

*Preparation of Detailed Project Report
for Development of Multimodal Logistics Park at Jogighopa
and External Trunk Connectivity Infrastructure to the
Multimodal Logistic Park Site at Jogighopa*

FINAL DPR FOR EXTERNAL ROADS & RAIL CONNECTIVITY

STAGE VI - VOLUME 2E

REPORT FOR EXTERNAL RAIL TRUNK INFRASTRUCTURE

March, 2020

Report

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FINAL DPR FOR EXTERNAL RAIL CONNECTIVITY

Preparation of Detailed Project Report for Development of Multimodal Logistics Park at Jogighopa and External Trunk Connectivity Infrastructure to the Multimodal Logistics Park site at Jogighopa

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PREFACE

Bharatmala Pariyojana, a centrally-sponsored project of the Government of India to build highways, connecting the border, also envisages to develop 28 Multimodal Logistics Park across the country and one Multimodal Waterway Ports in the North Eastern states in order to improve Logistics efficiency and to facilitate Domestic and EXIM trade. Of these one of the state-of-the-art Multimodal Logistics Parks is proposed to be developed at Jogighopa.

In order to develop a MMLP, it is imperative to understand the Logistic Scenario of the region so that the new development is in sync with the market conditions and investment climate. A detailed Market assessment of the region was undertaken and to understand the potentials and gaps in the existing logistic industry. Based on which, the current market size and future demand for the region as well as for the MMLP was estimated. Along with market study the trunk infrastructure gap assessment for the site and its surrounding was carried out. These analyses were submitted in the form of Trunk infrastructure gap assessment and draft market overview report (Stage 2). After the assessment of the market conditions and study of Jogighopa regional and site-specific location analysis, a Master Plan for the Multimodal Logistics Park at Jogighopa had been conceptualised with three concept plans (Stage 3). After consultation with the various stakeholders at both Central and State level, one option was selected and further developed for the Final Master Plan Report (Stage4) with the broad cost estimates. On the Final Master Plan, a Draft Feasibility Study and Draft Detailed Project Report for External Rail and Trunk Connectivity Infrastructure (Stage 5) was prepared. Currently, Stage 6 - Final Feasibility Report and Final Detailed Project Report for External Rail and Trunk Connectivity Infrastructure is being submitted, the deliverables are divided in 7 volumes viz.

Volume 1: Final Technical Feasibility Report

This report focuses on the technical feasibility aspects of the project, such as site, infrastructure and developments. The report summarises the proposed components and cost attached in developing the MMLP project, to determine the technical feasibility of the project.

Volume 2: Final Detailed Project Report for External Road and Rail Connectivity

This report provides the details design and BOQ for the proposed External road and rail infrastructure connecting the MMLP site. The volume is sub-divided into 5 sub volumes (2A –2D Report for External Road Trunk Infrastructure & 2E: Report for External Rail Connectivity.)

Volume 3: Detailed Economic Analysis and Financial Feasibility

This report discusses the economic and financial aspects of the project, viz. Operating costs, Economic analysis and benefits, Risk assessment study and the project Implementation structure. The report also analyses the revenue for the MMLP in order to estimate the expected IRR and recommends a structure for the project and the SPV along with their associated functions for effective functioning of the project. The volume is sub-divided into 4 sub volumes: 3A – Economic Analysis and Financial Feasibility Report, 3B – Request for Qualification, 3C – Request for Proposal & D – Draft Concession Agreement.

Volume 4: Environmental and Social Study Report

This volume focuses on the environmental impacts of the project, social impacts and the related measures such as Resettlement Action Plan (RAP).

Volume 5: Bid Documents for Package I – Road and Utility Works

This volume provides Bid Documents for “Development of External Trunk Connectivity and Internal Infrastructure Works at Multi Model Logistics Park at Jogighopa in the State of Assam on Engineering, Procurement & Construction (EPC) Mode”. The volume includes Notice Inviting Tender, Request for Proposal, Schedule, and Drawings & Draft Concession Agreement.

Volume 6: Bid Documents for Package II – Building and Infrastructure Works

This volume provides Bid Documents for “Development of Internal Infrastructure Works at Multi Model Logistic park at Jogighopa in the state of Assam on Engineering, Procurement & Construction (EPC) Mode”. The volume includes Notice Inviting Tender, Request for Proposal, Schedule including drawings & Draft Concession Agreement.

Volume 7: Bid Documents for Package III – Rail Works

This volume provides Request for Proposal for “Earthwork in Formation, Road Work, Construction of Bridges, and Blanketing. Way Linking works including Supply of P. Way Fittings and Track Ballasting connection with Construction of Railway Siding from Jogighopa Railway Station to MMLP at Jogighopa, Distt. - Bongaigaon, Assam from Ch. 00 to 3760”.

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1. Trunk Rail Connectivity

1.1 INTRODUCTION

Development of a Multimodal Logistics Park under the Bharatmala Pariyojana. Bharatmala Pariyojana is a centrally sponsored and funded Road and Highways Project of the Government of India. Development of Multimodal Logistics Park is proposed to improve the Logistics efficiency of the country, enabling reduction in logistics cost. Logistics parks act as hubs for freight movement enabling freight aggregation and distribution. Freight from production Zones will be shipped to nearby logistic parks, where it will be aggregated and shipped to a logistic park near the consumption zone on a larger sized vehicle. Logistic parks with Rail & Road connectivity enable multimodal freight transportation. This aids freight transportation on long haul (between hubs) to shift from Road to Rail, thereby reducing the freight cost. Under the above mandate of Bharatmala Pariyojana Jogighopa has been selected as one of the locations for development of Multi Modal Logistic in the North-East region with the support of Government of Assam. In order to develop MMLP in the region, the Government of Assam has provided 200 acres of land to NHIDCL. Accordingly, it has been proposed by MORTH to create world class Logistics facility at Jogighopa under Bharatmala Pariyojana& to connect the same with Railway network through a dedicated Siding.

In line with Ministry of Railways initiative of opening the area of Terminal development for Logistics services for Private Participation & development of World Class logistics facilities, it is also proposed to create facilities of Private Freight Terminal (PFT) to facilitate Third Party cargo booking also. This Railway Policy aims to stimulate development of privately owned freight terminals for dealing with Railway Freight Traffic including Parcel traffic & containers.

1.2 PROJECT LOCATION

The said MMLP with PFT facility& a dedicated siding is proposed at Jogighopa, within revenue District of Goalpara in an area of 200 Acre in the State of Assam. The proposed MMLP site is situated at a distance of approx. 3 Km from Jogighopa Station on Guwahati– Bongaigaon Single Line Non-Electrified section of Rangy Division of North East -Frontier Railway.

Land for MMLP & Siding has been identified. The site is close to NH 17& its connectivity with MMLP through a feeder road, is also part of proposed MMLP.

1.3 RAILWAY CONNECTIVITY

Proposed site of MMLP is located near Jogighopa Railway Station in the state of Assam at Jogighopa near to Guwahati – Bongaigaon Single Line Rail Section of North East Frontier Railway.

This Rail sections well connected to various parts of Assam and other parts of India through a Broad-Gauge Rail Network. This Rail Section is approved for doubling also and thereafter the sectional capacity will increase many folds and will be able to cater for additional traffic generated due to MMLP in future.

1.4 OBJECTIVE OF FEASIBILITY STUDY

The objective of study was to investigate the technical feasibility of the Railway siding proposed for MMLP & to establish a reliable cost estimate. The main aim of the study is to,

- Conceptualize the rail infrastructure and its connectivity with the existing Railway network.
- Develop engineering drawing for proposed Rail connectivity and interrelated modifications in operating system.
- To notify Stake holder.
- Cost assessment

1.5 APPROACH AND METHODOLOGY

- Table study conducted with help of Google Images to establish various feasibility options.
- Team of Infrastructure experts were mobilized to carry out study of the Project in a coordinated manner.
- Team carried out reconnaissance field survey for physical verification of existing siding to assess the siding & structures condition and picked up required details for revival of the siding.
- Based on field survey& input data collected from site most technically feasible connecting point for the proposed siding selected & concept plan developed.

1.6 EVALUATION CRITERION

- Suitability of serving Station
- Technical feasibility (Horizontal & Vertical Geometry)
- Land Acquisition Hurdles
- Resettlement Hurdles
- Environmental Hurdles
- Cost

1.7 ALIGNMENT STUDY

MMLP site is adjacent to Ashok Paper Mill, for which a siding is existing but defunct due to non-operation of Paper Mill since long. The length of siding is approx. 3.5 Km

The most cost-effective option would be to revive this existing Ashok Paper Mill Siding, serving through Jogighopa station. This Railway Station is situated at Km 31.33 on Guwahati – New Bongaigaon Non-Electrified Section of North East Frontier Railway. The station is equipped with Panel Interlocking and MACL signals. It is a 'B' Class Standard III interlocked station equipped with MACL signals. There is no DFC alignment planned in Assam area, hence connection with DFC is ruled out.

1.8 ALIGNMENT SELECTION

1.8.1 Survey

Detailed topographic survey of the area was carried out to identify structures / obstructions & other important details / features for formulation of the scheme, including existing siding alignment & Jogighopa yard.

Detailed condition survey of existing siding line was also done to assess the inputs required for revival of the existing siding.

1.8.2 PROPOSED SIDING ALIGNMENT

- Since existing defunct Railway siding of Ashok Paper Mill is proposed to be revived for MMLP, hence no alternative alignment was studied. A Railway siding, which was serving Ashok Paper Mill, still exists at site but disconnected from Railway network due to non-operation of Paper Mill for a long time. This siding was taking off from Jogighopa station at New Bongaigaon end. The connecting Turnout has been dismantled & therefore there is no connection with Jogighopa station at present. Since the proposal is for revival of old defunct siding, therefore alignment of siding up to Ashok Paper Mill will remain the same up to Chainage 2300 & there after it traverse through Green Field alignment till the Dead End of IWT area at Chainage 7345.37m.
- From 0 Chainage to 300 it runs parallel to N.F. Railway main line & there after deflects to left almost 180 degree and traverses through curves as shown in alignment plan placed below. There are total 8 curves of different radius. The minimum Radius of curvature is 255m (6.8 Degree) & is well within the prescribed standards of Indian Railway.
- The maximum grade of siding is 0.297% (1 in 337). Receipt & Dispatch yards of MMLP & IWT area have been designed at Level as per Railway standards.
- The siding is proposed to connect with Dead End of Line No. 1 (Bongaigaon end) of Jogighopa Railway station.

- The existing alignment up to Ch. 2300 can only be used & there after it deflects to Ashok Paper Mill. From Ch. 2300 onwards up to Ch. 7345 it will be new Green field alignment passing through MMLP.
- The entire siding planning has been done in such a way so as to cause minimum social impact.
- Concept siding Layout Plan is placed below & detailed Plan & Section are also attached as Annexure.



Description	Remark
Serving Station	Jogighopa
Single / Double Line	Single
Route Length (KM)	7.345 Km
Track Length	11.0 Km
Ruling Gradient	1 in 150
Proposed steepest Grade	0.297% (1 in 337)
Number of Curves	8
Sharpest Radius	255m (6.8 ⁰)
Number of Bridges	7
VUP / LHS	3
Bridge	2
ROB	1
ROR	1
Level Crossings (Nos)	1 (Manned)
Track Structure	
Rails	52 Kg T-12, IU Rails
Sleepers	PSC 52 Kg
Sleeper Density	1540 / Km
Turnout	1 : 8.5 (CS)

1.9 EXISTING SIDING CONDITION SURVEY

1.9.1 General condition

Due to non-operation of siding for a long-time soft encroachment have taken place on and along the Railway siding as shown in photograph below & therefore complete overhauling of track & Embankment would be necessary before its operation. All encroachments shall have to be removed before revival of the siding. These Social& Resettlement issues have been deliberated under separate chapter on resettlement.



1.9.2 Embankment condition

The existing Embankment up to MMLP area in major portion is damaged and would require repair. To restore embankment to the required profile 25000 Cum of earthwork would be required.



1.9.3 Existing Track condition

The existing Siding Track is laid with 90 R Rails /CST-9 Sleepers / M+4 densities with no ballast cushion. This will require replacement as per current standards & provision of Ballast cushion.

1.10 JUNCTION ARRANGEMENTS AT SERVING STATION

- Jogighopa station yard is equipped with one Main line and three loop lines. Each Loop line serves as Common loop and consists of one full train length of CSR 730 m. Jogighopa is equipped with Panel Interlocking. It is a 'B' Class Standard III interlocked station equipped with MACL signals on Single line. The Siding is proposed to be connected to Dead End of Line Number 1 at New Bongaigaon end. A Trap will be inserted at a distance of 180 m to isolate the siding from running Track.
- With above mentioned junction arrangement, it would be possible to directly receive / Dispatch trains to / from proposed MMLP siding.
- Jogighopa is located on Single line section of Guwahati –Bongaigaon section, which is already sanctioned for doubling & likely to be completed by 2021.
- The entire connectivity has been planned to cause minimum disturbance to the existing Railway facilities.

1.11 TRAFFIC PROJECTION

As per cargo movement pattern Total Projected Rail based cargo between NER & rest of India is estimated to be around 4.8 MMT / per Annum. If we consider 25 % of it through MMLP, then the total traffic will be around 1.2 MMT / Per Annum. in initial stage.

1.11.1 TRAIN PROJECTION

Based on the above and keeping in view the chargeable weight and composition of each train the number of rakes likely to be placed per month / day worked out are as under.

Sl. No.	Description	Total
	Projected Traffic per Annum	1200000 Ton
1	Carrying Capacity of BCN Wagon	54.08 Ton
2	Pay Load Per Standard Rake of 40 Wagons	2163 Ton
3	Average Number of Trains per Month	46.23 Rake
4	Peak Rake per Month (20% extra)	55.47 Rake
5	Maximum No. of Trains per Day	1.8 Rake Say 2 Rake

1.12 PROPOSED FACILITIES IN RAIL TERMINAL

- Adequate facilities in MMLP internal yard have been proposed to cater for bulk / break bulk / Container cargo, with adequate loading and unloading facilities at the container Terminal and Domestic Rail head.
- For the projected movement of 2 rakes a day MMLP yard is proposed with 3 lines, one loading, one unloading and one engine escape line initially, with provision of 2 more lines in future. In IWT yard provision of two lines have been planned one for loading / Unloading & one for Engine scape line.
- Full Rake Length Rail Level Platform on one side of Loading / Unloading line is proposed to facilitate full rake loading / unloading without disturbing Train composition. With such an arrangement it would be possible to Load / Unload the Rake within the free time allowed as per Railway norms.
- An additional sick line of 60m CSL is also proposed for placement & repairs of sick wagons.
- Proposed Railway Siding track will facilitate full train length handling inside terminal for Loading / Un-loading of freight traffic or containers. Therefore, no operational restriction on existing movement of Rail traffic or to siding traffic is expected.

1.13 SYSTEM OF OPERATION

All inward trains will be received at Jogighopa station on line 1& will be dispatched to MMLP yard & vice versa Rake after loading will be dispatched to Line 1 of Jogighopa station for onward journey. Movement of trains to & From MMLP will be controlled through Shunt Signals as per Station working Rules framed by Railway. The CSR of MMLP yard lines & IWT yard lines will be 730m to avoid any shunting operation either in Jogighopa Station or MMLP yard.

1.14 DESIGN STANDARD

- The Permanent Works shall be designed and constructed such that, they shall endure in a serviceable condition throughout their minimum design lives and standards contained in the technical specifications to minimize the cost of operation and maintenance whilst not compromising safety or the performance characteristics of the railway.
- The Permanent Works shall be designed to permit the railway to operate satisfactorily at a maximum design speed of 60Km/h for freight trains. All the bridges, culverts and the entire embankment and cutting would be constructed for an axle load of 25 ton.

- The Civil, Structures, Track and Building Works shall comply with Indian standards and IR regulations and standards

1.14.1 TECHNICAL PARAMETERS

All works for the siding shall be as per Railway's approved designs & drawings & constructed as per Railway's approved standard & specifications. The main characteristics and Technical Parameters for Design & construction are shown in table below,

S.No.	Parameters	Design Criteria
1.	Category of Line	Siding
2.	Track Gauge	Broad Gauge (BG)
3.	Number of Track	Single Track
4.	Type of Traction	Non-Electrified
5.	Ruling Gradient	1 in 150
6.	Type of Signaling	
	a. Receipt & Dispatch of Trains	As existing at serving station
	b. Internal yard	Manual
7.	Average Pay Load / Train	2165 MT
8.	Max Axel Load	25 MT
9.	Design Speed	30 Kmph
10.	No. of Loop Line in MMLPyard	Initially - 3 Nos (Each of CSR 730m) In Future - 5 Nos (Each of CSR 730m)
11.	No. of Loop Line in IWT yard	Initially - 2 Nos (Each of CSR 730m) In Future - 3 Nos (Each of CSR 730m)

1.14.2 LAND

Since Defunct siding of Ashok Paper Mill is being revived, hence there will be no additional requirement of land up to Ch. 3700. However, for connectivity to IWT Approx. 12.05 Acre land (assuming 20m corridor) will have to be acquired from Ch. 3900 to Ch. 6341. Land required for siding connectivity at Jogighopa station will be taken on lease from Railway & lease rent for the same would be payable to Railway as per extent rules.

1.14.3 FORMATION

Formation width of 6.85m for single line BG track shall be adopted with 2:1 slope. A Blanket Layer of 200 mm shall be provided on top of formation.

1.14.4 FIXED STRUCTURES

Fixed structures will be designed to suit the moving dimensions as specified in B.G. Schedule of dimensions of Indian Railway. Structure and track for the project siding shall be designed to cater for the clearances required for 25 KV A.C. Electrification.

1.14.5 TRACK DESIGN

- The nominal track gauge shall be 1676 mm measured at 14 mm below the top of the rail.
- The track layout shall be based on the provisions contained in Indian Railways Permanent Way Manual, Track Manual & relevant IRS specifications with latest amendments/corrections or any other alternative specification.
- Horizontal curve shall be circular with transition curves at either end of such circular curves.
- All circular curves including their transitions shall be designed for a speed of 60 kmph.
- The maximum actual cant shall be limited to 165mm & maximum cant deficiency shall be limited 75mm.
- All curves on mainlines shall be provided with transition curves and shall be in a shape of cubic parabola conforming to the equation $y = x^3 / 6RL$.
- The minimum length of the transition shall be the maximum length obtained from the following equation:

$$\begin{aligned} L &= 0.008 \cdot Ca \cdot V \\ &= 0.008 \cdot Cd \cdot V \\ &= 0.72Ca \end{aligned}$$

Where, Ca & Cd = Value of actual cant & Cant deficiency respectively in mm

V = Maximum permissible speed in km/h

- The ruling gradient of the section on the Siding line shall be 0.67.0% (1 in 150) compensated. The alignment shall be so designed to avoid frequent changes of gradient as far as possible. The gradients shall be compensated for curves @ 0.04% per degree of curve and the maximum gradient shall not be steeper than the ruling gradient of the section.
- All the rails to be laid in the track structure shall be Flat Bottom Rails as per specifications IRS T12-2009 & Rail Section Profile as per Appendix-II of IRS T12-2009 for 52kg/m. The Rail Steel Grade shall be 72 UTS
- The siding track will consist of 52 Kg/m T12 I U Rails / SH along with new 60 Kg Pre-Stressed Concrete Sleepers, 1540 per Km including that for Loop lines on 250 mm Ballast cushion. Rails shall be welded into 3 rail panels wherever possible

- All Point and crossings for siding shall be of 52 Kg curved switches on PSC sleeper layouts, 1 in 8.5 for Siding & 1 in 12 for Main line.

1.14.6 BRIDGE DESIGN

- Bridges to be designed and constructed shall allow simultaneous, unhindered and safe movement of traffic over the Siding and over/under roads, railway or flow of water in canals/nallahs/watercourses.
- The bridge loading for the Design shall be 25 Ton axle load with corresponding locomotives and wagons as per IRS Bridge Rules. Where a bridge is to be constructed for IR tracks, the applicable loading shall be as per the requirements of IR.
- Back fill arrangement behind abutments shall be as per relevant RDSO guidelines

1.15 SPECIFICATION

The Technical Specifications for the Works shall comply with Standards and Design Codes, Manuals which are in accordance with Indian Railway specifications attached as Annexure.

1.16 ROAD CROSSING

Existing siding alignment is crossing Roads at 3 locations. One at Ch. 32, where siding is parallel to IR track. At this location Manned LC is existing & same is proposed to be extended as the same falls within station limits of Jogighopa station. At other two Road crossings at Ch. 800 & 1391, LHS (Limited Height Subway) are proposed to be provided as per Railway norm. On green field alignment one LHS is also proposed at Ch. 5616 to provide easement rights to villagers & other ROB at Ch. 6341 for crossing NH.

1.16.1 RAIL CROSSING

Green field alignment between MMLP & IWT is crossing N.F. Railway track at Ch. 6236. At this location siding track will be at RL 39, whereas Rail is crossing at RL 48.771 & therefore it is feasible to provide ROR at this location.

1.17 LOADING / UNLOADING PLATFORM

Loading and Unloading Platform of 650m length, & 30m wide is proposed adjacent to one loop line to facilitate Loading / Unloading activities. One more Platform adjacent to future line will be added when traffic increases in future.

1.18 IN-MOTION WEIGH BRIDGE

Provision of an in Motion Electronic Weigh Bridge has also been kept as per Railway's requirement. A straight and level portion of 100m has been provided on either side of Electronic Weigh Bridge as per specification.

1.19 SIGNALING & TELECOMMUNICATION

- There will be minor modification in the Signaling System due to minor modification in Station working rule. As per Railway Board guidelines circulated vide **Railway Board Circular No. 99/TC(FM)/26/1 Dated 31st March, 2005**, the Railways shall bear the cost of modification to signaling and telecom at Junction station. Hence, only token provision of Rs.2 Cr has been kept for the S & T modifications.
- Suitable communication system between railway staff at station and MMLP staff at Terminal will be developed and shall be used for movement of rakes as per system of working for sidings in the section.

1.20 OVER HEAD ELECTRICAL TRACTION

Serving station Jogighopa falls on Non-Electrified Traction Route, but Electrification work is in progress now hence provision of Rs 10.345 Cr has been provided in the Estimate for Over Head Electrification work. All construction standards have been proposed to match with 25 KV AC OHE System.

1.21 MECHANICAL FACILITIES

Rest Room for crew & guard shall be developed inside Terminal area consisting of toilet block and retiring room as per Railway norms with basic amenities.

1.22 COMMERCIAL FACILITIES

FOIS system will be installed as per Railway's requirement and all charges payable as per extant rules and circulars shall be paid by the siding owner to the Railway. Facilities for commercial Railway staff as per requirement will be provided at MMLP site for Goods booking.

1.23 COST ESTIMATE

- Total Tentative cost of Siding, serving from Jogighopa station is estimated to be Rs.80.63 Crore as per cost estimate attached as Annexure "A"
- Proposed Railway siding, outside Railway Boundary will be laid on Private land and its connecting Track, thereafter will be laid on Railway Land, for which Siding owner shall pay lease rent to Railway as per agreement. The railway siding will have to be constructed under the supervision of Approved Railway consultant.
- The yard within the plant is non-interlocked, hence no Signaling work proposed for internal yard.

1.24 AREAS OF POLICY INTERVENTION

Railways are dealing siding subject under Deposit Work Scheme and have laid down Guide Lines for approval of New Railway sidings (MOR Letter No.99/TC(FM)/26/1/Pt-II Dated 22/08/2016) (Copy attached). As per this policy Private Players have to take approvals from Railway and are required to deposit Departmental Charges fixed by Railway. This present policy is even applicable to siding constructed by any Government departments (Central / State) i.e. Defence, FCI, NTPC, IOC, HPC, BPCL, CWC etc. Even for CONCORE, which is Railway undertaking, same policy is applicable. Therefore, approvals from Railways would be mandatory for construction and effective operations of siding, until Railways change their policy & provide Railway Siding up to MMLP site under a Policy decision or become JV partner in MMLP.

1.25 Status of Approvals:

Private Freight Terminal: Rs. 10,00,000 is required as an application fees for Private Freight Terminal (PFT) by North East Frontier Railways.

Private Railway siding: Rs. 20,000 is required as an application fees for Private Railway siding fees.

Railway application & Drafts for PFT and private siding for MMLP, Jogighopa is under progress. After the submission of all the documents, minimum of one month is required for the North East Frontier Railways to give due permission

2. RAILWAY APPROVALS

2.1 On line registration

- The Applicant shall have to register on line, for which registration Fee of Rs 20000/- shall be deposited with FA&CAO N.F. Railway Malegaon.

2.2 In-Principle Approval for PFT

- Applicant shall apply to Chief Commercial Manager / FM with Draft Feasibility Report, Concept Plan, projection of anticipated business volume, list of authorized users along with application fee of Rs 10 Lac. CCM after examining the proposal will issue "In Principle approval to the proposal. On receipt of approval Applicant shall have to deposit Rs 10 Lac with FA&CAO of N.F. Railway as security deposit within one month of approval.

2.3 In-Principle Approval for Siding

There after Applicant shall submit following to CTPM for "In Principle Approval"

- Concept Plan
- Feasibility Report
- Abstract cost estimate
- 1% Codal charges of Abstract Estimate

2.4 DPR & ESP Approval

On receipt of "IN Principle approval" for the Siding, Applicant shall submit following,

- Engineering Scale Plan (ESP)
- Detailed Project Report (DPR)
- 1% Codal charges

2.5 RECOMMENDATIONS ON WAY FORWARD

Since siding construction is covered under deposit work, therefore as per practice in vogue, the stake holder has to apply for siding and pay the Departmental charges to Railways and also to enter into an agreement with Railway for its maintenance and pay supervision charges. To implement the same an agreement is also to be executed with Railway. **It would, therefore be essential to notify Stake holder before submitting proposal to Railway for construction of Railway Siding.**

2.6 Status of Approvals:

Private Freight Terminal: Rs. 10,00,000 is required as an application fees for Private Freight Terminal (PFT) by North East Frontier Railways.

Private Railway siding: Rs. 20,000 is required as an application fees for Private Railway siding fees.

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Annexure "A"

DPR STUDY FOR DEVELOPMENT OF MULTIMODEL LOGISTICS PARK AT JOGIGHOPA, ASSAM				
ABSTRACT COST				
Item	Bill Description	1st Phase (MMLP Area)	2nd Phase (IWT Extension)	Amount (Rs)
Schedule 1	Supply P.Way	82706656	52379060	135085716
Schedule 2	Supply Ballast	13613730	9549930	23163660
Schedule 3	P.Way Linking	14240477	8482922	22723399
Schedule 4	Earth work	36359465	104407075	140766540
Schedule 5	NH Xing		50000000	50000000
Schedule 6	Rail Xing (ROR)		40000000	40000000
Schedule 7	Minor Br /RUB	95805760	40000000	135805760
Schedule 8	Road work	2115844		2115844
	S & T (Execution by Railway)		30000000	30000000
	OHE (Execution by Railway)		115900000	115900000
	Total Civil cost	24,48,41,932	45,07,18,987	69,55,60,919
	Codal charges @ 6.25%	1,53,02,621	2,81,69,937	4,34,72,557
	Total	26,01,44,553	47,88,88,924	73,90,33,476
	Pre construction activities			
	Cost of Land acquisition 12.5 Acre (5.06 Hac) @ 6000000 /Hac		3,03,60,000	3,03,60,000
	G. Total	26,01,44,553	50,92,48,924	76,93,93,476

Note:- Exclusive of Platform

Annexure “B”**LIST OF BRIDGES**

Bridge No.	Chainage	Type	Span	New /Extension
1	477.10	Steel Girder	2X12.2	Existing
2	800	LHS	1X5.5X3.6 M	New
3	1391.07	LHS	1X5.5X3.6 M	New
4	5376	Bridge	3X6	New
5	5616	LHS	1X5.5X3.6	New
6	6236	ROR	1X7X6.5	New
7	6341	ROB	1X7X6.5	New

Annexure “C”**LIST OF LEVEL CROSSINGS**

S.No.	Level Crossing No.	Chainage	Proposed/Extension	Category
1	LC1	32.609	Extension	Already Manned

Annexure “D”**LIST OF CURVES**

Curve No.	Direction	Radius (M)	Transition	Curve Length	TP1 Chainage	TP2 Chainage
1	L	275	20	286.491	283.741	610.232
2	L	280	20	354.660	647.806	1042.466
3	R	320	60	155.892	1332.438	1608.33
4	L	255	60	123.100	1819.378	2062.478
5	L	350	80	787.309	3565.166	4512.475
6	R	350	80	248.032	4674.836	5082.868
7	L	350	60	3.091	5601.550	5724.641
8	L	350	80	185.727	6514.216	6859.943

TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS FOR EARTHWORK IN RAILWAY FORMATION

TECHNICAL SPECIFICATIONS FOR EARTHWORK IN RAILWAY FORMATION**1.0 GENERAL**

- 1.1 The Technical Specifications to be followed for Earthwork in Railway Formation including in Cuttings and Embankments shall be as stipulated in enclosed **Annexure A**.
- 1.2 The Specifications at **Annexure A** should be read in conjunction with the Schedule (Bill) of Quantities. Where there is conflict between the provisions in **Annexure A** and in BOQ, the provisions in BOQ shall prevail.

ANNEXURE A

EARTHWORK IN RAILWAY FORMATION

1.1 EARTHWORK - GENERAL

- 1.1.1 **RDSO Guidelines:** For survey, design and execution of earthwork in railway formations, RDSO has issued detailed guidelines as “Guidelines for Earthwork in Railway Projects – Guideline No. GE: G-1” in July 2003. These Guidelines including their subsequent amended/revised versions, if any, shall apply to execution of earthwork in railway formations. These guidelines or their amended/revised versions have subsequently been referred to in this chapter as ‘RDSO Guidelines’. In case of any conflict between provisions of this chapter and those of RDSO Guidelines, the latter shall prevail.
- 1.1.2 **Site Clearance:** - Before work is started, the whole area between the toes of banks or tops of cuttings plus 1m additional width on both sides shall be properly and effectively cleared by the contractor of all vegetation, small trees of girth upto 30 cm (measured at a height of 1m above ground level), roots, bushes, heavy grass etc.; The Contractor shall also clear the site of all buildings, abandoned structures etc. as directed by the Engineer, for which extra payment will be made. The Contractor shall arrange removal of rubbish and other excavated material excluding earth up to a distance of 100 meters outside the periphery of the area under site clearance. Top soil obtained from site clearance as well as top layer of borrow pits which is rich in organic content and suitable for plant growth, if directed by the Engineer, may be stored for covering slopes of embankment and cuttings after construction. High portions of the ground shall be cut down and hollow depressions, if any, filled up with suitable excavated soil duly compacted and the ground dressed and levelled. The work of this nature will be covered by the initial rate for earth work, unless stated to the contrary in the agreement.
- 1.1.2.1 Trees of girth over 30 cm, measured at a height of 1m above ground level, shall be considered as large trees. Cutting down of large trees shall be paid extra at the rate specified in the Schedule of Rates. The rate shall include lopping of branches, trimming, removal from and clearing of site when stumps are grubbed up in addition. Large trees shall not be cut without specific orders from the Engineer. As few trees shall be cut as is absolutely necessary for the execution of work. The roots of trees and saplings shall be removed to a depth of 60 cm below ground level or 30 cm below formation level or 15 cm below sub grade level, whichever is lower. All holes or hollows formed due to removal of roots shall be filled up with earth rammed and leveled. Trees, shrubs, poles, fences, signs, monuments, pipe lines, cable, etc. adjacent to the area which are not required to be disturbed during site

clearance shall be properly protected by the contractor at his own cost and nothing extra shall be payable.

- 1.1.2.2 Any trees cut down or building materials released from dismantling of structures shall be stacked by the contractor within a distance of 100 meters outside the periphery of the area under site clearance as per instructions of the Engineer. The contractor shall have no claim to the trees or other material removed during site clearance and the same shall be the property of the Railway.

1.1.3 **DATA AND SETTING OUT:**

Initial Data

At the commencement of work, the Engineer in charge shall give to the contractor the following data/ guidance.

- (i) Concrete center line pillars fixed on the alignment at intervals of 250m
- (ii) Pucca level bench marks fixed along the alignment, about 30 m away from the center line at intervals of 500m. These bench marks shall have been connected by leveling to available GTS bench marks and the reduced level of each shall be communicated.
- (iii) Longitudinal section of the proposed formation to scale 1:2500 horizontal and 1:500 verticals with the existing ground level and the proposed formation level marked at intervals of 50m along the alignment and with the location of each curve, bridge, culvert, and level crossing on the entire alignment indicated.
- (iv) Existing ground level would be jointly recorded by the Engineer-in-Charge or his representative and the contractor or his representative by taking cross section at an interval of 25m or as suitable so as to produce the general existing ground profile. The Contractor will have to sign the level book as a token of acceptance of the level and it will form the original record for payment.
- (v) Ground levels recorded as above would be plotted to a natural scale 1:100 at a subsequent date and desired profile of bank/cutting would also be plotted on it. This will also be signed by contractor and would be the basis for the final payment of earth work to be done.

(vi) The contractor shall be responsible for subsequent preservation of all the above-mentioned pillars and drawings and shall pay for the cost of their replacement, if necessary.

(b) **Setting Out:**

Before commencement of earth work, the Contractor shall demarcate with a furrow, at least 20 cm wide and 15 cm deep, at 50 cms from the toes of slopes of banks and outside limits of tops of cuttings on both sides of centre line and the boundaries of the bottom and top of the borrow pits. The “dag belling” is to be maintained and renewed when necessary, throughout the duration of earth work. The cost of this is included in the rate for earth work.

Concrete pillars of 30 cms square at 50 cms away from and on both sides of the toe of the bank / top of cutting at each cross section would be constructed and maintained by the contractor at his own cost as a part of the setting out works. These concrete pillars should be embedded to a depth of 50 cms. No extra payment on this account is permissible. He will also provide and maintain and maintain templates, burjies, reference pillars etc. and shall take all necessary precautions to prevent these being removed, altered or disturbed and will be responsible for the consequence of such removal, alteration or disturbance and for their efficient reinstatement. No extra payment will be made on this account.

(c) **Profiles:**

In accordance with cross sections supplied, the Contractor shall at his own expense provide all stakes, bamboos, strings, pegs and labour for setting out profiles at every 25m or as directed for correct execution of the work. This will include provision of side drains and catch water drains as necessary in cutting and / or as marked in the cross sections supplied to the Contractor. The top of formation shall invariably have cross slopes of 1:30.

1.1.4 **Mechanized construction of Earthwork:** Manual methods of construction cannot achieve the desired quality of earthwork. Therefore, in all projects, it is necessary to deploy mechanized equipment's such as earthmovers, dozers, hydraulic excavators, motor graders, scrapers, dumpers, mobile water sprinklers, vibratory rollers, sheep foot rollers etc. so that quality of work meets laid down standards.

1.1.5 **Maintenance:** Banks and cuttings are to be correctly dressed and finished in profile with slopes as specified in each case. Where gullies or water-cuts commence to form on the slopes of embankments or cuttings, the erosion is to be checked as early as

practicable and made good with suitable material well rammed into place. Where a gully or water-cut has not been checked at its commencement, it may be advisable to cut it out or step it before filling it in, and to further protect the place by turfing, pitching or other means as may be ordered by the Engineer. Work, before being finally paid for, is to be checked by the Engineer as having been correctly brought up, or carried down, to the proper level and to be otherwise complete in all respects in accordance with the specifications.

- 1.1.5.1 As soon as the work has been satisfactorily completed, the Engineer shall issue a certificate of completion in respect of the work as specified in relevant Clause of the General Conditions of Contract. Unless otherwise specified in the Tender conditions, the contractor shall maintain the banks / cuttings, for a period of Twelve months from the date of completion of work as indicated in the certificate of completion. The contractor shall be responsible for the handing over of the banks/cuttings to the Railway in proper condition, and, where necessary, for their restoration to such condition, at the end of the maintenance period. Until then, the contractor is responsible for all losses due to subsidence, wastage or guttering due to rain, wind, wear, wash or from any other cause whatsoever, and he shall have no claim for any extra work or payment on this account.
- 1.1.6 **Spoil from cutting to bank:** - Up to the initial lead specified in the BOQ item, material from each end of every cutting – subject to its suitability for use in railway embankment- shall be led forward into the adjoining bank as a matter of course, and the rate to be paid for such material shall be the rate for cutting only. The Engineer shall specify in each case from what point in each cutting to what point in the adjoining bank, spoil shall be led out, payment being made only for the excess lead over and above the initial lead included in the rate for cutting. The Engineer can modify these limits at any stage of the work and all such changes shall be binding on the contractor without any claim for any extra payment on this account. Dressing and compaction of the bank will, however, be paid for in addition.
- 1.1.7 **Classification of soils:** -The classification of soil/rock met with in executing the work, if not made by the Engineer, shall be made by his representative authorized by him for this purpose subject to the approval and final decision of the Engineer. The rates to be paid to the contractor in his bills shall be based on these classifications.

Earth work shall be classified under the following heads: -

- 1.1.7.1 **All kinds of Soils:** -Generally any strata such as sand, gravel, loam, clay, mud, black cotton, moorum, shingle, river or nallah bed boulders, soling of roads, paths etc. macadam surface of any description, lime concrete, mud concrete and their mixtures which for excavation yields to the application of picks, shovels, jumpers, scarifiers, ripper and other manual digging implements.
- 1.1.7.2 **Ordinary Rock:** Generally, any rock which can be excavated by splitting with crowbars or picks and does not require blasting, wedging or similar means for excavation, such as lime stone, sand stone, hard laterite, hard conglomerate and unreinforced cement concrete below ground level. If required light blasting may be resorted to, for loosening the materials but this will not in any way entitle the material to be classified as 'Hard rock'.
- 1.1.7.3 **Hard Rock (Requiring Blasting):** - Generally any rock or boulder for the excavation of which blasting is required Such as granite, quartzite, basalt, reinforced cement concrete below ground level and the like.
- 1.1.7.4 **Hard Rock (Blasting Prohibited):** -Hard rock requiring blasting as described under **sub para 1.1.7.3**, but where blasting is prohibited for any reason and excavation has to be carried out by chiseling, wedging or any other agreed method.
- 1.1.8 **Measurements:** -Cutting and banks are to be excavated and made up neatly to the lines shown in the cross section as per approved construction drawing. No payment will be made for excess work done outside these lines except when such work is so ordered in writing by the Engineer. However, in case of embankments, extra width constructed, as per Para 1.2.5.6, to ensure proper rolling and compaction which is subsequently cut and dressed to avoid loose earth on the slopes shall not be paid for.
- 1.1.8.1 Should the Engineer so desire, he may, at any stage of the work, order the Contractor to increase or reduce the slopes of any cutting or bank or alter the formation level, in which case the amount of work actually done will be paid for in accordance with the specifications and the Schedule of Rates.
- 1.1.8.2 Unless otherwise specified the rate for Earth work is inclusive of an initial lead and lift as specified in the BOQ.
- 1.1.8.3 Additional lead for the purpose of payment will be measured from the centre of gravity of excavation to the centre of gravity of the bank or spoil heap, and shall be

measured along the shortest practicable route and not necessarily the route actually taken.

1.1.8.4 Where initial lift is specified, additional lift for the purpose of payment will be estimated by dividing the cross section of the bank or cutting into successive stages of 1.5m high or deep respectively from the natural ground level and only the quantity contained in each strip shall be paid for at the rate appertaining to its height or depth above or below the natural ground level, respectively. Lift from the borrow-pit to the ground level or from ground level to the spoil bank shall not be taken into account in any payment for lift unless the depth of the borrow- pit or the height of the spoil bank has been made in excess of 1.5m under instructions from the Engineer, and in such cases, only the portion of the borrow-pit below 1.5m depth or of the spoil bank above 1.5m height as measured from the natural ground level, shall be, measured separately for payment of lift on the same basis as for cuttings or banks respectively.

1.1.8.5 For the purpose of above para, the natural ground level shall be reckoned as that obtaining at the toe of the bank nearest to borrow pits or at toe of spoil bank nearest to the cutting as the case may be. No payment shall be made for any lift from the ground level at the borrow pit to that at the bank, or from the ground level at the cutting to that at the spoil bank, where such lift is inherent in the lead on account of natural ground slope and no obvious act of lifting is involved, in the opinion of the Engineer. Obvious lifts such as involved in crossing of existing pits or banks, which cannot be avoided, will be measured and taken into account for payment. In such cases, the additional lift thus measured shall be taken into account in fixing the successive stage of 1.5m, whether in the bank or in the cutting. In sidelong ground where borrow-pits or spoil banks, as the case may be, are made on both sides, any payment for lift shall be a matter of special agreement.

1.1.8.6 For purpose of payment, cuttings shall be assumed to be composed of such soil /rock only, as stand exposed on both or one side of the finished cuttings, depending upon whether the cutting is box type or one sided on a transversely sloping ground. The content of each type of soil/rock thus assigned to any cross section shall be determined as indicated below. It is to be noted that no portion of cutting will be payable for any such type of soil/rock as is not exhibited on the finished side slope, where the side slope exists.

(a) **For box type cutting:** - The centre line of the alignment will be marked vertically on the cross section and the content of each type of soil/rock will be determined by computing the area of the strip, formed by joining the points, which form the extremity of occurrence of the particular soil on

the finished side slope of cutting, by straight horizontal lines terminating on the centre line. **Figure No.1.1** is illustrative of the manner in which payment is to be made.

(b) **For one sided cutting on a transversely sloping ground:** -Content of each type of soil/rock will be determined by computing the area of the strip, formed by joining the points, which form the extremity of occurrence of the particular soil on the finished side slope of the cutting, by straight lines to the zero point. **FigureNo.1.2** is illustrative of the manner in which the payment for the cutting will be made.

(c) **For widening of existing cuttings for one or more lines where the existing cutting slope disappears and a fresh slope stands:** -Before undertaking widening of the cutting, pre-classification of the existing cutting slope (which will disappear) should be done after clearing and cleaning the surface and the strata met marked on the cross-section sheets. After completion of the work various strata as stand exposed on the new finished slope of the cutting shall again be marked on the cross-sections. Then the demarcation points of adjacent strata as determined by classification of the existing slope and the final slope should be joined as shown in **Figure No.1.3**.

The cross-sectional areas for different strata may be worked out and quantities payable classification-wise assessed accordingly.

(d) **For extension to the existing cutting where no fresh cutting slope is available after work:** - Before execution of the work pre-classification of the existing cutting slope which will not be finally available, should be done and recorded in the initial cross-section. **Figure No.1.4** is illustrative of the manner in which the payment for the cutting is to be made for soil of different classifications.

1.1.8.7 Classification in the above manner shall be made only at such points where the cross sections giving the ground profile have been recorded. The classification as recorded in the above manner in case of cuttings shall be signed by the contractor in token of his acceptance. The classification as recorded by the Authorized representative of the Engineer in the above cases for cuttings is subject to confirmation by the Engineer, whose decision shall be final and binding on the contractor. Where there is disagreement between the Contractor and the Authorized representative of the Engineer on classification of soil, payment shall be affected "on account" as per lower classification as made by the Authorized representative of the Engineer. Payment for extra at the rate for higher classification shall be made after final decision by the Engineer on the admissibility of the Contractor's claim for higher classification.

1.1.8.8 In computing the quantity of earth work in cuttings and side drains, no cognizance will be taken of the additional excavation, which may be necessitated during the progress of the work due to the presence of boulders or other material, and

payment will only be made for the quantity as per cross sections required to be provided.

1.1.8.9 Where cutting spoil is utilized for making the bank, stones over 75mm size, which are not to be used in the bank, shall be stacked separately at a site to be indicated by the Engineer. To determine the quantity of cutting spoil led out for making the bank, the sectional quantity of the cutting shall be reduced by the volume of stones and boulders stacked outside, which will be arrived at by deducting 50% for voids from the stack measurements of these stones and boulders. The stacking of these stones and boulders, including initial lead and lift specified in the item, is covered by the initial rate of Earth work.

1.1.8.10 It must be clearly understood that the Contract rates are intended to cover the full cost of finished work as per approved drawings or as directed by the Engineer with nothing extra payable for work carried out in excess of the requirements. Banks and cuttings are to be carefully dressed to formation with such slopes as may be specified in each case. The payment for the quantity of earth work in cutting / bank shall normally be made on cross sectional measurements. The existing ground / bank profile shall be taken and plotted by the Authorised representative of the Engineer in the presence of contractor or his authorized agent before commencement of the work. The profile of the bank or the cutting required to be provided shall also be plotted on the same sheets. The levels and cross sections shall be signed by both the Authorised representative of the Engineer and the contractor / his authorized agent. (The profiles of the bank or cutting as required to be provided are for the guidance of the contractor and not for the purpose of measurements).

The profiles of the finished and plotted bank/ cutting shall like-wise be taken in the presence of the contractor or his authorised agent and super-imposed on the original ground profile. These profiles are to be taken at locations as directed by the Engineer, at least at 25m intervals on straight and every 15m on Curves with radii sharper than 600m and at extra locations in special cases such as irregular or side long ground etc. The gross volume of earth work shall be calculated from the original and finished profile of the bank/ cutting.

As it may, at times, be difficult to measure by means of cross sections the quantity of rock excavated by blasting or chiseling, owing to its irregular configuration or intermixture with other materials, the quantity of rock may be measured after stacking the excavated rock spoil. The same procedure also applies to any other type of soil/rock, which requires to be measured separately from the material constituting the bulk of the spoil. In all such cases, the payable quantity of the

stacked material is to be arrived at by making suitable deductions for voids from the measured cubical contents of the stacks as specified below:

	Type of soil stacked	Deduction
(a)	Rock spoil of different sizes	30 per cent
(b)	Sandy materials	7 ½ per cent
(c)	Black cotton soil	20 per cent
(d)	Other soils, including coal ashes	15 per cent

To facilitate measurement, all stacks to be measured shall be made rectangular in plan and of uniform height, on level ground or ground leveled for this purpose. The stacking of spoil shall be done in a compact manner to the satisfaction of the Engineer. The rates provided shall include all charges on account of such stacking as well as any lead or lift, as also the re-stacking of stacks or portions of stacks which the Engineer considers, in his sole discretion, as not properly stacked.

Where earthwork is required to be done from borrow pits for repairs to bank to make up cess, to fill raincuts etc, the payment for such earthwork will be affected on borrow pit measurements.

As far as possible spoils from cuttings fit for embankment shall be used to make up the bank. If, however, this is found to be uneconomical due to excessive lead or lift, or if sufficient quantity of good earth fit for embankment is not available from the source of cut spoils contractor's earth approved by Engineer or earth from borrow pits in railway land as directed by Engineer shall be utilized. As far as possible each stretch of bank should be made of earth from only one source so as to avoid mix up. If however, this is not possible due to exigencies of work, earth from one source should be utilized first and compaction done before earth from the next source is allowed to be dumped. Initial cross section of bank and cross section after compaction of earth from each of the sources should be taken. Based on the cross-sectional areas, the gross quantity of earth work in embankment executed by utilizing the earth from different sources shall be determined

Final measurements shall be taken only after the bank/ cutting has been completed to the required profile as directed by the Engineer irrespective of the period of completion and number of monsoons that may pass during execution.

1.1.8.11

Where, for any reason at the discretion of the Engineer, borrow-pit measurements are resorted to, all matams and roads and excess earth work, such as bulges in the slopes of the banks, shall be excluded from the measurements.

1.1.8.12 Nothing extra shall be paid for: -

- (i) Excavation for insertion of planking and strutting.
- (ii) Removing slips or falls in excavations
- (iii) Bailing out water in excavations from rains, ordinary springs not requiring pumping etc.

(Note: - Pumping out water caused by powerful springs, tidal or river seepage, broken water mains or drains and the like, shall be paid separately if provided for in the Agreement)

- (i) Unauthorized battering or benching of excavations.
- (ii) Forming steps in sides of deep excavations and their removal after measurements.
- (iii) Protective measures for protection against risk of accidents to the public due to open excavation.
- (iv) Protective measures / precautions taken to avoid damage to existing Signal / Electrical / Telecom / other Miscellaneous Cables, Pipes, installations etc.

1.1.8.13 **On Account Payment**

1.1.8.13.1 Running on account payments will normally be made only for such length of banks as in the opinion of the Engineer-in-Charge has been finally executed in terms of the conditions of contract. On account payments may however be made at the discretion of the Engineer-in-Charge if uncompleted bank is high or there are other circumstances which may result in heavy investment on the part of the contractor, before he is able to complete a stretch of bank in all respect. Such on-account payment will be made to the extent of only 90% of the total quantity of earthwork. Contractor shall submit **royalty clearance certificate along with Running Account bill**, if the agency fails to submit the royalty clearance certificate, the required amount will be deducted as per extant Govt. rule, from his bill and will be deposited with the concerned dept.

1.1.9 **Dressing Surface: -**

1.1.9.1 This specification is applicable to Surface dressing executed as a separate work for purposes other than earthwork for embankment or cutting. In case of earthwork for embankment or cutting, provisions of **Para 1.1.2** will apply and the surface dressing will be covered by the initial rate of earthwork unless stated to the contrary in the Agreement. This specification shall also be applicable only to earthwork involving soil.

1.1.9.2 The terms “Dressing Surface” shall be taken to mean the cutting down of high portion of a specified area of ground and using the excavated earth to fill up the hollows and the depressions. The maximum depth of excavation or filling shall be restricted to 15 cms.

1.1.9.3 The levels to which the ground is to be dressed shall be such that the quantity filled is nearly equal to the quantity cut and the finished surface is even and tidy with such slopes as may be necessary for proper drainage. Before the work is commenced the proposed levels shall be set up at regular intervals both for the cuts and for the fills, by suitable means as directed by the Engineer and these shall be got checked and approved by him.

1.1.9.4 Unless otherwise provided for in the Contract, the rates shall be inclusive of removal of rubbish upto a distance of 50m outside the periphery of the area cleared.

1.2 EARTHWORK IN EMBANKMENTS

1.2.1 **Profiles:** -Profiles for banks shall be set out where every cross section has been taken. These profiles shall be set up atleast every 25m on the straight and every 15m on curves with radii shorter than 600m. Profiles shall also be set up at any additional places if ordered by the Engineer.

1.2.2 **Formation Width:** - The formation widths are to be as shown in the drawings.

1.2.3 **Side Slopes:** - The side slopes will ordinarily be as shown in the drawing, but the Engineer or his Authorised representative may, by order in writing, vary this slope to suit local conditions.

1.2.4 **Selection of Earth:** -Fill material proposed to be used, either from railway land or from outside shall be assessed for its suitability at contractor's expense, in accordance with RDSO Guidelines. The contractor shall get the prior approval of the Engineer for the quality of the fill material. Soil groups falling under the classifications GB, GW, GC, GM, GP, SB, SW and SC under IS Code 1498 are generally considered suitable.

1.2.5 Execution of Earthwork

1.2.5.1 The spreading of material in layers of desired thickness over the entire width of embankment should be done by mechanical means and finished by a motor grader. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the slope and grade.

- 1.2.5.2 Thickness of layer is to be decided in accordance with RDSO Guidelines. However, as a good practice thickness of layer should be generally kept as 300mm for fill material and 250mm for blanket material in loose state before compaction.
- 1.2.5.3 Efforts, in accordance with RDSO Guidelines, should be made to keep moisture content level of the soil in the range of $OMC \pm 2\%$ at the time of compaction.
- 1.2.5.4 The rate of progress should be, as far as possible, uniform so that the work is completed to final level almost at the same time.
- 1.2.5.5 The rolling for compaction of fill material should commence from edges towards center with minimum overlap of 200mm between each run of the roller. In final pass, roller should simply move over the surface without vibration so that top surface is properly finished.
- 1.2.5.6 Extra bank width of 500mm on either side shall be rolled to ensure proper compaction at the edges. The extra soil would be cut and dressed to avoid any loose earth at the slopes. This should preferably be done with help of grade cutter. In case of widening of embankments, the extra width to be rolled shall be 300mm instead of 500mm.
- 1.2.5.7 At the end of the working day, fill material should not be left un-compacted. Care should be taken during rolling to avoid ponding on formation.
- 1.2.5.8 During construction of formation, there may be rainfall to the extent that rain cuts may develop on the surface of formation due to erosion of soil. Care should be taken that these rain cuts are not allowed to develop wide and deep otherwise these locations will remain weak spots.
- 1.2.5.9 Top of the formation should be finished to cross slope as provided in contract drawings.
- 1.2.5.10 Once the top surface of the formation has been finished to proper slope and level, movement of material vehicle for transportation of ballast, sleepers etc. should be avoided since these movements will cause development of unevenness, ruts on the surface which will accumulate water and weaken the formation.
- 1.2.5.11 At locations where the water table is high and the fill soil is fine-grained, it may be desirable to provide a granular layer of about 30 cm thickness at the base, above

subsoil across the full width of formation. This work will be carried out if directed by the Engineer for which extra rate will be paid.

- 1.2.5.12 At places where embankment material is not conducive to plant growth, top soil obtained from site clearance as well as top layer of borrow pits which is rich in organic content and suitable for plant growth, may be stored for covering slopes of embankment and cuttings after construction or other disturbed areas, where revegetation is required as far as practicable.
- 1.2.5.13 In conversion / doubling / rehabilitation projects, suitable benching of existing slope, in steps 30cm in height and 60cm deep, shall be cut in the existing bank before any new earth is placed, to form a bond between the new and old earth work. It should be ensured that there is no humus material left on the benched slope. Care needs to be taken to avoid entry of rainwater into the formation from this weak junction, otherwise this would result in development of weak formation, slope failure, maintenance problem due to uneven settlement etc.
- 1.2.5.14 Similar benching is to be provided in side-long ground of which the slope at right angles to the alignment of the banks is 3 Horizontal to 1 vertical or steeper or if ordered by the Engineer. The benching in side long ground will not be separately measured or paid for, but is deemed to be covered by the initial rate for earth work.
- 1.2.6 **Embankment in Water-logged ground etc.:** -When embankments are to be carried across water-logged or swampy ground or to be made in soil which requires special protective measures, it rests with the Contractor in all such cases to bring these facts to the notice of the Engineer concerned who will direct on the methods to be adopted and the rates to be paid, and will arrange for a special agreement for the same if necessary.
- 1.2.7 **Borrow Pits:** -The Engineer concerned will direct from where material is to be obtained. As far as possible, Bank should be made of homogeneous material with no mix of rubble or boulders with soil. In case of land provided by the Employer, no excavation for borrow pits shall be made within 2m of the limits of the acquired land. Borrow pits shall not be dug close to level crossings, bridges or culverts, telegraph poles, electric poles, or close to inhabited areas, unless they can be properly drained to prevent water stagnating. Borrow pits within station limits shall be avoided as far as possible. The earth is to be excavated and thrown to such width, depth and height and in such places as may be from time to time decided.
- 1.2.7.1 During excavation, the contractor shall take particular care to avoid damage to drains, water mains, cables or other underground work. Should any damage be

caused, the Engineer shall be notified immediately and the damage shall be made good at the contractor's expense.

- 1.2.7.2 Where Earthwork is to be carried out within Railway land and where borrowing of Earth from Railway land is agreed to by the Railway as confirmed in writing by the Engineer-in-charge, borrow pits shall be excavated within the limits of railway land as directed by the Engineer. The pits must be rectangular or conform to the land boundaries. The sides of the pits next to the toe of the bank are to be sloped down at 2:1, and elsewhere at a slope of 1:1 unless otherwise directed by the Engineer. Any pits wrongly excavated shall be refilled by the contractor at his own cost, and in such a manner as the Engineer directs.
- 1.2.7.3 Borrow pits are not to be made of uneven depth but the whole area of each pit is to be neatly excavated to the same level. The outer or the most distant half of the borrow pits is to be excavated first, so that in the event of the pits being flooded by rain, there will still be ground available for work.
- 1.2.7.4 A berm 15m wide is to be left untouched initially at every 80m between edges of borrow pits, and is not to be encroached upon for any excavation except under the instructions of the Engineer. If it is necessary for drainage purposes to cut through the berm, the channel will be made on the side remote from the Bank.
- 1.2.7.5 Inside long ground, the borrow pits are to be dug on the upper side of the bank, and are to be continuous to serve as catch water drains; and, if so ordered, the contractor shall get the earth for the bank exclusively from such pits till the catch water drain is complete to the required length, section and level as prescribed by the Engineer.
- 1.2.7.6 When doing repair work to banks it is absolutely essential that diagonal bunds be kept, when digging fresh borrow-pits in the old ones, as a precautionary measure for correct assessment of the work. Diagonal bunds are also to be kept in borrow-pits for new works where payments are to be made on borrow-pit measurements. When doing earthwork repairs, Authorized representative of the Engineer should bear this point in mind and refuse to measure up any pit in which a diagonal bund has not been kept. For repair works it would save a large amount of unnecessary detailed measurements if all pits were excavated to a uniform size as far as practicable.
- 1.2.8 **Stream diversions:** - When it has been decided to divert a stream adjoining the bank, the excavation for this work is to be undertaken and completed before any borrow pit work is done at site and all earth from such diversion is to be put into the main bank, if so ordered. If earth excavated from the drain is led into the bank,

payment will only be made for the quantity excavated including lead and lift if any and not for both cut and fill. In excavating for diversion of stream, care must be exercised by the Engineer that such diversion does not start a land slip.

- 1.2.9 **Bank executed manually:** -All railway embankments shall be constructed only by mechanical means in accordance with RDSO Guidelines. Other embankments, when executed manually, shall be made in successive layers, of not more than 30cm uncompacted depth, over the whole width. The subsequent layer shall be started only when the previous layer has been completed for a length not less than 30m along the embankment. All large clods shall be broken up in the borrow pits or bank by labour specially detailed for this work. This shall be strictly ensured.
- 1.2.10 **Backing to bridges:** - In carrying embankments over a bridge or a culvert intended to be covered by the work, the earth work shall be brought up evenly on both sides of the structure so that the pressure may be equalized. In filling in the approaches of a bridge, or the spandrels between small arches, the earth filling shall be raised simultaneously with the wing walls in the former case and with the face walls in the latter, in order that the filling may be well trodden down under the feet of the laborers; and in filling in foundations and backing to revetments, the earth work shall similarly be brought up level as the masonry proceeds. Filling for the backing of bridges or culverts will conform to specifications under **Para 1.6.3** or as ordered by the Engineer.
- 1.2.11 **Dressing:** -After completion of earth work the slopes shall be neatly dressed to the correct profiles, and shall be made up where required during the maintenance period. The top should be neatly dressed off sloping at an inclination of 1 in 30 either side from the center line unless otherwise specified in the drawings.
- 1.2.12 **Turfing:** -Turfing of banks shall be done during the monsoon season, preferably after a heavy shower, when it can be ensured that the bank slopes will remain wet for a long time after planting the grass. Turfing shall be paid for separately. Turfing shall not be commenced without the prior written permission of the Engineer.
- 1.2.12.1 Before Turfing is commenced, the side slopes are to be dressed to the specified section. This dressing is included in the initial rate for earth work, and should a contractor stop work before dressing the bank, he shall be debited with the estimated cost of the dressing to be done by another contractor or departmental labour, as decided by the Engineer. Where the slope is already consolidated, it should be loosened for a depth of about 4 cms before the sods are laid.

- 1.2.12.2 Turfing shall consist of sods, not less than 10 cm thick and 20 cm square well beaten – into the bank till they get a proper hold and form a level and compact mat. The contractor shall be responsible for watering where necessary to ensure that the turf grows properly; and in the event of it not doing so, he will returf such parts as have not grown, at his own cost. The Turfing shall be measured and taken over only after the grass has rooted well and has formed a sufficiently dense growth over the earth slopes.
- 1.2.12.3 Turfing of side slopes of cuttings if ordered by the Engineer shall be carried out in a manner similar to Turfing of bank.
- 1.2.13 **Sarkanda or similar type of planting on bank slopes:** -Where Sarkanda is planted on bank slopes, the minimum distance center to center in rows shall be 75 cm in either direction. The plantation in adjacent rows will be staggered for proper coverage of the area. For other types of plantation, the local practice shall be followed as directed by the Engineer. Where directed to be done, this item will be paid for extra.
- 1.2.14 **Erosion Control of Slopes on Banks by use of Geo-jute**
Where stipulated, particularly in areas having high erosion problems, the slope may be protected by use of Geo-jute, an eco-friendly, bio degradable material made of jute yarn with a coarse open mesh structure. On degradation it helps in growth of vegetation. The Type of Geo-jute to be used 1, 2 or 3 will be as stipulated. The work of laying and maintaining Geo-jute should be carried out strictly in accordance with the provisions in RDSO's guidelines for Application of Jute Geo-textiles in Railway embankments and hill slopes issued under RDSO/2007/GE:G-008 read with all up to date amendments / revisions.
- 1.3 **EARTH WORK IN CUTTINGS**
- 1.3.1 **Formation width:** -The formation widths, exclusive of side drains, are to be as shown in the drawings. The top width of each side drain will ordinarily be 120 cm at formation level and depth 30 cm, unless shown otherwise in the drawing.
- 1.3.2 **Side Slopes:** The side slopes will ordinarily be 1:1, unless otherwise shown in the drawing or ordered by the Engineer.
- 1.3.3 **Excavation:**
- 1.3.3.1 When so ordered, the centre portion of gullet of the cutting shall be first taken out to the full width of formation to enable the Engineer to determine the slopes suitable to the full length of the particular cutting or to different lengths of it. When

the gullet is cut out to its full depth in shallow cuttings, or to the depth of the first cut in deep cuttings, the side portions or triangular sections up to the slopes may be excavated. In deep cuttings, the, second cut will not be started until the top portion is thus completed.

The necessity of excavating cuttings in this manner is evident as, in the event of heavy rain occurring with work partly completed, and the bottom of the excavation uneven and incapable of drainage, excessive delay might occur or excessive pumping might become necessary. The contractor is solely responsible for any such contingency and the railway will not be liable for any compensation.

1.3.3.2 All cuttings shall be taken down carefully to the precise level and section as delineated in the drawings or as ordered by the Engineer. In case the bottom of the cutting is taken down deeper than is necessary by over sight or neglect of the contractor, the hollow must be filled up to true depth with selected material and rammed, at his expense. Cuttings with the formation in rock will be excavated to 15 cm below the true formation and filled up to true level with cutting spoil to ensure that no lumps of solid rock project above formation level. The bottom sloping from centre towards side drains shall be as given in Sub **Para 1.3.3.3** below. Payment will, however be made for earth work in cutting up to the true formation level only.

1.3.3.3 In soft soil the excavation of cuttings shall, in the first instances be carried to about 15 cm short of the full depth, so much being left for dressing the bottom true to the formation. The side slopes shall be dressed true and straight and the bottom shall then be completed by sloping if from the centre line towards the side drains to a slope of 1 in 24 or any other slope as shown in the drawing.

1.3.4 **Drainage of Cuttings:**

1.3.4.1 In excavating cuttings, special precautions are to be taken to ensure that the excavations drain themselves automatically. To ensure this, the central block of earth or gullet is to be excavated first. This will be done in such a manner that the bottom of the excavation shall, where possible, slope downwards from the centre of the cutting towards the ends. It will be made in such cuts or steps as may from time to time, be directed. Generally, in deep cuttings the first cut or step will approximately follow the surface of the ground, where this will secure the necessary slope for drainage, and will be excavated to such depth not exceeding 3m as may be ordered, with perpendicular sides leaving pathways for workmen along the sides of the cut parallel to the central line about every 15 m. In shallow cuttings, not exceeding 2m in the deepest part, the gullet may be cut out at once to formation level.

- 1.3.4.2 Side drains shall be provided, according to the cross section shown in the drawing at the toe of the slope in all cuttings to ensure proper drainage. Excavation to the required cross section and longitudinal slope to form the side drain will be paid for at the same rates as the cutting.
- 1.3.5 **Catch-Water Drains:** - Where required, catch water drains cut to the section and profile prescribed, shall be constructed on the uphill side leaving a berm of one metre from the boundary of the railway land and shall be paid for at the same rates as for cutting. The cross-sectional area of the catch water drain shall normally not exceed 0.75 sq.m. The spoil from the catch water drain will be deposited to make a uniform slope from the edge of the cutting towards the drain. The material derived from the catch water drain will be used to the extent required to provide the slope and the surplus earth should be deposited in the spoil bank of the cuttings. Unless ordered to the contrary by the Engineer, the Catch water drain must be excavated before the cutting is started.
- 1.3.6 **Berms and Spoil Banks:** - No spoil shall be deposited within a distance of 9m from the top edge of the slope of any cutting duly taking into account the location of the catch water drain, if any. While doing so, the Engineer may bear in mind the side on which the doubling may eventually be done.
- 1.3.6.1 The spoil heap shall be roughly but neatly dressed off to a slope of 1 ½: 1, and shall form a continuous bund along the top of the cutting. In country where there is any cross fall, sufficient spoil shall be thrown on the uphill side of the cutting to supplement the catch water drain and assist in keeping drainage out. This work must be done first.
- 1.3.6.2 (a) All material excavated from cuttings suitable for pitching, ballast, masonry or any other purpose whatever, shall be the property of the Railway, and shall be stacked, as also disposed off, as directed by the Engineer, within the limits of lead specified for stacking of spoil. This is included in the rate for cutting.
- (b) Any finds of archaeological interest such as relics of antiquity, coins, fossils or other articles of value shall be delivered to the Engineer and shall be the property of the Railways.
- 1.3.7 **Springs or Inflow:** Should springs or inflow of water appear in cuttings, or should they be flooded, the contractor must arrange for bailing, pumping or drainage of water, without obstruction to adjacent works. Payment for the same shall not be made unless otherwise provided for in the Agreement with the Contractor.

1.3.8 Protections: Excavation, where directed by the Engineer, shall be securely fenced and provided with proper caution signs, conspicuously displayed during the day and properly illuminated with red lights during the night, to avoid accidents. The Contractor shall take adequate protective measures to see that the excavation operations do not damage the adjoining structures or dislocate the services. Water supply pipes, sluice valve chambers, sewerage pipes, manholes, drainage pipes & chambers, communication cables, power supply cables etc. met within the course of excavation shall be properly supported and adequately protected, so that these services remain functional. No extra payment will be made for taking such measures unless otherwise specifically provided for in the Contract. Excavation shall not be carried out below the foundation level of adjacent buildings until underpinning, shoring etc. is done as per the directions of the Engineer for which payment shall be made separately.

1.3.9 Blasting: If any blasting operations are necessary, they shall be carried out in accordance with the Explosives Act and the Rules as amended up to date. Explosives Rules 1983 should be strictly adhered to by the Contractor's staff as well as Railway employees engaged in blasting operations. For general guidance, the instructions contained in Chapter X of Indian Railways Works Manual may be referred to. The following specifications are supplementary to the above.

1.3.9.1 Where hard rock is met with and blasting operations are considered necessary, the contractor shall obtain the approval of the Engineer in writing for resorting to blasting operation.

Note: In ordinary rock, not requiring blasting, blasting operations shall not be generally adopted. However, the contractor may resort to blasting with the permission of the Engineer, but nothing extra shall be paid for such blasting operations.

The contractor shall obtain licence from the competent authority for undertaking blasting work as well as for containing and storing the explosive as per the Explosive Act, 1884 as amended upto date and the Explosive Rules, 1983. The contractor shall purchase the explosives fuses, detonators etc. only from a licensed dealer. Transportation and storage of explosive at site shall conform to the aforesaid Explosive Act and Explosive Rules. The contractor shall be responsible for the safe custody and proper accounting of the explosive materials. Fuses and detonators shall be stored separately and away from the explosives. The Engineer or his authorised representative shall have the right to check the contractor's store and account of explosives. The contractor shall provide necessary facilities for this.

The contractor shall be responsible for any damage arising out of accident to workmen public or property due to storage, transportation and use of explosive during blasting operation.

1.3.9.2 Blasting operations shall be carried out under the supervision of a responsible authorized agent of the contractor (referred subsequently as agent on duty), during specified hours as approved in writing by the Engineer. The agent shall be a licensed blaster. In case of blasting with dynamite or any other high explosive, the position of all the bore holes to be drilled shall be marked in circles with white paint. These shall be inspected by the Contractor's agent. Bore holes shall be of a size that the cartridge can easily pass down. After the drilling operation, the agent shall inspect the holes to ensure that drilling has been done only at the marked locations and no extra hole has been drilled. The agent shall then prepare the necessary charge separately for each bore hole. The bore holes shall be thoroughly cleaned before a cartridge is inserted. Only cylindrical wooden tamping rods shall be used for tamping. Metal rods or rods having pointed ends shall never be used for tamping. One cartridge shall be placed in the bore hole and gently pressed but not rammed down. Other cartridges shall then be added as may be required to make up the necessary charge for the bore hole. The top most cartridge shall be connected to the detonator which shall in turn be connected to the safety fuses of required length. All fuses shall be cut to the length required before being inserted into the holes. Joints in fuses shall be avoided. Where joints are unavoidable, a semi-circular notch shall be cut in one piece of fuse about 2 cm deep from the end and the end of another piece inserted into the notch. The two pieces shall then be wrapped together with string. All joints exposed to dampness shall be wrapped with rubber tape.

The maximum of eight bore holes shall be loaded and fired at one occasion. The charges shall be fired successively and not simultaneously. Immediately before firing, warning shall be given and the agent shall see that all persons have retired to a place of safety. The safety fuses of the charged holes shall be ignited in the presence of the agent, who shall see that all the fuses are properly ignited.

Careful count shall be kept by the agent and others of each blast as it explodes. In case all the charged bore holes have exploded, the agent shall inspect the site soon after the blast but in case of misfire, the agent shall inspect the site after half an hour and mark red crosses (X) over the holes which have not exploded. During this interval of half an hour, nobody shall approach the misfired holes. No driller shall work near such bore until either of the following operations have been done by the agent for the misfired boreholes.

(a) The contractor's agent shall very carefully (when the tamping is of damp clay) extract the tamping with a wooden scraper and withdraw the fuse, primer and detonator.

(b) The holes shall be cleaned for 30 cm of tamping and its direction ascertained by placing a stick in the hole. Another hole shall then be drilled 15cm away and parallel to it. This hole shall be charged and fired. The misfired holes shall also explode along with the new one.

Before leaving the site of work, the agent of one shift shall inform another agent relieving him for the next shift, of any case of misfire and each such location shall be jointly inspected and the action to be taken in the matter shall be explained to the relieving agent.

The Engineer shall also be informed by the agent of all cases of misfires, their causes and steps taken in that connection.

1.3.9.3 General Precautions: -For the safety of persons red flags shall be prominently displayed around the area where blasting operations are to be carried out. All the workers at site, except those who actually ignite the fuse, shall withdraw to a safe distance of at least 150 meters from the blasting site. Audio warning by blowing whistle shall be given before igniting the fuse.

Blasting work shall be done under careful supervision of licensed blaster and trained personnel shall be employed. Blasting shall not be done within 100 meters of an existing structure, unless specifically permitted by the Engineer in writing. In such cases, the Authorized representative of the Engineer must be present to ensure that special precautions as may be prescribed by the Engineer and those stipulated by the licensing authority are taken and that necessary warning is given to the inhabitants.

All procedures and safety precautions for the use of explosives drilling and loading of explosives before and after shot firing and disposal of explosives shall be taken by the contractor as detailed in IS 4081, Safety code for blasting and related drilling operation.

1.3.9.4 Precautions against Misfire: -The safety fuse shall be cut in an oblique direction with a knife. All saw dust shall be cleared from inside of the detonator. This can be done by blowing down the detonator and tapping the open end. No tools shall be inserted into the detonator for this purpose.

If there is water present or if the bore hole is damp, the junction of the fuse and detonator shall be made water tight by means of tough grease or any other suitable material.

The detonator shall be inserted into the cartridge so that about one-third of the copper tube is left exposed outside the explosive. The safety fuse just above the detonator shall be securely tied in position in the cartridge. Water proof fuse only shall be used in the damp bore hole or when water is present in the bore hole.

If a misfire has been found to be due to defective fuse, detonator or dynamite, the entire consignment from which the fuse, detonator or dynamite was taken shall be got inspected by the Engineer or his authorized representative before resuming the blasting or returning the consignment.

1.4 **EARTH WORK BY DEPARTMENTAL MATERIAL TRAINS - Deleted**

1.5 **EXCAVATION OF FOUNDATIONS FOR BUILDINGS / TRENCHES FOR PIPELINES ETC. - Deleted**

1.6 **EARTH FILLING IN FOUNDATION TRENCHES AND PLINTH, UNDER FLOORS AND BEHIND ABUTMENTS ETC. - Deleted**

1.7 **SHORING OR TIMBERING FOR TRENCHES – Deleted**

1.8 **PUDDLE – Deleted**

1.9 **MECHANICAL COMPACTION OF EARTHWORK**

Note: Based on RDSO's "Guidelines for Earthwork in Railway Projects" (July 2003 – Guideline No.GE: G-1 to which reference may be made for further details.)

1.9.1 **Orders for Compaction:** -Depending upon the height of the embankment the type of the soil, time available for completing the embankment, the importance of the line and other relevant factors such as axle load, permitting higher speeds within a limited time etc., the Engineer shall decide whether Mechanical compaction is to be done for the full or part height of the embankment.

1.9.2 **Advantages of Compaction: -**

1.9.2.1 Compaction is the process of increasing the density of soil by mechanical means by packing the soil particles closer together with reduction of air voids and to obtain a

homogeneous soil mass having improved soil properties. Compaction brings many desirable changes in the soil properties as follows:

- (a) Helps soils to acquire increase in strength in both bearing resistance and shear strength.
- (b) Reduces compressibility, thus minimizing uneven settlement during services.
- (c) Increased density and reduces permeability, thereby reducing susceptibility to change in moisture content.
- (d) Reduction in erodibility
- (e) Results in homogeneous uniform soil mass of known properties.
- (f) Reduction in frost susceptibility in cold regions.

1.9.3 Factors affecting Compaction in the field: -

Compaction of a particular soil is affected by moisture content, compacting effort, type of roller etc. as explained below:

(a) **Compacting Effort:** In modern construction projects, heavy compaction machinery is deployed to provide compaction energy. Types of machinery required are decided based on type of soil to be compacted. The method of compaction is primarily of four types viz kneading compaction, static compaction, dynamic or impact compaction and vibratory compaction. Different type of action is effective in different type of soils such as for cohesive soils, Sheep's foot rollers or pneumatic rollers provide the kneading action. Silty soil can be effectively compacted by Sheep's-foot roller / pneumatic roller or smooth wheel roller. For compacting sandy and gravelly soil, vibratory rollers are most effective. If granular soil has some fines both smooth wheeled and pneumatic rollers can be used.

(b) **Moisture Control:** Proper control of moisture content in soil is necessary for achieving desired density. Maximum density with minimum compacting effort can be achieved by compaction of soil near its OMC (Optimum Moisture Content). If natural moisture content of the soil is less than the OMC, calculated amount of water should be added with sprinkler attached to water tanker and mixed with soil by motor grader for uniform moisture content. When soil is too wet it is required to be dried by aeration to reach up to OMC.

(c) **Soil Type:** Type of soil has a great influence on its compaction characteristics. Normally, heavy clays, clays and silts offer higher resistance to compaction, whereas, sandy soils and coarse grained or gravelly soils are amenable for easy compaction. Coarse-grained soils yield higher densities in comparison to clay. A well-graded soil can be compacted to higher density.

(d) **Thickness of Layer:** Suitable thickness of soil of each layer is necessary to achieve uniform compaction. Layer thickness depends upon type of soil involved and type of roller, its weight and contact pressure of its drums. Normally, 200-300mm layer thickness is optimum in the field for achieving homogeneous compaction.

(e) **Number of Passes:** Density of soil will increase with the number of passes of roller but after optimum number of passes, further increase in density is insignificant for additional number of passes. For determination of optimum number of passes for given type of roller and optimum thickness of layer at a predetermined moisture content, a field trial for compaction is necessary which will be arranged by the Engineer for which the Contractor shall make all arrangements and bear the cost of test / tests as required.

1.9.4 **Compaction Procedure for Different Soils**

The embankments are constructed with locally available soil provided it fulfils the specified requirements. Procedure of compaction to be adopted will depend on the type of soil being used in construction. General guidelines to deal with compaction of various types of soils for attaining optimum dry density/ relative density at minimum effort, have been briefly given as under. The procedure to be adopted will be decided by the Engineer for strict adherence by the Contractor.

1.9.4.1 **Compaction of Cohesion-less Gravely and Sandy Soil**

(i) Sandy & gravely soils should be compacted with vibratory rollers. If fines are less in these types of soils, it can be compacted with minimum number of passes of vibratory rollers without strict control of moisture to achieve desired Relative Density. With higher percentage of fines, sandy and gravely soils need to be brought to OMC level to get effective compaction. Uniformly graded sand and gravel are difficult to be compacted. Top layer of sand and gravel remains loose in vibrating compaction. Therefore, in final pass the roller should move smoothly without vibration. Dry densities attained in field trials normally should be around MDD/ specified Relative Density as obtained from laboratory tests and should form the basis for specification and quality control.

(ii) Poorly graded sand and gravel with $C_u < 2.0$, should not be used in earthwork for the banks to safeguard against liquefaction under moving loads or especially due to earthquake tremor. Generally, fine sand is prone to liquefaction. This aspect should be specifically examined to prevent possibility of any liquefaction.

1.9.4.2 **Compaction of Silty- Clayey Soils**

Silty soil is a fine-grained soil. These can be plastic or non-plastic depending upon the clay content in it. Silts and fine sands with high water content have a tendency to undergo liquefaction under vibrating rolling due to the pore water pressure generated by mechanical work. Silty soils can be compacted satisfactorily near about OMC either with smooth rollers or vibratory rollers. Vibratory roller will give high degree of compaction and higher lift. Compaction of silty clays will have to be handled in a manner similar to clays.

1.9.4.3 **Compaction of Clays**

(i) Water content plays very important role in compaction of clays. Main objective of compacting predominantly clays is to achieve uniform mass of soil with no voids between the lumps of clays. If moisture content is too high, roller tends to sink into the soil and if too low the chunks would not yield to rolling by rollers. Appropriate water content i.e. OMC of the soil is in the range of about plastic limit plus, two percent. Sheeps- foot rollers are most effective in breaking the clods and filling large spaces.

(ii) Thickness of layer should not be more than depth of feet of roller plus 50mm. Pad foot vibratory roller with drum module weight of 7 tons (total static weight of 11 tons) for a lift thickness of 30 cm is found quite effective for compaction of clays. For better results, initial rolling with static pad foot roller followed by 15-ton vibratory roller can be tried.

(iii) In case of such soils, the MDD and OMC as determined in the Laboratory may not be very relevant and therefore achievable MDD and practicable moisture content at which such soils can be compacted should be determined by conducting field trials for which the Contractor shall make all arrangements and bear the cost of field trials as required.

1.9.5 **Selection of Compacting Equipment:**

The performance of roller is dependent mainly on type of soil used in construction. Guidelines on selection of compacting equipment are given in **Annexure 1.2**. Vibratory rollers which can be used in static as well as dynamic mode with plain and pad drum, are now being manufactured by reputed Indian Companies also. Salient features of some of models are given in **Annexure 1.3**. The Contractor should get the Engineer's approval for the type of equipment to be deployed for compaction.

1.9.6 General Aspects of Mechanical Compaction

- (a) The spreading of material in layers of desired thickness over the entire width of embankment should be done by mechanical means and finished by a motor grader. The motor grader blade shall have hydraulic control suitable for initial adjustment and maintain the same so as to achieve the slope and grade.
- (b) Thickness of layer is decided based on field compaction trials. However, as a good practice thickness of layer should be generally kept as 300mm for fill material and 250mm for blanket material in loose state before compaction.
- (c) If natural moisture content (NMC) of the soil is less than the OMC, calculated amount of water based on the difference between OMC and NMC and quantity of earthwork being done at a time, should be added with sprinkler attached to water tanker and mixed with soil by motor grader or by other means for obtaining uniform moisture content. When soil is too wet, it is required to be dried by aeration to reduce moisture content near to OMC. Efforts should be made to keep moisture content level of the soil in the range of $OMC \pm 2\%$ at the time of compaction.
- (d) Fill shall be placed and compacted in layers of specified thickness. The rate of progress should be, as far as possible, uniform so that the work is completed to final level almost at the same time.
- (e) The rolling for compaction of fill material should commence from edges towards center with minimum overlap of 200mm between each run of the roller. In final pass, roller should simply move over the surface without vibration so that top surface is properly finished.
- (f) Extra bank width of 500mm on either side shall be rolled to ensure proper compaction at the edges. The extra soil would be cut and dressed to avoid any loose earth at the slopes. This should preferably be done with help of grade cutter.
- (g) At the end of the working day, fill material should not be left un-compacted. Care should be taken during rolling to provide suitable slope on toe of the bank to facilitate quick shedding of water and avoid ponding on formation.
- (h) During construction of formation, there may be rainfall to the extent that rain cuts may develop on the surface of formation due to erosion of soil. Care should be taken that these rain cuts are not allowed to develop wide and deep otherwise these locations will remain weak spots.

- (i) Top of the formation should be finished to cross slope of 1 in 30 from one end to other towards cess / drain in multiple lines and from center of formation to both sides in single line.
- (j) Once the top surface of the formation has been finished to proper slope and level, movement of material vehicle for transportation of ballast, sleepers etc. should be avoided since these movements will cause development of unevenness, ruts on the surface which will accumulate water and weaken the formation.
- (k) In conversion / doubling / rehabilitation projects, suitable benching of existing slope shall be done as provided for in the contract before new earthwork is taken up to provide proper bonding between old and new earthworks. It should be ensured that there is no humus material left on the benched slope. Care needs to be taken to avoid entry of rainwater into the formation from this weak junction, otherwise this would result in development of weak formation, slope failure, maintenance problem due to uneven settlement etc.
- (l) At locations where the water table is high and the fill soil is fine-grained, it may be desirable to provide a granular layer of about 30 cm thickness at the base, above subsoil across the full width of formation. This work will be carried out if directed by the Engineer for which extra rate will be paid.

1.9.7 Quality Control of Compacted Earth / Blanket layer

1.9.7.1 **Compacted Earth:** Degree of compaction of each layer of compacted soil should be ascertained by measurement of dry density / Relative Density of soil at locations selected in specified pattern. The method of sampling, frequency of tests, method of tests to be conducted and acceptance criteria to be adopted are as under.

(a) Method of Sampling:

- (i) Various methods of selection of sample points for check of in-situ dry density are in vogue. The sampling adopted has to be such that effectiveness of proper compaction having been done for the entire area under consideration can be judged. For this, the Engineer will lay down in detail the method to be adopted in detail depending on site conditions and accordingly records of checks done are to be properly maintained. However, in absence of such procedure laid down, following method should be adopted.

Suggested Method of Sampling: For each layer, a minimum of one sample at a predetermined interval (in compliance with the requirement stated in next para) along the centerline of the alignment, would be taken in a staggered

pattern so as to attain a minimum frequency of tests as given in sub para “b” below. For subsequent layer, the stagger should be such that the point of sampling does not fall vertically on the earlier sampling points of the layer immediately below. Additional sampling points can be taken, as considered necessary.

- (ii) In case of bank widening, sampling should be done at an interval of minimum 200 meters on widened side(s) of embankment.

(b) Frequency of Tests:

Density check would be done for every layer of compacted fill / blanket material as per following minimum frequency:

- (i) At least one density checks for every 200 sqm. for blanket layers and top one meter of sub-grade.
- (ii) At least one density check for every 500 sqm. for other than blanket and one meter of sub-grade.

In case of bridge approaches or special locations closer frequency may be adopted.

(c) Method of In-situ Dry Density Measurements

Any of the following methods could be adopted as per the requirements at site. RDSO’s guidance may be taken for adoption of other methods such as by use of Nuclear Moisture Density gauge and Compact Meter fitted on rollers.

Method of Measurement	Procedure of test	Parameters to be measured	Remarks
(i) Sand Replacement Method	As per IS-2720 (Part 28) 1974	(a) Insitu Dry Density (b) Moisture content	May be adopted for all type of soils

(ii) Core Cutter Method	As per IS-2720 (Part 29) 1975	-do-	In some of the coarse-grained soils (with little fines) taking core cutter samples is difficult. In such cases, sand replacement method maybe used for density measurement.
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Acceptance Criteria:

(i) Coarse grained soils which contains fines passing 75 microns IS Sieve, upto 5 percent should have the Density Index (Relative Density) a minimum of 70% as obtained in accordance with IS:2720 (Part-14)-1983.

(ii) For other soils, field dry density should not be less than maximum attainable dry density obtained in field compaction trial. However, in field compaction trial, the maximum attainable dry density should not be less than 98% of MDD values as obtained by Heavy Compaction Test (IS 2720 (part 8) – 1983) in the laboratory.

In case, there are difficulties in achieving 98% of the MDD values as obtained by Laboratory test, in the field trials, the same may be relaxed up to 95% of MDD with the specific approval of the Engineer, recording reasons of such relaxation.

(iii) During widening of bank in case of gauge conversion and rehabilitation of unstable formation, compaction of earthwork should be minimum 95% of MDD as obtained by Laboratory test as per Heavy Compaction Test (IS:2720 (part 8) – 1983) or 70% Relative Density for cohesion less soil (IS:2720 (Part 14) –1983).

1.9.7.2 Formation Level: Finished top of sub-grade level may have variation from design level by ± 25 mm and finished top of blanket layer may also be permitted to have variation from design level by plus 25mm. The ballast should be placed only on level formation without ruts or low pockets.

1.9.7.3 Cross Slope: Cross slope should be within 1 in 28 to 1 in 30.

1.9.7.4 Side Slopes: Side slope should in no case be steeper than designed side slope. Provision of berm width should not be less than the designed width.

1.9.7.5 **Formation Width:** Formation width should not be less than the specified width.

1.10 **BLANKETING**

Note: Based on RDSO's Specification No. GE.IRS.2 (Final) dated July 2005 on "Mechanically produced Blanketing Material for Railway formation including Guidelines for Laying" to which reference may be made for further details.

1.10.1 **Scope:** Where the drawings provide for a Blanket of coarse and granular material of thickness as shown therein over the full width of formation, the contractor shall arrange for the supply of the materials at site, spreading over the formation earthwork and for consolidation as detailed below. The thickness of blanketing layer shall be fixed in light of the Guidelines dated July 2005 of RDSO referred to in the Note above.

1.10.2 **Sample for Material:** The successful contractor should submit for approval by the Engineer samples of the Blanketing material in three wide mouth sealed glass jars of a quantity of 0.0035 Cum. each. The material to be used by the contractor for blanketing should strictly adhere to the quality of material as approved by the Engineer.

1.10.3 **Specifications of Blanket Material**

Blanket material produced in a plant should generally conform to following specifications:

- (a) It should be coarse, granular and well graded.
- (b) Skip graded material is not permitted.
- (c) Non -plastic fines (particles of size less than 75 micron) are limited maximum to 12%, whereas plastic fines are limited maximum to 5%.
- (d) The blanket material should have particle size distribution curve within one of the bands of enveloping curves shown in **Figure 1.5** or the percent passing of the material through each IS sieves should lie between the upper and lower limit of blanket material as given in the **Table 1.1**
- (e) The material should be well graded with C_u & C_c as under: Uniformity Coefficient, $C_u = D_{60}/D_{10} > 7$

$$\text{Coefficient of curvature, } C_c = \frac{D_{40}^2}{D_{60} \times D_{10}} \text{ between 1 and 3}$$

- (f) Particle size distribution must follow one of the gradation ranges tabulated below.

Table 1.1: Particle size distribution ranges for different grades of blanket material

S. No.	IS Sieve size	Grade A	Grade B	Grade C
1.	40 mm	100	95-100	95-100
2.	20 mm	100	93-100	80-100
3.	10 mm	95-100	85-95	65-85
4.	4.75 mm	92-99	70-92	43-70
5.	2 mm	65-90	46-65	22-46
6.	600 microns	33-50	22-33	08-22
7.	425 microns	28-40	18-28	05-18
8.	212 microns	16-27	10-16	00-10
9.	75 microns	00-12	00-10	00-08

1.10.4 Selection of Blanket Material

Depending on the source of material, the blanket material can be categorized in the following categories:

- Natural material
- Machine manufactured material
- Crushed material
- Blended material

1.10.4.1 Proper survey of area close to projects needs to be carried out to identify suitable sources of blanket material required for the project. Aim of such source identification survey is to use naturally available material, or select alternatives of machine manufactured blanket material through crushing, blending or a combination, which is cheap and conforms to the specifications laid down.

1.10.4.2 The parent material of the blanket material so chosen should be chemically inactive and sturdy in normal working environment. Brickbats, factory slag, weak dissolvable stones like lime, shale, laterite etc. need not be selected as blanket material.

1.10.4.3 The choice of gradation as provided in 1.10.3 (f), above, may be exercised judiciously, and based on the availability of material. It may be advisable to choose the grade A for finest sub grade soils (requiring 1.0m thick layer of blanket), and grade B or C for coarser sub grades (requiring less thickness of blanket).

1.10.5 **Mechanical Production:**

The Blanket can be produced by adopting either crushing methodology or Blending Methodology as described in Paras 6.1 and 6.2 respectively of RDSO's Specification No.GE.IRS.2 (Final) dated July 2005 and to which reference can be made for any details. Crushing Methodology is resorted to in the event of non-availability of natural source of blanket materials and involves crushing the rock / boulder to produce crushed blanket material. Blending methodology involves proper blending of two or more soils or in combination with soils crushed material like stone chips or quarry dust.

1.10.6 **Quality Control on Blanket Material at Production Site**

1.10.6.1 The source of blanket material, detailed in para 1.10.4, needs to be identified based on tests & studies conducted and conformity of the material to the Specification as laid down in para 1.10.3.

1.10.6.2 It is desirable to have a check on quality of material at source/manufacturing point so that major deviation in quality of the material being sent to site does not exist. It would be in the interest of the supplier to have such tests conducted on his own to avoid any complication at a later stage.

1.10.6.3 The frequency of such test could be laid down by the engineer in-charge, if need be. In the absence of any other instructions, at least one test may be performed per day to check the particle size gradation at the point of loading into the trucks. However, the final acceptance of the blanket material should be at the site where it is laid, as per para 1.10.6.6.

1.10.6.4 The supplier/ Engineer may also lay down proforma for 'Incoming Material Register' to be maintained at manufacturing point for having a control on utilization of different grades of material, especially where blending is done using crushed as well as local material.

1.10.6.5 **Test for Quality:** Blanket material should be tested as per IS: 2720 (Part 4) of a minimum of one test per 500 cum. or part thereof to plot particle size distribution curve, so as to assess its suitability. It would be necessary to carry out wet analysis

to assess actual percentage of fines. To expedite testing work, dry sieve analysis may be carried out if variation between results of dry and wet analysis are not significant and adequate margin exists with respect to acceptance criteria. However, in such cases also, wet analysis has to be carried out at frequent interval to verify the extent of variation. In any situation, acceptance of blanket material would be based on wet analysis only. The sample for wet analysis should be prepared as per para 4.3 of IS: 2720 (Part 4).

1.10.6.6 Acceptance Criteria:

The material should generally conform to specification as given at para 1.10.3.

1.10.7 Transportation:

The blanket material should be transported wet after mixing water in order to achieve OMC, in tippers for direct unloading on formation.

1.10.8 Laying, Spreading and Compacting

1.10.8.1 The blanket material must be spread with a tractor mounted grader or a paver-finisher in layers of uniform thickness, before allowing compaction.

The blanketing should generally cover the entire width of formation from shoulder to shoulder. In case of sand or non-cohesive material it should be confined within a trench with berms of 60 to 75 cm width and sand drains across the cess to drain the track and the blanket. The cross drains should be with adequate slope at 5 to 10 cm below the bottom of the blanket and spaced 3 m apart. The thickness of the blanket shall be at least 30 cms but may be increased depending on local conditions.

1.10.8.2 Compaction to specified levels of RD or percentage of MDD (para **1.10.10.3**) will be carried out through a number of passes of vibratory rollers of 100-120 kN static weight or equivalent capacity. A combination of vibrating rolling initially and static finishing rolling may be established through trials. Speed of roller shall not exceed 5 km/hr.

1.10.8.3 Proper control of moisture is required to optimize the compaction effort. Optimum moisture content may be established through Modified Proctor Apparatus (IS: 2720, part 8) and moisture may be added by sprinkling at the plant or at site as per the requirement.

1.10.8.4 Rolling is to be carried out in layers of not more than 300 mm each, following the same camber profile as provided in the sub grade layer and to be maintained up to the top layer.

1.10.8.5 No provision for un-compacted portion may be made on the edges of embankment. The sides may be hand rammed with a suitable rammer.

Note: The engineer should generally expect to get MDD above 2.1 gm/cc, and OMC in the range of 5-9%, as matter of guidance.

1.10.9 **Quality Control Checks on Finished blanket work:**

1.10.9.1 Degree of compaction of each layer of compacted blanket should be ascertained by measurement of dry density/Relative Density of soil at locations selected in specified pattern. The method of sampling, frequency of tests, method of tests to be conducted and acceptance criteria to be adopted are as under.

1.10.9.2 **Method of Sampling:**

(a) The sampling adopted has to be such that effectiveness of proper compaction having been done for the entire area under consideration can be judged. For this, the Engineer in-charge should lay down the method adopted in detail depending on site conditions and accordingly records of checks done are properly maintained. However, in absence of such procedure laid down, following method should be adopted:

(b) **Suggested Method of Sampling:** For each layer, a minimum of one sample at a predetermined interval (in compliance with the requirement stated in next para) along the centerline of the alignment would be taken. The checking points may be staggered to the extent possible.

(c) **Frequency of Tests:** Density check would be done for every layer of blanket material as per following minimum frequency:

At least one density checks for every 200 sqm of blanket layer. (say, every 18 to 30 m for single line, or doubling work and every 12 to 16 m for a double line construction.)

1.10.9.3 **Method of in-situ dry density measurements:**

Any of the following methods could be adopted as per the requirements at site.

Method of measurement	Procedure of test	Parameters to be measured	Remarks
(i) Sand Replacement Method	As per IS-2720 (Part 28) 1974	(a) Insitu Dry Density (b) Moisture content	May be adopted for all type of material
(ii) Core Cutter Method	As per IS-2720 (Part 29) 1975	-do-	In some of the coarse-grained soils (with little fines) taking core cutter samples are difficult. In such cases, sand replacement method may be used for density measurement.
(iii) Nuclear Moisture Density Gauge	As issued by RDSO	(a) Bulk density (b) Moisture content (c) Dry density (d) Degree of Compaction	May be used in consultation with RDSO
(iv) Compactor meters fitted on roller (On roller continuous compaction control)	As issued by RDSO	As issued by RDSO	May be used in consultation with RDSO.

1.10.10 Acceptance Criteria

1.10.10.1 The material should pass the criteria laid under Para 1.10.6.6 above.

1.10.10.2 The blanket material, which contains fines passing 75 microns IS Sieve, upto 5percent should have the Density Index (Relative Density) a minimum of 70% as obtained in accordance with IS: 2720 (Part 14) – 1983.

1.10.10.3 For other materials, field dry density should not be less than maximum attainable dry density obtained in field compaction trial. However, in field compaction trial, the maximum attainable dry density should not be less than 98% of MDD values as obtained by Heavy Compaction Test (IS: 2720 (part 8) – 1983) in the laboratory. In case, there are difficulties in achieving 98% of the MDD values as obtained by Laboratory test, in the field trials, the same may be relaxed upto 95% of MDD with the specific approval of Chief Engineer/construction, recording reasons of such relaxation.

1.10.10.4 During widening of bank in case of gauge conversion and rehabilitation of unstable formation, compaction of blanket layer should be minimum 95% of MDD as obtained by Laboratory test as per Heavy Compaction Test (IS: 2720 (part 8) – 1983) or 70% Relative Density for cohesion less soil (IS: 2720 (Part 14) – 1983).

1.10.11 **Measurement**

1.10.11.1 Measurement of blanket material should be done on the basis of finished cross section after the material and workmanship have been accepted as per the above criteria. No deduction is to be made towards voids.

1.10.11.2 In very rare cases, where it is not possible to take blanket material on finished sub grade, measurement may be done on the basis of stack measurement with the permission of Chief Engineer in-charge. It may be necessary to frame different schedule items for different methods of measurement. There should be no occasion to change the method of measurement unless specifically provided for in the tender documents duly approved by competent authority.

1.10.11.3 Method of measurement in case of stack measurement may be the same as in case of ballast incorporated in "Specification for track ballast-1999".

1.10.11.4 It is advisable to tally the quantity and quality measured at site with the 'Incoming Materials Register' maintained at plant (para 1.10.6.4) as a means of double check.

Figure Nos.1.1 to 1.4

**SKETCHES SHOWING MANNER OF COMPUTATION OF QUANTITIES OF
VARIOUS CLASSIFICATIONS OF SOIL
(FIG. Nos. 1.1 to 1.4)**

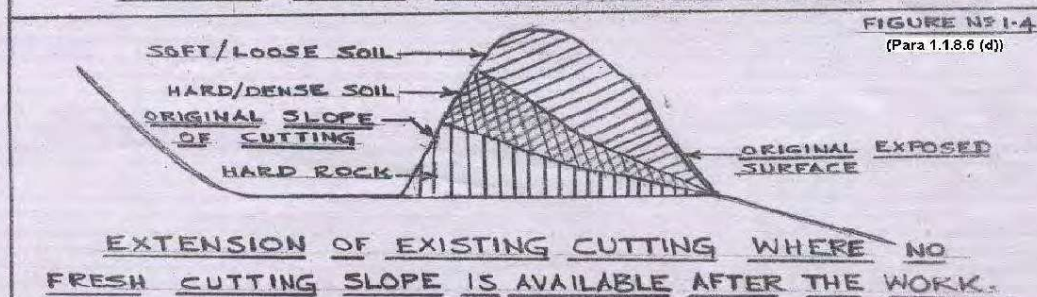
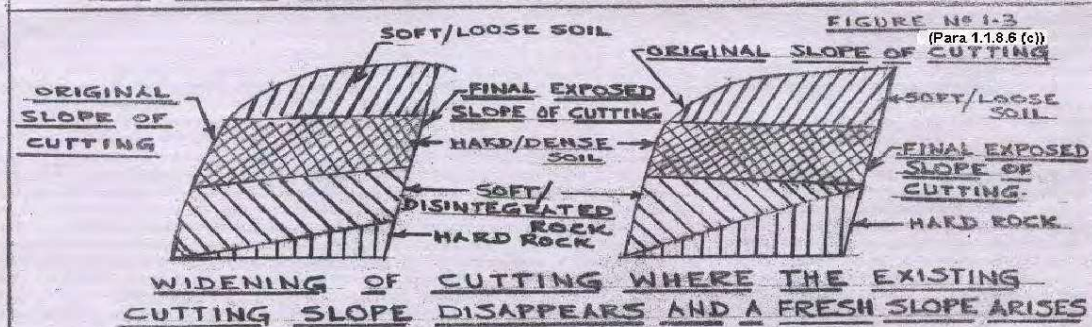
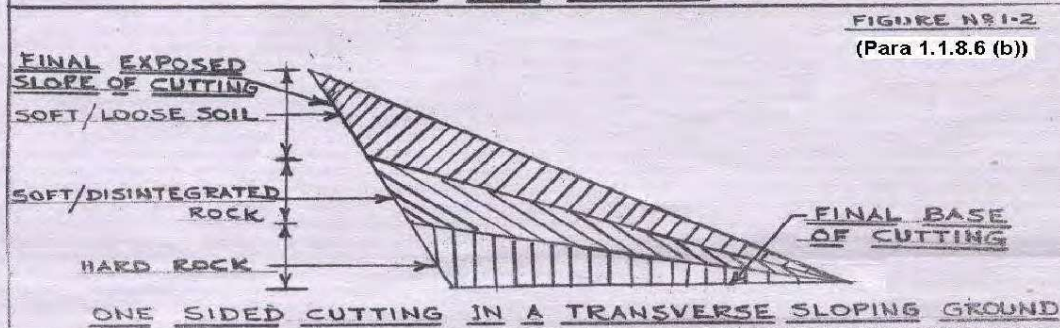
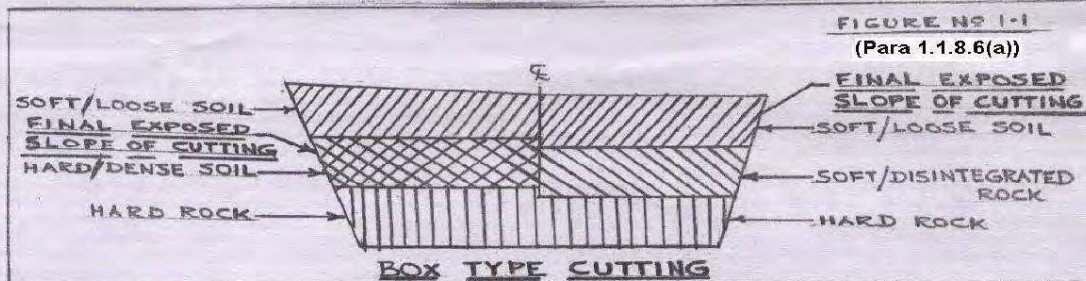
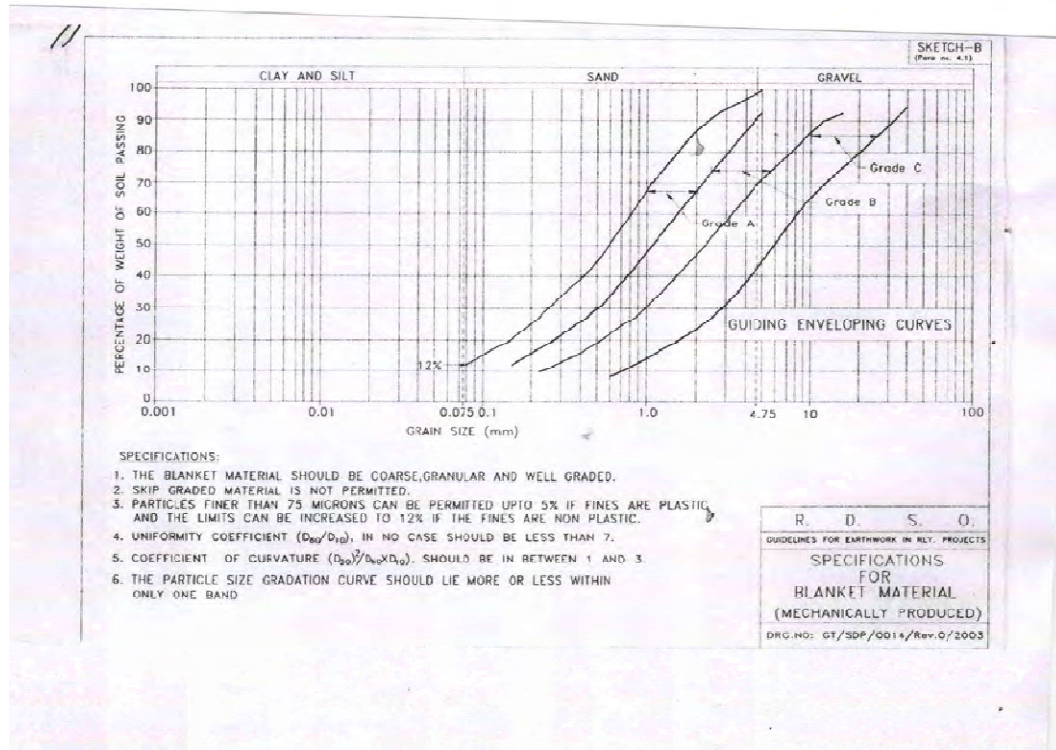


Figure 1.5

Graph showing the different enveloping curves for different grades of blanket material



TECHNICAL SPECIFICATIONS
FOR BRIDGE WORKS AND ROAD WORKS

TECHNICAL SPECIFICATIONS FOR BRIDGE WORKS AND ROAD WORKS**1.0 GENERAL****1.1 General Requirement**

The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings and as described herein.

1.2 Reference Points and Bench Marks

Permanent reference pillars established and fixed in the area shall not be removed or disturbed under any circumstances without the approval of the Engineer. The Engineer-in-Charge will locate initially the center line of the bridges and set out the center point. Contractor will provide all labour and materials required for this purpose. The contractor shall set out details of position/profile of individual foundations, piers, abutments etc. and be responsible for accuracy thereof. The contractor shall carefully maintain and protect all benchmarks and reference points and shall lay out all his work by accurate reference there to. The relevant level of structure at different part will be checked by Engineer-in-charge or his representative.

2.0 EXCAVATION**2.1 Site Clearance**

The contractor shall remove all vegetation, trees, structures and any foreign material existing at the site of proposed work. The area shall be stripped to remove roots of grass/trees, and other organic materials which shall be burnt and/or removed to approved disposal areas or other locations as indicated by the Engineer-in-Charge. Cost of labour, tools, transport etc. required for this is deemed to be included in the overall rate.

2.2 General Requirements

The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the approved drawings and as described herein.

2.3 Drainage in the Vicinity of Excavations

The contractor shall control the surface grade in the vicinity of all excavations so that the surface of the ground in vicinity is properly sloped or diked to prevent surface water from running into the excavated areas during the progress of the construction.

2.4 Excavations shall include the removal of all materials as per direction of the Engineer-in-Charge, as may be required to execute the work properly. Excavation shall be made with sufficient clearance to permit the placing, inspection and setting of forms and completion of all works for which the excavation is made.

2.5 Sides and bottoms of excavation shall be cut sharp and true. Undercutting shall not be permitted. Earth sides of excavation shall not be used in lieu of formwork for placement of concrete unless otherwise authorized in special cases, by the Engineer-in-Charge where limitations of space for larger excavation necessitate such a decision

2.6 When machines are used for excavation, the last 300 mm before reaching the required level shall be excavated by hand or by such equipment that will leave the soil at the required final level, in its natural condition.

2.7 The Bearing capacity of the soil at the bottom of excavation shall be determined by the Engineer-in-Charge, so as to decide on the depth of foundation.

2.8 The bottom of excavation shall be trimmed to the required levels and when carried below such levels by error shall be brought to level by filling with concrete 1:3:6 or as specified, at the contractor's cost.

2.9 If the contractor is directed by the Engineer-in-Charge to excavate to a lower level than that indicated on the drawings and covered by through rates, such additional excavation shall be paid for at the applicable unit rate.

2.10 The contractor shall be responsible for assumptions and conditions regarding the nature of materials to be excavated and the difficulty of making and maintaining the required excavations and performing the work required as shown on the drawing and in accordance with these specifications. Coffers-dams, sheeting, shoring, bracing, draining, dewatering, etc. shall be arranged and installed as required and the cost thereof shall be included in the unit rate quoted for the item of excavation. The contractor shall be held responsible for any damage to any part of the work and property caused by collapse of sides of excavations. Material used for temporary

works may be salvaged if it can be done without jeopardizing safety of the work and structures and subject to approval of the Engineer-in-Charge. However, no extra claim shall be entertained for material not salvaged or any other damage to contractor's property as a result of the collapse. He shall not be entitled to any claim for additional payment for having to re-do the excavation as a result of the same.

2.11 All excavation for installation of underground facilities, such as piping, sewing, sewer lines, tunnels, ducts, drain lines etc. shall be open cuts.

2.12 Where excavation requires bracing, sheeting, or shoring etc. the contractor shall submit to the Engineer-in-Charge, drawings showing arrangements and details of proposed installations and shall not proceed until he has received approval from the Engineer-in-Charge.

2.13 For purposes of excavation of earthwork, the following definitions shall apply, when a through rate is not specified.

(a) **Ordinary Soil**

All kinds of soil except soil containing 50% or more of kankar, moorum and/or shingle and rock.

(b) **Hard Soil**

Soil containing 50% or more of kankar, moorum and/or shingle and boulders upto 150 mm size, without binding material, shall be classified as hard soil, but the decision of the Engineer-in-Charge in the matter of classification of the soil shall be final and binding on the contractor.

2.14 **Measurement**

Measurement for payment will be based on volume calculations determined by the existing grade, (ground level) and the bottom elevation (level) of structure/lean concrete with lateral dimensions (vertical sides) 0.3 m outside concrete outline of lowest footing for depths upto 1 m below existing grade and 1 m outside concrete outline of lowest footing for depths more than 1 m below existing grade (ground level). (Concrete dimensions determined from drawings). The unit of measurement shall be cubic meter. Nothing extra would be payable for slope, shoring, strutting etc. irrespective of the fact that they are actually provided. Payment includes leading excavated soil to a spoil dump or for reuse in a location in the vicinity as directed by Engineer-in-Charge.

2.15 Excavation in Rock-Hard, Soft or Decomposed

2.15.1 For the purpose of classification of rock in excavation, the following definitions shall apply:

(a) **Hard rock requiring blasting**

Any rock excavation for which blasting is required.

(b) **Soft or Decomposed rock**

Lime stone, sand stone, laterite, hard conglomerate or other soft or disintegrated rock which can be quarried or split with crow bars or wedges.

2.15.2 Excavation

The specifications for excavation the Clause No.2.0 to 2.13 above shall apply to excavation work in rock also, except for the bottom of excavation, where depending on the type of rock, over-breaks upto a maximum depth of 0.3 m below the required level may be allowed by the Engineer-in-Charge at his discretion and paid accordingly. Concrete backfill in such over-breaks shall also be paid for. No payment shall, however, be allowed for backfilling, if such over breaks are required to be brought to grade by filling with only soil including its proper compaction.

2.15.3 Blasting material required for excavation work included in this tender shall be arranged by the contractor at his cost, from any authorized dealer of such approved material. Necessary assistance for obtaining approval for procurement of the material will be given by the NHIDCL/Employer. The contractor shall be fully responsible for entering into agreement with any authorized magazine contractor in respect of rates, regularity of supply etc. Contractor will also obtain necessary license for transporting, stocking and use of explosives and draft only suitable qualified and licensed personnel for handling the explosives.

2.15.4 Blasting

All rules under the Explosives Act or other local rules in force shall be fully observed. All blasting works shall be done in accordance with the stipulations contained in the Indian Standard Specification No. IS: 4081. Blasting shall be done by employing qualified personnel and under careful supervision. Blasting shall only be carried out at certain specified times as directed by the Engineer-in-Charge. Proper precautions for safety of persons and property shall be taken. Where blasting is to be carried out in the proximity of other structures, sand bags etc. shall be used on top of the blast holes to prevent the rock fragments, from causing damage to adjacent structures and other property. The unit rate for excavation involving blasting shall be inclusive

of the cost of providing all necessary materials, labour and arranging for such precautions.

2.15.5 Unexploded Charge

The number of blasts to be fired and the actual number of shots heard shall be compared and the person responsible shall satisfy himself by site examination that all blasts have exploded before any person working in the area is permitted to re-approach the work site. The withdrawal of the unexploded charge shall not be permitted under any circumstances. The unexploded charge shall be flooded with water and the hole marked in a distinguishable manner. Another hole shall be made at a distance of about 450 mm off the old hole and fired in the usual way. This process shall be continued till the original blast is exploded.

2.15.6 Decomposed or Soft rock

Excavation in "decomposed or soft rock" shall be carried out by blasting, by crow bars, by shovel and pick axes etc. or by both the methods. No extra shall be paid for the use of any particular method.

2.15.7 Chiseling in Hard Rock:

Where blasting is prohibited or not practicable, excavation shall be carried out by chiseling and payment shall be made at the same rate as provided for hard rock requiring blasting. The decision of the Engineer-in-Charge in this regard shall be final.

2.15.8 All excavated materials obtained from excavation shall remain client's property. The useful portion shall be separated from the useless ones and deposited in regular stacks at places indicated and as directed by the Engineer- in-Charge.

2.16 Measurement

(i) As soon as level of rock is reached, the contractor shall intimate the Engineer-in-Charge, who shall record the level for calculating quantities of excavation in rock.

(ii) When "hard rock" and "decomposed or soft rock" are mixed together, the entire quantity of excavation done below rock level shall be recorded from cross-section taken before commencement and after completion of rock excavation, payment lines being as provided in clauses 2.14 and 2.15.2. The hard rock

excavated shall be stacked, measured and reduced by 30% to allow for bulking and voids to arrive at the quantity payable under "hard rock". The difference between the entire excavation below rock level (between the pay lines) and the quantity payable under "hard rock" shall be paid for as "decomposed or soft rock".

(iii) In case, the quantity of "hard rock" alone as measured above is in excess of the theoretical total payable quantity of excavation below rock level, then payment under "hard rock" shall be restricted to the total theoretical payable quantity.

(iv) All excavated material, rock or soil, obtained as a result of over-excavation and for which payment shall not be made, shall also be carried and disposed of as directed and stacked at places shown by the Engineer-in-Charge, at the cost of the contractor.

(v) In the case of stray boulders which are classified as "hard rock", measurements of such outcrops shall be made on the basis of linear measurements of the outcrop made before excavation. Such measurements shall be signed by the contractor as token of acceptance before excavation is taken in hand.

(vi) When the excavation in rock is paid for as a single item for all classes of rock, the measurement will be made based on cross-sectional area after recording rock level at commencement and finishing.

2.17 **Excavation below Water Table**

2.17.1 Wherever water table is met with during the excavation the Contractor shall immediately report the fact to the Engineer-in-Charge who shall arrange to record the exact level of the water table. The decision of the Engineer-in-Charge in the matter shall be final.

2.17.2 The Contractor shall dewater and maintain the water table below the bottom of the excavation level during excavation. concreting and back-filling.

2.18 **Methods of Measurements**

In the case of excavation in rock, payment for over breaks upto a maximum depth of 0.3 m below the required level may be allowed by the Engineer-in-Charge at his discretion. No extra is payable for dewatering operation during execution of work.

3.0 RUBBLE BACKING

- 3.1 A backing of dry rubble walling will be provided behind abutments and wing walls for facilitating proper drainage. It shall be provided to dimensions in accordance with the drawings.
- 3.2 The materials used should be broken stone of quality approved by Engineer-in-Charge. The stones used will be of least dimension of 15 cm in any direction and not friable. Materials selected from out of excavated material may be permitted to be used by Engineer-in-Charge, in which case only labour rate is payable for the work. Otherwise, the cost will include supply of all materials, labour and tools.

4.0 BACKFILL

- 4.1 The contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings and as described herein.
- 4.2 After completion of foundation footings, abutments and wing walls and other constructions below the elevation of the final grades and prior to backfilling, all forms, temporary shoring, timber etc. shall be removed and the Excavation cleaned of all trash, debris, and perishable materials. Backfilling shall begin only with the approval of the Engineer-in-Charge.
- 4.3 Backfilling shall be done with inorganic materials, obtained from the excavation or borrow pits, if suitable, and subject to the approval of the Engineer-in-Charge. Filling behind abutments and wing walls shall be done with sandy materials to be obtained from approved source.
- 4.4 Backfill shall not be dropped directly upon or against any structure in locations where there is danger of displacement or damage.
- 4.5 Backfill shall be placed in horizontal layers not exceeding 20cm in thickness. Each layer shall be compacted under proper moisture content and with such equipment as may be required to obtain a density equal to or greater than 94% of maximum as determined by the relevant Indian Standards. Trucks or heavy equipment for depositing or compacting backfill shall not be used within 1.5 m of building walls, piers, or other facilities which may be damaged by their weight or operation. The methods of compaction shall be subject to the approval of the Engineer-in-Charge. Pushing of earth for backfilling shall not be adopted under any circumstances.

4.6 Backfill adjacent to pipes shall be hand placed, free of stones, concrete, etc. compacted uniformly on both sides of the pipe and where practicable, to a depth of 300 mm over the top of pipes. While tamping around piping, care shall be taken to avoid unequal pressures.

4.7 On completion of structures, the earth surrounding them shall be accurately finished to line and grade as shown on the drawings. Finished surface shall be free of irregularities and depressions and shall be within 50 mm of the specified level.

4.8 **Measurements**

Measurements shall be based on the volume by computed cross-sections.

5.0 **CONCRETE**

5.1 **Scope**

5.1.1 This section of the Specification covers the technical requirements for furnishing, forming, placing and finishing all concrete, plain and reinforced complete for all structures at all elevations, superstructures, tunnels, ducts and trenches and including encasement of steel section as shown on the drawings except as otherwise specified, and providing necessary recesses, weep holes etc.

5.1.2 All concrete works as indicated in the scope of this contract shall be carried out as per these specifications.

5.2 **General Requirements**

5.2.1 The contractor shall furnish all labour, material and equipment to form, place and finish all structural concrete and miscellaneous items complete, as indicated on the drawings and as described herein.

5.2.2 All materials, tests, mixing, placing, formwork, reinforcing and workmanship shall conform to the Indian Railway Standard Code of Practice for Plain and Reinforced Concrete for General Bridge Construction (Revised latest edition) (Concrete Bridge Code) and subsequent amendments and other relevant codes of the Bureau of Indian Standards and/or as shown on drawings and/or described herein, or quoted in the Concrete Bridge Code.

5.3 Materials

- 5.3.1 Cement shall conform to IRS Concrete Bridge Code of Year 1997 (incorporating A&C Slip No. 11, Year 2007) clause 4.1.
- 5.3.2 Concrete aggregates shall conform to "Specification for Coarse and Fine Aggregate from Natural Sources for Concrete" IS: 383 (Latest Edition).
- 5.3.3 Water used in mixing concrete shall be clean and free from injurious amounts of oils, acids, alkali's, organic materials, or other deleterious substances.
- 5.3.4 Reinforcement shall be Thermo Mechanically Treated (TMT) High Yield Strength Deformed (HYSD) bars of grade Fe 500 conforming to IS: 1786 (latest edition) from primary manufacturer. All reinforcement shall be clean and free from loose, mild scales, dust, loose rust and coats of paint, oil or other coatings, which may destroy or reduce bond.
- 5.3.5 Reinforcement accessories shall be furnished by the contractor. Binding wire shall be annealed from wire quality not less than No. 16 S.W. gauge (1.65 mm dia). Bar supports, chairs and bolsters (as approved by the Engineer-in-Charge) shall be sufficiently strong to support the steel properly

5.4 Concrete Mix

The compression strength as measured by works test at 28 days, shall be as indicated on the drawings for the different areas and types of construction or as indicated in IRS-Concrete Bridge Code 1997.

- 5.4.1 Where controlled concrete is used, the minimum cement content will be as per IRS Concrete Bridge Code 1997.
- 5.4.2 Concrete grade upto M-20 will be Nominal Mix Concrete with proportions of materials as per Clause-9.3 and Table-9 of I.S. 456: 2000. Concrete grade above M-20 will be as per mix design to be submitted by the contractor from the Govt. recognized laboratory as per direction of Engineer-in-charge conforming to Code IS-10262:1982(SP-23:1982, P-122). Trial mix will be carried out jointly by the Contractor and the Site Engineer of NHIDCL and cement consumption thereon will be decided on the basis of Trial mix (minimum cement content 400 Kg/cum for RCC and 350 Kg/cum for PCC or as per trail mix whichever is higher). No extra payment will be made for this mix design or trial mix of any grade.

5.5 Sampling and Testing in the Field

- 5.5.1 Samples of concrete shall be taken at the direction of Engineer-in-Charge in the field in accordance with IS: 1199 "Methods of sampling and analysis of concrete".
- 5.5.2 These samples shall be tested for strength and consistency attesting laboratory set up at the Project site or at any other Government Laboratory, approved by the Engineer-in-Charge, in accordance with IS: 516. The moulds, labour and material for cubes shall be supplied by the contractor who shall also arrange to transport the cubes to laboratory at his cost. Actual cost of the testing shall be borne by the contractor.
- 5.5.3 The acceptance criteria for concrete shall be as given in subsequent paras. Only the slumps indicated in the approved design mix shall be adopted. However, larger slumps than those indicated in the approved design mix of concrete of a specified grade (strength) may be necessary to get a workable consistency for concrete in the case of beams, walls columns and other heavily reinforced members. No extra payment shall be made for extra cement that may have to be added in such cases to get the concrete of the same specified grade (strength) with larger slumps. The decision of Engineer-in-Charge regarding the degree of consistency or the amount of slump shall be final.
- 5.5.4 Samples shall be cured under laboratory conditions, except when in the opinion of the Engineer-in-Charge extreme weather condition may prevail at which time the Engineer-in-Charge may require curing under job conditions.
- 5.5.5 If the 'test strength' of the laboratory-controlled cubes for any portion of the concrete work falls below the compressive strength specified, the Engineer-in-Charge shall have the right to order a change in the proportions or the water content for the remaining portion of the structure.
- 5.5.6 If the 'test strength' of the job cubes falls below the specified strength, the Engineer-in-Charge shall have the right to require provisions for temperature and moisture control during the period of curing as necessary to secure the required strength, and may require re-tests in accordance with "standard method of securing, preparing and testing specimens for hardened concrete for compressive and flexural strengths".
- 5.5.7 When the cubes tested reveal a strength lower than those specified, the acceptance criteria for such concrete shall be decided as stipulated in subsequent paras. The

Engineer-in-Charge shall also reserve the right to reject whole or any part of the work. In case of acceptance of such works the standard deviations shall be worked out, and examined by the Engineer-in-Charge and if he is satisfied only then such works can be accepted at the accepted or at the reduced rate.

- 5.5.8 For the purposes of statistical analysis any cube result, which in the opinion of Engineer-in-Charge is due to improper sampling, moulding or testing shall be discarded and a dummy result shall be substituted. The value of dummy result shall be equivalent to the average value of the cubes from the same grade of concrete tested immediately before and after the discarded value.

5.6 General Storage

- 5.6.1 All materials shall be stored by the contractor in a manner affording convenient access for identification and inspection at all times. The storage facilities arrangements shall be subject to the approval of the Engineer-in-Charge.

- 5.6.2 Cement shall be stored by the contractor in silos or suitable weather-proof buildings with dry floors, to be provided by the contractor, in a manner to prevent deterioration.

- 5.6.3 Aggregate shall be stored by the contractor in areas floored with tightly laid wooden planks or other approved hard, smooth and clean surface, in a manner precluding intrusion of any foreign material. Aggregates of different classes shall be stored in separate piles sufficiently removed from each other to prevent the material at edges of the piles from getting intermixed.

- 5.6.4 Reinforcement shall be stored off the ground in a manner to prevent objectionable changes in original surface characteristics in separate piles or racks above grade.

5.7 Mixing and Placing Concrete

- 5.7.1 Concrete shall not be placed in any unit of the work until after the forms, bracing, reinforcing steel and other preparations for casting have been approved by the Engineer-in-Charge and approval given in writing to proceed with the casting. Concreting under severe cold conditions shall not be permitted.

- 5.7.2 No concrete shall be placed except in the presence of the Engineer-in-Charge or his authorised representative. Concrete which is not placed in accordance with the specifications or which is of inferior quality as determined by the Engineer-in-Charge shall be removed and replaced by the contractor at his cost.

- 5.7.3 It is imperative that all excavations prepared for concrete construction are maintained free of water until such concrete work is completed. The contractor shall make provisions and furnish equipment as required for such dewatering, subject to approval by the Engineer-in-Charge. Water used for flushing concrete placing equipment shall be discharged clear of the concrete and forms.
- 5.7.4 All concrete shall be mixed until there is a uniform distribution of materials, and shall be discharged completely before the mixer is recharged. Mixing shall be done in a mechanical mixer and the type and size shall be subject to the approval by the Engineer-in-Charge. The mixer shall be rotated at a speed recommended by the manufacturer and mixing shall be continued at least two minutes after all materials are in the drum. For batches larger than 0.75 cum, mixing time shall be increased at the rate of 15 seconds for each additional 0.75 cum or fraction thereof. All concrete shall be discharged within 3 minutes after the introduction of mixing water to the cement and aggregates unless a different time is specified by the Engineer-in-Charge.
- 5.7.5 Before beginning a run of concrete all hardened concrete and foreign materials shall be removed from the inner surfaces of mixing and conveying equipment. The first batch of concrete through a cleaned mixer for use in the works shall contain 15% less coarse aggregates than normal in order to compensate for coating the interior of the mixer. All conveyance buggies and borrows shall be thoroughly cleaned at frequent intervals during the placing of concrete. Concrete shall be rapidly handled from the mixer to the place of final deposit and shall not be delivered by spout or troughs nor dumped into carriers with a free fall from the mixer of more than 1 m. Every possible precaution shall be taken to prevent separation or loss of the ingredients while transporting the concrete.
- 5.7.6 The placing of concrete shall be a continuous operation with no interruption in excess of 30 minutes between the placing of continuous portions of concrete. Concrete shall be deposited in such a manner as would prevent displacement of forms or reinforcement above the level of the fresh concrete, and the formation of seams or planes of weakness within the sections. Each layer shall be plastic where a new layer is placed upon it. Concrete shall be deposited as close to its final position as practicable in order to prevent segregation. After initial set of concrete the forms shall not be jarred and no strain or vibrating equipment shall be placed on the ends of projecting reinforcement. Chutes used to convey concrete shall be surfaced with metal or other material, and their slopes shall not be such as to cause segregation. Suitable spouts or baffles shall be provided to prevent segregation during discharge. Where concrete is placed manually by use of pans, the entire pan with the concrete

shall be dropped to the surface where concrete is to be deposited instead of emptying the pan manually.

5.7.7 Concrete shall not ordinarily be placed underwater. In unavoidable cases, such concreting shall be done only with the specific approval of procedure and application by the Engineer-in-Charge. Additional cement shall be added as necessary and shall be paid for only at issue rate.

5.7.8 To secure maximum density and eliminate formation of air pockets the concrete shall be thoroughly vibrated and worked around all reinforcement, embedded facilities and into corners of forms. Unless other methods are authorised by the Engineer-in-Charge, mechanical vibrators shall be used for the purpose, the type and operation of which is subject to the approval of the Engineer-in-Charge. The extent of vibration shall be through the entire depth of each new layer and several inches into the layer below. With vibration applied at the point of deposit and uniformly throughout the freshly placed concrete, not farther apart than the radius over which the vibration shall be sufficient to accomplish thorough compaction and complete embedment of reinforcement. The tendency for large aggregate to gravitate to lower elevations due to vibration shall not relieve the contractor from his responsibility of obtaining a uniform density throughout the mass. Excess cement pastes thus formed at the top of each layer shall be removed before the succeeding layer is deposited. Hand tamping shall not be permitted.

Contractor shall provide proper equipment other similar areas where conventional methods would not be adequate. Immersion type vibrators shall be provided at the rate of at least one 65 mm unit per 4 cum per hour together with at least one stand-by vibrator of the appropriate size. Vibrators shall be inserted in the concrete at a sufficient number of places so that their fields of influence overlap and shall not be used to work the concrete along the forms or screens. Vibrators shall be withdrawn in time to prevent the formation of voids. Over-vibration causing segregation, surface laitance, or leakage through the forms shall be avoided. Where electrically operated vibrators are used, diesel or petrol driven stand-by vibrators shall be available for carrying on uninterrupted vibration in case of power failure.

5.7.9 **The contractor shall establish/arrange for concrete batching plant of adequate capacity for speedy execution of the work and shall have adequate number of transit mixture/concrete pump etc. for transportation & placement of concrete. (NOT MANDATORY)**

5.8 Construction Joints

- 5.8.1 The location and details of construction joints not indicated on the drawings must be approved of by the Engineer-in-Charge before concrete is poured.
- 5.8.2 Construction joints in foundations shall not be provided without specific concurrence of the Engineer-in-Charge.
- 5.8.3 When the work has to be resumed on a surface which has hardened, such surface shall be roughened. It shall then be swept clean with wire brushes etc. thoroughly wetted, and covered with a 10 mm layer of neat cement slurry. This 10 mm layer of mortar shall be freshly mixed and placed immediately before the placing of the concrete.
- 5.8.4 Where the concrete has not fully hardened, all laitance shall be removed by scrubbing the wet surface with wire or bristle brushes, care being taken to avoid dislodgment of particles of aggregate. The surface shall be thoroughly wetted for 24 hours beforehand and all free water removed. The surface shall then be coated with neat cement grout. The first layer of concrete to be placed on this surface shall not exceed 150 mm in thickness and shall be well-rammed against old work, particular attention being paid to corners and close spots.
- 5.8.5 The unit rate of concrete work shall include the cost of preparation of construction joints as mentioned above and no extra payment shall be admissible on this account.

5.9 Inserts

- 5.9.1 All anchors, anchor bolts, inserts, pipes, conduits, sleeves, brackets, frames, nosings, bolts, etc. and any other items that are required to be embedded in the concrete shall be placed in correct position before pouring. Extra care shall be taken during pouring operation to maintain their location. Blockouts and openings shall be kept as indicated in the drawings. These inserts shall be welded to the nearest reinforcement to keep them in position and all such welding shall be deemed to be included in the unit rate quoted and no extra shall be payable on this account.
- 5.9.2 Provision will be made for insertion of holding down bolts on piers/bed-blocks in form of necessary holes by leaving a suitable insert before concreting and removing the same after the concrete attains adequate strength. These holes will be filled with cement sand mortar after the girders are aligned and holding down bolt is inserted and fixed in position.

5.10 Curing

5.10.1 Unless otherwise specified, all concrete shall be moist, cured by keeping all exposed surfaces, edges and corners continuously moist for at least seven days after being placed by spraying, ponding or covering with waterproof paper or moisture retaining fabric.

5.10.2 Immediately after stripping of the forms, water shall be applied directly to the concrete surfaces, the wetting down operations shall be continuous within the curing time specified. As an alternative to continual wetting down of pier/abutment/girder faces, the use of a sprayed-on membrane may be substituted subject to approval by the Engineer-in-Charge.

5.11 Method of Measurement

Measurement shall be in cubic meters correct upto second place of decimal. Deductions shall be made for all block outs and openings but not for embedment, reinforcements, and weep holes.

6.0 FORMWORK

6.1 All details of formwork, placing, tying etc. shall be subject to the approval of the Engineer-in-Charge and the contractor when required shall submit drawings, showing details of form construction. The contractor shall be responsible for the adequacy of the formwork to withstand the pressure of freshly placed concrete or other loads imposed without failure, movement or deflection of the component parts. Forms shall be true to the shape, lines and dimensions of the concrete work as shown on the drawings.

6.2 For concrete surfaces that are exposed to view and for all other concrete surfaces that are to be finished smooth, the lining of forms shall be of smooth, non-absorbent lining material. The type and conditions of such lining for forms shall be subject to the approval of the Engineer-in-Charge. All edges of panels shall be square and straight in both directions, and all panels shall match perfectly in length, width and alignment as required.

6.3 All forms shall be sufficiently tight to prevent the loss of liquid from the concrete. All rubbish particularly chipping, shaving and saw dust shall be removed from the interior of the forms before the concrete is placed and the formwork in contact with concrete shall be cleaned and thoroughly wetted or treated with an approved composition to prevent absorption of water from adherence of form to the

concrete. Such composition shall be kept out of contact with reinforcement and shall be non-staining and non-injurious to concrete.

6.4 Form lumber may be reused, provided it is true unwrapped, thoroughly clean and without broken or damaged edges and equal in every respect to new lumber. All reform lumber shall have the contact surfaces re-oiled or recoated with an approved composition prior to usage.

6.5 Contractor shall keep an accurate record of the date on which the concrete is cast for each part of the work and the date on which the form work is removed.

6.6 Removal of forms from structural concrete shall be in accordance with the following requirements.

6.7 No supporting forms shall be removed suddenly in such a manner as to create shock-loading.

6.8 Form work for sides shall not be removed before 2 days.

6.9 Bottom forms shall not be removed before 28 days unless this period is reduced with specific concurrence of Engineer-in-Charge.

6.10 **Method of Measurement**

Measurement of form work where separately provided for and so included in the Schedule shall be based on contact area of concrete work from dimensions shown on the drawings. The unit of measurement shall be sq. metres correct to second place of decimal. Otherwise, the cost will be part of rate quoted for concrete works.

7.0 **BENDING AND PLACING REINFORCEMENT**

7.1 Contractor shall as per instruction of Engineer-in-Charge, fabricate and place reinforcement to shapes and dimensions as indicated or required to carry out intent of drawings and specifications.

7.2 The contractor shall prepare bar-bending Schedule on the basis of the drawings marked "released for construction" and submit the same for approval. No work shall be commenced without the approval of the Schedule.

- 7.3 Any adjustments in reinforcement to suit field conditions and construction joints other than shown on drawings shall be subject to the approval of the Engineer-in-Charge.
- 7.4 The contractor shall adhere strictly to requirements for concrete cover over steel reinforcement, protection of bars for bonding with future extensions, columns ties, splices, laps, spacer bars, temperature reinforcement, mesh reinforcement and other items in connection with proper placing.
- 7.5 Reinforcement shall be placed accurately, tied or welded securely at intersections and splices, and held in position with spacers or other approved supports during concrete placement. Tie wire ends shall be pointed away from surface. Where bars at laps are welded, the length of weld shall be minimum 8xd welded on both sides of the joint and shall be in accordance with the relevant Indian Standards. The contractor will not be entitled to any extra payment for welding the reinforcements.
- 7.6 Payment for steel reinforcement bars shall be on the basis of weight of bare steel irrespective of any coating applied in metric ton. The weight of the bar shall be derived from the sizes and corresponding unit weights given in hand book of BIS. Standard hook lengths, chairs, spacer bars and authorised laps only shall be included in the weight calculated. Binding wires shall not be weighed nor otherwise measured. Measurements for weight shall not include cutting allowance etc.
- 7.7 Bending of bars will normally be done 'cold'. Engineer-in-Charge's specific approval will be obtained for hot-bending of bars. Torsteel/Deformed bars will under no circumstances be hot-bent. No extra will be payable for hot-bending in lieu of cold bending.
- 8.0 **TESTING OF GRADE MIX CONCRETE**
- For Grades M-20 and above Sampling, Strength Test and Acceptance Criteria shall be as stipulated in Para 8.7 of Concrete Bridge Code-197, extracts at **Annexure A**. Procedure for carrying out Cube Compressive Test is at **Annexure B**.
- 9.0 **PIPE CULVERTS**
- 9.1 **General**
- 9.1.1 The pipe used shall be in accordance with IS: 458-56 "Concrete Pipes" and the type will generally be to class NP-4, unless otherwise specified in the drawing. They shall

also be provided with collar unless otherwise specified or permitted by the Engineer-in-Charge.

- 9.1.2 The laying of pipes will be in accordance with IS:783 Code of Practice for laying of concrete pipes and guidelines in Section 2300 of Ministry of Shipping and Transport Specification for Road and Bridge works.

9.2 Materials and Handling

- 9.2.1 All materials used in the manufacture of pipes as well as laying in the pipe culverts shall conform to the general requirements contained in the IS Specification mentioned above and indicated in the foregoing sections.

- 9.2.2 Each consignment of the pipes shall be inspected, tested where considered necessary and approved by the Engineer-in-Charge before their incorporation in the works. If the pipes are not being cast in the vicinity of the works, suitable facilities shall be provided for the Engineer-in-Charge to inspect them during the process of manufacture and at the place of manufacture. Necessary test certificates for the material used shall be produced to the Engineer-in-Charge when demanded.

9.3 Excavation

- 9.3.1 The foundation bed for the pipes shall be excavated true to the levels and grades shown in the drawing or as directed by the Engineer-in-Charge. The pipes shall be placed in shallow excavation made in natural ground, or in trenches cut in the previously made embankments. Where the height of fill exceeds 3 times the external diameter of the pipe before excavating for pipe laying, the embankment shall first be made and properly consolidated upto a level of one pipe diameter above the proposed top of the pipe for length equal to 5 pipe diameters on either side of centerline, trenching being done thereafter. The sides of the trench shall be nearly vertical as possible, and the clearance between sides, and pipe shall not be less than 150 mm or more than 1/3rd the pipe diameter.

- 9.3.2 If soft, spongy or other type of unstable soil is met with during such excavation, the unsuitable material shall be removed to depth, width and length as directed by the Engineer-in-Charge and be back filled with approved granular soil which shall be thoroughly compacted and shaped to the specified level and shape.

- 9.3.3 Where bed-rock-boulder, hard clay, shale or other hard material is met with, the excavation shall be taken for at least 20mm below the bottom level of the pipe and space filled with approved soil, free of stone, fragmented material etc. and

compacted for providing adequate support unless concrete bedding is specified otherwise.

- 9.3.4 Generally pipes for railway culverts will be laid on concrete bedding unless otherwise specified in the drawing.

9.4 **Bedding for Pipe**

The concrete used for the bedding shall have mix which shall have a 28-day compressive strength of not less than 140 Kg/Sq.cm. Unless otherwise specified bedding shall have a minimum thickness of 1/4th of the normal diameter of the pipe and form a cradle extending for 1/4th of the diameter of the pipe above the lowest bedding level. Suitable recess will be provided in the bedding for resting the projection, collars, etc. for the pipe.

9.5 **Back Filling**

- 9.5.1 Trenches shall be back filled soon after the jointing material has hardened. Back filling shall be made of selected good soil free of stones, roots or other organic matter and the soil shall be approved by the Engineer-in-Charge. The back filling shall be done carefully with selected/approved material upto 30 cm above the top of pipe and entirely rammed and consolidated at optimum moisture content. It shall be laid in layers not exceeding 150 mm. Care should be taken particularly while consolidating the soil under the haunches of the pipe. Consolidation below and above haunches of the back fill shall be done by foot, light tampers or hand-operated mechanical equipment approved by Engineer-in-Charge.

- 9.5.2 Filling shall be done simultaneously on both sides of the pipe so that unequal pressures do not occur. No walking or working out the completed pipe shall be permitted till it is back-filled upto 30 cm over the pipe except for purpose of consolidation of fill.

- 9.5.3 In case of high embankment after filling the trench upto the top of the pipe, a loose fill of a depth equal to the external diameter of the pipe shall be placed over the pipe before further layers are added and compacted. This shall be done for the full width of the trench. Only further layers placed above this level, shall be compacted.

9.6 **Face Walls and Wing Walls**

Face walls, wing walls and aprons, etc. shall be constructed in accordance with shall be permitted over the pipe culvert unless the filling over the pipe is at least 60 cm.

9.7 Measurements for Payment

9.7.1 RCC pipe culverts shall be measured along their centre between the inlet and outlet ends in linear meters. Length for supply and laying includes supply of collars jointing material and all labour required for laying, aligning, jointing and curing joints.

9.7.2 Selected granular material and cement concrete for pipe bedding shall be measured as laid in cubic metres. Ancillary work like head walls, etc. shall be measured as provided under the respective sections.

9.8 Rates

9.8.1 The rate for the pipe shall include the cost of pipe and matching collars including loading, unloading hauling handling, storing, laying in position and jointing complete.

9.8.2 Ancillary work such as excavation including back filling, concrete and masonry shall be paid for separately, as provided under the respective clauses.

10.0 PROTECTION WORKS

10.1 Pitching

General

Pitching shall not be laid until the banks on which it is to be laid have become consolidated. Before slope pitching is commenced, unless a floor apron is also provided, a trench is to be dug at the toe of the bank, 50 cm deep, or to the depth shown on the drawings, and 15 cm layer of quarry chips or ballast must be laid in trench, on the bed of the pitching.

All earth surfaces that are to be pitched and subsequently exposed to the action of running water, must be covered with a rammed layer of gravel, moorum or quarry refuse to a depth of about 15 cm or as ordered by the Engineer in charge. This under layer prevents the finer material of the bank of being sucked out by the flowing water.

10.2 Stone Pitching and Flooring

The stones for stone pitching shall be set in the work as received from the quarry, and without any dressing except knocking off weak corners and edges with a

mason's hammer. A small proportion of chips may be allowed to show in the face work. The face stones must in general weigh at least 30 Kg and not more than 60 Kg unless otherwise specified, and be well-bedded and hand set in the earth or dry-stone backing, which must be brought up at the same time as the hand set face work. If the backing is of earth, it shall be rammed in 30 cm layers. For bank protection, only rough stone pitching should be used for reasons of economy.

Stone pitching in continuous lengths will be divided suitably in panel by stone masonry walls 45 cm wide and equal to a depth of pitching with cement mortar 1: 6 or otherwise specified in such a way that total enclosed area does not exceed 10 sqm.

11.0 FLOORING

11.1 Base

The base shall consist of dry rammed moorum or dry rammed quarry refuse of 15 cm thickness as decided by the Engineer- in-Charge.

11.2 Drop Walls & Curtain Walls

The drop walls both on the upstream and downstream shall be built in Cement concrete as specified in the Drawing. On the upstream side the foundation shall be taken to a depth of 90 cm below the bed level while on the downstream side it shall be taken to a sufficient depth and to effectively dissipate the hydraulic head due to high flood level and afflux thereby preventing seepage underneath the flooring towards the downstream side. Alternatively, the depth of the drop walls and the length of the flooring should be as shown in the drawings so that the minimum flow is longer than the piping gradient line. The foundation for the drop wall shall also be laid in cement concrete and dimensions shall be in accordance with the drawings.

11.3 Aprons

11.3.1 Aprons are provided at the toes of Banks in continuation of the slope pitching for affording protection to the banks. These are provided to overcome the effects of scour that will be caused in the bed of the river at this location due to high velocities, whirls etc. Aprons are provided in such a manner that they can launch slope pitching below bed level and extending beyond scour level. Hence such aprons are provided in form of loose stones to a predetermined thickness and width.

11.3.2 A base consisting of smaller stones not exceeding 25 Kg in weight and not exceeding 20 cm in any direction shall be laid first over a layer of stones varying from 25 to 60 Kg in weight. The stones in the pitching shall be laid in such a way that the longest side is bedded vertically. Aprons shall be grouted by the cement mortar as specified in the drawing.

11.4 **Payment**

Measurement will be taken in Cubic meters for pitching and flooring where thickness is predetermined and specified uniformly in drawing.

12.0 **MISCELLANEOUS**

Stone masonry random rubble/coursed rubble/dry course rubble would be used in breast/retaining walls, drop and curtain walls, top, toe and intermediate walls of supporting panels in pitching and flooring in bridges as shown in the drawing and/or as directed by the Engineer-in-Charge.

12.1 **Weep Holes**

75/100mmdia weep hole along with filter media at back would be provided in retaining walls at regular intervals as specified in the drawings/directed by the Engineer-in-Charge. Keeping these holes would be a part of the masonry work/concrete but no deduction would be made in the quantities for holes.

12.2 The following IS codes apply for the special works: -

a) IS-2911 code of practice for construction of pile foundation (with bored piles)

13.0 The contractor shall submit royalty clearance certificate for the material used in RCC, PCC, boulder work etc. with related R/A Bill. If the agency fails to do so, the required amount will be deducted as per extant Govt. rule, from his bill and will be deposited with the concerned dept.

14.0 **WATER BOUND MACADAM ROAD WORKS**

14.1 **General**

The works shall be carried out in accordance with provisions in CPWD Specifications. Chapter 17 on Road Works.

14.2 **Materials**

- 14.2.1 Coarse Aggregates
Para 17.1.1 of CPWD Specifications may be referred to. The Physical requirements have been outlined in Table 17.1 and Grading requirements of size range 90mm to 45mm and 63mm to 45mm in Table 17.2.
- 14.2.2 Fine Aggregates
Para 17.1.2 of Specifications may be referred to.
- 14.3 Preparation of Sub-Grade
Para 17.6 may be referred to.
- 14.4 Sub Base
The Sub Base shall consist of Water Bound Macadam with Stone aggregate of size 90mm to 45mm. Para 17.7.2 of CPWD Specifications may be referred to. Base

The Base Course shall consist of Water Bound Macadam with Stone aggregate of size 63mm to 45mm. Para 17.8.1 of CPWD Specifications may be referred to.
- 14.5 Surface Course
100mm thick Surface course over Water Bound Macadam surface shall be provided as detailed in the relevant item in the BOQ.

ANNEXURE A**GRADE MIX CONCRETEWORKS TESTS ON CONCRETE SAMPLING, STRENGTH TESTING AND ACCEPTANCE CRITERIA****EXTRACTED FROM CONCRETE BRIDGE CODE (REVISED – 1997)**

Note: Unless otherwise specified in the Contract the cost of tests including Materials, labour and testing charge in Laboratory will be borne by the contractor.

8.7 Sampling, Strength Tests and Acceptance Criteria**8.7.1 General**

Samples from fresh concrete shall be taken as per IS: 1199 and cubes shall be made, cured and tested at 28 days in accordance with IS: 516.

8.7.1.1 In order to get a relatively quick idea of the quality of concrete, optional tests on beams for modulus of rupture at 72 ± 2 hours or at 7 days, or compressive strength tests at 7 days may be carried out in addition to 28 days' compressive strength tests. For this purpose, the values given in **Table 7** may be taken for general guidance in case of concrete made with ordinary Portland cement. In all cases, the 28 days' compressive strength specified in **Table 2** shall alone be the criterion for acceptance or rejection of the concrete.

(Note: -Table 2 is on "Grading Concrete" in terms of which the specified characteristic compressive strength at 28 days in N/mm^2 is 20 in case of M-20, 25 in case of M-25 and so on).

TABLE 7 - OPTIONAL TESTS REQUIREMENTS OF CONCRETE (Clause 8.7.1.1)

GRADE OF CONCRETE	COMPRESSIVE STRENGTH ON 15 CM CUBES (N/mm ²)	MODULUS OF RUPTURE BY BEAM TEST Min. (N/mm ²)	
	Min. at 7 days	At 72 + 2 h	At 7 days
(1)	(2)	(3)	(4)
M 20	13.5	1.7	2.4
M 25	17.0	1.9	2.7
M 30	20.0	2.1	3.0
M 35	23.5	2.3	3.2
M 40	27.0	2.5	3.4
M 45	30.0	2.7	3.6
M 50	33.5	2.9	3.8
M 55	37.0	3.1	4.0
M 60	40.0	3.3	4.2

8.7.2. Frequency of Sampling

8.7.2.1 Sampling Procedure - A random sampling procedure shall be adopted to ensure that each concrete batch shall have a reasonable chance of being tested: that is, the sampling should be spread over the entire period of concreting and cover all mixing units.

8.7.2.2 Frequency - The minimum frequency of sampling of concrete of each grade shall be in accordance with the following: -

Quantity of concrete in the work m ³	Number of Samples
1-5	1
6-15	2
16-30	3
31-50	4
51 and above	4 plus one additional sample for each additional 50m ³ or part thereof.

NOTE - At least one sample comprising of 3 cubes shall be taken from each shift.

8.7.3 Test Specimen - Three test specimens shall be made from each sample for testing at 28 days. Additional cubes may be required for various purposes such as to determine the strength of concrete at 7 days or at the time of striking the form

work, or to check the testing error. Additional cubes may also be required for testing cubes cured by accelerated methods as described in IS: 9013. The specimen shall be tested as described in IS: 516.

8.7.4. Test Strength of Samples – The test strength of the sample shall be the average of the strength of three specimens. The individual variation should not be more than ± 15 percent of the average. If more, the test results of the sample are invalid. When individual variation exceeds this limit, the procedure for the fabrication of specimen and calibration of the testing machine should be checked.

8.7.5 Standard Deviation

8.7.5.1 Standard Deviation Based on Test Results

(a) **Number of Test Results:** The total number of test results required to constitute an acceptable record for calculation of standard deviation shall not be less than 30. Attempts should be made to obtain 30 test results, as early as possible, when a mix is used for the first time.

(b) **Standard Deviation to be brought up to date:** The calculation of the standard deviation shall be brought up to date after every change of mix design and at least once a month.

8.7.5.2 Determination of Standard Deviations (Not given in this Annexure)

8.7.5.3 Assumed Standard Deviation – of concrete are not available, the value assumed.

Where sufficient test results for a particular grade of standard deviation given in **Table 8** may be assumed.

TABLE 8 - ASSUMED STANDARD DEVIATION (Clause 8.7.5.2)

GRADE OF CONCRETE	ASSUMED STANDARD DEVIATION N/mm ²
M 20	4.6
M 25	5.3
M 30	6.0
M 35	6.3
M 40	6.6
M 45	7.0
M 50	7.4
M 55	7.6
M 60	7.8

However, when adequate past records for a similar grade exist and justify to the designer a value of standard deviation different from that shown in **Table 8**, it shall be permissible to use that value.

8.7.6 Acceptance Criteria

8.7.6.1 Compressive Strength

When both the following conditions are met, the concrete complies with the specified compressive strength:

- (a) The mean strength determined from any group of four consecutive test results complies with the appropriate limits in column A of **Table.9**; and
- (b) Any individual test result complies with the appropriate limits in column B of **Table.9**.

8.7.6.2 **Flexural strength:** when both the following conditions are met, the concrete complies with the specified flexural strength:

- (a) The mean strength determined from any group of four consecutive test results exceeds the specified characteristic strength by at least 0.3 N/mm^2 .
- (b) The strength determined from any test result is not less than the specified characteristic strength less 0.3 N/mm^2 .

TABLE 9 CHARACTERISTIC COMPRESSIVE STRENGTH COMPLIANCE REQUIREMENTS

(Clauses 8.7.6.1 & 8.7.6.2)

Specified grade	Group of test results	A The mean of the group of test results exceeds the specified characteristic compressive strength by at least N/mm^2	B Any individual test result is not less than the specified characteristic compressive strength less N/mm^2
M20 & above	Any consecutive 4 Tests	3	3

Special Note for Table. 9

8.7.6.3 Quantity of Concrete Represented by Strength Test Results

The quantity of concrete represented by a group of 4 consecutive test results shall include the batches from which the first and last samples were taken together with all intervening batches.

For the individual test result requirements given in column B of **Table 9** or in item (b) of para 8.7.6.2 only the particular batch from which the sample was taken shall be at risk.

Where the mean rate of sampling is not specified the maximum quantity of concrete that four consecutive test results represent shall be limited to 60 m³.

8.7.6.4 If the concrete is deemed not to comply pursuant to para 8.7.6.2 the structural adequacy of the parts affected shall be investigated and any consequential action as needed shall be taken.

8.7.6.5 Concrete of each grade shall be assessed separately.

8.7.6.6 Concrete shall be assessed daily for compliance.

8.7.6.7 Concrete is liable to be rejected if it is porous or honey combed; its placing has been interrupted without providing a proper construction joint, the reinforcement has been displaced beyond the tolerances specified; or construction tolerances have not been met. However, the hardened concrete may be accepted after carrying out suitable remedial measures to the satisfaction of the Engineer.

ANNEXURE B
CUBE TEST FOR COMPRESSIVE STRENGTH OF CONCRETE

A-0 One sample (consisting of six cubes 15 x 15 x 15 cm) shall be taken for every 20 cum or part thereof of concrete work, ignoring any part less than 5 cum or as often as considered necessary by the Engineer. The test of concrete cubes shall be carried out in accordance with the procedure as described below. A register of cubes shall be maintained at the site of work. The casting of cubes, concrete used for cubes and all other incidental charges such as curing, carriage to the testing laboratory shall be borne by the Contractor. The testing fee for the cubes, if any, shall also be borne by the Contractor unless the contract provides otherwise.

A-1 Test Procedure

A1.1 Mould

The mould shall be of size 15 cm x 15 cm x 15 cm for the maximum nominal size of aggregate not exceeding 40 mm. For concrete with aggregate size more than 40 mm. Size of mould shall be specified by the Engineer, keeping in view the fact that the length of size of mould should be about four times the size of aggregate.

The moulds for test specimens shall be made of non-absorbent material and shall be substantially strong enough to hold their form during the moulding of test specimens. They shall not vary from the standard dimensions by more than one percent. The moulds shall be so constructed that there is no leakage of water from the test specimen during moulding. All the cube moulds for particular site should, prior to use, be checked for accuracy in dimensions and geometric form and such test should at least be made once a year.

Each mould shall be provided with a base plate having a plane surface and made of non-absorbent material. This plate shall be large enough in diameter to support the moulds properly without leakage. Glass plates not less than 6.5 mm thick or plain metal not less than 12 mm thick shall be used for this purpose. A similar plate shall be provided for covering the top surface of the test specimen when moulded.

Note: Satisfactory moulds can be made from machine or steel castings, rolled metal plates or galvanized iron.

A.1.2 Sample of Concrete

Sample of concrete for test specimen shall be taken at the mixer or in the case of ready mixed concrete from the transportation vehicle discharge or as directed by the Engineer. Such samples shall be obtained by repeatedly passing a scoop or pail through the discharge stream of concrete. The sampling operation should be spread over evenly to the entire discharging operation. The samples thus obtained shall be transported to the place of moulding of the specimen. To counteract segregation, the concrete shall be mixed with a shovel until it is uniform in appearance. The location in the work of the batch of concrete thus sampled shall be noted for further reference. In case of paving concrete, samples shall be taken from the batch immediately after deposition of the sub-grade. At least five samples shall be taken from different portion of the pile and these samples shall be thoroughly mixed before being used to form the test specimen. The sampling shall be spread as evenly possible throughout the day. When wide changes occur during concreting, additional samples shall be taken if so desired by the Engineer.

A.1.3 Preparation of Test Specimens

The interior surfaces of the mould and base plate shall be lightly oiled before the concrete is placed in the mould. The samples of concrete obtained as described under the test specimen shall be immediately moulded by one of the following methods as indicated below: -

When the job concrete is compacted by manual methods, the test specimen shall be moulded by placing the fresh concrete in the mould in three layers, each approximately one third of the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around the top edge of the mould as the concrete there slides from it, in order to ensure a uniform distribution of concrete within the mould. Each layer shall be pounded 35 time with 16mm rod, 60 cm in length, bullet pointed at the lower end. The strokes shall be distributed in uniform manner over the cross section of the mould and shall penetrate into underlying layer. The bottom layer shall be pounded through its depth. After the top layer has been rodded, the surface of the concrete shall be struck off with a trowel and covered with a glass plate at least 6.5 mm thick or a machined plate. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of water- cement ratio of the concrete by loss of water, either by leakage from the bottom or ever flow from the top of the mould.

When the job concrete is placed by vibration and the consistency of the concrete is such that the test specimens cannot be properly moulded by hand-rodding as described above, the specimens shall be vibrated to give a compaction corresponding to that of the job concrete. The fresh concrete shall be placed in mould in two layers, each approximately half the volume of the mould. In placing each scoopful of concrete the scoop shall be moved around

the top edge of the mould as the concrete there slides from it, in order to ensure a symmetrical distribution of concrete within the mould. Either internal or external vibrators may be used. The vibration of each layer shall not be continued longer than is necessary to secure the required density. The internal vibrators shall vibrate only the layer to be compacted. In compacting the first layer, the vibrators shall not be allowed to rest on the bottom of the mould. In placing the concrete for top layer there should be no mortar loss during vibrations. After vibrating the second layer enough concrete shall be added to bring level above the top of the mould. The surface of the concrete shall then be struck off with a trowel and covered with a glass or steel plate as specified above. The whole process of moulding shall be carried out in such a manner as to preclude the alteration of water-cement ratio of the concrete by loss of water, either by leakage from the bottom or over flow from the top of the mould.

A.1.4 Curing and Storage of Specimen

In order to ensure reasonably uniform temperature and moisture conditions during the first 24 hours for curing the specimen and to protect them from damage, moulds shall be covered with wet straw or gunny sacking and placed in a storage box so constructed and kept on the work site that its air temperature when containing concrete shall remain 22°C to 33°C. Other suitable means which provide such a temperature and moisture conditions may be used.

Note: - It is suggested that the storage box be made of 25 mm dressed tongued and grooved timber, well braced with battens to avoid warping. The box should be well painted inside and outside and should be provided with a hinged cover and padlock.

The test specimen shall be removed from the moulds at the end of 24 hours and stored in a moist condition at a temperature within 24°C to 30°C until the time of test. If storage in water is desired, a saturated lime solution shall be used.

A.1.5 Testing

The specimens shall be tested in accordance with procedure as described below: -

- (a) The tests shall be made at an age of concrete corresponding to that for which the strengths are specified.
- (b) Compression tests shall be made immediately upon removal of the concrete test specimen from the curing room i.e. the test specimen shall be loaded in damp condition. The dimensions of the test specimens shall be measured in mm accurate to 0.5 mm.

(c) The metal bearing plates of the testing machine shall be placed in contact with the ends of the test specimens. Cushioning materials shall not be used. In the case of cubes, the test specimen shall be placed in the machine in such a manner that the load is applied to sides of the specimens as cast. An adjustable bearing block shall be used to transmit the load to the test specimen. The size of the bearing block shall be the same or slightly larger than that of test specimen. The upper or lower section of the bearing block shall be kept in motion as the head of the testing machine is brought to a bearing on the test specimen.

(d) The load shall be applied axially without shock at the rate of approximately 140 kgs. per/ Sq.cm. per minute. The total load indicated by the testing machine at failure of test specimen shall be recorded and the unit compressive strength is calculated in kg per sq.cm. using the area computed from the measured dimensions of the test specimen. The type of failure and appearance of the concrete shall be noted.

TECHNICAL SPECIFICATIONS FOR TRACK BALLAST

SPECIFICATIONS FOR SUPPLY OF BALLAST
(BASED ON IRS-GE-1/JUNE-2004)

1.0 Ballast Supply:

1.19 This specification will be applicable for stone ballast to be used for all types of sleepers on normal track, turn-outs, tunnels and deck slabs etc. on all routes.

2.0 Quality of Stone Ballast in General:

2.1 **Basic quality:** Ballast should be hard durable and as far as possible angular along edges/corners, free from weathered portions of parent rock, organic impurities and inorganic residues.

2.2 **Particle shape:** Ballast should be cubical in shape as far as possible. Individual pieces should not be flaky and should have generally flat faces with not more than two rounded/ sub-rounded faces.

2.3 **Mode of manufacture:** The ballast shall be machine crushed and conforming to the Railway specifications for machine crushed ballast.

2.4 **Physical Properties:** The ballast samples when tested for physical properties (abrasion and impact) in accordance with IS: 2386 (Part-IV)-1963 should have the under mentioned values:

(i) Aggregate Abrasion Test (Using 105 Angles Abrasion Testing Machine).

(ii) Aggregate Impact Test.
Impact values (Percent) – Maximum 20%

2.5 The water absorption test as per IS: 2386, Part-III-1963, which should not be more than **2.5%** vide correction slip-3 issued by Railway Board.

2.6 Track ballast should be obtained from good quality stones / boulder; and top layer, if weathered, must not be used.

3.0 Size and Gradation of Ballast:

3.1 The track ballast shall be well graded of the following size: -

- | | |
|--|--|
| (a) Retained on 65 mm square mesh sieve | - 5% maximum. |
| (b) Retained on 40 mm square mesh sieve* | - 40% to 60% |
| (c) Retained on 20 mm square mesh sieve | - not less than 98% for machine crushed. |

- not less than 95% for hand broken.

* For machine crushed ballast only.

4.0 **Over-size and under-size ballast:**

4.1 **Over-size ballast Tolerances:**

- 4.1.1 Retention on 65 mm square mesh sieve: A maximum of 5% ballast retained on 65 mm square mesh sieve shall be allowed without deduction of in payment.

In case ballast retained on 65 mm square mesh sieve exceeds 5% but does not exceed 10%, payment at 5% reduction in contracted rate shall be made for the full stack. Stacks having more than 10% retention of ballast on 65 mm square mesh sieve, the stack shall be rejected.

In case ballast retained on 40 mm square mesh sieve (machine crushed case only) exceeds 60% limit prescribed in 3.1 (b) above, payment at following reduced rates shall be made for the full stack in addition to the reduction worked out at 4.1.1 above.

5% reduction in contracted rate shall be made if retention on 40 mm Square mesh sieve is between 60% (excluding) and 65% (including).

10% reduction in contracted rate shall be made if retention on 40 mm Square mesh sieve is between 65% (excluding) and 70% (including).

- 4.1.3 In case retention on 40 mm square mesh sieve exceeds 70%, the stack shall be rejected.

- 4.1.4 In case of Hand broken ballast supply, 40 mm sieve analysis may not be carried out. The executive may however ensure that the ballast is well graded between 65 mm and 20 mm.

4.2 **Under-Size Ballast – Tolerances:**

The ballast shall be treated as under-sized and shall be rejected if-

- 4.2.1 Retention on 40 mm Sq. mesh sieves less than 40%.

- 4.2.2 Retention on 20 mm Sq. mesh sieve is less than 98% (for machine crushed ballast) or 95% (for Hand broken ballast).

5.0 **Sieve Analysis for Size and Gradation:**

The screens for sieving ballast shall be of square mesh and shall not be less than 100cm in length, 70cm in breadth and 10cm in height on the sides. The squareness of the individual hole in the sieves viz. 65, 40 and 20 mm should be ensured. The sieves to be used for the sieve analysis.

Sieve sizes mentioned above are the nominal sizes. However, the following tolerances in the sizes of holes for 65, 40- and 20-mm nominal sizes are permitted.

65mm square mesh sieve plus minus (\pm) 1.5mm

40mm square mesh sieve plus minus (\pm) 1.5mm

20mm square mesh sieve plus minus (\pm) 1.0mm

When carrying out sieve analysis, the screen shall not be kept inclined, but held horizontally, and shaken vigorously. The pieces of ballast retained on the screen can be turned with hand to see if they pass through but should not be pushed through the screen openings.

The percentage of ballast passing through or retained on the sieve shall be determined by weight.

6.0 **Sampling of Ballast:**

6.1 A minimum of 3 samples of ballast for sieve analysis shall be taken for measurement done on any particular date even if the numbers of stacks to be measured are less than three.

6.2 The test viz. determination of Abrasion value, Impact value and water absorption value should be got done through the following laboratories/Govt. Institutions.

Any Zonal Railway Laboratory or any Railway approved Laboratory/ Institution.

National Test House, Alipore, Kolkata

NHIDCL Laboratory (where available),

Any Govt. laboratory/institution

6.3 In order to ensure supply of uniform quality of ballast, the following norms shall be followed in respect of sampling, testing and acceptance.

6.3.1 On supply of first 100 cum. the test for size, Gradation, Abrasion value, Impact value and water absorption value (as prescribed) shall be carried out. Further supply shall be accepted only after this ballast satisfies the specification for these tests. NHIDCL reserves the right to terminate the contract at this stage itself in case the ballast supply fails to conform to any of these specifications.

6.3.2 All Costs towards the laboratory test should be borne by the contractor.

6.3.3 Subsequent tests shall be carried out as follows:

S.N.		Supply in stacks	
		For each stack of volume less than 100 cum	For each stack of volume more than 100 cum.
(a)	Size & Gradation Test: - Testing frequency ----- Size of sample -----	One for each stack. ** 0.027 cum	One for each stack. ** 0.027 cum. for every 100cum or part thereof.
(b)	Abrasion value, Impact value and Water absorption Tests **: - Testing frequency -----	One for every 2000 cum.	

** This sample should be collected using a wooden box of internal dimension 0.3m x 0.3m x 0.3m from different parts of the stack/wagon.

These tests shall be done for the purpose of maintaining quality during supply. In case of the test results not being as per the prescribed specifications at any stage, further supplies shall be suspended till suitable corrective action is taken and supplies ensured as per the specifications.

The above tests may be carried out more frequently if warranted at the discretion of Engineer-in-charge of NHIDCL.

All tests for Abrasion value, Impact value and water absorption value conducted subsequently after award of contract shall be done as per direction of In-charge of the work at contractor cost.

6.4 In the event of the ballast being rejected the Contractor/Agency will have to remove the rejected ballast from the work-site expeditiously at his own cost.

6.5 The Engineer shall mark all rejected ballast in any manner he considers fit to prevent them from being removed and mixed with good/accepted ballast and the Contractor shall within a

fortnight from the date of the order of removal, remove the rejected ballast to such place as may be directed by the Engineer and, in the event of contractor's failure to do so the Engineer may cause it to be removed and all costs of such removal shall be payable on demand by the Contractor to NHIDCL and without prejudice to any other mode of recovery, may be deducted from any money, that may be due or may become due to the contractor or from the Contractor's bill for any other works executed for NHIDCL on behalf of Employer.

- 6.6 Should NHIDCL, under any special circumstances, agree to take over all or part of the rejected ballast, the same will be paid for at rates to be fixed by the authority accepting the tender and agreed to by the contractor in writing.
- 7.0 The screen for sieve analysis as specified in specification as also the standard box for measuring volume should be kept available at site by the contractor at his own cost, for use by the Engineer or his representative after proper check, in carrying out sieve analysis. Labors required for doing sieve analysis will be supplied by the contractor free of cost. The contractor must also accept the results of such analysis in writing.
- 8.0 Each stack of ballast shall be serially numbered and may be as long and broad as possible. After the stacks are measured, they should be sprinkled with lime in the form of cross on all the sides of the stack at the contractor's own cost to the satisfaction of the Engineer-in-Charge of NHIDCL. Suitable space should be left in between stacks in adjacent zones so that there is no possibility of materials of fresh stacks in one zone mixing with stacks already measured in the adjacent zone.
- 9.0 Entries in the ballast measurement register should not be over written. If any correction is required, the same should be done by striking off the old entry by drawing a line and showing proper entry by its side.
- 10.0 Ballast is to be stacked proper trapezoidal section on the cess or berms, or on the line or in depots as may be ordered by the Engineer concerned, in stacks as large as possible and ordinarily not less than 1.0 meter in height except hilly areas where it may 0.5 m. The height shall not be more than 2.0 m. Top width of the stack shall not be less than 1.0 meter. Top of stack shall be kept parallel to the ground plane. The side slopes of stack should not be flatter than 1.5: 1 (Horizontal: Vertical). Cubical content of each stack shall normally be not less than 30 (thirty) Cum in plain areas and 15 cum in hilly areas.
- 11.0 The Engineer should, as far as possible, set out the sites for ballast stacks. Stacking ground must be fairly dressed to a proper plane by the contractor at his own cost before stacking is started. Completed stacks must be properly finished before being offered for acceptance and measurement.

- 12.0 It must be distinctly understood that the accepted rate is for ballast which conforms in all particulars of quality, stack measurements, gauge, completion within time limit and delivery at site fixed upon, with the specification and conditions of contract. If, therefore, the officer deputed to measure up a Contractor's ballast is not satisfied that the above conditions and specifications have been complied with, he is at liberty to take either of the following courses.

To refuse to measure up such ballast at all giving his reasons in writing for so doing to the Contractor.

To call upon the contractor in writing to screen his ballast of dirt and admixtures beyond the specified limit or to break it to gauge, or to re-stack it to proper dimensions, or all three as may be required, prior to further inspection and measurement by a fixed date, within the time limit imposed in the agreement.

- 13.0 The contractor shall provide at his own cost adequate labour and tools for opening out stacks for inspection and for carrying out screening test.
- 14.0 The contractor shall supply all necessary tools for the work and also bamboos, pegs, strings etc. necessary for measurement of ballast.

15.0 **Wagon Measurement:**

In case ballast supply taken by direct loading into wagons, a continuous white line should be painted inside the wagon to indicate the level to which the ballast should be loaded. The cubical content in cubic meter corresponding to white line should also be painted on both sides outside the wagon.

In addition to painted line, mentioned in para 15(i) above, short pieces of flats (cut pieces of tie bars or otherwise) with cubical contents punched shall be welded at the center of all the four sides as permanent reference. In case the supply is taken in general service wagon, actual measurements will be taken.

16.0 **Shrinkage allowance:**

Payment shall be made for the gross measurement either in stacks or in wagons without any deduction for shrinkage/voids. However, when ballast supply is made in wagons, shrinkage upto 8% shall be permitted at destination while verifying the booked quantities by the consignee.

17.0 **Stack measurement:**

The quantity shall be calculated as per the following formula for the ballast supplied.

$$Q = \frac{LB + LT}{2} \times \frac{WB + WT}{2} \times H$$

When, Q = Quantity of Ballast

LB = Average length of the stack at the bottom.

LT = Average length of the stack at the top

WB = Average width of the stack at the bottom

WT = Average width of the stack at the top

H = Average height of the stack.

The plan of the stack should be either square or rectangular.

**TECHNICAL SPECIFICATIONS FOR
THERMIT WELDING OF RAILS**

ANNEXURE - 'A'
TECHNICAL SPECIFICATION FOR THERMIT WELDING

1.0 Portion for Welding

- 1.1 The 'portion' used for welding shall conform to the technical requirements as mentioned in IRS: T-19-1994. The suitability of the 'portion' for the welding process in respect of the type and section of rails to be welded shall be ensured before commencing welding. Only RDSO certified/passed portions should be used for welding.
- 1.2 **Equipment and staff for welding:** The list for one set of A.T. welding equipment by short preheating process is given in Annexure 2. The composition of termite welding team is given in Annexure 3.
- 1.3 **Preparation of rail ends to be welded:** The rail end face and adjacent sides afoot (top and bottom), web and head up to 50 mm shall be thoroughly cleaned using kerosene oil and brushing with wire brush to remove all dirt, grease and rust before welding. Any burrs at the rail ends shall be removed by chiseling or grinding.

Normally, no alumino -thermic welded joint shall be located closer than 4m from any other welded or fish plated joint.

- 1.4 **Gap between rail ends:** The two rail ends to be welded shall be held in position with a uniform and vertical gap as per gap specified in Annexure 1. The uniformity and verticality of the gap shall be measured by a gauge prior to welding. In case of wide gap $50 \pm 1 / 75 \pm 1$ mm welding, for repairing fractured /defective welds, it shall be ensured that the enfaces vertical. In LWR/CWR territory, hydraulic/mechanical rail tensor of suitable and approved design should be used for maintaining correct rail gap during welding.
- 1.5 **Preliminary work prior to welding.**
- 1.5.1 In case of in-situ welding the rail fastenings for at least five sleepers on either side of the proposed weld shall be loosened. The sleepers adjacent to the joint to be welded shall be shifted to obtain a clear working space of 250 mm on either side to accommodate the moulds, clamps, preheating equipment, etc. The rails shall then be properly aligned, both horizontally and vertically.
- 1.5.2 When the welding work is carried out on cess, full rail length shall be leveled by supporting on at least ten wooden blocks on either side. The rails shall be properly aligned in horizontal and vertical direction and held in position.

1.6 Alignment of Rail Ends Before Welding

1.6.1 The rail ends to be welded shall be aligned in horizontal and vertical planes to the dimensional limits indicated below.

1.6.1.1 **Lateral Alignment:** The two rail ends, after alignment shall be within ± 0.5 mm. when checked with a 1.0 m straight edge at rail ends [Fig. 4.7.1.1(a) & (b)]. Any difference in the widths of rail heads shall always be fully kept on the non-gauge side, correctly aligning the rail ends on the gauge face.

1.6.1.2 **Vertical Alignment:** The joint shall be kept higher by 3 to 4 mm for 72 UTS rails and 2 to 2.4 mm for higher UTS rails when measured at the end of 1 m straight edge (as compensation against sagging caused by differential shrinkage on cooling) (Fig. 4.7.1.2). This shall be achieved by wedges applied on the rail supporting blocks on both sides of the joint.

1.7 Fixing of Moulds

1.7.1 Only prefabricated moulds supplied by the portion manufacturer shall be used for welding. These are to be made by mixing high silica sand to IS:1987 with sodium silicate to the required consistency, followed by passage of carbon dioxide gas. These prefabricated moulds shall have adequate permeability for escape of moulds gases and adequate reinforcement to avoid moulds crushing during transportation and welding.

1.7.2 Before mounting on the rail ends to be welded, each pair of moulds shall be examined for defects, dampness, cracks, blocked vents, etc. and defective moulds discarded. The prefabricated moulds shall be handled with care as they are fragile and liable to breakage.

1.7.3 During fixing the moulds, it shall be ensured that the Centre line of the rail gap coincides with Centre line of the moulds to avoid cross joint. The moulds jackets/shoes holding the pre-fabricated moulds in a snug fit condition, after fixing, shall be tightened by the application of adequate pressure. Excessive pressure may cause breakage of mould and dropping of sand inside the moulds cavity. Care shall be taken during application of adequate pressure; it is essential for the moulds to fit flush to each other across the bottom of the rail flange which can be checked by feeling with fingers across the junction of the two halves of the moulds and by looking down the riser aperture. The moulds should touch the bottom of rail foot to ensure proper size of collar at the bottom.

1.7.4 After fixing the moulds, the gap between mould and the rail shall be packed firmly with luting sand to prevent leakage of liquid weld metal. To protect the rail top table from metal splashes during reaction, the adjacent rail surface on either side of the moulds shall be covered with metal cover or smeared with luting sand upto 15 cm. on either side.

1.8 Preheating

- 1.8.1 After fixing and luting of the moulds, the rail ends shall be uniformly pre-heated throughout the rail section with specially designed air petrol/compressed air petrol/oxygen-LPG burner as the case may be. The flame shall be properly adjusted to achieve the desired rail temperature. The pre-heating shall be done from the top of the mould box for stipulated period for welding technique adopted, so as to achieve a temperature of around $600 \pm 20^{\circ}\text{C}$.
- 1.8.2 In welding process using air petrol burner, the compressor tank pressure during operation of the burner shall be maintained at $7 \pm 0.70 \text{ kg/cm}^2$ ($100 \pm 10 \text{ lb per sq.in}$). In case of pre-heating by oxygen and LPG cylinders shall be adjusted in the range of $7.0\text{-}8.0 \text{ kg/cm}^2$ and $2.0\text{-}2.5 \text{ kg/cm}^2$ respectively. While preheating with oxy-LPG burner LPG supply should be opened first and the gas ignited, thereafter oxygen supply should be opened. While closing, oxygen supply should be stopped first followed by LPG supply. The burner shall be properly adjusted during preheating to ensure that the head, web and foot of both the rail ends are heated uniformly.
- 1.8.3 **Preheating Time:** Preheating time would be about 10 to 12 minutes and 2 to 2.5 minutes for air-petrol and oxy-LPG preheating techniques respectively. The actual preheating time would depend upon the rail section and welding technique adopted as given in Annexure 1.
- 1.8.4 Special emphasis shall be given to the tank pressure, efficiency of burner and flame condition for achieving required rail temperature within the stipulated time. From time to time or in case of any doubt with a view to maintain proper quality control, temperature measuring devices like optical pyrometer, contact type pyrometer or temperature indicating crayons may be used for measuring rail end temperature just after completion of preheating i.e. after removal of burner.

1.9 Welding

- 1.9.1 The crucible lined with refractory material (magnesite/crushed alumina slag) and fitted with bottom stone and thimble shall be preheated before making the first weld of the day to ensure freedom from moisture.
- 1.9.2 Slag shall be cleaned from the crucible after each reaction, if necessary. During cleaning, care shall be taken not to damage the refractory crucible lining. The lining shall be examined regularly and patch repairing, or relining as necessary shall be carried out.
- 1.9.3 The crucible shall be positioned relative to the pouring gate with respect to its height from the mould after it has been placed on the stand mounted on the rail head. The tap hole in the crucible shall be sealed with closing pin, asbestos powder and stag power. The 'portion',

for the required technique, shall be thoroughly hand mixed and poured into the crucible striking the crucible wall so that the bottom plugging remains undisturbed. The portion shall be coned to the Centre of the crucible and a sparkler be placed at the top. The crucible shall then be brought to the proper position over the mould in line with the pouring gate of the mould with a vertical distance of about 50 mm. between the tap hole and sand core/top of the pouring gate.

1.9.4 After preheating the rail joint, the sparkler shall be ignited and inserted in the portion at the Centre top to start the reaction. The reaction shall not be vigorous or boiling. By the time the reaction is completed the burner shall be removed quickly and the gap closed with a dried sand core in case of central pouring to prevent loss of heat and turbulence during flow of metal. The time period between removal of burner and tapping of metal should be as minimum as possible. After the reaction subsides, about three seconds shall be allowed for the separation of slag from the metal, which may be judged by looking into the crucible through colored glass to IS:5983. Thereafter, the molten steel shall be tapped into the mould by striking the closing pin with a tapping rod. It shall be ensured that since the commencement of the reaction, termite steel is tapped within the time limit as specified in Annexure 1. Care shall be taken to ensure that the crucible does not move from its position during tapping. When pouring is over, the crucible and swivel stand shall be removed and kept aside without disturbing the joint. If their action is found to be boiling, the metal shall be out-tapped. Vigorous reaction and loose closing of crucible may cause self-tapping. In this case also, the metal shall be out tapped. If, in any case, self-tapped metal enters the mould, the joint shall be rejected, cut and rewarded. In cases of out tapping, the joint should be cooled to ambient temperature and the process of welding restarted a fresh. However, if temperature can be measured, the rail end may be heated to an extent so as to achieve temperature of about $600 \pm 20^{\circ}$ and welding of joint may be completed.

1.9.5 After pouring, molten metal shall be allowed to cool and solidify with mould intact for the stipulated time (mould waiting time) depending upon the rail section and ambient temperature. In case of alloy steel rails, full rail section up to 300 mm on either side of the joint shall be heated by using burner during this period. The mould shoes shall be removed just prior to completion of mould waiting time. The mould waiting time is generally four to six minutes for 25 mm gap joints. After the mould waiting time has elapsed, the trimming should be done by using weld trimmer of suitable and approved design without knocking out the mould. List of approved manufacturers of rail profile weld grinder and weld trimmer is given at Annexure 4.

In the eventuality of sudden failure of weld trimmer, manual chipping may be resorted to. In case of welding of old rails, if it is not possible to use weld trimmer due to flow of metal at rail head, manual chipping should be done.

1.9.6 During the trimming operation, it shall be ensured that the wedges used in aligning are in their proper places without loosening, and they are not removed for at least 20 minutes after stripping. The runner and riser must not be removed until cold, and that too only by knocking towards the rail.

1.9.7 No welding shall be carried out if it is raining. In case, the rains start while the joint is under execution, immediate arrangement to adequately cover the site shall be made.

2.0 Operations Subsequent to Welding

2.1 Post Weld Cooling

In case of welding of head hardened rails, the average hardness of the HAZ of the rail becomes considerably less than the parent rail hardness. This lower hardness is due to transformation of rail steel occurring at cooling rate much lower than that achieved during the original head hardening operation. Such a hardness difference can lead to differential plastic deformation during wheel rail contact which may cause localized cupping. head hardened rails, therefore, must be subjected to controlled quenching for a specific time by the arrangement approved for the technique.

2.2 **Post Weld Packing of Sleeper:** Before the passage of traffic, the wedges used for aligning should be removed and joint sleepers which were shifted to obtain the clear gap of 250 mm on either side as per para 1.5.2 shall be re-shifted to the original location and repacked. Packing of these re-shifted sleepers should be carried out gently and carefully.

2.3 **Passing of Traffic:** The first train should be allowed to pass on the newly welded joint only after 30 minutes have elapsed since pouring of weld metal. Necessary speed restriction shall be observed until the grinding operation is over.

2.4 Grinding

2.4.1 After the excess metal is trimmed off, the grinding of the remaining metal on the rail table and the sides of the rail head shall be carried out only with rail profile guided grinding trolley of approved design. Use of hand files should not be resorted to except in unavoidable circumstances. In the case of in-situ joints, the grinding shall commence only after the sleeper fastenings are reflexed, after the removal of wedges. The rail table shall first be ground down to original profile and checked by a one meter straight edge. This should be followed by grinding of the sides of rail head. The accuracy of grinding shall be checked by using 10 cm straight edge. While grinding, only light pressure should be applied and grinding wheel should be moved to and fro to avoid local overheating.

2.4.2 Tolerances on Finished Welds: All the finished joints shall be checked to ensure that the joint geometry is within the following tolerances:

- (i) Vertical alignment: Variation not more than + 1.0 mm, -0 mm measured at the end of one meter straight edge.
- (ii) Lateral alignment: Variation not more than ± 0.4 mm. -0 mm measured at the end of 10 cm straight edge.
- (iii) Finishing of top surface ± 0.4 mm, -0 mm measured at the end of 10 cm straight edge.
- (iv) Head finishing on side: ± 0.3 mm over gauge side of the rail head measured at the Centre of 10 cm straight edge.

Note: In specific cases, for joint geometry, in case of old rails, dispensations may be permitted by Chief Engineer.

The method of checking the geometry of welded joints is illustrated in Fig. 5.4.2.

2.5 Record of Joint Geometry: The details of geometry of each joint shall be jointly signed by the firm's and NHIDCL' representative and kept as record. Any joint found not conforming to the above stipulations shall be cut and rewelded, free of cost, by the firm.

2.6 Marking: Each joint shall have a distinctive mark indicating month, year, agency, welder's code and weld number of the welded joint in the following manner.

Month	Last two digits of Year	Agency Specific Weld No. person number
-------	-------------------------------	--

This should be done by punching on an aluminum strip of suitable thickness and dimension of 30 x 100 mm which should be fixed to the web of the rail with epoxy adhesive at approximately 300 mm from the joint. The welded joints shall be serially numbered. Repair welds/additional welds done at a later date may be given continuing weld number. For example, the last termite weld number 88 and subsequently a termite weld has been executed, it shall be numbered 89, irrespective of its location. Engineer-in-Charge shall maintain 'Termite Weld Register' as per proforma given in Annexure 5. No punch marking should be done on the rail.

2.7 Painting of hermit welds

Painting of weld collar should be done on all welds to protect them against normal and severe corrosion immediately after the welding. The procedure of painting and specification of paint is outlined in Annexure 6 and 7.

3.0 Accepted tests

3.1 **Visual Inspection:** All the welded joints shall be examined carefully to detect any visible defect like cracks, blow holes, etc. Any joint, which shows any visible defect should be rejected.

3.2- **Dimensional check:** All finished joints shall be checked for dimensional tolerances which should be within the tolerances as specified in para 2.4.2.

3.3 **Ultrasonic flaw detection test:** All the fusion welded joints shall be ultrasonically tested and accepted by the purchaser or his representative as per the 'Procedure for ultrasonic testing of hermit welded rail joints' given at Annexure 8. This testing shall be completed as early as possible but, in any case, before the contractor/welding team leaves the welding site.

3.4 Rewelding of Defective Joints

3.4.1 All the joints found to be defective as per acceptance tests as given in paras 3.1, 3.2 & 3.3 and/or joints failed in guarantee period as specified in para 4.3 will be cut and rewelded by the firm free of cost using their portions, equipment, labour and consumables.

3.4.2 Where one bad joint is required to be replaced by two new joints, the entire cost of both the joints shall be borne by the firm.

3.4.3 All the rewelded joints should meet the acceptance tests as indicated in paras 3.1 to 3.3.

3.5 Sample Test Joint

3.5.1 One out of every 100 joints welded shall be selected at random by the purchaser or by the inspecting officer within one month of welding and subjected to hardness, transverse load/deflection tests and porosity as per clause 4.2 of IRS: T-19-1994 (reproduced partly as Annexure 9 for ready reference) and the joint shall comply with the provisions laid down therein.

3.5.2 If the sample test joint fails to satisfy any of the requirements of specification IRS-T-19-1994, the NHIDCL will be at liberty to suspend further welding. However, two more randomly

selected joints from the same lot of 100 joints shall be subjected to re-tests as per clause 1.1 of IRS-T-19-1994. Both the joints should clear all the tests. If this report is also not satisfactory, further welding of joints shall be suspended until the firm's welding technique has been examined and the same satisfies the requirements of IRS: T-19-1994.

3.6 Guarantee

3.6.1 Rail joints welded by a firm shall be guaranteed against failure for a period of one year from the date of welding the joints in track or from the date such welded joints made 'in cess' are inserted in the track. Any such welded joint which fails within the guarantee period shall be rewelded free of cost by firm as per stipulations of para 3.4

3.6.2 In case of failure of sample test joint (refer para 3.5), the period of guarantee for 100 joints represented by the sample joint shall be extended for a further period of one year. In case of failure of joints or joints exhibiting signs of failure by cracking within extended period of guarantee, the joints shall be rewelded free of cost by the supplier as per stipulations of para 3.4.

3.6.3 The welded joints with the extended period of guarantee shall be marked 'X' with yellow paint on the outer side of the web of the rail near the joint in addition to the marking prescribed in para 2.6. Such marked joints shall be kept under careful observation by the purchaser.

3.7 Other Requirements

3.7.1 Welding shall be supervised by trained welding supervisor and carried out by trained welder having valid competency certificate from RDSO/TPP, NR, Lucknow in their possession.

3.7.2 A welding supervisor shall supervise not more than two welding teams deployed within 50 m distance at a time.

3.8 Precautions

While carrying out welding at site, the following precautions shall be observed:

- (i) It should be ensured that the portion being used matches with type and chemistry of rail.
- (ii) Rail ends should be square.
- (iii) Alignment to rail ends should be perfect as checked by straight edge.
- (iv) Rail ends should be properly cleaned with kerosene oil and wire brushes.
- (v) Stop watch should be provided to the welding supervisor at each welding site.
- (vi) Pressure in the tanks/cylinder should be properly maintained during pre-heating.
- (vii) Correct gap between rail ends at head, web and foot shall be ensured.
- (viii) Correct gap between rail ends at head, web and foot shall be ensured.

- (ix) Tightness of clips fitted with hose connections to compressor tank and burner shall be checked before commencing preheating.
- (x) Nozzles of burners shall be cleaned periodically to avoid back-fire.
- (xi) The compressor tank shall be kept at least 2 to 3 m away from the burner to prevent fire hazard.
- (xii) The tapping shall be done within the time specified for that particular technique. Welding parameters for techniques presently being used are available at Annexure 1 For special type of welding i.e. 75 mm gap, combination joint, etc. the time of reaction and tapping shall be as stipulated by RDSO for that particular welding technique.
- (xiii) Arrangements for first aid shall be available at site.
- (xiv) Welders should be provided with gloves and colored glasses.
- (xv) Boiling portion shall be out tapped.
- (xvi) No moist portion/torn portion bag shall be used for welding.
- (xvii) Dampness in moulds can lead to porosity and early fatigue failure of welds.
- (xviii) Only those contractual agencies as have clearance from the RDSO /Railway Board can execute welding work. Supply of portions must be from sources approved by RDSO/Railway Board.
- (xix) Many weld failures show evidence of badly cut rail ends. The evenness and verticality of a rail cut depends solely upon the skill of the welder. With portable disc cutters, very little skill is required to produce good cut.

ANNEXURE -1
STATUS OF VARIOUS A.T. WELDING TECHNIQUES (AS ON 31.12.97)

I. India Thermit Corporation Ltd., Kanpur

1. Techniques with air-petrol pre-heating.

Sl No	Welding Technique	Gap (mm)	Pre-heating Time(mm)	Reaction Time (sec)	Wt. Of portion (Kg)+ 2%	Remarks
1.	60Kg (90 UTS)	25+1	12	20+	13.4	Approved
2.	60Kg (72 UTS)	25+1	12	20+		
3.	52kg (90 UTS)	25+1	10	20+	11.8	Approved
4.	52kg (72 UTS)	25+1	10	20+	11.8	Approved

II. HARSHAD THERMIT INDUSTRIES, RAIPUR

1. Techniques with air-petrol pre-heating

Sl No	Welding Technique	Gap (mm)	Pre-heating Time(mm)	Tapping Time (sec)	Wt. Of portion(Kg)+2 %	Remarks
1.	60Kg (90 UTS)	25+1	12	20+	13	Approved
2.	52kg.(90 UTS)	25+1	10-11	20+ 3	12.5	Approved
3.	52kg.(72 UTS)	25+1	10	20+ 3	12	Approved

III. Sagar Electrical & General Industries Hyderabad

1. Techniques with air-petrol pre-heating

Sl No	Welding Technique	Gap (mm)	Pre-heating Time(mm)	Tapping Time (sec)	Wt. Of portion (Kg)+2%	Remarks
1.	60Kg (90 UTS)	25+1	12	20+ 3	13.8	Approved
2.	60Kg (72 UTS)	25+1	10-12	20+ 3	12.5	Approved
3.	52kg (90 UTS)	25+1	10	20+ 3	11.0	Approved
4.	52kg (72 UTS)	25+1	10-11	20+ 3	11.0	Approved

IV. Raybon Metals Private Limited, Bilaspur

1. Technique with air-petrol pre-heating

Sl No	Welding Technique	Gap (mm)	Pre-heating Time(mm)	Tapping Time (sec)	Wt. of portion (Kg)+ 2%	Remarks
1.	52kg (90 UTS)	25+1	10	20+ 3	12.4	Approved
2.	52kg (72 UTS)	25+1	10	20+ 3	12.2	Approved

ANNEXURE-2

LIST OF EQUIPMENT FOR ALUMINO-THERMIC WELDING OF RAIL JOINTS BY SHORT PRE-HEATING
PROCESS PER WELDING TEAM

S. No.	Description	Quantity	
		Mass Welding	Repair Welding
A.	PRE-HEATING EQUIPMENT		
A-1	Air-petrol pre-heating		
1	Pressure tanks with pressure gauges complete	2Nos.	1No.
2	Vaporisers (burner) complete	2Nos.	1No.
3	Nozzle crickers	4Nos.	2Nos.
4	Nozzle keys	1No.	1No.
5	Vaporiser stand	2Nos.	1No.
6	Goose neck attachment to vaporiser	4Nos.	2Nos.
A-2	Compressed air-petrol pre-heating		
1	Suitable compressor system with pressure gauges	2Nos.	1No.
2	Torch (burner) complete 2Nos. 1No.	2Nos.	1No.
3	Torch (burner) keys 1No. 1No.	1No.	1No.
4	Torch (burner) stand 2Nos. 1No.	2Nos.	1No.
5	Goose neck attachment to vaporiser 4Nos. 2Nos.	4Nos.	2Nos.
A-3	Oxy-LPG pre-heating		
1	Oxy-LPG torch (burner)	2Nos.	1No.
2	Oxygen cylinder with pressure gauge	2Nos.	1No.
3	LPG cylinder with pressure gauge	2Nos.	1No.
4	Torch (burner) stand	2Nos.	1No.
5	Connecting hose pipe	4Nos.	2Nos.
B	<u>OTHER EQUIPMENT</u>		
1	Crucible complete	2Nos.	1No.
2	Crucible caps	2Nos.	1No.
3	Crucible forks	2Nos.	1No.
4	Crucible stands	2Nos.	1No.
5	Crucible rings	2Nos.	1No.
6	Mould pressure (clamp)	2Nos.	1No.
7	Cleaning rod round	2Nos.	1No.
8	Tapping rod	1No.	1No.
9	Straight edge 1m long	2Nos.	1No.
10	Straight edge 10 cm long	2Nos.	1No.
11	Aluminium steel rod for thermal plugging	2Nos.	2Nos.
12	Leather washers for pump	4Nos.	2Nos.

13	Gap gauges and height gauge	2Nos.	1No.
14	Filler gauge	2Nos.	1No.
15	Tools for punching the marking	2Nos.	1No.
16	Mould shoes	6 pairs	2Nos.
17	Stop watches	1No.	1No.
18	Pyrometer/thermal chalk for measurement of rail temperature	1No.	1No.
19	Wooden wedges for rail alignment	24 Nos.	12 Nos.
20	First aid box filled with medicines, bandages, cotton etc.	1No.	1No.
21	Mirror 150 X 100 mm with handle	2 Nos.	1No.
22	Tool box containing:		
(i)	Hot sets (chisels) (For emergency use only)	2 Nos.	2 Nos.
(ii)	Funnel tin (for pouring petrol)	1No.	1No.
(iii)	Adjustable spanner	1No.	1No.
(iv)	Hammer 1 Kg.	1No.	1No.
(v)	Sledge hammer double panel 5 Kg.	2 Nos.	2 Nos.
(vi)	Steel wire brush	1No.	1No.
(vii)	Blue goggles	2 Pairs	1 Pair
(viii)	Paint brush 50 mm	1No.	1No.
(ix)	Slag container (bowl)	2 Nos.	1No.
(x)	Asbestos gloves	4 Nos.	2 Pairs
(xi)	Hose clips	4 Nos.	4 Nos.
(xii)	Pliers	1No.	1No.
(xiii)	Rail file 350 X 40 X 6 mm (For emergency use only)	4 Nos.	2 Nos.
(xiv)	Weld trimmer	1No.	1No.
23	Insulation hood for control cooling (for 110 UTS rail welding)	1No.	1No.
24	Rail profile guided grinding trolley	1No.	1No.
25	To ensure quality, protective clothing, shoes gear & leather gloves		

ANNEXURE-3
COMPOSITION OF THERMIT WELDING TEAM
(COMPRESSOR TANK-WISE)

Description	Numbers
Welder Grade-I/Grade-II	1
Welder Grade-III / Skilled Artisan	2
Helper Khalasi / Khalasi	5
Gangman	As per work load

Note: The composition of welding team has been framed taking into account that trimming and grinding operation would be done by weld trimmer and rail profile grinder.

ANNEXURE 4
LIST OF APPROVED SUPPLIERS OF RAIL PROFILE
WELD GRINDER AND WELD TRIMMER (as on 01.09.97)

<u>S. No.</u>	<u>Name of Machine</u>	<u>Approved supplier</u>	
1.	Rail Profile Weld Grinder	(i)	M/s Indiana Machine D-151, Phase-VII, S.A.S. Nagar-160 055 (Near Chandigarh)
		(ii)	M/s Phooltas Tamper Pvt. Ltd. Layak Bhavan, Canal Road, Patna-800 001
		(iii)	M/s Rajasthan Mining & Engg. Pvt. Ltd. 65, Gopal Bari, Jaipur-302 001
		(iv)	M/s. ITC Ltd. 84/22, Fazalganj, Kanpur - 208 012
2.	Weld Trimmer	(i)	M/s CTR Manufacturing Trimmer Industries Ltd. Nagar Road, Pune - 411 014
		(ii)	M/s ITC Ltd. 84/22, Fazalganj, Kanpur-208 012

ANNEXURE 5
PROFORMA FOR THERMIT WELD REGISTER

S. No.	Date of Welding	Location Details				Rail		Bolt Hole Dist. (mm)
		Cess/Situ	Location	Line No.	L/R	Sect.	UTS	
1	2	3				4		

Portion Details				Welding Details			
Agency Code	Batch No.	Portion No.	Date of Manufacturing	Agency Code	Process	Supervisor	Welder Code
5				6			

Weld No.	Block Time		Date of Finish Grinding	Dimensional Toler on Finished Joint				USFD testing after Welding	
	From	To		On 1 m		On 10 Cm		Date	Result (Pass/Fail)
				Lat.	Ver.	Top	Side		
7	8		9	10				11	

In service failure details	Test Joint Date Removed	Repl. Weld Ref.		Signature of Engineer-in-Charge
		Weld	Weld 2	
12	13	14		15

Date of Sending Test Jt. With ref.	Test Joint Results					
	Date of Results with ref.	Hardness (BHN)	Transverse Load	Porosity (%)	Date of marking 'X' for extended guarantee	Remarks
		Rail Weld HAZ Load (t) Def (mm)				
16	17					

ANNEXURE-6
PROCEDURE FOR PAINTING OF WELD COLLAR FOR THERMIT WELDED RAIL JOINTS TO PROTECT
AGAINST NORMAL CORROSION

A. NEW WELDED JOINT

1. Surface Preparation.

- 1.1 Remove dust, loose rust and mill scale by wire brushing.
- 1.2 Scrub welded area with water to make it free from slag and other water-soluble compounds. Make it dry.

2. Painting procedure

- 2.1 Apply one coat of ready mixed paint, brushing, bituminous black, lead free, acid, alkali, water and chlorine resisting, conforming to IS:9862-1981 on the welded area and 10 cm on either side.
- 2.2 After eight hours drying, apply a second coat of the same paint.
- 2.3 Painting should be carried out by brush only.

B. MAINTENANCE PAINTING (FOR OLD PAINTED JOINTS)

1. Surface preparation

- 1.1 Remove dust, dirt, and flaked paint from the welded joint by wire brushing.
- 1.2 Degrease the surface by petroleum hydrocarbon or any other suitable solvent, if oil or grease is present. Allow it to dry.

2. Painting Procedure

- 2.1 Apply one coat of ready mixed paint, brushing, bituminous black, lead free, acid, alkali and chlorine resistant to IS.9862-1981 or bituminous emulsion to IRS: P-30-1996 on welded area and 10 cm on either side.
- 2.2 If required, a second coat of the same paint may be applied after a minimum of eight hours drying.
- 2.3 Painting should be carried out by brush.

- 3. The list of approved manufacturers for the above quality of paints is issued every year by the Director General(M&C), RDSO, Lucknow to Zonal Railways.

ANNEXURE-7**PROCEDURE FOR PAINTING OF WELD COLLAR FOR THERMIT WELDED RAIL JOINTS TO PROTECT AGAINST SEVERE CORROSION****A. NEW WELDED JOINT****1. SURFACE PREPARATION**

- 1.1 Remove dust, loose rust and mill scale by wire brushing.
- 1.2 Scrub welded area with water to make it free from slag and other water-soluble compounds. Make it dry.

2. Painting procedure

- 2.1 Apply one coat of high build epoxy paint (two pack) conforming to RDSO specification No. M&C/PCN-111/88 on the welded area up to 10 cm on either side.

NOTE:

1. The epoxy-based paint recommended is a two-pad system with a pot life of around five hours. Hence, prepare only that much quantity of paint which can be consumed in less than five hours.
2. The paint should be procured along with the thinner recommended by the manufacturer of the paint. No other thinner i.e. kerosene oil, etc. should be used.
3. The painting shall be carried out by brush only. Brush shall be cleaned by the thinner after use.
4. The list of probable suppliers is given below as per RDSO's letter No. M&C/PCN/ II/TR/3 dt. 13/14-5-1991.

(i) M/s Asian Paints (India) Ltd.
'Nirmal', 5th Floor,
Nariman Point, P.B. No.1546,
Mumbai-400421

(iii) M/s Goodlass Nerolac Paints (P) Ltd.,
Nerolac House,
Ganpat Rao Kadaw Marg,
Lower Parel, Mumbai-400013

(ii) M/s Addison Paints & Chemicals Ltd.,
'Huzur Gardens' Sembium,
Chennai-600011

(iv) M/s Shalimar Paints Ltd.
13, Camac St., Kolkata - 700071

(v) M/s Berger Paints India Ltd.
32, Chowringhee Road, Kolkata-700071

ANNEXURE-8

PROCEDURE FOR ULTRASONIC TESTING OF ALUMINO THERMIC RAIL JOINTS

1. This procedure covers the requirement of ultrasonic testing of alumino thermic (AT) welded rail joints immediately after execution of the weld.

2. General conditions of test

2.1 Surface preparation

After execution of the AT weld, the welded zone shall be dressed properly to facilitate placement of probes and to avoid incidence of spurious signals on the CRT. The rail table shall be dressed to obtain reasonably flat and smooth surface. The flange and the web, up to a distance of 200 mm on either side of the weld collar shall be thoroughly cleaned with a wire brush to ensure freedom from dust, dirt, surface unevenness, etc.

2.2 Couplant:

Water/soft grease shall be used as Couplant.

2.3 Sensitivity:

The equipment sensitivity shall be set for normal, 70° and 80° probes in accordance with the procedure laid down in para 4. The sensitivity so adjusted shall be considered as normal gain setting and shall be utilized during AT weld testing. The sensitivity level shall not be altered during the course of testing.

3. Apparatus required

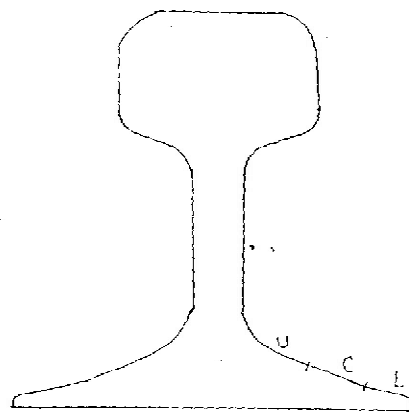
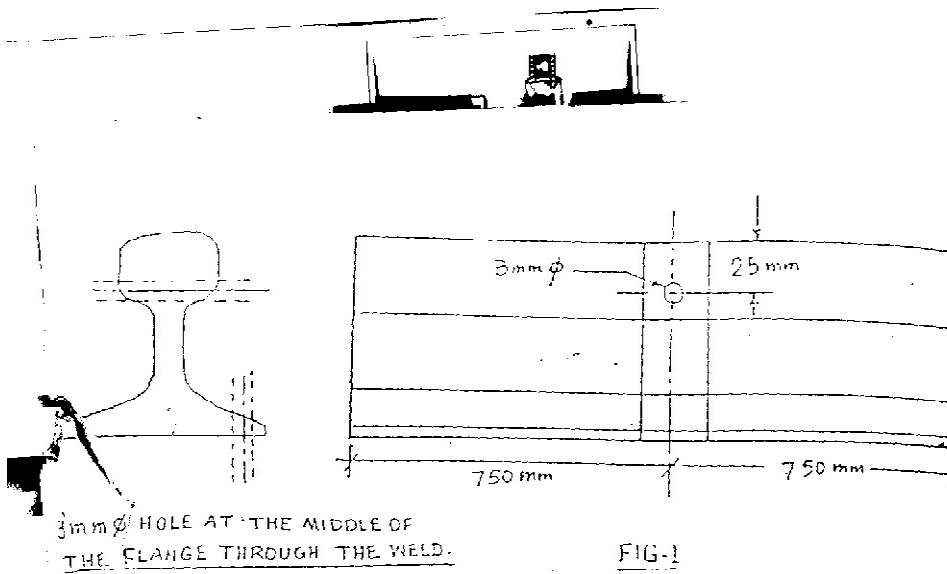
3.1 Equipment:

Any model of RDSO approved rail tester shall be considered suitable for testing of AT welded rail joints.

3.2 Probes:

During ultrasonic examination of AT welded joints, the following probes shall be utilized:

- (a) Normal (0°), 4MHz Double crystal fitted in trolley
- (b) 70° , 2 MHz, Double crystal fitted in trolley
- (c) 80° , 1.25 MHz Single crystal for hand probing.



3.3 Cable:

One co-axial cable of suitable length for connecting 80° probes to flaw detector shall be used. The length should not exceed more than 5m.

4. Sensitivity Setting Procedure

4.1 Calibration:

The equipment shall be set for a depth range of 250 mm by manipulating the depth control knob suitably. Each main scale division, therefore, shall correspond to 25 mm.

4.2 Test Rail

The sensitivity of the ultrasonic equipment shall be set with the help of a standard AT welded rail piece of 1.5 m length having a simulated flaw at standard locations as shown in Fig.1.

4.3 Alignment of probes:

Alignment of normal and 70° probes fitted with the trolley may be checked by placing the rail tester on the test rail using water/oil as a couplant and ensuring that the probes travel along the vertical axis of the rail.

4.4 Sensitivity setting for 70° probes

- 4.4.1 Place the trolley on the test rails shown in Fig.1. Keep the switches of all the probes in off positions and turn the potentiometer knobs of all the probes to 50% of their highest working range.
- 4.4.2 Switch on only 70° towards probe and move the equipment towards the drilled hole of 3 mm dia in rail head. When the probe is just in the reflecting range, a pulse corresponding to the hole shall appear on the screen which during onward traveling shall show higher amplitude. The pulse shall appear moving from right to left. The equipment should be progressively moved forward till maximum height of the pulse is obtained. At this location the height of the pulse shall be adjusted to 50% of full screen height by suitable manipulation of the gain knob.
- 4.4.3 The forward probe shall be switched off and the 70° backward probe shall now be switched on. In this case a flaw signal shall appear moving from left to right. The signal height in this position shall also be adjusted to 60% of full screen height. This can be accomplished through suitable manipulation of relevant potentiometer.
- 4.4.4 The sensitivity setting for the normal problem has to be done while keeping all other probes in off position. Switch on only the normal probe and bring it above 3 mm dia hole drilled in the head of the test rail. Manipulate the potentiometer control knob to obtain echo height of 60% of full screen height at 1.0 division horizontal scale.
- 4.4.5 80° probe shall be connected to the socket available in the ultrasonic equipment. The selector switch may be set to single crystal mode. Move the probe towards the 3 mm dia hole drilled at the middle of the flange through in the AT weld and manipulate knobs to obtain a 60% full screen height on the CRT.

5. Criteria for defect classification

5.1 Any flaw signal obtained by normal probe of 40% height or more from head location shall be treated as a defective AT welded joint and any flaw signal obtained from the normal probe either from the web or the foot location shall also be a cause for rejection of the AT weld.

5.2 In the case of lack of fusion, inclusions, blow holes, etc. in the rail head, moving signal shall be obtained while testing with 70° probes. The position of onset of the signal and its corresponding range on the horizontal screen as well as their maximum amplitude shall be recorded.

A welded joint showing the moving signal of 40% or more of the full screen height shall be considered as a defective welded joint.

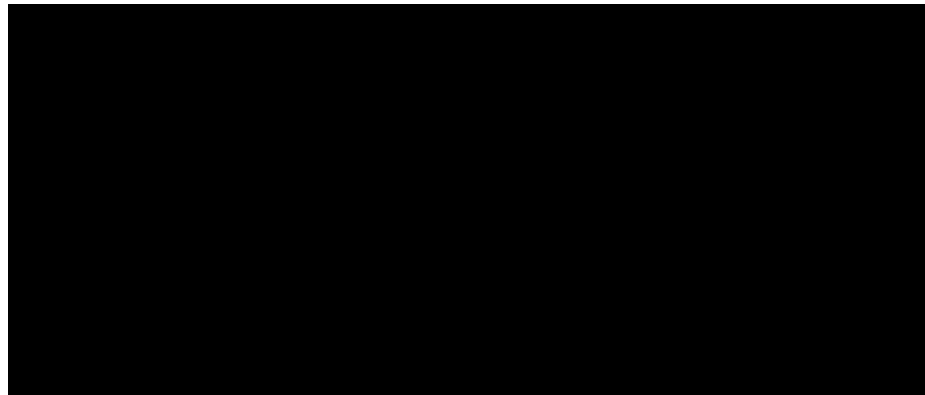
5.3 80° probes shall be placed on the flange at a distance of 180 mm corresponding to position 'L' in Fig.2 such that ultrasonic waves are directed towards the weld. The probe shall thereafter be moved slowly in zigzag pattern towards the weld. A welded joint showing a flaw echo of 40% vertical height or more with the stipulated gain setting shall be treated as a defective welded joint. Similar testing shall be carried out of 'C' and 'U' regions as shown in Fig.2. In these cases, also the criteria for rejection shall remain the same.

6. The defective joints based on the criteria mentioned at para 5 shall not be allowed to remain in service and shall be cropped, re-welded and tested again. This execution shall be done by the contractor free of cost. The re-welded joints shall be scanned ultrasonically again with the same set of acceptance criteria to ensure freedom any harmful defects.

ANNEXURE – 9**EXTRACTS FROM IRS: T-19-1994 CLAUSE 4.2 ON MECHANICAL AND METALLURGICAL TESTS ON TEST WELDS AND RETESTS****4.2 Mechanical and metallurgical tests on test welds**

4.2.1 Two new rail pieces of same section and grade, each approximately 750 long, shall be used to make test weld joint. The welded joint shall be made as per the technique offered by the manufacturer. The rail table and sides of rail head shall be finished to the geometrical tolerances specified in para 18.1

4.2.2 **Hardness test:** Brinell hardness test shall be carried out at the welded zone, heat affected zones and parent metal of the rails in accordance with IS:1500 "Method for Brinell hardness test for steel". The test shall be done on the top surface of the head of the test weld with a ball of 10 mm dia and a test load of 3000 kg maintained for 10 sec. The average hardness number (of two readings) determined for the weld metal at locations shown as 'A' in Fig. 1 given below shall be within +20 HB of the hardness values of rail as shown in table 1. The average hardness number (of two readings) on each heat affected zone at locations shown as 'B' and 'C' in Fig. 1 shall be within ± 20 HB actual hardness of the parent rail, except in case of head hardened rail. The average hardness of medium Manganese IRS-T-18 for welding is 230 HB.



1. For 25 mm gap Sky welding X = 55 mm and Y = 45 mm
2. For wide gap (50 mm & 75 mm) welding

$$X = \text{Gap in mm} + 42 \text{ mm and } Y = \text{Gap in mm} + 32 \text{ mm}$$

FIG.1.

TABLE 1

Type of Rail	72 UTS Rail	90 UTS Rail	UIC Cr-Mn or Cr-V. Alloy steel rail	Head Hardened Rail
Average Hardness (BHN)	230	265	310	365

4.2.3 Transverse breaking load test

4.2.3.1 The test weld shall be supported on cylindrical or semi-cylindrical supports having a distance of one meter between them from Centre to Centre. The weld shall be at the Centre of the span and loaded in such a manner that the foot of the rail is in tension. The diameter of mandrel and the supports shall be between 30 to 50 mm. The load shall be gradually increased (rate of loading shall not exceed 2.5 t/sec) till rupture occurs.

The test weld shall withstand a minimum load and show corresponding minimum deflection as stipulated in Table 2 for different sections and types of rails.

TABLE 2

	Rail type	Rail Section	Min. transverse breaking load (t)	Min. deflection at the centre at the load in col.3 (mm)
	(1)	(2)	(3)	(4)
1.	72 UTS to IRS: T-12- 1996	52 Kg.	85	18
	-do-	60 Kg.	95	18
2.	90 UTS to IRS: T-12- 1996/860-0	52 Kg.	90	15
	or eqv.	60 Kg.	115	15

4.2.3.2 If the fracture does not occur through weld slice shall be cut transversely at the weld and etched boiling 1: 1 hydrochloric acid for about 20 minutes determine casting defects if any.

4.2.3.3 The fractured surface of the weld, or in case while macro-etching is done on transverse section through joint, shall not show defects such as blow holes, porosity inclusions, etc. exceeding total permissible area of defects shown in Table 3. However, the size of any individual defect shall not exceed 2 mm diameter. The defects should not exceed 2 mm diameter. The defects should not be interconnected and none of these shall extend upon the outer surface of the welded There shall not be any lack of fusion. The fractured surface shall also not show the presence of accretions or mirror like structure and should be crystalline in acceptance.

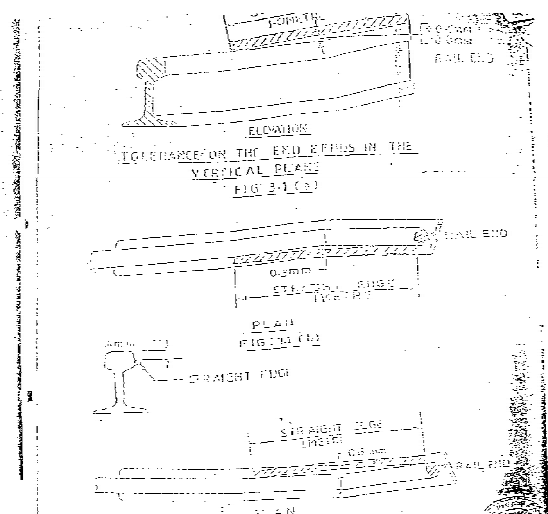
TABLE 3

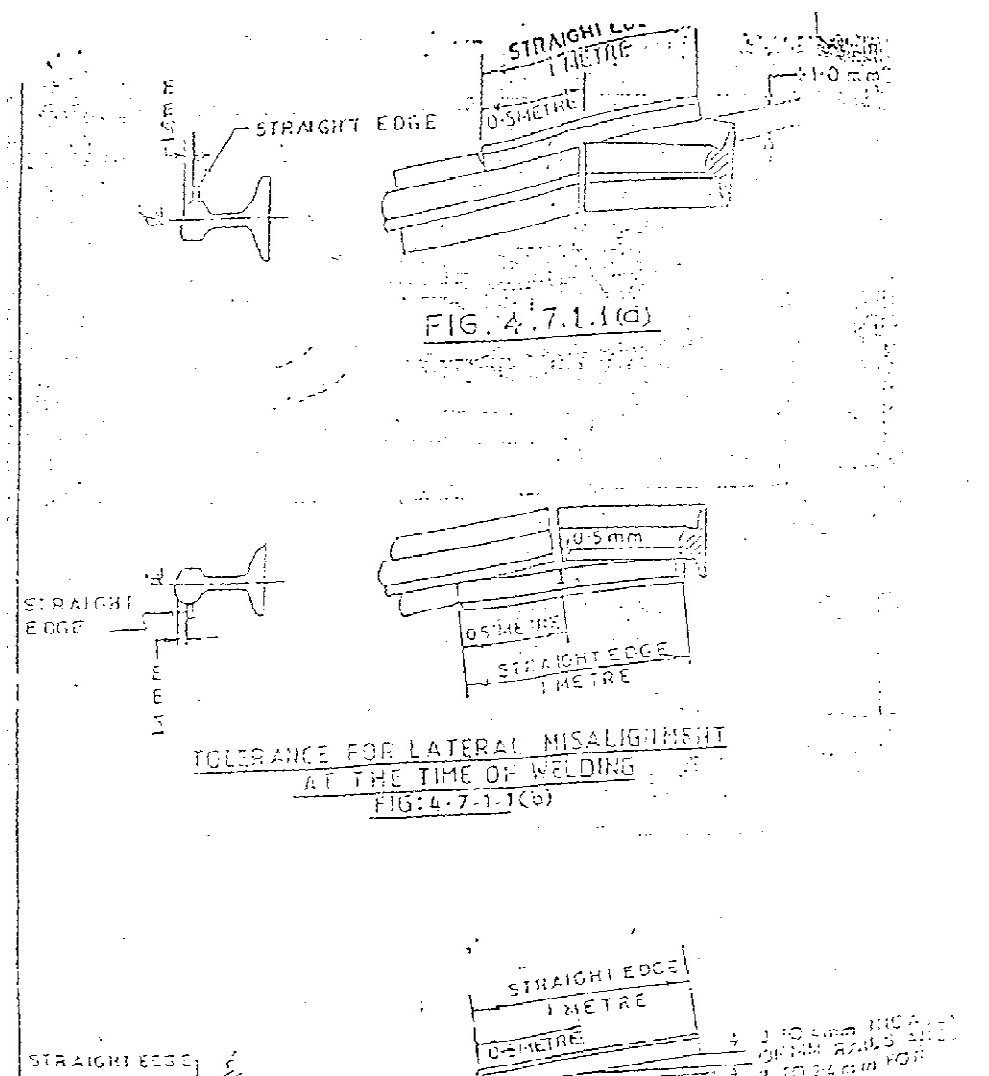
Area of permissible defects

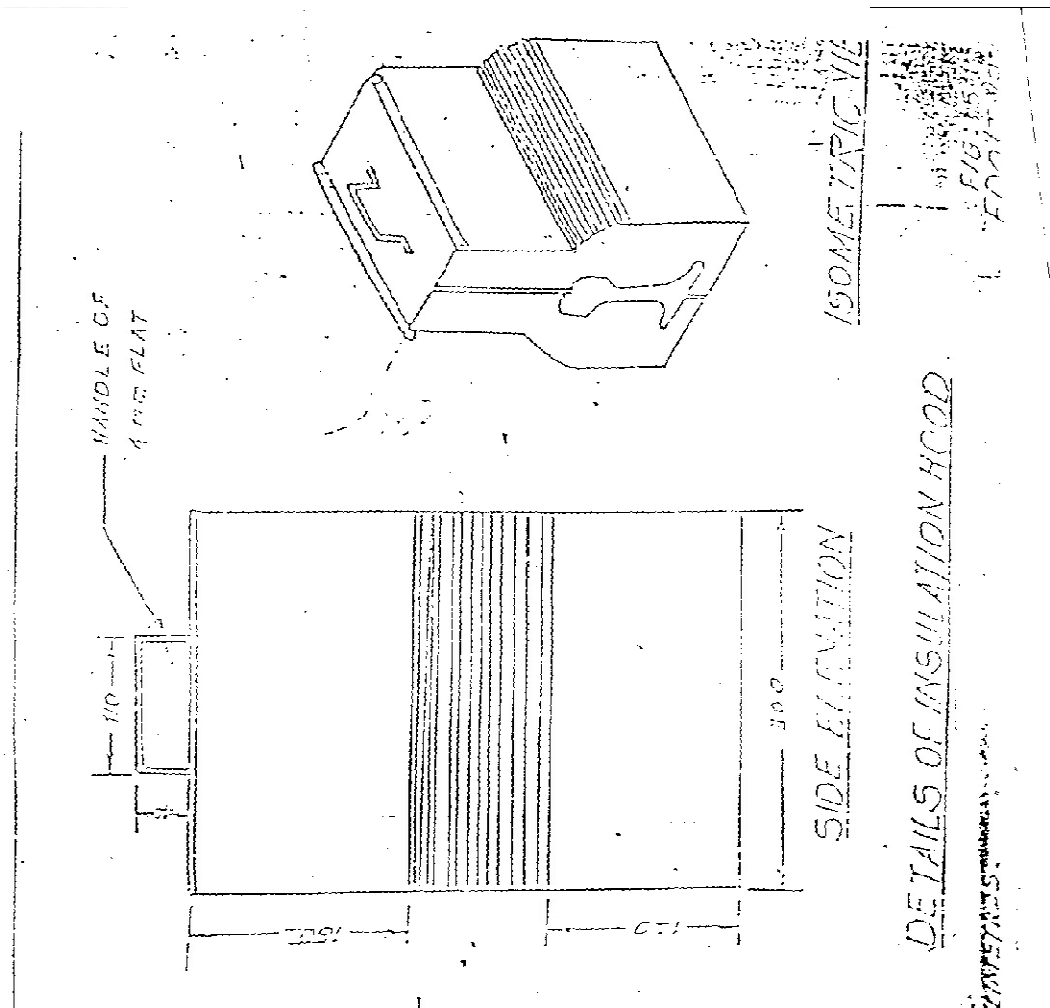
Rail Section	Permissible total area of defect (mm)
52 Kg.	33.0
60 Kg.	38.4

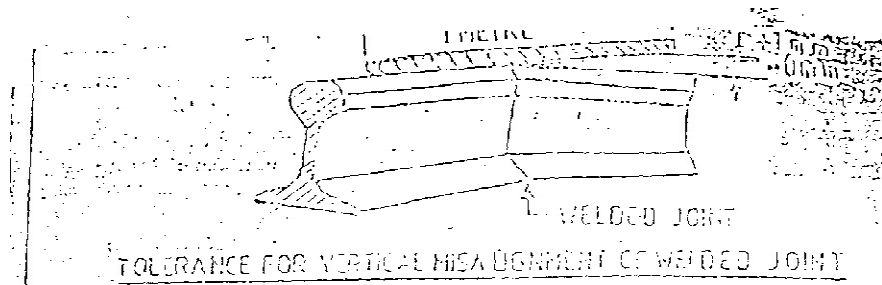
4.3 Re-tests

- 4.3.1 If the results of any of the tests referred to in para 4.1 and 4.2 are found to be unsatisfactory, the batch will stand rejected. However, re-tests can be carried out at the manufacturer's request. These re-tests shall be carried out as per 4.1 and 4.2 on twice the original sample size.
- 4.3.2 If the results of all the re-tests samples are satisfactory, the batch represented by the sample portions shall be accepted. If any sample fails to meet the requirements of any of the tests, the batch shall be rejected.

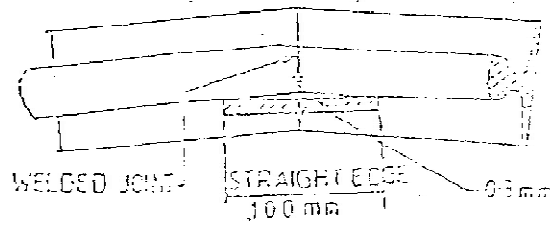




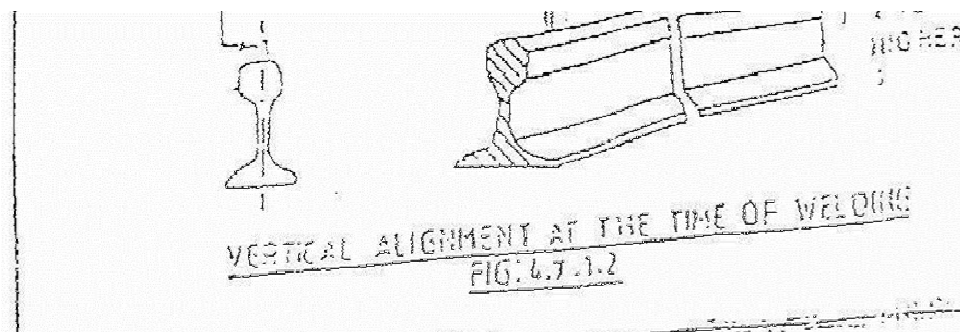




TOLERANCE FOR LATERAL MISALIGNMENT OF WELDED JOINT



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SPECIFICATIONS FOR P.WAY WORKS

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1. All works - linking of Railway tracks, assembling, laying and linking of points and crossings, ballasting, through packing and connected works shall conform to the various instructions and specifications stipulated in "Indian Railways Permanent Way Manual with upto date correction slips, IRS drawings, track manual and other relevant Railway Codes/Manuals.
2. The proposed sidings will be laid with 52 Kg S/H or IU Rails on PSC sleepers in SWR/single rails as the case may be.
3. The Turn-outs assembly i.e. switch assembly, lead portion and crossing assembly will be laid with 52/60 Kg Rails to the Indian Railway Standard on PSC sleepers with a ballast cushion as directed by Engineer in-charge or his authorized representative at site.
4. The operation of dumping ballast, lifting and packing should continue till such time the track attains final level and shape of ballast section.
5. Pack the sleeper with ballast as directed by Engineer in-charge or his authorized representative at site.
6. Lift the track to the required level as directed by Engineer in-charge or his authorized representative at site.
7. Rails shall be connected by means of pair of fish plate in the first instance only with two bolts and nuts, one in each rail. The fishing planes of the fish plates and rail are to be greased. Proper size of expansion liners is to be provided at the joints to ensure correct expansion gaps. Cutting of rails where necessary, will be done to suit squaring of joints.
8. On curves sharper than 5° (radius less than 350m) the rail joints will be mid-staggered or as directed by the Engineer-in-Charge.
9. All the drilled bolt holes are to be chamfered by chamfering tools.
10. Paint mark shall be made on the rails showing the spacing of sleepers as directed by Engineer-in-Charge at site.
11. Sleeper spacing:
 - a. Sleeper spacing for fish-plated joints having 13m/12m single rails:

Sleeper spacing	M+7 density		M+4 density	
	13m	12m	13m	12m
i) Rail ends to centre of sleeper	15cm	15cm	15cm	15cm
ii) Centre of joint sleeper to centre of 1 st shoulder sleeper	61cm	60cm	61cm	60cm
iii) Centre of 1 st shoulder sleeper to centre of 2 nd shoulder sleeper	64cm	63cm	70cm	69cm
iv) Centre of 2 nd shoulder sleeper to centre of intermediate shoulder sleeper	68cm	66cm	84cm	83cm

- b. Sleeper spacing for SWP of 3X13m/3X12m/3X 11m rails:

Sleeper spacing	M+7 density		M+4 density		
	39m	36m	39m	36m	33m
i) Rail ends to centre of sleeper	15cm	15cm	15cm	15cm	15cm
ii) Centre of joint sleeper to centre of 1 st shoulder sleeper	59cm	58cm	66cm	62cm	60cm
iii) Centre of 1 st shoulder sleeper to centre of 2 nd shoulder sleeper	61cm	60cm	75cm	67.5cm	66cm
iv) Centre of 2 nd shoulder sleeper to centre of intermediate shoulder sleeper	66cm	65.5cm	78cm	77cm	77.5cm

- c. Sleeper spacing for curve with Mid-Staggered Joint:
Sleepers =18 nos. per single rail length.

Sleeper spacing	18 Sleepers per rail	
	13m	12m
i) Rail ends to centre of sleeper	15cm	15cm
ii) Centre of joint sleeper to centre of 1 st shoulder sleeper	65cm	65cm
iii) Centre of 1 st shoulder sleeper to centre of 2 nd shoulder sleeper	75cm	70cm
iv) Centre of 2 nd shoulder sleeper to centre of intermediate shoulder sleeper	85cm	75cm

12. Full quantities of small fittings are to be fitted completely after slewing the track to correct alignment as directed by Engineer-in-Charge at Site.

13. The track so linked shall be aligned correctly to the alignment pegs given or as directed by Engineer till it takes correct position and the remaining two bolts to be fixed in fish plated joints.
14. During the above process, alignment, adjustment and squaring of sleepers, gauging, Cross level and longitudinal levels should be checked and rectified by doing packing as directed.
15. The operation of spreading of stone ballast, lifting and packing should continue till such time the track attains final level and shape.
16. Greasing of fish plates, fish bolts and nuts with lubricating oil and graphite grease to be done by cleaning fishing planes of rail ends with wire brush.
17. **Screening of Track** should be done as per Indian Railways Permanent Way Manual Para-238 and as per direction of Engineer-in-Charge. **For screening work, required wooden blocks & wedges are to be arranged by the contractors. No extra payment will be made for arranging wooden blocks.**
18. The works should be executed in a workman like manner to the satisfaction of the Engineer-in-Charge at site. The contractor will be primarily responsible for Safety of traffic that moves on opened up track, notwithstanding the presence of Engineer representative at site.
19. Good quality track ballast as per specification and of approved quality will have to be supplied and stacked on 'Cess' of formation or at the toe of bank or at suitable places as directed by Engineer-in-Charge. Stacks will be measured jointly by the contractor and Engineer-in-Charge and entered in a register to be signed jointly by them.
20. Lifting and spreading of stone ballast includes all lead, lift, ascent, descent, crossing road/railway, handling as required for packing tracks from the stacks measured and passed already including all labour, tools and plants for the operation and the same will be arranged by the contractor at his own cost. The payment for spreading will be made based on measurement of ballast supplied in stacks.
21. Pulling out of ballast on to the formation by ballast rakes and boxing is to be done as per specified profiles. Proper templates and loglines should be used. The width at the shoulder should be as directed by Engineer-in-Charge which will normally be not less than 3.55 meter (11'-0") and not more than 3.66 meter (12'-0").
22. No ballast should be wasted on the slopes of banks or in cuttings or any places.

23. After the ballast is measured, the Contractor shall spread it on top of the blanketing surface/formation/in the track with standard profile. After spreading, the ballast profile should be consolidated.
24. The thickness of the finished ballast spread should be as specified by Engineer-in-Charge, and the layer should be dressed and boxed to proper profile and dimensions.
25. While spreading the ballast on the finished formation, care shall be taken that the formation/blanketing surfaces is not damaged. In no circumstances, vehicular carts/trucks shall be permitted to ply on the finished blanketing/ formation. In case some damage to the surface is done, the Contractor shall repair the damages at his own cost before spreading the ballast.
26. Through packing of railway track on any type and any density of sleepers which will consist of –
- (i) Opening of the road,
 - (ii) Examination of rails, sleepers and fastenings,
 - (iii) Squaring of sleepers,
 - (iv) Slewing of track to correct alignment,
 - (v) Gauging,
 - (vi) Packing of sleepers including lifting & leveling,
 - (vii) Repacking of joint sleepers,
 - (viii) Boxing of ballast section & tidying.
27. The length of track to be opened out on any day must not be more than that can be efficiently tackled by the end of the day. Broken or missing fittings are to be replaced and loose ones tightened. Cross drains are to be provided at mid-section each rail except sharper curve track. On sharper curve track the cross drains are to be provided as per direction of Engineer in-charge.
28. Through packing of points and crossings 1 in 8.1/2 or diamond x-over will comprise opening out of ballast, squaring of sleepers, replacing or readjusting fittings to keep correct gauge clearances of check rail, wing rails, etc. including lifting or lowering as necessary and packing all the sleepers in the points and crossings efficiently and finishing all works with boxing and dressing of the shoulder ash ballast neatly. All bolts and nuts including crossing bolts, check rail bolts, slide chairs, tongue rails, heel block bolts etc. are to be properly oiled and greased also.
29. Picking up slacks will include lifting and packing of sleepers where necessary, attention to all fittings and fastenings, adjusting gauge, cross level and longitudinal level, cleaning of drain etc. as directed by the NHIDCL' representative at site at specified scattered locations. The work should be neatly finished with proper boxing.

30. Any sleeper which have shifted from correct spacing or gone out of square shall be moved back and square after loosening the fastenings. The fastenings shall be tightened again after squaring.
31. The track shall be slewed to correct alignment by sighting along the rail head of the base rail. It should be ensured that track does not get lifted in the process of slewing.
32. The track shall then be given a final packing. For this, sighting shall be done along the base rail and any dip or low joint are found, the same are to be attended for its correction by packing of sleepers. After the base rail is thus packed for two or three rails length, the cross level should be checked and the opposite rail lifted wherever necessary and sleepers under the rail seat packed.
33. The joint and shoulder sleepers shall be re-packed and cross level adjusted at the time of each through packing of sleepers.
34. Oiling and greasing of hand operated points will include adjusting the point Roding and fixing hand lever frame, where found necessary by means of spikes with the sleepers for smooth operation of the point and adjusting the opening between tongue rail and stock rail. For any bent tongue rail, if required, Jim-crowing may have to be done and the gap adjusted as required. Blacksmith and other staff for this work, as required, will be deputed by the Contractor at his cost. Oil & Grease to be supplied by the Contractor at his own cost.
35. Gauge
Will be with standard broad gauge on straight and curves up to 350 m radius and 5 mm slack on sharper curves with a Permissible variation with (+) or (-) 3 mm. But not exceeding 1 mm between consecutive sleepers
36. Alignment:

Should be perfectly straight verified by sighting. On curves, the alignment should be correct of versine or as directed by the Engineer-in-Charge, who will pass the work.
- (i) Straight on 10M chord = (+) or (-) 2mm;
(ii) Curves of radius 600M on 10M chord = (+) or (-) 5mm;
(iii) Curves of radius 600M on 20M chord = (+) or (-) 10mm.
37. Level:

To be checked by level board and spirit level. Track should be free from sag and low joints. Permissible variation of Cross levels being (+) or (-) 3 mm. but not exceeding 1 mm between consecutive sleepers.

38. Joint out of square:
- i) On straight = (+) or (-) 10mm;
 - ii) On curves = 1/2 pitch of fish bolt holes.
39. High Joint: Permissible up to 2mm.
40. Low Joint: Not permissible.
41. All the elastic rail clips should be thoroughly cleaned. Grease to IS:400-1981 (Specifications for Grease No. 'O' Graphite) should then be applied on Central leg of the E.R.C. and eye of Inserts and then the clip should be driven at the time of assembly. The rate accepted includes the cost of the grease as per specifications and labour.
42. During execution of the work, contractor should arrange for protection of track and displaying the signals as per extent rule of Indian Railways.

All the P. Way tools such as (a) Rail tongs, (b) Crow bars, (c) Fishing spanners, (d) Hammers, (e) Keying hammers, (f) Cotter splitters, (g) Shovels, (h) Mortar Pans, (i) Beaters, (j) Track Lifting Jacks, (k) Gauges, (l) Level Board, (m) Spirit levels, (n) Cant Board, (o) Expansion Liners, (p) Wooden Squares, (q) Steel Tape, (r) Wire brushes, (s) Cotton waster, (t) Rake Ballast, (u) Chamfering tools, (v) Soap as required for the work as assessed by the Engineer-in-Charge depending on the labour strength will be arranged by the contractor at his own cost.

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20. Lifting and spreading of stone ballast includes all lead, lift, ascent, descent, crossing road/ railway, handling as required for packing tracks from the stacks measured and passed already including all labour, tools and plants for the operation and the same will be arranged by the contractor at his own cost. The payment for spreading will be made based on measurement of ballast supplied in stacks.
21. Pulling out of ballast on to the formation by ballast rakes and boxing is to be done as per specified profiles. Proper templates and loglines should be used. The width at the shoulder should be as directed by Engineer-in-Charge which will normally be not less than 3.55 meter (11'-0") and not more than 3.66 meter (12'-0").
22. No ballast should be wasted on the slopes of banks or in cuttings or any places.
23. After the ballast is measured, the Contractor shall spread it on top of the blanketing surface/formation/in the track with standard profile. After spreading, the ballast profile should be consolidated.
24. The thickness of the finished ballast spread should be as specified by Engineer-in-Charge, and the layer should be dressed and boxed to proper profile and dimensions.
25. While spreading the ballast on the finished formation, care shall be taken that the formation/blanketing surfaces is not damaged. In no circumstances, vehicular carts/trucks shall be permitted to ply on the finished blanketing/ formation. In case some damage to the surface is done, the Contractor shall repair the damages at his own cost before spreading the ballast.
26. Through packing of railway track on any type and any density of sleepers which will consist of –
- (i) Opening of the road,
 - (ii) Examination of rails, sleepers and fastenings,
 - (iii) Squaring of sleepers,
 - (iv) Slewing of track to correct alignment,
 - (v) Gauging,
 - (vi) Packing of sleepers including lifting & levelling,
 - (vii) Repacking of joint sleepers,
 - (viii) Boxing of ballast section & tidying.
27. The length of track to be opened out on any day must not be more than that can be efficiently tackled by the end of the day. Broken or missing fittings are to be replaced and loose ones

tightened. Cross drains are to be provided at mid-section each rail except sharper curve track. On sharper curve track the cross drains are to be provided as per direction of Engineer in-charge.

28. Through packing of points and crossings 1 in 8.1/2 or diamond x-over will comprise opening out of ballast, squaring of sleepers, replacing or readjusting fittings to keep correct gauge clearances of check rail, wing rails, etc. including lifting or lowering as necessary and packing all the sleepers in the points and crossings efficiently and finishing all works with boxing and dressing of the shoulder ash ballast neatly. All bolts and nuts including crossing bolts, check rail bolts, slide chairs, tongue rails, heel block bolts etc. are to be properly oiled and greased also.

29. Picking up slacks will include lifting and packing of sleepers where necessary, attention to all fittings and fastenings, adjusting gauge, cross level and longitudinal level, cleaning of drain etc. as directed by the NHIDCL representative at site at specified scattered locations. The work should be neatly finished with proper boxing.

30. Any sleeper which have shifted from correct spacing or gone out of square shall be moved back and square after loosening the fastenings. The fastenings shall be tightened again after squaring.

31. The track shall be slewed to correct alignment by sighting along the rail head of the base rail. It should be ensured that track does not get lifted in the process of slewing.

32. The track shall then be given a final packing. For this, sighting shall be done along the base rail and any dip or low joint are found, the same are to be attended for its correction by packing of sleepers. After the base rail is thus packed for two or three rails length, the cross level should be checked and the opposite rail lifted wherever necessary and sleepers under the rail seat packed.

33. The joint and shoulder sleepers shall be re-packed and cross level adjusted at the time of each through packing of sleepers.

34. Oiling and greasing of hand operated points will include adjusting the point Roding and fixing hand lever frame, where found necessary by means of spikes with the sleepers for smooth operation of the point and adjusting the opening between tongue rail and stock rail. For any bent tongue rail, if required, Jim-crowing may have to be done and the gap adjusted as required. Blacksmith and other staff for this work, as required, will be deputed by the Contractor at his cost. Oil & Grease to be supplied by the Contractor at his own cost.

35. Gauge

Will be with standard broad gauge on straight and curves up to 350 m radius and 5 mm slack on sharper curves with a Permissible variation with (+) or (-) 3 mm. But not exceeding 1 mm between consecutive sleepers

36. Alignment:

Should be perfectly straight verified by sighting. On curves, the alignment should be correct of versine or as directed by the Engineer-in-Charge, who will pass the work.

- (i) Straight on 10M chord = (+) or (-) 2mm;
- (ii) Curves of radius 600M on 10M chord = (+) or (-) 5mm;
- (iii) Curves of radius 600M on 20M chord = (+) or (-) 10mm.

37. Level:

To be checked by level board and spirit level. Track should be free from sag and low joints. Permissible variation of Cross levels being (+) or (-) 3 mm. but not exceeding 1 mm between consecutive sleepers.

38. Joint out of square:

- i) On straight = (+) or (-) 10mm;
- ii) On curves = 1/2 pitch of fish bolt holes.

39. High Joint: Permissible up to 2mm.

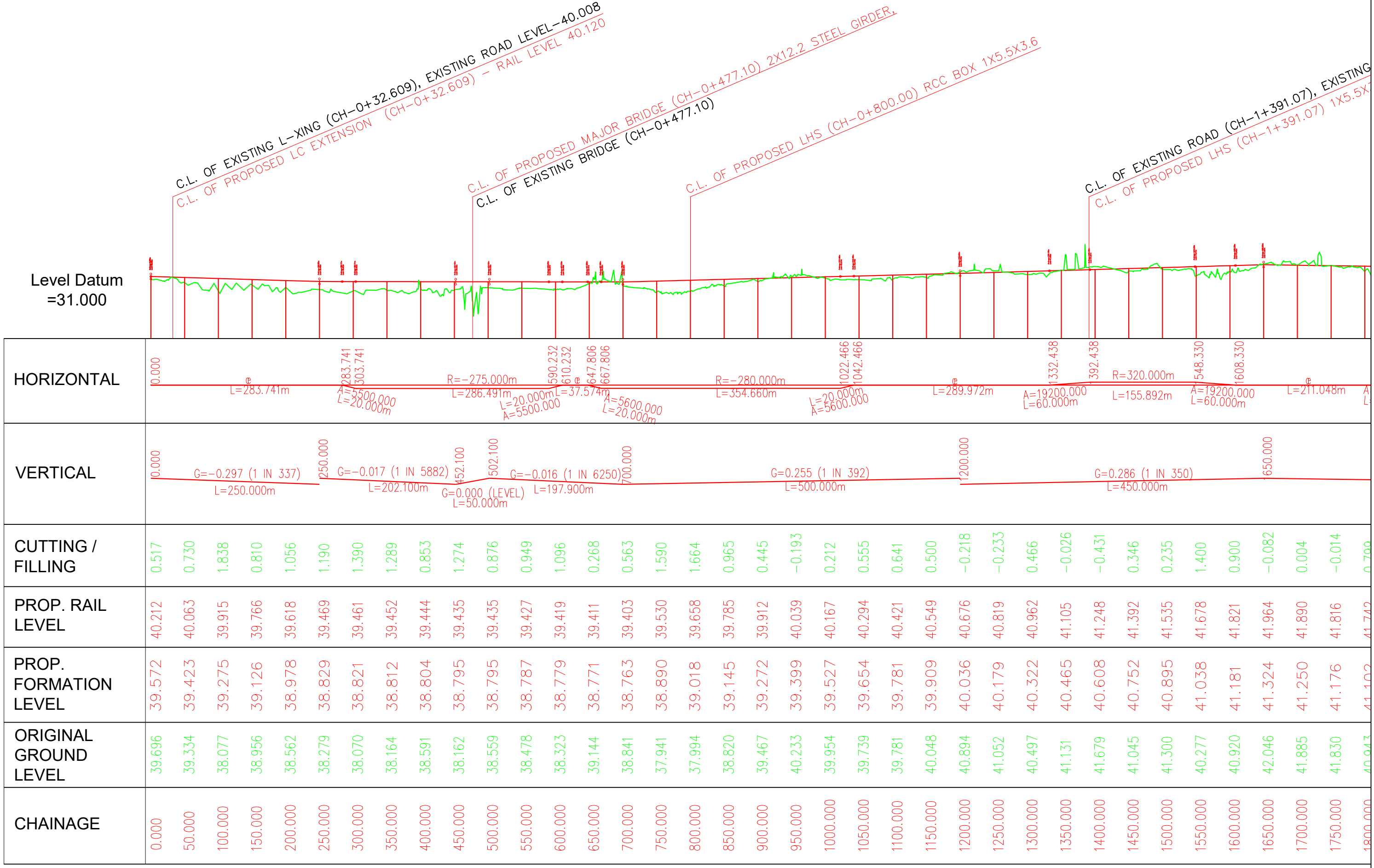
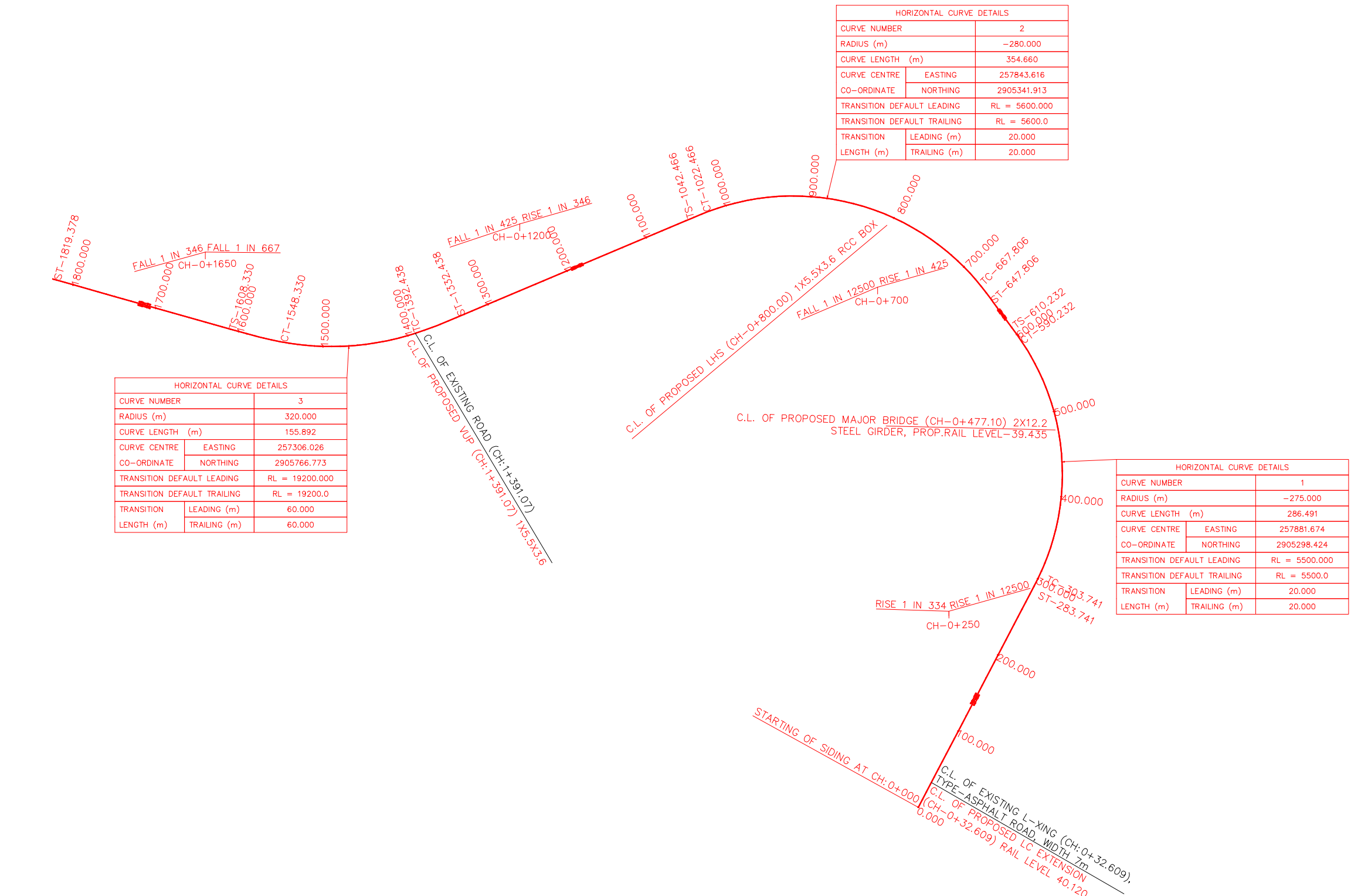
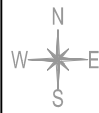
40. Low Joint: Not permissible.



41. All the elastic rail clips should be thoroughly cleaned. Grease to IS:400-1981 (Specifications for Grease No. 'O' Graphite) should then be applied on Central leg of the E.R.C. and eye of Inserts and then the clip should be driven at the time of assembly. The rate accepted includes the cost of the grease as per specifications and labour.

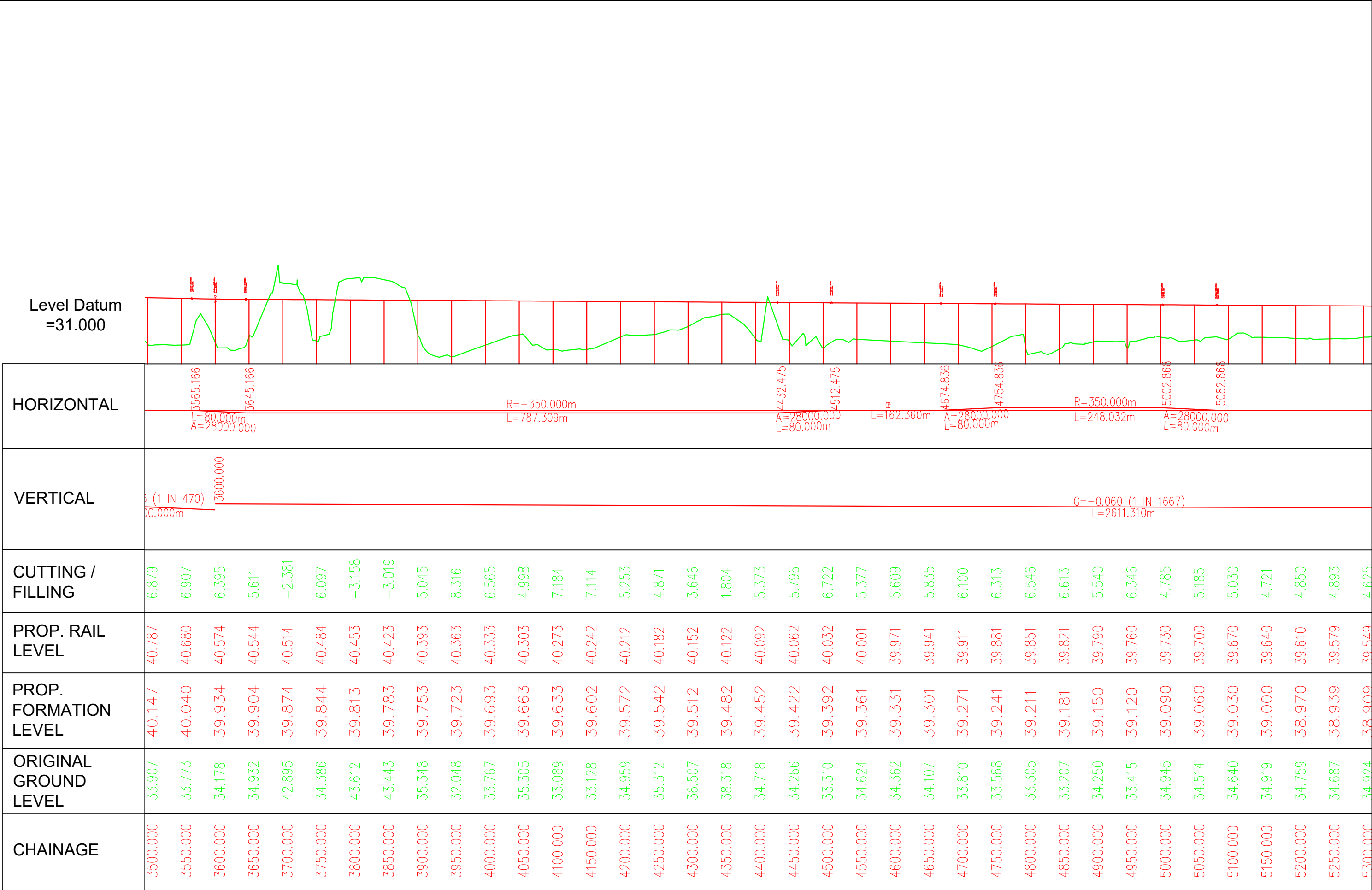
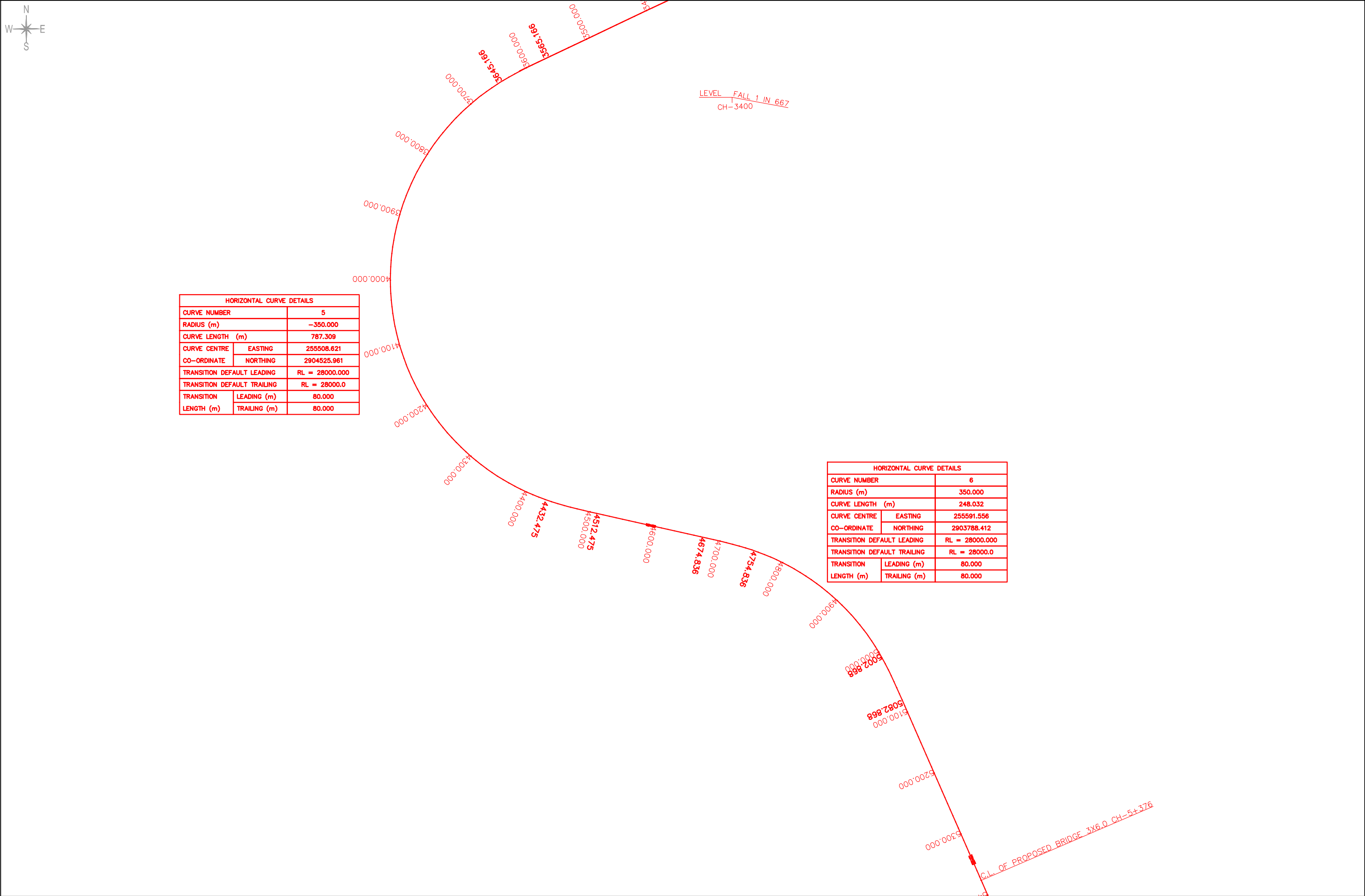
42. During execution of the work, contractor should arrange for protection of track and displaying the signals as per extent rule of Indian Railways.


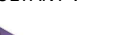
All the P. Way tools such as (a) Rail tongs, (b) Crow bars, (c) Fishing spanners, (d) Hammers, (e) Keying hammers, (f) Cotter splitters, (g) Shovels, (h) Mortar Pans, (i) Beaters, (j) Track Lifting Jacks, (k) Gauges, (l) Level Board, (m) Spirit levels, (n) Cant Board, (o) Expansion Liners, (p) Wooden Squares, (q) Steel Tape, (r) Wire brushes, (s) Cotton waster, (t) Rake Ballast, (u) Chamfering tools, (v) Soap as required for the work as assessed by the Engineer-

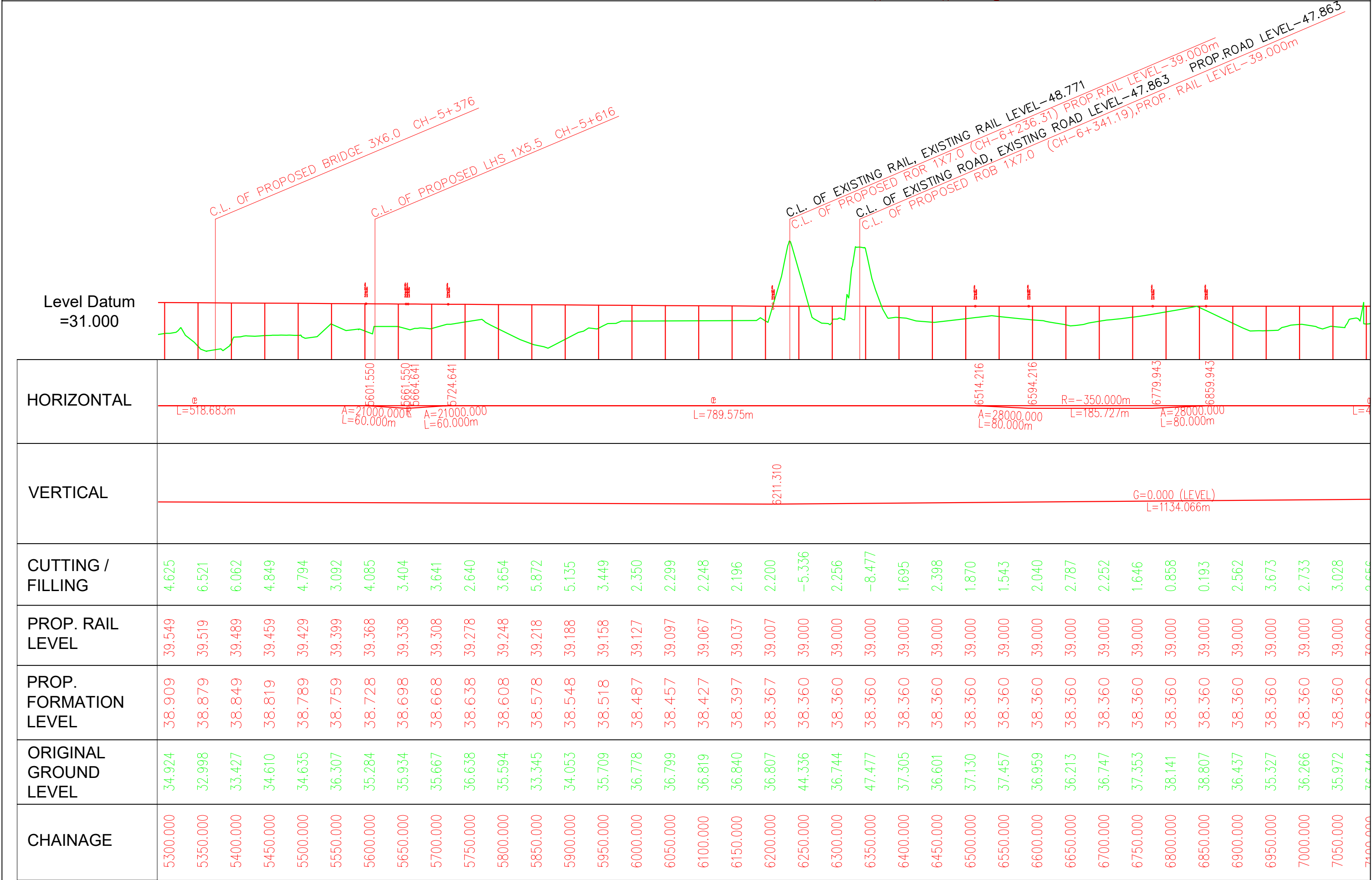
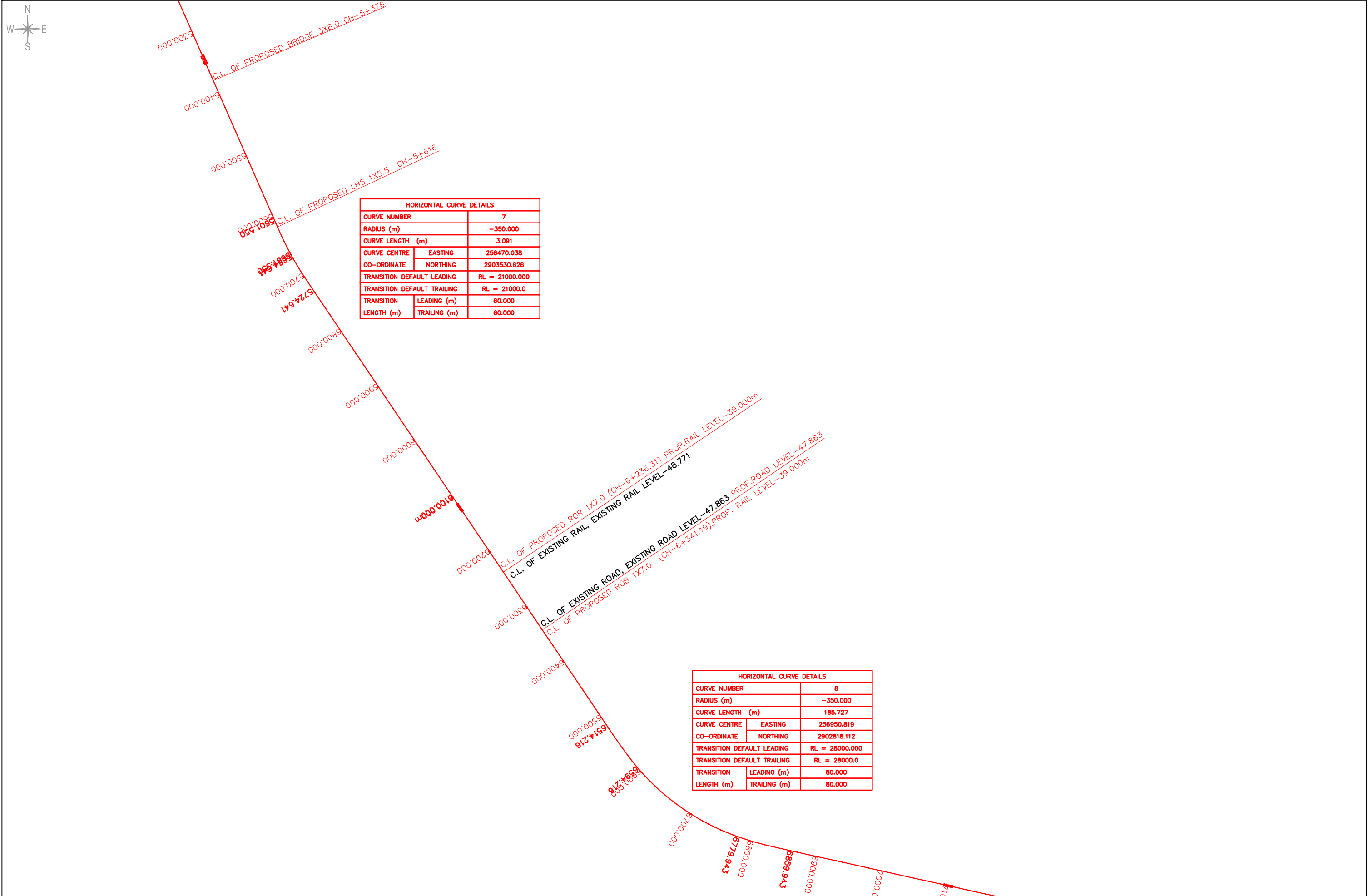
in-Charge depending on the labour strength will be arranged by the contractor at his own cost.





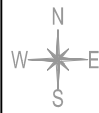
REVISION BLOCK			QUALITY ASSURANCE				CLIENT :		PROJECT TITLE :				
5			The responsibility of control, check and verification of accuracy, correctness, completeness, integration and full compliance of contract provisions in respect of design analysis and drawings rests with the approving agency				 National Highway Infrastructure Development Corporation Limited (NHIDCL)	DEVELOPMENT OF MULTI MODAL LOGISTICS PARK AT JOGIGHOPA, ASSAM					
4													
3													
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0			V.S.	V.S.	R.K.S.	R.K.S.		DRAWING TITLE :		RAILWAY ALIGNMENT PLAN		ISSUE RECORD	APPROVED FOR ISSUE
REV.	DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY	 Voyants Solutions PVT. LTD. 403, 4th Floor, Park Centra, Sec.-30 NH-8,Gurgaon - 122001,India. & KPMG Advisory Services Private Limited 4th Floor, Building No.10, Cybercity Phase II Gurugram- 122002,Haryana India.	DRAWING NO :		VSPL/IPD/1819_030/RID/P&P-01 (Sheet 1/5)		Concept	
												DPR	
												Tender Dwg.	
												FDPR	✓
												Revision	RO
												Date	Jul.2019



REVISION BLOCK			QUALITY ASSURANCE				CLIENT :		PROJECT TITLE :			
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4												
3												
2												
1												
0			V.S.	V.S.	R.K.S.	R.K.S.	 Voyants Solutions PVT. LTD. 403, 4th Floor, Park Centra, Sec.-30 NH-8, Gurgaon - 122001, India. & KPMG Advisory Services Private Limited 4th Floor, Building No.10, Cybercity Phase II Gurugram- 122002, Haryana India.	DRAWING TITLE : RAILWAY ALIGNMENT PLAN		ISSUE RECORD	APPROVED FOR ISSUE	
REV.	DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY		DRAWING NO : VSPL/IPD/1819_030/RID/P&P-01 (Sheet 3/5)		Concept		
								SCALE : PLAN - 1:5000 L-SECTION - HOR-1:5000 VER-1:500		DPR		
								SHEET SIZE A2		Tender Dwg.		
										FDPR	✓	
									Revision	R0		
									Date	Jul.2019		



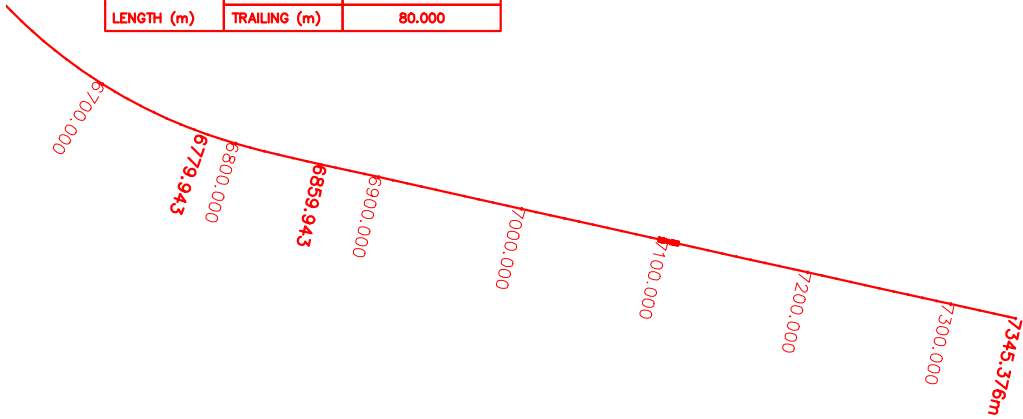
REVISION BLOCK			QUALITY ASSURANCE				CLIENT :		PROJECT TITLE :			
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4												
3								DRAWING TITLE :		RAILWAY ALIGNMENT PLAN	ISSUE RECORD	APPROVED FOR ISSUE
2								DRAWING NO :		VSPL/IPD/1819_030/RID/P&P-01 (Sheet 4/5)	Concept	
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0			V.S.	V.S.	R.K.S.	R.K.S.		Tender Dwg.				
REV.	DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY		CONSULTANT :		SHEET SIZE		
							 VOYANTS SOLUTIONS PVT. LTD.	Voyants Solutions PVT. LTD. 403, 4th Floor, Park Centra, Sec.-30 NH-8, Gurgaon - 122001, India.				
								& KPMG Advisory Services Private Limited 4th Floor, Building No.10, Cybercity Phase II Gurugram- 122002, Haryana India.				
								 KPMG				
										FDPR	✓	
										Revision	RO	
										Date	Jul. 2019	



31) PROP. RAIL LEVEL=39.000m
VEL=48.771

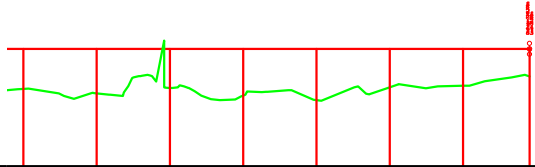
IG ROAD LEVEL=47.865 PROP. ROAD LEVEL=47.865
J (CH=6+341.19) PROP. RAIL LEVEL=39.000m

HORIZONTAL CURVE DETAILS			
CURVE NUMBER		8	
RADIUS (m)		-350.000	
CURVE LENGTH (m)		185.727	
CURVE CENTRE		EASTING	256950.819
CO-ORDINATE		NORTHING	2902818.112
TRANSITION DEFAULT LEADING		RL =	28000.000
TRANSITION DEFAULT TRAILING		RL =	28000.0
TRANSITION LENGTH (m)	LEADING (m)	80.000	
	TRAILING (m)	80.000	




47.865

Level Datum
=31.000



HORIZONTAL	<div><div></div><div>L=485.433m</div><div>7345.376</div></div>						
VERTICAL	<div><div></div><div>7345.376</div></div>						
CUTTING / FILLING	2.733	3.028	2.656	3.181	3.490	2.613	2.516
PROP. RAIL LEVEL	39.000	39.000	39.000	39.000	39.000	39.000	39.000
PROP. FORMATION LEVEL	38.360	38.360	38.360	38.360	38.360	38.360	38.360
ORIGINAL GROUND LEVEL	36.266	35.972	36.344	35.818	35.509	36.387	36.483
CHAINAGE	7000.000	7050.000	7100.000	7150.000	7200.000	7250.000	7300.000
							7345.376

REVISION BLOCK			QUALITY ASSURANCE				CLIENT :		PROJECT TITLE :					
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2									DRAWING NO :		VSPL/IPD/1819_030/RID/P&P-01 (Sheet 5/5)		Concept	
1									SCALE :		PLAN - 1:5000 L-SECTION - HOR-1:5000 VER-1:500		DPR	
0			V.S.	V.S.	R.K.S.	R.K.S.			SHEET SIZE		FDPR	✓		
REV.	DATE	DESCRIPTION	DRAWN BY	DESIGNED BY	CHECKED BY	APPROVED BY					Revision	R0		
											Date	Jul.2019		