GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
(RAILWAY BOARD)

2025/Proj./MMRDA/C-1/L9/30/133 New Delhi, dated 14.08.2025

Managing Director,
Mumbai Metropolitan Region Development Authority (MMRDA),
C-14&15, Bandra- Kurla Complex,
Bandra (East), Mumbai – 400051

Sub: Approval of Track Structure (Annexure C-1 - July 2025) for Main Line of Mumbai Metro Line 9 (From Dahisar East Station to Subhash Chandra Stadium Station) of Mumbai Metropolitan Region Development Authority (MMRDA)

Ref: Track Structure (Annexure C-1) documents uploaded on RDSO's online portal by MMRDA on 29.07.2025 along with compliance

Mumbai Metropolitan Region Development Authority (MMRDA)'s request for approval of Track Structure (Annexure C-1 - July 2025) for Main Line of Mumbai Metro Line 9 (From Dahisar East Station to Subhash Chandra Stadium Station) has been examined in consultation with RDSO and approval of Railway Board is hereby conveyed for the same.

Accordingly, approved copy of Track Structure (Annexure C-1 July 2025) is enclosed.

Encl: As above

Delhi 14.8.25

(**F. A. Ahmad**)
Director/Gati Shakti (Civil)-IV
Railway Board
Ph: 011-47845480
Email: dirgsc4@gmail.com

Copy to:

1. **Executive Director/UTHS, RDSO**, Manak Nagar, Lucknow w.r.t letter No. UT/116/MMRDA dated 31.07.2025

2. **OSD/UT & Ex-Officio Joint Secretary** , Ministry of Housing & Urban Affairs (MoHUA), Nirman Bhavan, New Delhi-110011

TECHNICAL STANDARD OF TRACK STRUCTURE FOR STANDARD GAUGE OF MAIN LINE OF MUMBAI METRO LINE 9 (RED LINE)

(Annexure – C1)

July 2025

ANNEXURE C1

MAIN LINE OF MUMBAI METRO LINE 9 (RED LINE)

MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY

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Bandra (East), Mumbai - 400 051.

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ANNEXURE C1

COMPLIANCE OF TECHNICAL STANDARDS OF TRACK STRUCTURES STANDARD GAUGE MAIN LINE OF MUMBAI METRO LINE 9 (RED LINE)

PART -A: COMPLIANCE MATRIX FOR TECHNICAL STANDARDS OF TRACK STRUCTURE FOR STANDARD GAUGE MAIN LINE OF MUMBAI METRO LINE 9 (RED LINE)	
1.	**Scope:** The Scope is to formulate the Track Structure Design Basis, with Broad parameters for getting the Ministry of Railways approval for stipulated and Desirable technical standards / Specifications for Mumbai Metro Line 9 from Dahisar (E) Station (Chainage : 15+194.260) to Subhash Chandra Bose Stadium Station (Chainage : 24+036.000) From Chainage : 15+194.260 to 24+036.000 1. Initial Station – Dahisar (E) Station. 2. Terminus Station - Subhash Chandra Bose Stadium Station.
2.	**Operating Environment:**
	Track Structure should fulfil the general following conditions:

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ANNEXURE C1

Sl. No	Standards Stipulated as per Annexure -C1 of Procedure for safety Certification and Technical Clearance of Metro System	Standard Specification adopted by MUMBAI METROPOLITAN REGION DEVELOPMENT AUTHORITY(MMRDA) for Mainline of Mumbai Metro Line 9 (RED LINE)
2.1	Gauge – Broad gauge- 1676/1673mm (nominal) and standard gauge – 1435mm	**Complied** Gauge- standard gauge – 1435mm
2.2	Rail Seat inclination (slope): 1 in 20	**Complied** Rail Seat inclination (slope): 1 in 20
2.3	Speed potential – 110 kmph (max.)	**Complied** Maximum Design speed - 95 kmph, Operating Speed – 80 Kmph
2.4	Static axle load –20 T (max.)	**Complied** Maximum Static Axle Load -17 T
2.5	Design rail temperature range – (-)10 degree Celsius to (+) 70 degree Celsius	Complying Design rail temperature range- (+) 8 degree Celsius to (+) 54 degree Celsius depicted in the map of rail temperature zones in the LWR Manual of Indian Railway for Mumbai Zone (Zone -II).
2.6	Maximum Curvature and ruling gradient - As specified in approved SOD SOD Provision 120m minimum radius on elevated & At-Grade sections, (Para 1.2.1 of SOD)	**Complied to requirement approved SOD** Minimum Radius of Curve (Horizontal) 1) On Main Line the Sharpest Radius of Curve is 123.000 m. 2) On main line in curves with a radius of 190 m and sharper is provided checkrail. 3) Entire Section is elevated. There is no at-grade section or underground section.

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	SOD Provision 1000 m on the passenger platform (Para 1.2.1 of SOD)	**Complied** Minimum Radius of curve 2200 m
	SOD Provision Ruling Gradient:- Maximum grade (compensated) shall be 4% with grade compensation at the rate of 0.04% per degree of curve. (Para 1.3.1 of SOD).	**Complied** Maximum grade (compensated) is 3.868 %
	SOD Provision Vertical Curve – 1500 m minimum radius (Para 1.2.3 of SOD)	**Complied** Vertical Curve – 1510 m minimum radius is provided
	SOD Provision Maximum Track gradient in platform is 1 in 400 (Para 2.3(a) of SOD)	**Complied** There are no gradients on platforms. All Station platforms are on Level
	SOD Provision Maximum Cant (SE)=110 mm Maximum Cant Deficiency (cd)=85 mm (Para 1.9 of SOD)	**Complied** Maximum Cant has been designed (SE)=110 mm Maximum Cant Deficiency (cd)=82.241 mm

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3.	**Track Structure:**	
3.1	General: The track structure should fulfil the following requirements:	
3.1.1	The track structure should conform to / satisfy Schedule of Dimension requirement and other maintenance instructions of Metro systems	**Complied**
3.1.2	Ride comfort and running safety of track vehicle dynamics should be satisfied.	**Complied** RDSO oscillation trail will be conducted.
3.1.3	The track structure should be designed with Long welded / Continuously welded rail on main line track (For both the ballasted as well as ballastless track).	**Complied** The track structure has been designed with Continuously Welded Rail (CWR) on the main line.
3.1.4	The horizontal alignment shall consist of a series of straights joined to circular curves generally with transition curves. Curvature and cant shall be calculated based on the train speed for each train type on the section. Compound and reverse curves are acceptable, provided they are connected by an adequate transition curve	**Complied** Track GAD is enclosed at **Appendix C1/9.** Horizontal Track alignment have been designed as per approved track parameters.
3.1.5	The vertical alignment should be designed to achieve a smooth profile line with gradual changes. Changes in the profile should be connected by vertical curves, which shall be as generous in length as the location allows. Vertical curves including its transition shall not be located at stations within the length of platform. A vertical curve within the length of transition and Turnouts is also not desirable. Vertical curve radius is	**Complied** Track GAD is enclosed at **Appendix C1/9.** Vertical Track alignment have been designed as per approved track parameters.

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	constrained by the need to limit the vertical acceleration for passenger ride comfort.	
3.2	The technical standards for Track structure deal with the following components-	
(i)	Rail and Welding	**Complied** Manual for Flash Butt Welding of rail Reprint April -2022 incorporated up to ACS NO-04
(ii)	Sleeper and fastening for ballasted track	**Not Applicable**, since the entire corridor is ballastless.
(iii)	Track slab for ballastless track	**Complied** Track is laid on cast in situ plinth or slab, herein referred to as the 'track slab'. The track slab shall be designed as Plinth beam or slab type ballastless track structure with derailment guards. It should accommodate the base plates of the fastening system. Detailed design calculations of track slab along with detailed structural drawings & explanations as approved by Metro Authorities is attached **Appendix C1/5** Structural Design of sharpest curve of SOD is also now enclosed at **Appendix C1/6.**
(iv)	Fastening system for ballastless track	**Fastening system for ballastless track:** **(i) Straight & Curved Track Radius greater than 700 m.**

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		Pandrol Double Resilient Baseplate Assembly 21166 (2 Holes) fastening system is also approved by MOR vide letter no: 2021/Proj/DMRC/FS-BLT/30/40 New Delhi, dated 15.03.2021 and further vide letter no 2021/Proj/DMRC/FS-BLT/30/40 dated 19.07.2022 for other Metros after obtaining clearance from MOR. **(ii) On Curved Track Radius less than 700 m.** Pandrol Double Resilient Baseplate Assembly 13145 Fastening system which has been approved by Railway board vide letter no. 2003/Proj/Bangalore/2/2 (Pt) dt. 07/10/2011. The C2 for the Pandrol Double Resilient Baseplate Assembly 13145 Fastening system was approved for MMRDA Line – 7 (Line – 9 is the continuity of Line – 7) vide letter No: 2020/Proj./MMRDA/C-2/30/01 dated 07.07.2020 **(iii) One Turnout :-** The adopted Fastening system for Turnouts is System 336 of M/s Vossloh. Fastening system has been approved by Railway board vide letter no. 98/Proj./DLI/30/1(Vol III) dated 24.01.2013
(v)	Insulated Glued joint	Insulated glued joint is not required in this project as the CBTC moving block signaling system adopted.

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(vi)	Turnout, scissors crossover	**Turnout, Crossover & Scissor Crossover** Turnout: - 1 in 9 R300m and 1 in 7 R190m Crossover: - 1 in 9 R300m and 1 in 7 R190m Scissor Crossover: - 1 in 9 R300m
(vii)	Switch Expansion Joints	Switch Expansion joints are not required based on the Rail Structure Interaction analysis. Rail Structure interaction Analysis reports are enclosed at **Appendix C1/1.**
(viii)	Gradients	**Complied** Maximum grade (compensated) is 3.868 %
4.	**Rails and Rail Welding**	
4.1	**Rails:**	
4.1.1	For Main line Track:	
4,1.1.1	The rail used on main line on curves and approaches of Stations shall be 60E1 (UIC 60), 1080 grade Head Hardened	**Complied.** 1080 grade HH / 60 E1 Rails are used in complete section
4.1.1.2	At other locations on straight line of main line, the use of 60E1 (UIC 60), 1080 grade HH / 60E1 (UIC 60), 880 grade rail shall be decided by Metro Railway depending upon speed, axle load and other factors pertaining to safety and life of rail. However, on curves with small straight track in between, the 60E1 (UIC 60), 1080 grade Head hardened rail should be continued on straight patches also.	**Complied.** 1080 grade HH / 60 E1 Rails are used in complete section

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4.1.1.3	It is essential to have preventive rail grinding arrangements in case 60E1, 1080 HH rails are used.	**Complied.** Preventive rail grinding of 60E1(UIC60) 1080 grade rails will be done,
4.1.2	**Depot lines:** The rail used on depot lines can be non-head hardened and shall be 60E1 (UIC 60), 880 grade.	Not applicable for Main line For Mumbai Metro Line 9, Charkop depot shall be used, **Complied**
4.1.3	Specification:	
4.1.3.1	The rail shall be class 'A' rails as per IRS-T-12-2009 specification with latest amendments. However, any suitable length of rail more than 13 m considered appropriate by metro on consideration of transportation and handling can be adopted, provided the rails are ultimately welded into long welded rails.	**Complied** 18 m length of Class 'A' rails as per (IRS-T-12-2009 (Reprint: October -2021 (covering up to ACS no 5 and Corrigendum no 1 of ACS no. 1 & 5) are used in Main line of Mumbai Metro line 9. Rails are continuously welded.
4.1.3.2	The rail shall be manufactured and tested in accordance with IRS-T-12-2009 (with latest amendment). The chosen manufacturers shall be required to submit their inspection and test plan for approval by Metro railway as per IRS-T-12-2009. Metro railways will ensure that the inspection and test plan approved by them strictly conforms to the requirement of IRS specifications	**Complied** Rails manufactured and tested in accordance with IRS-T-12-2009 (Reprint: October -2021 (covering up to ACS no 5 and Corrigendum no 1 of ACS no. 1 & 5) are used. Inspection and test plan of 1080 HH grade rail enclosed as **Appendix C1/2**.
4.2	**Welding of rail**	

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4.2.1	The welding of rails should conform to Indian Railway specifications and technical instructions issued from time to time	**Complied** Manual for Flash Butt Welding of rail Reprint April -2022 incorporated upto ACS NO-04
4.2.2	The present instructions are contained in following documents	
4.2.2.1	**Alumino Thermit Welding**	
(i)	Indian Railway Standard specifications for Alumino Thermit Welding of Rails (IRS/T-19-2020 with latest amendments)	**Complied** Indian Railway Standard specifications for Alumino Thermit Welding of Rails (Serial no. IRS/T-19-2021 Version no. 07 effective date 01.02.2022)
(ii)	Manual For Fusion Welding Of Rails By The Alumino-Thermic Process: Revised-2012 with latest amendments	**Complied** Manual For Fusion Welding of Rails by The Alumino-Thermic Process: Revised-2022
4.2.2.2	**Flash Butt Welding**	
	Manual for Flash Butt Welding of Rails, (Revised January 2012) with latest amendments	**4.2.2.2 & 4.2.2.3 - Complied** Manual for Flash Butt Welding of rail Reprint April -2022 incorporated upto ACS NO-04
4.2.2.3	Special attention is required by metros for provisions of these instructions regarding procurement, execution of works and areas requiring prior approval/ standardization by RDSO.	QAP for Flash Butt Welding Plant for welding 1080 Grade HH Rails has been approved by RDSO, vide letter no. CT/JW/MFBWP/RIL Dt. 07.01.2016 for FBW machine sl. No. CW651, Model: H-1000, make: Holland LP, USA for FB welding of UIC 60/60E1, 1080 Grade HH rail Following are now enclosed at **Appendix C1/3**

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		MMRDA has issued welders competency certificate, and a copy of the certificate is now enclosed. **Appendix C/4.** .
4.3	**Ultrasonic Testing of Rail and Welds:**	
	The rails and welds shall be ultrasonically tested in field as per requirement of concerned specification/ manual/ instructions. The testing shall be ensured as per provisions of "Manual for Ultrasonic Testing of Rail and Welds- Revised 2012" with latest amendments. The provisions, as given in the "IRS specification for Ultrasonic testing of Rails/Welds, Revised-2020 (Document No: T-53)" shall also be followed.	**Complied** The testing shall be ensured as per Provisions of "Manual for ultrasonic testing of rails and welds, (Revised – 2022)". USFD specification and addendum & corrigendum slip no. 2 of 2022 of IRS for Ultrasonic testing Rails/Welds, Revised – 2020 (Document No. T-53).
5.	**Sleeper and fastening for Ballasted track**	
5.1	**Sleepers**	
5.1.1	**Broad Gauge** The PSC sleepers shall be used in accordance with RDSO drawing no. T-2496 and specification IRS-T-39 (revised from time to time).	**Not applicable** Mumbai Metro Line 9 entire section is standard Gauge Ballast less track
5.1.2	**Standard Gauge** PSC sleeper for standard gauge will be designed by Metro Railways following in principal guidelines of Indian Railway and the same shall be approved by Metro.	**Not applicable** Mumbai Metro Line 9 entire area section is Ballast less track
5.2	**Fastening system:**	

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	The elastic fastening system prevalent on Indian Railways shall be used duly ensuring the Inspection protocol for fastening components laid down for IR. In case of use of elastic fastening other than in use on IR, prior approval shall be obtained from Railways.	**Not applicable** Mumbai Metro Line 9 entire section is Ballast less track
6.	**Track slab for Ballastless track**	
6.1	Track shall be laid on cast in situ/precast reinforced plinth or slab, herein referred to as the 'track slab'. The track slab shall be designed as plinth beam or slab type ballastless track structure with derailment guards. It shall accommodate the base plates of the fastening system.	**Complied** Track is laid on cast in situ plinth or slab, herein referred to as the 'track slab'. The track slab shall be designed as Plinth beam or slab type ballastless track structure with derailment guards. It had accommodated the base plates of the fastening system. Detailed design calculations of track slab along with detailed structural drawings & explanations as approved by Metro Authorities is attached **Appendix C1/5** Structural Design of sharpest curve of SOD is also now enclosed at **Appendix C1/6.**
6.2	In general, track slab (including sleeper, if any) on which the fastening and rail are to be fitted shall perform the following functions	
i)	Resist the track forces. (Static and dynamic)	**Complied** Track is designed to resist static and dynamic forces such as self-weight, train weight, dynamic impact load, centrifugal, traction and braking, lurching, racking, wind, LWR, seismic, radial, temperature and accidental derailment load.

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		Reinforcement has been designed to resist maximum moments induced due to combination of these loads acting on the track slab. Detailed design calculations of track slab along with detailed structural drawings as approved by Metro authorities is attached vide **Appendix C1/5 and C1/6**
ii)	Have adequate edge distance of concrete beyond the anchor bolts to provide resistance against edge failure	**Complied** Edge distance from center of the anchor bolt to edge of the concrete slab is maintained as 140mm minimum as per the design. Detailed design calculations of track slab along with detailed structural drawings as approved by Metro authorities is attached vide **Appendix C1/5 and C1/6**
iii)	Provide a level base for uniform transmission of track/rail forces.	**Complied** Level base provided with Plinth slab for normal track, Slab Track provided for turnout and crossover for uniform transmission of track/rail forces.
iv)	Have geometrical accuracy and enable installation of track to tolerances laid down.	**Complied** The track geometry are considered and shown in the construction reference drawings as per the SOD. Tolerance for standard gauge is as per RDSO Annexure C-2, Clause No 4.2.(iv)
v)	Ensure drainage.	**Complied** At Every 4.40m/ 4.05m Gap between plinths has been provided and viaduct is having a transverse slope of 2.5% all the water will pass through gaps in the plinths and drainage pits of viaduct and dropdown at pier locations.
vi)	Resist weathering	**Complied** In design minimum cover for top and side reinforcement-40mm and bottom reinforcement-35mm is provided as

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		per the Environmental condition, Minimum cement content in the mix design in order to resist weathering action.
vii)	Be construction friendly, maintainable and quickly repairable in the event of a derailment. The 'Repair and Maintenance methods shall be detailed in a Manual to be prepared and made available.	**Complied** Construction is friendly, maintainable and quickly repairable in the event of any accident. Repair and Maintenance methods are detailed in the 'Track Maintenance Manual. Track Maintenance Manual is under preparation.
viii)	Ensure provision for electrical continuity between consecutive plinths/slabs by an appropriate design	**Complied** Electrical continuity between consecutive plinths/slabs has been provided.
ix)	Plinth beam or slab of ballastless track should be suitable for embankment or viaduct or tunnel/Underground structure.	**Complied** Plinth beam or slab of ballast less track is designed so that it is suitable for viaduct, since the entire section is elevated.
x)	Proper design of expansion joints suitable for joints of viaduct structure.	**Complied** Plinth lengths have been adjusted such that the gap between plinths will match with the viaduct expansion joints.
xi)	Design should be suitable for curves as per SOD of Metro system	**Complied** The Curve tolerances and specifications are considered for design according to RDSO approved SOD for MMRDA. Detailed calculations or studies with regard to clearance of check rails/restraining rails is attached vide **Appendix C1/7**

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xii)	Design of subgrade/embankment for slab should be furnished to ensure durability and functional stability in service	**Not applicable** Track slabs are resting on elevated viaduct of U-Girder & Deck slabs on I-Girder.
xiii)	Design should be suitable and incorporate provision of utilities e.g. cable, wires, ducts, water channels, etc. The detailed design calculations of track slab along with detailed structural drawings as approved by metro authorities shall be furnished for record.	**Complied** Design is suitable and incorporates provision of utilities e.g. cable, wires, ducts, water, channels, etc. Detailed design calculations of track slab along with detailed structural drawings as approved by Metro authorities is attached vide **Appendix C1/5 and C1/6**
7.	**Check Rail / Restraining Rail:**	.
7.1	Check rails/ Restraining Rails should be provided on curves on main line where radius is 218m or less on Broad gauge and radius is 190m or less on Standard gauge. The clearance of check rail/ restraining rails shall be suitably decided after requisite studies. The detailed design calculations/ studies in this regard shall be furnished for record.	**Complied** Check rails as per the approved design will be provided on curves on main line where radius is 190 m or less. The clearance for check rail adopted is 65 mm to 70 mm. The calculation sheet of check rail is enclosed herewith as **Appendix-C1/7**.
7.2	Check rails/ Restraining Rails shall not be mandatory for curves in depots, yards and non-passenger lines where speed is not more than 25 kmph. However, decision in this regards may be taken by Metro themselves based on layout and maintenance requirement.	**Noted.** Mumbai Metro Line 9 entire section is main Line, Charkop Depot will be used for Mumbai Metro Line 9.
8.	**Derailment Guards**	
8.1	The derailment guard should be provided inside/outside of running rail on viaduct as well as in tunnel and at grade section locations specified by the	**Complied**

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	Metro railway. In tunnels, the derailment guard should preferably be provided inside the track, so that it permits less sway of coach towards tunnel wall in case of derailment. **NOTE:** **Location for providing Derailment Guard in single track tunnel** 1. Entry of tunnel: 200 m from tunnel portal outside the tunnel to 50 m inside the tunnel. 2. Exit of tunnel: 50 m from inside of tunnel portal to 200 m outside the tunnel. 3. In curved track having radius 500 m or less including transition portion but excluding locations where check rail is provided. 4. Covering locations of all important installations e.g. Location of any sub-station or hazardous structures inside the tunnel, etc. damage to which in the assessment of metro rail administration can result into serious loss of life or/and infrastructure as a result of derailment in the tunnel. 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.	The derailment guard is provided on passenger line on inside of running rail on viaduct and outside of running rails in turnouts. There is no underground & At-Grade section in Main line of Mumbai Metro Line 9. Not applicable for Main line of Mumbai Metro Line 9., since entire section is on elevated viaduct.
8.2	The lateral clearance between the running rail and the derailment guard shall be 210 ±30 mm. It shall not be lower than 25 mm below the top of the running rail and should be clear of the rail fastenings to permit	**Complied** Derailment Guard is kept with top not more than 25 mm below the top of the running rail and kept clear of the rail

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	installation, replacement and maintenance, Metro Administration should ensure that KE is not infringing the Structure Gauge, in case of derailment in single track tunnel, so long the wheels of any derailed vehicle are within the main rail and derailment guard." **Note:-** "In case of Double Resilient Base Plate Assembly Fastening System as approved by MoR, the lateral clearance between running rail and the derailment guard shall be 250±20 mm. This fastening system, if used in tunnels having multiple tracks, Metro Administration should ensure that KE for adjacent track is not infringed so long as the wheels of any derailed vehicle are within the main rail and derailment guard."	fastenings to permit installation, replacement and maintenance. The lateral clearance between rail and derailment guard are sufficient to accommodate the base plates of fastening system. The clearance between rail and derailment guard provided is 210 ± 30 mm for fastening system PDRBA 21166 and 250 ± 20 mm for fastening system PDRBA 13145 respectively. For Turnout Fastening adopted is System 336 and the lateral clearance of 210 ± 30 mm between the running rail and derailment guard is provided.
8.3	Derailment guard shall be designed such that in case of derailment:	
(i)	The wheels of a derailed vehicle under crash load, moving at maximum speed are retained on the viaduct or tunnel.	**Complied** The detailed design calculations & concerned drawings of derailment guards are attached at **Appendix -C1/5 and C1/6.**
(ii)	Damage to track and supporting structures is minimum.	**Complied** The detailed design calculations & concerned drawings of derailment guards are attached at **Appendix -C1/5 and C1/6.**
(iii)	The detailed design calculations of derailment guards along with detailed structural drawings shall be furnished for record	The detailed design calculations & concerned drawings of derailment guards are attached at **Appendix -C1/5 and C1/6.**
9.	**Glued Insulated Rail joint**	

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9.1	Normally glued joints should be avoided	Insulated glued joint is not required Mumbai Metro Line 9 as the CBTC moving block signaling system adopted.
9.2	Wherever inescapable, G3 (L) type of glued insulated rail joint shall be used as per RDSO drawing no.T-5843. The glued joints shall be manufactured and tested in accordance with RDSO's 'Manual for Glued Insulated Rail Joints-1998' with all amendments	
10	**Turnouts, Scissors Crossover**	
10.1	**Standards of Turnout**	
10.1.1	Main lines: On main lines, the turnouts and diamond crossing shall be of the following standards	
(i)	**Standard Gauge** a) 1 in 9 type or flatter turnout (desirable) b) 1 in 7 type turnouts (minimum) c) Scissors cross-over of 1 in 9 / 1 in 7 type consisting of 4 turnouts and 1 diamond crossing	**Complied** Turnout: - 1 in 9 (300m Radius) and 1 in 7 (190 m radius). Crossover: - 1 in 9 (300m Radius) and 1 in 7 (190 m radius) Scissor Crossover: - 1 in 9 (300m Radius) consisting of 4 turnouts and 1 diamond crossing.
(ii)	**Broad Gauge** a) 1 in 12 type turnouts b) 1 in 8.5 type turnout c) Scissors cross-over of 1 in 12 type consisting of 4 turnouts and 1 diamond crossing.	Not applicable on Main line of Mumbai Metro Line 9, since entire section is standard gauge.
10.1.2	**Depots and non-running lines**	Not applicable on the Main line of Mumbai Metro 9. Charkop Depot will be used for Mumbai Metro Line 9
	On depot and other non-running lines, the turnouts and diamond crossing shall be of the following standards.	

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(i)	**Standard Gauge**	
	a) 1 in 7 type or flatter turnout b) Scissors crossover of 1 in 7 type consisting of 4 turnouts and 1 diamond crossing c) 1 in 7 derailing switches/1 in 7 type symmetrical split turnout **(ii) Broad Gauge** a) 1 in 8.5 type turnout b) Scissors cross-over of 1 in 8.5 type consisting of 4 turnouts and 1 diamond crossing c) 1 in 8.5 derailing switches/ 1 in 8.5 type symmetrical split turnout	Not applicable on the Main line of Mumbai Metro 9. Charkop Depot will be used for Mumbai Metro Line 9
10.1.3	If any Metro railway decides to use sharper angle layout, they should establish the adequacy of the speed potential of the turnout for the purpose for which it is used and the negotiability of the turnout by the rolling stock with a safety margin.	All turnouts in Mumbai Metro Line 9 corridor are 1 in 9 R300 type except crossover between Miragaon Station and Kashigaon Station is 1 in 7 R190 type which will serve during phase -1 operation between Dahisar (E) station and Kashigaon station. However, when the complete section from Dahisar (E) station to Subhash Chandra Bose Stadium Station will be operational, then this crossover will be used as emergencies only
10.1.4	The requirement for turnouts as specified in the following clauses shall include switch devices, crossings and associated check and lead rails as appropriate	

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	(a) Turnouts (switches, lead, crossings and associated closure & check rails) shall be suitable for installation on PSC sleepers for ballasted track or concrete slab for ballast less track.	(a) **Complied:** Turnouts (switches, lead, crossings and associated closure & check rails) are suitable for installation on concrete slab for ballast less track.
	(b) Turnouts shall be manufactured to allow for installation of continuously welded track.	(b) **Complied:** Turnouts are manufactured to allow for installation of continuously welded tracks.
	(c) Turnouts shall be compatible with proposed rolling stock and its operational characteristics.	(c) **Complied:** Turnouts are compatible with proposed rolling stock and its operational characteristics
	(d) The assembly must ensure continuous electrical contact with the train and all the points shall be operated by electric motors.	(d) **Complied:** The assembly ensures continuous electrical contact with the train and all the points shall be operated by electric motors.
	(e) The CMS crossing to be used on mainline shall be subjected to explosive hardening.	(e) **Complied:** The CMS crossings that are used on mainline have been subjected to explosive hardening
	(f) All turnouts shall be laid with cant with a rail slope as that of main line towards centre of track.	(f) **Complied:** All turnouts are laid with 1 in 20 cant with a rail slope as that of main line towards Centre of track
	(g) All turnouts and their components shall be designed to minimize electrical leakage from running rails to the ground.	(g) **Complied:** All turnouts and their components are designed to minimize electrical leakage from running rails to the ground

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	(h) Scissor crossover should be designed for Track centres not infringing SOD.	(h) **Complied:** Scissor crossover has been designed for Track centers of 5.030m and the same is not infringing SOD.
10.2	**Type and geometry of turnout** Detailed design of all turnouts, scissors, and crossover should comply the following geometrical parameters.	
(a)	**Standard Gauge**	
(i)	**1 in 9 turnout**	
	The design shall be tangential with a switch angle not exceeding 0°20'00''. It is desirable that the radius of lead rail of turnout is not less than 300m. Lead curve of 190 m radius may be laid as an exception. All clearances shall be in accordance with relevant provisions of SOD.	**Complied** The Design Switch entry angle in this project is 0^0 9' 15.6". The radius of lead rail of turnout is 300 m. All clearances are within the provisions of SOD.
(ii)	**1 in 7 turnout:** The design shall be tangential with a switch angle not exceeding 0°20'00''. It is desirable that the radius of lead rail of turnout is not less than 190m. Lead curve of 140 m radius may be laid as an exception. All clearances shall be in accordance with relevant provisions of SOD.	**Complied** The Design Switch entry angle in this project is 0^0 14' 36" for 1 in 7 turnout with 190 m Radius. All clearances are within the provisions of SOD.

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(iii)	**Scissors Crossover** The basic geometry of the turnouts of scissors crossover shall be same as that of corresponding ordinary turnouts as mentioned in clause 10.2 (i) (ii) above	**Complied** Turnouts of Scissor Crossover are 1 in 9 Radius 300 m.
	(b) Broad Gauge **(i) 1 in 12 turnout** The design shall be tangential with a switch entry angle not exceeding 00 20'00". The radius of lead rail of turnout shall not be less than 410m. All clearances shall be in accordance with relevant provisions of SOD. **(ii) 1 in 8.5 turnout** The design shall be tangential with a switch entry angle not exceeding 00 20'00". The radius of lead rail of turnout shall not be less than 218m. All clearances shall be in accordance with relevant provisions of SOD. **(iii) Scissors Crossover** The basic geometry of the turnouts of scissors crossover shall be same as that of corresponding ordinary turnouts as mentioned in clause 10.2 (iv) & (v) above.	**(b)** Not applicable for Main Line of Mumbai Metro Line 9 as entire section is Standard Gauge
10.3	**Operating requirement of turnout, scissor crossover:**	
	Track layout design shall permit trains to operate at maximum capability wherever possible. Turnouts and	Track layout design permits trains to operate at maximum capability wherever possible. Turnouts and crossover

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	crossover shall be selected such that they do not form a restriction to the operating speed on main line. Switches and crossings shall not be located on transition curves or vertical curves.	have been selected such that they do not form a restriction on the operating speed on the main line Switches and crossings are not located on transition curves or vertical curves
10.3.1	**Speed** The turnout shall be designed for the speed on mainline side equal to the speed as on mainline track. The minimum speed potential of the various turnouts and scissors crossover on the Turnout side should be as follows.	**Complied** The turnout has been designed for the speed on the mainline side equal to the speed as on mainline track.
10.3.1.1	Standard Gauge	
(i)	1 in 9 type turnout with 300 m radius (speed potential of 45Kmph)	**Complied** 1 in 9 ~~type~~ turnout with 300 m radius (speed potential of 45Kmph)
(ii)	1 in 7 / 1 in 9 type turnout with 190 m radius (speed potential of 35Kmph).	**Complied** 1 in 7 ~~type~~ turnout with 190 m radius (speed potential of 35 Kmph)
(iii)	1 in 7 type turnout with 140 m radius (speed potential of 25 Kmph)	Not provided in Mumbai Metro Line 9
(iv)	Scissors crossover 1 in 9 types with 300 m radius (speed potential of 45 Kmph).	**Complied** 1 in 9 ~~type~~ turnouts with 300 m radius (speed potential of 45 Kmph)
(v)	Scissors crossover 1 in 9/1 in 7 types with 190 m radius (speed potential of 35 Kmph)	Not provided in Mumbai Metro Line 9

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(vi)	Scissors crossover 1 in 7 types with 140 m radius (speed potential of 25 Kmph)	
(vii)	1 in 7 type symmetrical split turnout (speed potential of 45Kmph)	
10.3.1.2	**Broad Gauge**	
(i)	1 in 12 type turnouts (speed potential of 50Kmph)	Not applicable. Mumbai metro line 9 entire section is standard gauge.
(ii)	1 in 8.5 type turnout (speed potential of 30Kmph)	
(iii)	Scissors crossover 1 in 12 type (speed potential of 50Kmph)	
(iv)	Scissors crossover 1 in 8.5 type (speed potential of 30Kmph)	
(v)	1 in 8.5 type symmetrical split turnout (speed potential of 40Kmph)	
10.4	**Technical Specification**	
10.4.1	**General**	
(a)	All the points shall be capable of being operated by electric motors in accordance with the signaling specification.	**Complied** All the points are capable of being operated by electric motors in accordance with the signaling specification.
(b)	The top surfaces of PSC sleeper/RCC slab supporting rail seat of turnouts and scissors crossover shall be flat without any cant/slope	**Complied**

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		The top surfaces of RCC slab supporting rail seat of turnouts and scissors crossover provided with flat without any cant/slope
(c)	The track form of the turnout shall have uniform resilience as that of the adjoining track form.	**Complied** The track form of the turnout provided uniform resilience as that of the adjoining track form.
(d)	The fixation of turnouts, scissor cross-over on track slab shall be through base plates/bearing plates.	**Complied** The fixation of turnouts, scissor cross-over on track slab provided through base plates/bearing plates
10.4.2	**Rails**	
1.	The rails used in turnouts shall be 1080 grade Head Hardened. However, rails used in turnouts on depot and other non-running lines may be of 880 grade.	**Complied** The rails used in turnouts have 1080 grade Head Hardened.
2.	The rails used for manufacturing of turnouts shall satisfy the following conditions:	
a.	The rails shall be manufactured and tested in accordance with IRS/T-12-2009 with latest amendment	**Complied** The rails have been manufactured and tested in accordance with IRS-T-12-2009 (Reprint: October -2021 (covering up to ACS no 5 and Corrigendum no 1 of ACS no. 1 & 5)
b	The section of rails shall be 60E1 (UIC60) for stock, lead and 60E1A1 (ZU1-60) /60E1A4 for switch rail.	**Complied** The section of rails has been 60E1 (UIC60) for stock, lead and 60E1A1 (ZU1-60) /60E1A4 for switch rail.
c.	The rails shall qualify as Class 'A' rails as per IRS/T-12-2009.	**Complied** The rails are qualified as Class 'A' rails as per IRS-T-12-2009 (Reprint: October -2021 (covering up to ACS no 5 and Corrigendum no 1 of ACS no. 1 & 5)

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d.	The rails shall be with ends un-drilled.	**Complied** The rails provided with ends un-drilled
e.	The rails shall be grade 1080HH and be suitable for being welded by Alumino- thermic or flash butt welding technique.	**Complied** The rails have been of grade 1080HH and are suitable for being welded by Alumino - thermic and flash butt welding technique
10.4.3	**Switches**	
1.	Each switch device shall consist of two stock rails, one left hand and one right hand and two switch rails, one left hand and one right hand.	**Complied** Each switch device consists of two stock rails, one left hand and one right hand and two switch rails, one left hand and one right hand
2.	The switch rail shall be one piece with no weld or joint within the switch rail length.	**Complied** The switch rail is one piece with no weld or joint within the switch rail length.
3.	The end of the asymmetrical switch rail shall be forged to 60E1 rail profile with minimum length of 500 mm. The forged switch rail end shall be suitable for welding or installation of insulated rail joint	**Complied** The end of the asymmetrical switch rail is forged to 60E1 rail profile with a length of 500 mm. The forged switch rail end shall be suitable for welding.
4.	Slide chairs in the switch portion shall be coated with an appropriate special coating, so as to reduce the point operating force and to eliminate the requirement of lubrication of sliding surfaces during service	**Complied** Slide chairs in the switch portion is coated with an appropriate special coating, so as to reduce the point operating force and to eliminate the requirement of lubrication of sliding surfaces during service. Certificate of Conformity of special Ni-Cr coating as per EN code is now enclosed at **Appendix C1/8**.

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5	Switches shall provide suitable flange way clearance between the stock rail and the switch rail with the switch rail in open position (minimum 60mm). The 1 in 12 and 1 in 9 (with radius of 300 m) and flatter turnouts shall be provided with second drive or other suitable arrangement to ensure minimum gap of 60mm at JOH as well as proper housing of switch rail with stock rail up to JOH. 1 in 8.5, 1 in 9 turnout (with radius of 190m) and 1 in 7 and sharper turnouts may not be provided with second drive arrangement, however minimum gap of 60mm at JOH as well as proper housing of switch rail with stock rail up to JOH should be ensured. The normal opening of switch at toe of switch shall be kept as 160mm.	**Complied** Switches provide suitable flange way clearance between the stock rail and the switch rail with the switch rail in an open position (minimum 60mm). The 1 in 9 (with radius of 300 m) turnouts are provided with second drive to ensure a minimum gap of 60mm at JOH as well as proper housing of switch rail with stock rail up to JOH. 1 in 7 turnout (with radius of 190m) turnouts did not provide second drive arrangement, however minimum gap of 60mm at JOH as well as proper housing of switch rail with stock rail up to JOH **shall** be ensured. The normal opening of switch at toe of switch shall be kept as 160mm.
6.	The switch manufacturer shall include provision for all holes required to main drive machines, stretcher bars and detection equipment to suit the requirements of the signaling and switch operating system duly chamfered to avoid stress concentration at the edge of the holes	**Complied** The switch manufacturer are including provision for all holes required to main drive machines, stretcher bars and detection equipment to suit the requirements of the signaling and switch operating system duly chamfered to avoid stress concentration at the edge of the holes
7.	The switches shall be designed with an anti-creep device at the heel of switch to withstand thermal forces of the CWR track	**Complied** The switches are designed with an anti-creep device at the heel of switches to withstand thermal forces of the CWR track
8	The switches and all slide chairs shall be same for ballasted and ballastless turnouts.	**Complied** The switches and all slide chairs are the same for ballastless turnouts.
10.4.4	**Crossings**	

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1.	All crossings shall be cast manganese steel (CMS) crossings with weldable rails of minimum 1.2m length undrilled for welding into the overall turnout.	**Complied** All crossings are cast manganese steel (CMS) crossings with weldable rails of 1.2m length undrilled for welding into the overall turnout.
2.	The CMS crossings shall be manufactured from Austenitic Manganese steel as per UIC 866.	**Complied** The CMS crossings are manufactured from Austenitic Manganese steel as per UIC 866
3.	All CMS crossings shall have welded leg extensions of 60E1 rails. This shall be achieved by flash butt welding of buffer transition rail piece of suitable thickness to CMS crossings and rail leg extension.	**Complied** All CMS crossings have welded leg extensions of 60E1 rails. This has been achieved by flash butt welding of buffer transition rail piece of suitable thickness to CMS crossings and rail leg extension.
4.	All CMS crossings on main line shall have a minimum initial hardness of 340 BHN	**Complied** All CMS crossings on main line have a minimum initial hardness of 340 BHN
5.	All CMS crossings and their welded leg extensions for all scissor crossovers shall be suitably dimensioned so as to eliminate the necessity of providing small cut rail pieces for the purpose of inter-connection. However, the need for providing insulated glued joints from signalling requirement point of view shall be taken care of in the design, if required.	**Complied** All CMS crossings and their welded leg extensions for all scissor crossovers ae suitably dimensioned so as to eliminate the necessity of providing small cut rail pieces for the purpose of inter-connection.
6.	The provision of rail cant shall be taken care of on the top surface of the CMS crossing and the bottom surface of all CMS crossing shall be flat	**Complied** The provision of rail cant are taken care of on the top surface of the CMS crossing and the bottom surface of all CMS crossing are flat
10.4.5	**Check Rails**	

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1.	The check rail section shall be 33C1 (UIC33) or similar without any direct connection with running rails.	**Complied** The check rail section is 33C1 (UIC33) without any direct connection with running rails.
2.	Check rails shall have the facility for the adjustment of check rail clearances up-to 10mm over and above the initial designed clearance.	**Complied** Check rails have the facility for the adjustment of check rail clearances up to 10mm over and above the initial designed clearance with provision of shims.
3.	Each check rail end shall be flared by machining to have minimum clearance of 62mm at end	**Complied** Each check rail end is flared by machining to have minimum clearance of 80mm at end
4.	The check rail connections in turnouts shall be through specially designed bearing plates / brackets.	**Complied** The check rail connections in turnouts are through specially designed bearing plates.
5.	All the check rails shall be higher by 25mm above running rails. The lengths and positions of the check rail in diamond crossings shall provide safety and be compatible with the overall track layout	**Complied** All the check rails have been higher by 25mm above running rails. The lengths and positions of the check rail in diamond crossings provide safety and be compatible with the overall track layout
10.4.6	**Sleeper for Turnouts, Scissor crossover (Ballasted Track)**	
10.4.6.1	Sleeper shall be of pre-stressed concrete, mono-block, suitable for installation in track both with and without signalling circuits and with and without electrification.	

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10.4.6.2	Sleepers shall be designed to provide a minimum service life of fifty years under nominal axle load as that of main line for the Metro system. Rail seat pads and rail clip etc shall be designed to provide a minimum service life of 15 years	Not applicable to Main Line of Mumbai Metro Line 9. The Entire section is ballastless Track
10.4.6.3	The sleeper base surface shall be rough cast while the top and side surface shall be smooth to prevent retention of moisture and foreign materials.	
10.4.6.4	Sleepers must be suitable for installation by track laying machines and sleeper insertion equipment of a type used for isolated sleeper laying.	
10.4.6.5	The sleeper must be able to transfer all the relevant track forces generated by train operations and the forces of rail expansion and contraction to the ballast.	
10.4.6.6	Design Requirements for PSC Sleepers	
A) (i) (ii)	The sleepers should satisfy the following design requirement: **Design Parameters** Rail sleeper fastening – Elastic resilient type Spacing of sleepers – 600mm (max) for main line and 650 mm (max) for Depots and other non-running lines, except at few locations such as near point machine locations where it may be varied to meet the design requirements.	Not applicable to Main Line of Mumbai Metro Line 9. The Entire section is ballastless Track

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(iii) (iv)	Ballast cushion – 300 mm for mainline and 250mm for Depots and sidings. Ballast profile suitable for LWR/CWR.	
	Specifications and Drawings (With latest amendment)	
(i) (ii) (iii) (iv) (v) (vi)	Special Cement for PSC sleeper 53-S grade OPC to BIS specification IS 269:2015 HTS wire plain and strand – BIS – 1785 (Pt-1) 1983 and BIS 6006 Polyethylene dowels – Drg. No. RDSO/T 3002 IRS Specification for polyethylene dowels for concrete Sleepers Serial no T- 57 2020 IRS Specification for Turnout sleeper T-45:2021 IRS Bridge code 1982 Code of Practice for Pre-stressed Concrete IS-1343	Not applicable to Main Line of Mumbai Metro Line 9. The Entire section is ballastless Track
(B)	**The design should satisfy the following additional requirements-**	

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(i)	The connections of the slide chairs and bearing plates/special bearing plates/brackets shall be designed for easy installation and maintenance. All the fittings shall be suitably designed to ensure full compatibility & also to ensure interchangeability of slide chairs between ballasted and ballastless turnouts.	Not applicable to Main Line of Mumbai Metro Line 9. The Entire section is ballastless Track
(ii)	For attaining suitable cant of the rail, as provided on mainline, (excluding crossing and switch portion), suitably designed pads of appropriate material shall be provided between rail pad & PSC sleeper. Also fastening system should be designed to get the desired Toe Load.	Not applicable to Main Line of Mumbai Metro Line 9. The Entire section is ballastless Track
(iii)	The detailed design of Monoblock PSC sleepers for the turnouts along with structural drawings shall be checked and approved by metro railways	Not applicable to Main Line of Mumbai Metro Line 9. The Entire section is ballastless Track

11.	**Switch Expansion Joint.**	
1.	The SEJ for ballasted track shall be laid on PSC sleepers whereas the SEJs for ballastless track, if required, shall be laid on reinforced concrete slab.	As per Rail Structure interaction Analysis, No Switch Expansion joints are required for Main Line of Mumbai Metro Line 9. RSI report is enclosed at **Appendix C1/1.**
2	The rail section for all SEJs shall be UIC 60, 1080 HH grade as per IRS-T-12-2009.	
3	The SEJ for ballasted track shall be designed for a maximum gap of 80 mm.	

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4	The SEJ for ballastless track should be designed for the maximum gap required as per design.	
5	The ballasted SEJ shall be as per RDSO drawing T-6902 &T-6922.	
6	The ballasted SEJ for BG shall be laid with PSC sleepers as per RDSO drawing T-4149. For Standard Gauge, PSC sleeper shall be designed such that SEJ to RDSO drawing along with its bearing plates/chairs may be accommodated for installation of SEJ.	
7	Sleepers used for SEJs shall be flat and cant will be provided through CI chair.	
8	The SEJ shall be suitable for two way directional traffic.	
12.	**Fastening system for ballastless track:** Provisions contained separately in "PERFORMANCE CRITERIA OF FASTENING SYSTEM FOR BALLASTLESS TRACK ON METRO RAILWAYS/MRTS SYSTEM" (Annexure C-2) be referred to.	**Complied.** **Straight & Curved Track Radius greater than 700 m .** The adopted Fastening system is Re-engineered two hole "Pandrol Double Resilient Baseplate Assembly" fastening system Drg.No 21166, which has been provisionally approved by Railway board vide letter no. 2021/Proj/DMRC/FS-BLT/30/40 New Delhi, dated 15.03.2021. **On Curved Track Radius less than 700 m.** The adopted Fastening system is Pandrol Double Resilient Baseplate Assembly 13145 Fastening system has been

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		approved by Railway board vide letter no. 2003/Proj/Bangalore/2/2 (Pt) dt. 07/10/2011. The adopted Fastening system for Turnouts is System 336 of M/s Vossloh. Fastening system has been approved by Railway board vide letter no. 98/Proj./DLI/30/1(Vol III) dated 24.01.2013.
13.	**Noise and Vibration** Metro system shall be designed to ensure that noise emitted is well within the prescribed limits for the particular area. Each Metro system shall specify the prescribed limits of permissible Noise and vibration parameters as per legal and statutory requirement of India.	**Complied** Mumbai Metro Line 9 system has been designed to ensure that the noise emitted is within the Statutory requirement for noise as per RDSO 'Guidelines for Noise and Vibrations, September 2015' (CT-38) Clause 3.2.5 (Table:3.6 enclosed as Appendix C1/9) as well as Govt. of Maharashtra (Ministry of UDD) Circular No. TPB 4312/208/CR-20/2013/UD-11 dtd.26.10.2015 enclosed as Appendix C1/10) and the same shall be followed by MMRDA.
14	**GRADIENTS**	
14.1	The maximum grade (compensated) shall be 4%.	**Complied.** Maximum grade (compensated) is 3.868%
Note: **(i)**	There will be no change of gradient in transition portion of curves.	**Complied.** There are no change of gradient in transition portion of curves.
(ii)	The gradient will be compensated for curvature at the rate of 0.04% per degree of curve.	**Complied.** The gradient compensated for curvature at the rate of 0.04% per degree of curve.
14.2	Maximum permissible gradient on turnouts	
(i)	On Ballasted Track 0.25%	Not applicable for Main Line of Mumbai Metro Line 9. The Entire section is ballastless Track

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Director (Work)
Metro-PIU
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(ii)	On Ballastless Track 3.0%	**Complied.** Maximum gradient is 2.727 %
Note: (i)	There shall be no change of gradient (i.e. vertical curve) on and within 15.0 m (desirable)/ 3.0 m (minimum) of any turnout on Ballastless track. In case of Ballasted track, there shall be no change of gradient on and within 30 meters of any turnout.	**Complied.** There is no change of gradient (i.e. vertical curve) on and within 15.0 m
(ii)	There shall be no horizontal curve within 15.0m (desirable)/ 3.0 m (minimum) of any turnout on Ballastless Track and 30 meters of any Turnout on Ballasted Track	**Complied.** There is no horizontal curve within 15.0 m
(iii)	Turnout shall normally be installed on straight track. In exceptional situations, turnout may take off from curve provided that the radius of lead curve (main line as well as diverging line) is not less than 190m. The negotiability of rolling stocks on such turnout must be certified by rolling stock supplier and confirmed through oscillation trial and a suitable speed restriction should be imposed on main and/or diverging line based on track geometry and other considerations, if required. In case of turnout installed on curved track, the minimum distance for commencement of vertical curve or another horizontal curve shall be 15m for Ballastless track. Turnout shall not be laid on the transition curve.	**Complied.** All Turnouts are installed on straight track.
(iv)	The limit of turnout for the above purposes shall be taken from Stock Rail Joint (SRJ) to end (i.e. heel) of crossing for Ballastless track. For Ballasted	The limit of turnout for the above purposes has been taken from Stock Rail Joint (SRJ) to end (i.e. heel) of crossing for Mumbai Metro Line 9. Details were enclosed in Appendix C1/9. However the details are also tabulated below.

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<table>
<tr><td></td><td>track, it shall be from SRJ to last common sleeper behind end of crossing.</td><td>
<table>
<tr><th rowspan="2">Sr. No.</th><th rowspan="2">SRJ Chainage</th><th rowspan="2">UP/DN</th><th colspan="2">Distance in Metres Between</th></tr>
<tr><th>Horizontal Curve SRJ/HOC</th><th>Vertical Curve SRJ/HOC</th></tr>
<tr><td>1</td><td>15+329.190</td><td>UP</td><td>26.724</td><td>114.500</td></tr>
<tr><td>2</td><td>15+411.083</td><td>DN</td><td>72.813</td><td>106.354</td></tr>
<tr><td>3</td><td>15+424.391</td><td>DN</td><td>120.167</td><td>59.010</td></tr>
<tr><td>4</td><td>15+984.362</td><td>DN</td><td>300.073</td><td>139.156</td></tr>
<tr><td>5</td><td>15+997.950</td><td>DN</td><td>252.442</td><td>91.487</td></tr>
<tr><td>6</td><td>16+075.324</td><td>UP</td><td>207.707</td><td>49.563</td></tr>
<tr><td>7</td><td>18+830.689</td><td>DN</td><td>22.096</td><td>63.213</td></tr>
<tr><td>8</td><td>18+895.051</td><td>UP</td><td>19.537</td><td>97.265</td></tr>
<tr><td>9</td><td>23+321.292</td><td>UP</td><td>225.977</td><td>60.640</td></tr>
<tr><td>10</td><td>23+311.979</td><td>DN</td><td>225.108</td><td>15.007</td></tr>
<tr><td>11</td><td>23+401.500</td><td>DN</td><td>271.924</td><td>15.007</td></tr>
<tr><td>12</td><td>23+392.187</td><td>UP</td><td>271.055</td><td>60.640</td></tr>
</table>
</td></tr>
<tr><td>(v)</td><td>The maximum permissible gradient on turnout and the location of turnout with respect to vertical/ horizontal curves in vicinity shall be confirmed from rolling stock supplier for the negotiability of rolling stock.</td><td>Maximum Permissible gradient on turnouts is 3.0% (Approved SOD vide letter No- 2018/Proj./MMRDA/SoD/30/27, Dated 21.02.2020, clause no 1.3.2.(ii)). In Mumbai Metro Line 9, maximum Gradient provided is 2.727% (From Chainage 18+743.365 to 19+025.943) at Crossover Between Mairagaon Station to Kashigaon Station. Hence the same is complied.</td></tr>
<tr><td>(vi)</td><td>The above stipulations shall also be applicable for turnout to be laid outside station limit, if any.</td><td>Complied</td></tr>
<tr><td>14.3</td><td>TRACK GRADIENT IN PLATFORM</td><td></td></tr>
</table>

SYSTRA-CEG SMC/RT CONSORTIUM MUMBAI

Project Directorate Approved on 19/12/2025 Railway Board

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(a)	Desirable : Level	All Station are level.
(b)	Maximum Gradient: 1 in 1200	
(c)	Exceptional Gradient: 1 in 400	
Note	Any gradient steeper than 1 in 1200 and upto Exceptional gradient of 1 in 400 shall be proposed by Civil Engineering Head and approved by Managing Director in consultation with Head of Safety nominated by Metro Rail Authority. (ii) There shall be no change of gradient in platform track	

Project Directorate
Approved on
14/8/2024
Railway Board

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Chief Engineer (Civil) - PIU
Mumbai Metropolitan Region Development Authority,
Bandra (East), Mumbai - 400 051.

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Part B: Salient features of Track Structure as adopted by Main Line of Mumbai Metro Line 9

i) Track

S. No.	Components / Items	Provisions / Reference
1.	Gauge	Standard Gauge - 1435mm (Approved SOD vide letter No- 2018/Proj./MMRDA/SoD/30/27, Dated 21.02.2020. Introduction, Page no 1)
2.	Axle Load	17 T
3.	Design Speed	Design speed 95kmph (Max)
4.	Rail Section and Grade	60E1(UIC60) (Grade 1080 Head Hardened (HH))
5.	Rail Specifications	(IRS-T-12-2009 (Reprint: October -2021 (covering up to ACS no 5 and Corrigendum no 1 of ACS no. 1 & 5) .
6.	Ballasted or Ballastless	Viaduct Mainline – Ballastless (BLT)
7.	Rail inclination (Canting of Track)	1 in 20
8.	Check Rails provision	On main line in curves with radius 190 m and sharper.
9.	Provision of Derailment upstand/Guard	Derailment guards have been provided on elevated sections on inside of plinth for plain line track and outside of slab for turnouts.
10.	Horizontal Clearance of Derailment upstand	The clearance between rail and derailment guard provided is 210 ± 30 mm for fastening system PDRBA 21166 and 250 ± 20 mm for fastening system PDRBA 13145 respectively.

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		For Turnout Fastening adopted is System 336 and the lateral clearance of 210 ± 30 mm between the running rail and derailment guard is provided.
11.	Vertical location of Derailment upstand w.r.t. Rail plane	Not lower than 25mm from the top of rail level.
12.	Glued insulated Rail Joint provided? If Yes , type of GIRL	Insulated glued joint is not required in this project as the CBTC moving block signaling system adopted.
13.	Welding Of Rail (LWR /CWR)	CWR
14.	Whether SEJ provided? If Yes Type of SEJ	No
15.	Type of welding	FBW (Flash Butt) and ATW (Alumino Thermic)

ii) Turnouts & Switches:

S.N.	Components / Items	1	2
1	Type of turnout, scissors crossovers (crossing angle)	1 in 9	1 in 7
2	Canted or uncanted	Canted 1 in 20	Canted 1 in 20
3	Radius	300m	190m
4	Length of switch	14.390 m	11.462m
5	Type of Switch (Thick web or otherwise)	Thick web	Thick web
6	Switch entry angle	0° 9' 15.6"	0° 14' 36"
7	Speed potential	45 Kmph	35 Kmph
8	Location of Use (Main line or Depot)	Mainline	Mainline
9	Rail Section used for switch	60E1, IRS-T-12-2009, 1080 grade HH for stock rail &	60E1, IRS-T-12-2009, 1080 grade

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		60E1A1 for switch/tongue rail.	HH for stock rail & 60E1A1 for switch/tongue rail.
10	Second drive provided	Provided	No

iii) Crossing:

S.N.	Components / Items	Provisions / Reference
1.	Crossing: Curved or straight	Crossing of turnout 1 in 9 R300m and turnout 1 in 7 R190m are in curve
2.	Crossing: Canted or uncanted	Canted
3.	Length of Weldable leg extension	1.2 m minimum
4.	Check Rail section	UIC 33 (33 C1)
5.	Height of Check rail above the rail plane	25 mm
6.	Check Rail clearance at the middle	36-42mm
7.	Check Rail clearance at the end	80mm

Part - C: Check List of submissions while submitting compliance:

1.	Compliance of Part-A	Complied
2.	Design of subgrade/embankment for slab (Para 6.xii)	Not applicable in Main line
3.	Design calculations of track slab /plinth beam along with detailed structural drawings as approved by metro authorities. (Para 6)	Complied, Enclosed in **Appendix C1/5 and C1/6**
4.	Design calculations/ studies with regard to clearance of Check rails / Restraining Rails. (Para 7.1)	Compiled Enclosed in **Appendix-C1/7**
5.	Design calculations of derailment guards along with detailed structural drawings shall be furnished for record. (Para 8)	Compiled, Enclosed in **Appendix -C1/5 and C1/6**

SYSTRA-CEG SMCIPL CONSORTIUM MUMBAI

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