Madhya Pradesh Metro Rail Corporation Limited (MPMRCL)

(A Joint Venture of Government of India and Government of Madhya Pradesh)

CIN: U75100MP2015SGC034434

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Corrigendum – 7

No.: 0114/MPMRCL/2022 **Date: 31.01.2022**

With reference to Tender Notification No.: 1427/MPMRCL/2021/Package BH&IN-02, Date: 02.11.2021, regarding "Design, Manufacture, Supply, Installation, Testing, Commissioning and Training of Standard Gauge Passenger Rolling Stock Cars (with 15 Years Comprehensive Maintenance) – 81 Cars for Bhopal and 75 Cars for Indore, including Signalling & Train Control and Telecommunication Systems (with 7 Years Comprehensive Maintenance)" for Bhopal Metro Rail Project and Indore Metro Rail Project, following corrigendum are issued in pursuant to clause 3.5 of Volume I – ITT. The corrigendum will be part of the said tender document.

Sr. No.	Tender Document Reference	Clause/Sub-Clause/Para (Page No)	Clause Description (relevant portion) as existing in the Tender Documents	Clause Description (relevant portion) as amended now to be read as
1	Volume 1 Part-2	As per Clause No.2.3.1 of Part-	In case of Foreign Partners, Power of Attorney(ies) and Board Resolution(s) confirming authority on the	In case of Foreign Partners, Power of Attorney(ies) and Board Resolution(s) confirming authority on the

Sr. No.	Tender Document Reference	Clause/Sub-Clause/Para (Page No)	Clause Description (relevant portion) as existing in the Tender Documents	Clause Description (relevant portion) as amended now to be read as
		2:	persons issuing the Power of Attorney for such actions, shall be submitted duly notarised by the notary public in the country of origin and stamped by the Indian Embassy or High Commission. However, the Power of Attorney(ies) and Board Resolution(s) provided by the tenderers from the countries that have signed the Hague Legislation Convention 1961, are not required to be legalised by the Indian Embassy, if it carries a confirming Apostille Certificate. If the documents are in foreign language the translation of the same in English shall be authenticated by Indian Embassy or High Commission.	persons issuing the Power of Attorney for such actions, shall be submitted duly notarised by the notary public in the country of origin and stamped by the Indian Embassy or High Commission. However, the Power of Attorney(ies) and Board Resolution(s) provided by the tenderers from the countries that have signed the Hague Legislation Convention 1961, are not required to be legalised by the Indian Embassy, if it carries a confirming Apostille Certificate. If the documents are in foreign language the translation of the same in English shall be authenticated by Indian Embassy or High Commission. However, due to unavoidable circumstances if embassy is not able to apostille, the document duly notarised may be accepted.
2	Volume I, Part 3: EQC	EQC - 10.3.1, Notes: (xiii) (Page 170 of 239) & Corrigendum-3 S. No. 22	xiii. Tenderers may propose more than one Subcontractor to satisfy these criteria 10.3 [Work Experience for Signalling & Train Control] in tender submission. Each proposed Subcontractor(s) shall be evaluated and the qualified proposed Subcontractor(s) shall be terms as “Specialist Subcontractor”. In case, none of the proposed	xiii. Tenderers may propose more than one Subcontractor to satisfy these criteria 10.3 [Work Experience for Signalling & Train Control] in tender submission. Each proposed Subcontractor(s) shall be evaluated and the qualified proposed Subcontractor(s) shall be terms as “Specialist Subcontractor”. In case, none of the proposed

Sr. No.	Tender Document Reference	Clause/Sub-Clause/Para (Page No)	Clause Description (relevant portion) as existing in the Tender Documents	Clause Description (relevant portion) as amended now to be read as
		(8 of 133)	Subcontractor(s) in tender submissions is meeting these criteria, then the Tender shall be treated as nonresponsive and no alternative proposal shall be considered during tender evaluations. However, the Tenderer/ Contractor shall be free to choose any of the qualified Specialist Subcontractor, or alternatively may propose any new Specialist Subcontractor (after award of the Contract) than those proposed at tender stage, which shall be subject to meeting these criteria and with written approval of the Employer. Quoted rates and prices shall be deemed inclusive for whichever Specialist Subcontractor(s) is(are) appointed, and no adjustment of the rates and prices shall be permitted.	Subcontractor(s) in tender submissions is meeting these criteria, then the Tender shall be treated as nonresponsive and no alternative proposal shall be considered during tender evaluations. However, the Tenderer/ Contractor shall be free to choose any of the qualified Specialist Subcontractor, or alternatively may propose any new Specialist Subcontractor (after award of the Contract) than those proposed at tender stage, which shall be subject to meeting these criteria and with written approval of the Employer. Any new Specialist Subcontractor (after award of the Contract) will be permitted only if the previously qualified proposed Subcontractor is unable to execute the Works for whatsoever reason. Quoted rates and prices shall be deemed inclusive for whichever Specialist Subcontractor(s) is(are) appointed, and no adjustment of the rates and prices shall be permitted.
3	Volume II, PC, Part B: Special Provisions	PC 13.3.1 (1) (215 of 244) & Corrigendum-3	(1) Variations in case of Rolling Stock: The Contractor shall be bound to carry out and complete the stipulated work as instructed by the Engineer.	(1) Variations in case of Rolling Stock: The Contractor shall be bound to carry out and complete the stipulated work as instructed by the Engineer.

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		S. No. 64 (27 of 133)	The Employer is entitled to vary about increase of the total quantity up to 6 (six) complete 3-car Train-sets, each for Bhopal and Indore. The Employer may exercise the option on any day before 180 days of the scheduled delivery of last trainset/s. The Contractor shall be required to supply increased ordered quantities at the contracted terms & conditions and determined prices as detailed in Pricing Document Sub-Clause 2.15. The Contract Price for Defect Liability and Comprehensive Maintenance Period for the actual additional quantities shall be adjusted proportionately. In case of increase in quantity beyond the original tendered quantity, the Key Dates for the increased quantities shall be as mutually agreed between the Contractor and the Employer. The Employer is entitled to vary about increase of the Comprehensive Maintenance Period to enable the Contractor for completion of major overhaling of Rolling Stock systems/ sub-systems as per scheduled maintenance programme, subject to maximum of 5 (five) years, each for Bhopal and	The Employer is entitled to increase the total quantity up to 6 (six) complete 3-car Train-sets, each for Bhopal and Indore. The Employer may exercise the option on any day before 180 days of the scheduled delivery of last trainset/s. The Contractor shall be required to supply increased ordered quantities at the contracted terms & conditions and determined prices as detailed in Pricing Document Sub-Clause 2.15. The Contract Price for Defect Liability and Comprehensive Maintenance Period for the actual additional quantities shall be adjusted proportionately. In case of increase in quantity beyond the original tendered quantity, the Key Dates for the increased quantities shall be as mutually agreed between the Contractor and the Employer. The Employer is entitled to increase the Comprehensive Maintenance Period to enable the Contractor for completion of major overhaling of Rolling Stock systems / sub-systems as per scheduled maintenance programme, subject to maximum of 5 (five) years, each for Bhopal and Indore. This will be applicable to Rolling Stock scope

<table>
<tr><th>Sr. No.</th><th>Tender Document Reference</th><th>Clause/Sub-Clause/Para (Page No)</th><th>Clause Description (relevant portion) as existing in the Tender Documents</th><th>Clause Description (relevant portion) as amended now to be read as</th></tr>
<tr><td></td><td></td><td></td><td>Indore. The Employer’s decision about the period of extension shall be final and binding on the Contractor. The Employer may exercise the option on any day before 180 days of the scheduled completion of DLCMP. The Contractor shall be required to executed extended DLCMP at the contracted terms & conditions and at the price of last year.</td><td>only. The Employer’s decision about the period of extension shall be final and binding on the Contractor. The Employer may exercise the option on any day before 180 days of the scheduled completion of DLCMP. The Contractor shall be required to execute the extended DLCMP at the contracted terms & conditions and at the price as given below:<table><tr><td>Year 16</td><td>180%</td></tr><tr><td>Year 17</td><td>90%</td></tr><tr><td>Year 18</td><td>110%</td></tr><tr><td>Year 19</td><td>100%</td></tr><tr><td>Year 20</td><td>130%</td></tr></table></td></tr>
<tr><td>4</td><td>Volume III Part 1: ERGS-RS</td><td>1.1.5 (3rd sentence (11 of 397)</td><td>The Contractor shall ensure that major overhaul (except mid-life refurbishment related activities) of all the systems of Rolling Stock have been performed at least once during the contract period.</td><td>The Contractor shall ensure that major overhaul (except mid-life refurbishment related activities) of all the systems of Rolling Stock have been performed at least once during the contract period (including extension of 5 years as per PC 13.3.1(1)).</td></tr>
<tr><td>5</td><td>Volume III Part 1: ERGS-RS</td><td>26.1.4 2nd sentence (133 of 397)</td><td>However, maintenance of M&P procured by MPMRCL (mentioned in Appendix XI) will not come under the scope of Contractor.</td><td>Maintenance of M&P procured by MPMRCL (mentioned in Appendix XI) will not come under the scope of Contractor. However, electricity consumption charges of all the depot M&Ps will be borne by the Contractor.</td></tr>
</table>

Sr. No.	Tender Document Reference	Clause/Sub-Clause/Para (Page No)	Clause Description (relevant portion) as existing in the Tender Documents	Clause Description (relevant portion) as amended now to be read as
6	Volume III Part 1: ERGS-RS	APPENDIX VIII SPARES (Table 1.1) (356 of 397)	S. No. 33: Automatic Track monitoring system complete (with Camera).	Deleted.
7	Volume III Part 2: ERGS -S&T	5.16. Table 1. (66 of 233)	Table 1. Mandatory Contractor OHS&E Management Resource Requirement	Refer Attachment – 1 to Corrigendum – 7 for amended Table 1.
8	Volume III Part 2: ERGS -S&T	Appendix 13 N15 (128 of 134)	N15	Refer Attachment – 2 to Corrigendum – 7 for amended Appendix 13, N15
9	Volume III Part 2: ERGS -S&T	Annexure 1 Chapter - 03. (221 of 233)	3 Programme Management Software CPM programming software shall be Primavera Project Planning (P6) Program & TILOS of the latest version. The Contractor shall supply the Employer/Engineer with an original and two (2) copies of licence, including manuals and approved training of the software and any subsequent versions thereof at no extra cost	3 Programme Management Software CPM programming software shall be Primavera Project Planning (P6) Program or the latest version. The Contractor shall supply the Employer/Engineer with an original one copy of licence, including manuals and provide training of the software and any subsequent versions thereof at no extra cost.
10	Volume IV Part 1: ERTS-RS	2.5.8 (2nd line) (21 of 492)	This shall be submitted within 2 months of Commencement Date and revised and updated for	This shall be revised and updated for the completion of the preliminary, pre-final and final design stages.

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			the completion of the preliminary, pre-final and final design stages.	
11	Volume IV Part 1: ERTS-RS	2.17.1 (2nd paragraph) (43 of 492)	The inspection will be based to check the functionalities not covered under Type 4 Service Failure (SF4) and the aesthetics for which the reference will be a guideline that will be finalized during design stage.	The inspection will be based to check all the functionalities and the aesthetics for which the reference will be a guideline that will be finalized during design stage.
12	Volume IV, Part 1: ERTS-RS	2.22.3 (i) & 2.22.5 (i) (49 & 50 of 492)	During Stationary condition the specified limits shall be met with all auxiliary equipment operating simultaneously at maximum capacity.	During Stationary condition the specified limits shall be met with auxiliary equipment operating simultaneously as specified in the latest version of standard mentioned in 2.22.1(ii).
13	Volume IV Part 1: ERTS-RS	2.22.5 (iii) (50 of 492)	For running conditions, the specified limits shall be met for the entire speed range up to 80kmph (including acceleration and deceleration) with all equipment operating simultaneously. Noise level measurement to be done at a location 7.5m horizontally from the track centre-line on a horizontal plane passing through the axle centrelines/floor level.	For running conditions, the specified limits shall be met for the entire speed range as per ISO 3095 (including acceleration and deceleration) with all equipment operating simultaneously. Noise level measurement to be done at the locations as per ISO 3095.
14	Volume IV Part 1: ERTS-RS	2.24.2.5 (52 of 492)	The system shall be able to distinguish between dusty tunnel/saloon environment and other smoke/fume sources such as diesel fumes from smoke being caused by fire.	Deleted.

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15	Volume IV Part 1: ERTS-RS	3.21.6 (73 of 492)	The Tenderer shall ensure that the cars conform to the latest version of Schedule of Dimension which shall be made available during detail design stage.	The Tenderer shall ensure that the cars conform to the latest version of Schedule of Dimension which shall be made available during detail design stage. However, draft Schedule of Dimension has been attached at attachment-3 of Corrigendum-7 for the Contractor reference but any changes in the final approved SoD by RDSO / RB have to be complied by the Contractor at no extra cost to the Employer.
16	Volume IV Part 1: ERTS-RS	3.23.1 (ii) (74 of 492)	AW1: The weight of the vehicle with all seats occupied and one passenger in a wheelchair, the weight of passenger as 65 kg each.	AW1: The weight of the vehicle with all seats occupied, the weight of passenger as 65 kg each.
17	Volume IV Part 1: ERTS-RS	4.18.4 (vii) (119 of 492)	Flip type seats shall be provided in the wheelchair area.	Deleted.
18	Volume IV Part 1: ERTS-RS	4.18.7 (x) (122 of 492)	The floor, and its mounting structure, shall be designed to withstand any loads that may be applied over 35 years in normal operation of metro train. Floor shall resist to a load of 1.5 times the passenger load corresponding to 10 passenger /m2 (950 daN/m2) and to a stamping effort of 35 daN on a surface.	The floor, and its mounting structure, shall be designed to withstand any loads that may be applied over 35 years in normal operation of metro train. The floor shall be designed for load corresponding to 10 passenger/m2 at least with suitable margin to be decided during design stage. However, damage of floor or loss of aesthetics, on account of floor not being able to resist the required load of passengers may be considered for penalty under clause 2.11

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				and 2.17.1.
19	Volume IV Part 1: ERTS-RS	5.1.1 (129 of 492)	Further, during contract execution, the manufacture of the bogies by the sub-contractor shall be required to be inspected and certified by a reputed Third-Party Inspecting Agency engaged by the Contractor having sufficient previous experience of similar nature. The contractor's proposal for engaging Third Party Inspecting Agency with detailed terms of reference (TOR) indicating detailed scope of work shall be submitted to Engineer for the approval not later than six (06) months from the commencement date. However, maintaining the quality standards, ensuring performance requirement and timely delivery shall be the sole responsibility of the contractor.	Further, during contract execution, the manufacture of the bogies by the sub-contractor shall be required to be inspected and certified by a reputed Third-Party Inspecting Agency engaged by the Contractor having sufficient previous experience of similar nature. The contractor's proposal for engaging Third Party Inspecting Agency with detailed terms of reference (TOR) indicating detailed scope of work shall be submitted to Engineer for the approval not later than six (06) months from the commencement date. The decision to engage third-party agency will be taken by the Employer/Engineer during design stage. However, maintaining the quality standards, ensuring performance requirement and timely delivery shall be the sole responsibility of the contractor.
20	Volume IV Part 1: ERTS-RS	6.2.5 (Formula) (147 of 492)	Compressor Duty Cycle = [(Total compressor running on load) / (Total vehicle service time)] x100%.	Deleted.

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21	Volume IV Part 1: ERTS-RS	6.2.18 (Last sentence) (148 of 492)	The motor shall have at least IP65 protection.	The motor shall have at least IP55 protection.
22	Volume IV Part 1: ERTS-RS	6.6.9 (2nd line) (151 of 492)	The hole shall be sealed with EPDM modular based pipe sealing system with multi diameter technology. EPDM (ethylene – propylene diene monomer) should be low smoke index, halogen free cross-linkable rubber compound.	The hole shall be sealed with proven sealing method. The sealant used should be of low smoke index and halogen free. Final decision will be taken during design stage.
23	Volume IV Part 1: ERTS-RS	6.12.7 (154 of 492)	The friction brake system shall be proven and capable of independently achieving all performance requirements for continuous one round trip with maximum speed of 65 kmph with AW4 load case without the aid of electric regenerative braking for 3-Car and 6-Car. The Contractor shall submit thermal analysis.	The friction brake system shall be proven and capable of independently achieving all performance requirements for continuous one round trip with maximum speed of 50 kmph with AW3 load case without the aid of electric regenerative braking for 3-Car and 6-Car. The Contractor shall submit thermal analysis.
24	Volume IV Part 1: ERTS-RS	6.16.17 (164 of 492)	An emergency brake control system shall be provided by two independent hardwired and fibre optic circuits that shall demand an emergency brake application on all vehicle unless a satisfactory status of all the Train's integral safety devices are proved to be safe.	An emergency brake control system shall be provided by two independent hardwired that shall demand an emergency brake application on all vehicle unless a satisfactory status of all the Train's integral safety devices are proved to be safe.

Sr. No.	Tender Document Reference	Clause/Sub-Clause/Para (Page No)	Clause Description (relevant portion) as existing in the Tender Documents	Clause Description (relevant portion) as amended now to be read as
25	Volume IV Part 1: ERTS-RS	8.5.5 (192 of 492)	The arrestor shall consist of a non-linear metal oxide varistor fitted in a porcelain housing, which is sealed off by a flange. This contains a pressure relief device with gas diverter.	The arrestor shall consist of a non-linear metal oxide varistor fitted in a porcelain housing, which is sealed off by a flange. Proven housings with other material can also be used with the approval of Engineer. This contains a pressure relief device with gas diverter.
26	Volume IV Part 1: ERTS-RS	9.5.4 (212 of 492)	The box for battery shall be such that to avoid any corrosion throughout the service life on any account and the box shall last for the lifetime of the cars. Within the battery box, the battery shall be mounted in roll out trays to allow for easy maintenance. The battery box shall be completely sealed against intrusion of dust / water. IP65 level of protection shall be ensured.	The box for battery shall be such that to avoid any corrosion throughout the service life on any account and the box shall last for the lifetime of the cars. Within the battery box, the battery shall be mounted in roll out trays to allow for easy maintenance. The battery box shall be sealed against intrusion of dust / water as required by the design.
27	Volume IV Part 1: ERTS-RS	10.11.5 (ii) (234 of 492)	The overall time required for uploading the software and downloading fault data for all subsystems shall not be more than 15 minutes each and the same shall be demonstrated. The individual Electronic Door Control Unit (EDCU) shall be connected with dedicated port of TCMS to minimize the time taken for data downloading and uploading of door software.	The overall time required for uploading the software and downloading fault data for all subsystems shall not be more than 15 minutes each and the same shall be demonstrated.
28	Volume IV Part 1: ERTS-	12.9.1 (iii) (280 of 492)	The colour of the LEDs shall be white (temperature 3000K-3300K). It shall be ensured that all LEDs are	The colour of the LEDs shall be white (temperature 3000K-5000K, to be decided during design stage).

Sr. No.	Tender Document Reference	Clause/Sub-Clause/Para (Page No)	Clause Description (relevant portion) as existing in the Tender Documents	Clause Description (relevant portion) as amended now to be read as
	RS		selected from same bin to avoid any difference in colour and performance.	It shall be ensured that all LEDs are selected from same bin to avoid any difference in colour and performance.
29	Volume IV Part 1: ERTS-RS	13.1.2 (xxiii) (294 of 492)	Cables for PA, PIS and PSSS shall be suitably insulated, screened, armoured and overall outer sheathed. These cables shall also be of fire survival, fire retardant as well as resistant type. The Rolling Stock Contractor shall design and install in such a way that its integrity is ensured until no longer required for evacuation. Full details of standard along with relevant catalogue etc. shall be submitted for review and approval.	Cables for PA, PIS and PSSS shall be suitably insulated, screened, armoured and overall outer sheathed. These cables shall also be of fire survival, fire retardant/resistant type. The Rolling Stock Contractor shall design and install in such a way that its integrity is ensured till it is no longer required for/during evacuation. The integrity of the cable shall also be tested as per EN50289 or equivalent. Full details of integrity duration, standards along with relevant catalogues etc. shall be submitted for review and approval.
30	Volume IV Part 1: ERTS-RS	13.10.27 (2nd last sentence) (315 of 492)	The Rolling Stock Contractor shall supply, install and commission the track monitoring system at the time of delivery of two trains nominated by the Engineer in each depot.	The Rolling Stock Contractor shall supply, install and commission the track monitoring system at the time of delivery of two trains nominated by the Engineer for each line along with mandatory items (including camera) & tools as approved during design stage.
31	Volume IV Part 1: ERTS-RS	14.16.3 (iv) (337 of 492)	Ducting with top access lids shall be avoided whenever possible and will not be accepted for under floor mounting.	Design of access lid of cable ducting shall be decided during design stage considering maintainability aspect.

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32	Volume IV Part 2: ERTS-SIG	2.3.5 (16 of 238)	Detrainment of passengers, during DLCMP period, caused due to a failure of Signalling and Train Control system shall call for imposition of penalty on the Contractor, equal to INR Two Lakhs per such event. This provision will become effective section wise after 6 months of revenue operation of that section. The detrainment will be done under following scenario:	Detrainment of passengers, during DLCMP period, caused due to a failure of Signalling and Train Control system shall call for imposition of penalty on the Contractor, equal to INR Fifteen Lakhs per such event. This provision will become effective section wise after 6 months of revenue operation of that section. The detrainment will be done under following scenario:
33	Volume IV Part 2: ERTS-SIG	3.4.8.2 (37 of 238)	Main line & depot Point machines shall be non-trailable type. Main line point machines shall be used in conjunction with additional external mechanical locking arrangement. For Mainline Point Machine shall be Electric; operating on 3-Phase 380/400 V AC Point or suitable machines shall be capable of operating points with Curved / thick web section with UIC HH 60 (60 kg/m) stock rail and 73 kg/m or 90kg/m thick web section. Generally, 1:9/1:7 turnouts for standard gauge will be used. Nominal Switch opening at Toe will be 160 mm. Depot Point Machine shall be electric; operation on 3-Phase 380/400 V AC or 110V DC.	Main line & depot Point machines shall be non-trailable type. Main line point machines shall be used in conjunction with additional external mechanical locking arrangement. For Mainline Point Machine shall be Electric; operating on 3-Phase 380/400 V AC Point or suitable machines shall be capable of operating points with Curved / thick web section with UIC HH 60 (60 kg/m) stock rail and 73 kg/m or 90kg/m thick web section. Generally, 1:9/1:7 turnouts for standard gauge will be used. Nominal Switch opening at Toe will be 160 mm. Depot Point Machine shall be electric; operation on 3-Phase 380/400 V AC (RDSO approved) or 110V DC.
34	Volume IV Part 2: ERTS-SIG	3.4.10.4 (40 of 238)	Separate Interlocking units (CBI) shall be provided at Depot. The Interlocking Capacity in Depot shall have capacity of at least 150% of present Stabling Lines. The area of jurisdiction of the CBIs with associated interlocking shall be configured so as to	Separate Interlocking units (CBI) shall be provided at Depot. The Interlocking Capacity in Depot shall have capacity of at least 150% of present Stabling Lines. The area of jurisdiction of the CBIs with associated interlocking shall be configured so as to

<table>
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<tr><td></td><td></td><td></td><td>cover the entire section. The plan (including Quantity) for the same shall be submitted for review by the Engineer. The Contractor shall ensure that the effect of induced voltage is taken into account while designing the location and number of CBI units on the line. Wherever the induced voltage is likely to be more than defined, Object controllers or separate interlocking unit at stations without points and crossings should be provided to cover the entire Line.</td><td>cover the entire section. The plan (including Quantity) for the same shall be submitted for review by the Engineer. The Contractor shall ensure that the effect of induced voltage is taken into account while designing the location and number of CBI units on the line. Wherever the induced voltage is likely to be more than defined, Object controllers or separate interlocking interface unit at stations without points and crossings should be provided to cover the entire Line.</td></tr>
<tr><td>35</td><td>Volume IV Part 2: ERTS-SIG</td><td>3.11.3.1 (47 of 238)</td><td>k. Signal number.</td><td>k. Signal number / Virtual Signal marker (as required)</td></tr>
<tr><td>36</td><td>Volume IV Part 2: ERTS-SIG</td><td>3.13.12 (52 of 238)</td><td><table><tr><td>ATS user profile</td><td>Central ATS</td><td>CBI sector</td><td>Depot ATS</td></tr><tr><td>DCC depot controller</td><td>Control during handover</td><td></td><td>YES</td></tr></table></td><td><table><tr><td>ATS user profile</td><td>Central ATS</td><td>CBI sector</td><td>Depot ATS</td></tr><tr><td>DCC depot controller</td><td>Control during handover</td><td>YES</td><td>YES</td></tr></table></td></tr>
<tr><td>37</td><td>Volume IV Part 2: ERTS-SIG</td><td>3.23.3 (57 of 238)</td><td>As a minimum the indications shown in Appendix A4 shall be provided from the field to the OCC.</td><td>As a minimum the indications shown in Appendix A3(I) shall be provided from the field to the OCC.</td></tr>
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Sr. No.	Tender Document Reference	Clause/Sub-Clause/Para (Page No)	Clause Description (relevant portion) as existing in the Tender Documents	Clause Description (relevant portion) as amended now to be read as
			Appropriate indications shall also be provided from the field to the SCR.	Appropriate indications shall also be provided from the field to the SCR.
38	Volume IV Part 2: ERTS-SIG	3.29.1 (64 of 238)	Automatic Route Setting the Train Control and Signalling System shall provide communication bands to disable automatic route setting on specific routes and manually set routes in various modes. The following modes shall be available for route setting:	Automatic Route Setting the Train Control and Signalling System shall provide commands to disable automatic route setting on specific routes and manually set routes in various modes. The following modes shall be available for route setting:
39	Volume IV Part 2: ERTS-SIG	3.33.3.2 (78 of 238)	ATS for Depot shall be as per the design criteria (Appendix A3)	ATS for Depot shall be as per the design criteria (Appendix A2)
40	Volume IV Part 3: ERTS-TEL	4.3.10 (43 of 279)	The Contractor shall design the Telephone System with main exchange in the Depot Administration Building CER-OCC and the back-up exchange at the CER-BCC.	The Contractor shall design the Telephone System with fully redundant main exchange in the Depot Administration Building CER-OCC and the fully redundant exchange at the CER-BCC.
41	Volume IV Part 3: ERTS-TEL	6.4.15 (86 of 279)	The Contractor shall design the CCTV system with the OCC primary server at the CER-OCC and the back-up server at the CER-BCC.	The Contractor shall design the CCTV system with fully redundant server (primary plus secondary) at TER-OCC and fully redundant server at the TER-BCC as backup.

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42	Volume IV Part 3: ERTS-TEL	Appendix VIII (new added)	New appendix added.	Refer Attachment–4 to Corrigendum-7 for Summary of Equipment of Telecom systems.

The other conditions will remain the same.

Further modifications/amendments (if any) regarding aforesaid tender will be uploaded as and when required.

Managing Director
Madhya Pradesh Metro Rail Corporation Limited
Bhopal

Attachment – 1 to Corrigendum – 7

Table 1. Mandatory Contractor OHS&E Management Resource Requirement

1	2	3
Chief OHS&E Manager	Senior OHS&E Manager	Occupational Health Officer with necessary Nursing Assistant
1	2	1 (FT)
Note 1	Qualified and trained OHS&E Professionals with required support staff to be deployed for worksite at each shift.	
Note 2	(FT) means Full-Time.	

Attachment – 2 to Corrigendum – 7

Volume III, Part 2: ER-GS -S&T. Appendix 13, N15 ST/PSD-01:

N15 - Indicative Interface Sheet for Signaling, Train Control and Telecommunication System (S&T) and Platform Screen Door (PSD)

Bhopal and Indore Metro **Interface Sheet**	**Contract A**	**S&T**	**Contract B**	**PSD**	**Rev#:** **Date:**	**A0**
Approved by:	S&T (Signaling Train Control and Telecommunication Systems) Lead Contract		PSD (Platform Screen Door) Participating Contract		**First Issue:**	
GC issued by:					**Last Change:**	
Checked by:						

Interface description brief / Key elements (time schedule, physical, functional, ...):

1. General Interface details between the Signaling, Train Control and Telecommunication Systems (S&T) and Platform Screen Door (PSD)

Contract A (S&T)	**DESIGN STAGE**	**Contract B (PSD)**
ST/PSD-01: 1. Shall design and provide the Ethernet/LAN ports at Stations and Depot TER as per requirements provided by PSD system. 2. Shall coordinate with PSD contractor for ATS interfaces. 3. Shall coordinate with PSD contractor during the installation, testing, commissioning and joint testing.		ST/PSD-01: 1. Shall provide the no. of Ethernet/LAN port requirements to Telecomm contractor, and estimated bandwidth required for PSD system data transfer from station to station. 2. Shall lay the Data/OFC cable from PSD network switch/ Server up to TER FOTS Rack.

Bhopal and Indore Metro **Interface Sheet**	**Contract A**	**S&T**	**Contract B**	**PSD**	**Rev#:** **Date:**	**A0**
			3. Shall lay Data/OFC cable from PSD Network switch/ Server up to SER ATS system. 4. Shall coordinate with S&T contractor during the installation, testing, commissioning and joint testing.			
ST/PSD-02: Shall provide the Ethernet requirements of PSD interfaces. Coordinating, during installation testing and commissioning. Coordinate during joint testing.			**ST/PSD-02:** Shall provide the requirement to the S&T. Shall design, Install, testing and commissioning the equipment at stations. Perform joint testing with S&T			
ST/PSD-03: Shall provide the Power requirements for PSD. Coordinating, during installation testing and commissioning. Coordinate during joint testing.			**STPSD-03:** Shall provide the load requirements of PSD equipment to the S&T. Shall design, Install, testing and commissioning the equipment at stations. Perform joint testing with S&T			
ST/PSD-04: Shall ensure the coverage of all PSD with CCTV			**ST/PSD-04:** Shall facilitate.			
Contract A (S&T)		**CONSTRUCTION / INSTALLATION STAGE**			**Contract B (PSD)**	
NIL			**NIL**			
Contract A (S&T)		**TEST & COMMISSIONING STAGE**			**Contract B (PSD)**	
NIL			**NIL**			
Contract A (S&T)		**MAINTENANCE STAGE**			**Contract B (PSD)**	
NIL			**NIL**			

Attachment – 3 to Corrigendum – 7

Draft SoD (Draft Schedule of Dimensions) is attached:

SCHEDULE OF DIMENSIONS (SOD)

FOR

STANDARD GAUGE (1435 mm)

FOR AT-GRADE, ELEVATED AND UNDERGROUND SECTIONS

BHOPAL AND INDORE METRO RAIL SYSTEM

JANUARY 2022

Madhya Pradesh Metro Rail Corporation Limited (MPMRCL)
2nd Floor, Bhopal Smart City Development Corp. Ltd.,
Sector A, Berkheda, Bhopal – 462023,
Madhya Pradesh, India.

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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 4080 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. Metro operation shall be stopped when Wind speed reaches 100 kmph or more. Continuous recording of wind speed shall be done at critical locations defined by metro administration. The speed of trains on elevated or at- grade station shall be restricted to 40 kmph, when wind speed is more than 70 kmph.

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 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 at stations and Structure Gauge for all locations other than stations shall not be infringed under any circumstances.

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.

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 4080 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

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 rails / Restraining Rails should be provided on curves on main line where radius is 190 m or less on Standard gauge. The clearance of check rails / restraining rails shall be suitably decided by Metro Authority.

b) Check rails / Restraining Rails are not mandatory for curves in depots, yards and other non-passenger lines. However, if check rails are not provided, train speed shall be restricted to 25 kmph or the safe speed, whichever is lower.

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/sec2

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.

iii) Degree of Curve = 1746.29 / R, 'R' is the radius in 'm'.

1.3.2 Maximum permissible gradient on turnouts.

a) On Ballasted Track : 0.25%

b) On Ballastless Track : 3.00%

Note:

i) 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.

ii) 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.

iii) Turnouts shall normally be installed on straight track. In exceptional situations, turnout may take off from a curve provided that the radius of the 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.

1.4 BUILDINGS AND STRUCTURES (OUTSIDE STATION AREA)

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 1170 mm
viii.	4064 mm to 4246 mm	1170 mm increasing to 1040 mm
ix.	4246 mm to 4300 mm	1040 mm increasing to 833 mm

Refer Drawing no. MPMRCL/GEN/SOD/UND-01 at Page no. 52

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
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 1170 mm
viii.	4064 mm to 4246 mm	1170 mm increasing to 1040 mm
ix.	4246 mm to 4300 mm	1040 mm increasing to 833 mm

Refer Drawing no. MPMRCL/GEN/SOD/UND-03 at Page no. 53

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 2873 mm	1736 mm increasing to 1808 mm
vi.	2873 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. 51

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 901 mm	1765 mm
ii.	901mm to 2032 mm	1765 mm increasing to 1813 mm
iii.	2032mm to 3356 mm	1813 mm increasing to 1835 mm
iv.	3356mm to 4058 mm	1835 mm decreasing to 1374 mm
v.	4058m to 4359 mm	1374 mm decreasing to 1366 mm

Refer Drawing no. MPMRCL/GEN/SOD/ATG-02 at Page no. 54

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 At-Grade and Elevated Sections, a clearance of minimum 150 mm has been considered over the Kinematic Envelope to arrive at the Structure Gauge. For Underground Sections this clearance is 100 mm.

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. 47
- Drawing no. MPMRCL/GEN/SOD/UND-02 at Page no. 48
- Drawing no. MPMRCL/GEN/SOD/ATG-01 at Page no. 49

b) For Kinematic Envelope for level or constant grade (tangent track) in Platform area, refer to - Drawing no. MPMRCL/GEN/SOD/ELE&UND – 70 kmph at Page no. 50.

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. 52.

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. 53.

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. 51.

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. MPMRCL/GEN/SOD/ATG - 02 at Page no. 54.

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 for Curves.

1.7.1 Inside of Curve:

A. Curvature effect:

a) Mid throw at the centre of the Vehicle = V (in mm) = $125\ C^2 / R$

b) 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.

c) Lateral shift for nosing is 32 mm for ballasted track and 28mm for ballastless track.

For values of curvature effect,

i) For At-Grade (Surface) Sections – Ballasted Track refer Appendix – 2A at

Page no. 33 and Appendix – 2B at Page no. 34.

ii) 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:

i) Underground, Elevated and At-Grade Ballastless 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).

ii) At-Grade (Surface) Ballasted sections:

Lateral shift of 32mm due to nosing is included in Kinematic Envelope for At-grade (Surface) sections with ballasted 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 in Para 1.7.1(A) above if the value of mid throw (V) is equal to or greater than 32 mm. However, if the value of mid throw (V) is less than 32 mm, the curvature effect shall be due to widening of the gauge only (mid throw minus 32 mm shall be taken as zero).

B. Clearance for Cant:

a. 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:

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

Where, G = 1435 + c =1507 mm

'c' being the rail head width, and 'C_a' 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. 44 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. 42 and drawing no. MPMRCL/GEN/SOD/UND-04 at Page no. 55.

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. 45.

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:

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) <u>Underground (Box Structure), Elevated and At-Grade (Surface) Sections</u>

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)

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. 44.

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. 42 and MPMRCL/GEN/SOD/UND-04 at Page no. 55.

C. Clearance for Vertical curve (Vertical Throw):

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

a) Vertical Throw V1 and V2 (in mm) for vertical curve shall be calculated as under:

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. 45.

Abbreviations used in **Para 1.7 above**:

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

'C_1' 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.

1.8 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.

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. 46.

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. 46 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)

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:

i. 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.

ii. 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 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

i) Walkway shall not infringe the Structure gauge.

ii) Walkway should be used by Metro inspection and maintenance staff only during non-operation hours and for transfer of passengers during emergency evacuation.

iii) Maximum and minimum heights of walkway on curves are above inner rail.

iv) No structure, other than signalling and minor signalling telecom equipment post, shall be permitted within the minimum width of walkway.

v) If tunnel provided with walkway on the same side of the platform is connecting two stations, one station having island platform and another station having a side platform, track crossing at rail level is to be provided to allow access from either of the stations to the walk way and vice versa. The track crossing shall not

infringe the Structure Gauge and shall be put to use only after train operation is stopped and traction power is switched off.

1.10 DERAILMENT GUARDS:

1.10.1 The derailment guard shall be provided outside in Viaduct and at grade sections. For UG section, the derailment guard shall be provided inside the track. For single track tunnel, location for providing derailment guard is given in note..

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±30mm. 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.

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 : **1515 mm** **(A)**

b) Elevated Station/At-Grade : **1525 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 : **1535 mm**

Notes:

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

- 1575 ± 5 for Under Ground and Elevated Stations.
- 1590 ± 5 for Surface (At-Grade) Stations.

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

iii) 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 on ballastless track:

a) Maximum height above Rail Level for Passenger platform : **1095 mm**

b) Minimum height above Rail Level for Passenger platform : **1085 mm**

Note: No station shall be proposed on ballasted track.

2.2.4 Horizontal distance

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

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. 56 and MPMRCL/GEN/SOD/ELE-05 at Page no. 58 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. 57 and MPMRCL/GEN/SOD/ELE-06 at Page no. 59 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. 60 and MPMRCL/GEN/SOD/UND-07 at Page no. 62 for Underground Stations with side platform without and with Platform Screen Doors respectively.

Figure No: MPMRCL/GEN/SOD/UND-06 at Page no. 61 and MPMRCL/GEN/SOD/UND-08 at Page no. 63 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;

a)	For Elevated and At-Grade Stations (Side platform) with/without platform screen gate	Drawing no. MPMRCL/GEN/SOD/ELE-03 at Page no. 56 and ELE-05 at Page no. 58
b)	For Elevated and At-Grade Stations (Island platform) with/without platform screen gate.	Drawing no. MPMRCL/GEN/SOD/ELE-04 at Page no. 57 and ELE-06 at Page no.59
c)	For Underground Stations (Side platform) with/without platform screen door	Drawing no. MPMRCL/GEN/SOD/UND-05 at Page no. 60 and UND-07 at Page no. 62
d)	For Underground Stations (Island platform) with/without platform screen door	Drawing no. MPMRCL/GEN/SOD/UND-06 at Page no. 61 and UND-08 at Page no. 63

2.2.6 For Kinematic Envelope on platform at station, refer to:

MPMRCL/GEN/SOD/ELE&UND - 70 kmph at Page no. 50.

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:

1. There shall be no change of grade in platform track.
2. 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 consultationwith the Head of Safety Nominated by Metro Rail Authority.

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)	**In Under Ground Stations**	
	From centre of track to 1610 mm	**0 mm**
	Beyond 1610 mm from centre of track up to 1705 mm	**250 mm**
b)	**In Elevated Stations**	
	From centre of track up to 1610 mm	**0 mm**

	Beyond 1610 mm from centre of track up to 1755 mm	**250 mm**
c)	**In At-Grade/ Surface Stations**	
	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, upstands 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 the track.

2.5 Points and Crossing:

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

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.

a) 1 in 9 turnouts : 190 m radius

b) 1 in 7 turnouts : 140 m radius

c) Scissors cross-over of 1 in 9 type consisting of 4 turnouts and 1 diamond crossing

d) 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):

a) 1 in 7 type turnouts : 140 m radius

b) Scissors cross-over of 1 in 7 type consisting of 4 turnouts and 1 diamond crossing

c) 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:

a) 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.

b) 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 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. 43.

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.

3 CHAPTER - III: ROLLING STOCK

3.1 PASSENGER ELECTRIC MULTIPLE UNITS:

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 : **4080 mm**

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. 48.
- For At- Grade & elevated sections, ballastless track, refer drawing no. MPMRCL/GEN/SOD/ELE-1 at Page no. 47.

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/ELE&UND - 70 kmph at Page no. 50.

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 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 measured from tread at 70 mm from the Wheel Gauge face. : **28 mm**

b) Maximum projection for flange of worn Wheel measured from tread at 70 mm from the Wheel Gauge face. : **36 mm**

3.1.9

a) Maximum thickness of flange of Wheel measured from Wheel Gauge face at 18 mm from outer edge of flange. : **32.5 mm**

b) Minimum thickness of flange of Wheel measured from Wheel Gauge face at 18 mm from outer edge of flange. : **22 mm**

3.1.10 Width of Wheel : **135 ± 1 mm**

3.1.11 Incline of tread : **UIC 510-2/EN13715/15313(or any other profile accepted internationally)**

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**

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. 48.

For At-Grade and elevated sections refer drawing no. MPMRCL/GEN/SOD/ELE-01 at Page no. 47.

For Surface (At-Grade) sections for ballasted track refer drawing no. MPMRCL/GEN/SOD/ATG - 01 at Page no. 49.

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**

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:

i) Assumed +/- 300 mm Stopping accuracy

ii) Platform Screen Doors at station on curves shall be considered separately taking into account the additional clearance as per Appendix-5.

iii) 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.

iv) 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. 64.

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. 65.

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-Grade	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 readius of curvature may be obtainied by adopting the value for sharper curve.

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 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	32	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	32	0	0	
2600	10.8	32	0	0	
2400	11.7	32	0	0	
2200	12.8	32	0	0	
2000	14.1	32	0	0	
1900	14.8	32	0	0	
1800	15.6	32	0	0	
1700	16.5	32	0	0	
1600	17.6	32	0	0	
1500	18.8	32	0	0	
1400	20.1	32	0	0	
1300	21.6	32	0	0	
1200	23.4	32	0	0	
1100	25.6	32	0	0	
1000	28.1	32	0	0	T1 = V-N+G For 'V' equal to or greater than ' N'
950	29.6	32	5	3	
900	31.3	32	5	4	
850	33.1	32	5	6	T1 = G for V < N
800	35.2	32	5	8	
750	37.5	32	5	11	
700	40.2	32	5	13	
650	43.3	32	5	16	
600	46.9	32	5	20	
550	51.1	32	5	24	
500	56.3	32	5	29	
450	62.5	32	9	40	
400	70.3	32	9	47	
350	80.4	32	9	57	
300	93.8	32	9	71	
250	112.5	32	9	90	
200	140.6	32	9	118	
175	160.7	32	9	138	
150	187.5	32	9	165	
120	234.4	32	9	211	
100	281.3	32	9	258	

Mid throw (in mm) V = 125 C2 / 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

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, T2 = V_0+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	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.
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	226.8	9	2.0	238	
120	283.5	9	2.0	294	
100	340.2	9	2.0	351	

End throw (in mm) $V_0 = (125\ C1^2)/ R - (125x\ C^2) / R;$ = 34020 / R

Where ' C ' is the distance between bogies centers = 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)

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	GAUGE WIDENING ON CURVES:
3000	9.4	28	0	0	is 9mm for Curves sharper than 500m radius.
2800	10.0	28	0	0	
2600	10.8	28	0	0	is 5mm for Curves of radius from 500m to 1000m and
2400	11.7	28	0	0	
2200	12.8	28	0	0	is 0mm for Curves with radius 1000m and above.
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	T1 = V-N+G For 'V' equal to or greater than ' N'
1000	28.1	28	0	0	
950	29.6	28	5	7	T1 = G for V < N
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

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	GAUGE WIDENING ON CURVES:
1500	22.7	0	0.0	23	
1400	24.3	0	0.0	24	is 9mm for Curves sharper than 500m radius.
1300	26.2	0	0.0	26	
1200	28.4	0	0.0	28	is 5mm for Curves of radius from 500m to 1000m and
1100	30.9	0	0.0	31	
1000	34.0	0	0.0	34	is 0mm for Curves with radius 1000m and above.
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	226.8	9	2.0	238	
120	283.5	9	2.0	294	
100	340.2	9	2.0	351	

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)

APPENDIX - 3A

CANT EFFECT ON STRUCTURE GAUGE
AT-GRADE (SURFACE) SECTION (BALLASTED TRACK)

REFERENCE DRAWING NUMBER: MPMRCL/GEN/SOD/ATG- 02 & MPMRCL/GEN/SOD/GEN -01 & PARAs 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 'h' =					**901**				**2032**				**3356**				**3937**				**4058**				**4359**			
Distance from centre line of track to Structure Gauge for tangent track 'ab'=					**1765**				**1813**				**1835**				**1443**				**1374**				**1366**			
Cant mm	angle α in radians	Sin α	Cos α	Tan α	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2
125	0.083	0.083	0.997	0.083	1833.7	1684.2	1106.8	814.0	1975.3	1638.2	2237.9	1937.1	2107.0	1550.3	3559.1	3254.7	1764.6	1111.5	4105.6	3866.2	1705.9	1032.7	4220.5	3992.5	1722.9	999.7	4519.8	4293.2
120	0.080	0.080	0.997	0.080	1831.1	1687.7	1098.7	817.6	1969.0	1645.4	2229.9	1941.2	2096.4	1561.9	3551.5	3259.2	1751.9	1124.9	4099.4	3869.6	1692.8	1046.5	4214.5	3995.7	1708.8	1014.6	4513.9	4296.4
115	0.076	0.076	0.997	0.077	1828.6	1691.1	1090.6	821.2	1962.8	1652.7	2221.9	1945.2	2085.7	1573.6	3543.7	3263.7	1739.2	1138.4	4093.1	3872.9	1679.7	1060.3	4208.5	3998.8	1694.7	1029.4	4508.0	4299.5
110	0.073	0.073	0.997	0.073	1826.1	1694.5	1082.4	824.8	1956.5	1659.8	2213.9	1949.2	2075.1	1585.1	3536.0	3268.1	1726.5	1151.8	4086.8	3876.2	1666.5	1074.1	4202.5	4001.9	1680.5	1044.2	4502.1	4302.7
105	0.070	0.070	0.998	0.070	1823.5	1697.9	1074.3	828.3	1950.2	1667.0	2205.9	1953.2	2064.4	1596.7	3528.2	3272.5	1713.8	1165.2	4080.5	3879.4	1653.4	1087.9	4196.4	4004.9	1666.4	1059.0	4496.1	4305.7
100	0.066	0.066	0.998	0.067	1820.9	1701.3	1066.1	831.9	1943.8	1674.2	2197.8	1957.2	2053.6	1608.3	3520.4	3276.8	1701.1	1178.6	4074.1	3882.6	1640.2	1101.7	4190.2	4007.9	1652.2	1073.7	4490.0	4308.7
95	0.063	0.063	0.998	0.063	1818.3	1704.7	1058.0	835.4	1937.5	1681.3	2189.7	1961.2	2042.9	1619.8	3512.5	3281.1	1688.3	1191.9	4067.6	3885.7	1627.1	1115.5	4184.0	4010.8	1638.1	1088.5	4483.9	4311.7
90	0.060	0.060	0.998	0.060	1815.7	1708.0	1049.8	839.0	1931.1	1688.4	2181.6	1965.1	2032.1	1631.3	3504.6	3285.4	1675.5	1205.3	4061.2	3888.8	1613.9	1129.2	4177.8	4013.7	1623.9	1103.2	4477.8	4314.6
85	0.056	0.056	0.998	0.056	1813.0	1711.4	1041.6	842.5	1924.7	1695.5	2173.5	1969.0	2021.4	1642.8	3496.7	3289.7	1662.8	1218.6	4054.6	3891.8	1600.7	1142.9	4171.5	4016.5	1609.7	1118.0	4471.6	4317.5
80	0.053	0.053	0.999	0.053	1810.3	1714.7	1033.4	846.0	1918.3	1702.6	2165.4	1972.9	2010.6	1654.3	3488.7	3293.9	1650.0	1232.0	4048.1	3894.8	1587.5	1156.6	4165.2	4019.3	1595.5	1132.7	4465.4	4320.3
75	0.050	0.050	0.999	0.050	1807.7	1718.0	1025.2	849.5	1911.9	1709.6	2157.2	1976.8	1999.7	1665.7	3480.7	3298.0	1637.1	1245.3	4041.4	3897.8	1574.3	1170.3	4158.9	4022.1	1581.2	1147.4	4459.1	4323.1
70	0.046	0.046	0.999	0.047	1804.9	1721.2	1017.0	853.0	1905.4	1716.7	2149.0	1980.6	1988.9	1677.1	3472.6	3302.1	1624.3	1258.6	4034.8	3900.7	1561.0	1184.0	4152.4	4024.8	1567.0	1162.1	4452.7	4325.8
65	0.043	0.043	0.999	0.043	1802.2	1724.5	1008.8	856.5	1899.0	1723.7	2140.8	1984.4	1978.0	1688.5	3464.5	3306.2	1611.5	1271.8	4028.1	3903.6	1547.8	1197.7	4146.0	4027.5	1552.7	1176.7	4446.4	4328.5
60	0.040	0.040	0.999	0.040	1799.5	1727.7	1000.6	860.0	1892.5	1730.7	2132.6	1988.2	1967.2	1699.9	3456.4	3310.3	1598.6	1285.1	4021.3	3906.4	1534.5	1211.3	4139.5	4030.1	1538.5	1191.4	4439.9	4331.2
55	0.037	0.036	0.999	0.037	1796.7	1730.9	992.3	863.5	1886.0	1737.6	2124.3	1992.0	1956.3	1711.3	3448.2	3314.3	1585.7	1298.4	4014.5	3909.2	1521.2	1225.0	4132.9	4032.7	1524.2	1206.0	4433.4	4333.7
50	0.033	0.033	0.999	0.033	1793.9	1734.1	984.1	866.9	1879.4	1744.6	2116.0	1995.7	1945.3	1722.6	3440.0	3318.3	1572.8	1311.6	4007.7	3912.0	1507.9	1238.6	4126.4	4035.2	1509.9	1220.6	4426.9	4336.3
45	0.030	0.030	1.000	0.030	1791.1	1737.3	975.8	870.4	1872.9	1751.5	2107.7	1999.5	1934.4	1734.0	3431.8	3322.2	1559.9	1324.8	4000.8	3914.7	1494.6	1252.2	4119.7	4037.7	1495.6	1235.2	4420.3	4338.8
40	0.027	0.027	1.000	0.027	1788.3	1740.5	967.5	873.8	1866.3	1758.4	2099.4	2003.2	1923.4	1745.3	3423.5	3326.1	1547.0	1338.0	3993.9	3917.3	1481.2	1265.8	4113.0	4040.1	1481.2	1249.8	4413.7	4341.2
35	0.023	0.023	1.000	0.023	1785.4	1743.6	959.2	877.3	1859.7	1765.3	2091.1	2006.8	1912.4	1756.6	3415.2	3330.0	1534.0	1351.2	3987.0	3919.9	1467.9	1279.4	4106.3	4042.5	1466.9	1264.4	4407.0	4343.6
30	0.020	0.020	1.000	0.020	1782.6	1746.7	951.0	880.7	1853.1	1772.2	2082.7	2010.5	1901.4	1767.8	3406.9	3333.8	1521.1	1364.3	3979.9	3922.5	1454.5	1292.9	4099.5	4044.8	1452.5	1279.0	4400.3	4345.9
25	0.017	0.017	1.000	0.017	1779.7	1749.8	942.7	884.1	1846.5	1779.0	2074.3	2014.1	1890.4	1779.1	3398.5	3337.6	1508.1	1377.5	3972.9	3925.0	1441.1	1306.5	4092.7	4047.1	1438.1	1293.5	4393.6	4348.2
20	0.013	0.013	1.000	0.013	1776.8	1752.9	934.3	887.5	1839.8	1785.9	2065.9	2017.8	1879.4	1790.3	3390.1	3341.4	1495.1	1390.6	3965.8	3927.5	1427.7	1320.0	4085.9	4049.4	1423.7	1308.0	4386.7	4350.5
15	0.010	0.010	1.000	0.010	1773.9	1755.9	926.0	890.9	1833.1	1792.7	2057.4	2021.4	1868.3	1801.5	3381.6	3345.1	1482.1	1403.7	3958.7	3929.9	1414.3	1333.5	4079.0	4051.6	1409.3	1322.5	4379.9	4352.7
10	0.007	0.007	1.000	0.007	1770.9	1759.0	917.7	894.3	1826.4	1799.5	2049.0	2024.9	1857.2	1812.7	3373.1	3348.7	1469.1	1416.8	3951.5	3932.3	1400.9	1347.0	4072.0	4053.8	1394.9	1337.0	4373.0	4354.8
5	0.003	0.003	1.000	0.003	1768.0	1762.0	909.4	897.6	1819.7	1806.2	2040.5	2028.5	1846.1	1823.9	3364.6	3352.4	1456.1	1429.9	3944.3	3934.7	1387.5	1360.5	4065.0	4055.9	1380.5	1351.5	4366.0	4356.9
0	0.000	0.000	1.000	0.000	1765.0	1765.0	901.0	901.0	1813.0	1813.0	2032.0	2032.0	1835.0	1835.0	3356.0	3356.0	1443.0	1443.0	3937.0	3937.0	1374.0	1374.0	4058.0	4058.0	1366.0	1366.0	4359.0	4359.0

E1 = [Ab + (h x tan α)] x cos α
F1 = [ab - (h x tan α)] x cos α
H1 = (C_a / 2) +(h/cos α) + (Ab-h x tan α) x sin α
H2 = (C_a / 2) +(h/cos α) - (Ab+h x tan α) x sin α
ab = 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 niclined centre line of canted 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.
bc = h x tan α = Lateral increment due to cant (measured along the line parallel to line joining the top of rails).

APPENDIX - 3B

CANT EFFECT ON STRUCTURE GAUGE
ELEVATED & AT-GRADE (SURFACE) SECTIONS (BALLASTLESS TRACK)

REFERENCE DRAWING NUMBER: MPMRCL/GEN/SOD/ELE - 02 & MPMRCL/GEN/SOD/GEN - 01 AND PARAs 1.7.1B., 1.7.2 B. and 1.8.2

All figures in mm

Height above rail level measured above perp to track plane 'h' =					348				879				2873				3338				4058				4350			
Distance from centre line of track to Structure Gauge for tangent track'ab'=					1730				1736				1808				1808				1374				1366			
Cant mm	angle 'α' in radians	Sin α	Cos α	Tan α	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2
####	0.083	0.083	0.997	0.1	1752.9	1695.2	552.8	265.8	1802.9	1657.1	1082.5	794.5	2040.1	1563.5	3075.6	2775.6	2078.6	1524.9	3539.0	3239.0	1705.9	1032.7	4220.5	3992.5	1722.1	1000.5	4510.8	4284.2
####	0.080	0.080	0.997	0.1	1752.2	1696.8	544.7	269.1	1800.5	1660.5	1074.4	798.0	2031.0	1573.5	3067.8	2779.9	2068.1	1536.5	3531.4	3243.4	1692.8	1046.5	4214.5	3995.7	1708.0	1015.3	4505.0	4287.4
####	0.076	0.076	0.997	0.1	1751.5	1698.4	536.5	272.5	1798.0	1663.9	1066.4	801.5	2022.0	1583.5	3060.1	2784.2	2057.5	1548.0	3523.7	3247.8	1679.7	1060.3	4208.5	3998.8	1694.0	1030.1	4499.1	4290.6
####	0.073	0.073	0.997	0.1	1750.8	1700.0	528.3	275.8	1795.5	1667.2	1058.4	804.9	2012.9	1593.5	3052.3	2788.4	2046.8	1559.5	3516.1	3252.1	1666.5	1074.1	4202.5	4001.9	1679.9	1044.8	4493.1	4293.7
####	0.070	0.070	0.998	0.1	1750.0	1701.5	520.2	279.1	1793.0	1670.5	1050.3	808.4	2003.8	1603.4	3044.5	2792.5	2036.2	1571.0	3508.4	3256.4	1653.4	1087.9	4196.4	4004.9	1665.8	1059.6	4487.1	4296.8
####	0.066	0.066	0.998	0.1	1749.3	1703.1	512.0	282.4	1790.5	1673.8	1042.3	811.9	1994.7	1613.4	3036.6	2796.7	2025.5	1582.5	3500.6	3260.7	1640.2	1101.7	4190.2	4007.9	1651.6	1074.3	4481.1	4299.8
####	0.063	0.063	0.998	0.1	1748.5	1704.6	503.9	285.8	1788.0	1677.1	1034.2	815.3	1985.5	1623.3	3028.8	2800.8	2014.8	1594.0	3492.8	3264.9	1627.1	1115.5	4184.0	4010.8	1637.5	1089.1	4475.0	4302.7
####	0.060	0.060	0.998	0.1	1747.7	1706.1	495.7	289.1	1785.4	1680.4	1026.1	818.8	1976.4	1633.2	3020.8	2804.9	2004.1	1605.4	3485.0	3269.1	1613.9	1129.2	4177.8	4013.7	1623.3	1103.8	4468.8	4305.7
####	0.056	0.056	0.998	0.1	1746.9	1707.6	487.5	292.4	1782.8	1683.7	1018.0	822.2	1967.2	1643.1	3012.9	2808.9	1993.4	1616.8	3477.2	3273.2	1600.7	1142.9	4171.5	4016.5	1609.2	1118.5	4462.6	4308.5
####	0.053	0.053	0.999	0.1	1746.0	1709.1	479.3	295.7	1780.2	1686.9	1009.9	825.6	1958.0	1652.9	3004.9	2813.0	1982.7	1628.3	3469.3	3277.3	1587.5	1156.6	4165.2	4019.3	1595.0	1133.2	4456.4	4311.4
####	0.050	0.050	0.999	0.0	1745.2	1710.5	471.2	299.0	1777.6	1690.1	1001.8	829.0	1948.7	1662.8	2996.9	2817.0	1971.9	1639.6	3461.3	3281.4	1574.3	1170.3	4158.9	4022.1	1580.8	1147.8	4450.1	4314.1
####	0.046	0.046	0.999	0.0	1744.3	1712.0	463.0	302.3	1775.0	1693.3	993.7	832.4	1939.5	1672.6	2988.9	2820.9	1961.1	1651.0	3453.4	3285.4	1561.0	1184.0	4152.4	4024.8	1566.6	1162.5	4443.8	4316.9
####	0.043	0.043	0.999	0.0	1743.4	1713.4	454.8	305.6	1772.3	1696.5	985.6	835.8	1930.2	1682.4	2980.8	2824.8	1950.3	1662.3	3445.4	3289.4	1547.8	1197.7	4146.0	4027.5	1552.4	1177.1	4437.4	4319.5
####	0.040	0.040	0.999	0.0	1742.5	1714.8	446.6	308.8	1769.6	1699.6	977.4	839.2	1921.0	1692.2	2972.7	2828.7	1939.5	1673.7	3437.3	3293.4	1534.5	1211.3	4139.5	4030.1	1538.1	1191.7	4430.9	4322.2
####	0.037	0.036	0.999	0.0	1741.5	1716.1	438.4	312.1	1766.9	1702.8	969.3	842.6	1911.6	1701.9	2964.6	2832.6	1928.6	1685.0	3429.3	3297.3	1521.2	1225.0	4132.9	4032.7	1523.8	1206.3	4424.5	4324.7
####	0.033	0.033	0.999	0.0	1740.6	1717.5	430.2	315.4	1764.2	1705.9	961.1	845.9	1902.3	1711.7	2956.4	2836.4	1917.8	1696.3	3421.1	3301.2	1507.9	1238.6	4126.4	4035.2	1509.6	1220.9	4417.9	4327.3
####	0.030	0.030	1.000	0.0	1739.6	1718.8	422.0	318.7	1761.5	1709.0	952.9	849.3	1893.0	1721.4	2948.2	2840.2	1906.9	1707.5	3413.0	3305.0	1494.6	1252.2	4119.7	4037.7	1495.3	1235.5	4411.3	4329.8
####	0.027	0.027	1.000	0.0	1738.6	1720.2	413.8	322.0	1758.7	1712.1	944.8	852.6	1883.6	1731.1	2940.0	2844.0	1896.0	1718.8	3404.8	3308.8	1481.2	1265.8	4113.0	4040.1	1481.0	1250.1	4404.7	4332.2
####	0.023	0.023	1.000	0.0	1737.6	1721.5	405.6	325.2	1755.9	1715.1	936.6	855.9	1874.2	1740.8	2931.7	2847.7	1885.0	1730.0	3396.6	3312.6	1467.9	1279.4	4106.3	4042.5	1466.7	1264.6	4398.1	4334.6
####	0.020	0.020	1.000	0.0	1736.6	1722.7	397.4	328.5	1753.2	1718.2	928.4	859.3	1864.8	1750.4	2923.4	2851.4	1874.1	1741.2	3388.3	3316.3	1454.5	1292.9	4099.5	4044.8	1452.3	1279.1	4391.3	4336.9
####	0.017	0.017	1.000	0.0	1735.5	1724.0	389.2	331.8	1750.3	1721.2	920.2	862.6	1855.4	1760.1	2915.1	2855.1	1863.1	1752.4	3380.0	3320.0	1441.1	1306.5	4092.7	4047.1	1438.0	1293.6	4384.6	4339.2
####	0.013	0.013	1.000	0.0	1734.5	1725.2	380.9	335.0	1747.5	1724.2	912.0	865.9	1846.0	1769.7	2906.7	2858.8	1852.1	1763.5	3371.7	3323.7	1427.7	1320.0	4085.9	4049.4	1423.6	1308.1	4377.7	4341.5
####	0.010	0.010	1.000	0.0	1733.4	1726.5	372.7	338.3	1744.7	1727.2	903.7	869.2	1836.5	1779.3	2898.4	2862.4	1841.1	1774.7	3363.3	3327.3	1414.3	1333.5	4079.0	4051.6	1409.2	1322.6	4370.9	4343.7
####	0.007	0.007	1.000	0.0	1732.3	1727.7	364.5	341.5	1741.8	1730.1	895.5	872.5	1827.0	1788.9	2889.9	2865.9	1830.1	1785.8	3354.9	3330.9	1400.9	1347.0	4072.0	4053.8	1394.8	1337.1	4364.0	4345.8
5.000	0.003	0.003	1.000	0.0	1731.1	1728.8	356.2	344.8	1738.9	1733.1	887.3	875.7	1817.5	1798.5	2881.5	2869.5	1819.1	1796.9	3346.5	3334.5	1387.5	1360.5	4065.0	4055.9	1380.4	1351.6	4357.0	4347.9
0.000	0.000	0.000	1.000	0.0	1730.0	1730.0	348.0	348.0	1736.0	1736.0	879.0	879.0	1808.0	1808.0	2873.0	2873.0	1808.0	1808.0	3338.0	3338.0	1374.0	1374.0	4058.0	4058.0	1366.0	1366.0	4350.0	4350.0

E1= [ab + (h x tan α)] x cos α
F1 = [ab - (h x tan α)] x cos α
H1 = (Ca / 2) +(h/cos α) + (Ab-h x tan α) x sin α
H2 = (Ca / 2) +(h/cos α) - (Ab+h x tan α) x sin α
ab = Ab = Distance from 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 niclined centre line of canted 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.
bc = h x tan α = Lateral increment due to cant (measured along the line parallel to line joining the top of rails).

APPENDIX - 3C

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

REFERENCE DRAWING NUMBER: MPMRCL/GEN/SOD/UND-03 & MPMRCL/GEN/SOD/GEN-01 AND PARAs 1.7.1B., 1.7.2 B. and 1.8.2

All figures in mm

Height above rail level measured above perp to track plane 'h' =					348				885				2884				3320				4246				4300			
Distance from centre line of track to Structure Gauge for tangent track'ab'=					1680				1676				1729				1729				1040				833			
Cant mm	angle 'α' in radians	Sin α	Cos α	Tan α	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2	E1	F1	H1	H2
125	0.083	0.083	0.997	0.083	1703.1	1645.3	548.7	270.0	1743.6	1596.8	1083.5	805.4	1962.3	1483.8	3080.0	2793.1	1998.4	1447.7	3514.5	3227.6	1388.6	684.2	4380.1	4207.6	1186.8	473.5	4416.8	4278.6
120	0.080	0.080	0.997	0.080	1702.4	1647.0	540.7	273.1	1741.1	1600.2	1075.6	808.7	1953.2	1493.9	3072.5	2797.2	1987.9	1459.1	3507.1	3231.8	1374.8	698.6	4375.3	4209.7	1172.8	488.0	4412.7	4280.0
115	0.076	0.076	0.997	0.077	1701.7	1648.5	532.7	276.3	1738.6	1603.6	1067.8	812.0	1944.0	1503.9	3065.0	2801.1	1977.3	1470.6	3499.8	3235.9	1361.0	713.0	4370.5	4211.8	1158.7	502.4	4408.5	4281.4
110	0.073	0.073	0.997	0.073	1700.9	1650.1	524.7	279.4	1736.1	1606.9	1060.0	815.3	1934.9	1513.9	3057.5	2805.1	1966.7	1482.1	3492.3	3239.9	1347.2	727.3	4365.6	4213.8	1144.6	516.9	4404.3	4282.7
105	0.070	0.070	0.998	0.070	1700.2	1651.7	516.7	282.6	1733.6	1610.3	1052.1	818.6	1925.7	1523.9	3050.0	2809.0	1956.1	1493.5	3484.9	3244.0	1333.3	741.6	4360.6	4215.7	1130.6	531.4	4400.1	4284.0
100	0.066	0.066	0.998	0.067	1699.4	1653.2	508.7	285.8	1731.0	1613.6	1044.3	821.8	1916.6	1533.8	3042.4	2812.9	1945.5	1504.9	3477.4	3248.0	1319.5	756.0	4355.7	4217.6	1116.5	545.8	4395.8	4285.2
95	0.063	0.063	0.998	0.063	1698.6	1654.7	500.7	288.9	1728.5	1616.9	1036.4	825.1	1907.4	1543.8	3034.8	2816.8	1934.9	1516.3	3469.9	3251.9	1305.6	770.3	4350.6	4219.5	1102.4	560.3	4391.5	4286.4
90	0.060	0.060	0.998	0.060	1697.8	1656.2	492.7	292.0	1725.9	1620.2	1028.5	828.3	1898.2	1553.7	3027.1	2820.6	1924.2	1527.6	3462.3	3255.8	1291.7	784.6	4345.5	4221.3	1088.3	574.7	4387.1	4287.6
85	0.056	0.056	0.998	0.056	1697.0	1657.7	484.7	295.2	1723.2	1623.4	1020.6	831.6	1888.9	1563.6	3019.4	2824.4	1913.5	1539.0	3454.7	3259.7	1277.8	798.9	4340.4	4223.1	1074.2	589.1	4382.6	4288.7
80	0.053	0.053	0.999	0.053	1696.1	1659.2	476.7	298.3	1720.6	1626.7	1012.7	834.8	1879.7	1573.5	3011.7	2828.1	1902.8	1550.3	3447.1	3263.5	1263.9	813.1	4335.2	4224.8	1060.1	603.6	4378.2	4289.7
75	0.050	0.050	0.999	0.050	1695.2	1660.6	468.7	301.5	1718.0	1629.9	1004.8	838.0	1870.4	1583.3	3004.0	2831.9	1892.1	1561.6	3439.4	3267.3	1250.0	827.4	4330.0	4226.5	1046.0	618.0	4373.6	4290.7
70	0.046	0.046	0.999	0.047	1694.4	1662.0	460.7	304.6	1715.3	1633.1	996.9	841.2	1861.1	1593.2	2996.2	2835.6	1881.3	1572.9	3431.7	3271.1	1236.1	841.7	4324.7	4228.1	1031.8	632.4	4369.1	4291.7
65	0.043	0.043	0.999	0.043	1693.4	1663.4	452.6	307.7	1712.6	1636.3	989.0	844.4	1851.8	1603.0	2988.4	2839.2	1870.6	1584.2	3424.0	3274.8	1222.2	855.9	4319.4	4229.7	1017.7	646.8	4364.4	4292.6
60	0.040	0.040	0.999	0.040	1692.5	1664.8	444.6	310.8	1709.9	1639.4	981.0	847.6	1842.5	1612.8	2980.6	2842.9	1859.8	1595.4	3416.2	3278.5	1208.2	870.1	4314.0	4231.2	1003.5	661.1	4359.8	4293.4
55	0.037	0.036	0.999	0.037	1691.6	1666.2	436.6	314.0	1707.2	1642.6	973.1	850.7	1833.1	1622.6	2972.7	2846.5	1849.0	1606.7	3408.4	3282.2	1194.3	884.3	4308.6	4232.7	989.4	675.5	4355.0	4294.2
50	0.033	0.033	0.999	0.033	1690.6	1667.5	428.5	317.1	1704.4	1645.7	965.1	853.9	1823.7	1632.4	2964.8	2850.0	1838.2	1617.9	3400.5	3285.8	1180.3	898.6	4303.2	4234.2	975.2	689.9	4350.3	4295.0
45	0.030	0.030	1.000	0.030	1689.6	1668.9	420.5	320.2	1701.7	1648.8	957.2	857.1	1814.3	1642.1	2956.8	2853.6	1827.4	1629.1	3392.6	3289.4	1166.3	912.7	4297.7	4235.6	961.0	704.2	4345.5	4295.7
40	0.027	0.027	1.000	0.027	1688.6	1670.2	412.5	323.3	1698.9	1651.9	949.2	860.2	1804.9	1651.8	2948.9	2857.1	1816.5	1640.3	3384.7	3292.9	1152.3	926.9	4292.1	4236.9	946.8	718.6	4340.6	4296.4
35	0.023	0.023	1.000	0.023	1687.6	1671.5	404.4	326.4	1696.1	1655.0	941.2	863.3	1795.5	1661.6	2940.9	2860.6	1805.6	1651.4	3376.8	3296.4	1138.3	941.1	4286.5	4238.2	932.6	732.9	4335.7	4297.0
30	0.020	0.020	1.000	0.020	1686.6	1672.7	396.4	329.5	1693.3	1658.1	933.2	866.5	1786.1	1671.2	2932.8	2864.0	1794.7	1662.6	3368.8	3299.9	1124.3	955.3	4280.9	4239.5	918.4	747.2	4330.7	4297.6
25	0.017	0.017	1.000	0.017	1685.5	1674.0	388.3	332.6	1690.5	1661.1	925.2	869.6	1776.6	1680.9	2924.8	2867.4	1783.8	1673.7	3360.7	3303.4	1110.3	969.4	4275.2	4240.7	904.2	761.6	4325.7	4298.1
20	0.013	0.013	1.000	0.013	1684.5	1675.2	380.3	335.7	1687.6	1664.1	917.2	872.7	1767.1	1690.6	2916.7	2870.8	1772.9	1684.8	3352.7	3306.8	1096.3	983.6	4269.4	4241.8	890.0	775.9	4320.7	4298.6
15	0.010	0.010	1.000	0.010	1683.4	1676.5	372.2	338.8	1684.7	1667.1	909.1	875.8	1757.6	1700.2	2908.6	2874.1	1762.0	1695.9	3344.5	3310.1	1082.2	997.7	4263.6	4242.9	875.8	790.2	4315.6	4299.0
10	0.007	0.007	1.000	0.007	1682.3	1677.7	364.1	341.8	1681.8	1670.1	901.1	878.9	1748.1	1709.8	2900.4	2877.5	1751.0	1706.9	3336.4	3313.5	1068.2	1011.8	4257.8	4244.0	861.5	804.4	4310.4	4299.4
5	0.003	0.003	1.000	0.003	1681.1	1678.8	356.1	344.9	1678.9	1673.1	893.1	881.9	1738.6	1719.4	2892.2	2880.7	1740.0	1718.0	3328.2	3316.7	1054.1	1025.9	4251.9	4245.0	847.3	818.7	4305.2	4299.7
0	0.000	0.000	1.000	0.000	1680.0	1680.0	348.0	348.0	1676.0	1676.0	885.0	885.0	1729.0	1729.0	2884.0	2884.0	1729.0	1729.0	3320.0	3320.0	1040.0	1040.0	4246.0	4246.0	833.0	833.0	4300.0	4300.0

E1= [ab + (h x tan α)] x cos α
F1 = [ab - (h x tan α)] x cos α
H1 = (Ca / 2) +(h/cos α) + (Ab-h x tan α) x sin α
H2 = (Ca / 2) +(h/cos α) - (Ab+h x tan α) x sin α
ab = Ab = Distance from 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 niclined centre line of canted 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.
bc = h x tan α = Lateral increment due to cant (measured along the line parallel to line joining the top of rails).

APPENDIX - 3D

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

REFERENCE DRAWING NUMBER: MPMRCL/GEN/SOD/ATG-01 & MPMRCL/GEN/SOD/GEN-01 AND PARA 1.8.1

All figures in mm

Height above rail level measured above perp to track plane 'h' =					907				2036				3311				3826				4014				4209			
Distance from centre line of track to Kinematic Envelope for tangent track'ab'=					**1615**				**1663**				**1684**				**1337**				**1225**				**1220**			
Cant mm	angle 'α' in radians	Sin α	Cos α	Tan α	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	0.083	0.083	0.997	0.083	1684.7	1534.2	1100.3	832.4	1826.1	1488.4	2229.4	1953.5	1952.8	1403.6	3501.8	3222.4	1649.7	1015.0	3986.2	3764.4	1553.7	887.8	4164.3	3961.1	1564.9	866.7	4358.2	4155.8
120	0.080	0.080	0.997	0.080	1682.1	1537.6	1092.7	835.5	1819.8	1495.6	2222.0	1957.1	1942.3	1415.0	3494.6	3226.4	1637.4	1028.1	3980.3	3767.4	1540.7	901.5	4158.8	3963.7	1551.3	881.0	4352.8	4158.5
115	0.076	0.076	0.997	0.077	1679.5	1541.1	1085.1	838.6	1813.5	1502.8	2214.5	1960.7	1931.8	1426.4	3487.4	3230.3	1625.1	1041.1	3974.4	3770.3	1527.7	915.1	4153.3	3966.3	1537.6	895.3	4347.3	4161.1
110	0.073	0.073	0.997	0.073	1676.9	1544.5	1077.5	841.7	1807.2	1510.0	2207.0	1964.2	1921.2	1437.8	3480.1	3234.2	1612.7	1054.2	3968.4	3773.2	1514.7	928.7	4147.7	3968.9	1524.0	909.5	4341.8	4163.7
105	0.070	0.070	0.998	0.070	1674.3	1547.9	1069.8	844.8	1800.8	1517.1	2199.4	1967.7	1910.6	1449.2	3472.8	3238.1	1600.3	1067.2	3962.4	3776.0	1501.7	942.3	4142.1	3971.4	1510.3	923.8	4336.3	4166.3
100	0.066	0.066	0.998	0.067	1671.6	1551.3	1062.2	847.8	1794.4	1524.2	2191.9	1971.2	1900.0	1460.6	3465.4	3242.0	1587.9	1080.2	3956.3	3778.8	1488.7	955.9	4136.4	3973.9	1496.6	938.0	4330.7	4168.8
95	0.063	0.063	0.998	0.063	1669.0	1554.6	1054.5	850.9	1788.0	1531.3	2184.3	1974.6	1889.4	1471.9	3458.1	3245.8	1575.5	1093.2	3950.2	3781.6	1475.6	969.5	4130.7	3976.3	1482.9	952.2	4325.0	4171.2
90	0.060	0.060	0.998	0.060	1666.3	1558.0	1046.8	853.9	1781.6	1538.4	2176.7	1978.0	1878.7	1483.3	3450.7	3249.5	1563.1	1106.1	3944.0	3784.3	1462.5	983.1	4125.0	3978.7	1469.2	966.5	4319.3	4173.6
85	0.056	0.056	0.998	0.056	1663.6	1561.3	1039.1	857.0	1775.2	1545.5	2169.1	1981.5	1868.1	1494.6	3443.2	3253.2	1550.7	1119.1	3937.8	3787.0	1449.5	996.6	4119.2	3981.0	1455.5	980.7	4313.6	4176.0
80	0.053	0.053	0.999	0.053	1660.9	1564.6	1031.5	860.0	1768.7	1552.6	2161.4	1984.8	1857.4	1505.9	3435.7	3256.9	1538.2	1132.0	3931.6	3789.6	1436.4	1010.2	4113.4	3983.3	1441.7	994.8	4307.8	4178.3
75	0.050	0.050	0.999	0.050	1658.1	1567.9	1023.8	863.0	1762.3	1559.6	2153.7	1988.2	1846.7	1517.1	3428.2	3260.6	1525.8	1144.9	3925.3	3792.2	1423.2	1023.7	4107.5	3985.6	1428.0	1009.0	4302.0	4180.6
70	0.046	0.046	0.999	0.047	1655.4	1571.1	1016.0	866.0	1755.8	1566.6	2146.0	1991.6	1836.0	1528.4	3420.6	3264.2	1513.3	1157.8	3919.0	3794.8	1410.1	1037.2	4101.6	3987.8	1414.2	1023.2	4296.1	4182.8
65	0.043	0.043	0.999	0.043	1652.6	1574.4	1008.3	869.0	1749.3	1573.6	2138.3	1994.9	1825.2	1539.6	3413.1	3267.8	1500.8	1170.7	3912.6	3797.3	1397.0	1050.7	4095.6	3989.9	1400.4	1037.3	4290.2	4185.0
60	0.040	0.040	0.999	0.040	1649.8	1577.6	1000.6	872.0	1742.7	1580.6	2130.6	1998.2	1814.5	1550.8	3405.4	3271.3	1488.3	1183.6	3906.2	3799.7	1383.8	1064.2	4089.6	3992.0	1386.6	1051.5	4284.2	4187.1
55	0.037	0.036	0.999	0.037	1647.0	1580.8	992.8	875.0	1736.2	1587.6	2122.8	2001.5	1803.7	1562.0	3397.8	3274.8	1475.7	1196.5	3899.7	3802.2	1370.7	1077.7	4083.5	3994.1	1372.8	1065.6	4278.2	4189.2
50	0.033	0.033	0.999	0.033	1644.2	1584.0	985.1	877.9	1729.6	1594.5	2115.1	2004.7	1792.9	1573.2	3390.0	3278.3	1463.2	1209.3	3893.3	3804.5	1357.5	1091.1	4077.4	3996.1	1359.0	1079.7	4272.2	4191.2
45	0.030	0.030	1.000	0.030	1641.4	1587.2	977.3	880.9	1723.1	1601.5	2107.3	2007.9	1782.1	1584.4	3382.3	3281.7	1450.7	1222.2	3886.7	3806.9	1344.3	1104.6	4071.3	3998.1	1345.1	1093.8	4266.1	4193.2
40	0.027	0.027	1.000	0.027	1638.5	1590.4	969.5	883.8	1716.5	1608.4	2099.4	2011.1	1771.3	1595.5	3374.5	3285.1	1438.1	1235.0	3880.1	3809.2	1331.1	1118.0	4065.1	4000.1	1331.3	1107.9	4259.9	4195.1
35	0.023	0.023	1.000	0.023	1635.6	1593.5	961.8	886.7	1709.8	1615.3	2091.6	2014.3	1760.4	1606.6	3366.7	3288.5	1425.5	1247.8	3873.5	3811.4	1317.9	1131.4	4058.9	4002.0	1317.4	1121.9	4253.7	4197.0
30	0.020	0.020	1.000	0.020	1632.7	1596.6	954.0	889.7	1703.2	1622.1	2083.7	2017.5	1749.6	1617.8	3358.9	3291.8	1412.9	1260.6	3866.9	3813.6	1304.7	1144.9	4052.6	4003.8	1303.5	1136.0	4247.5	4198.9
25	0.017	0.017	1.000	0.017	1629.8	1599.7	946.2	892.6	1696.5	1629.0	2075.8	2020.6	1738.7	1628.8	3351.0	3295.1	1400.3	1273.3	3860.2	3815.8	1291.4	1158.2	4046.3	4005.6	1289.7	1150.0	4241.2	4200.7
20	0.013	0.013	1.000	0.013	1626.9	1602.8	938.4	895.5	1689.9	1635.8	2067.9	2023.8	1727.8	1639.9	3343.1	3298.4	1387.7	1286.1	3853.4	3817.9	1278.2	1171.6	4039.9	4007.4	1275.8	1164.0	4234.8	4202.4
15	0.010	0.010	1.000	0.010	1623.9	1605.9	930.5	898.4	1683.2	1642.7	2060.0	2026.8	1716.9	1651.0	3335.1	3301.6	1375.0	1298.9	3846.6	3820.0	1264.9	1185.0	4033.5	4009.1	1261.8	1178.0	4228.4	4204.1
10	0.007	0.007	1.000	0.007	1621.0	1608.9	922.7	901.3	1676.5	1649.5	2052.0	2029.9	1705.9	1662.0	3327.1	3304.8	1362.4	1311.6	3839.8	3822.0	1251.6	1198.3	4027.0	4010.8	1247.9	1192.0	4222.0	4205.8
5	0.003	0.003	1.000	0.003	1618.0	1612.0	914.9	904.1	1669.7	1656.2	2044.0	2033.0	1695.0	1673.0	3319.1	3307.9	1349.7	1324.3	3832.9	3824.0	1238.3	1211.7	4020.5	4012.4	1234.0	1206.0	4215.5	4207.4
0	0.000	0.000	1.000	0.000	1615.0	1615.0	907.0	907.0	1663.0	1663.0	2036.0	2036.0	1684.0	1684.0	3311.0	3311.0	1337.0	1337.0	3826.0	3826.0	1225.0	1225.0	4014.0	4014.0	1220.0	1220.0	4209.0	4209.0

E1= [ab + (h x tan α)] x cos α
F1 = [ab - (h x tan α)] x cos α
H1 = (Ca / 2) +(h/cos α) + (Ab-h x tan α) x sin α
H2 = (Ca / 2) +(h/cos α) - (Ab+h x tan α) x sin α
ab = Ab = Distance from 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 niclined centre line of canted 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.
bc = h x tan α = Lateral increment due to cant (measured along the line parallel to line joining the top of rails).

APPENDIX - 3E

CANT EFFECT ON KINEMATIC ENVELOPE
ELEVATED/UNDERGROUND AND AT-GRADE (SURFACE) SECTION - BALLASTLESS TRACK

REFERENCE DRAWING NUMBER: MPMRCL/GEN/SOD/ELE-01 & MPMRCL/GEN/SOD/GEN-01 AND PARA 1.8.1

All figures in mm

Height above rail level measured above perp to track plane 'h' =					348				895				2876				3296				4014				4200			
Distance from centre line of track to Kinematic Envelope for tangent track'ab'=					1451				1586				1658				1658				1225				1220			
Cant mm	angle 'α' in radians	Sin α	Cos α	Tan α	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	0.083	0.083	0.997	0.083	1474.9	1417.1	529.7	288.9	1654.8	1506.3	1086.0	822.9	1890.8	1413.7	3066.1	2791.1	1925.7	1378.9	3484.7	3209.6	1553.7	887.8	4164.3	3961.1	1564.2	867.4	4349.2	4146.8
120	0.080	0.080	0.997	0.080	1474.1	1418.7	522.4	291.4	1652.2	1509.7	1078.4	825.9	1881.7	1423.7	3058.9	2794.8	1915.2	1390.3	3477.6	3213.5	1540.7	901.5	4158.8	3963.7	1550.6	881.7	4343.8	4149.5
115	0.076	0.076	0.997	0.077	1473.3	1420.2	515.2	293.8	1649.7	1513.1	1070.9	828.9	1872.6	1433.7	3051.6	2798.6	1904.7	1401.6	3470.4	3217.4	1527.7	915.1	4153.3	3966.3	1536.9	895.9	4338.4	4152.2
110	0.073	0.073	0.997	0.073	1472.5	1421.7	508.0	296.2	1647.1	1516.4	1063.4	831.8	1863.5	1443.7	3044.4	2802.3	1894.2	1413.0	3463.2	3221.2	1514.7	928.7	4147.7	3968.9	1523.3	910.2	4332.8	4154.7
105	0.070	0.070	0.998	0.070	1471.7	1423.2	500.8	298.6	1644.5	1519.8	1055.8	834.8	1854.4	1453.6	3037.0	2806.0	1883.6	1424.3	3456.0	3225.0	1501.7	942.3	4142.1	3971.4	1509.7	924.4	4327.3	4157.3
100	0.066	0.066	0.998	0.067	1470.9	1424.7	493.5	300.9	1641.9	1523.1	1048.3	837.8	1845.2	1463.5	3029.7	2809.6	1873.1	1435.6	3448.8	3228.7	1488.7	955.9	4136.4	3973.9	1496.0	938.6	4321.7	4159.8
95	0.063	0.063	0.998	0.063	1470.1	1426.2	486.3	303.3	1639.3	1526.4	1040.7	840.7	1836.0	1473.4	3022.3	2813.3	1862.5	1446.9	3441.5	3232.4	1475.6	969.5	4130.7	3976.3	1482.3	952.8	4316.1	4162.2
90	0.060	0.060	0.998	0.060	1469.2	1427.6	479.0	305.7	1636.6	1529.7	1033.1	843.7	1826.8	1483.3	3014.9	2816.8	1851.9	1458.2	3434.1	3236.1	1462.5	983.1	4125.0	3978.7	1468.7	967.0	4310.4	4164.6
85	0.056	0.056	0.998	0.056	1468.3	1429.1	471.8	308.1	1634.0	1533.0	1025.5	846.6	1817.6	1493.1	3007.4	2820.4	1841.3	1469.5	3426.8	3239.7	1449.5	996.6	4119.2	3981.0	1455.0	981.2	4304.6	4167.0
80	0.053	0.053	0.999	0.053	1467.4	1430.5	464.5	310.5	1631.3	1536.3	1017.9	849.5	1808.3	1503.0	3000.0	2823.9	1830.6	1480.7	3419.4	3243.3	1436.4	1010.2	4113.4	3983.3	1441.2	995.3	4298.8	4169.3
75	0.050	0.050	0.999	0.050	1466.5	1431.9	457.3	312.9	1628.6	1539.5	1010.3	852.5	1799.1	1512.8	2992.5	2827.4	1820.0	1491.9	3411.9	3246.9	1423.2	1023.7	4107.5	3985.6	1427.5	1009.5	4293.0	4171.6
70	0.046	0.046	0.999	0.047	1465.6	1433.3	450.0	315.2	1625.9	1542.7	1002.7	855.4	1789.8	1522.6	2984.9	2830.9	1809.3	1503.1	3404.5	3250.4	1410.1	1037.2	4101.6	3987.8	1413.8	1023.6	4287.1	4173.8
65	0.043	0.043	0.999	0.043	1464.7	1434.6	442.8	317.6	1623.1	1545.9	995.1	858.3	1780.5	1532.4	2977.3	2834.3	1798.6	1514.3	3396.9	3253.9	1397.0	1050.7	4095.6	3989.9	1400.0	1037.7	4281.2	4176.0
60	0.040	0.040	0.999	0.040	1463.7	1436.0	435.5	320.0	1620.4	1549.1	987.4	861.1	1771.2	1542.2	2969.7	2837.7	1787.9	1525.5	3389.4	3257.4	1383.8	1064.2	4089.6	3992.0	1386.3	1051.8	4275.2	4178.1
55	0.037	0.036	0.999	0.037	1462.7	1437.3	428.2	322.3	1617.6	1552.3	979.8	864.0	1761.9	1551.9	2962.1	2841.1	1777.2	1536.6	3381.8	3260.8	1370.7	1077.7	4083.5	3994.1	1372.5	1065.9	4269.2	4180.2
50	0.033	0.033	0.999	0.033	1461.7	1438.7	421.0	324.7	1614.8	1555.4	972.1	866.9	1752.5	1561.7	2954.4	2844.4	1766.4	1547.7	3374.2	3264.2	1357.5	1091.1	4077.4	3996.1	1358.7	1080.0	4263.2	4182.2
45	0.030	0.030	1.000	0.030	1460.7	1440.0	413.7	327.0	1612.0	1558.6	964.5	869.7	1743.1	1571.4	2946.7	2847.7	1755.7	1558.8	3366.5	3267.5	1344.3	1104.6	4071.3	3998.1	1344.9	1094.0	4257.1	4184.2
40	0.027	0.027	1.000	0.027	1459.7	1441.3	406.4	329.4	1609.2	1561.7	956.8	872.6	1733.8	1581.1	2939.0	2851.0	1744.9	1569.9	3358.8	3270.8	1331.1	1118.0	4065.1	4000.1	1331.0	1108.1	4250.9	4186.1
35	0.023	0.023	1.000	0.023	1458.7	1442.5	399.1	331.7	1606.4	1564.8	949.1	875.4	1724.3	1590.8	2931.2	2854.2	1734.1	1581.0	3351.1	3274.1	1317.9	1131.4	4058.9	4002.0	1317.2	1122.1	4244.7	4188.0
30	0.020	0.020	1.000	0.020	1457.6	1443.8	391.8	334.0	1603.5	1567.9	941.4	878.2	1714.9	1600.4	2923.4	2857.4	1723.3	1592.1	3343.4	3277.3	1304.7	1144.9	4052.6	4003.8	1303.4	1136.1	4238.5	4189.9
25	0.017	0.017	1.000	0.017	1456.6	1445.0	384.5	336.4	1600.6	1570.9	933.7	881.1	1705.5	1610.1	2915.6	2860.6	1712.5	1603.1	3335.6	3280.5	1291.4	1158.2	4046.3	4005.6	1289.5	1150.2	4232.2	4191.7
20	0.013	0.013	1.000	0.013	1455.5	1446.3	377.2	338.7	1597.7	1574.0	926.0	883.9	1696.0	1619.7	2907.8	2863.7	1701.6	1614.1	3327.7	3283.7	1278.2	1171.6	4039.9	4007.4	1275.6	1164.2	4225.8	4193.4
15	0.010	0.010	1.000	0.010	1454.4	1447.5	369.9	341.0	1594.8	1577.0	918.2	886.7	1686.5	1629.3	2899.9	2866.9	1690.7	1625.1	3319.8	3286.8	1264.9	1185.0	4033.5	4009.1	1261.7	1178.1	4219.4	4195.1
10	0.007	0.007	1.000	0.007	1453.3	1448.7	362.6	343.4	1591.9	1580.0	910.5	889.5	1677.0	1638.9	2891.9	2869.9	1679.8	1636.1	3311.9	3289.9	1251.6	1198.3	4027.0	4010.8	1247.8	1192.1	4213.0	4196.8
5	0.003	0.003	1.000	0.003	1452.1	1449.8	355.3	345.7	1589.0	1583.0	902.8	892.2	1667.5	1648.4	2884.0	2873.0	1668.9	1647.1	3304.0	3293.0	1238.3	1211.7	4020.5	4012.4	1233.9	1206.1	4206.5	4198.4
0	0.000	0.000	1.000	0.000	1451.0	1451.0	348.0	348.0	1586.0	1586.0	895.0	895.0	1658.0	1658.0	2876.0	2876.0	1658.0	1658.0	3296.0	3296.0	1225.0	1225.0	4014.0	4014.0	1220.0	1220.0	4200.0	4200.0

E1= [ab + (h x tan α)] x cos α
F1 = [ab - (h x tan α)] x cos α
H1 = (Ca / 2) +(h/cos α) + (Ab-h x tan α) x sin α
H2 = (Ca / 2) +(h/cos α) - (Ab+h x tanα) x sin α
ab = 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 niclined centre line of canted 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.
bc = h x tan α = Lateral increment due to cant (measured along the line parallel to line joining the top of rails).

APPENDIX - 4

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

REFERENCE DRAWING NUMBER: MPMRCL/GEN/SOD/UND -04 AND PARAs 1.7.1 B & 1.7.2 B

Tan(q) = (r-D)/(G/2)	2.707365627					Radius of circular tunnel ' r ' =	2800
q in radians	1.216977044					Height from invert to rail level ' D_1 ' =	760

Cant	sin α	α	Angle Pi()/2- θ- α/2)	Lateral shift of tunnel centre =X	Vertical shift of tunnel centre =Y	Remarks
mm		radians	radians	mm	mm	(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.
125	0.082946251	0.0830416593	0.3123	172	55	
120	0.079628401	0.0797127915	0.3140	165	54	
115	0.076310551	0.0763848087	0.3156	158	52	
110	0.072992701	0.0730576733	0.3173	151	50	(B). LATERAL SHIFT OF THE CENTRE OF THE TUNNEL (TOWRDS INSIDE OF CURVE) IS
105	0.069674851	0.0697313480	0.3190	144	48	
100	0.066357001	0.0664057952	0.3206	137	46	
95	0.063039151	0.0630809777	0.3223	130	43	$X = [\{ 2 \times (r-D_1)/\sin\theta\} \times \sin(\alpha/2)\}] \times \cos(90-\theta-\alpha/2)$
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	0.0497883178	0.3289	102	35	$Y = [\{ 2 \times (r-D_1)/\sin\theta\} \times \sin(\alpha/2)\}] \times \sin(90-\theta-\alpha/2)$
70	0.046449900	0.0464666200	0.3306	96	33	
65	0.043132050	0.0431454353	0.3322	89	31	where,
60	0.039814200	0.0398247266	0.3339	82	28	
55	0.036496350	0.0365044573	0.3356	75	26	'r' is internal radius of the circular tunnel = 2800mm
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	'α' is the angle of rotation = $\sin^{-1}$ (Cant /G) and
30	0.019907100	0.0199084153	0.3439	41	15	
25	0.016589250	0.0165900112	0.3455	34	12	'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 cirular 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	= tan -1[(r-D_1)/(G/2) in degrees = 69.752367
5	0.003317850	0.0033178561	0.3522	7	2	
0	0.000000000	0.0000000000	0.3538	0	0	G = Centre to centre of rails = 1507mm

APPENDIX - 5

ADDITIONAL CLEARANCE FOR PLATFORMS ON CURVES UNDER GROUND, ELEVATED AND AT GRADE SECTIONS

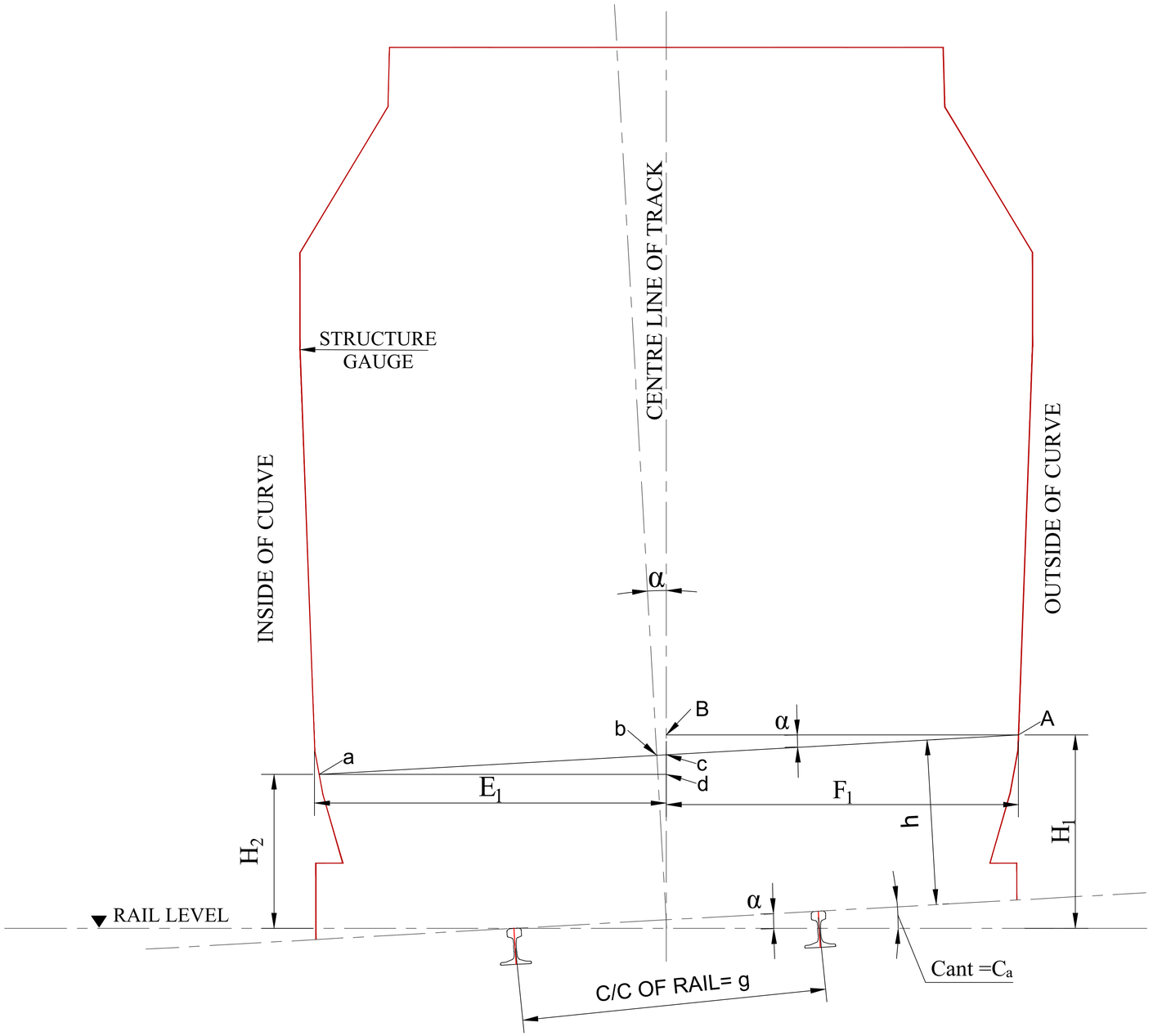
EXTRA CLEARANCE

Radius	INSIDE OF CURVE								OUTSIDE OF CURVE					
	AT CENTRE LINE OF BOGIES				AT EDGE OF OPEN DOOR NEAREST TO C.L. OFBOGIES				AT END OF COACH	AT EDGE OF OPEN DOOR FARTHEST FROM C.L. OF BOGIES				
	MID THROW =28125/R	NOSING	ADDITIONAL CLEARANCE	ADDITIONAL CLEARANCE (ROUNDED OFF NEAREST 5 mm, (i)	THROW =28121/R	NOSING = 17 x0.873/10.97	ADDITIONAL CLEARANCE	ADDITIONAL CLEARANCE (ROUNDED OFF NEAREST 5 mm, (ii)	END THROW =34020/R	THROW =19340/R	NOSING = 17 x 9.59/10.97	DIFFERENCE BETWEEN N AND N_2	ADDITIONAL CLEARANCE	ADDITIONAL CLEARANCE (ROUNDED OFF NEAREST 5 mm, (ii)
R	V	N	V-N	V-N	V_3	N_1	V_3 - (N-N_1)	V_3 - (N-N_1)	V_0	V_4	N_2	N-N_2	V_4-(N-N_2)	V_4-(N-N_2)
meters	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
1	*2*	*3*	*4a*	*4*	*5*	*6*	*7a*	*7*	*8*	*9*	*10*	*11*	*12a*	*12*
3000	9.4	17.0	-7.6	0	9.4	1.1	-6.5	0	11	6.4	14.9	2.1	4.3	5
2800	10.0	17.0	-7.0	0	10.0	1.1	-5.8	0	12	6.9	14.9	2.1	4.8	5
2400	11.7	17.0	-5.3	0	11.7	1.1	-4.2	0	14	8.1	14.9	2.1	5.9	10
2000	14.1	17.0	-2.9	5	14.1	1.1	-1.8	5	17	9.7	14.9	2.1	7.5	10
1800	15.6	17.0	-1.4	5	15.6	1.1	-0.3	5	19	10.7	14.9	2.1	8.6	10
1600	17.6	17.0	0.6	5	17.6	1.1	1.7	5	21	12.1	14.9	2.1	9.9	10
1500	18.8	17.0	1.8	5	18.8	1.1	2.9	5	23	12.9	14.9	2.1	10.8	15
1200	23.4	17.0	6.4	10	23.4	1.1	7.6	10	28	16.1	14.9	2.1	14.0	15
1000	28.1	17.0	11.1	15	28.1	1.1	12.2	15	34	19.3	14.9	2.1	17.2	20

NOTES:

1.0	**For outside of curve**, the difference between clearance required at coach end that at the farthest door edge is less than 25 mm. As half width of coach at ends is at least 25 mm less than that at door location, additional clearance to be provided is additional clearance required at the farthest door edge (column 12)
2.0	Values of additional clearance (column 4, 7 and 12) are rounded off to the nearest 5 mm.
3.0	Negative values of additional clearance are taken as Zero in the column 4 and 7 with rounded off figures.
4.0	**Extra clearance for curve:**
(a)	**Inside of curve:**
	$V = (125\ C^2 / R) = 28125 / R$ with C=15.00 m for the worst case.
	$V_3 = [(125) \times (15.0^2) - 4x0.873^2) R] = 28121 / R$
	$N_1 = N \times (X) / (C_1/2) = 17 \times 0.873 / 10.97 = 1.03$ mm
	Minimum distance 'X' for the nearest edge of an open door from centre line of Bogies is 0.873m (assumed).
	Higher of (i) in column 4 and (ii) in column 7 shall be adopted.
(b)	**Outside of curve:**
	$V_0 = (125\ C_1^2 / R) - (125\ C^2 / R) = 34020/R$ for coach end with C = 14.6m and C_1 = 2x10.97m.
	$V_4 = 125 \times (19.18 \times 19.18 - 14.6 \times 14.6) / R = 19340 / R$ for the farthest edge of end door in open position with C_1 = 2 x 9.590=19.18m and C = 14.60m for the worst case.
	N_2 = Nosing at the farthest edge of an open door = N x (X) / (C_1/2) = 17x9.59 / 10.97mm = 11.3 mm
	R = Radius of curve in metres
	Maximum distance (X) for the farthest edge of open door from centre line of two bogies = 9.590m (assumed).
	Exact position of door will be finalized during the design stage.
5.0	There will be no superelevation on curve in Platform portion.

REFERENCE PARA NO.: 1.7.1B, 1.7.2B & 1.8.2



NOTES:

1. STRUCTURE GAUGE FOR AT-GRADE/ELEVATED SECTION HAS BEEN SHOWN AS A TYPICAL FIGURE.
2. THE FORMULA FOR E_1,F_1,H_1 AND H_2 SHOWN THIS FIGURE WILL ALSO APPLY TO UNDER GROUND BOX TUNNELS.
3. KINEMATIC ENVELOPE IS VALID FOR THE MAXIMUM SPEED OF 90 KMPH, WIND SPEED OF 100 KMPH.
4. MAXIMUM DESIRABLE CANT (CA) =110 MM, MAXIMUM DESIRABLE CANT DEFICIENCY(CD) = 85 MM

ab= Ab= Distance from centreline of track to structure gauge for tangent track at height 'h'

$\sin \alpha$ = cant/g

g= 1510mm

Ca= Cant applied

$E_1 = [ab + hx \tan \alpha)] \times \cos \alpha$

$F_1 = [ab - hx \tan \alpha] \times \cos \alpha$

$H_1 = (Ca/2) + (h/\cos \alpha) + (Ab - hx \tan \alpha) \times \sin \alpha$

$H_2 = (Ca/2) + (h/\cos \alpha) - (Ab + hx \tan \alpha) \times \sin \alpha$

For values of E_1, F_1, H_1 and H_2, refer to Appendix 3A,3B & 3C.

LEGEND

———	STRUCTURE GAUGE

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
2	18.01.22	Revised	MG	RS/CB	S.Fourie
1	21.08.21	Revised/RDSO comments dt.30.07.21	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

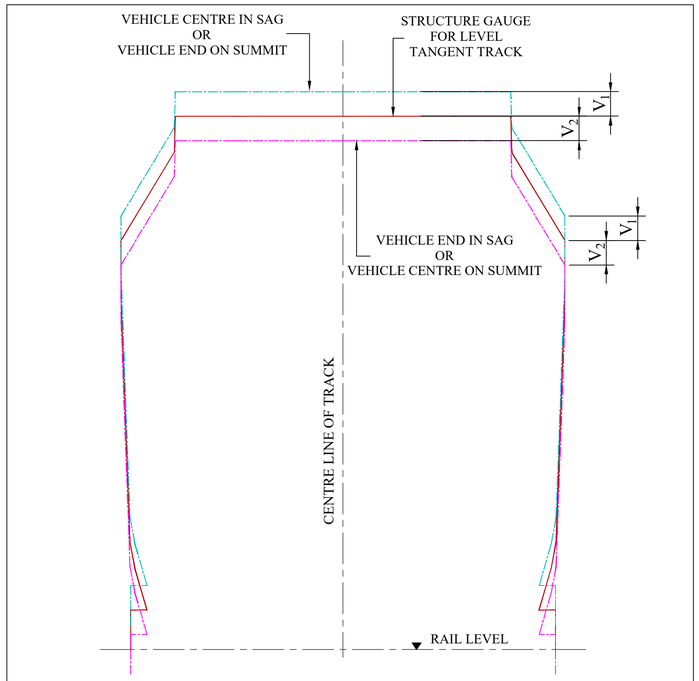
DRAWING TITLE

EFFECT OF CANT ON STRUCTURE GAUGE (TYPICAL)

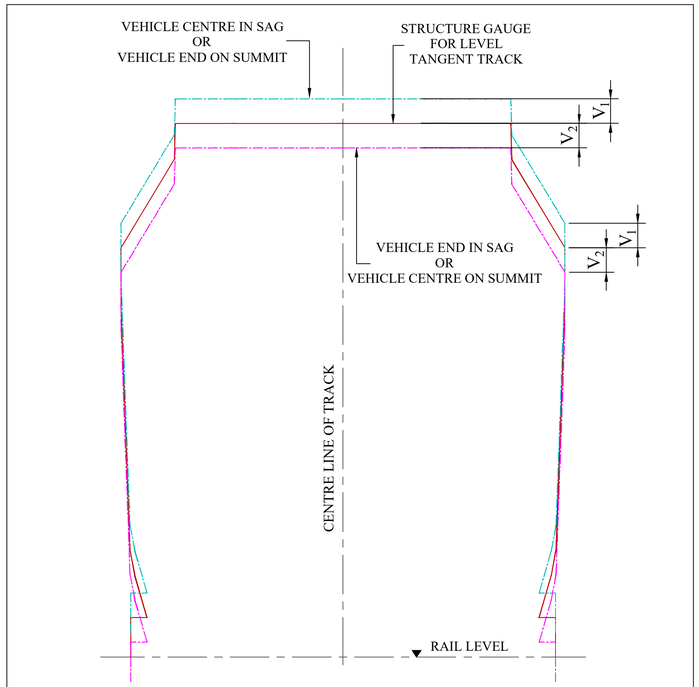
STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV	SCALE	DATE	STATUS
MPMRCL/GEN/SOD/GEN-01	2	NTS	28/05/2019	

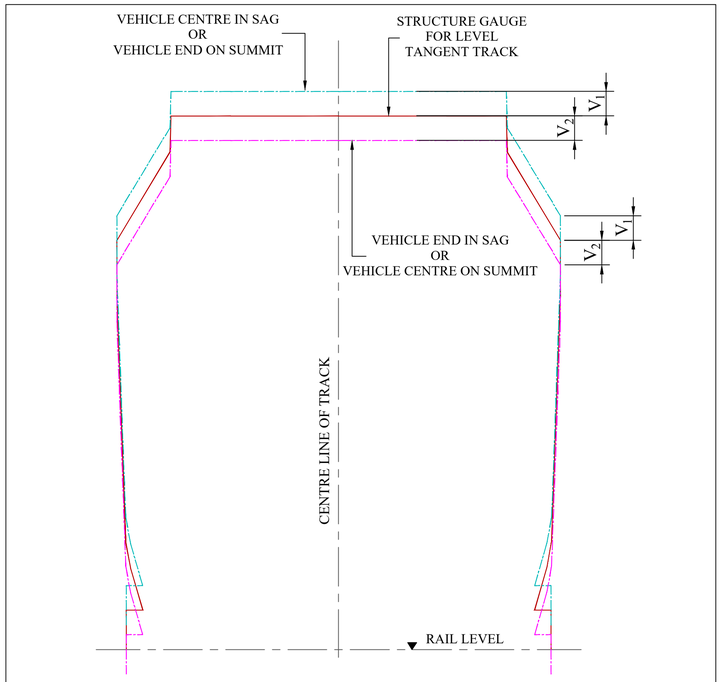
REFERENCE PARA NO.: 1.7.1C &1.7.2C



FOR UNDER GROUND SECTIONS



FOR ELEVATED SECTIONS



FOR SURFACE (AT GRADE) SECTIONS

NOTES:
1. THE FIGURE IS TYPICAL AND WILL APPLY TO UNDER GROUND ELEVATED AND AT-GRADE SECTIONS.
2. VALID FOR MAXIMUM SPEED OF 90 KMPH .

VERTICAL THROW		
RADIUS OF VERTICAL CURVE (M)	V_1 (mm)	V_2 (mm)
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

V1 = $125 \times C^2/R$

V2 = $(125 \times C_1^2/R) - (125 \times C^2/R)$

C = BOGIE CENTRE DISTANCE

C1 = COACH LENGTH

LEGEND

STRUCTURE GAUGE

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
1	18.01.22	Revised	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

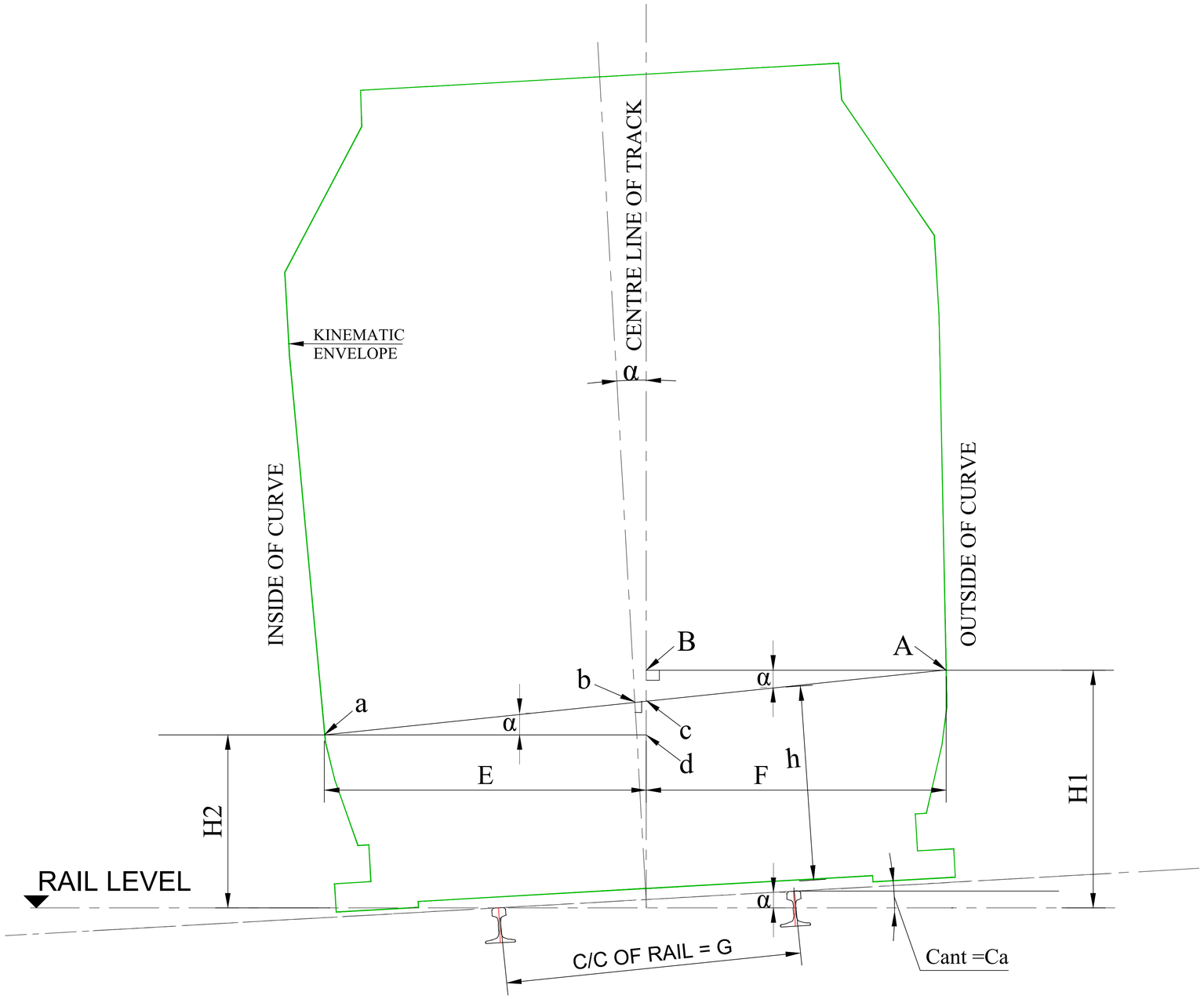
EFFECT OF VERTICAL CURVE ON STRUCTURE GAUGE

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/GEN-02	1

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 1.8.1



NOTES:
1. KINEMATIC ENVELOPE FOR AT- GRADE/ELEVATED SECTION HAS BEEN SHOWN AS A TYPICAL FIGURE.
2. THE FORMULA FOR E_1, F_1, H_1 AND H_2 SHOWN THIS FIGURE WILL ALSO APPLY TO UNDER GROUND BOX TUNNELS.
3. MAXIMUM DESIRABLE CANT (CA) =110 MM, MAXIMUM DESIRABLE CANT DEFICIENCY(CD) = 85 MM

ab= Ab= Distance from centreline of track to kinematic envelope for tangent track at height 'h'

$\sin \alpha = ca/G$

G= 1507mm

Ca= Cant applied

$E = [ab+hxv \tan \alpha)] \times \cos \alpha$

$F = [ab-hxtan \alpha)] \times \cos \alpha$

$H_1 = (Ca/2)+(h/\cos \alpha)+(Ab-hxtan\alpha) \times \sin\alpha$

$H_2 = (Ca/2)+(h/\cos \alpha)-(Ab+hxtan\alpha) \times \sin\alpha$

For values of E, F, H_1 and H_2, refer to Appendix-3D and 3E

LEGEND

——	KINEMATIC ENVELOPE OF COACH

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
1	18.01.22	Revised	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB GEODATA Louis Berger

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

MPMETRO

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

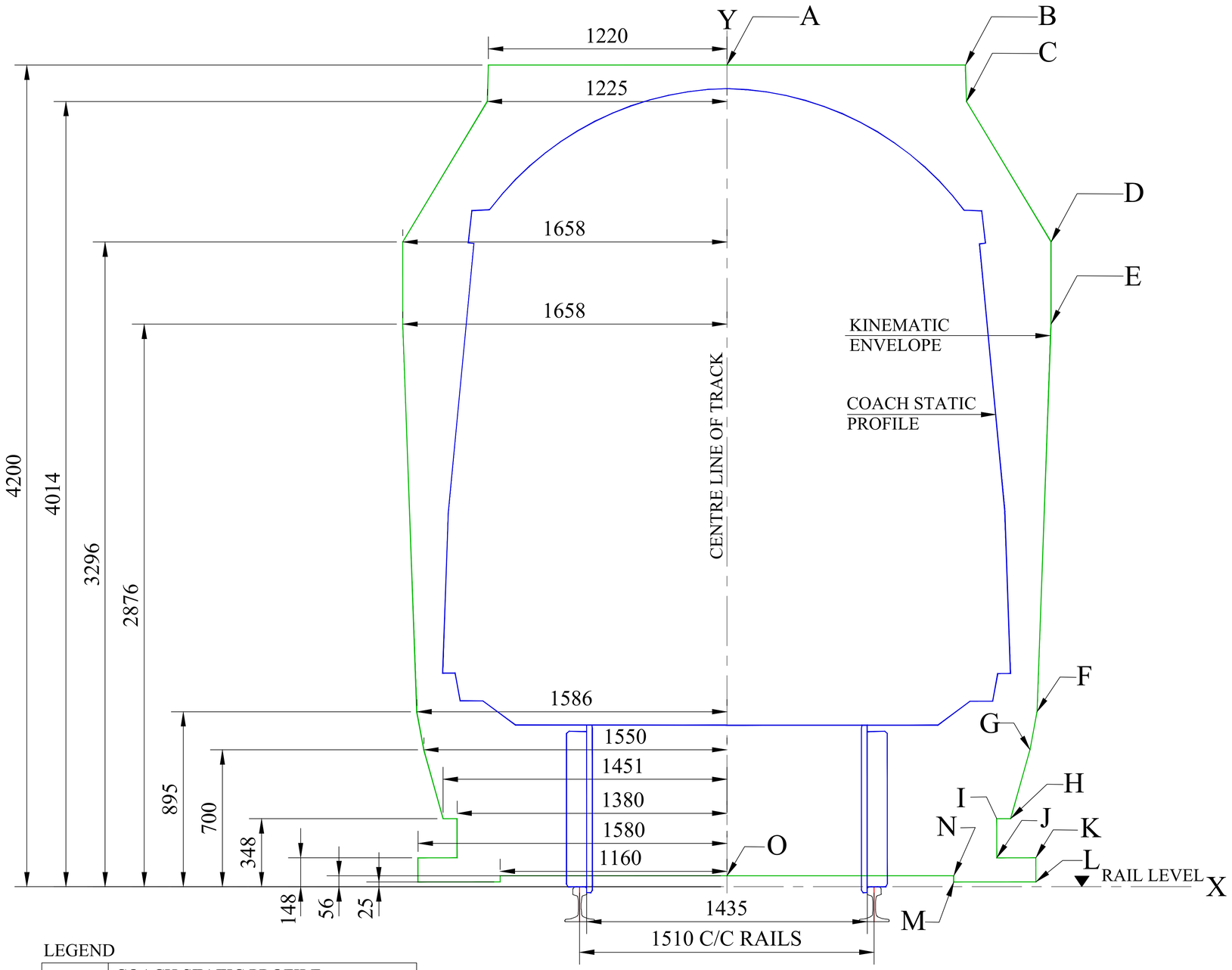
EFFECT OF CANT ON KINEMATIC ENVELOPE (TYPICAL)

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/GEN-03	1

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 1.5



LEGEND

———	COACH STATIC PROFILE
———	KINEMATIC ENVELOPE OF COACH

NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. HORIZONTAL AND VERTICAL ALLOWANCE DUE TO CURVES, 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 90 KMPH WITH WIND SPEED 100 KMPH.
6. COACH SIZE WIDTH=2900 mm AND HEIGHT=4080 mm.

CO-ORDINATES		
SL.NO.	X	Y
A	0	4200
B	1220	4200
C	1225	4014
D	1658	3296
E	1658	2876
F	1586	895
G	1550	700
H	1451	348
I	1380	348
J	1380	148
K	1580	148
L	1580	25
M	1160	25
N	1160	56
O	0	56

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
2	18.01.22	Revised	MG	RS/CB	S.Fourie
1	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

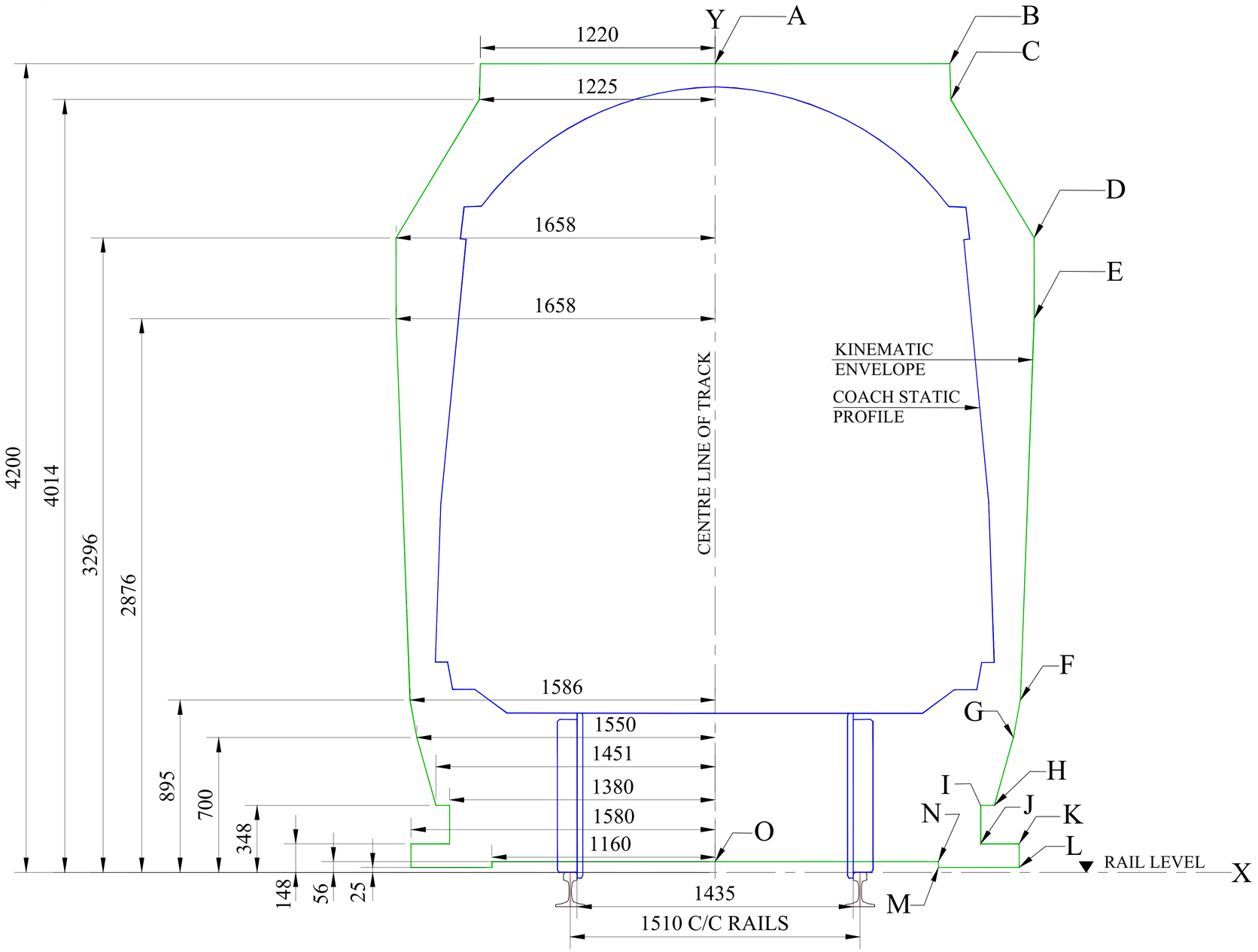
DRAWING TITLE

KINEMATIC ENVELOPE FOR AT-GRADE & ELEVATED SECTION WITH BALLASTLESS TRACK ON LEVEL / CONSTANT GRADE (TANGENT TRACK)OUTSIDE STATION

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV	SCALE	DATE	STATUS
MPMRCL/GEN/SOD/ELE-01	2	NTS	28/05/2019	

REFERENCE PARA NO.: 1.5



NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. HORIZONTAL AND VERTICAL CLEARANCE DUE TO CURVES INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
3. KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE 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. KINEMATIC ENVELOPE IS VALID FOR THE MAXIMUM SPEED OF 90 KMPH AND SIDE WIND SPEED OF 42 KMPH.#42 KMPH SIDE WIND REPRESENTS 100 PA PRESSURE CONSIDERED AS BUFFETING EFFECT.
6. COACH SIZE WIDTH=2900 mm AND HEIGHT=4080 mm.

CO-ORDINATES		
SL.NO.	X	Y
A	0	4200
B	1220	4200
C	1225	4014
D	1658	3296
E	1658	2876
F	1586	895
G	1550	700
H	1451	348
I	1380	348
J	1380	148
K	1580	148
L	1580	25
M	1160	25
N	1160	56
O	0	56

LEGEND

———	COACH STATIC PROFILE
———	KINEMATIC ENVELOPE OF COACH

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
2	18.01.22	Revised	MG	RS/CB	S.Fourie
1	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

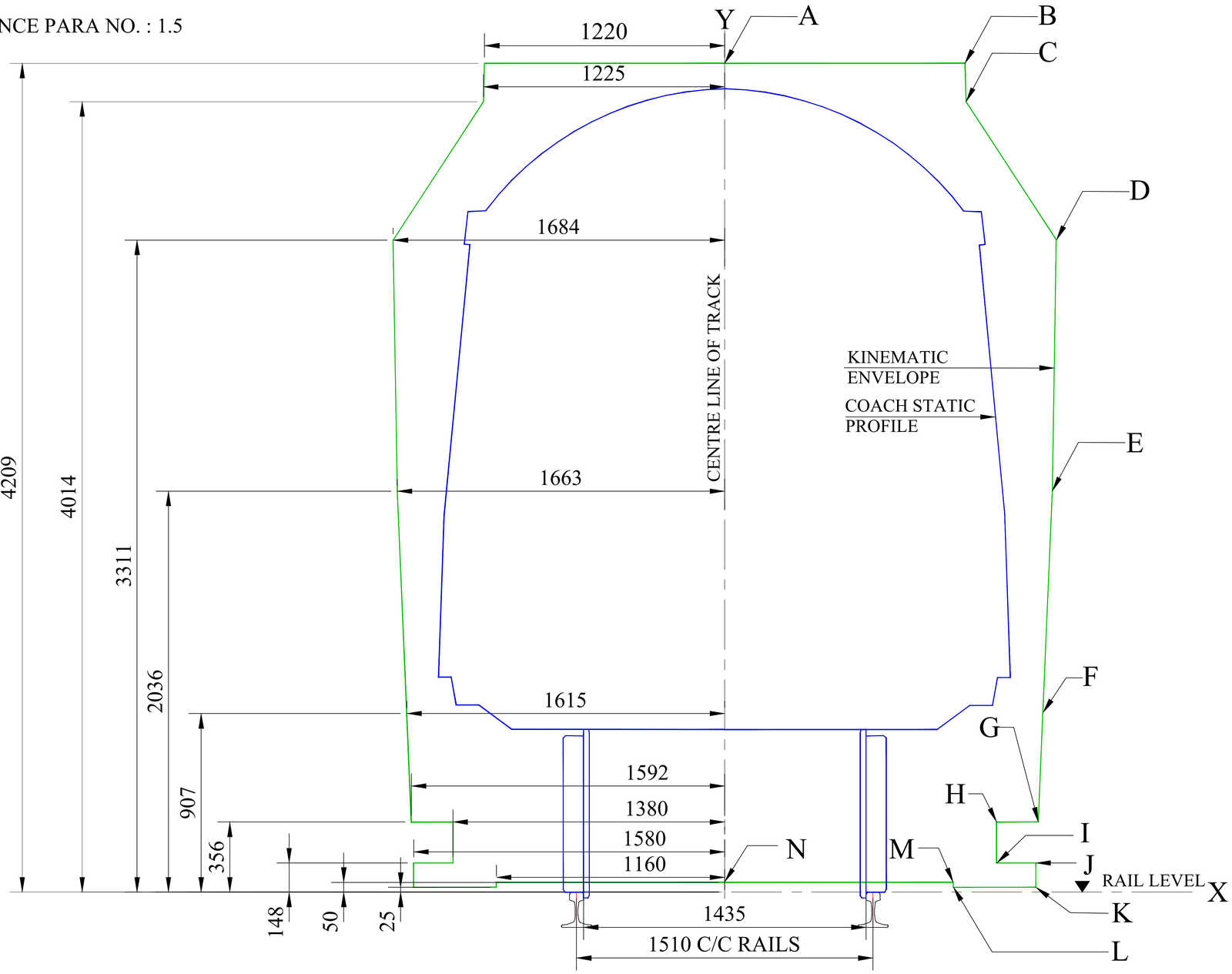
DRAWING TITLE

KINEMATIC ENVELOPE FOR UNDERGROUND SECTION WITH BALLASTLESS TRACK ON LEVEL / CONSTANT GRADE (TANGENT TRACK)

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV	SCALE	DATE	STATUS
MPMRCL/GEN/SOD/UND-02	2	NTS	28/05/2019	

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 WHEN IN MOTION.
4. COACH SIZE WIDTH=2900 mm AND HEIGHT=4080 mm.
5. THE KINEMATIC ENVELOPE IS FOR A DESIGN SPEED OF 90 KMPH WITH MAXIMUM PERMISSIBLE TOLERANCE FOR TRACK AND ROLLING STOCK FOR WIND SPEED OF 100 KMPH.

CO-ORDINATES		
SL.NO.	X	Y
A	0	4209
B	1220	4209
C	1225	4014
D	1684	3311
E	1683	2036
F	1615	907
G	1592	356
H	1380	356
I	1380	148
J	1580	148
K	1580	25
L	1160	25
M	1160	50
N	0	50

LEGEND

———	COACH STATIC PROFILE
———	KINEMATIC ENVELOPE OF COACH

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
2	18.01.22	Revised	MG	RS/CB	S.Fourie
1	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

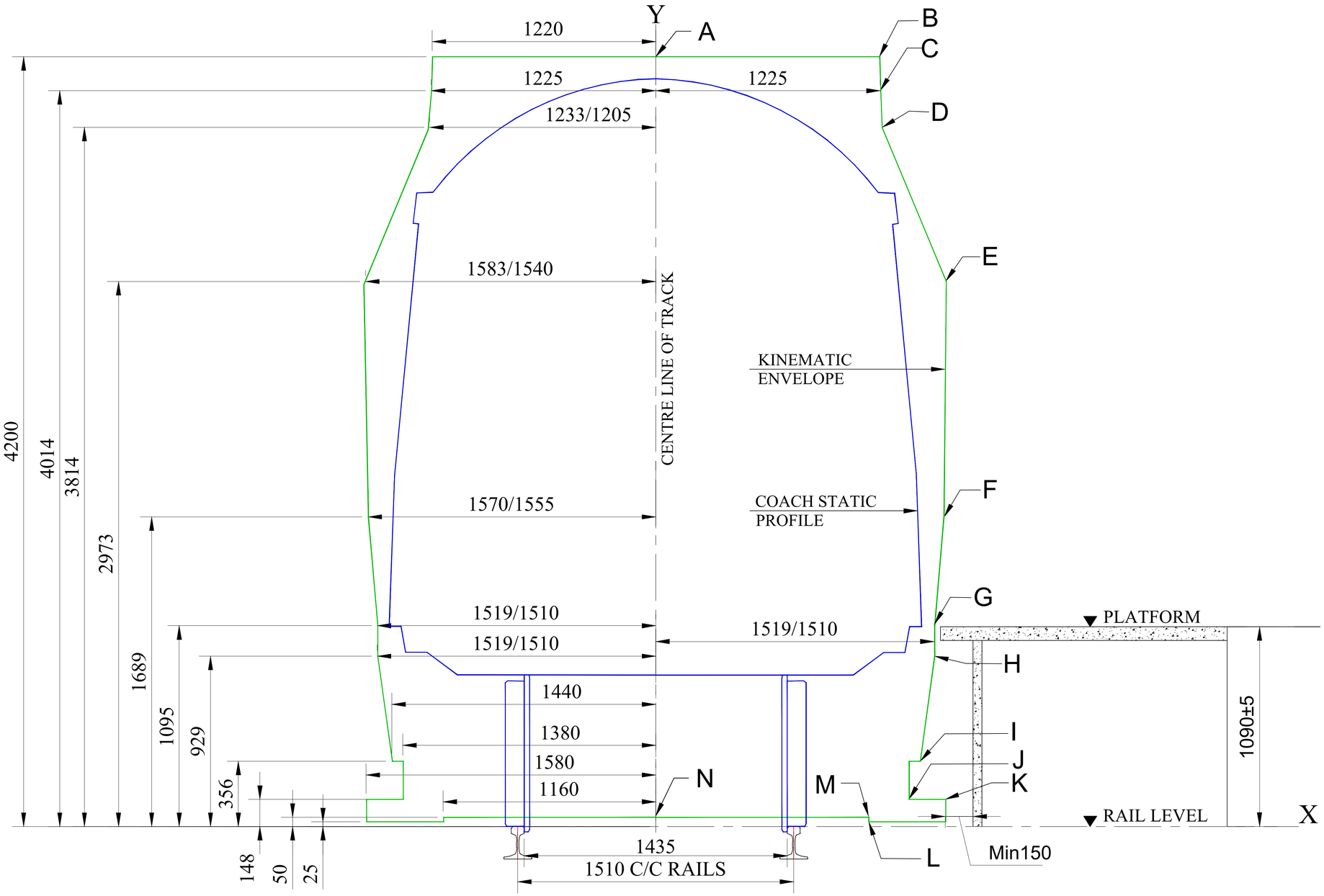
KINEMATIC ENVELOPE FOR SURFACE (AT-GRADE) SECTION BALLASTED TRACK ON LEVEL / CONSTANT GRADE TANGENT TRACK) OUTSIDE STATION

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/ATG-01	2

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 1.5



NOTES:
1. ALL DIMENSIONS ARE IN mm.
2. HORIZONTAL AND VERTICAL CLEARANCE DUE TO CURVES INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
3. KINEMATIC ENVELOPE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. KINEMATIC ENVELOPE IS VALID FOR 70 KMPH OPERATING SPEED & WIND SPEED OF 70 KMPH.
5. COACH SIZE WIDTH=2900 mm AND HEIGHT=4080 mm.

CO-ORDINATES			
SL.NO.	X FOR At-Grade &	X FOR UG	Y
A	0	0	4200
B	1220	1220	4200
C	1225	1225	4014
D	1233	1205	3814
E	1583	1540	2973
F	1570	1555	1689
G	1519	1510	1095
H	1519	1510	929
I	1440	1440	356
J	1380	1380	148
K	1580	1580	148
L	1160	1160	25
M	1160	1160	50
N	0	0	50

LEGEND

———	COACH STATIC PROFILE
———	KINEMATIC ENVELOPE OF COACH

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
2	18.01.22	Revised	MG	RS/CB	S.Fourie
1	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

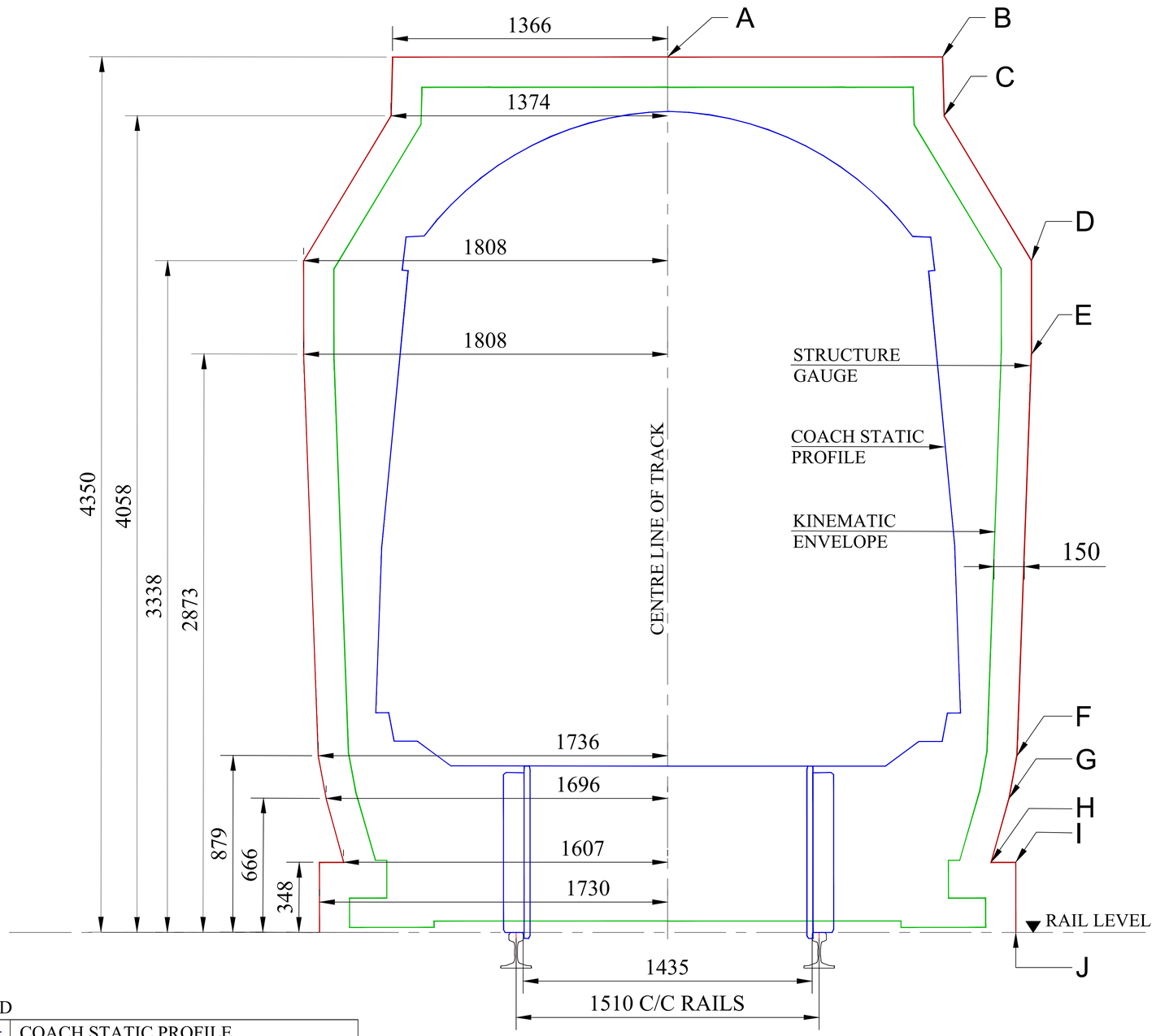
DRAWING TITLE KINEMATIC ENVELOPE FOR UNDERGROUND & AT GRADE AND ELEVATED SECTION WITH BALLASTLESS TRACK OVER PLATFORM LINE ON LEVEL / CONSTANT GRADE (TANGENT TRACK) (SPEED - 70 KMPH)

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER MPMRCL/GEN/SOD/ELE & UND | REV 2

SCALE NTS | DATE 28/05/2019 | STATUS

REFERENCE PARA NO.: 1.4.2 & 1.6.2



NOTES

1. ALL DIMENSIONS ARE IN mm.
2. MINIMUM CLEARANCE BETWEEN KINEMATIC ENVELOPE AND STRUCTURE GAUGE WILL BE 150 mm.
3. THE KINEMATIC ENVELOPE & STRUCTURE GAUGE ARE VALID FOR ROLLING STOCK WITH SEALED WINDOWS & DOORS CLOSED WHILE IN MOTION.
4. HORIZONTAL & VERTICAL CLEARANCE DUE TO CURVES INCLUDING VERTICAL CURVE & CANT SHALL BE EXTRA.
5. FOR KINEMATIC ENVELOPE, REFER TO MPMRCL/GEN/SOD/ELE-01.
6. THE STRUCTURE GAUGE IS VALID FOR MAXIMUM SPEED OF 90 KMPH & WIND SPEED OF 100 KMPH.

CO-ORDINATES		
SL.NO.	X	Y
A	0	4350
B	1366	4350
C	1374	4058
D	1808	3338
E	1808	2873
F	1736	879
G	1696	666
H	1607	348
I	1730	348
J	1730	0

LEGEND

———	COACH STATIC PROFILE
———	KINEMATIC ENVELOPE OF COACH
———	STRUCTURE GAUGE

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
1	18.01.22	Revised	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

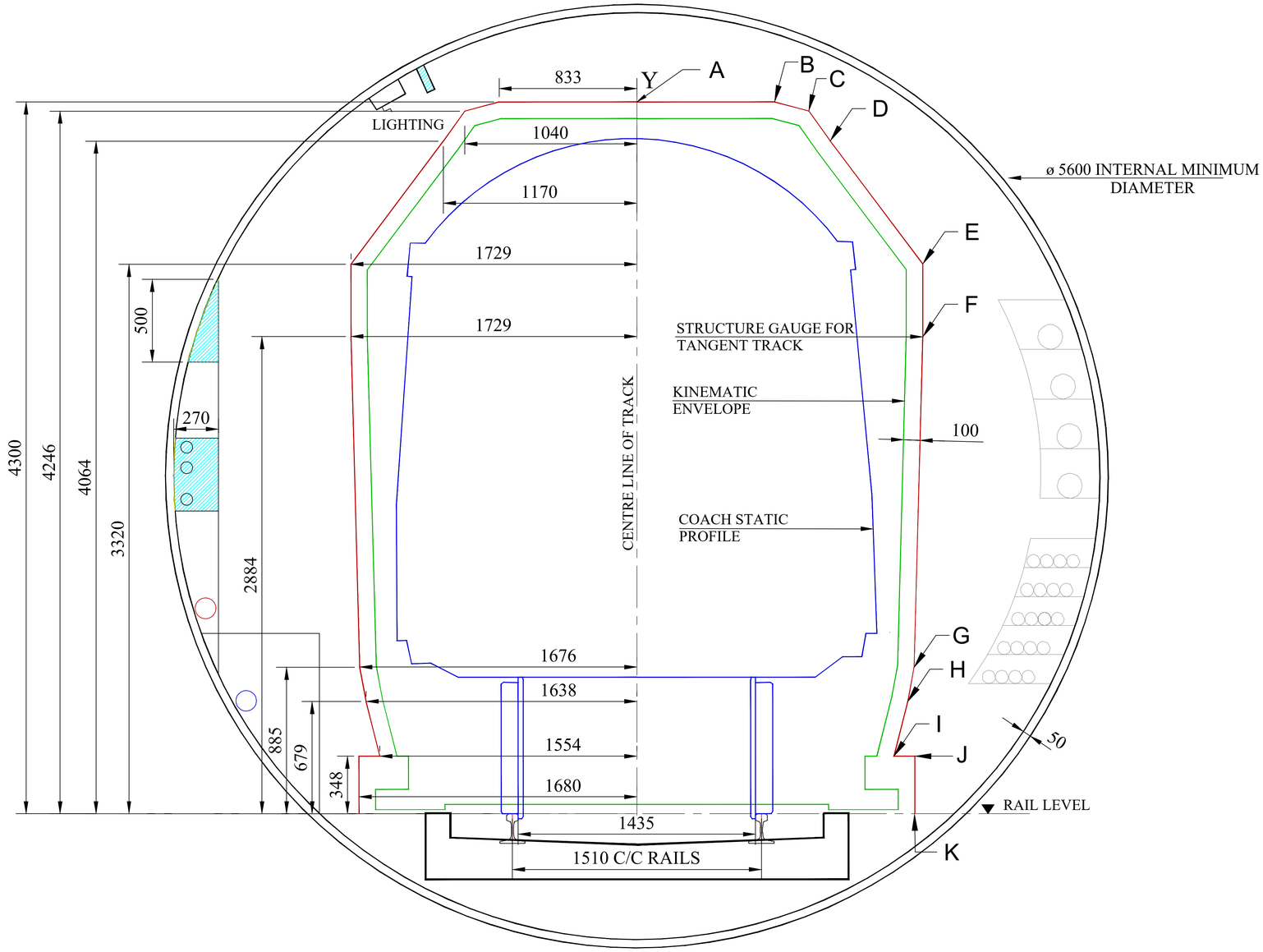
DRAWING TITLE

STRUCTURE GAUGE ON ELEVATED & AT GRADE SECTION (BALLASTLESS TRACK ON LEVEL / CONSTANT TRACK TANGENT TRACK (OUT SIDE STATION)

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV	SCALE	DATE	STATUS
MPMRCL/GEN/SOD/ELE-02	1	NTS	28/05/2019	

REFERENCE PARA NO.: 1.4.1(1) & 1.6.1



CIRCULAR TUNNEL 5600mm DIA

NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. KINEMATIC ENVELOPE AND STRUCTURE GAUGE ARE VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
3. STRUCTURE GAUGE FOR CURVE DOES NOT INCLUDE LATERAL SHIFT (LEAN) DUE TO CANT.
4. HORIZONTAL AND VERTICAL CLEARANCE DUE TO CURVES INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
5. CANT WILL BE PROVIDE BY RAISING OUTER RAIL ONLY AND SHIFTING OF THE CENTRE OF THE CIRCULAR TUNNEL TOWARDS INSIDE OF THE CURVE AND UPWARDS. THIS WILL BE SAME AS ROTATING THE CIRCULAR TUNNEL ABOUT THE MID POINT OF TOP OF INNER RAIL.
6. MINIMUM CLEARANCE BETWEEN KINEMATIC ENVELOPE AND STRUCTURE GAUGE=100 mm.
7. VERTICAL THROW DUE TO VERTICAL CURVE HAS NOT BEEN SHOWN IN THE FIGURE AND SHALL BE EXTRA.
8. FOR DETAILS OF KINEMATIC ENVELOP, REFER TO MPMRCL/GEN/SOD/UND-02.
9. COACH SIZE WIDTH=2900 mm AND HEIGHT=4080 mm.

CO-ORDINATES		
SL.NO.	X	Y
A	0	4300
B	833	4300
C	1040	4246
D	1170	4064
E	1729	3320
F	1729	2884
G	1676	885
H	1638	679
I	1554	348
J	1680	348
K	1680	0

LEGEND

	COACH STATIC PROFILE
	KINEMATIC ENVELOPE OF COACH
	STRUCTURE GAUGE

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
2	18.01.22	Revised	MG	RS/CB	S.Fourie
1	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

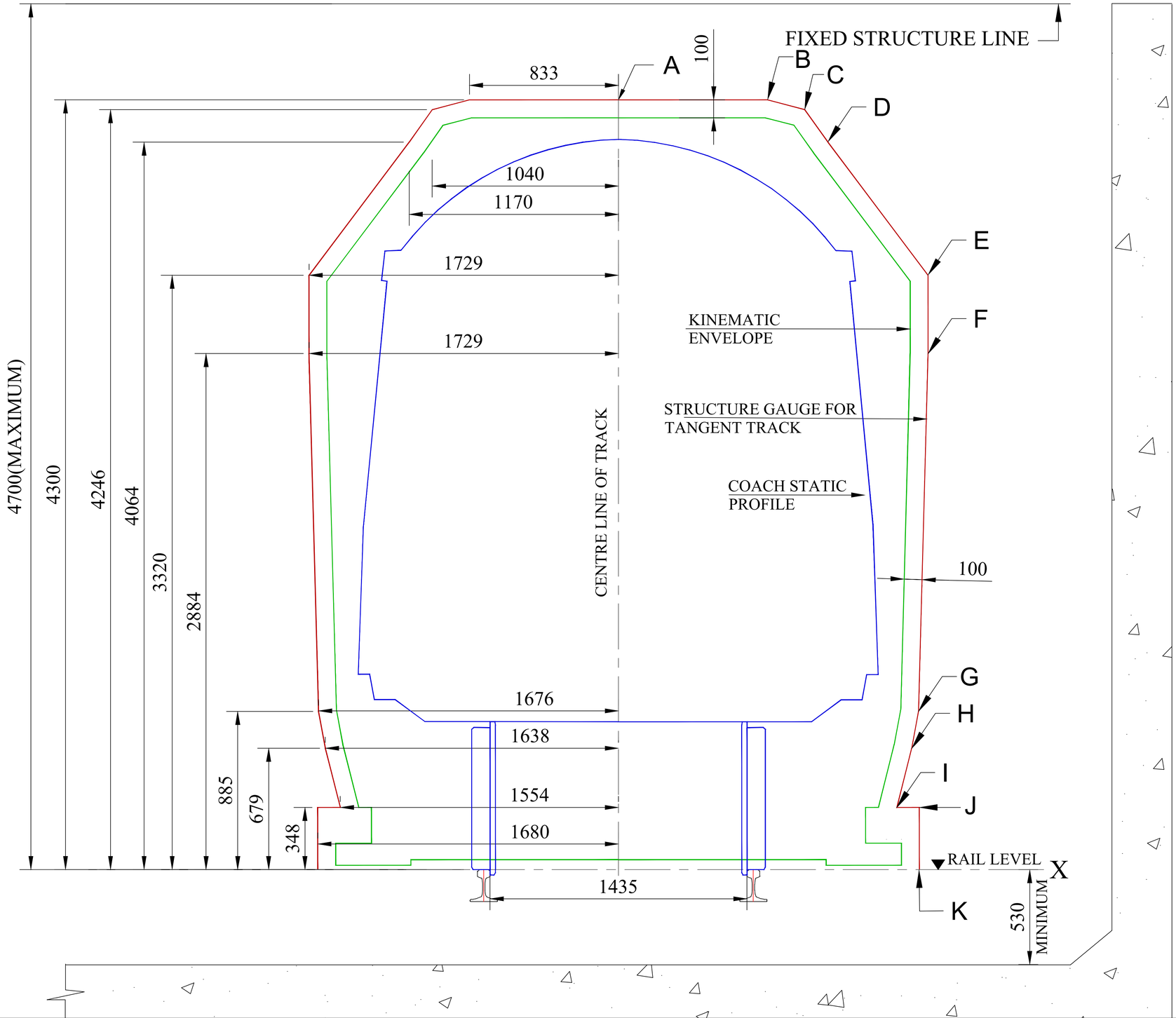
STRUCTURE GAUGE FOR UNDERGROUND SECTION (CIRCULAR TUNNELS) WITH BALLASTLESS TRACK ON LEVEL / CONSTANT GRADE (TANGENT TRACK)

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/UND-01	2

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 1.4.1 (2) &1.6.1



NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. KINEMATIC ENVELOPE AND STRUCTURE GAUGE ARE VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
3. STRUCTURE GAUGE FOR CURVE DOES NOT INCLUDE LATERAL SHIFT (LEAN) DUE TO CANT.
4. HORIZONTAL AND VERTICAL CLEARANCE DUE TO CURVES INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
5. CANT WILL BE PROVIDE BY RAISING OUTER RAIL ONLY AND SHIFTING OF THE CENTRE OF THE CIRCULAR TUNNEL TOWARDS INSIDE OF THE CURVE AND UPWARDS. THIS WILL BE SAME AS ROTATING THE CIRCULAR TUNNEL ABOUT THE MID POINT OF TOP OF INNER RAIL.
6. MINIMUM CLEARANCE BETWEEN KINEMATIC ENVELOPE AND STRUCTURE GAUGE=100 mm.
7. VERTICAL THROW DUE TO VERTICAL CURVE HAS NOT BEEN SHOWN IN THE FIGURE AND SHALL BE EXTRA.
8. FOR DETAILS OF KINEMATIC ENVELOP, REFER TO MPMRCL/GEN/SOD/UND-02.
9. COACH SIZE WIDTH=2900 mm AND HEIGHT=4080 mm.

CO-ORDINATES		
SL.NO.	X	Y
A	0	4300
B	833	4300
C	1040	4246
D	1170	4064
E	1729	3320
F	1729	2884
G	1676	885
H	1638	679
I	1554	348
J	1680	348
K	1680	0

LEGEND

	COACH STATIC PROFILE
	KINEMATIC ENVELOPE OF COACH
	STRUCTURE GAUGE

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
1	18.01.22	Revised	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

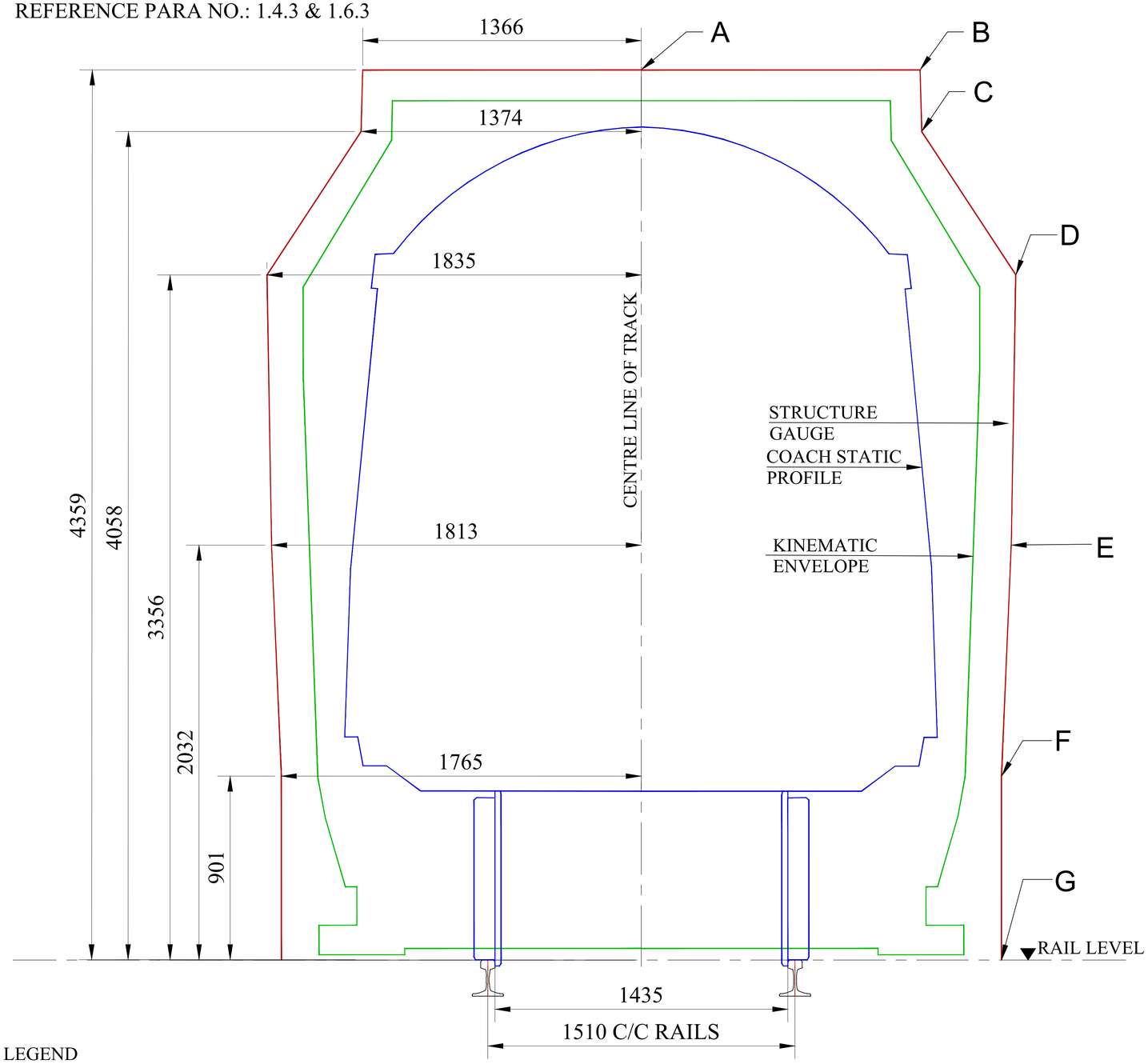
DRAWING TITLE

STRUCTURE GAUGE FOR UNDER GROUND SECTION (RECTANGULAR BOX TUNNELS) WITH BALLASTLESS TRACK ON LEVEL / CONSTANT GRADE (TANGENT TRACK)

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV	SCALE	DATE	STATUS
MPMRCL/GEN/SOD/UND-03	1	NTS	28/05/2019	

REFERENCE PARA NO.: 1.4.3 & 1.6.3



NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. HORIZONTAL AND VERTICAL CLEARANCES DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
3. STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND DOORS CLOSED WHILE IN MOTION.
4. COACH SIZE WIDTH=2900 mm AND HEIGHT=4080 mm.
5. MINIMUM CLEARANCE BETWEEN KINEMATIC ENVELOPE & STRUCTURE GAUGE IS 150mm.

CO-ORDINATES		
SL.NO.	X	Y
A	0	4359
B	1366	4359
C	1374	4058
D	1835	3356
E	1813	2032
F	1765	901
G	1765	0

LEGEND

	COACH STATIC PROFILE
	KINEMATIC ENVELOPE OF COACH
	STRUCTURE GAUGE

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
1	18.01.22	Revised	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

STRUCTURE GAUGE FOR AT-GRADE SECTION (BALLASTED)TRACK ON LEVEL / CONSTANT TRACK TANGENT OUT SIDE STATION

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/ATG-02	1

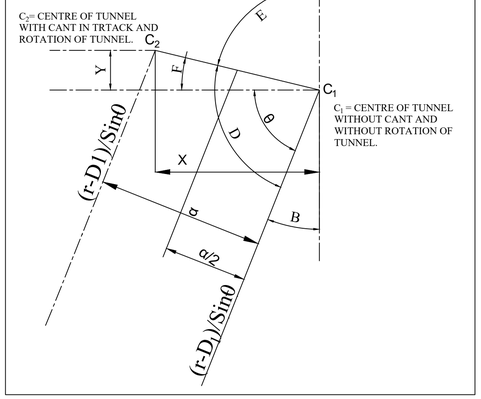
SCALE	DATE	STATUS
NTS	28/05/2019	

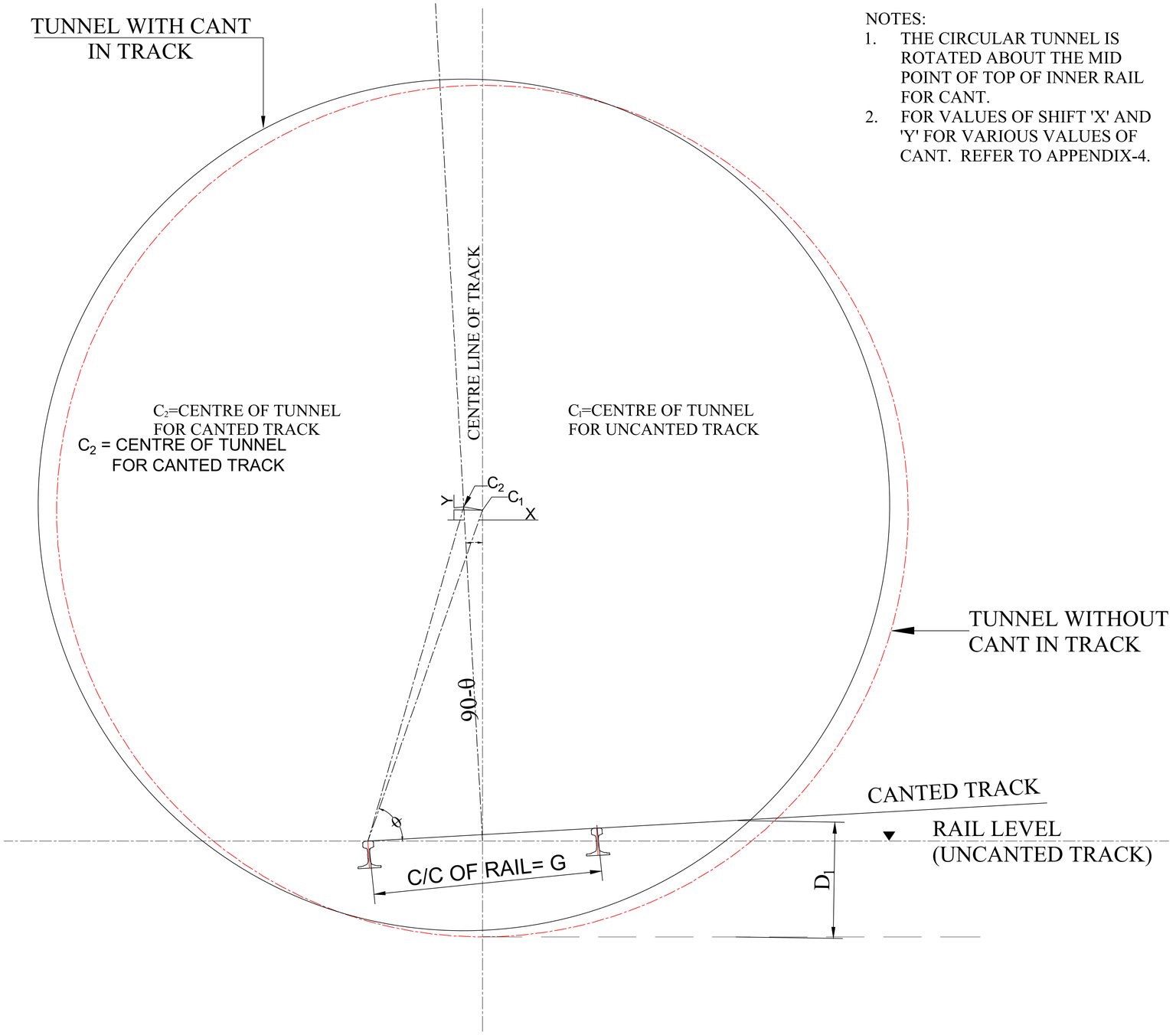
REFERENCE PARA NO.: 1.7.1B (b) & 1.7.2 B (b) & APPENDIX-4

$\tan\theta = (r-D_1) / (g/2)$
$\theta = \tan^{-1} [(r-D_1) / (g/2)]$
$\sin\alpha = \text{cant}/g$
$\alpha = \sin^{-1} (\text{cant}/g)$
Chord $c_1 c_2 = 2x[(r-D_1)/\sin\theta)x(\sin\alpha/2)]$
$X = c_1 c_2 \times \cos(90 - \theta - \alpha/2)$
$= 2 \times [\{(r-D_1)/\sin\theta\} \times (\sin\alpha/2)] \times \cos(90-\theta-\alpha/2)$
$Y = 2 \times [\{(r-D_1)/\sin\theta\} \times (\sin\alpha/2)] \times \sin(90-\theta-\alpha/2)$
Where 'r' is internal radius of tunnel.
D_1= depth from Rail level to invert of tunnel
g=distance between centers of rails = 1510mm

DETAIL AT CENTRE OF TUNNEL

Angle B = (90-θ)
Angle D = (90-α/2)
Angle E = (θ+α/2)
Angle F = (90-θ-α/2)





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.

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
2	18.01.22	Revised	MG	RS/CB	S.Fourie
1	21.08.21	Revised/RDSO comments dt.30.07.21	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT
MADHYA PRADESH METRO RAIL CORP. LTD.

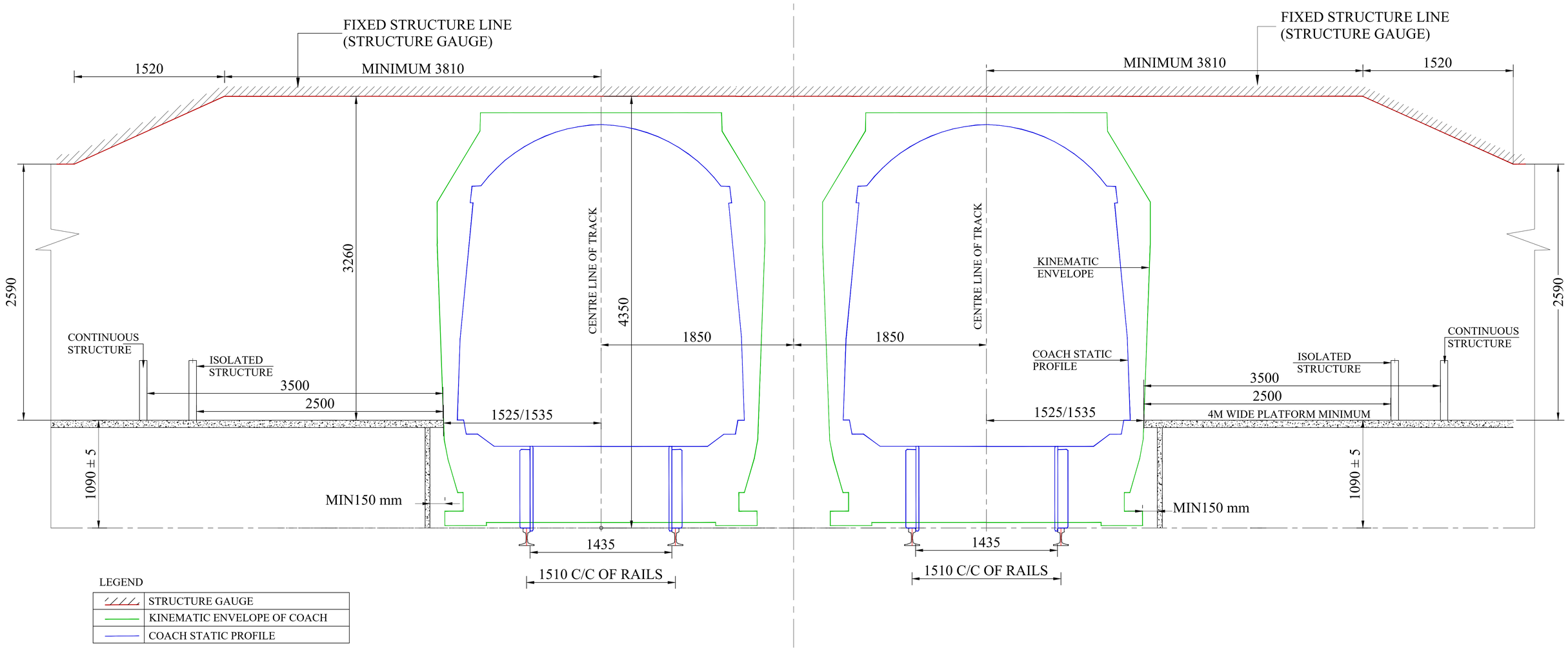
DRAWING TITLE
CLEARANCE OF THE CENTRE OF CIRCULAR TUNNEL DUE TO ROTATION OF TRACK FOR CANT

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/UND-04	2

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 2.2.4 & 2.2.5



LEGEND

	STRUCTURE GAUGE
	KINEMATIC ENVELOPE OF COACH
	COACH STATIC PROFILE

NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. CLEARANCE FOR CURVE SHALL BE EXTRA. HOWEVER THE TRACK CENTRES AT STATION WILL NOT INCREASE WITH CURVES OF RADIUS OF 1000 M & ABOVE.
3. STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS & DOORS CLOSED WHILE IN MOTION.

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
4	18.01.22	Revised	MG	RS/CB	S.Fourie
3	21.08.21	Revised/RDSO comments dt.30.07.21	MG	RS/CB	S.Fourie
2	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
1	04.05.21	Revised as per RDSO checklist	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

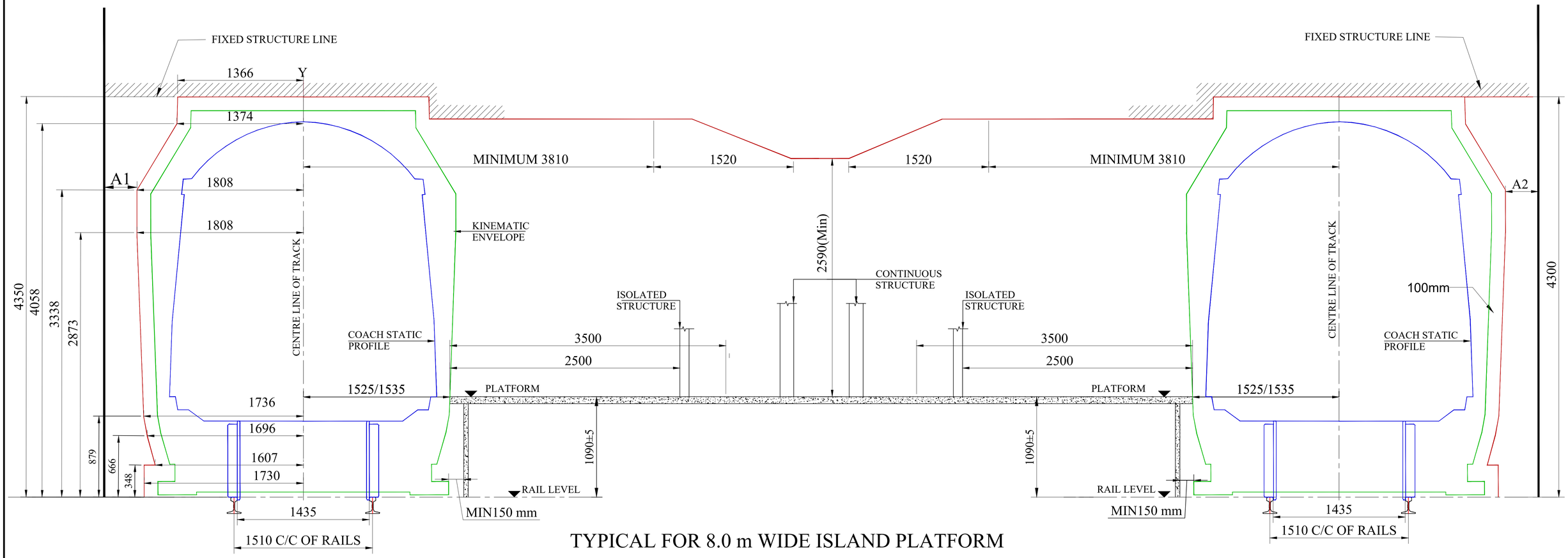
DRAWING TITLE STRUCTURE GAUGE AT ELEVATED/AT GRADE STATION WITH 4m WIDE (MIN.) SIDE PLATFORMS WITH BALLASTLESS TRACK ON LEVEL/CONSTANT GRADE TANGENT TRACK WITHOUT PLATFORM SCREEN GATE

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/ELE-03	4

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 2.2.4 & 2.2.5



TYPICAL FOR 8.0 m WIDE ISLAND PLATFORM

LEGEND

//////	STRUCTURE GAUGE
———	KINEMATIC ENVELOPE OF COACH
———	COACH STATIC PROFILE

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.

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
4	18.01.22	Revised	MG	RS/CB	S.Fourie
3	21.08.21	Revised/RDSO comments dt.30.07.21	MG	RS/CB	S.Fourie
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1	04.05.21	Revised as per RDSO checklist	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

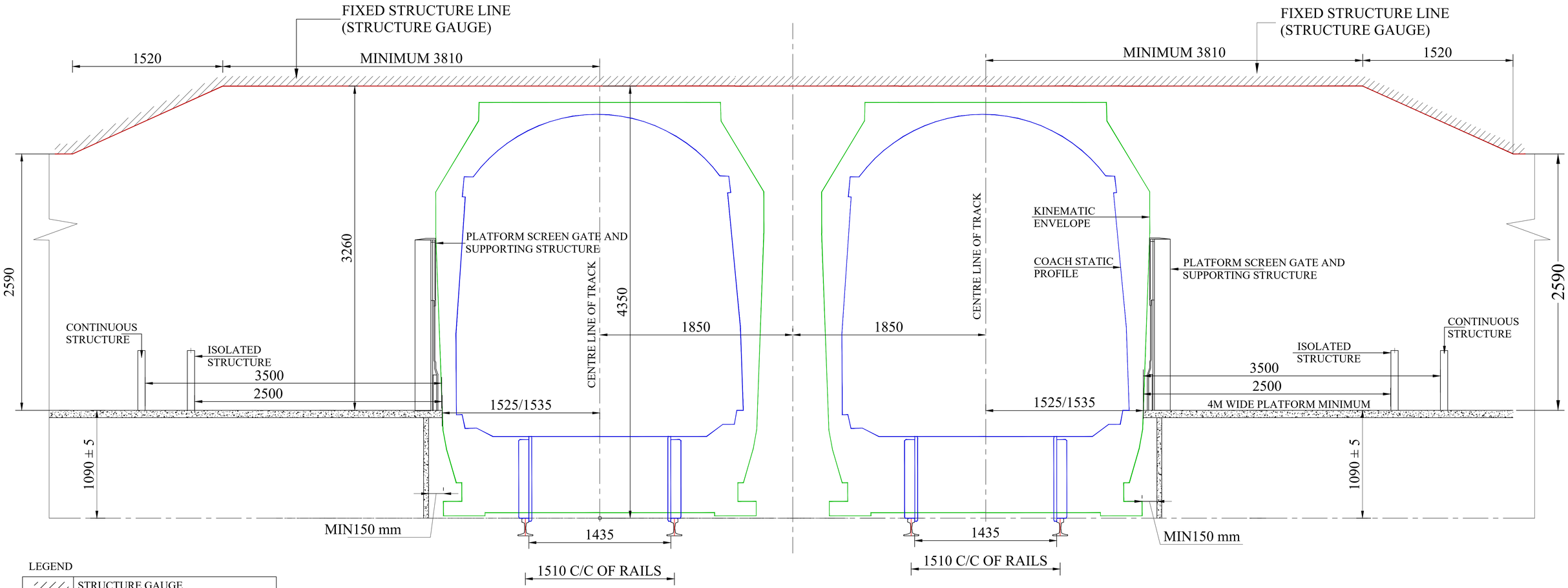
STRUCTURE GAUGE FOR ELEVATED / AT GRADE STATION WITH AN ISLAND PLATFORM ON LEVEL/CONSTANT GRADE TANGENT TRACK WITHOUT PLATFORM SCREEN GATE

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/ELE-04	4

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 2.2.4 & 2.2.5



LEGEND

//////	STRUCTURE GAUGE
———	KINEMATIC ENVELOPE OF COACH
———	COACH STATIC PROFILE

NOTES:

1. ALL DIMENSIONS ARE IN mm.
2. CLEARANCE FOR CURVE SHALL BE EXTRA. HOWEVER THE TRACK CENTRES AT STATION WILL NOT INCREASE WITH CURVES OF RADIUS OF 1000 M & ABOVE.
3. STRUCTURE GAUGE IS VALID FOR VEHICLES WITH SEALED WINDOWS & DOORS CLOSED WHILE IN MOTION.

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
4	18.01.22	Revised	MG	RS/CB	S.Fourie
3	21.08.21	Revised/RDSO comments dt.30.07.21	MG	RS/CB	S.Fourie
2	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
1	04.05.21	Revised as per RDSO checklist	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

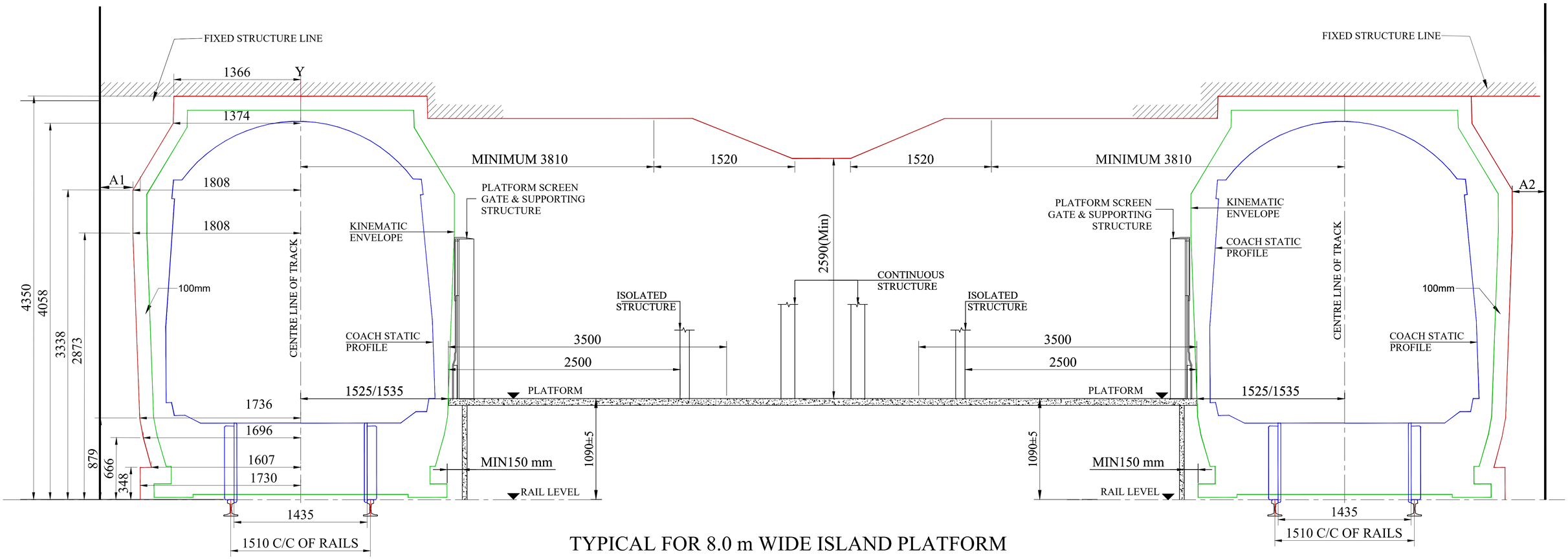
MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE STRUCTURE GAUGE AT ELEVATED/AT GRADE STATION WITH 4m WIDE (MIN.) SIDE PLATFORMS WITH BALLASTLESS TRACK ON LEVEL/CONSTANT GRADE TRACK WITH PLATFORM SCREEN GATE

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV	SCALE	DATE	STATUS
MPMRCL/GEN/SOD/ELE-05	4	NTS	28/05/2019	

REFERENCE PARA NO.: 2.2.4 & 2.2.5



TYPICAL FOR 8.0 m WIDE ISLAND PLATFORM

LEGEND

	STRUCTURE GAUGE
	KINEMATIC ENVELOPE OF COACH
	COACH STATIC PROFILE

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.

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
4	18.01.22	Revised	MG	RS/CB	S.Fourie
3	21.08.21	Revised/RDSO comments dt.30.07.21	MG	RS/CB	S.Fourie
2	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
1	04.05.21	Revised as per RDSO checklist	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

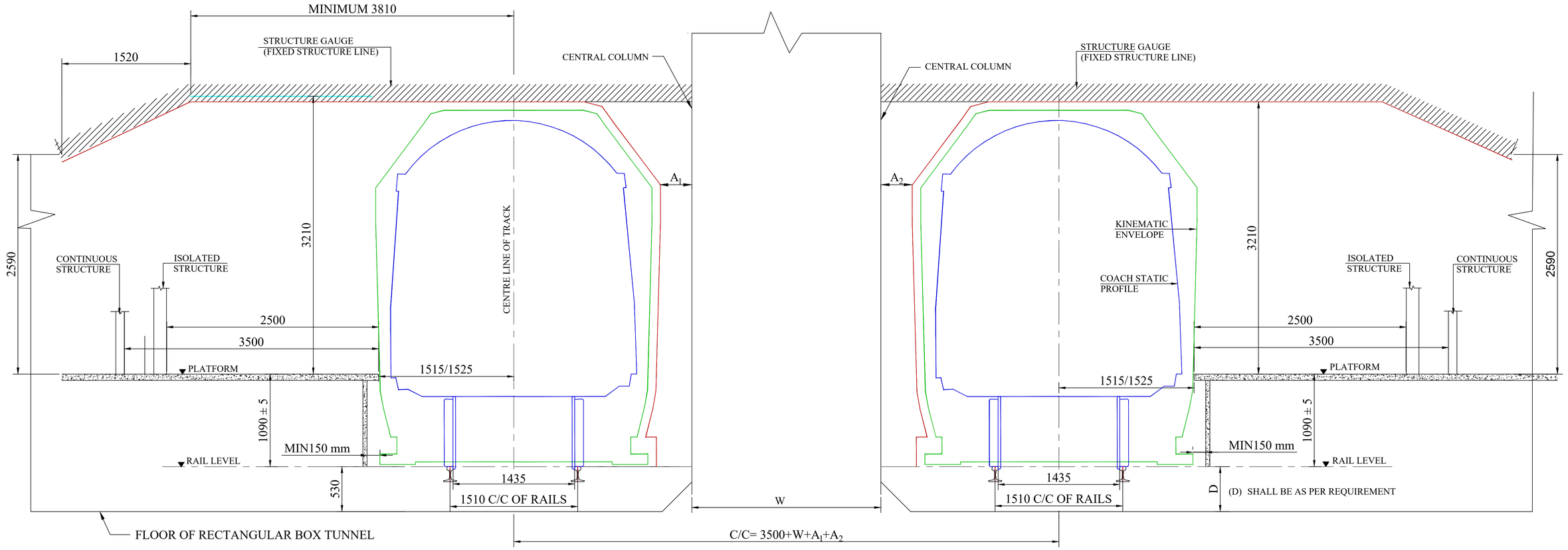
STRUCTURE GAUGE FOR ELEVATED/AT GRADE STATION WITH AN ISLAND PLATFORM ON LEVEL/CONSTANT GRADE TANGENT TRACK WITH PLATFORM SCREEN GATE

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/ELE-06	4

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 2.2.4 & 2.2.5



LEGEND

////	STRUCTURE GAUGE
——	KINEMATIC ENVELOPE OF COACH
——	COACH STATIC PROFILE

NOTES:

1. ALL DIMENSIONS ARE IN mm.
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_1' AND 'A_2' SHALL NOT BE LESS THAN 100 MM.
5. FOR KINEMATIC ENVELOPE REFER TO FIGURE -MPMRCL/GEN/SOD/ELE & UND

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
3	18.01.22	Revised	MG	RS/CB	S.Fourie
2	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
1	04.05.21	Revised/RDSO letter no. UTHS/120/MPMRCL dt.10.02.20	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

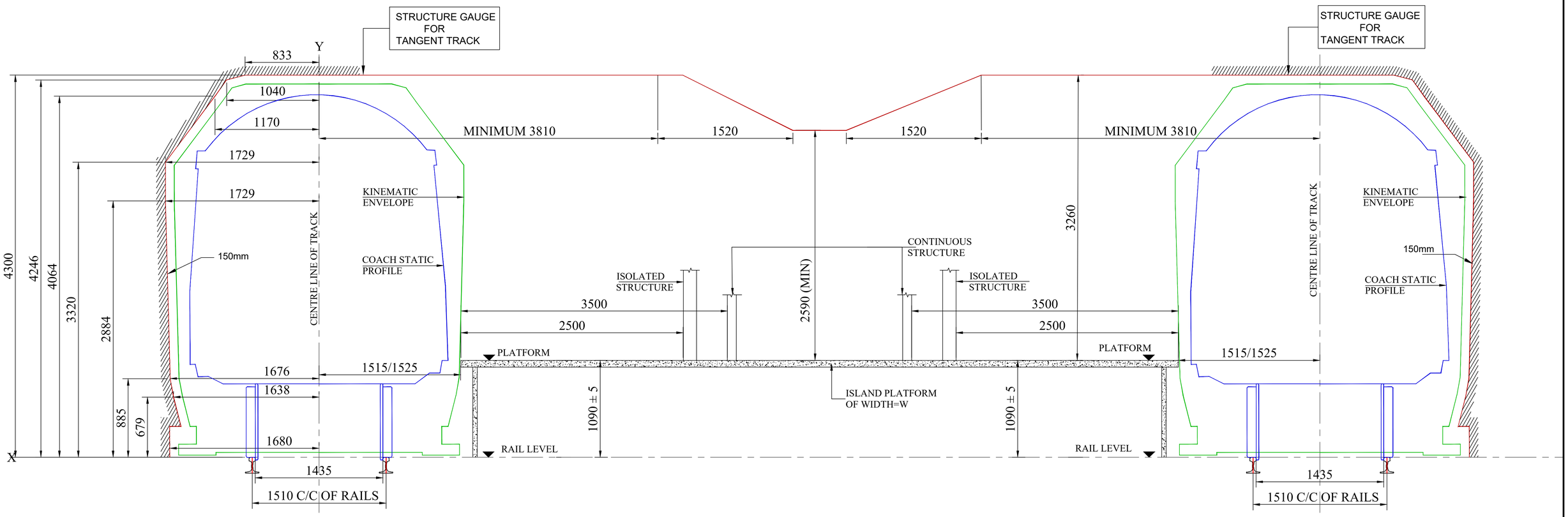
STRUCTURE GAUGE FOR UNDER GROUND STATION WITH SIDE PLATFORMS ON LEVEL/CONSTANT GRADE TANGENT TRACK WITHOUT PLATFORM SCREEN DOOR

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/UND-05	3

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 2.2.4 & 2.2.5



LEGEND

//////	STRUCTURE GAUGE
———	KINEMATIC ENVELOPE OF COACH
———	COACH STATIC PROFILE

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.

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
3	18.01.22	Revised	MG	RS/CB	S.Fourie
2	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
1	04.05.21	Revised as per RDSO checklist	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

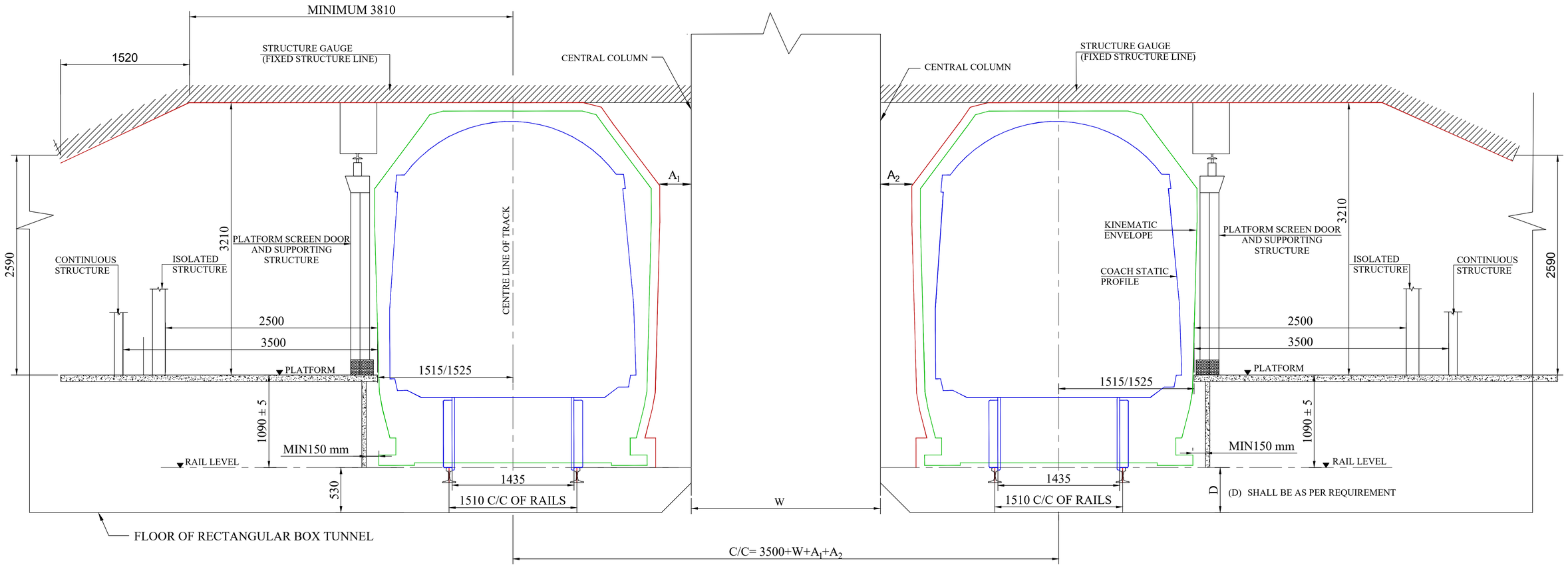
DRAWING TITLE

STRUCTURE GAUGE FOR UNDER GROUND STATION WITH ISLAND PLATFORM ON LEVEL/CONSTANT GRADE TANGENT TRACK WITHOUT PLATFORM SCREEN DOOR

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV	SCALE	DATE	STATUS
MPMRCL/GEN/SOD/UND-06	3	NTS	28/05/2019	

REFERENCE PARA NO.: 2.2.4 & 2.2.5



LEGEND

//////	STRUCTURE GAUGE
———	KINEMATIC ENVELOPE OF COACH
———	COACH STATIC PROFILE

NOTES:

1. ALL DIMENSIONS ARE IN mm.
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_1 ' AND 'A_2 ' SHALL NOT BE LESS THAN 100 MM.
5. FOR KINEMATIC ENVELOPE REFER TO FIGURE -.....(TNL)

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
3	18.01.22	Revised	MG	RS/CB	S.Fourie
2	04.06.21	Revised / RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
1	04.05.21	Revised as per RDSO checklist	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

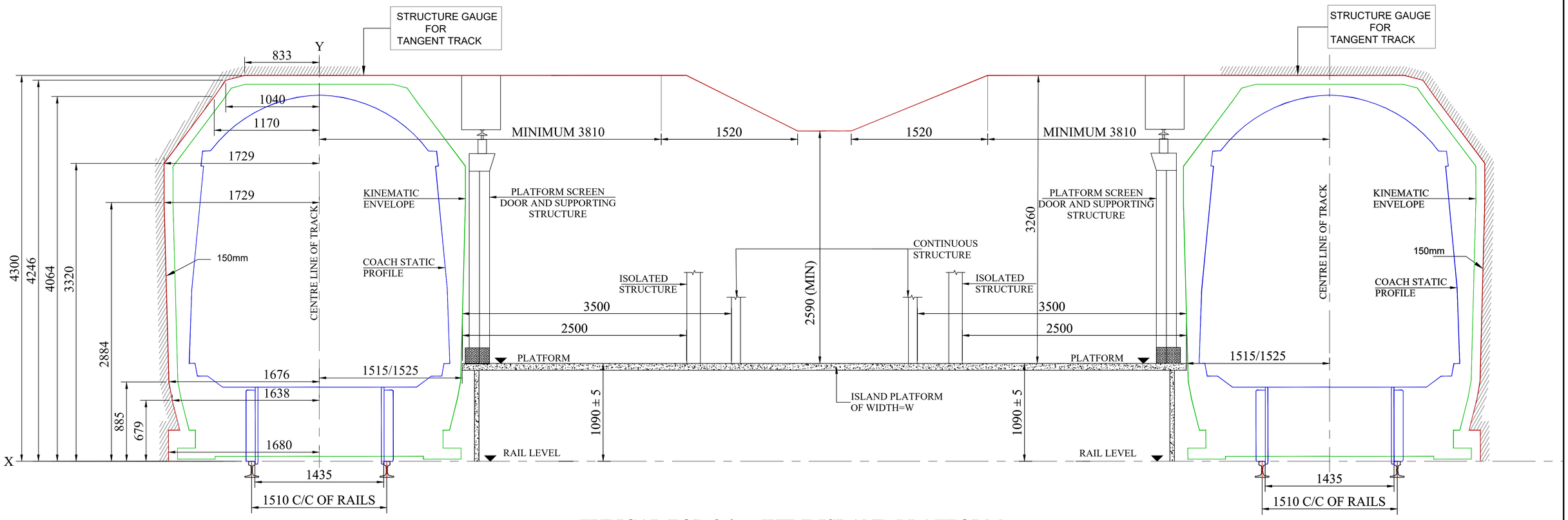
STRUCTURE GAUGE FOR UNDER GROUND STATION WITH SIDE PLATFORMS ON LEVEL/CONSTANT GRADE TANGENT TRACK WITH PLATFORM SCREEN DOOR

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/UND-07	3

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 2.2.4 & 2.2.5



TYPICAL FOR 8.0 m WIDE ISLAND PLATFORM

LEGEND

	STRUCTURE GAUGE
	KINEMATIC ENVELOPE OF COACH
	COACH STATIC PROFILE

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.

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
3	18.01.22	Revised	MG	RS/CB	S.Fourie
2	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
1	04.05.21	Revised as per RDSO checklist	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

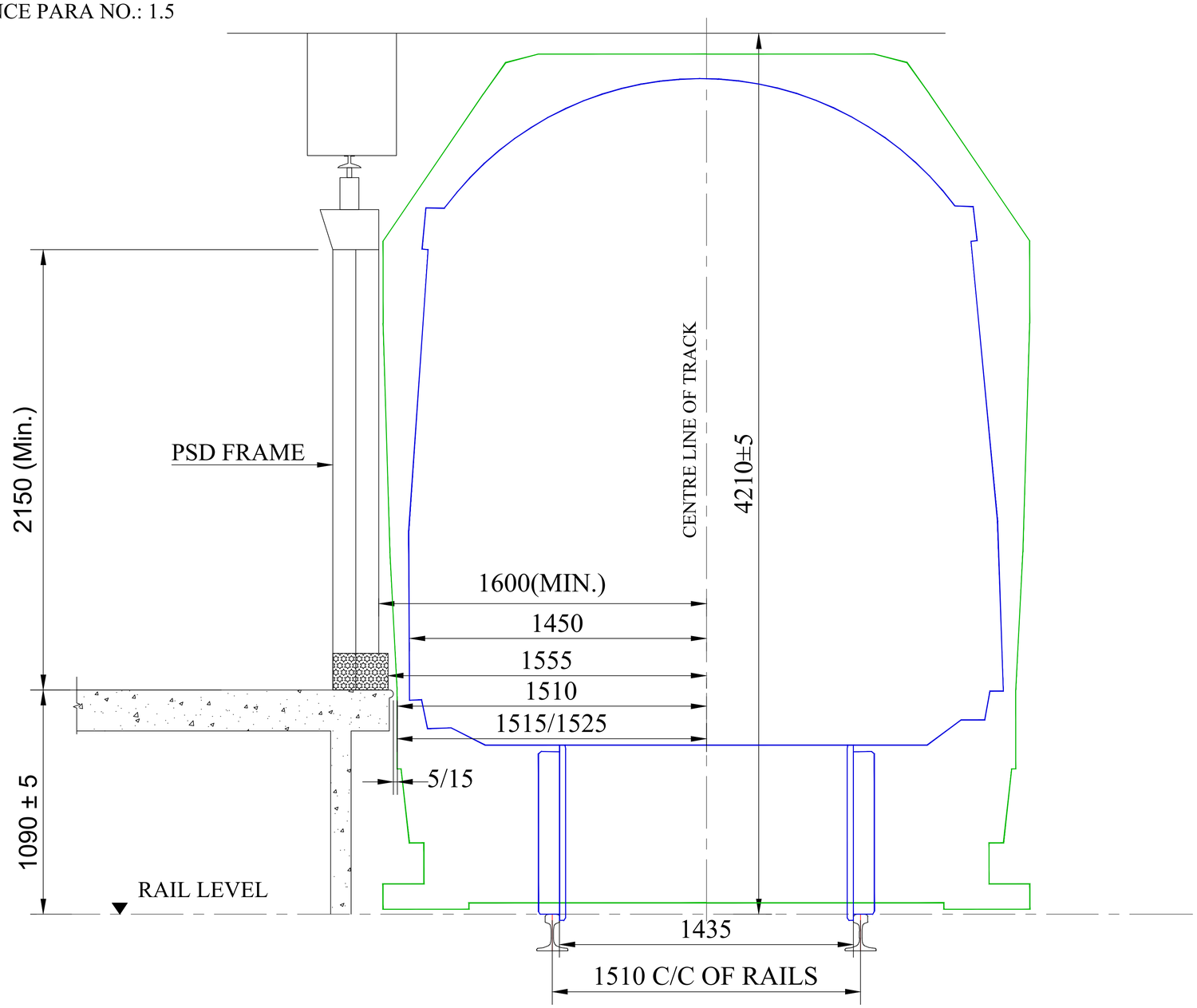
STRUCTURE GAUGE FOR UNDER GROUND STATION WITH ISLAND PLATFORM ON LEVEL/CONSTANT GRADE TANGENT TRACK WITH PLATFORM SCREEN DOOR

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/UND-08	3

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 1.5



NOTE:

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 DOORS CLOSED WHILE IN MOTION.
4. COACH SIZE H-2900,V-4080.
5. FOR CURVED PLATFORM, THESE DIMENSIONS TO BE INCREASED AS TABLE IN APPENDIX-5.
6. DESIGN SPEED OVER PLATFORM LINES SHALL NOT EXCEED 70KMPH.
7. THE KINEMATIC ENVELOPE IS VALID FOR A WIND SPEED OF 0KMPH.

LEGEND

———	COACH STATIC PROFILE
———	KINEMATIC ENVELOPE OF COACH

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
4	18.01.22	Revised	MG	RS/CB	S.Fourie
3	21.08.21	Revised/RDSO comments dt.30.07.21	MG	RS/CB	S.Fourie
2	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
1	04.05.21	Revised/RDSO letter no. UTHS/120/MPMRCL dt.10.02.20	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB GEODATA Louis Berger

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

MPMETRO

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

STATIC AND KINEMATIC ENVELOPE FOR UNDERGROUND STATIONS WITH PLATFORM SCREEN DOOR

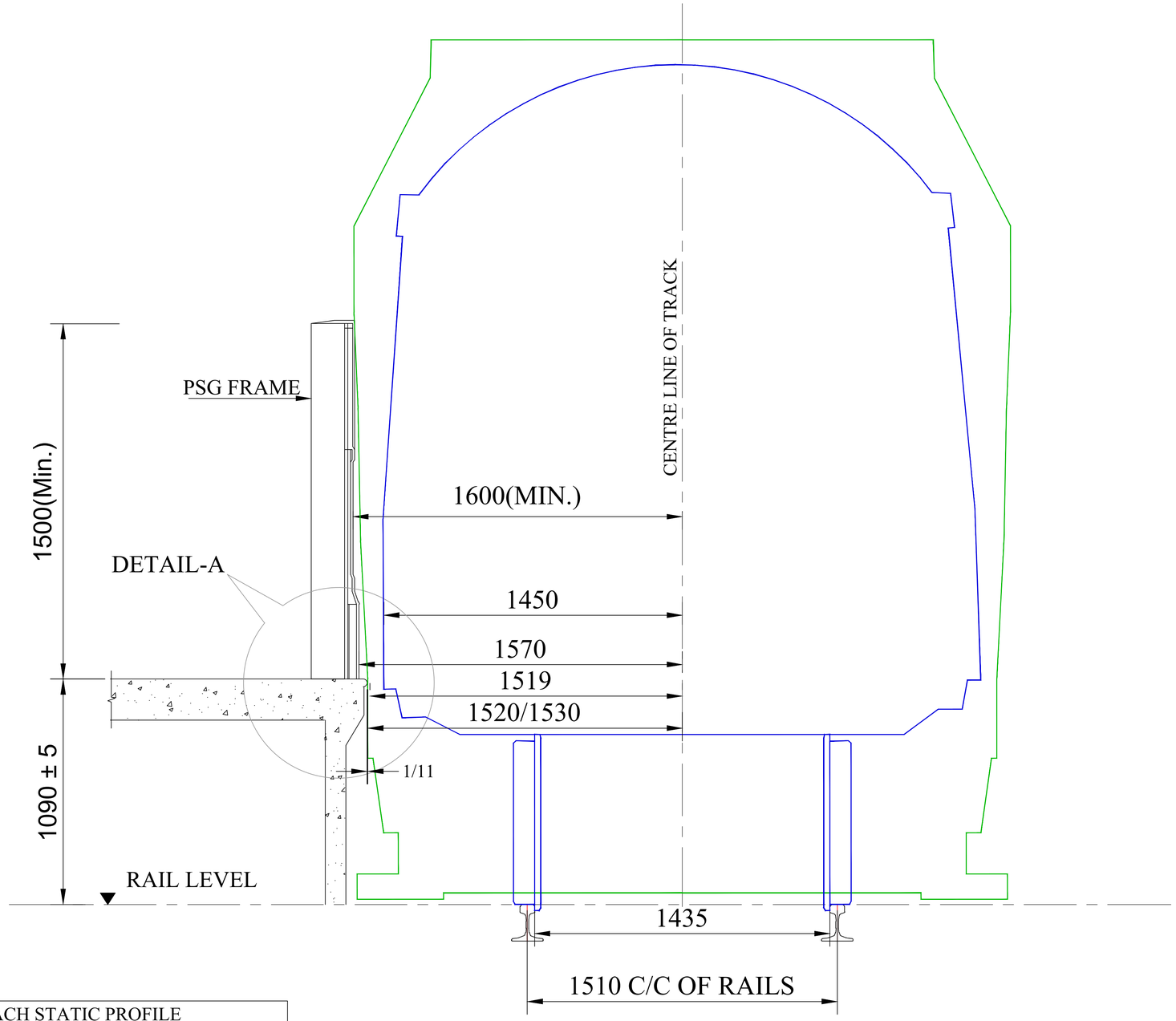
STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

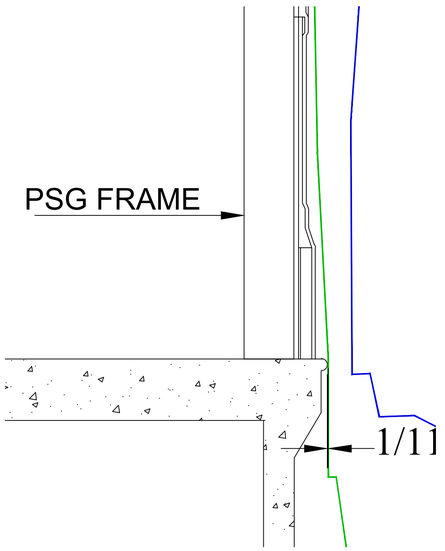
DRAWING NUMBER	REV
MPMRCL/GEN/SOD/PSD-01	4

SCALE	DATE	STATUS
NTS	28/05/2019	

REFERENCE PARA NO.: 1.5

NOTE:
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 DOORS CLOSED WHILE IN MOTION.
4. COACH SIZE H-2900,V-4080.
5. DESIGN SPEED OVER PLATFORM LINES SHALL NOT EXCEED 70KMPH.
6. THE KINEMATIC ENVELOPE IS VALID FOR A WIND SPEED OF 70KMPH.





DETAIL-A

LEGEND

———	COACH STATIC PROFILE
———	KINEMATIC ENVELOPE OF COACH

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
4	18.01.22	Revised	MG	RS/CB	S.Fourie
3	21.08.21	Revised/RDSO comments dt.30.07.21	MG	RS/CB	S.Fourie
2	04.06.21	Revised/RDSO comments dt.19.05.21	MG	RS/CB	S.Fourie
1	04.05.21	Revised/RDSO letter no. UTHS/120/MPMRCL dt.10.02.20	MG	RS/CB	S.Fourie
0	28.05.19	First Submission	SM	GC	J.SWANN

GENERAL CONSULTANT

DB GEODATA Louis Berger

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

MPMETRO

CLIENT

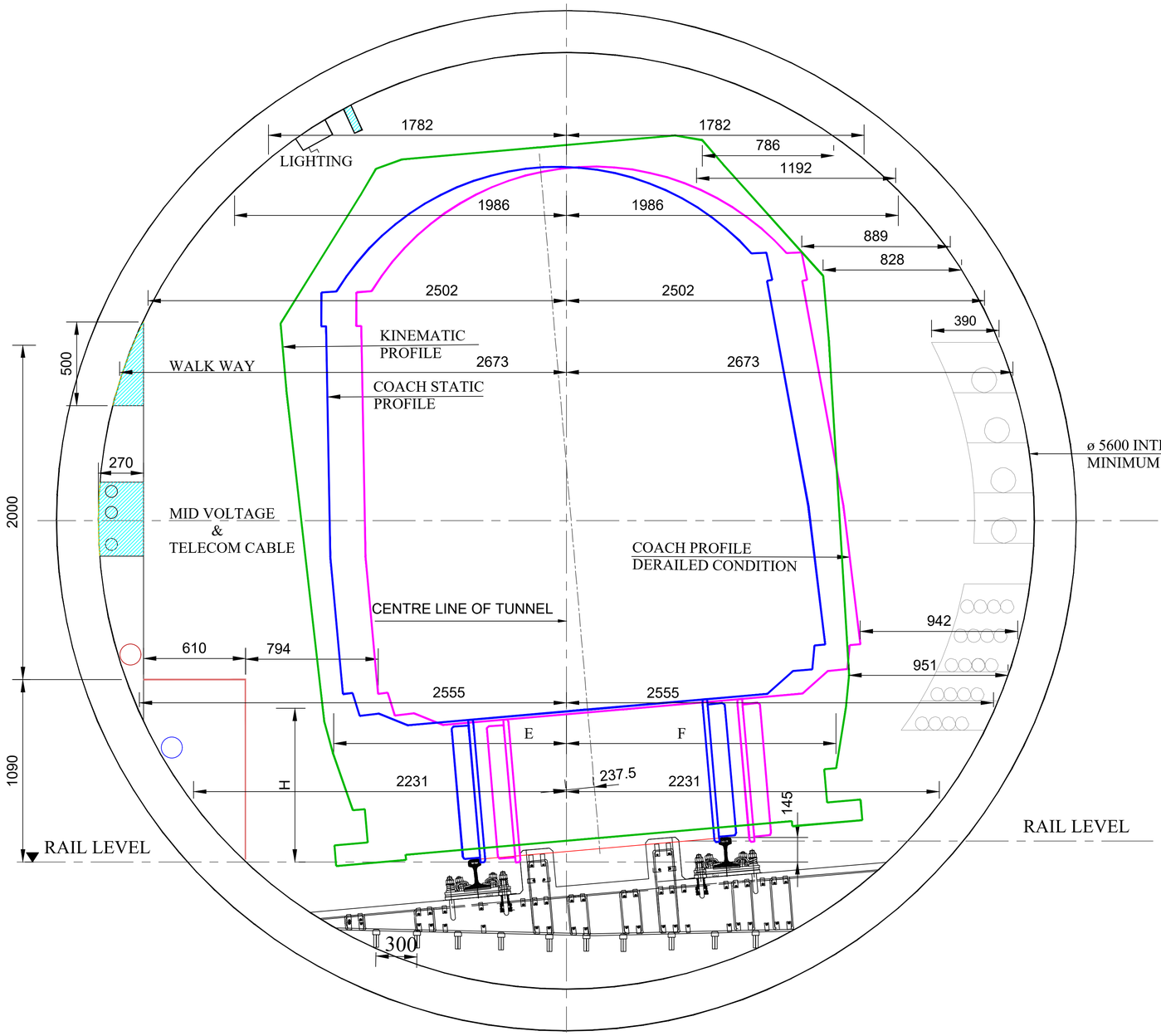
MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

PLATFORM SCREEN GATE AT ELEVATED/AT GRADE (STATION) ON LEVEL OR CONSTANT GRADE TANGENT TRACK

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV	SCALE	DATE	STATUS
MPMRCL/GEN/SOD/PSD-02	4	NTS	28/05/2019	



NOTE:

1. ALL DIMENSIONS ARE IN mm.
2. HORIZONTAL AND VERTICAL CLEARANCES DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
3. STRUCTURE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND CLOSED DOORS WHILE IN MOTION.
4. COACH SIZE WIDTH=2900 mm AND HEIGHT=4080 mm.
5. MIN. CLEARANCE BETWEEN KINEMATIC ENVELOPE & STRUCTURE GAUGE IS 100mm.

H Height above Rail level	E as per table Appendix 3E	F as per Appendix 3E	Distance between center line of Track to tunnel	Clearance	
				Inner Rail	Outer Rail
348	1474.9	1417.1	2231	756.1	813.9
895	1654.8	1506.3	2555	900.2	1048.7
2876	1890.8	1413.7	2673	782.2	1259.3
3296	1925.7	1378.9	2502	576.3	1123.1
4014	1553.7	887.8	1986	432.3	1098.2
4200	1564.2	867.4	1782	217.8	914.6

LEGEND

	COACH PROFILE - NORMAL CONDITION
	COACH PROFILE - DERAILED CONDITION
	KINEMATIC PROFILE - NORMAL CONDITION

DERAILED OUTSIDE THE CURVE

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
1	18.01.22	Revised	MG	RS/CB	S.Fourie
0	21.08.21	First submission	MG	RS/CB	S.Fourie

GENERAL CONSULTANT

DB GEODATA Louis Berger

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

MPMETRO

CLIENT

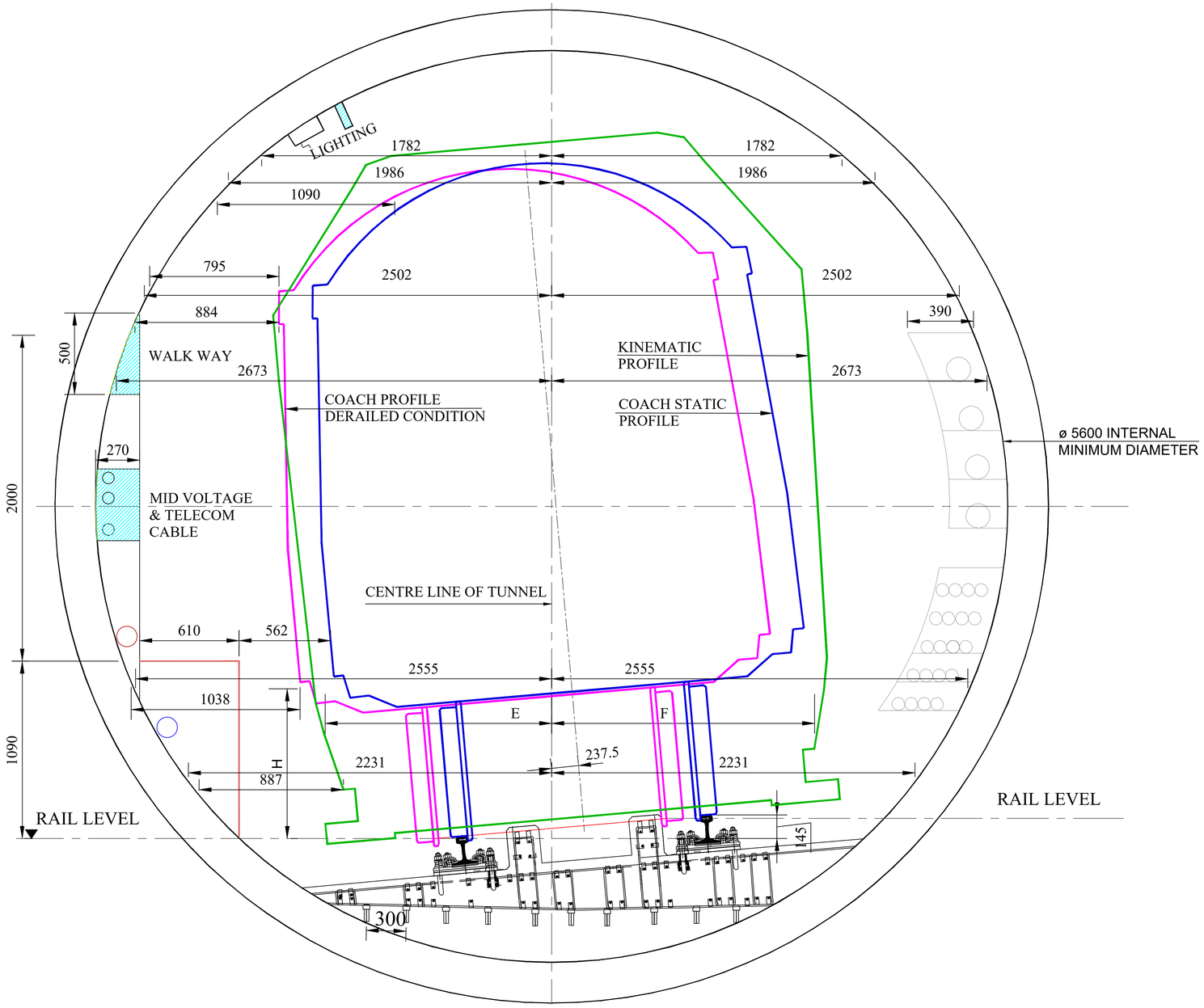
MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

DERAILMENT PROFILE FOR UNDERGROUND SECTION (CIRCULAR TUNNELS) WITH BALLASTLESS TRACK WITH MAX. CANT & MIN. RADIUS OF CURVE

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV	SCALE	DATE	STATUS
MPMRCL/GEN/SOD/UND-DR-01A	1	NTS	21/08/2021	



NOTE:

1. ALL DIMENSIONS ARE IN mm.
2. HORIZONTAL AND VERTICAL CLEARANCES DUE TO CURVES, INCLUDING VERTICAL CURVES AND CANT SHALL BE EXTRA.
3. STRUCTURE IS VALID FOR VEHICLES WITH SEALED WINDOWS AND CLOSED DOORS WHILE IN MOTION.
4. COACH SIZE WIDTH=2900 mm AND HEIGHT=4080 mm.
5. MIN. CLEARANCE BETWEEN KINEMATIC ENVELOPE & STRUCTURE GAUGE IS 100mm.

H Height above Rail level	E as per table Appendix 3E	F as per Appendix 3E	Distance between center line of Track to tunnel	Clearance	
				Inner Rail	Outer Rail
348	1474.9	1417.1	2231	756.1	813.9
895	1654.8	1506.3	2555	900.2	1048.7
2876	1890.8	1413.7	2673	782.2	1259.3
3296	1925.7	1378.9	2502	576.3	1123.1
4014	1553.7	887.8	1986	432.3	1098.2
4200	1564.2	867.4	1782	217.8	914.6

LEGEND

	COACH PROFILE - NORMAL CONDITION
	COACH PROFILE - DERAILED CONDITION
	KINEMATIC PROFILE - NORMAL CONDITION

DERAILED INSIDE THE CURVE

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
1	18.01.22	Revised	MG	RS/CB	S.Fourie
0	21.08.21	First submission	MG	RS/CB	S.Fourie

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

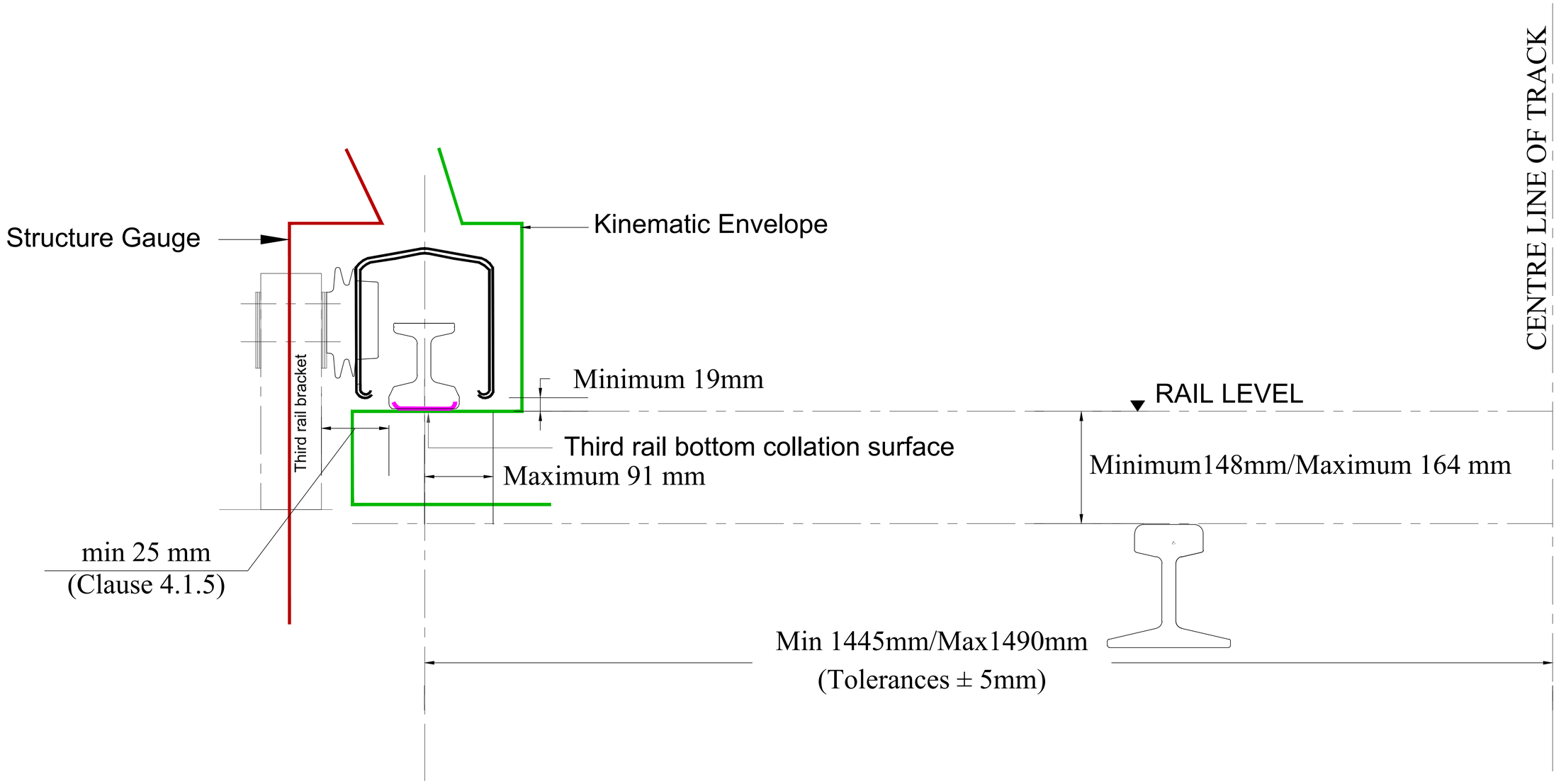
DRAWING TITLE

DERAILMENT PROFILE FOR UNDERGROUND SECTION (CIRCULAR TUNNELS) WITH BALLASTLESS TRACK WITH MAX. CANT & MIN. RADIUS OF CURVE

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/UND-DR-01B	1

SCALE	DATE	STATUS
NTS	21/08/2021	



LEGEND

———	KINEMATIC ENVELOPE OF COACH
———	STRUCTURE GAUGE

REVISIONS

REV.	DATE	DESCRIPTION	Drawn	Checked	Approved
0	18.01.22	First submission	MG	RS/CB	S.Fourie

GENERAL CONSULTANT

DB Engineering & Consulting GmbH - GEODATA Engineering S.p.A - Louis Berger SAS

CLIENT

MADHYA PRADESH METRO RAIL CORP. LTD.

DRAWING TITLE

THIRD RAIL CURRENT COLLECTION SYSTEM

STANDARD GAUGE (1435) - 750 VOLT.D.C.TRACTION

DRAWING NUMBER	REV
MPMRCL/GEN/SOD/TR-01	0

SCALE	DATE	STATUS
NTS	18/01/2022	

Attachment – 4 to Corrigendum – 7

Volume IV: ER-TS - TEL

APPENDIX VIII
SUMMARY OF EQUIPMENTS FOR
BHOPAL METRO (PURPLE LINE AND RED LINE) AND
INDORE METRO (YELLOW LINE) PROJECTS OF MPMRCL
FOR TELECOMMUNICATION SYSTEMS

S. No	SYSTEM
1.	FOTS & OA-IT
2.	Telephone System (TEL)
3.	Emergency Help Point System (EHPS)
4.	Public Address System (PAS)
5.	Passenger Information Display System (PIDS)
6.	Time Distribution System (TDS)
7.	CCTV System (Including Video wall)
8.	Access Control & Intrusion Detection System (ACIDS)

Note: The summary of equipment has been prepared for easy reference by the bidders. This summary indicated in this appendix is the minimum tentative quantity for the above systems. Being design-built contract, any additional items or enhancement of any quantity to complete the scope of work for all Telecommunication systems including the above systems, in line with practices of other metro and various tender drawings, shall be borne by the Tenderer without any additional cost.

1. FOTS & OA-IT

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
1	Fully redundant Central Core Switches for FOTS and associated accessories	Nos.	4	4	8
2	Layer 3 Distribution switches for FOTS and associated accessories for stations, RSSs, Depots, TERs, etc	Nos.	64	62	126
3	Layer 2 Access PoE Switches 24-port for FOTS and associated accessories for TERs, Stations, Depots, etc.	Lots	1 Lot	1 Lot	2 Lots
4	Layer 2 Access non-PoE Switches 24-port for FOTS and associated accessories for Stations, Depots, etc.	Lots	1 Lot	1 Lot	2 Lots
5	Central Core Switches for OA & IT and associated accessories.	Nos.	2	2	4
6	Access switches for OA & IT and associated accessories for stations, Depots, etc.	Nos.	32	31	63
7	Network Management System along with servers, workstations and associated accessories for FOTS.	Nos.	2	2	4
8	Network Management System along with servers, workstations and associated accessories for OA & IT System.	Nos.	2	2	4
9	Routers, Firewalls & Unified Threat Management Systems for Cyber Security	Lots	1 Lot	1 Lot	2 Lots
10	96 Fibres Armoured Cable for Stations, depots, etc	Kms	67	69	136
11	24 Fibres Armoured Cable for Stations, depots, RSS etc	Kms	72	74	146
12	HDPE Telecom Duct (40/33mm) for stations, depots, etc	Kms	234	240	474
13	19" Rack, Cable managers, Optical Distribution Frames, Distribution boards, Patch panels, Loop boxes for fibre, Power Cables, Data Cables, Pigtails, Patch Cards, Connectors, Terminations etc. as per requirements of TS for stations, SCR, OCCs, TERs, depots, RSSs, FOTS – OA&IT etc.	Lots	1 Lot	1 Lot	2 Lots

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
14	Any Other Items necessary for meeting fully the Contract Requirements as per TS.	Lots	1 Lot	1 Lot	2 Lots

2. Telephone System (TEL)

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
1	EPABX system complete with fully redundant Server and wired with Analog cards, digital cards, Ethernet ports, etc and associated accessories	Nos	4	4	8
2	Network Management System along with Servers, Workstations & Central Telephone System and associated accessories for Telephone System	Sets	2	2	4
3	Full Features IP Telephone	Nos	46	46	92
4	Standard Features IP Telephone	Nos	545	529	1074
5	Hot Line Telephones for OCC and	Nos	8	8	16
6	TEL Laptop PCs with application software and accessories	Nos	2	2	4
7	One unit of each type of TEL Test Jig as per Para 4.6.2 of Telecom TS	sets	1	1	2
8	10% Full Features IP Telephone Desktop	Nos	5	5	10
9	10% Standard Features IP Telephone Desktop	Nos	55	53	108
10	Stranded patch cord type 8P8C LAN cable 1.5m long for movable desktop telephone	Nos	50	50	100
11	Stranded patch cord type 8P8C LAN cable 3m long for movable desktop telephone	Nos	50	50	100
12	Stranded patch cord type 8P8C LAN cable 5m long for movable desktop telephone	Nos	50	50	100
13	10% Standard Features IP Telephone with Wall mount kit	Nos	55	53	108
14	TEL OCC Server Exchange equipment provided at TER-OCC	Nos	1	1	2
15	NMS Workstation fully loaded with NMS software	Nos	1	1	2
16	Each type of exchange subscriber line card as per Para 4.7.9 of Telecom TS	Nos	10%+1	10%+1	

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
17	Each type of exchange junction line card as per Para 4.7.10 of Telecom TS	Nos	10%+1	10%+1	
18	Each type of exchange system control card as per Para 4.7.11 of Telecom TS	Nos	10%+1	10%+1	
19	Call Control Server, loaded with operating system, applications and databases	Nos	1	1	2
20	Each type of power supply module as per Para 4.7.13 of Telecom TS.	Nos	10%+1	10%+1	
21	Other spares recommended by Manufacturer / Bidder	Lots	1 Lot	1 Lot	2 Lots
22	TEL Equipment for Telecom Workshop training	Lots	1 Lot	1 Lot	2 Lots
23	19" Rack, Cable managers, Optical Distribution Frames, Distribution boards, Patch panels, Loop boxes for fibre, Power Cables, Data Cables, Pigtails, Patch Cards, Connectors, Terminations etc. as per requirements of TS for stations, OCCs, TERs, depots, RSSs, etc.	Lots	1 Lot	1 Lot	2 Lots
24	Any Other Items necessary for meeting fully the Contract Requirements as per TS.	Lots	1 Lot	1 Lot	2 Lots

3. Emergency Help Point System (EHPS)

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
1	EHPS Server	Nos.	2	2	4
2	EHPS NMS	Nos.	2	2	4
3	EHPS Telephones	Nos.	267	275	542
4	EHPS Dispatcher Workstation with Button Box	Nos.	74	72	146
5	EHPS Button Box	Nos.	60	58	118
6	EHPS Laptop PCs	Nos.	2	2	4
7	Hand Specialized Tools	Nos.	2	2	4
8	Test Jig	Nos.	1	1	2
9	EHPS Dispatcher Button Box	Nos.	1	1	2
10	EHPS Dispatcher (Spare)	Nos.	14	14	28
11	EHPS Telephones identical to Cross Passage EHPS Telephone	Nos.	10	10	20
12	EHPS Button Box (Spare)	Nos.	7	7	14
13	EHPS Directional Tunnel Signs	Nos.	50	82	132
14	19" Rack, Cable managers, Optical Distribution Frames, Distribution boards, Patch panels, Loop boxes for fibre, Power Cables, Data Cables, Pigtails, Patch Cards, Connectors, Terminations etc. as per requirements of TS for stations, OCCs, TERs, depots, RSSs, etc.	Lots	1 Lot	1 Lot	2 Lots
15	Any Other Items necessary for meeting fully the Contract Requirements as per TS.	Lots	1 Lot	1 Lot	2 Lots

4. Public Address System (PAS)

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
1	PAS Server for OCC/Station	nos.	32	31	63
2	Digital Voice Announcer and Recorder	nos.	32	31	63
3	PAS Work Station for Station PAS	nos.	34	33	47
4	Desktop Controllers for Station PAS	nos.	38	37	75
5	PAS NMS	nos.	2	2	4
6	Desktop controllers with microphone for Depot PAS	nos.	17	17	34
7	PAS Speakers (Ceiling, Wall-mount, Projection, Horn)	nos.	5828	5653	11481
8	PAS laptop PCs with application software complete with all software and accessories	nos.	2	2	4
9	Portable Sound Level Measurement Devices	nos.	2	2	4
10	One test jig of each type recommended by the manufacturer for maintenance of the PAS equipment.	sets	1	1	2
11	Station PAS SCR desktop controller (Spare)	nos.	3	3	6
12	Station PAS gooseneck microphone for SCR desktop controller (Spare)	nos.	10	10	20
13	Station PAS OCC/BCC desktop controller (Spare)	nos.	2	2	4
14	Station PAS gooseneck microphone for OCC/BCC desktop controller (Spare)	nos.	3	3	6
15	Station PAS Workstation for OCC/BCC (Spare)	nos.	1	1	2
16	Spares 10% plus one for each installed Station PAS OCC/BCC Server	nos.	4	4	8
17	Spares 10% plus one of each type of PA Speaker in stations	nos.	583	565	1148
18	Other spare parts recommended by the manufacturer and The Contractor.	sets	1	1	2
19	PAS Equipment for Telecom Workshop Training	sets	1	1	2
20	Depot PAS Desktop Controller (Spares)	nos.	5	5	10
21	Depot PAS Microphone for Desktop Controllers (Spares)	nos.	10	10	20

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
22	Depot PAS Workstation for NMS Room (Spares)	nos.	1	1	2
23	Depot PAS Server (Spares)	nos.	1	1	2
24	19" Rack, Cable managers, Optical Distribution Frames, Distribution boards, Patch panels, Loop boxes for fibre, Power Cables, Data Cables, Pigtails, Patch Cards, Connectors, Terminations etc. as per requirements of TS for stations, OCCs, TERs, depots, RSSs, etc.	Lots	1 Lot	1 Lot	2 Lots
25	Amplifiers, Special Microphones and any other Items necessary for meeting fully the Contract Requirements as per TS.	Lots	1 Lot	1 Lot	2 Lots

5. Passenger Information Display System (PIDS)

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
1	PIDS NMS Server	nos.	2	2	4
2	PIDS Central Server	nos.	2	2	4
3	PIDS Workstations	sets	38	37	75
4	PIDS Single Sided Displays for Concourse	sets	63	61	124
5	PIDS Double Sided Displays for Platforms	nos.	120	116	236
6	PIDS Laptop with accessories and software to configure and maintain the PIDS	nos.	2	2	4
7	Any other type of instrument used for maintenance of PIDS	sets	1	1	2
8	PIDS Test jig of each type recommended by the manufacturer for maintenance of the PIDS equipment	sets	1	1	2
9	Spare 1 (one) for each installed PIDS Workstation for OCC	nos.	4	4	8
10	Spare 1 (one) for each installed PIDS Workstation for Station Control Room	nos.	30	29	59
11	Spare 1 (one) for each installed PIDS OCC Server	nos.	1	1	2
12	Spare 10% plus one of each type of Single-sided display	nos.	7	7	14
13	Spare 10% plus one of each type of Double-sided display	nos.	13	13	26
14	Other spare parts recommended by the manufacturer and The Contractor.	Lots	1 Lot	1 Lot	2 Lots
15	PIDS Equipment for Telecom Workshop Training complete including Server, NMS, Workstations, displays and all accessories and software	Lots	1 Lot	1 Lot	2 Lots
16	19" Rack, Cable managers, Optical Distribution Frames, Distribution boards, Patch panels, Loop boxes for fibre, Power Cables, Data Cables, Pigtails, Patch Cards, Connectors, Terminations etc. as per requirements of TS for stations, OCCs, TERs, depots, RSSs, etc.	Lots	1 Lot	1 Lot	2 Lots
17	Any Other Items necessary for meeting fully the Contract Requirements as per TS.	Lots	1 Lot	1 Lot	2 Lots

6. Time Distribution System (TDS)

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
1	TDS Central Server	nos.	4	4	8
2	TDS NMS Server	nos.	2	2	4
3	Hours-minutes Analog display clocks	nos.	122	120	242
4	Hours-minutes-seconds Digital display clocks	nos.	575	557	1132
5	Outdoor Facade clocks 1 - 2 meters diameter	nos.	4	4	8
6	TDS laptop PCs with application software	nos.	2	2	4
7	Test jig of each type recommended by the manufacturer for maintenance of the TDS equipment	sets	1	1	2
8	TDS Equipment for Telecom Workshop Training	sets	1	1	2
9	GNSS rooftop receiver assembly identical to installed on Depot Administration Building, with cables (Spare)	nos.	1	1	2
10	GNSS rooftop antenna assembly identical to installed on Depot Administration Building, with cables (Spare)	nos.	1	1	2
11	GNSS power supply for rooftop receiver identical to installed in TER of Depot Administration Building, with cables (Spare)	nos.	1	1	2
12	Hours-minutes Analog display clocks (Spare)	nos.	10	10	20
13	Hours-minutes-seconds Digital display clocks (Spare)	nos.	25	25	50
14	Spare TDS Server	nos.	1	1	2
15	Other spare parts recommended by the manufacturer and The Contractor.	Lots	1 Lot	1 Lot	2 Lots
16	19" Rack, Cable managers, Optical Distribution Frames, Distribution boards, Patch panels, Loop boxes for fibre, Power Cables, Data Cables, Pigtails, Patch Cards, Connectors, Terminations etc. as per requirements of TS for stations, OCCs, TERs, depots, RSSs, etc.	Lots	1 Lot	1 Lot	2 Lots
17	Any Other Items necessary for meeting fully the Contract Requirements as per TS.	Lots	1 Lot	1 Lot	2 Lots

7. Closed Circuit Television System (CCTV)

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
1	CCTV Servers (Primary, Secondary + Spare)	nos.	4	4	8
2	CCTV Recording Server	nos.	32	31	63
4	CCTV Wall Monitors	sets	1	1	2
5	CCTV Wall Monitors (Spare)	nos.	1	1	2
6	CCTV NMS	nos.	2	2	4
7	Operations CCTV Workstation	nos.	22	22	44
8	Security CCTV Workstations	nos.	84	82	166
9	IP Cameras	nos.	3414	3317	6731
10	Station TER Video Server	nos.	31	30	61
11	CCTV laptop PCs with application software complete with all software and accessories necessary to configure and maintain the CCTV System	nos.	2	2	4
12	CCTV portable CCTV monitors intended for testing of 2MP IP cameras in the field and adjusting the pan, tilt, zoom and focus of the fixed cameras	nos.	4	4	8
13	CCTV portable signal generators intended for testing the resolution of HDMI monitors of the CCTV System	nos.	2	2	4
14	CCV Hand tools for removing and entering the camera enclosure.	nos.	5	5	10
15	CCTV Light level measurement instruments capable of measuring the CCTV camera lowest light level specification	nos.	2	2	4
16	CCTV Test jig of each type recommended by the manufacturer for maintenance of the CCTV equipment.	sets	1	1	2
17	10% plus one for each installed CCTV Station Workstation	nos.	7	7	14
18	10% plus one for each installed CCTV OCC Workstation	nos.	3	3	6
19	10% plus one for each installed CCTV TER-OCC Video Server	nos.	1	1	2

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
20	10% plus one for each installed CCTV STN-TER Video Server	nos.	4	4	8
21	5% plus one of each type of multimedia converter used with CCTV	Lots	1 Lot	1 Lot	2 Lots
22	External power supply of each type used for CCTV	Lots	1 Lot	1 Lot	2 Lots
23	10% plus one of each CCTV STN-TER Video Storage media	Lots	1 Lot	1 Lot	2 Lots
24	Projector remote controller	nos.	1	1	2
25	Other spare parts recommended by the manufacturer and The Contractor	Lots	1 Lot	1 Lot	2 Lots
26	CCTV Equipment for Telecom Workshop Training as per Para 6.13	Lots	1 Lot	1 Lot	2 Lots
27	19" Rack, Cable managers, Optical Distribution Frames, Distribution boards, Patch panels, Loop boxes for fibre, Power Cables, Data Cables, Pigtails, Patch Cards, Connectors, Terminations etc. as per requirements of TS for stations, OCCs, TERs, depots, RSSs, etc.	LS	LS	LS	LS
28	Any Other Items necessary for meeting fully the Contract Requirements as per TS.	LS	LS	LS	LS

8. Access Control and Intrusion Detection System (ACIDS)

Sl. No.	Item Description	UOM	QTY for Bhopal	QTY for Indore	Total QTY
1	ACIDS Access Control and Intrusion Detection Workstations	nos.	11	11	22
2	ACIDS Alarm Annunciator Panels	nos.	65	63	128
3	ACIDS Server	nos.	2	2	4
4	ACIDS Logging Printer	nos.	6	6	12
5	ACIDS Access Control Points complete with ruggedized CSC Reader, Exit unlock button and electric strikes	nos.	780	757	1537
6	ACIDS NMS	nos.	2	2	4
7	ACIDS Laptop PC with Application Software and accessories to maintain ACIDS system	nos.	1	1	2
8	ACIDS Smartcards	nos.	1000	1000	2000
9	ACIDS Test Jigs	nos.	1	1	2
10	10% plus 1 of each type ACIDS CSC Reader installed	nos.	79	77	156
11	10% plus 1 of each type ACIDS Door open sensor installed	nos.	79	77	156
12	10% plus 1 of each type ACIDS Door Strike installed	nos.	79	77	156
13	Spare Ink Ribbon for ACIDS Logging Printer	nos.	5	5	10
14	Other Spares recommended by manufacturer and The Contractor	Lots	1 Lot	1 Lot	2 Lots
15	19" Rack, Cable managers, Optical Distribution Frames, Distribution boards, Patch panels, Loop boxes for fibre, Power Cables, Data Cables, Pigtails, Patch Cards, Connectors, Terminations etc. as per requirements of TS for stations, OCCs, TERs, depots, RSSs, etc.	Lots	1 Lot	1 Lot	2 Lots
16	Any Other Items necessary for meeting fully the Contract Requirements as per TS.	Lots	1 Lot	1 Lot	2 Lots