.3	1588.7	971.2	4183.0	4182.8
45	0.030 0.030 0.008 0.030 16.01	16.01	15.68	417.9	322.8	1728.6	1587.2	997.3	980.0	1743.0	1621.6	210.7	2007.3	1782.1	1584.4	3382.0	3281.7	1344.3	1104.6	4071.3	3998.1	1590.0	973.7	4180.3	4185.1
40	0.027 0.027 0.008 0.027 16.00	16.00	15.68	410.1	325.6	1739.0	1590.4	999.5	983.0	1736.4	1628.4	210.0	2010.6	1771.3	1595.5	3374.5	3285.1	1331.1	1118.0	4065.1	4000.1	1591.3	975.9	4177.6	4189.4
35	0.023 0.023 0.008 0.023 15.99	15.99	15.68	402.4	328.4	1749.4	1593.5	998.1	986.7	1729.8	1635.3	209.2	2013.9	1760.4	1606.6	3365.7	3289.5	1317.9	1131.4	4058.9	4002.0	1592.0	978.2	4174.9	4191.7
30	0.020 0.020 0.008 0.020 15.98	15.98	15.68	394.6	331.2	1759.8	1596.6	994.0	989.4	1723.2	1642.1	208.1	2017.1	1749.6	1617.8	3358.9	3293.0	1304.7	1144.8	4052.6	4003.0	1593.4	980.5	4172.2	4194.0
25	0.017 0.017 0.008 0.017 15.97	15.97	15.68	386.8	334.0	1769.2	1599.7	994.8	992.0	1716.6	1649.0	207.0	2020.3	1738.7	1628.0	3351.0	3295.1	1291.4	1158.2	4046.3	4003.6	1594.8	982.9	4169.5	4196.3
20	0.013 0.013 0.008 0.013 15.96	15.96	15.68	379.1	336.8	1779.6	1602.9	994.8	994.8	1710.0	1655.8	206.2	2023.5	1732.1	1639.9	3343.1	3295.4	1278.2	1171.6	4039.9	4004.7	1596.2	985.1	4166.6	4198.6
15	0.010 0.010 0.008 0.010 15.95	15.95	15.68	371.3	339.6	1789.0	1606.0	994.8	994.8	1703.4	1662.7	205.0	2026.6	1725.5	1651.0	3335.1	3295.1	1264.9	1185.0	4033.3	4005.9	1597.5	987.3	4163.7	4200.9
10	0.007 0.007 0.008 0.007 15.94	15.94	15.68	363.5	342.4	1798.4	1609.1	994.8	994.8	1696.8	1669.5	203.9	2029.8	1718.9	1662.0	3327.1	3294.8	1251.6	1198.3	4026.7	4007.0	1598.7	989.5	4160.8	4203.0
5	0.003 0.003 0.008 0.003 15.93	15.93	15.68	355.8	345.2	1807.8	1612.0	994.8	994.8	1689.7	1676.5	203.1	2033.0	1712.3	1673.0	3319.1	3294.5	1238.3	1211.7	4020.3	4007.2	1599.9	991.7	4157.9	4205.1
0	0.000 0.000 0.008 0.000 15.92	15.92	15.68	348.0	348.0	1816.5	1615.0	994.8	994.8	1683.0	1683.0	203.0	2036.9	1706.0	1684.0	3311.0	3294.0	1225.0	1225.0	4014.0	4007.4	1600.0	992.0	4155.0	4207.0

$$E = [a_0 + (a \times \sin \alpha) + (b \times \cos \alpha)] \times \cos \alpha$$

$$F = [a_0 + (a \times \sin \alpha) + (b \times \cos \alpha)] \times \cos \alpha$$

$$H1 = [a_0 + (a \times \sin \alpha) + (b \times \cos \alpha)] \times \cos \alpha$$

$$H2 = [a_0 + (a \times \sin \alpha) + (b \times \cos \alpha)] \times \cos \alpha$$

$$a_0 = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$a = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$b = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$c = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$d = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$e = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$f = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$g = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$h = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$i = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

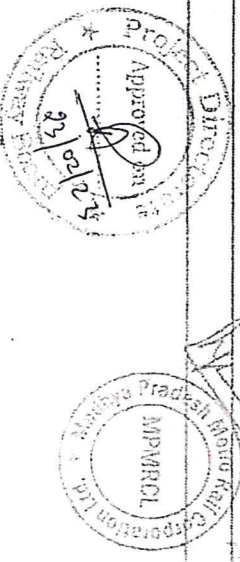
$$j = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$k = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$l = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$m = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$

$$n = \text{Distance from inclined centre line of cant to structure gauge for tangent track at height 'y' from rail level in the direction parallel to the line joining the top of rails.}$$





Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

APPENDIX - 3E

ELEVATED AND AT-GRADE (SURFACE) SECTION - BALLASTLESS TRACK

REFERENCE DRAWING NUMBER: MPMRCL/SOD/ET-1 (REVISED EDITION OF ET-1)

All figures in mm

Height above rail level measured above 2212 to rock plane "b" =	348	895	2876	3296	4014	4200
Distance from centre line of track to Kinematic Envelope for lampset	1451	1566	1650	1668	1725	1720
Track No.						
Cant in mm	E	F	H1	H2	E	F
Slope in 100	E	F	H1	H2	E	F
125	0.003	0.003	0.003	0.003	0.003	0.003
120	0.003	0.003	0.003	0.003	0.003	0.003
115	0.076	0.076	0.097	0.097	0.076	0.076
110	0.073	0.073	0.097	0.097	0.073	0.073
105	0.070	0.070	0.090	0.090	0.070	0.070
100	0.065	0.065	0.090	0.090	0.065	0.065
95	0.063	0.063	0.093	0.093	0.063	0.063
90	0.060	0.060	0.090	0.090	0.060	0.060
85	0.055	0.055	0.095	0.095	0.055	0.055
80	0.053	0.053	0.095	0.095	0.053	0.053
75	0.050	0.050	0.090	0.090	0.050	0.050
70	0.045	0.045	0.095	0.095	0.045	0.045
65	0.043	0.043	0.095	0.095	0.043	0.043
60	0.040	0.040	0.095	0.095	0.040	0.040
55	0.033	0.033	0.095	0.095	0.033	0.033
50	0.033	0.033	0.095	0.095	0.033	0.033
45	0.030	0.030	0.095	0.095	0.030	0.030
40	0.027	0.027	0.095	0.095	0.027	0.027
35	0.027	0.027	0.095	0.095	0.027	0.027
30	0.020	0.020	0.095	0.095	0.020	0.020
25	0.017	0.017	0.095	0.095	0.017	0.017
20	0.013	0.013	0.095	0.095	0.013	0.013
15	0.010	0.010	0.095	0.095	0.010	0.010
10	0.007	0.007	0.095	0.095	0.007	0.007
5	0.001	0.001	0.095	0.095	0.001	0.001
0	0.003	0.003	0.003	0.003	0.003	0.003

ET = (ab - (a x tan α)) / x cos α
 F1 = (ab - (a x tan α)) / x sin α
 H1 = (Ca + 2) / (2 x sin α)
 H2 = (Ca + 2) / (2 x sin α)
 ab = Distance from inclined centre line of vehicle to Structure Gauge for tangent track at height 'h' from rail level in the direction parallel to the line joining the top of rails
 ac = Distance from inclined centre line of vehicle to Structure Gauge for tangent track at height 'h' from rail level in the direction parallel to the line joining the top of rails
 bc = Distance from inclined centre line of vehicle to Structure Gauge for tangent track at height 'h' from rail level in the direction parallel to the line joining the top of rails

CANT EFFECT ON KINEMATIC ENVELOPE

REFERENCE DRAWING NUMBER: MP/ROL/GEN/SOD/ELE-01 & MP/ROL/GEN/SOD/GEN-01 AND PARA 1.0

Height above rail level measured above P.W.10 track, ft. =	346	895	2885	3207	4158	4780																							
Distance from centre line of track to Kinematic Envelope for tangent	14.81	1576	1620	1820	980	E20																							
Track offset																													
Profile	E	F	H1	H2	E	F																							
Station	14.81	1576	1620	1820	980	E20																							
125	0.003	0.003	0.997	0.083	1474.9	1417.1	629.7	268.0	1644.8	1436.3	1065.1	923.7	1862.7	1364.1	3072.2	2902.4	1696.0	1350.7	3413.3	3203.1	1321.6	631.7	4787.5	4124.0	1165.5	468.8	4316.0	4180.0	4170.0
126	0.000	0.000	0.997	0.089	1474.1	1418.7	522.2	291.4	1642.3	1439.7	1077.7	927.7	1853.6	1364.1	3065.6	2905.1	1808.0	1382.1	3456.3	3205.8	1308.0	645.0	4782.8	4126.6	1151.8	478.0	4317.0	4181.0	4170.0
110	0.076	0.076	0.997	0.077	1473.3	1420.2	515.2	293.6	1630.7	1430.7	1070.2	926.5	1844.4	1404.1	3056.4	2899.0	1875.1	1372.4	3458.0	3210.6	1284.4	659.0	4778.2	4128.1	1138.1	497.1	4307.8	4182.0	4170.0
110	0.073	0.073	0.997	0.073	1472.6	1421.7	508.0	296.2	1627.1	1430.8	1068.5	926.8	1835.2	1414.1	3051.2	2893.4	1864.6	1368.7	3452.1	3214.3	1280.6	673.9	4773.4	4130.4	1124.4	511.7	4303.7	4183.3	4170.0
105	0.070	0.070	0.998	0.070	1471.7	1423.2	500.8	298.6	1614.5	1430.0	1065.1	926.8	1826.1	1404.0	3046.7	2887.6	1854.5	1358.1	3445.0	3218.0	1267.3	687.9	4768.7	4132.1	1110.6	525.2	4298.0	4185.0	4170.0
100	0.065	0.065	0.998	0.066	1470.8	1424.7	493.5	300.8	1601.9	1430.1	1062.6	926.8	1816.8	1348.0	3034.7	2880.5	1843.5	1340.2	3437.9	3221.7	1253.6	701.9	4763.9	4133.8	1090.9	538.6	4285.2	4185.9	4150.0
95	0.063	0.063	0.998	0.063	1470.1	1426.2	486.3	303.3	1592.3	1430.4	1060.1	926.8	1807.6	1337.6	3028.5	2874.1	1833.0	1329.6	3430.7	3225.3	1240.2	715.9	4759.0	4135.5	1083.1	552.0	4280.8	4187.7	4130.0
90	0.059	0.059	0.999	0.060	1469.2	1427.6	479.9	305.7	1582.6	1430.5	1057.5	926.8	1798.4	1328.1	3023.2	2867.6	1823.5	1320.2	3423.4	3229.8	1226.6	729.9	4754.1	4137.1	1069.4	567.7	4265.5	4188.5	4110.0
85	0.056	0.056	0.999	0.056	1468.3	1429.1	471.8	308.1	1573.0	1430.6	1055.0	926.8	1788.1	1318.6	3017.1	2857.6	1813.6	1310.7	3416.1	3234.2	1213.0	743.9	4749.2	4138.6	1055.6	581.8	4262.4	4190.0	4100.0
80	0.053	0.053	0.999	0.053	1467.4	1430.5	464.5	310.6	1562.3	1430.7	1052.4	926.8	1779.9	1309.1	3010.4	2847.6	1804.2	1301.2	3408.6	3238.5	1199.3	757.9	4744.2	4140.1	1041.6	595.9	4257.8	4190.0	4100.0
75	0.050	0.050	0.999	0.050	1466.5	1431.9	457.3	312.9	1551.5	1430.8	1049.9	926.8	1770.6	1300.4	3003.7	2837.6	1795.0	1291.4	3401.5	3243.8	1187.1	770.8	4739.1	4141.6	1028.0	610.0	4254.1	4191.0	4100.0
70	0.046	0.046	0.999	0.047	1465.6	1433.3	450.0	315.2	1540.7	1430.9	1047.2	926.8	1761.2	1291.2	2998.2	2828.1	1779.9	1281.4	3394.1	3248.1	1172.1	785.0	4734.0	4143.0	1014.2	624.0	4250.5	4192.0	4100.0
65	0.043	0.043	0.999	0.043	1464.6	1434.6	442.3	317.6	1531.3	1431.3	1045.9	926.8	1751.9	1281.9	2988.9	2818.6	1769.6	1271.4	3384.6	3253.2	1159.4	794.7	4728.9	4144.4	1000.4	630.1	4246.0	4193.0	4100.0
60	0.040	0.040	0.999	0.040	1463.7	1435.9	435.5	320.0	1520.4	1431.5	1043.0	926.8	1742.6	1272.6	2979.7	2809.1	1759.6	1261.4	3375.1	3258.5	1146.8	803.7	4723.7	4145.7	986.5	639.1	4241.5	4194.0	4100.0
55	0.037	0.036	0.999	0.037	1462.7	1437.3	428.2	322.2	1509.2	1431.7	1040.2	926.8	1733.2	1262.9	2970.0	2799.1	1749.6	1251.4	3365.6	3263.7	1134.1	812.6	4718.5	4146.9	972.7	646.2	4236.5	4194.5	4100.0
50	0.033	0.033	0.999	0.033	1461.7	1439.7	421.0	324.7	1504.8	1431.8	1037.3	926.8	1723.6	1253.6	2960.5	2789.4	1739.2	1241.6	3356.1	3269.0	1121.2	821.5	4713.2	4148.2	958.6	650.2	4231.9	4195.0	4100.0
45	0.030	0.030	0.999	0.030	1460.7	1442.0	413.7	327.0	1500.2	1431.9	1034.7	926.8	1714.4	1244.4	2954.9	2787.6	1728.4	1231.6	3346.7	3274.2	1108.7	830.5	4707.9	4149.5	945.0	659.2	4227.5	4195.5	4100.0
40	0.027	0.027	1.000	0.027	1459.7	1444.3	406.4	329.4	1495.2	1432.0	1031.7	926.8	1705.0	1235.0	2947.2	2780.9	1717.6	1221.6	3336.7	3279.3	1095.7	839.5	4702.9	4150.8	931.2	668.2	4223.0	4196.0	4100.0
35	0.023	0.023	1.000	0.023	1458.7	1446.5	398.1	331.7	1490.5	1432.1	1028.8	926.8	1695.6	1225.6	2938.6	2773.0	1704.9	1211.6	3326.8	3284.4	1082.8	848.6	4697.8	4152.1	917.3	677.2	4218.5	4196.5	4100.0
30	0.020	0.020	1.000	0.020	1457.6	1448.8	389.8	334.0	1485.9	1432.2	1025.9	926.8	1686.1	1216.1	2929.1	2765.9	1694.1	1201.6	3316.9	3289.5	1070.0	857.7	4692.8	4153.4	903.4	686.2	4214.0	4197.0	4100.0
25	0.017	0.017	1.000	0.017	1456.6	1450.0	381.5	336.3	1481.2	1432.3	1023.0	926.8	1676.6	1206.6	2920.0	2758.8	1684.1	1191.6	3307.0	3294.6	1057.1	866.8	4687.9	4154.7	889.3	695.3	4209.5	4197.5	4100.0
20	0.013	0.013	1.000	0.013	1455.6	1453.3	373.2	338.7	1476.5	1432.4	1020.1	926.8	1667.1	1197.1	2910.9	2751.7	1674.1	1181.6	3297.1	3300.6	1044.2	875.8	4683.0	4155.9	875.2	704.2	4205.0	4198.0	4100.0
15	0.010	0.010	1.000	0.010	1454.4	1454.5	365.0	341.0	1471.8	1432.5	1017.2	926.8	1657.6	1187.6	2901.8	2744.6	1664.1	1171.6	3287.2	3305.7	1031.3	884.9	4678.1	4157.0	861.3	713.2	4200.5	4198.5	4100.0
10	0.007	0.007	1.000	0.007	1453.3	1454.7	356.7	343.4	1467.1	1432.6	1014.3	926.8	1648.1	1178.1	2892.7	2737.5	1654.1	1161.6	3277.3	3310.8	1018.4	893.9	4673.2	4158.1	847.4	721.7	4196.0	4199.0	4100.0
5	0.003	0.003	1.000	0.003	1452.1	1454.9	348.3	345.7	1462.4	1432.7	1011.4	926.8	1638.6	1168.6	2883.6	2730.4	1644.1	1151.6	3267.4	3315.9	1005.5	903.0	4668.3	4159.2	833.0	730.2	4191.5	4199.5	4100.0
0	0.000	0.000	1.000	0.000	1451.0	1455.0	340.0	348.0	1457.0	1432.8	1008.5	926.8	1629.1	1159.1	2874.5	2723.3	1635.1	1141.6	3257.5	3321.0	992.6	912.1	4663.4	4160.3	819.1	739.7	4187.0	4200.0	4100.0



Bhopal and Indore Metro Rail System
Schedule of Dimensions (SOD)

APPENDIX - 4

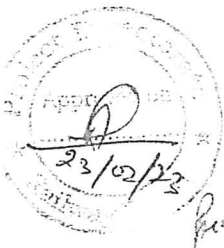
LATERAL AND VERTICAL SHIFT OF CENTRE OF CIRCULAR TUNNEL FOR DIFFERENT CANT VALUES

REFERENCE DRAWING NUMBER: MPMRCL/GEN/SOD/UND-44 AND PARAS 1.7.1 B & 1.7.2 B

$\tan(q) = (r-D_1)(G/2) \quad 2.707365627$
 $q \text{ in radians } 1.216977044$

$\text{Radius of circular tunnel 'r' } = 2800$
 $\text{Height from invert to rail level 'D}_1\text{' } = 760$

Cant	$\sin \alpha$	α	Angle $Pi(q/2 - \theta - \alpha/2)$	Lateral shift of tunnel centre = X	Vertical shift of tunnel centre = Y	Remarks
mm		radians	radians	mm	mm	
125	0.082946251	0.0830416593	0.3123	172	55	(A). THE CANT IS PROVIDED BY ROTATING THE TUNNEL ABOUT THE MID POINT OF TOP OF INNER RAIL, THIS WILL RESULT IN LATERAL AND VERTICAL SHIFT OF THE CENTRE OF THE CIRCULAR TUNNEL
120	0.0795628401	0.0797127915	0.3140	165	54	
115	0.076310551	0.0763849087	0.3156	158	52	
110	0.072992701	0.0730576733	0.3173	151	50	
105	0.069674351	0.0697313480	0.3190	144	48	(B). LATERAL SHIFT OF THE CENTRE OF THE TUNNEL (TOWARDS INSIDE OF CURVE) IS
100	0.066357001	0.0664057952	0.3206	137	46	
95	0.063039151	0.0630909777	0.3223	130	43	
90	0.059721301	0.0597568584	0.3239	123	41	
85	0.056403451	0.0564334000	0.3256	116	39	(C). VERTICAL SHIFT OF THE CENTRE OF THE TUNNEL (UPWARDS) IS
80	0.053085601	0.0531105655	0.3273	109	37	
75	0.049767750	0.0497833178	0.3289	102	35	
70	0.046449900	0.0464666200	0.3306	96	33	
65	0.043132050	0.0431454353	0.3322	89	31	where, Y is internal radius of the circular tunnel = 2800mm
60	0.039814200	0.0398247266	0.3339	82	28	
55	0.036496350	0.0365044573	0.3356	75	26	
50	0.033178500	0.0331845906	0.3372	68	24	
45	0.029860650	0.0298650897	0.3389	61	22	D_1 is the depth from rail level to invert of circular tunnel.
40	0.026542800	0.0265459179	0.3405	54	19	
35	0.023224950	0.0232270387	0.3422	48	17	
30	0.019907100	0.0199084153	0.3439	41	15	
25	0.016589250	0.0165900112	0.3455	34	12	α is the angle of rotation = $\sin^{-1}(\text{Cant}/G)$ and θ is angle subtended by line joining top of two rails and the line joining mid point of top of inner rail and the centre of circular Tunnel.
20	0.013271400	0.0132717897	0.3472	27	10	
15	0.009953550	0.0099537145	0.3488	20	7	
10	0.006635700	0.0066357488	0.3505	14	5	
5	0.003317850	0.0033178561	0.3522	7	2	$= \tan^{-1}((r-D_1)/(G/2))$ in degrees = 69.752367 G = Centre to centre of rails = 1507mm
0	0.000000000	0.0000000000	0.3538	0	0	



Examined & Found in order
Date



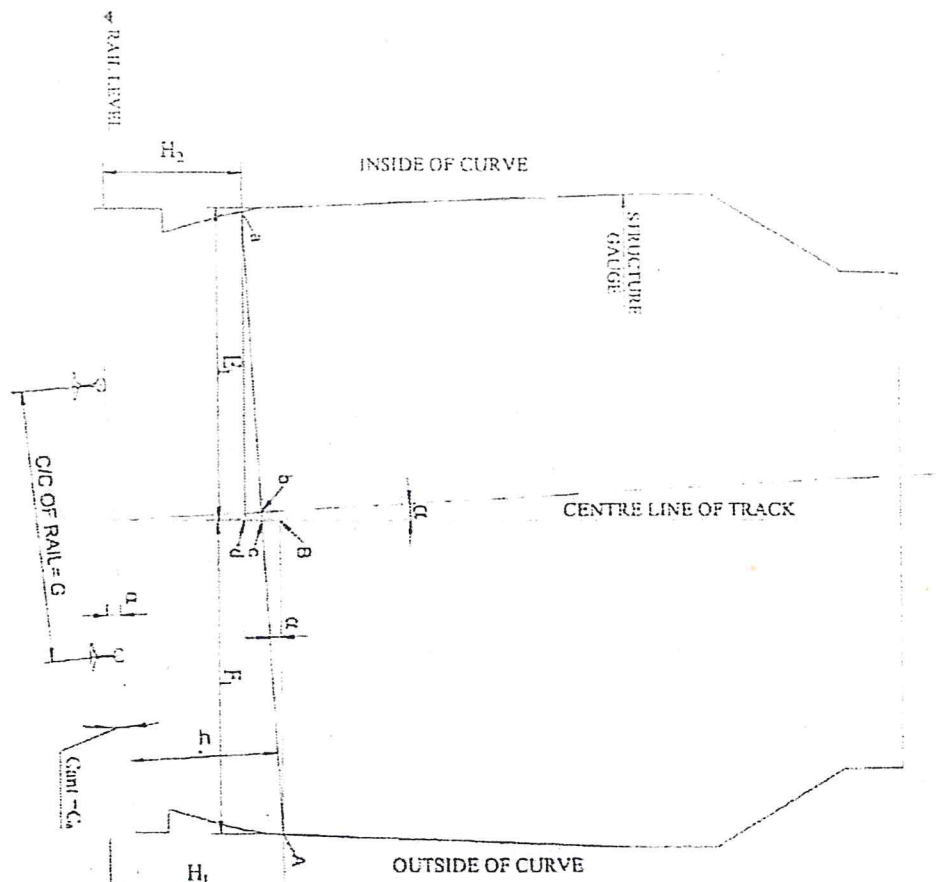


APPENDIX - 5 ADDITIONAL CLEARANCE FOR PLATFORMS ON CURVES UNDERGROUND, ELEVATED AND SURFACE SECTIONS (REFERENCE PARA 2.7)				
Radius R	Cant	Extra clearance for passenger platform		Remarks
		Inside of Curve	Outside of Curve	
m	mm	mm	mm	Extra Clearance for Curves
1000	0	28	34	(A). Inside of Curve = Midthrow = $28125/R$ (B). Outside of Curve = Endthrow = $34020/R$.
1100	0	26	31	
1200	0	23	28	Please see Appendix 2A, 2B, 2C & 2D.
1300	0	22	26	
1500	0	19	23	Additional sway (nosing effect) has been neglected in the calculations as a measure of additional safety to passengers.
1750	0	16	19	
2000	0	14	17	
2500	0	11	14	
3000	0	9	11	
5000	0	6	7	



Examined & Found in order
B. S. Singh
1/3/2023

REFERENCE PARA NO: 1.7.1B, 1.7.2B & 1.8?



Examined & found correct
Date _____
Auth. Sign. _____
23/01/23

$\Delta h =$ Distance from centreline of track to structure flange for tangent track at height 'h'
 $\sin \alpha = \text{cant}/G$
 $G = 1507 \text{ mm}$
 $C\alpha =$ Cant applied
 $E_1 = [ab + bx \tan \alpha] \times \cos \alpha$
 $F_1 = [ab - bx \tan \alpha] \times \cos \alpha$
 $H_1 = [C\alpha/2 + (b/\cos \alpha)^2 \times (Ab - bx \tan \alpha) \times \sin \alpha$
 $H_2 = [C\alpha/2 + (b/\cos \alpha) \times (Ab - bx \tan \alpha) \times \sin \alpha$
 For values of E_1 , F_1 , H_1 and H_2 , refer to Appendix 3.A.3B & 3C.

- NOTES
1. STRUCTURE GAUGE FOR AT-GRADE BELLEVILLE SECTION HAS BEEN SHOWN AS A TYPICAL FIGURE.
2. THE PORENAT FOR E-1, E-2 AND E-3, SHOWN THE FIGURE WILL ALSO APPLY TO INDIAN BORED BOX TUNNELS.
3. KINEMATIC LEVEL ONE, IS VALID FOR THE MAXIMUM SPEED OF 90 KM/HR, WIND SPEED OF 100 KM/HR.
4. MAXIMUM DESIGNABLE GWT (G.A.) = 110 MM.
5. MAXIMUM DESIGNABLE GWT DEFICIENCY (CD) = 85 MM.



LEGEND

1950-1951										
Name										
Age										
Sex										
Religion										
Marital Status										
Occupation										
Education										
Income										
Assets										
Liabilities										
Net Worth										
1	John Doe	45	M	Protestant	Married	Teacher	High School	\$12,000	\$15,000	\$3,000
2	Jane Doe	42	F	Catholic	Married	Homemaker	High School	\$12,000	\$15,000	\$3,000
3	Robert Smith	55	M	Methodist	Married	Engineer	College	\$18,000	\$25,000	\$7,000
4	Emily White	38	F	Baptist	Single	Nurse	College	\$10,000	\$12,000	\$2,000
5	Michael Brown	60	M	Presbyterian	Married	Retired	High School	\$8,000	\$10,000	\$2,000
6	Sarah Green	48	F	Anglican	Married	Homemaker	High School	\$10,000	\$12,000	\$2,000
7	David Black	52	M	Quaker	Married	Engineer	College	\$15,000	\$20,000	\$5,000
8	Linda Gray	40	F	Methodist	Single	Teacher	College	\$10,000	\$12,000	\$2,000
9	James Hall	58	M	Catholic	Married	Retired	High School	\$8,000	\$10,000	\$2,000
10	Patricia King	35	F	Protestant	Married	Nurse	College	\$10,000	\$12,000	\$2,000

DB **GEODATA**  Louis Berger

DB Consulting & Consulting GmbH • Geodata Engineering AG • Louis Berger AG

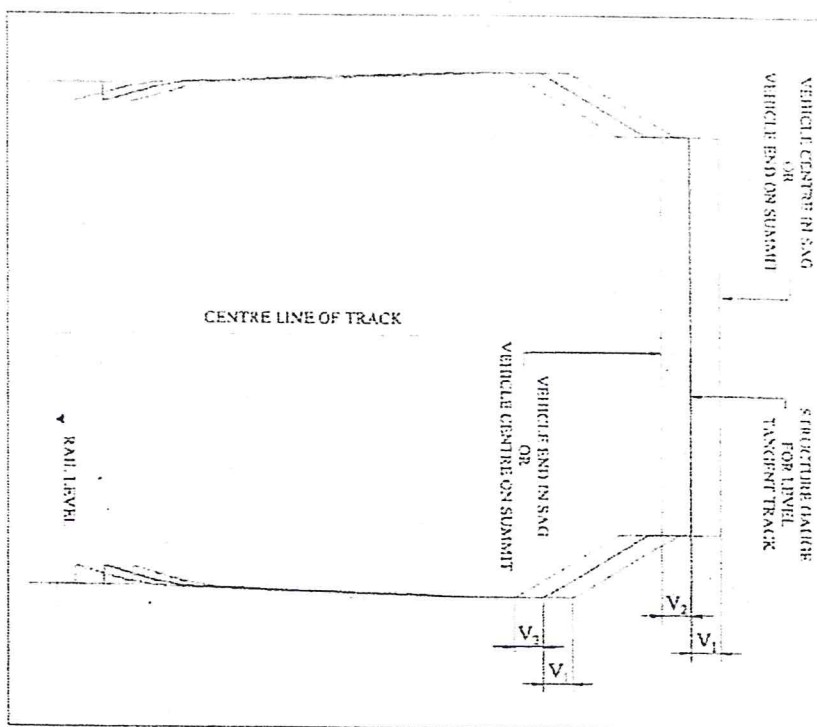
MPMETRO

KRYVIA PROJEKTI KRO PAV. COB. LTD.

EFFECT OF CLAY ON STRUCTURE, GARDING

Page No 45 of 70

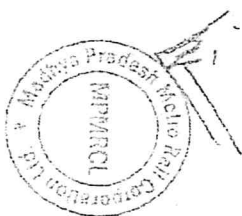
REFERENCE PARA NO. 17 OF A.1.230



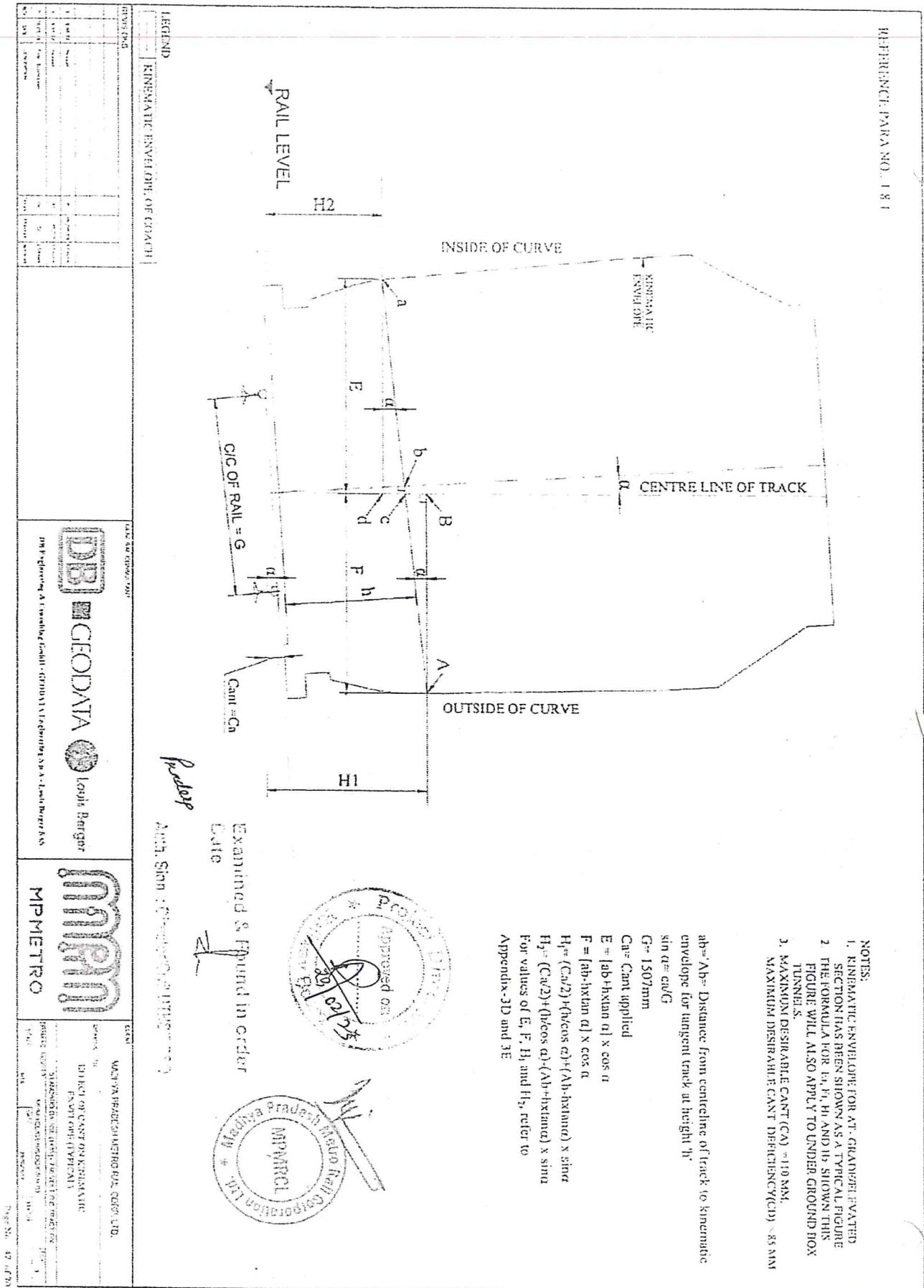
VI = 125 x CTR
V2 = (125 x CTR) - (125 x CTR)
C = ROAD CENTRE DISTANCE
CI = COACH LENGTH

VERTICAL THROW	
RADIUS OF VERTICAL CURVE (m)	
1500	19 22
1600	18 21
1700	17 20
1800	16 19
1900	15 18
2000	14 17
2100	14 16
2200	13 15
2300	12 15
2400	12 14
2500	11 14
2600	11 13
2700	11 12
2800	10 12
2900	10 12
3000	10 11

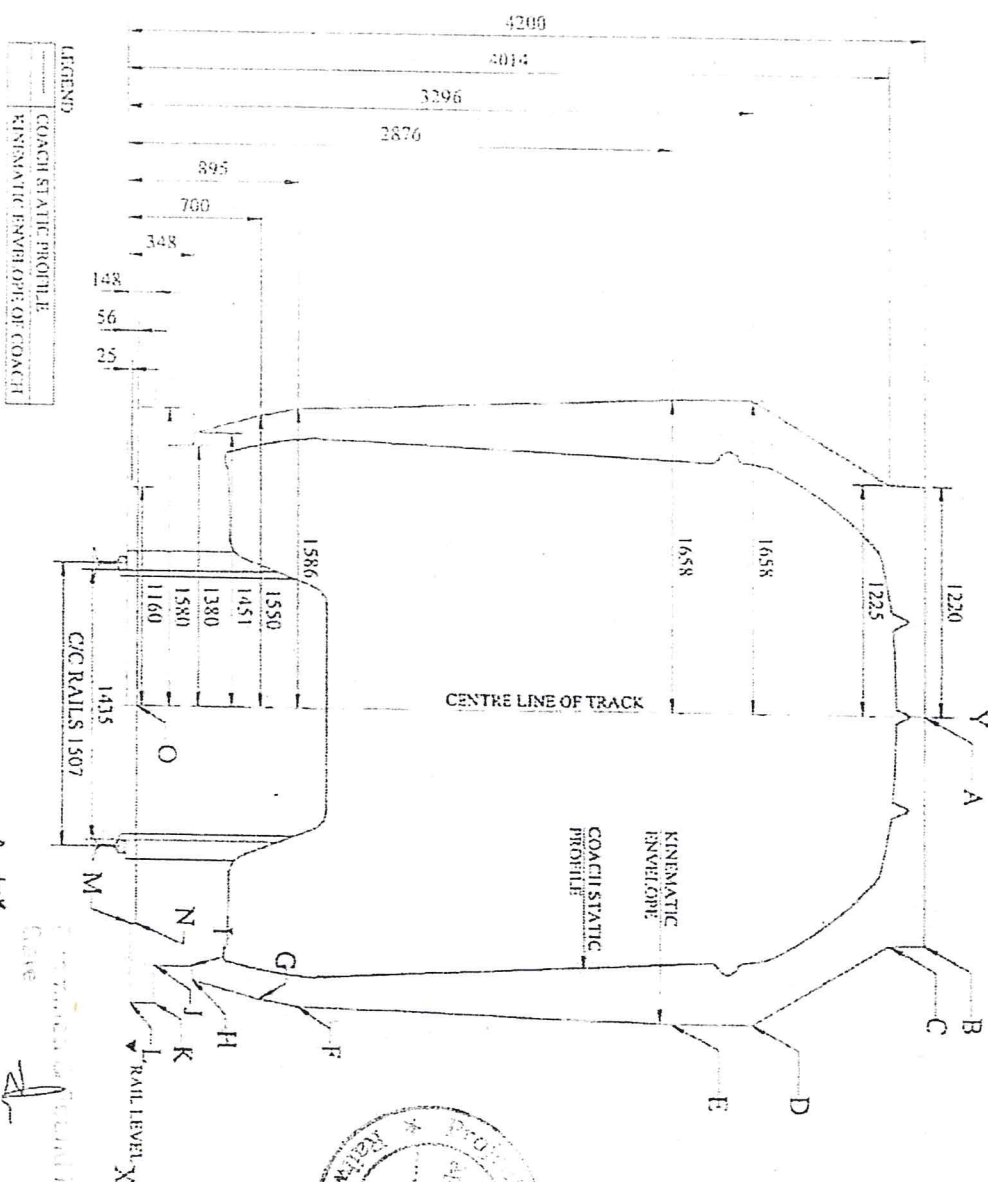
NOTES:
1. THE FIGURE IS TYPICAL AND WILL APPLY TO UNDERGROUND TUNNELS AND AT-GRADE SECTIONS.
2. VALID FOR MAXIMUM SPEED OF 60 KM/PH



DD Engineering & Consulting GmbH - CEODATA Engineering S.p.A. India Branch S.A.		UDAHAPRINTS INDIAN RAIL CO. LTD. PROJECT OF VERTICAL CURVE ON STRUCTURE GAUGE (SAG CURVE)	
Page No. 46 of 46		Date: 27/01/2023	



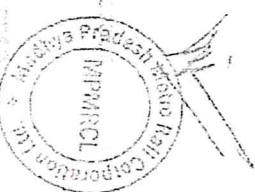
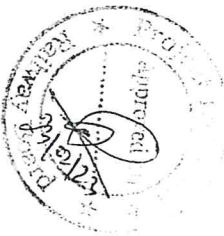
REFERENCE PARA NO. 1.5



LEGEND
COACH STATIC PROFILE
KINEMATIC ENVELOPE OF COACH

SL. NO.	X	Y
A	0	2700
B	1225	4200
C	1225	4014
D	1658	3296
E	1658	2876
F	1586	885
G	1451	705
H	1451	348
I	1380	148
J	1380	56
K	1380	25
L	1160	25
M	1160	25
N	1160	56
O	0	56

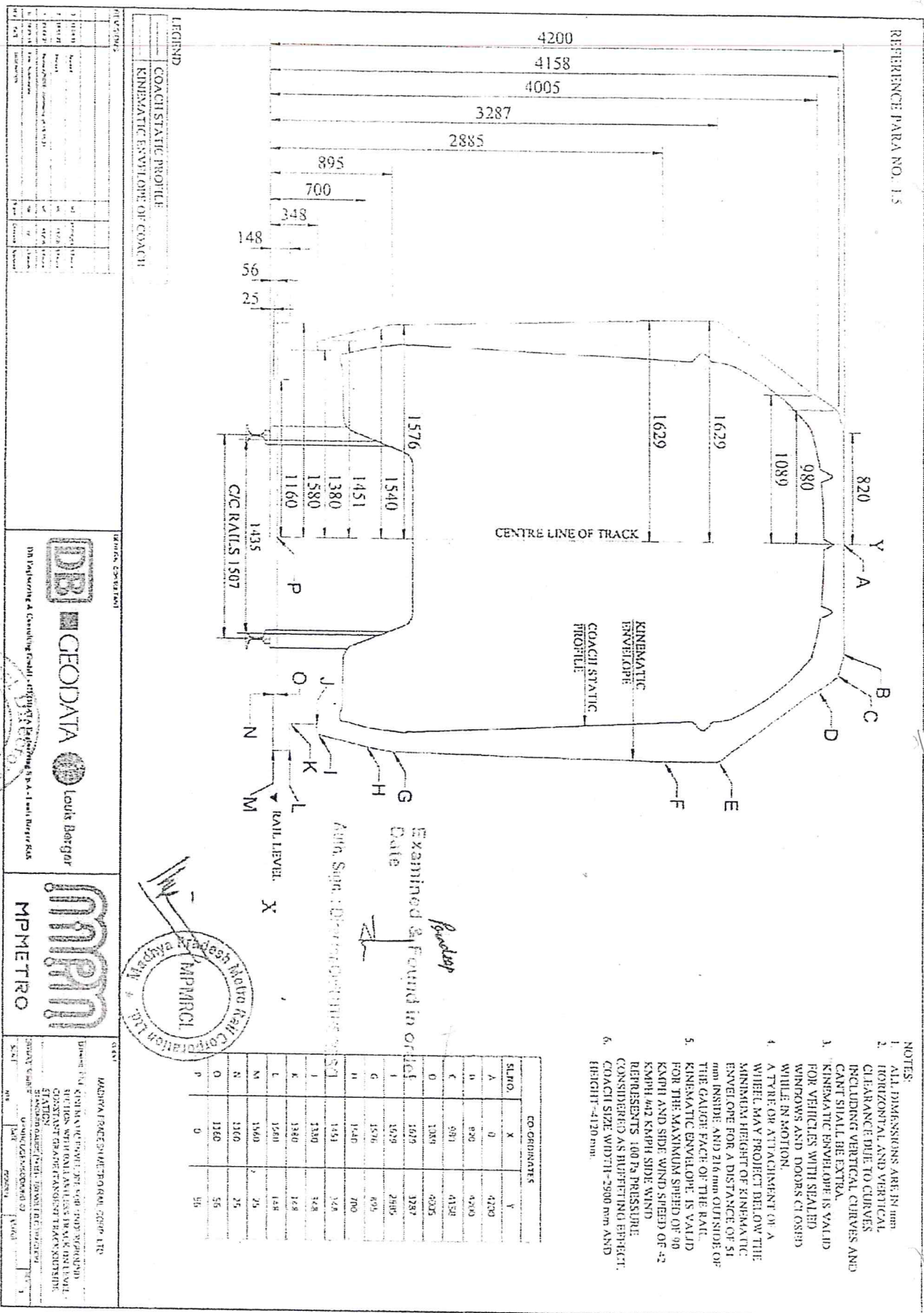
- NOTES:
1. ALL DIMENSIONS ARE IN mm.
 2. HORIZONTAL AND VERTICAL CLEARANCE FROM TRACK CENTERLINE, INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
 3. KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND CLOSED DOORS WHEN IN MOTION.
 4. A TYRE OR ATTACHMENT OF A WHEEL MAY PROJECT BELOW THE MINIMUM HEIGHT OF KINEMATIC ENVELOPE FOR A DISTANCE OF 51 mm, INSIDE AND 216 mm OUTSIDE OF THE GAUGE FACE OF THE RAIL.
 5. THE KINEMATIC ENVELOPE IS FOR A DESIGN SPEED OF 96 kmph WITH WIND SPEED 100 kmph.
 6. COACH SIZE WIDTH 2900 mm AND HEIGHT 4129 mm.



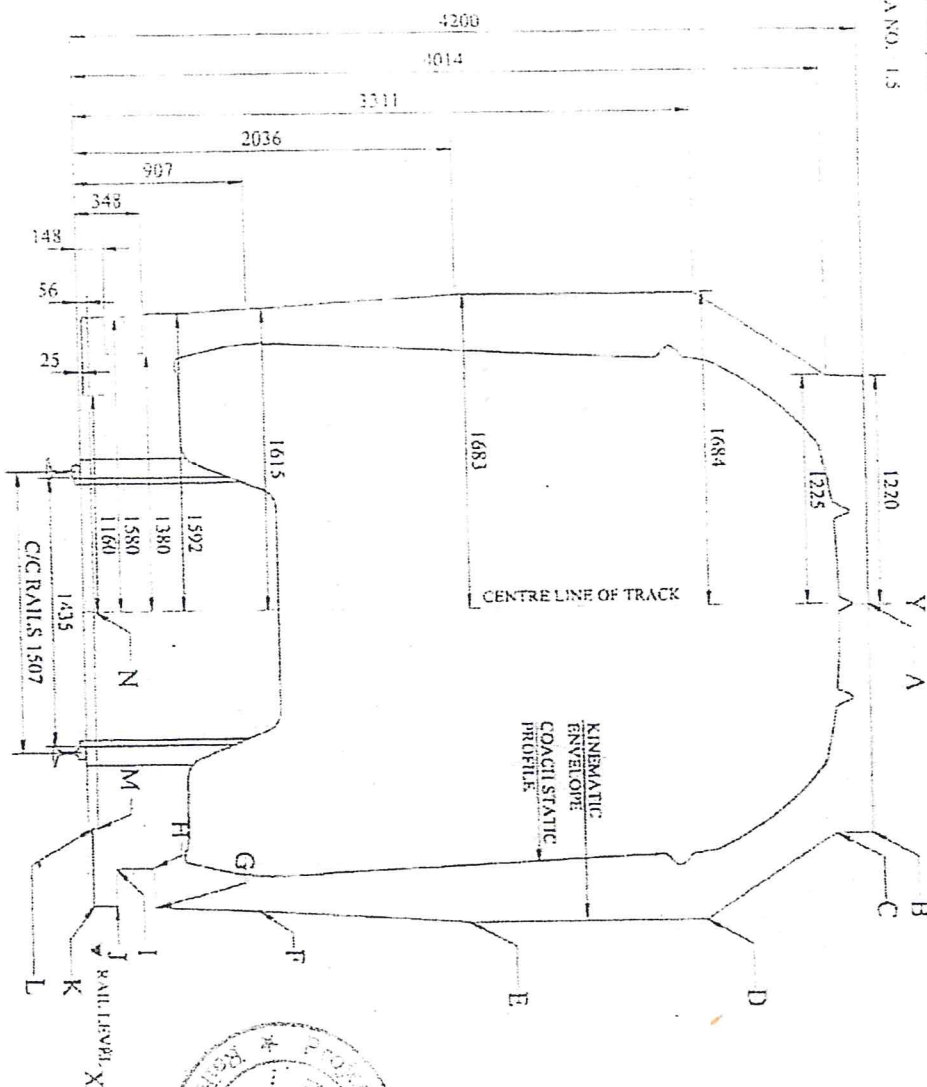
DB GEODATA
DD Projecting & Consulting Limited, C-10/27, A, Park Road, S.P. Road, Bhopal, M.P.

MPMETRO

STATION PROFILE OF INDORE STATION, LTD
KINDLY NOTE: THE TRACK CENTERLINE IS NOT TO BE USED FOR TRACK CENTERLINE / CONSTANT CHORD (CANT) TRACK CENTERLINE STATION
STATION PROFILE OF INDORE STATION, LTD
STATION PROFILE OF INDORE STATION, LTD



REFERENCE PARA NO. 1.5



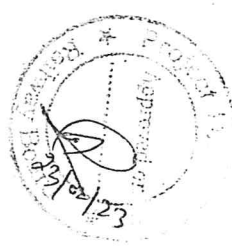
- NOTES:
1. ALL DIMENSIONS ARE IN mm.
 2. HORIZONTAL AND VERTICAL CLEARANCES DUE TO CURVES INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
 3. KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND CLOSED DOORS WHILE IN MOTION.
 4. COACH SIZE WIDTH - 2600 mm AND HEIGHT - 4170 mm.
 5. THE KINEMATIC ENVELOPE IS FOR A DESIGN SPEED OF 90 KM/H WITH MAXIMUM PERMISSIBLE TOLERANCE FOR TRACK AND ROLLING STOCK FOR WIND SPEED OF 100 KM/H.

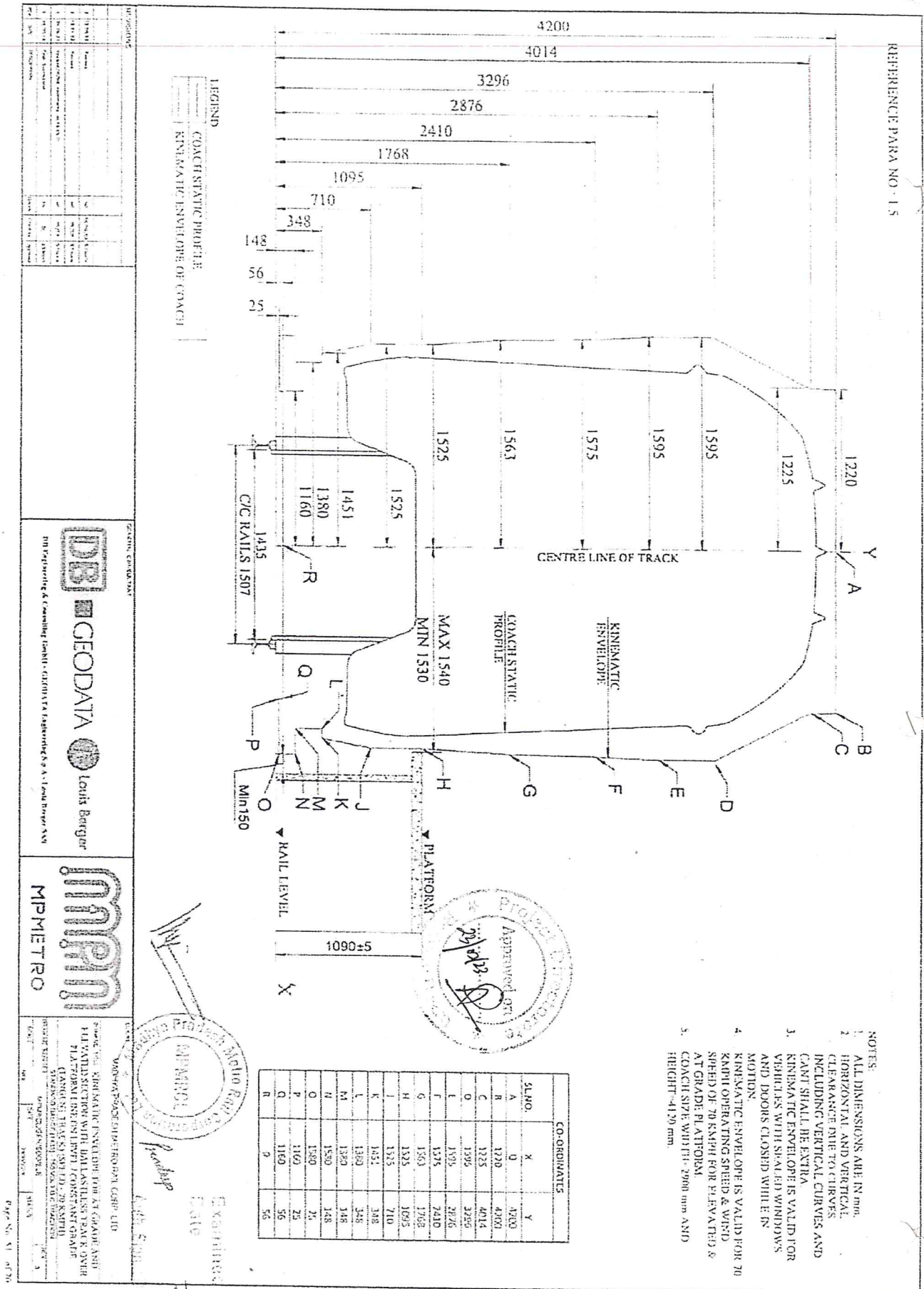
CO-ORDINATES		
S.NO.	X	Y
A	0	4200
B	1220	4200
C	1225	4014
D	1684	1311
E	1683	2036
F	1615	907
G	1592	348
H	1380	148
I	1320	56
J	1580	25
K	1580	25
L	1160	25
M	1160	56
N	0	56

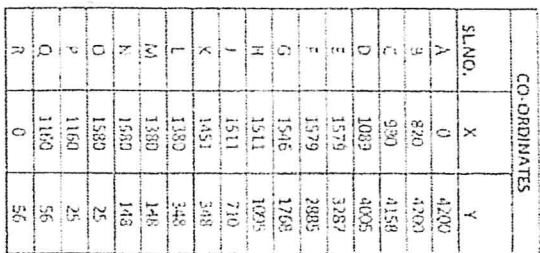
LEGEND
CROSS STATE PROFILE
KINEMATIC ENVELOPE OF COACH

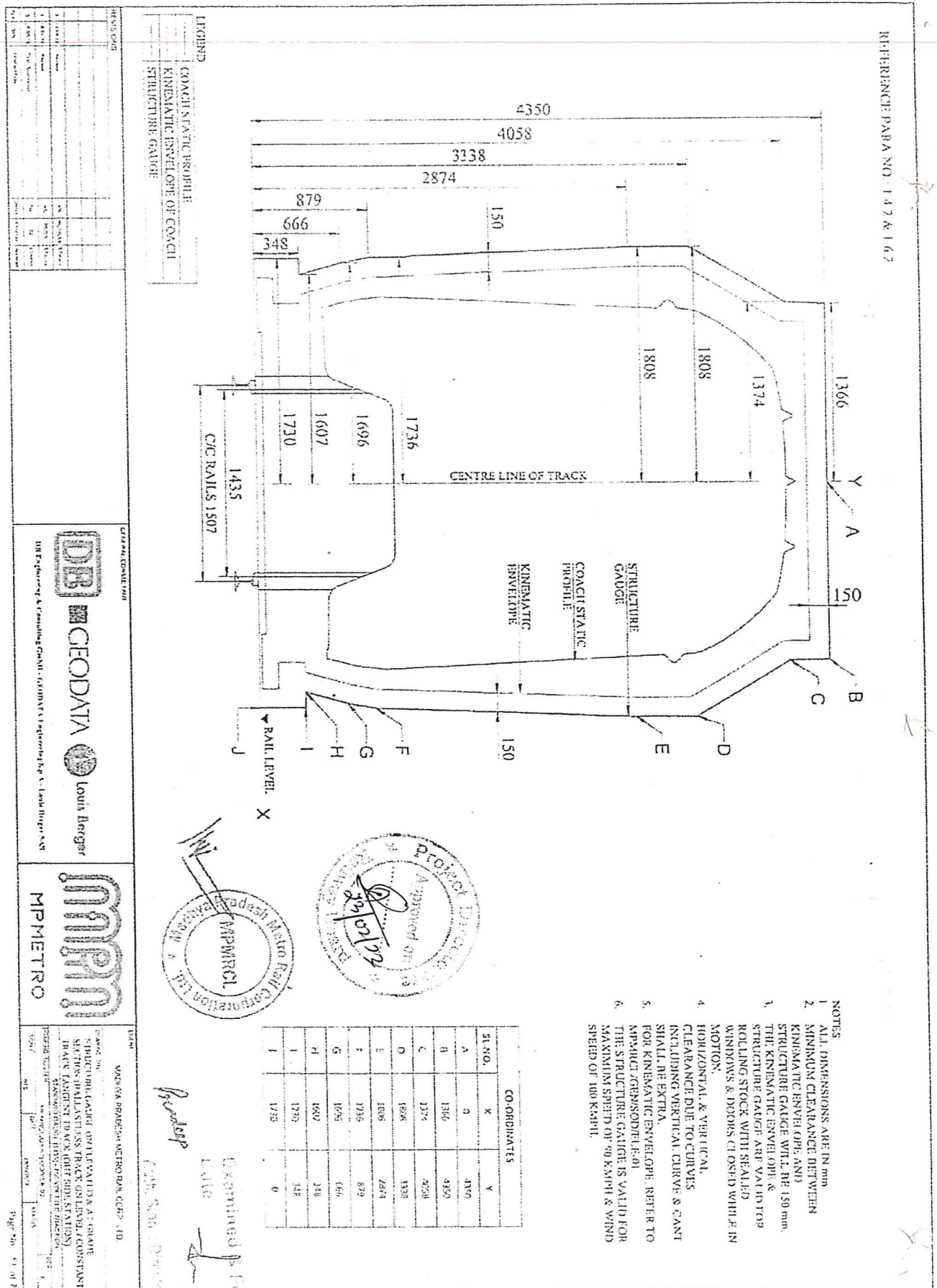


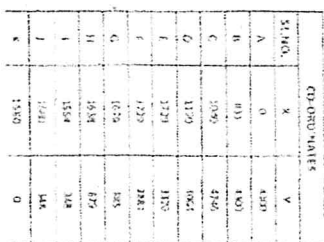
MPMETRO

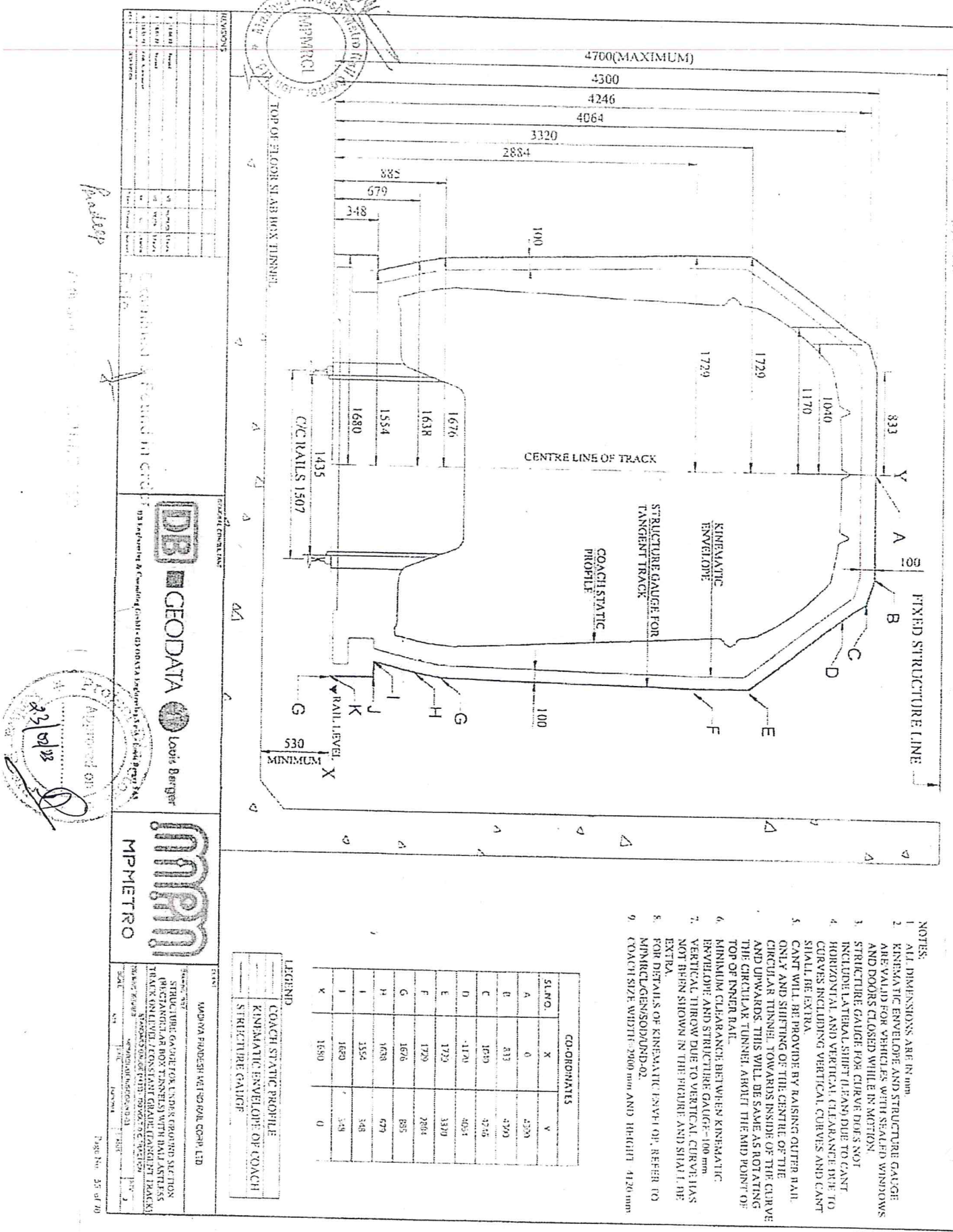


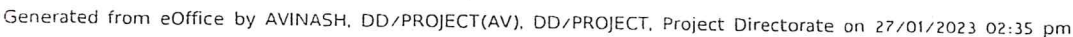












REFERENCE PARA NO. 1.7.1B (a) & 1.7.2 B (a) & APPENDIX-4

$$\tan \theta = (r-D_1) / (g/2)$$

$$\theta = \tan^{-1} [(r-D_1) / (g/2)]$$

$$\sin \alpha = \cos \theta$$

$$\alpha = \sin^{-1} (\cos \theta)$$

$$\text{Chord } c_1 c_2 = 2r [(r-D_1) \sin \theta] \times (\sin \alpha / 2)$$

$$X = c_1 c_2 \times \cos (90 - \theta - \alpha / 2)$$

$$Y = 2 \times [(r-D_1) \sin \theta] \times (\sin \alpha / 2) \times \cos (90 - \theta - \alpha / 2)$$

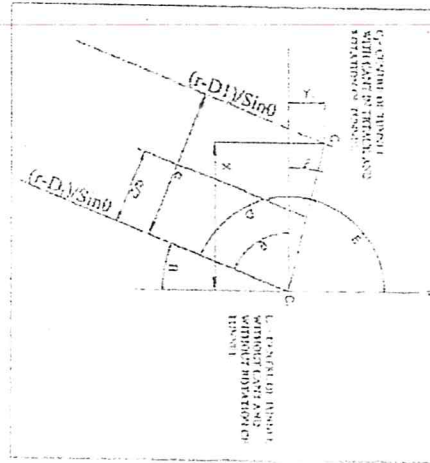
Where r is internal radius of tunnel

D_1 - depth from Rail level to invert of tunnel

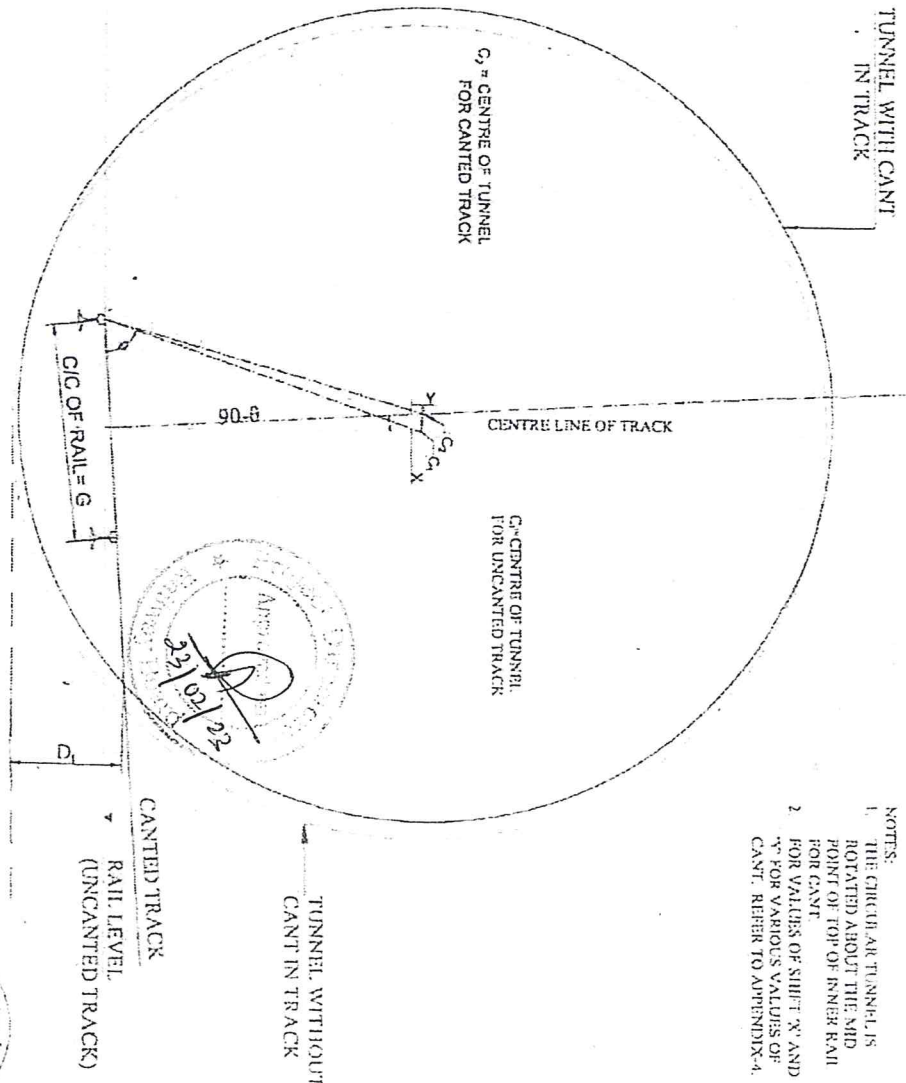
g - distance between centers of rails = 1507mm

DETAIL AT CENTRE OF TUNNEL

Angle B = (90-0)
Angle D = (90- $\alpha/2$)
Angle E = (0+ $\alpha/2$)
Angle F = (90-0- $\alpha/2$)



TUNNEL WITH CANT
IN TRACK



- NOTES:
1. THE CIRCULAR TUNNEL IS ROTATED ABOUT THE MID POINT OF TOP OF INNER RAIL FOR CANT
 2. FOR VALUES OF SHIFT 'X' AND 'Y' FOR VARIOUS VALUES OF CANT, REFER TO APPENDIX-4.

Examined & Found in order
Date: 30/01/2023



DBI GEODATA



Louis Burger



MPMETRO

MACHA PRADASH METRO RAIL CORP. LTD.

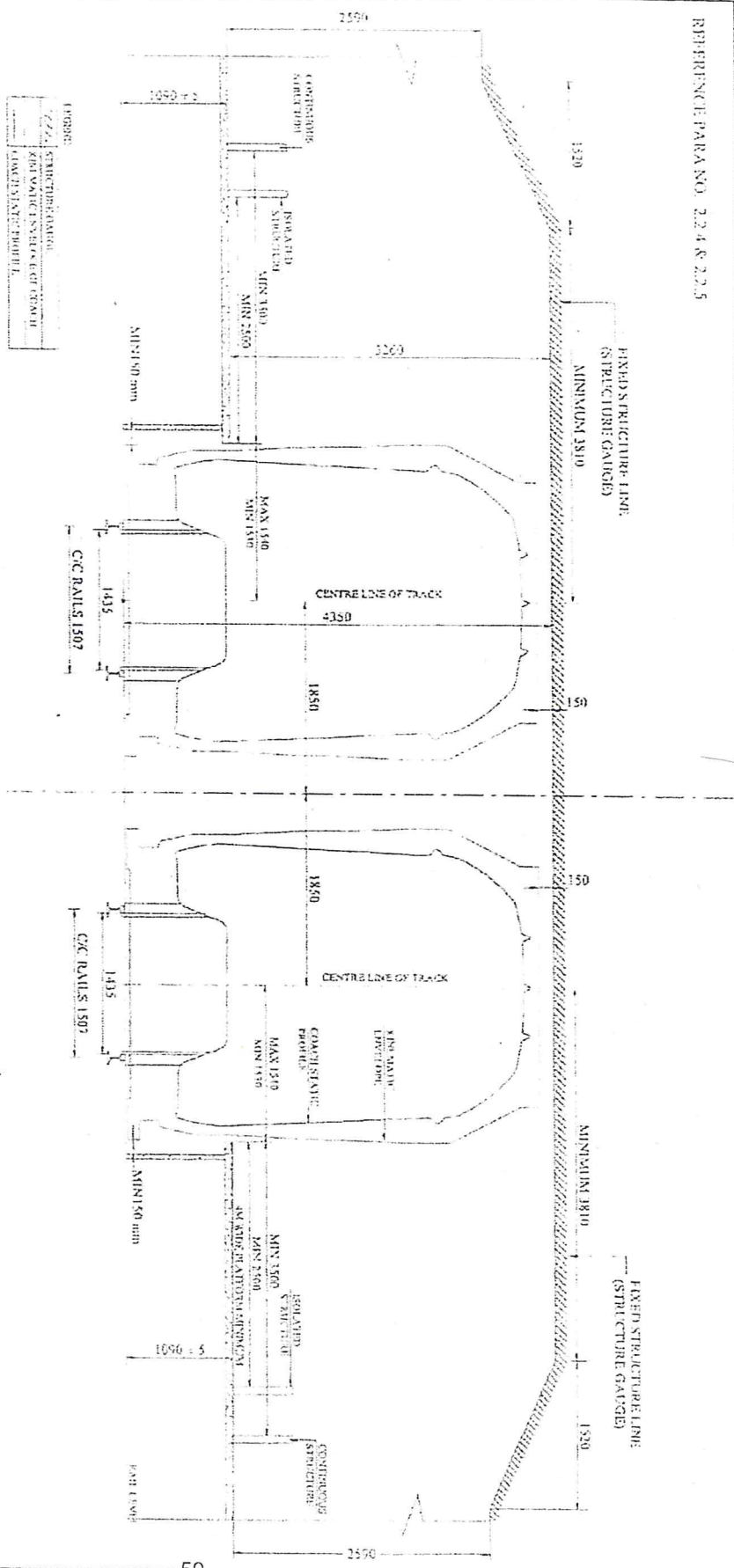
CLEARANCE OF ONE CENTRE TO CIRCULAR TUNNEL

DATE OF INSPECTION: 30/01/2023

NAME OF INSPECTOR: [Signature]

Page No. 5/7 of 70

REFERENCE PARA NO. 2248/2023



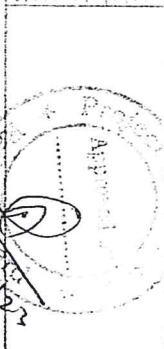
- NOTE
1. ALL DIMENSIONS ARE IN mm
 2. CLEARANCE FOR C/PVI SHALL BE EXTRA HOWEVER THE TRACK CENTRES AT STATION WILL NOT DECREASE WITH CURVES OF RADIUS OF 1000 M & ABOVE
 3. STRICTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS & DOORS CLOSED WHILE IN MOTION.
 4. CLEARANCE FROM TOP IS VALID FOR TO RAIL OPERATING SPEED & WIND SPEED OF 70 KM/H FOR ELEVATION & AT GRADE PLATFORM

Handwritten signature/initials.

Handwritten text: "Check of all points in level" with a checkmark.



Sl. No.	Particulars	Unit	Quantity
1	Design & Detailing of Track	Sq. Mtr	1000
2	Supply & Installation of Track	Sq. Mtr	1000
3	Testing & Commissioning of Track	Sq. Mtr	1000
4	Other	Sq. Mtr	1000
5	Total	Sq. Mtr	4000



DBI Engineering & Consulting Pvt. Ltd.

CEODATA

Logo of DBI Engineering & Consulting Pvt. Ltd.

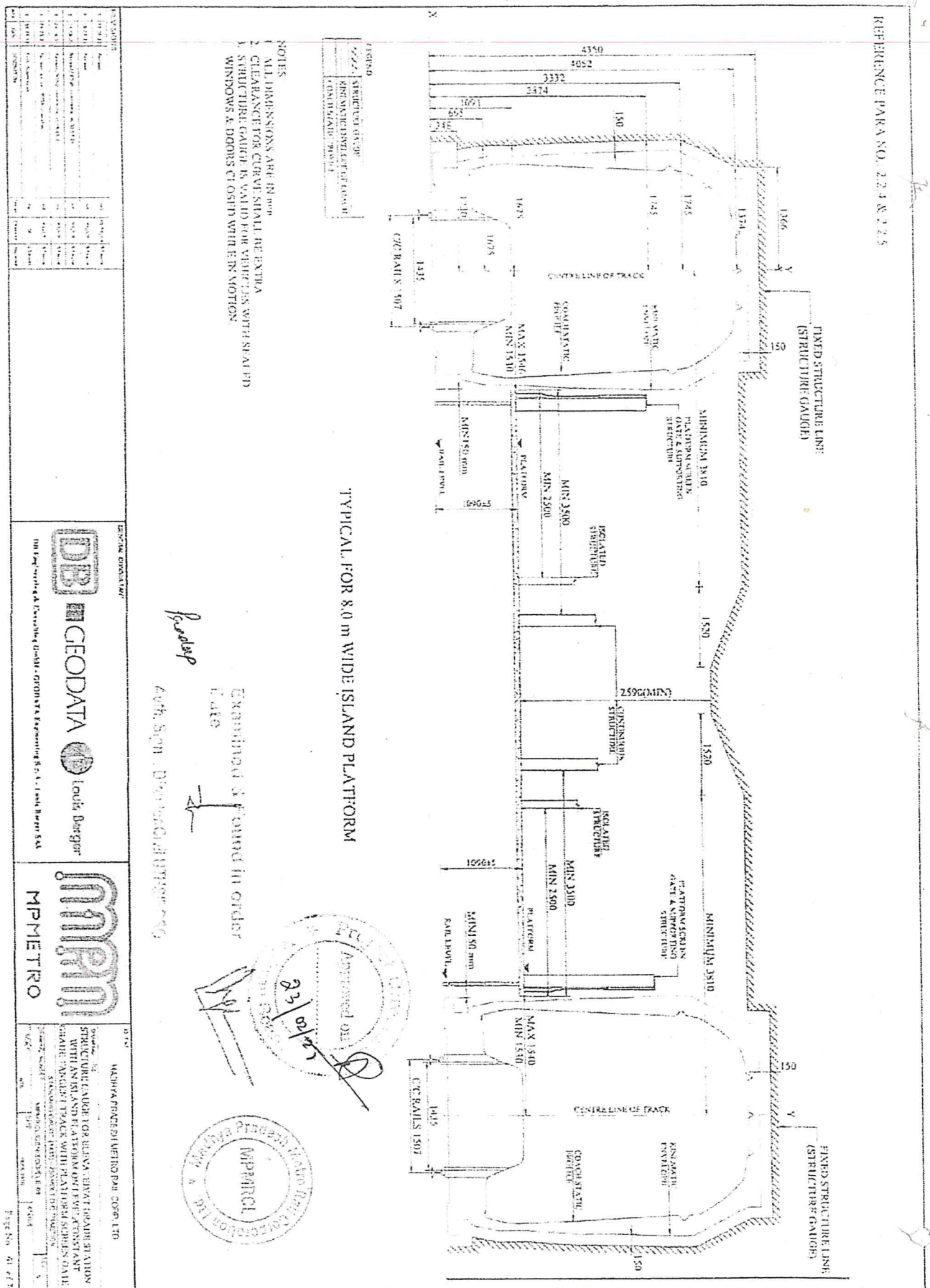
MPMETRO

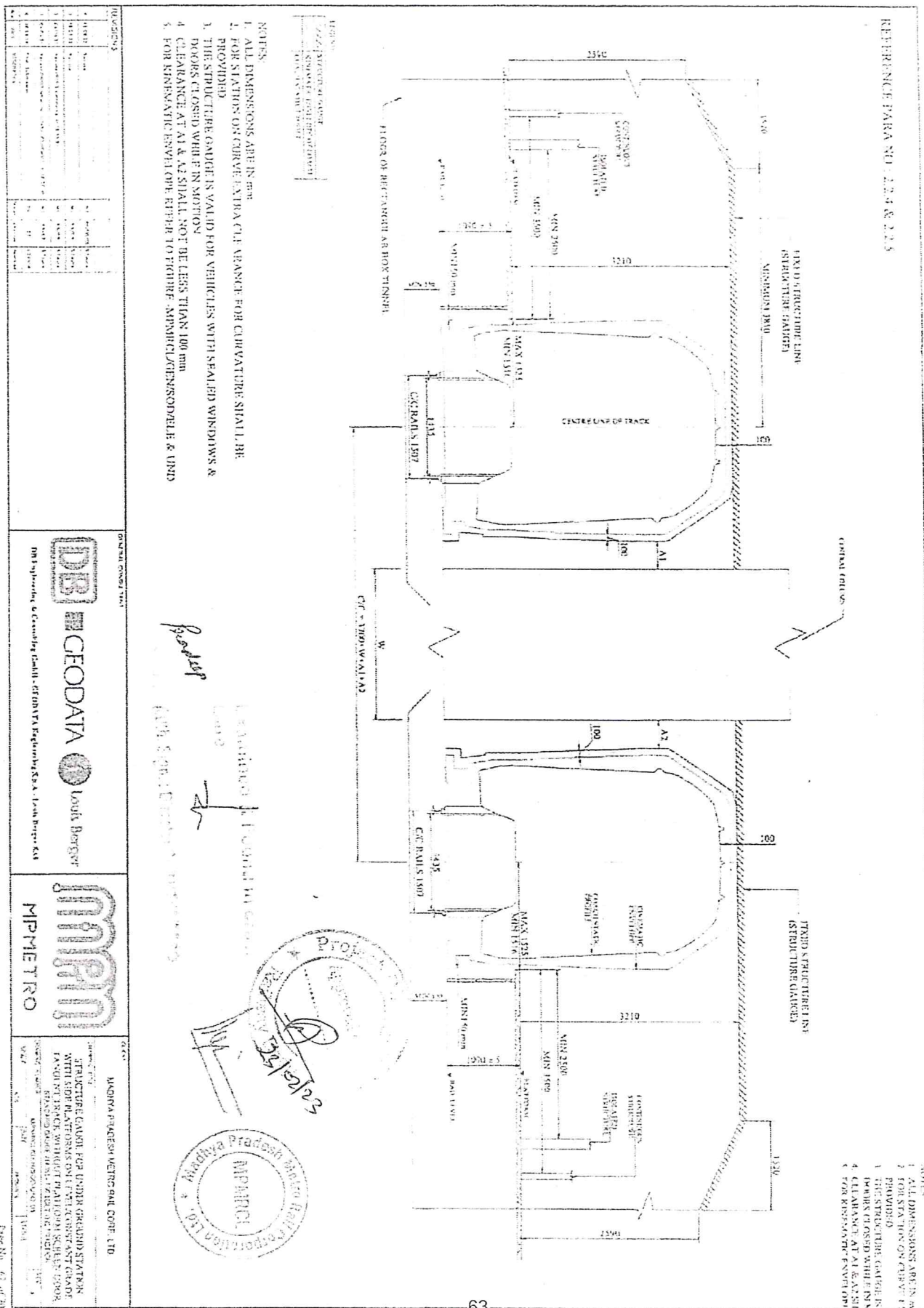
MPMETRO

MPMETRO

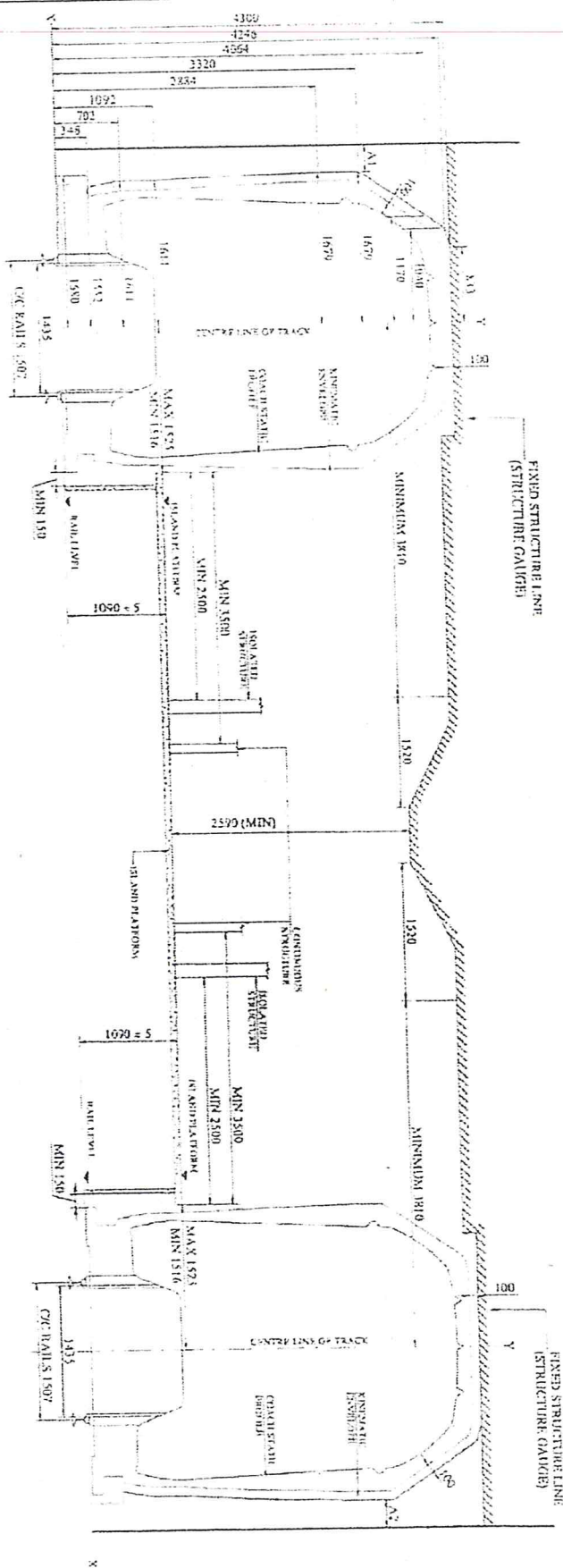








REFERENCE PARA NO. 2.2.4 & 2.2.5



STATION
STATION BUILDING
STATION PLATFORM
STATION TRACK

COORDINATES									
X	D	1040	1170	1679	1573	1646	1611	1611	1552
Y	4390	1245	4384	3320	2824	1764	1092	702	348
									0

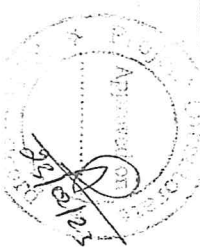
- NOTES
1. ALL DIMENSIONS ARE IN MM.
 2. CLEARANCE FOR CURVE SHALL BE EXTRA.
 3. STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS & DOORS CLOSED WHILE IN MOTION.
 4. CLEARANCES AT A1 & A2 SHALL NOT BE LESS THAN 100 mm.



GEODATA
Louis Bangalore



MPMETRO



Architectural drawings of a fixed structure line structural canal. The drawings include a plan view (top) and a cross-section view (bottom). The plan view shows a rectangular canal with a central 'CENTRE LINE OF CANAL' and various dimensions including 'MIN 1250', 'MAX 1325', and 'MIN 1316'. The cross-section view shows the canal's profile with dimensions like '100', '100', and '100'. A north arrow is present in the upper right corner.

1. ALL DIMENSIONS ARE GIVEN IN MILLIMETERS.
2. FOR STATION ON CURVE, EXTRA CLEARANCE FOR CURVATURE SHALL BE PROVIDED.
3. THE STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS & DOORS CLOSED WHILE IN MOTION.
4. CLEARANCE AT A & A2 SHALL NOT BE LESS THAN 100 mm.
5. FOR KEMPAVE, ETC., PLEASE REFER TO SPECIFICATION: MP/CT/CLDS/IND/MD/02

Project Director
Approved
9/24/02
P. [Signature]

100



No.		Author	Title	Year	Notes
1	1	W. H. R. R.	W. H. R. R.	1910	W. H. R. R.
2	2	W. H. R. R.	W. H. R. R.	1911	W. H. R. R.
3	3	W. H. R. R.	W. H. R. R.	1912	W. H. R. R.
4	4	W. H. R. R.	W. H. R. R.	1913	W. H. R. R.
5	5	W. H. R. R.	W. H. R. R.	1914	W. H. R. R.
6	6	W. H. R. R.	W. H. R. R.	1915	W. H. R. R.
7	7	W. H. R. R.	W. H. R. R.	1916	W. H. R. R.
8	8	W. H. R. R.	W. H. R. R.	1917	W. H. R. R.
9	9	W. H. R. R.	W. H. R. R.	1918	W. H. R. R.
10	10	W. H. R. R.	W. H. R. R.	1919	W. H. R. R.
11	11	W. H. R. R.	W. H. R. R.	1920	W. H. R. R.
12	12	W. H. R. R.	W. H. R. R.	1921	W. H. R. R.
13	13	W. H. R. R.	W. H. R. R.	1922	W. H. R. R.
14	14	W. H. R. R.	W. H. R. R.	1923	W. H. R. R.
15	15	W. H. R. R.	W. H. R. R.	1924	W. H. R. R.
16	16	W. H. R. R.	W. H. R. R.	1925	W. H. R. R.
17	17	W. H. R. R.	W. H. R. R.	1926	W. H. R. R.
18	18	W. H. R. R.	W. H. R. R.	1927	W. H. R. R.
19	19	W. H. R. R.	W. H. R. R.	1928	W. H. R. R.
20	20	W. H. R. R.	W. H. R. R.	1929	W. H. R. R.
21	21	W. H. R. R.	W. H. R. R.	1930	W. H. R. R.
22	22	W. H. R. R.	W. H. R. R.	1931	W. H. R. R.
23	23	W. H. R. R.	W. H. R. R.	1932	W. H. R. R.
24	24	W. H. R. R.	W. H. R. R.	1933	W. H. R. R.
25	25	W. H. R. R.	W. H. R. R.	1934	W. H. R. R.
26	26	W. H. R. R.	W. H. R. R.	1935	W. H. R. R.
27	27	W. H. R. R.	W. H. R. R.	1936	W. H. R. R.
28	28	W. H. R. R.	W. H. R. R.	1937	W. H. R. R.
29	29	W. H. R. R.	W. H. R. R.	1938	W. H. R. R.
30	30	W. H. R. R.	W. H. R. R.	1939	W. H. R. R.
31	31	W. H. R. R.	W. H. R. R.	1940	W. H. R. R.
32	32	W. H. R. R.	W. H. R. R.	1941	W. H. R. R.
33	33	W. H. R. R.	W. H. R. R.	1942	W. H. R. R.
34	34	W. H. R. R.	W. H. R. R.	1943	W. H. R. R.
35	35	W. H. R. R.	W. H. R. R.	1944	W. H. R. R.
36	36	W. H. R. R.	W. H. R. R.	1945	W. H. R. R.
37	37	W. H. R. R.	W. H. R. R.	1946	W. H. R. R.
38	38	W. H. R. R.	W. H. R. R.	1947	W. H. R. R.
39	39	W. H. R. R.	W. H. R. R.	1948	W. H. R. R.
40	40	W. H. R. R.	W. H. R. R.	1949	W. H. R. R.
41	41	W. H. R. R.	W. H. R. R.	1950	W. H. R. R.
42	42	W. H. R. R.	W. H. R. R.	1951	W. H. R. R.
43	43	W. H. R. R.	W. H. R. R.	1952	W. H. R. R.
44	44	W. H. R. R.	W. H. R. R.	1953	W. H. R. R.
45	45	W. H. R. R.	W. H. R. R.	1954	W. H. R. R.
46	46	W. H. R. R.	W. H. R. R.	1955	W. H. R. R.
47	47	W. H. R. R.	W. H. R. R.	1956	W. H. R. R.
48	48	W. H. R. R.	W. H. R. R.	1957	W. H. R. R.
49	49	W. H. R. R.	W. H. R. R.	1958	W. H. R. R.
50	50	W. H. R. R.	W. H. R. R.	1959	W. H. R. R.
51	51	W. H. R. R.	W. H. R. R.	1960	W. H. R. R.
52	52	W. H. R. R.	W. H. R. R.	1961	W. H. R. R.
53	53	W. H. R. R.	W. H. R. R.	1962	W. H. R. R.
54	54	W. H. R. R.	W. H. R. R.	1963	W. H. R. R.
55	55	W. H. R. R.	W. H. R. R.	1964	W. H. R. R.
56	56	W. H. R. R.	W. H. R. R.	1965	W. H. R. R.
57	57	W. H. R. R.	W. H. R. R.	1966	W. H. R. R.
58	58	W. H. R. R.	W. H. R. R.	1967	W. H. R. R.
59	59	W. H. R. R.	W. H. R. R.	1968	W. H. R. R.
60	60	W. H. R. R.	W. H. R. R.	1969	W. H. R. R.
61	61	W. H. R. R.	W. H. R. R.	1970	W. H. R. R.
62	62	W. H. R. R.	W. H. R. R.	1971	W. H. R. R.
63	63	W. H. R. R.	W. H. R. R.	1972	W. H. R. R.
64	64	W. H. R. R.	W. H. R. R.	1973	W. H. R. R.
65	65	W. H. R. R.	W. H. R. R.	1974	W. H. R. R.
66	66	W. H. R. R.	W. H. R. R.	1975	W. H. R. R.
67	67	W. H. R. R.	W. H. R. R.	1976	W. H. R. R.
68	68	W. H. R. R.	W. H. R. R.	1977	W. H. R. R.
69	69	W. H. R. R.	W. H. R. R.	1978	W. H. R. R.
70	70	W. H. R. R.	W. H. R. R.	1979	W. H. R. R.
71	71	W. H. R. R.	W. H. R. R.	1980	W. H. R. R.
72	72	W. H. R. R.	W. H. R. R.	1981	W. H. R. R.
73	73	W. H. R. R.	W. H. R. R.	1982	W. H. R. R.
74	74	W. H. R. R.	W. H. R. R.	1983	W. H. R. R.
75	75	W. H. R. R.	W. H. R. R.	1984	W. H. R. R.
76	76	W. H. R. R.	W. H. R. R.	1985	W. H. R. R.
77	77	W. H. R. R.	W. H. R. R.	1986	W. H. R. R.
78	78	W. H. R. R.	W. H. R. R.	1987	W. H. R. R.
79	79	W. H. R. R.	W. H. R. R.	1988	W. H. R. R.
80	80	W. H. R. R.	W. H. R. R.	1989	W. H. R. R.
81	81	W. H. R. R.	W. H. R. R.	1990	W. H. R. R.
82	82	W. H. R. R.	W. H. R. R.	1991	W. H. R. R.
83	83	W. H. R. R.	W. H. R. R.	1992	W. H. R. R.
84	84	W. H. R. R.	W. H. R. R.	1993	W. H. R. R.
85	85	W. H. R. R.	W. H. R. R.	1994	W. H. R. R.
86	86	W. H. R. R.	W. H. R. R.	1995	W. H. R. R.
87	87	W. H. R. R.	W. H. R. R.	1996	W. H. R. R.
88	88	W. H. R. R.	W. H. R. R.	1997	W. H. R. R.
89	89	W. H. R. R.	W. H. R. R.	1998	W. H. R. R.
90	90	W. H. R. R.	W. H. R. R.	1999	W. H. R. R.
91	91	W. H. R. R.	W. H. R. R.	2000	W. H. R. R.
92	92	W. H. R. R.	W. H. R. R.	2001	W. H. R. R.
93	93	W. H. R. R.	W. H. R. R.	2002	W. H. R. R.
94	94	W. H. R. R.	W. H. R. R.	2003	W. H. R. R.
95	95	W. H. R. R.	W. H. R. R.	2004	W. H. R. R.
96	96	W. H. R. R.	W. H. R. R.	2005	W. H. R. R.
97	97	W. H. R. R.	W. H. R. R.	2006	W. H. R. R.
98	98	W. H. R. R.	W. H. R. R.	2007	W. H. R. R.
99	99	W. H. R. R.	W. H. R. R.	2008	W. H. R. R.
100	100	W. H. R. R.	W. H. R. R.	2009	W. H. R. R.

CELESTIAL CORPORATION



GEO DATA
 Louis Berger



Louis Berger



MPMETRO

10

NADHYA PROGRESS ELECTRONIC CORP. LTD.

STRUCTURAL DAMAGE FOR UNDERGROUND STATION
WITH SIDE PLATFORM ON LEVEL GROUND AND GRADE-
RAISED TRACK WITH PLATFORM SITUATION

RECEIVED
JAN 10 1967

Technical drawing of a bridge section showing two spans. The left span is 1570 units long and the right span is 1570 units long. The total length is 3140 units. The drawing includes dimensions for the main span (1570), approach spans (1090 ± 5), and various structural components like the platform screen door and supporting structure. The center line of the track is marked. The drawing is labeled "C/C RAILS 1507" and "C/C RAILS 1507".

NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. CLEARANCE FOR CURVE SHALL BE EXTRA.
3. STRUCTURE GABLETS VALID FOR VEHICLES WITH SEALED WINDOWS & DOORS CLOSED WHILE IN MOTION
4. CLEARANCES AT A1 & A2 SHALL NOT BE LESS THAN 160

Excluded from order
File

[illegible]

Paradise



Run	Time	Temp	Pressure	Flow	Detector	Response	Retention Time	Identification
1	0.00-0.10	100	1.0	1.0	1.0	1.0	1.0	1.0
2	0.10-0.20	100	1.0	1.0	1.0	1.0	1.0	1.0
3	0.20-0.30	100	1.0	1.0	1.0	1.0	1.0	1.0
4	0.30-0.40	100	1.0	1.0	1.0	1.0	1.0	1.0
5	0.40-0.50	100	1.0	1.0	1.0	1.0	1.0	1.0
6	0.50-0.60	100	1.0	1.0	1.0	1.0	1.0	1.0
7	0.60-0.70	100	1.0	1.0	1.0	1.0	1.0	1.0
8	0.70-0.80	100	1.0	1.0	1.0	1.0	1.0	1.0
9	0.80-0.90	100	1.0	1.0	1.0	1.0	1.0	1.0
10	0.90-1.00	100	1.0	1.0	1.0	1.0	1.0	1.0



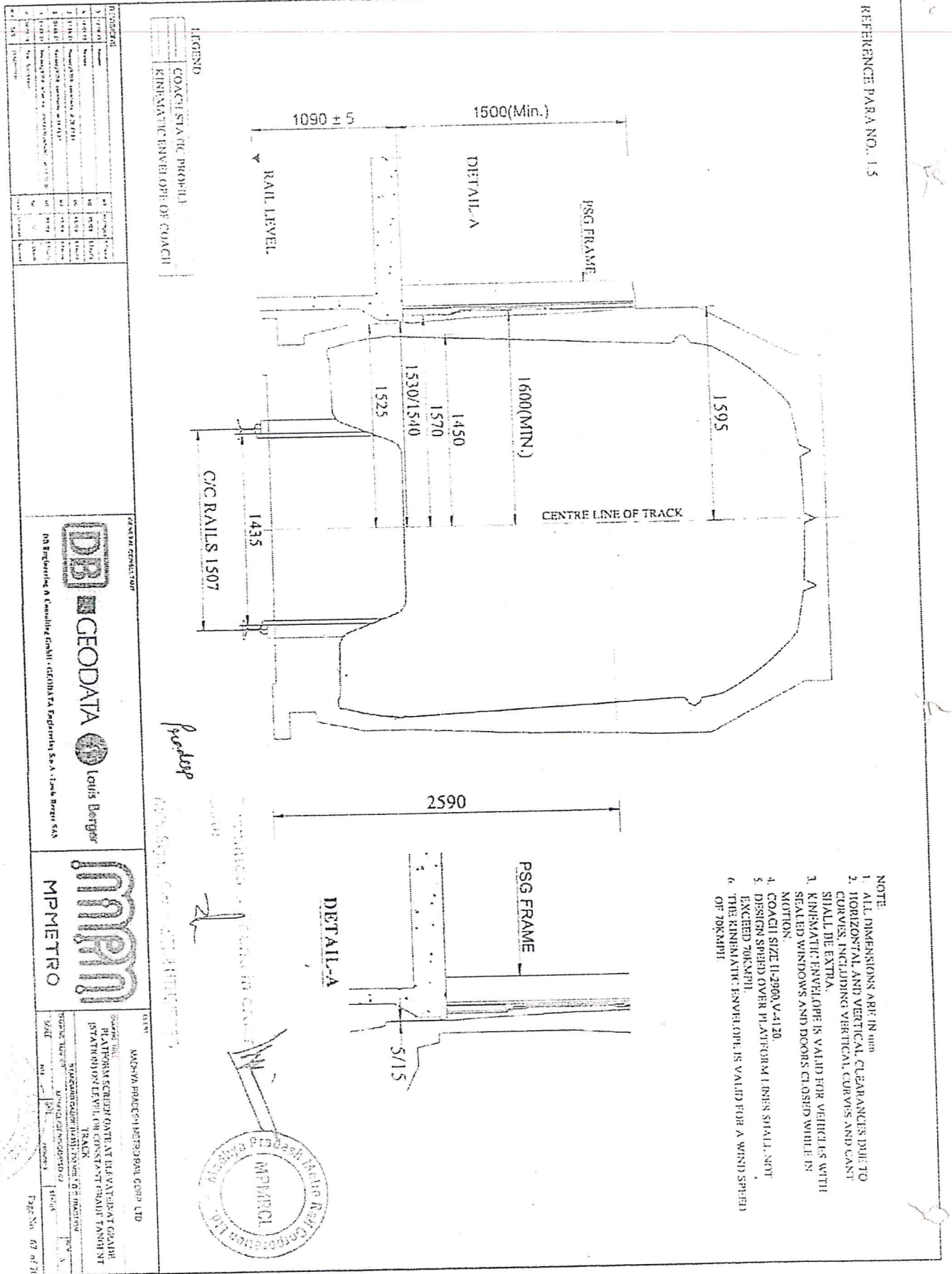
THE GEODATA  Louis Berger

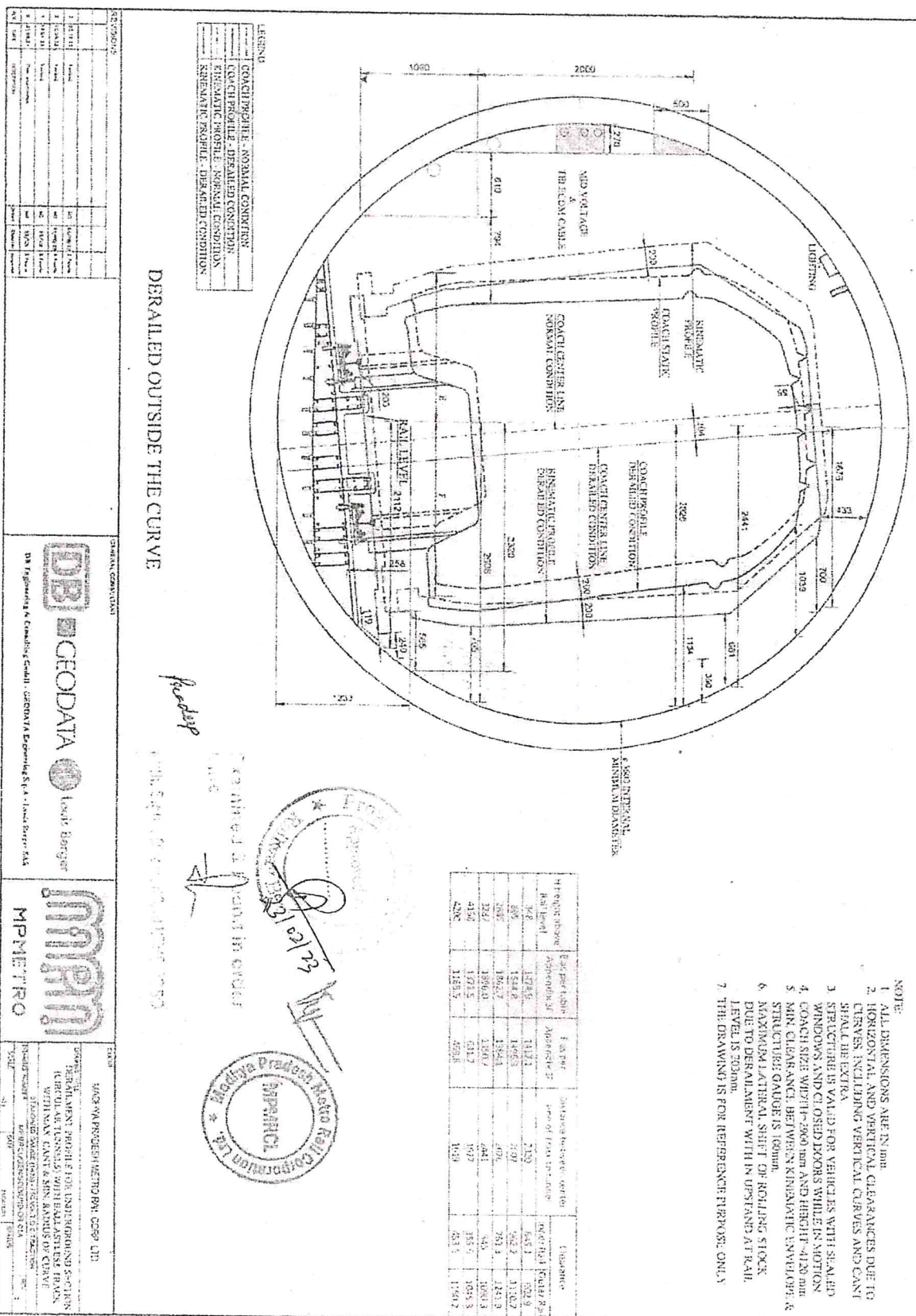
1111 Engineering Dr., Chesapeake, CA 94003, U.S.A. Virginia Tech., 1000 College Ave., Blacksburg, VA 24061, U.S.A.

MPMETRO

MOBIO PLASTICS NITRO RAIL CO., LTD.
SUSPECT GUNTS FOR TRADING GROUND STATIONS
WIND ISLAND PLANT WITH PLANT KIDS PART BORD
TANGENT TRACER WITH PLANT KIDS PART BORD
GROUNTS GROUND PLANT KIDS PART BORD
UNION/PLASTICS NITRO RAIL CO., LTD.
[Signature] [Stamp]







DB ENGINEERING & CONSULTING

CEODATA

MPMRCL

Page No. 68 of 70

