"WIDENING AND UPGRADATION TO 2 LANE WITH PAVED SHOULDER CONFIGURATION AND GEOMETRIC IMPROVEMENT ON CHENANI – SUDHMAHADEV SECTION OF NH-244."

A

PROJECT REPORT

Submitted in fulfilment of the requirements for the award of the degree

of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision

of

Mr. Ankur Verma

Planning Engineer

(SRM CONTRACTORS PVT. LTD)

by

Puneet Garg (151645)

Suryabhan Singh Jamwal (151674)

to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT, SOLAN-173234

HIMACHAL PRADESH, INDIA

May-2019

STUDENTS' DECLARATION

We hereby declare that the work presented in the project report entitled **"Widening and Upgradation to 2 lanes with paved shoulder configuration and geometric improvement on Chenani – Sudhmahadev section of NH-244"** submitted for fulfilment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of our work carried out under the supervision of **Mr.Ankur Verma (Planning Engineer) SRM Contractors Pvt. Ltd.**. We are fully responsible for the contents of my project report.

Puneet Garg

151645

Department of

Civil Engineering

May 24, 2019

Suryabhan Singh Jamwal

151674

Department of

Civil Engineering

May 24, 2019

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"Widening and Upgradation to 2 lanes with paved shoulder configuration and geometric improvement on Chenani – Sudhmahadev section of NH-244"** in the fulfilment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering. **Jaypee University of Information Technology, Waknaghat** is an authentic record of work carried out by **Puneet Garg (151645), Suryabhan Singh Jamwal (151674),** during a period from 11th February, 2019 to 20th May,2019 under the supervision of **Mr.Ankur Verma (Planning Engineer) SRM Contractors Pvt. Ltd.**The above statement made is correct to the best of our knowledge.

Date: May 24, 2019

Dr. Ashok Kumar Gupta
Professor & Head of Department
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Internal Supervisor

External Examiner

ACKNOWLEDGEMENT

This report highlights the progress of our work that we have achieved in “Design Basis Report (DBR) Chenani-Sudhmahadev” till 22th May, for the project entitled “Widening and Upgradation to 2 lanes with paved shoulder configuration and geometric improvement from km 0.000 to km 16.990 on Chenani–Sudhmahadev section of NH-244 in the State of Jammu & Kashmir”.

We would like to take an opportunity to extend our heartily gratitude to our Training Head **Mr. Ankur Verma (Planning Engineer) SRM Contractors Pvt. Ltd** who has helped us in every situation and has always entertained our doubts no matter how much busy or exhausted he was. We want to thank **Dr. Ashok Kumar Gupta, Professor and H.O.D Civil Engineering** who helped us in achieving the progress we could not have made without his help. We would like to thank all the SRM Team for their constant support and guidance.

ABSTRACT

The Quality Assurance Plan (QAP) for: Widening & up-gradation of 2-lane with paved shoulders configuration & geometric improvement from 0+000 KM to 16+990 KM from Chenani to Sudhmahadev section of NH-244 in the state of Jammu & Kashmir on EPC mode.

It is essentially intended to assist the project team to carry out the various project-related activities in conformity with the contractual and technical requirements as per Technical Schedules, IRC Standards, MORT&H Specifications and Terms of Reference (TOR) as given in the Contract Agreement.

The overall aim of the QAP is to eliminate errors rather than detect errors so that deliverables are of required quality and can be submitted to the agreed time frame.

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ABBREVATIONS

ASCII	American Standard Code for Information Interchange
BOQ	Bill of Quantities
CBR	California Bearing Ratio
DCP	Dynamic Cone Penetrometer
DRC	Discipline Reviewer/ Checker
DTM	Digital Terrain Model
EPC	Engineering Procurement Construction
FBF	Field Book Format
FRL	Finished Road Level
FWD	Falling Weight Deflectometer
GPS	Global Positioning System
HFL	Higher Flood Level
IRC	Indian Road Congress
LWL	Lowest Water level
MDR	Major District Roads
MORTH	Ministry Of Road Transport & Highway
NHAI	National Highways Authority of India
OFC	Optical fiber cable
PBM	Permanent Benchmark
PCC	Pre-stressed Cement Concrete
QAP	Quality Assurance Plan
ROW	Right of Way
RQD	Rock Quality Designation
SPT	Standard Penetration Test
TBM	Temporary Bench Marks
TOR	Terms of Reference

TRL	Transport Research Laboratory
UTM	Universal Transit Method

CHAPTER 1

INTRODUCTION AND SCOPE OF WORK

PROJECT BACKGROUND

The Quality Assurance Plan (QAP) for: Widening & up-gradation of 2-lane with paved shoulders configuration & geometric improvement from 0+000 KM to 16+990 KM from Chenani to Sudhmahadev section of NH-244 in the state of Jammu & Kashmir on EPC mode.

It is essentially intended to assist the project team to carry out the various project-related activities in conformity with Technical Schedules, IRC Standards, MORT&H Specifications and Terms of Reference (TOR) as given in the Contract Agreement.

The overall aim of the QAP is to eliminate errors rather than detect errors so that deliverables are of required quality and can be submitted to the agreed time frame.

All the activities of the project to be undertaken by the ECI-SRM PROJECTS will be based on the quality assurance system/procedures set out on the basis of the Technical Schedules, IRC Standards, BIS Specifications, MORT&H Specifications and Circulars, sound engineering practices and as approved by the MORT&H.

The QAP is based on the existing Quality Policy and System Procedures prevalent in the organization and has been suitably modified to meet the specific project requirements. The QAP will ensure that all investigations are controlled from inception and controlled at appropriate levels and the data collected is authorized and approved before use. Similarly, all designs and reporting documentation will be subjected to the rigors of the QAP and ultimately approved by the Team Leader.

Quality Assurance Procedures have been framed for the following activities covering the different stages of the project:

- Traffic Surveys
- Inventory and Condition Survey of Road, Bridges and Culverts
- Topographic Surveys
- Axle Load Survey
- Falling weight deflecto-meter test, if required
- Soil and Material Investigations
- Geo-technical and sub-soil Investigations
- Checking, approval and Filing of Calculations
- Design, Drawing and Documentation
- Identification and Traceability of Project Document

CHAPTER 2

QUALITY ASSURANCE POLICIES, SYSTEMS AND PROCEDURES

2.1 General

In this chapter, the quality policy, the management responsibility, the quality systems and procedures etc. under which all the projects undertaken by the Company are executed, are briefly brought out in the following paragraphs to provide the overall idea about the general systems and controls which are going to be adopted for quality assurance of this project.

2.2 Quality Policy

Proposed quality assurance system of ECI-SRM PROJECTS is shown in **Figure 2.1.** It provides for the overall quality assurance system of the company, and the commitment of the management to implement and maintain the quality at all levels of the organization. A Quality Assurance Plan (QAP) Manual in conformity with the standards has been prepared to detail the quality system procedures, and all the functionaries have been imparted training on the systems for various operations in the respective areas of activities.

2.3 Management Responsibility

The responsibility undertaken by Design management team for implementation of the quality assurance system includes:

- Definition of responsibility and authority of the various team members such as job title/objective, principal responsibilities/duties, the lines of communication, etc.
- Provision and maintenance of adequate and appropriate resources for performance, verification and management.
- Designation of Project Director at Head Office vested with the authority and responsibility for ensuring that the Quality Systems for various activities as given in the QAP and approved by Client are implemented and maintained properly.
- Arranging design reviews by suitable personnel not directly involved in the particular activity.
- Conduct of Quality System Audits by suitable independent personnel not responsible in any way for quality of item to be audited.
- Management reviews to assess the suitability and effectiveness of the system and to determine whether any changes in the procedures or philosophy are warranted to meet current and future needs.

2.4 Quality Systems

The quality system adopted by **ECI-SRM PROJECTS** has been designed to encourage and reinforce throughout the organization a Client-oriented quality culture that conforms to the Client's agreed requirements and on time.

The quality system is structured on three levels as follows:

Level 1- Project Specific Quality Assurance Plan (QAP)/Manual that describes the responsibilities of everybody involved in the project with respect to the requirements of Technical schedules, IRC/MORT&H Specifications and Standards.

Level 2- Training before commencement of activities, on-the-job training and post activities briefing with interpretation of results to make the sub-professionals and support staff understand the importance of each data collected from the site and each activity carried out by them.

Level 3 - Independently, random checking of all the field activities, design and drawing activities by the experts not directly involved with the project and communication with the personnel of Client at regular interval to take their views, advise and guidelines, timely.

The 3-level quality system is depicted in Figure 2.2.

2.5 Contract Review

After award of the work, contract review is done by the team leader as to ensure that quality and scope of services offered to the Client by **ECI-SRM PROJECTS** have been adequately addressed, that **ECI-SRM PROJECTS** has the capability to meet the contractual requirements and the differences, if any, between the tender and contract requirements are resolved.

2.6 Design Control

The design control is essentially intended for controlling all activities of design planning, design preparation, verification, review and validation so that the final products meet specified requirements. The various project functionaries engaged in the design work, drawing and preparation of reports carry this out. The procedure includes the following activities:

- Identification and definition of organizational interfaces.
- Design and Development Planning, definition of responsibilities and assignments for design control.
- Identification of Tasks and Scheduling
- Assigning qualified and experienced personnel equipped with adequate resources.
- Preparation, checking / verification, review and approval of design inputs.

- Review, approval and checking / verification of Design outputs.
- Control of design changes and validation of design

2.7 Document and Data Control

The quality system of **ECI-SRM PROJECTS** provides for a clear and precise procedure for control of documents for approval, issue, distribution, review and removal of obsolete ones.

2.8 Process Control of Project Activities

ECI-SRM PROJECTS has established Quality Assurance procedures for planning and execution of the various activities involved in a project.

The quality assurance procedures for the various survey and investigation, as also in the preparation of designs and drawings are provided in this QAP.

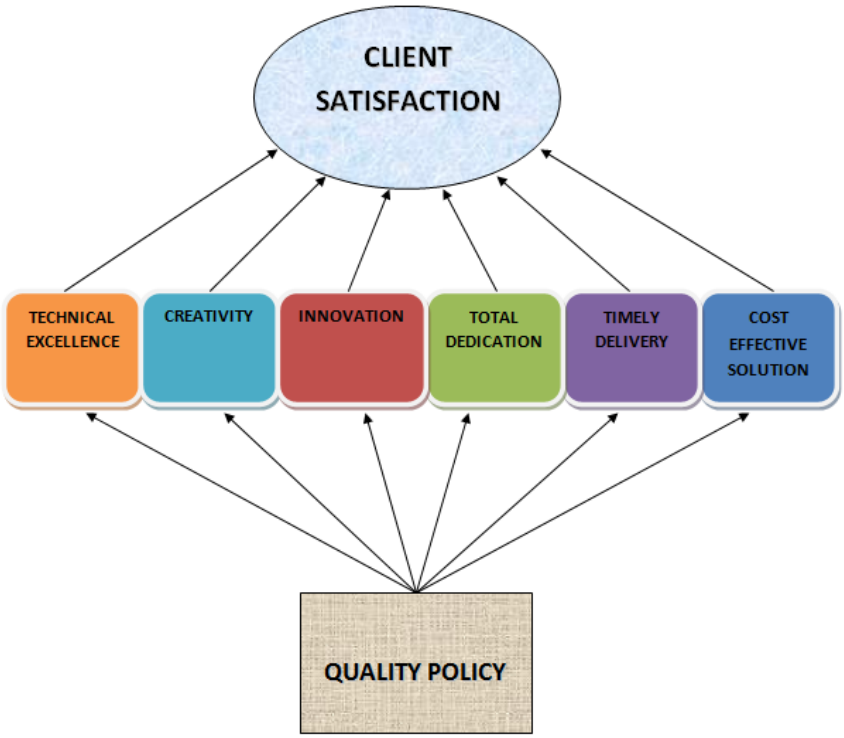

Figure 2.1 Client Satisfaction

Figure – 2.2 Quality Management System

- Setting out the Team Structure, task assignments, responsibilities and the authorities Training of Sub- Professional and support staff Pre, during and post activities trainings and briefings including short workshops for all the team members which are involved.
- Continuous Monitoring by the immediate supervisor and Random checking by the Experts not directly involved with the Project Supervision, Monitoring and Random checking to ensure quality, time as well as cost.
- Preparation of Project Specific QAP.

CHAPTER – 3

TRAFFIC SURVEYS

3.1 Number and Location of Survey Stations

The type of traffic surveys and the minimum number of survey stations will comply with the minimum requirements specified in the TOR. The exact location for each type of survey will be finalized in consultation with the Client.

3.2 Manpower and Responsibility

The surveys will be planned and programmed by the Traffic Expert under overall guidance of the Design Director. He will be assisted by a Traffic Engineer who will be directly responsible for controlling the field operations and quality/collection of field data.

Trained enumerators will be given an orientation of the project requirements prior to start of the survey. A one-hour dummy counting will be carried out at the start of the survey to enable the enumerators to appreciate and understand our requirements.

3.3 Applicable Codes / Standards

Classified Traffic Counts: IRC: 9 -1972 (Traffic census on Non-Urban Roads)

O-D Survey: IRC: 102-1988 (Traffic Studies for Planning Bypasses around Towns)

Normally all the standards as given in the IRC: SP: 19 – 2001 (Manual for Survey, Investigation and Preparation of Road Projects) will be followed including standard formats.

3.4 Regulatory Requirements

All the survey teams will carry with them a letter of authority from the Client.

Help of local police will be taken for stopping vehicles while carrying out the O-D Surveys and Axle Load Surveys.

3.5 Safety / Environmental Considerations

The Volume Count / O-D survey / Axle Load Survey stations will be located where the road is straight and fairly level and where adequate shoulder space is available for positioning the enumerators, and for stopping vehicles in the case of O-D survey.

3.6 Training

All the enumerators will be given an orientation about the objective of the project, the purpose of the survey and the methodology for filling the Performa. The Supervising Engineers will work with the enumerators on the first day and have periodic checks on the following days till completion.

3.7 Data Verification

The Supervising Engineer will visit each count station to check whether the enumerators are entering the data correctly, at regular interval. He will also carry out an independent check himself by counting at a location away from the survey station for data check.

At the end of each shift of 8 hours, the Supervising Engineer will make a summary of hourly counts. This data will be used to check consistency of traffic volumes from day to day of counting with respect to hourly and daily volumes.

In case of major variations exceeding 20% without any corresponding reason, the survey will be repeated. All the field survey data sheets will be filled with identification information like date, day, shift, direction, weather condition etc. these will be checked and signed by the supervisor.

3.8 Documentation

All the filled-up data sheets will be suitably numbered, got stitched and submitted to Traffic Engineer for data punching and analysis.

3.9 Work Procedure

The work will be carried out in accordance with the requirement of the relevant standards, or as per the approved procedure by the Client for items not covered by IRC standards.

Particular attention will be paid for locating the survey stations. These will be located away from urban influence with due consideration that each survey location represents a section of homogenous traffic.

For the O-D survey, vehicles will be stopped with the help of local police on a random sampling basis. A sample size of at least 20% will be targeted.

To capture the quantum local traffic in the vicinity of urban areas, additional counts for a day are planned. The extent of urban influence will also be delineated during this survey so that suitable measures like providing additional lanes or service roads or bypass could be considered.

3.10 Proposed Number and Locations of Traffic Survey Stations

3.10.1 General

The specific details regarding locations of the various traffic surveys as mentioned above will be submitted in traffic survey plan after detailed reconnaissance survey of the alignment to be carried out by the Key Personnel of our Team.

3.10.2 Performa for Recording Data

Performa for recording data in respect of the following surveys should be as per relevant IRC codes

- Classified Traffic Volume Count Survey for trucks & cars
- Origin-Destination Count Survey (Goods Vehicles)
- Origin-Destination Count Survey (Car/Jeep/Bus)

- Turning Movement Count for trucks & cars
- Pedestrian Survey
- Truck Terminal Survey
- Speed Delay Survey

CHAPTER – 4

INVENTORY & CONDITION SURVEYS FOR HIGHWAYS & STRUCTURES

4.1 Manpower and Responsibility

The following key personnel of the consultants will be responsible for the various tasks as follows:

Road Inventory

The Team Leader cum Highway Engineer will be directly responsible. Assistant Highway Engineer will assist him Highway Engineer.

Pavement Condition Survey

The Pavement Specialist assisted by an Assistant Highway Engineer will be responsible for the task.

Inventory / Condition Survey for Bridge / Culverts and other Structures

The Bridge / Structural Engineer assisted by an Assistant Bridge Engineer will be directly responsible for the job.

Hydrology

During this survey the Consultant will try to find out the hydraulic particulars such as HFL, LWL, construction age of the structure, etc. by the help of enquiry done from the local residents.

4.2 Equipment

3m and 30 m tape for making linear measurements.

4.3 Applicable Standards / Codes

IRC: SP: 19 (Manual for Survey, Investigation and Preparation of Road Projects) for road related features

IRC: SP: 35 (Guidelines for Inspection and Maintenance of Bridges) for inventory condition survey of bridges and culverts

In house procedure for pavement condition survey.

All the inventory data will initially be recorded in appropriate Performa.

4.4 Regulatory Requirements

The Survey / investigation teams will carry with them the following documents:

Letter of authority from the Client to carry out the investigation

A list of equipment including identification numbers and approximate cost

A letter of octroi exemption, if applicable

4.5 Safety / Environmental Considerations

A flagman with red flag will be used to make vehicles to slow down or stop when any measurement across the carriageway is made.

4.6 Training

The concerned Senior Personnel will give an induction course to the Assistant Engineers before start of the inventory surveys. The concerned senior personnel themselves will carry out the condition survey of the pavement and structures.

4.7 Data Verification

The individual who has collected the data will sign all the data sheets. The concerned senior personnel will have a check on all the data sheets and countersign these as a measure of authentication.

4.8 Documentation

All the data sheets duly signed by the concerned will be suitably stitched in files, labeled and sent to office for further analysis.

4.9 Work Procedure

Inventory of road and culvert / bridge structure:-

This will be in the form of linear measurements with tape to capture all the existing physical features. All chainage will be with reference to the existing hectometer and kilometer stones fixed along the highway. Dimensions of the visible approachable portions of the bridges and structures will be similarly measured. Also all other information related to the structures will be collected. Requirement of the details of existing structures to carry out further engineering analysis will thus be met.

Pavement Condition Survey:-

Pavement Condition survey will be carried out under the Supervision of Pavement Specialist. The survey on general pavement conditions will be primarily a visual exercise undertaken by means of slow drive-over survey, and supplemented with measurements where necessary. Visual assessment will be carried out from a vehicle, with speed not exceeding 20 km/hrs and stopping at various locations at suitable intervals and wherever necessary, by variations in pavement conditions.

At the points of stoppage, simple measurements using measuring tape, straight edge will be carried out to quantify pavement deficiency on a representative basis. Aspects of pavement conditions assessed include surface defects, rut depth, cracking, potholes, patched areas, shoulder condition etc. An overall assessment of performance – serviceability of the road will also be done to qualitatively rate the existing pavement and shoulder condition.

The pavement condition will be measured under the following sub-heads:

Shoulder condition (Fair/Poor/Failed)

Riding Quality (Speed, quality: G/F/P/VP)

Pavement condition (cracking %age, Raveling %age, Potholes / Patching (Nos. & %age per 100 m, Rut Depth (None/Moderate/ Severe).

Pavement Edge Drop (mm)

Embankment Condition (Good/Fair/Poor)

Road Side Drain (Non-Existing/Partially Functional/Functional)

All the distress condition will be estimated by carrying out visual condition survey and taking measurements wherever necessary after dividing each distress mode of the Pavement in nine categories i.e. Light / Medium / Heavy and each category further sub-divided in three more categories, e.g. Light distress condition as Light (-) / Light / Light (+). By studying, the pavement condition of the project road, each category of distress mode will be given a definite quantitative value and data sheet prepared in the field in the coded form will be converted into the quantitative values.

Condition survey of Bridges and Culverts:-

Bridge Structural Engineer assisted by an Assistant Bridge Engineer will carry this out. The condition assessment will be carried out in accordance with guidelines given in IRC: SP: 35. In IRC: SP: 35, Inspection Performa for bridges/structures have been provided. The same is applicable to any kind of distressed structures. Thus, based on the actual condition of the bridges and structures only the relevant information contained in the Performa will be collected.

HFL (High Flood Level) and LWL (Lowest water Level) bed level of the Drainage Structures:-

The observed HFL and LWL bed level for all the drainage structures will be ascertained from the available data records if any or from the local enquiry and from the marks visible on the structures. Overtopping and submergence for the structures, if any, will also be ascertained from the available records and from the local enquiry.

Site Selection, if required as per scope:-

In order to evolve an efficient realignment or new bridge/ structure the several possible options will be studied to arrive at the most viable alignment/site. Following general factors are to be considered for the evolution of the most viable option:

Objective for realignment/ proposed bridge/ structure;

Safeguarding the environment;

Least disturbance to land use in the area or navigation/ hydrology of the stream; and

Cost effectiveness.

Factors controlling the above Criteria are as follows:

Objectives:

- Accessibility;
- Service to Highway users;
- Directness of route;
- Network connectivity; and
- Traffic Demand.

Environment:

- Minimal impact on environment;
- Rehabilitation and resettlement;
- Water and Air quality;
- Minimum noise pollution;
- Preservation of culture; and
- Protection of flora and fauna.

Land Use:

- Minimal impact on agricultural activities;
- Minimal impact on commercial activities; and
- Consideration of future land use plan.

Financial:

- Cost effective construction;
- Minimal cost of construction; and
- Other construction considerations.

The above factors are to be presented in the form of evaluation matrix for each of the option, and recommendations for the selected options will be made accordingly.

Topographic Survey for the longitudinal section and cross section:-

To get the longitudinal and cross-sections of the streams, survey will be carried out as felt necessary by the concerned senior personnel. The topographic survey will be carried out as detailed under QAP of topographic surveys.

Highway Drainage Parameters: -

Site specific parameters will be recorded at site regarding design of rural, semi-urban, urban, super- elevated and high embankment stretches.

CHAPTER – 5

TOPOGRAPHIC SURVEYS

5.1 Technical Specification

Entire survey activity should take the guideline from SP: 19-2001 manual for survey investigation at preparation of Road project. Topographic survey is to be carried out using Total Station of one sec accuracy. Total station will be checked periodically for horizontal and vertical collimation. Auto level of 1-mm accuracy will be used for fixing benchmark levels and control points levels / traverse stations. The calibration certificate of the total stations calibrated not before than 3 months to be produced.

5.2 TBM, PBM & DGPS Pillar Construction

Pillar Construction bench marks pillars at every 250m along the route within the ROW but as far as possible out of construction limit will be constructed. These pillars have to be constructed in a location opposite to the widening scheme so that they remain undisturbed by the proposed improvement. All these pillars will have to be furnished with X, Y, Z co-ordinates. The pillars will be of size 150x150x500 mm long and provided with steel plates/nail at the top. The pillars will be embedded and concreted of which 250 mm will remain above ground. A steel plate/nail will be fixed in the center for punching the point and finally these are to be painted yellow. The RL has to be marked on the pillars with red paint after leveling surveys. These pillars will officially be handed over by **ECI-SRM PROJECTS**.

At every 5Km a pair comparatively larger pillars for GPS (300x300x600mm size) will be constructed. These pillars will also have the steel plate's arrangements as in Bench mark pillars. The horizontal face of pillars should be absolutely flat and truly vertical with the ground. Reference marks with paint marks will be made on pavement for pillars.

Fixity of the BM and GPS pillars would be ensured by providing adequate thickness of PCC below and around the pillars at the time of pillar construction. The pillars should be free of workmanship defects. Defects to the pillars, if any, would be made good by the survey team.

BM will be fixed on all parapets of existing culverts, minor bridges, major bridges and nearby permanent structures (such as well, house, bus stand, etc.).

Note: The following survey activities would be taken up after completing pillar construction/fixation at site.

5.3 GPS Traverse

Closed loop differential GPS (DGPS) survey will be conducted along the corridor. Pair of permanent GPS stations will be left at every 5 KM. GPS readings in Latitude and longitude as well as converted into local and UTM coordinate system will be submitted. In case any

horizontal control points exist along the corridor (GPS stations), they need to be connected and accuracy of existing GPS traverse control will be verified.

Once GPS traverse is established, the same will be verified with closed loop traversing for at least 2-3 loops (6-9 km) in accordance with procedure mentioned below. If the GPS and closed loop traversing match with each other within the prescribed accuracy levels mentioned below, no further closed loop traversing is required for remaining loops. In case it does not match, closed loop traverse will be done for entire length and it will be considered as incidental to the work of GPS Submission of co-ordinates will be converted to scale factor (universal transit method (UTM) Co-ordinates). A list pillars with location and description sketch and photographs will be provided for all GPS pillars.

5.4 Total station traverse

In every stretch traversing in loop has to be completed prior to detailed survey. A closed loop traverse will be done from GPS to GPS. Maximum length of each loop will not be more than 5km. While traversing, stations will be established 200 to 300 m apart and all reference/BM pillars will be connected. These points would be further used for detailed survey. The minimum accuracy of this survey will be 1:10000. Traverse line diagrams for each closed loop traverse will be submitted. Surveyor will keep hand written survey notes for all the observations of traverse and the same will be submitted with traverse data. Traverse loops will be submitted in Excel format compatible with soft disk. Distance & included angle observations format will be used in traversing. Traverse lines will also be run along the selected realignments and proposed bypasses along the project corridor, if any in same manner as described above.

All the existing traverse (control) stations will be connected while doing the traverse and accuracy of existing horizontal control needs to be verified. Traverse loops will be submitted in field book format (FBF) all computation will comply with the following:

Traverse adjustment by Bowditch method

Least square adjustment by variation of coordinates

5.5 Leveling

A closed circuit leveling (double territory) will be run along the entire route. Maximum length of each loop will not be more than 5km. It is required to locate GTS/GPS benchmarks along the project corridor by 'The Consultant' and details of which will be submitted along with the leveling data. All the leveling survey will be with respect to the GTS/GPS benchmark. During the course of leveling all the temporary benchmarks (TBMs/Reference Pillars) as established above at intervals of 250m will be connected with GTS/GPS benchmark. Apart from these, reference benchmarks will also be left on permanent structure like buildings, bridge & culverts, etc. available en route.

The accuracy of leveling will be of the order of $6\sqrt{k}$ mm where k is the loop length in km. Precision auto level / digital level will be used for the leveling purpose. The lists of TBMs / Reference Pillars are to be submitted with clear description and reference sketches. The checked and verified leveling data will be handed over in CD. Along with the CD, all the recorded field books in original are to be submitted with RL computations. Three hair level readings have to be recorded as per enclosed sample format. Intermediate sights should not be taken on traverse station/main benchmarks pillars and will not be accepted.

Leveling will be run along the project corridor including the selected realignments and proposed bypasses along the project corridor in same manner, if any as described above.

5.6 Detailed survey : Will be done with a Total Station

The survey will involve picking up of all existing features for the specified corridor width of 60m or as instructed by engineer in charge, on either side of the existing center line. In urban / built-up areas the corridor width to be surveyed will be that between building lines. The survey will cover any major important features if any within ROW. In such cases it will be intimated to the site- in- charge beforehand and follow his instructions accordingly.

At sharp curves (R<1200 m) the survey will extend up to 30m on either side. At important road junctions and railway crossings, small streams and nallas survey will extend up to a maximum distance as per IRC specifications. For the purpose of Blow up Surveys of water bodies and junctions, total stations will be used. Collection of DTM data will begin from two known station points and closed station but not the backside station point, i.e. compulsory check shots will be taken at known points before shifting the occupied station or before stopping the survey work for the day. Point data collected will be strictly as per a uniform code list. Details to be picked up during the detailed survey are not limited to the following:

Building lines indicating the type of buildings (shops or houses), Right of Way boundary if available at site by presence of boundary stones.

Sufficient road center points, edge points and shoulder points will be taken to define the existing layout of the roadway. The cross section points to be surveyed will be as detailed below in sub-section “cross sections”.

Approach road details for 60m length to be recorded on either side of the road. But on important junctions, length of road to be surveyed will be as per the instructions of the Engineer in charge subjected to a minimum length of 100m.

Location of bus bays / bus stops, truck – parking areas, taper length, roadway width.

Special emphasis will be laid in identifying all religious places – temples, mosque, church; its locations, boundary lines and clear dimensions of compound walls and entrances.

Locations of roadside drain clearly identifying the type (Built-up/Earthen, Rectangular/Trapezoidal etc., and whether Open/Closed), width of drain (waterway width and wall width in case of built-up drain) including the beginning and end of drain. While surveying the existing drains, care has to be taken to take the top and bottom points of the drain to get the true contour and shape of the drain. All water features such as ponds, tanks, lakes, streams, canals and wells etc. will be mapped.

Roadside cultivation viz., agricultural, residential, commercial, shops and business established areas etc. Will be marked.

Identification of all bridges and culverts along the project road – will include location (Chainage) reference number, width of bridge/culvert (width of slab or diameter of pipe, no of pipes/spans), course of water path, skew of bridge/culvert, span arrangement. Bridge/culvert cross section. Any other Structures/Utilities found at site should also be recorded as per the instructions of the Engineer in site.

5.7 Detailed survey for realignments & bypass

Detail survey will also be carried out for the stretches of Realignments and bypasses along the project corridor in same manner as described detailed above. Traversing and leveling in closed loops will continue without any break along the realignment and bypasses.

5.8 Longitudinal – sections: Auto Level instrument

Collection of longitudinal centerline points would be 10m apart in straight section or as instructed in letter of acceptance. On the vertical and horizontal curves it has to 5m apart depending on the nature of curve i.e. degree of sharpness of curve. Apart from this, in case of vertical curves and causeway the points should be captured in such a fashion by which the crest and bottom most points of the curve and the extent of causeways should not be missed.

5.9 Cross – sections:-Auto Level instrument

All cross–sections should be taken with reference to the proposed center line, extended normally up to the proposed ROW limits or between building lines, whichever is more, and show levels at every 2.5m intervals and at all breaks in the profile. While taking cross-section of Median top Median bottom, existing road apart from center lines and edges of the existing pavement, midpoint of each traffic lane in each direction, paved shoulder demarcation (if any), shoulder drop, edges of formation, toe lines and points on existing ditches have to be taken. Total 7 points to be taken on existing carriageway on each side. Under new carriageway interval will be 1.5m center to center and thereafter Up to ROW will be 2.0m center to center.

Wherever ditches are encountered, point(s) should be taken to indicate the depth of the ditches. Points on the natural surface will be taken 2.5m apart within the proposed ROW or between building lines, whichever is more. Also, cross–sections should be taken at points of beginning and end of spiral transition curves, at the beginning, middle and end of circular curves, culverts and at other critical locations. Cross sections have to be collected at 10 m interval. For isolated curvy and hilly stretches, the cross-section interval will be 5 m.

5.10 Minor Intersections

At small intersections (the intersections with MDR and the road below this category), survey will be extended up to 300 to 400m on either side on the crossroad. The cross width to be covered along the crossroad would be at least 40m. RL will be picked up on these roads within this width at 10-meter interval.

5.11 Major Intersections

At road intersections (i.e. intersection with SHs, NHs and Expressways) survey will be extended up to 500m on either side on the crossroad. The cross width to be covered along the crossroad would be at least 50m. Wherever cloverleaf interchange is proposed the survey will be carried out area wise in the specified hectares as required to design the cloverleaf interchange. RL will be picked up on these roads within this width at 10meter interval.

5.12 Cross Sections at Horizontal Curves

At curves, the pavement cross-sections should be taken at closer intervals to get the arc to chord tolerance within an acceptable limit (say 0.1 m). In any case, it will not be more than 10m.

5.13 Culverts

At every existing culvert the invert level (on both the sides of the culvert) will be recorded against the culvert number/location and at the proposed culverts site the existing ground levels will be taken up to Project Right of Way and 10m beyond Right of Way on either side at 2 to 5m intervals.

For pipe culverts, the levels along the stream/drain up to 50m on both upstream side & downstream side at 10.0 m interval (min. 5 levels on both u/s & d/s) will be taken. Thereafter, the cross sections of the stream/drain for a width of 20m (10m on each side from center of stream/drain) and at 10m adjacent to structure on u/s and d/s side will be taken.

The thickness of the earthen shoulder and pavement over the pipe at each extreme will be taken. Moreover, it is necessary to take the height of the existing road at these points. All the details of existing left Highway and right Highway like body wall, parapet wall/handrail, median details, FRL's of both left side and right side road, wing wall details, clearance details of all overhead features/ structures, utilities details if any, service road structure details, any structures nearby like buildings, compound walls, temples, tomb stones etc., will be also taken. In case of urban drain, the existing details of drain side walls on both u/s & d/s will be taken.

In case of Slab Culvert the existing bottom level of left side of the left culvert and vice versa are taken. In case of defined stream/drain, at site the shape of the drain (bank edge points) up to 100m on both u/s & d/s will be taken. The thickness of the pavement over the slab at the four corners will be taken. Moreover, it is necessary to take the height of the existing road at these points.

If the flow is in skew the levels will be picked up in the skew direction. Where the flow direction is in normal to the road at the existing location but has skewed upstream or downstream within the ROW the sections will be taken in the original flow direction with additional points to be taken in the normal direction within the ROW limit. Ground Level, Formation Level and Invert Level will be picked up at each abutment and pier location. For pipe culvert the dia. of pipe, head wall location is to be taken in addition.

If there is any NHAI number marked on the culvert, it should be indicated clearly. In addition to above details survey detail will include the R.L of the different sections of wing wall/return wall of all the structures.

If the project corridor has some additional features where on the existing road no structure present yet some canal which may be lined or unlined is in the process of construction by some other Govt. agency that may or may not affect the project road in future over which any structure has been constructed by the other agency, details are to be taken as per the above guidelines of the stream, structure as well as of the Project road specifically at that location and should be clearly shown in the Base plan.

5.14 Minor Bridges

At every Minor bridges and causeways (where existing bridge/ causeway length is in between 6m to 60m) survey will be extended up to 300m on either side. The levels along the stream/drains up to 300m on both upstream side & downstream side at 10.0m interval (min. 30 levels on both u/s & d/s) will be taken. Usually it will take into account a bigger length for the flood level calculation in the main streams, principally in flat zones. The cross sections of the stream/drain for a width up to HFL spread on both sides at minimum 10m, 20m, 50m, 100m, 200m, 300m adjacent to structure on u/s and d/s are taken.

A Contour Survey Plan of the Stream is to be prepared showing all topographical features and extending upstream and downstream of the bridge up to 150m and to a sufficient distance on either side to give a clear indication of the topographical features that might influence design of the bridge and its approaches.

For structural calculations Ground Level and Formation Level at the abutment and pier locations should be taken. Total Four points at each abutment and pier locations will be taken. If the bridge is under reconstruction in addition to the points taken by the above procedure Ground level on the side of widening will be taken @10 meter interval for a total length of 30 meter on either side of the proposed Bridge Center Line.

5.15 Major Bridges

At major bridge locations (where existing bridge/causeway length is more than 60m) survey will be extended up to 500m on either side. Points to be taken for bunds wherever available, edge of water and detailed survey on the bank for the strip specified earlier. The cross sections of the stream/drain for a width up to HFL spread on both sides at minimum10m, 20m, 50m, 100m, 150m, 200m, 300m, 600m adjacent to structure on u/s and d/s will be taken.

For Major Bridges levels along the stream/drain up to 500m on both upstream side & downstream side at 10.0m interval (min. 60 levels on both u/s & d/s) should be taken.

A Contour Survey Plan of the Stream is to be prepared showing all topographical features and extending upstream and downstream of the bridge up to 500m and to a sufficient distance on either side to give a clear indication of the topographical features that might influence design of the bridge and its approaches.

For structural calculations Ground Level and Formation Level at the abutment and pier location should be taken. Total Four points at each abutment and pier locations will be taken. If the bridge is under reconstruction in addition to the points taken by the above procedure Ground level on the side of widening will be taken @10-meter interval for a total length of 30 meter on either side of the proposed Bridge Center Line.

The cross-sections will be perpendicular to the flow of stream and spot level will be along this line (straight line).

For minor bridge up to 20m length, at least four spot levels will be taken between two bank bottom lines of the stream. For all other bridges, spot level will be taken at 5m interval.

The bed levels up to the top of banks and the ground (flood plain) levels up to the ½ of width of the banks top lines, in both sides of the C/S are to be taken. For minor bridge up to 20m length, spot levels will be taken at 2.5m interval. For all other bridges, spot level will be taken at 5m interval.

Where there is no flood plain, the left and right side of C/S to be extended up to a point where ground level is at least 1.0 m above the local enquiry HFL.

Bed level of the stream in hill road is steep. Therefore, spot levels of C/S should be taken at 2m interval so as to cover all topographical details.

L/S of the channel, along the approximate center line of the deep-water channel should be extending u/s and d/s of the proposed site for distances indicated in **Table-1.** For minor bridge up to 20m length, spot levels will be taken at 10m interval. For all other bridges, spot level will be taken at 15m interval

Pier Top and Soffit Levels of Existing Bridge:

Pier top level is not the pier cap top level. Pier top and/or soffit levels of existing bridge are to be taken and given in the Topographic survey drawing file. Three to five photographs of each bridge are to be taken showing pier top and/or soffit levels. Another two photographs showing entire U/S & D/S of stream are also to be taken, standing on the existing bridge.

HFL Data:

HFL data (flood marks left on the piers and abutments of existing bridges and this should be supplemented by local enquiry) also to be taken and given in the Topo survey drawing file.

C/S of the stream at the site of the bridge crossing and four/five cross-sections, as mention in **Table-5.1,** are to be taken.

Table 5.1 C/S of the stream

S. No.	Existing length (L) of bridge u/s or d/s of the bridge	Distance (u/s and d/s of the crossing) at which cross-sections should be taken
1	From 1m to 10 m	100 m
2	From 10 m to 20 m	300 m
3	From 20 m to 40 m	500 m
4	From 40 m to 150 m	500 m and 1000 m
5	Over 150 m	750 m and 1500 m or “L/2” m and “L” m whichever is more

5.16 ROBs

For ROBs levels on either side of crossing up to 500m along with necessary Railway features should be taken.

5.17 Way Side Amenities

Survey team will interact with representative at site to check the final location of the Way Side Amenities and then carryout the detail survey of the total Way Side Amenities area capturing all the data for the proposed facilities.

5.18 Manmade Features

Location of any sort of manmade feature (over or/and under the ground) like structures, OFC lines, signal lines, sewer line, water line, telephone poles, electric poles, high-tension lines, fence line boundary walls, bore wells, hand pumps etc. have to be collected through total station. At location where HT lines cross the project corridor the height of crossing of the lines for the entire right of way would be captured so as to enable the drawing of cable profile.

5.19 Stacking out Survey

Stacking out survey will be done with a total station. Stacking out survey for Centre line will be marked on the ground at every 50-mtr intervals in straight portion and 100mts interval in curve portion. All the Marking will be done with Yellow paint.

5.20 Survey record and report

The Design Head will submit the following

- Work program for the survey work indicating the no. of Team members, mobilization of teams and target dates for submission of field and compiled data.
- The Design Head will also submit the Methodology for survey work and brief note on procedure being followed
- The report will consist of Topo-survey drawings (Hard and soft copies), field books / level books, and all relevant details of the survey. Report will be handed over to the Engineer in-charge at site, approved and certified for work or to send the same to the Assistant Engineer's office as advised by Engineer in-charge at site.
- Comments / discussion on results, including a note on accuracy achieved standard deviation.
- Survey network diagram inclusive of control points (traverse points) and Bench Marks Positions with their number and abbreviations.

Final coordinate and elevation list

Field observation if any

5.21 Survey Drawings

- The Design Head will submit the raw-data in a coma separated ASCII file format with the details such as Easting, Northing, Level and Code.
- Preparation of base plan will also form a part of the work. One hard copy of the three-dimensional Auto-CAD drawings of the survey as per the layer name, color, line type, font size and symbols/blocks provided by the Design Team will be submitted. Scale of the drawing should be 1 in 1000. These drawings will also contain additional details like names of villages, names of approach roads, road destinations & directions, names of junctions & interchanges, names of major buildings, structures, rivers, nallas, water-

bodies and other landmark points, in separate AutoCAD Layer. Details of reference pillars, benchmark pillars, and control points are to be submitted as a separate Excel file with their location landmarks and also as a 3D drawing file.

5.22 Ground Verification

On completion of Detail Survey and further plotting the same on mapping software a check plot would be taken by the Design Team themselves and all details should be verified on ground before the finalization of prepared drawings. All culverts & bridge details like invert level will be picked up.

5.23 Setting up Instrument on Station

The Senior Survey Engineer will inspect all instruments to verify that no damage has occurred in transit. The instrument will be then set up as follows:

- Set up total station over the station and measure height of instrument
- Fill in top of Detail Survey Booking Sheet.
- Filename e.g. 2912PC.FC5
- Station number
- Height of instrument
- Date
- Observer (Surveyor)
- Page number (start each day on page 1)
- Start string number (add 1 to previous station or start at 01 for each new day)

The vertical Collimation will be checked on the First station for each day in the following manner:

- In Face Left sight to a distant well-defined object and record the Vertical circle reading on the booking sheet.
- In face Right re-sight the same object and again record the Vertical circle
- Add the two readings and subtract 360
- This difference is Twice the Vertical Collimation Error. This error should be less than 20” to maintain the required vertical accuracy
- Check that the prism constant is correct for the prisms being used for the Traverse Detail Survey
- Place a mark about 120 m from the station and measure the distance with the 30-metre tape
- Take a reading to the Prism at this point and ensure the horizontal distance is within 5 mm of the taped distance

TOPOGRAPHIC SURVEY

The Carrying out of topographical surveys will be one of the most important and crucial field tasks under the project. The detailed field surveys will be carried out using Total Station. The data from the topographical surveys will be available in x, y and z format for use in MX software to develop digital terrain model (DTM). Senior Survey Engineer will be fully

responsible for accuracy and sufficiency of the topographical survey. Following will be adhered to:

- Traverse accuracy is 1:10000,
- Closing loop distance ± 5cm per km
- Permissible Levelling error 12 ± k

It will be assured that the surveys extend a minimum of 30m beyond either side of the center-line of the proposed divided carriageway or land boundary whichever is more. Wherever larger widening is proposed, more width will be surveyed. At Junctions surveys will be done up to a length of at least 120m on the intersecting roads to design junction improvements.

Longitudinal and cross sections for major and minor streams will be taken as per recommendations contained in IRC Special Publication No. 13 and IRC: 5–1985 with cross sections at 10m interval.

Survey

Topographic survey will be carried out with reference to Intermediate Reference Pillars. The x, y, z co- ordinates for each station surveyed will be recorded with respect to the values of traverse stations. All features will be accurately picked up and properly coded as explained below. A sketch for surveyed points with respect to traverse station will be proposed. The sketch will include:

- Station positions (including Set up, Back sight, Foresight and Temporary Stations)
- All features with string numbers.
- Any additional information as felt necessary and as directed by the Site In-charge.
- A record of the string numbers on the right of the sketch will be properly kept.
- Any error found in the field will be recorded on the booking sheet for correction. The following will be recorded:
- Point number of errors
- The actual error
- The corrected error

Coding

Coding for feature will comprise of four characters. First two characters will describe the feature and last two characters will mention the string number. The string number i.e. last two characters will be alphanumeric starting from 01 to 09, A1 – A9, B0 – B9…….Z0 – Z9, AA-AZ, BA-BZ,…….., ZA-ZZ. Whenever there is a break in a string, its number will be changed.

Break will be introduced in the left & right edges of shoulder due to culverts, bridges etc. While recording information for a particular string number, it should be loaded in the sequence of joining them i.e. for BR01, BR02.

All the surveyed points having the string number BR01 will be joined together in the sequence of recording to draw the first residential building and all points having code BR02 will be joined together to draw the second building i.e. numeric part will indicate the points to be joined

to form the detail and descriptive part indicates the feature. The survey data will be thoroughly checked before it is processed through MX Software.

All the features that are not to be joined (e.g. telephone poles, trees, electricity poles, spot levels etc.), will be having their codes in the form p… i.e. the point strings code will always start with P. No feature will have its survey code starting with M, L or G.

Normally all heights observed are contour-able. If for some unavoidable reasons any height cannot be observed correctly then this is to be coded differently so that design engineer can understand that these points are not to be considered for contouring.

Guidelines for Typical Feature Surveys

In one string, points are to be taken in exact sequence, in one direction only for the complete section of the project road. All survey teams will follow same direction.

Topography

Banks or Side Slopes (Code EB and ET)

- Banks will be located opposite the chalk marks and any change of direction or grade where they run parallel to the road.
- When the Banks are not parallel to the alignment, readings every 20 m or change of direction or grade, whichever is earlier.
- While following a bank that changes direction often, keep the top and bottom readings next to Each other to avoid the lines overlapping.
- Irrigation Canal (Code CA)
- Canal strings run along the top of the Canal bank
- The location of the string will be the same as for Top of Banks

Natural Surface points (Code PNSL)

These points will be located every 10 m to show high or low points. Natural surface points should never be used to show changes of grade instead of a string.

Edge of Water / Pond (Code WP)

- Readings to be taken at edge of water outline as shown
- Readings should be in proper sequence, beginning from start to end point.

Edge of Ditch / Borrow pit (Code D)

- Readings to be taken to the edge of ditch and one reading to the bottom of the ditch.
- Outline of Rocks (Code RO)
- Readings to be taken at edge of rocks to show outline and on reading on the top of the rock.

Electricity, Telephone and Underground utilities

- Electricity / Transformer/ Telephone poles (Codes PELP, PTF, PTB)

- Locate these features on the roadside. Height of electric wires telephone wires crossing project Road will be recorded taking minimum of three points just above the carriageway.
- Locate a string of well by taking at least three points around the well so that a circle can be created.

Level Crossing

At level crossing cover the railway line at least 200 to 300 m on either side of road and rail track noting layout, level and physical features around the area.

Code (RL.)

Take two points at the center of Railway line as marked by x in the sketch shown below @ 10m interval

In the sketch shown below a typical level crossing is shown.

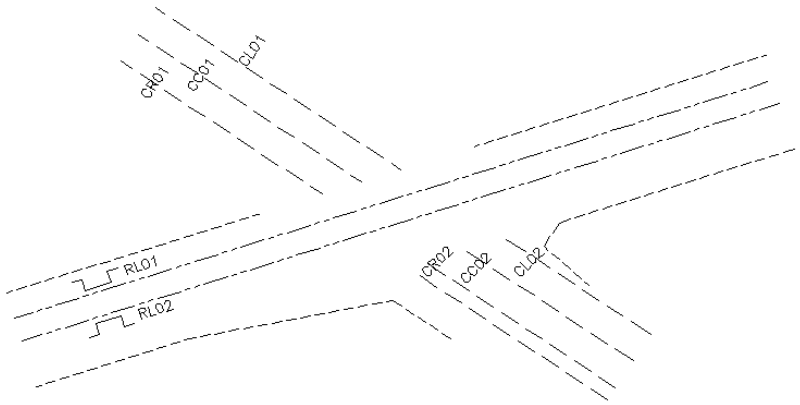

Figure – 5.1 Level Crossing

b) SAFETY

It will be ensured that the field staffs are made aware of their safety while carrying out field surveys along and across the highway. As and when required, the survey staff will be supplied with the following items for use:

Green vest with yellow reflective tape ‘X’ on the back;

Hard Hats;

Safety working goods i.e. red flags etc. to warn, slow down and divert the traffic;

Movable warning signs (survey in progress) with orange flag placed at both ends of survey activity zone;

Traffic cones with orange and black horizontal stripes; and

First Aid Box.

Table Error! No text of specified style in document.**.2**
Survey Code List

Sl. No.	Code	Description
	" * "	**TEXT**
1	*	All descriptions of remarks (Cultivation Land, School, Government Buildings, Village Name, Destination of Surveyed Features)
	" B "	**Building**
2	BA	
3	BC	Building Commercial
4	BD	Building Ruined
5	BE	Building Educational
6	BG	Building Government Office
7	BH	Building Mud and Straw Houses
8	BI	Building Industrial
9	BL	Building Religious (Temple, Mosque, Church, Gurudwara, Worship Place)
10	BO	Building Overhead Tank
11	BOG	Building Overhead Ground
12	BR	Building Residential
13	BS	Building Under Construction (up to Plinth Level / up to Roof Level)
14	BT	Building Temporary Shed (Open Market Huts, Pan Shops etc.)
15	BU	Building Utility (Urinals, Bus Stand, Cycle Stand etc.)
16	BW	Building Water Tank
	" BO "	**Boundary**
17	BOF	Boundary of Forest / Garden
18	BOG	Boundary Grave Yard, Funeral Place, Cemetery
19	BOV	Boundary of Village
20	BOW	Boundary of Weigh Bridge
	" C"	**CARRIAGEWAY**
21	CC	"Carriageway" Centre Line
22	CCE	Center of Secondary Earthen Road

Sl. No.	Code	Description
23	CCP	Centre Line of Secondary Paved Road
24	CCU	Centre Line of Sec. Unpaved Road
25	CL	"Carriageway" Left Edge
26	CLE	Left Edge of Secondary Earthen Road
27	CLP	Left Edge of Sec. Paved Road
28	CLU	Left Edge of Sec. Unpaved Road
29	CR	"Carriageway" Right Edge
30	CRE	Right Edge of Secondary Earthen Road
31	CRP	Right Edge of Sec. Paved Road
32	CRU	Right Edge of Sec. Unpaved Road
	" D "	**Ditches, Drains and Rivers**
33	DB	Ditch Bottom (All Water Bodies, Ponds, Water Logged Area, River, Drain)
34	DC	Ditch Channel Centre
35	DH	High Flood Level
36	DT	Ditch Top (All Water Bodies, Ponds, Water Logged Area, River, Drain)
37	DW	Water Level
38	DI	Soffit LEVEL
	" E "	**Embankment**
39	EMB	Embankment Bottom
40	EMT	Embankment Top
	" F "	**Fence**
41	FB	Fence Barbed Wire
42	FC	Fence Cement
43	FG	Fence Grill
44	FW	Fence Wooden / Bamboo
	" G "	**Gates**
45	GP	Gate Permanent
46	GT	Gate Temporary

Sl. No.	Code	Description
	" H "	**Hedges**
47	H	Hedges
	" I "	**Irrigation Channel**
48	IB	Canal Bottom
49	IC	Canal Centre
50	IT	Canal Top
	" K "	**Kerb**
51	KB	Kerb Bottom
52	KT	Kerb Top (Island, Medians)
	" L "	**Spot Level**
53	L	Cross Section Point/ Spot Level
54	Layer	Extra Points
54	LSA	Land Slide Area
	" O "	**Overhead Cables**
55	OVRE/ORE	Electric Lines Less than 11 KV
56	OVRH	Electric Line High Tension (11 KV and More)
57	OVRT	Telephone Lines
	" P "	**Point Features**
58	PBS	Bench Seat
59	PEB	Electric Box
60	PF	Flag Post
61	PFH	Fire Hydrant
62	PGR	Grave Point
63	PGV	Gas Vent / Oil Pillars
64	PHP	Hand Pump
65	PHS	Hectometer Stone
66	PIE	Isolated Electric Poles
67	PIT	Isolated Telecom Pole

Sl. No.	Code	Description
68	PKS	Kilometer Stone
69	PL	Lamp Post
70	PMH	Manhole
71	PMT	Municipal Water Tap
72	PO	OFC Pillar
73	POB/PBM	Benchmark Pillar
74	POG	GPS Pillar
75	PP	Petrol Filling Points
76	PPY	Pylon (any Isolated Pylon)
77	PPL	WATER PIPE LINE
78	PRO	Right of Way Pillar
79	PSB	Road Sign Boards
80	PSG	Railway / Road Signals
81	PSS	Traverse Points
82	PST	Statue
83	PT3	Tree 900-1200
84	PT4	Tree 1200-1800
85	PT5	Tree 1800-2700
86	PT6	Tree 2700 -onward
87	PTL	Tree Line
88	PTB	Telephone Box
89	PTF	Transformer Points
90	PTW	Tube Well
91	PWL	Well
	" RA "	**Rails**
92	RAB	Railway Ballast Verge (Top only)
93	RAT	Rail Top
94	RBB	Toe of Road Embankment

Sl. No.	Code	Description
95	RBC	Top of canal along the Road Embankment
	" S "	**Shoulder**
96	SL	"Carriageway" Shoulder Left
97	SLP	"Carriageway" Paved Shoulder Left
98	SR	"Carriageway" Shoulder Right
99	SRP	"Carriageway" Paved Shoulder Right
	" V "	**Verges**
100	VF	Footpath
101	VST	Stairs
	" W "	**Wall / Parapet Wall**
102	WB	Brick / Concrete / Stone Walls
103	WBA	Abutment Bridge / Culvert
104	WBR	Road Length Blocked due to water crossing
105	WC	Water Crossing
106	WE	Earthen Wall / Loose Stone Wall
107	WPB	Wall Parapet (Bridge)
108	WPC	Wall Parapet (Culvert)
109	WPI	Piers
110	WR	Retaining / Wing Wall / Breast Wall
111	EB	Banks
112	ET	Side Slope
113	CA	Canal
114	PNSL	Natural Surface Points
115	RO	Outlines of Rocks
116	WP	Edge of Water/ Pond
117	FL	Fence Line
118	PGRM	Grave yard
119	TH	Temporary House/ Hut

Sl. No.	Code	Description
120	WA	Edge of Wall
121	PBWE	Bore well
122	PTR	Trees
123	RL	Railway Line
124	WC	Concrete Well
125	OFC	Optical Fiber Cable
126	WI	Irrigation Well
127	PRS	Religious Structure

CHAPTER -6

BBD AND FWD SURVEY

6.1 Manpower and Responsibility

The structural strength surveys will be carried out under the direct supervision and direction of the pavement specialist and senior Material Engineer. One Assistant Engineer will assist them. The Design Head will provide logistic, equipment and other support to them to carry out this task in totality and satisfactorily.

6.2 Equipment

The equipment will be used as follows:

- Standard Benkelman Beam with Dial Gauge
- Standard Loaded Truck with dual rear wheels
- Banners and red cones for traffic safety and temporary diversion.
- Glycerol and thermometer
- Hand tools for making holes in the bituminous pavement for temperature measurement.
- Paint for marking on the road.
- At the start of work on each day, the calibration of the deflection beam will be verified using feeler gauges of known thickness.

The truck will be loaded with bricks uniformly spread over rear axle and then weighed at a local stationery weigh bridge and the load adjusted such a way that the average weight of the rear axle amounts to 8170 kg.

6.3 Applicable Standards / Codes and Methodology

The evaluation of structural strength of existing flexible pavement will be carried out by using a Benkelman Beam in accordance with the procedure given in IRC 81-1997.

For measuring pavement deflection, the C.G.R.A procedure that is based on testing under static load will be adopted. A standard truck having a rear axle weighing 8170kg fitted with dual tyres inflated to a pressure of 5.60 kg/sq.cm will be used for loading the pavement. The beam will be calibrated using metal plates of known thickness prior to testing. The dual wheels of the truck are centered above the selected point.

Deflection surveys will be carried out as per the scheme given below:

Deflection points will be taken at every 50m interval in staggered manner on both the lanes (i.e. 20 points in each kilometer) for both directions throughout the project road. Please refer Figure 1 given below.

Pavement temperature will be recorded at every one hour during the testing period by inserting a thermometer in a hole (approximately 5 cm deep and 10 mm diameter) drilled in the pavement and filled with glycerol. At any deviation of the pavement temperature during measurements from the standard temperature of 35°C, correction will be applied to the deflection measured in accordance with the procedure described in IRC: 81-1997. Seasonal correction will be carried out using the moisture correction factors given in Figures 2 to 7 in IRC: 81-1997.

The overlay in terms of Bituminous Macadam (BM) will be worked out with respect to characteristic deflection and Design MSA for identified traffic homogeneous sections.

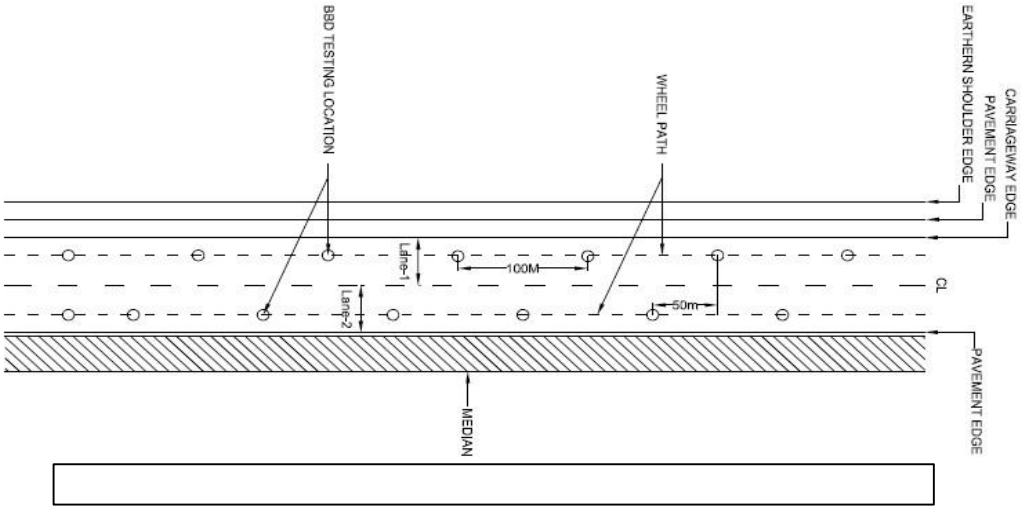

Figure 6.1: Graphical representation of BBD Survey Procedure

6.4 Falling weight Deflectometer Test

A falling weight deflectometer (FWD) is a testing device used by civil engineers to evaluate the physical properties of pavement. FWD data is primarily used to estimate pavement structural capacity for 1) overlay design and 2) to determine if a pavement is being overloaded. The FWD is designed to impart a load pulse to the pavement surface which simulates the load produced by a rolling vehicle wheel. The load is produced by dropping a large weight and transmitted to the pavement through a circular load plate - typically 300 mm diameter on roads and 450 mm on airports. A load cell mounted on top of the load plate measures the load imparted to the pavement surface. The load plate can be solid or segmented. The advantage of a segmented load plate is that it adapts to the shape of the pavement, giving an even distribution of the load on uneven surfaces. Typically, the load for road testing is about 40 KN giving about 700 KPa pressure under the load plate. The guideline for this test is provided in IRC: 117-2015.

6.5 Regulatory Requirements

The Survey team will carry with them the following documents:

- Letter of Authority from project proponent to carry out the survey
- A list of equipment

- A letter of octroi exemption.

6.6 Safety / Environmental Considerations

Six safety cones (red and white striped), three on each side will be put out when the deflection measurements are being taken. Besides, banners stating “Road Testing in Progress- Keep Distance” will be posted on the front and rear of the test truck. Further, flagmen with red flags will be positioned on either side for warning public vehicles for keeping away from the test truck.

6.7 Training

The assistant Engineers with similar type of experience of conduction Benkelman Beam Deflection Surveys on at least three projects will be deputed and the pavement specialist will give a brief training to them.

6.8 Data Verification

Data Collected would include:

- Dial gauge reading from the deflection beam.
- Pavement temperature measured at a small hole made in the pavement and filled with glycerol.
- The Assistant Engineer will record all the data and duly sign the same. While testing a homogenous control segment, any deflection reading varying by more than 20% will be considered doubtful, and the test will be repeated.

6.9 Documentation

All the data sheets will be countersigned by the Material and Pavement Engineer and sent to office for data analysis.

6.10 Quality Plan

During each hour of testing, a small hole will be made in the un-cracked area of the pavement filled with glycerol, and the temperature measured and recorded. The Benkelman Beam Deflection readings will be taken along the outer wheel path as defined in IRC: 81. Alternate test points will be staggered left and right.

Tyre pressure will be checked and adjusted to 5.6 Kg/cm2 before start of the tests each day. In the initial period the Pavement Specialist will be present with the group conducting BBD Survey.

CHAPTER – 7

SOIL AND MATERIALS INVESTIGATIONS

7.1 Requirements

The activities will include:

- Identification of quarry sites and borrows areas/source for procuring the various natural materials including fly ash/slag for use in the project.
- Sampling the materials from the sources and subjecting these to relevant laboratory tests.
- Estimating quantities of materials available for extraction at the various sources
- Evaluation of test results for suitability for incorporation in the various works and making recommendations on the use of the materials from different sources based on techno-economic considerations.
- Preparation of quarry and material location charts and Soil/Materials Report for inclusion in the Bid Documents.
- Preparation of mass haul diagram indicating location of selected borrow areas / sources.
- Make suitable recommendations regarding making good the borrow areas and quarry areas after exploitation.

7.2 Manpower and Responsibility

The Senior Material Engineer will visit all the potential quarries; borrow areas and other material source. Based on his visual inspection, he will select the sites from where samples will be collected for laboratory testing. An Assistant Material Engineer and a few laborers will assist him.

The Senior Material Engineer assisted by Material Engineer and laboratory technicians will be responsible for all the laboratory tests.

7.3 Equipment

The equipment will include hand tools like crowbars, Spades, wedges etc. for collecting representative samples. The samples will be packed in suitable bags, labeled and sent to laboratory for various tests on aggregates, soils etc.

7.4 Applicable Codes / Standards

Sampling and testing of borrow areas soils; granular materials for sub-base, stone aggregates etc. will be as per relevant BIS-standards.

7.5 Regulatory Requirements

The samples will be collected after obtaining necessary authorization from the owner of the land / quarry.

7.6 Safety / Environmental Considerations

As the work involves only collection of samples from off-road locations, the safety/ environmental aspects will not be significant. However, any holes made for sampling will be leveled and made good prior to leaving the site.

7.7 Training

At the site, experienced personnel will carry out sampling and for that no formal training is envisaged but Senior Material Engineer will strictly undertake the entire laboratory testing under his direct supervision.

7.8 Data Verification

The Senior Material Engineer will verify that samples have been collected in sufficient quantities from all the potential sources and Pavement Expert will check all the test results received from the laboratory for compatibility and make an evaluation for suitability / adoption.

7.9 Documentation

All the samples will be suitably labeled in a systematic manner for easy identification. A list will also be prepared for checking at various stages.

All the Performa for recording test results will be suitably numbered for identification and retrieval.

7.10 Work Procedure

(a) Collection of Secondary Data

To start with, secondary data regarding Location maps of operating quarries and material sources will be collected from appropriate sources. Discussions if necessary, will also be held with crusher operators and materials suppliers etc. to ascertain the sources used by them, preliminary information regarding quality and quantities available etc.

(b) Sample Collection

Each quarry / material source will be visited by the Material Engineer and the available materials will be examined in detail. The location of the source, the approachability, ownership, volumes of material available for extraction, visual assessment about suitability, and other relevant information will be recorded. Samples (30-40kg) will be collected from each source adopting standard sampling procedures. These will be packed in suitable bags, labeled and sent to laboratory for the testing.

The sequence of operation for each large pit will be as follows:

- Manual excavation of 1 m x 1 m size pit down to subgrade level;
- Removal of the top part of the shoulder or bituminous part of the pavement;
- On reaching subgrade level, noting down the average thickness of different pavement layers at the exposed face with the material type;
- Field (in-situ) density test using sand replacement method as per IS: 2720, Part–28;
- DCP test (TRL method, Road Note-8) beginning at the bottom of the pit to a minimum depth of 900 mm below subgrade level;

- Collection of disturbed samples of 40 kg from the top 300 mm of subgrade for detailed laboratory examination for the following parameters:
- Field moisture content as per IS: 2720, Part- II; 1973
- Atterberg's limits as per IS: 2720, Part- V; 1985
- Grain size analysis as per IS:2720, Part- IV; 1985
- Max. laboratory dry density (heavy compaction) as per IS:2720, Part- VIII; 1983
- Optimum moisture content as per IS:2720, Part- VIII; 1983
- CBR (4 days soaked) as per IS:2720, Part- XVI; 1987 at 97% energy level

(c) Laboratory Testing of Borrow Soils and Granular Materials

The samples of materials for use in the project will be subjected to the following tests:

- Determination of water content - IS: 2720 (Part 2)
- Grain size analysis - IS: 2720 (Part 4)
- Liquid and Plastic Limits - IS: 2720 (part 5)
- Compaction Test (Modified Proctor) - IS: 2720 (part 8)
- Un-soaked and 4-days soaked - IS: 2720 (Part 16)

(d) Laboratory Testing of Quarry Sample

- Grading - IS: 2386 (Part 1)
- Flakiness Index - IS: 2386 (part 4)
- Aggregate Impact Value - IS: 2386 (part 4)
- Specific Gravity and Water Absorption - IS: 2386 (part 3)
- Soundness - IS:2386 (part 5)

(e) Laboratory Testing of Natural Sand

- Gradation and Fineness modulus - IS 383
- Deleterious constituents - IS 383

(f) Water for Construction Purposes

- PH value - IS 3025 (part 2)
- Chemical - IS 3025

(g) Review & Verification of Test Results

Material Engineer and Pavement Expert will review all the laboratory test results for consistency and compatibility. For any inconsistencies or where the results are in doubt, the tests will be repeated.

CHAPTER – 8

GEOTECHNICAL AND SUB-SOIL INVESTIGATIONS

8.1 Requirements

The Geo-technical investigations and sub-surface explorations will be carried out for the proposed Bridges / Road over Bridges / tunnels / viaducts / interchanges etc., along high embankments and any other locations as necessary for proper design of the works and all the relevant laboratory and field tests on soil and rock samples will also be conducted.

The sub-soil investigations will start once Design Head provides location and tentative depth of bore holes to the Client. Besides the structure locations, the investigations will also be carried out along high embankment (height > 6m).

8.2 Manpower and Responsibility

The sub-soil exploration and testing jobs are to be carried out through a sub-soil consultant appointed by ECI-SRM PROJECTS The ECI-SRM PROJECTS Quality System has prescribed procedure for evaluation and procurement of services of sub-consultants in accordance with the following procedure:

Review of credential of Consultants appointed by ECI-SRM PROJECTS

Verification data / report / results supplied by Consultants.

Supervision during Field activity

Verification of Documentation.

The Geo-Technical Engineer of Consultant will be fully responsible for all the activities related to sub-soil investigations and geo-technical investigations.

8.3 Equipment

The boring, sampling and testing equipment will be in accordance with the requirements of the relevant IS Standards.

8.4 Calibration of Instruments

Geotechnical Engineer will ensure that all the field instruments are pre-calibrated as per standard procedures. The measurement and analysis are to be carried out as per the standard operating procedures. Any deviations from the set procedures are to be recorded in the logbooks.

8.5 Applicable Standards / Codes & Methodology (With Scope of contract)

GENERAL TECHNICAL SPECIFICATION

SCOPE OF WORK

The purpose in brief of the proposed Geotechnical Investigation works at the proposed site is to know the type of sub-strata, Geotechnical parameters, and their suitability and to recommend the type of foundations and substructures to be adopted. Further, give recommendations for safe bearing capacity for willow foundation and in case of deep foundation, the depth and vertical load carrying capacity, however, in case of pile foundations, lateral load capacity also. The foundations may be checked for uplift pressures in case the condition will be confronted. In case the depth and type of foundation recommended are not sufficient, ECI-SRM PROJECTS will convey requirements for revision of SBC/load carrying capacity computation & recommendations.

TECHNICAL SPECIFICATION FOR GEOTECHNICAL INVESTIGATION

This specification covers technical requirements in respect of materials, workmanship and quality for a detailed Geo-Technical investigation works to be carried out onshore to know about the subsurface features and soil profiles and relevant soil and rock properties. The Geotechnical Consultant will carry out Geotechnical investigations to an extent so as to obtain satisfactory substrata conditions and which are reasonable for Design of Foundation System.

CODES AND STANDARDS

Unless specifically mentioned otherwise, all applicable codes and standards of practice in their latest editions as published by the Bureau of Indian Standards and all relevant amendments published by them during the currency of the contract, will govern in respect of design, workmanship and methods & procedures of testing. Some of the relevant available codes are listed hereunder.

In the event of any conflict between the requirements in this specification and the following referred codes, the former will govern.

Table 8-3 Daily Traverse / Topo Checklist

IS:	1498	Classification and identification of soils for general engineering purposes
IS:	1888	Method of load tests on soils
IS:	1892	Code of practice for sub-surface investigations for foundations
IS:	2131	Method of standard penetration test for soils
IS:	2132	Code of practice for thin-walled tube sampling of soils
IS:	2720	Methods of test for soils (ALL PARTS)
IS:	2809	Glossary of terms and symbols relating to soil engineering
IS:	2810	Glossary of terms and symbols relating to soil dynamics
IS:	3025	Methods of sampling and Testing(Physical and Chemical) for Water used in
		Industry

IS:	**1498**	**Classification and identification of soils for general engineering purposes**
IS:	3043	Code of Practice for Earthing
IS:	4078	Code of practice for Indexing and storage of drill cores.
IS:	4434	Code of practice for in-situ vane shear test for soils
IS:	4453	Code of practice for exploration by pits, trenches, drifts and shafts
IS:	4464	Code of Practice for presentation of Drilling information and Core Description
		of Foundation Investigation
IS:	4968	Method for sub-surface sounding for soils (ALL PARTS)
IS:	5249	Method of test for determination of dynamic properties of soils
IS:	5313	Guide for Core Drilling Observations
IS:	5529	Code of practice for in-situ permeability tests (ALL PARTS)
IS:	6065	Recommendations for the preparation of Geological and Geotechnical maps
		for River Valley Project
IS:	6403	Code of practice for determination of Allowable Bearing Pressure on Willow
		Foundation
IS:	6926	Code of practice for Diamond core Drilling for Site Investigation for River
		Valley Project
IS:	6935	Method of determination of water level in bore holes
IS:	6955	Code of Practice of subsurface exploration for Earth and Rock fill dams
IS:	7422	Symbols and abbreviations for use in geological maps, sections and
		Subsurface exploratory logs. (ALL PARTS)
IS:	8763	Guide for undisturbed sampling of sands
IS:	8764	Method of determination of point load strength index of Rocks
IS:	9143	Method for the determination of unconfined compressive strength of Rock
		Materials
IS:	9179	Method of preparation of Rock specimen for Laboratory testing
IS:	9798	Specification for Compaction rammer for soil testing

IS:	1498	Classification and identification of soils for general engineering purposes
IS:	9214	Method for determination of modulus of subgrade reaction (k-value) of soils in
		the field
IS:	9259	Specification for Liquid Limit apparatus
IS:	9640	Specification for split spoon sampler
IS:	9669	Specification for CBR mould and its accessories.
IS:	10050	Method of determination of Slake Durability Index of Rocks
IS:	10060	Code of practice for subsurface investigation for powerhouse sites
IS:	10074	Specification for compaction mould assembly for light and heavy compaction test for soils.
IS:	10108	Code of practice for sampling by thin wall sampler with stationary piston
IS:	10589	Equipment for determination of subsurface sounding of soils
IS:	10837	Specification of moulds for determination of Relative density and its accessories.
IS:	11229	Specifications for shear box testing of soils
IS:	12070	Code of practice for design & construction of willow foundations on rocks.
IRC	78	Standard specifications and code of Practice for Road Bridges & MORTH Specifications.

FILED WORK

The following works will be carried out by the Geotechnical consultant as a minimum.

Equipment and Personnel

The Geotechnical consultant will ensure that all machinery, equipment, instruments, etc., mobilized by him at site are in proper working order. The Geotechnical consultant will ensure that the field investigation and laboratory work are performed by competent personnel and Labor who are specifically experienced in soil investigation work. Interpretation and recommendation will be the direct responsibility of the top technical personnel in the Geotechnical consultant's organization.

Setting Out

All investigations will be carried out at natural ground conditions as per the drawings. If there is any obstruction at given location, the same may be shifted by maximum 5 to 10 m for the sake of convenience in consultation with ECI-SRM PROJECTS.

Equipment's

Before starting the investigations, all the equipment's will be carefully inspected to make sure that they are as per the relevant IS Specifications and in good working condition and latest relevant certification of equipment such as proving rings etc. should be made available to ECI-SRM PROJECTS. Following points may be particularly observed.

The drilling equipment's for heavy-duty shell and auger should be used for making a bore hole of minimum 150 mm diameter in soil strata and/or Hydraulic Feed Rotary drilling machines for deeper boreholes in soils and for all rocky strata. The drilling rods should be standard `A' selection with 41 mm outer diameter and square threaded ends.

The drilling rods will not have any bends; the inside should be clear without any blockage and should maintain verticality when connected together or with any test equipment.

The cutting edge of the standard penetration spoon and disturbed sampling tube should be free from any bends/damages.

The undisturbed sampling tube will have minimum 100mm diameter. Shelby thin tube samplers should be used for undisturbed samples in soil or double core barrel arrangement will be used for rocks and for soils also wherever conditions warrant.

The outer diameter of the cutting shoe will be slightly greater than that of the tube to aid penetration and withdrawal. In any case, the outer clearance should not be much greater than the inside clearance. Specifications for area-ratios should be followed.

The hose pipe and swivel will be in good condition with proper joints to ensure that there is no leakage and effective circulation of bentonite slurry.

BORING THROUGH SOIL

Bore holes will be taken at specified locations to obtain information about the subsoil profile and to collect soil samples for strata identification and conducting laboratory tests. The minimum diameter of boring or internal diameter of casing will be 150mm and will extend up to the depths specified in drawings or as instructed by the engineer. Shell/Bailer and Auger boring will be used in either cased or uncased holes. Uncased holes are permitted only up to a depth where the side can stand unsupported. In case side fall is noticed, the holes will be stabilized immediately by using bentonite slurry or providing casing pipes as directed by the engineer. The Geotechnical consultant will not advance the boring by adding water except in the case of dry granular soils and stiff clays. For conditions in cohesive soils where the addition of water is permitted, the Geotechnical consultant will use the absolute minimum amount of water necessary for advancing the bore. Where boring reveals soft alluvial soils or where sub-artesian ground water loosens granular soils the Geotechnical consultant must at all times add and maintain a head of water to at least ground level during all operations to counteract the disturbance caused by the removal of overburden. Water will not be added while boring above water table level. Mud circulation/ bentonite slurry will not be used in the boreholes in which water sample is to be collected for analysis. In borings where hard strata are encountered, through which the auger or shell cutter cannot penetrate, which may or may not be rock, the Geotechnical consultant will use rotary drilling or other methods. Casing pipes where used will not be driven below sampling level and stopped 150 mm short of the bottom of the bore at any stage of boring. For no suction effect due to shell, the outer diameter of

shell will be at least 25 mm smaller than the inner diameter of the casing. While recording bore logs, all necessary information will be recorded. During boring operation, the excavated soil from auger or the wash sample in case of rotary drill will be continuously inspected and the level of change in strata recorded to nearest 50mm level. Extreme care is to be taken to see that thin layers are not missed. Water table in the bore hole will be carefully recorded and reported. Boreholes will be backfilled after all samples are taken and after obtaining all other information from the boreholes. The Geotechnical consultant will backfill and compact exploratory holes in such a manner that no subsequent depression is formed at the ground surface due to settlement of the backfill. The Geotechnical Consultant will send copies of daily boring records to the engineer (ECI-SRM PROJECTSs). These records will include the field observations with regard to visual description of various soil strata, the variations in consistency, the sequence and the depths to changes in strata, Level of ground water table, drilling fluid consumption, presence of lime, mica, etc. When a deep boring has deviated from line, a plan and section should accompany the record.

BORING THROUGH ROCK

Rotary core drilling technique with continuous core recovery should be adopted for drilling through rock for determining the depth and nature of rock strata as outlined below. The method and the procedure for drilling operation will conform to IS: 1892. Drilling in rock will be done at specified locations and the starting depth of drilling in rock will be certified by the engineer. The core drilling will be carried out and a good drilling technique will be adopted, so as to recover maximum amount of core of the specified diameter to obtain an intact sample truly representative of the in-situ material. The type and state of the drill bit, feed rates and management of the drill must be controlled by the driller to achieve the same. Depending on the type of rock, drilling will be carried out with NX size tungsten carbide (TC) or diamond tipped drill bits and as per IS: 6926. Drill runs will not exceed 1.50 meter in length and the core barrel will be removed from the drill hole as often as may be required in order to get the best possible core recovery. In zones which are highly fractured or where the barrel becomes continuously blocked, it is essential that short runs be used although this amounts to removal of the entire string of drilling tools every 300 mm or less. Reduced bit pressure will be resorted when rod vibration or chatter occurs. The drilling fluid will normally be clean water or air. Where appropriate and with the approval of the engineer drilling mud or additives may be used. The pressure under which the drilling fluid should be introduced into the hole will be minimum to be consistent with adequate removal of cuttings from the hole and proper cooling of the bit. To minimize the erosive action of the drilling fluid on the core and thereby to improve core recovery, double tube core barrels should be used. The casing and core barrel to be used will be of designation BX or NX. During drilling operations observations of return water, rate of penetration, etc will be made and recorded as per IS: 5313; The color of return water at regular intervals, the depth at which any change of color of return water is observed, the depth of occurrence and amount to flow of hot water, if encountered, will be recorded. The depth through which a uniform rate of penetration was maintained, the depth at which marked change in rate of penetration or sudden fall or drill rod occurs, the depth at which any blockage of drill bit causing core loss, if any, will be recorded. Any heavy vibration or torque noticed during drilling should be recorded together with the depth of occurrence. Special conditions like the depth at which grouting was done during drilling, presence of artesian conditions, loss of drilling fluid, observation of gas discharge with return water etc., will also be observed and recorded. In addition to the above-mentioned points, the Geotechnical

consultant will also take into consideration the provisions of the latest revisions of the relevant BIS Codes of Practice along with Amendments, if any.

TERMINATION CRITERIA

If No refusal or rocky strata is encountered the bore hole will be terminated at the specified depth.

In case refusal strata with N>100 and no core recovery or conglomerate/boulderly strata is there the bore hole will be terminated after drilling 10m into refusal strata or specified depth whichever is earlier.

In case rocky strata is met below 2.0m from ground level with RQD > 30% for continuous length of 6.0m the bore hole will be terminated after drilling 6.0m into such strata.

In case rocky strata is met below 2.0m from ground level with RQD > 60% for continuous length of 3.0m the bore hole will be terminated after drilling 3.0m into such strata.

In case rocky strata is encountered in between with RQD>30% & < 60% then bore hole should be terminated by drilling up to 6m in such strata and if RQD > 60% the bore hole will be terminated after drilling 3.0m into such strata.

The Geotechnical consultant will furnish all the information's mentioned above fully verified and signed by the Engineer at site and submit them to the Engineer.

SAMPLING

Practice for Sampling

The preparations for and methods of taking samples, together with their size, preservation and handling will be in accordance with the provisions of relevant code of practice, specification and as directed by the engineer.

Sampling Frequency

The samples will be taken by the Geotechnical Expert as follows: Soil samples will be taken generally at every 1.5 m intervals and at each change in soil type or change in consistency, a disturbed sample will be taken. An 'Undisturbed' sample will be taken in cohesive soils, a representative sample in granular soils, or a field test as appropriate.

Precaution will be taken to ensure that there will not be any change in moisture content and disturbance, i.e. they will be suitable sealed. All samples will be labeled with date, bore hole or trail pit number, depth of sampling as per IS: 1892.

For sampling at the bottom of the hole allowance should be made for the disturbed zone by either removing it using an auger or suitable tools. In cohesive soils the bore hole may be cleaned using a bailer with flap valve.

When the collection of undisturbed soil sample at a specified depth is not possible the reason for the same will be indicated in the bore log. In such a case, undisturbed sampling may be replaced by using remolded samples to field density and moisture content. The Geotechnical consultant will take samples in excess of the above as directed by the engineer.

Disturbed sampling

Disturbed samples weighing approximately 1.0 kg will be collected in bore holes at 1.5 meter intervals starting from a depth of 0.5 meter below ground level or at every change in stratum, whichever is less. Disturbed soil samples will be collected from thin walled samplers or split spoon samplers of SPT.

Undisturbed sampling in soil

For compression test samples, a core of 40mm diameter and about 150mm long may be sufficient. For other laboratory tests a core of 75 to 100mm diameter will be preferable. Undisturbed samples in soft to stiff cohesive soils will be obtained using a thin walled sampler. The sampler head which connect the tube to the boring rod is provided with vents to permit water to escape sampling under water and check valve to help to retain the sample while withdrawing the sampler.

Sampling will be done as soon as possible after the clean out operation. The sampling tube will be pushed/driven into the soil in such a manner that the structure of the soil its moisture content do not get altered. The distance by which the sampler penetrates into the soil strata will be checked. After removal of the sampling tube the same will be sealed with wax on both sides.

Wherever solid cores are recovered, the lengths beyond the ones required for undisturbed lab testing such as tri-axial shear strength (under appropriate drainage conditions, i.e. UU, CU or CD) or consolidations tests, be preserved and suitably labeled & stored in core box. Colored photographs should be taken for core samples & some typical disturbed sample material also.

Rock samples

Cores of rock should be taken by means of rotary drills with coring bit with core retainer if warranted. All types of rotary drills will be fitted with core barrels. Core samples will be extracted with the barrel held horizontally without vibration. Care will be taken to maintain the direction of extrusion of sample same as while coring to avoid stress reversal. The samples will be placed in core box. The core box will be made from seasoned timber or any other durable material and will be indexed on top of the lid as per IS: 4078. The description of core samples will be recorded as per IS: 4464 and continuous record of core recovery and RQD to be mentioned in the core log as per IS: 11315, Part-II. Colored photographs should be taken and enclosed with reports wherever encountered (to register stable depth of W.T.)

GROUND WATER SAMPLE

The water level in each borehole will be recorded before commencement and after completion of drilling. The depth of the borehole and casing (if any) will also be recorded.

Sub-soil Water Samples

Sub-soil water samples will be collected for carrying out chemical analysis.

Representative samples of ground water will be collected to carry out the chemical analysis and sent to laboratory in air tight bottles with proper labeling. Chemical analysis of water will include determination of pH value, turbidity, Sulphate, carbonate, nitrate and chloride contents, presence of organic matters and suspended solids.

STANDARD PENETRATION TEST

This test will be conducted in all types of soil deposits met within a borehole to arrive at the variation in soil stratification by correlating with the number of blows required for unit penetration of a standard penetrometer. The equipment and procedure for Standard Penetration Test will conform to IS: 2131. The bottom of bore hole will be cleaned of mud slurry before conducting the Standard Penetration Test (SPT). The SPT will be conducted generally at 1.5 m intervals and in addition at changes of soil strata, as per IS: 2131. The blow count will be recorded.

Following points are to be particularly observed:

All equipments will conform to IS: 2131 and IS: 9640.

Casing will not be driven below the level of test. If the strata cannot stand without casing, the casing may be penetrated by slow rotation and static force from top. Driving of casing pipe with tip at test level will disturb the deposit.

The SPT hammer will be operated manually and not with a power winch. This will ensure free fall of hammer. Throughout the test, care will be taken to ensure that the threaded joints are tight. If they are getting loosened during driving, the same will be tightened as and when required so that energy loss due to rod vibration is minimized.

The split spoon will be driven first for 15 cm and the number of blows noted as seating drive. The spoon will be further driven by 30 cm noting number of blows for each 15 cm penetration. The total blows required for second and third 15 cm penetration will be termed as penetration resistance N. Where full 45 cm penetration of the spoon is not possible, a minimum of 50 blows will be applied and the actual penetration for 50 blows recorded to extrapolate the N Value. If the blow count exceeds 100 or if the penetration is less than 25 mm for 50 blows, the test will be stopped. However test should be carried out at each interval mentioned above. This test will be carried out by driving a standard split spoon sampler in the borehole by means of a 63.5 Kg hammer having a free fall of 75cm. The split span sampler resting on the bottom of the borehole should be allowed to sink under its own weight. Then the spoon sampler will be seated 15 cm. The first 15 cm will be considered as seating drive. The sampler will be driven using the hammer for 450 mm recording the number of blows for every 150 mm. The number of blows for the last 300 mm drive will be reported as ‘N’ value. The test will be discontinued when the blow count is equal to 100 or the penetration is less than 25 mm for 50 blows whichever is earlier. The penetration and number of blows will be reported at the location where the test is terminated.

Sufficient quantity of representative soil samples will be collected from the split spoon sampler for identification and laboratory testing. The sample will be visually classified and recorded at the site and will be properly preserved without loss of moisture content and labeled for future identification.

The observed ‘N’ values will be corrected for ground water table corrections and the corrected (N’) values will be entered into the bore log. The ground water table will be recorded and described in the borehole log after the water level has settled.

LABORATORY TEST

Depending upon the type of substrata, appropriate laboratory tests will be conducted on soil and rock samples. All storing, preparation and testing of samples will be in accordance with IS codes and standards. Calibration of all the instruments and accessories will be done precisely and apparatus will comply with the requirements of specifications of Indian Standards.

It is not intent nor is it practical to specify all technical details and requirements of soil testing in laboratory that would enable the proper evaluation of the soil parameters used in the detailed engineering stage. Tests as indicated in this specification and as called for by the Engineer will be conducted. These tests will include but not be limited to the following. All samples, whether disturbed or undisturbed will be extracted, prepared and examined by competent personnel properly trained and experienced in soil sampling, examination, testing and in using the apparatus as per the specified standards. All the laboratory test data will be recorded in the Performa recommended in the Indian Standard Codes and a copy of these will be sent to the engineer every week during the progress of laboratory testing. Whenever desired during the progress of work the owner / engineer-in-charge may be present at the laboratory where the Geo-tech consultant is arranging for execution of the laboratory tests.

Tests on Disturbed Samples

- Sieve and hydrometer analysis (Grain size analysis),
- Visual and Engineering classification,
- Liquid and plastic limits,
- Moisture content, porosity and density,
- Specific Gravity,

Tests on Undisturbed Samples

- Natural moisture content,
- Unit weight,
- Consolidation test,
- Unconfined Compression,
- Tri-axial Shear test (Unconsolidated Un-drained test - UU Test, Consolidated drained test – CD Test),
- Direct Shear test
- Swell pressure and determination of free swell pressure index

Chemical analysis of Ground Water

- Visual examination,
- pH
- Sulphur content
- Chloride content

Tests on Rock Samples

- Unconfined compression test and
- Point load strength index

GEOTECHNICAL INVESTIGATION REPORT

Detailed Geo-technical report

Final Geo-technical Investigation report will contain procedure adopted for investigation, field observations, summarized test data, conclusion and recommendations. The report will include detailed bore logs, soil conditions at the surface, expected soil conditions below the surface, Subsoil sections, field test results, laboratory observations and test results both in tabular as well as graphical form, practical and theoretical considerations for the interpretation of test results, the supporting calculation for the conclusions drawn etc.

Possible scouring or flooring anticipated during heavy rain. The above information has to be provided in the Geo-tech consultant to the Owner's Engineer through intermediate reports to enable the Engineer to furnish instructions for more intensive or additional investigation if any. The detailed final report based on field observations, in-situ and laboratory tests will encompass theoretical as well as practical considerations for foundations for different type of structures envisaged in the area under investigation. The report will also include but not be limited to the following:

Detailed write up on the methods, procedures and equipment's used in all phases of the work. A plot plan showing the locations and reduced levels of top of each BH and all field tests. A true cross section in two perpendicular and diagonal directions of all individual bore holes and trial pits with reduced levels and coordinates showing the classification and thickness of individual stratum, position of ground water table, grain size distribution, index and engineering properties of representative samples, various in-situ tests conducted and samples collected at different depths and the rock stratum if met with, A set of longitudinal and transverse Soil/Rock profiles connecting various bore holes, Geological information of the area such as Geomorphology, Geological structure, Lithology, Stratigraphy and techniques, core recovery and rock quality designation etc. Detailed test results of all laboratory tests for both in tabular and graphical form for each sample with all the relevant charts, tables, graphs, figures supporting calculations, conclusions and photographs of representative rocks. Necessary extracts from technical literature used in calculation, evaluation and recommendations, Plot of SPT (N value both observed and corrected) with depth for identified areas. The value of Cohesion, Angle of Internal Friction, will be furnished along with sample calculation. Calculation for allowable bearing pressure w.r.t. shear failure and corresponding total settlements for open foundation and pile capacities for various combinations of diameter and length (both vertical and lateral). Load test curves and consolidation curves to be included.

Recommendations

The Geotechnical consultant will include specific and definitive information and all necessary interpretations on the following supported by detailed calculation area wise duly considering the type of soil, structure and foundation in the area.

Type of foundation, minimum founding depth and width of foundation to be adopted for various structures considering sub-soil characteristics, water table, max scour depth, total settlements permissible for structures. Values obtained from field test and laboratory tests will be compared and suitable interpretation will be furnished.

Net safe allowable bearing pressure for isolated footings, strip footings of width 2.0, 3.0, 4.0 m at suitable founding depths below ground level considering both shear failure and settlement criteria.

Net safe allowable bearing pressure for raft foundations of widths greater than 5.0 m at suitable depths below ground level considering shear failure and settlement criteria.

Consolidation characteristics of clayey soil from laboratory test results. Additional specific and definitive recommendations.

If expansive soil is met with clear indication of swelling characteristics etc., recommendation on removal or retainment of the same under the structure/ roads etc. will be given.

Harmful chemical contents in soil and ground water, if any, and recommendations to protect underground structures from their harmful effects.

Susceptibility of subsoil strata to liquefaction in the event of earthquake, if so recommendation for remedial measures.

Anticipated problems during foundation construction and recommended solutions.

8.6 Regulatory Requirements

The work will start on approval of geotechnical scheme by the Client. The boring team will carry with them a list of equipment including identification numbers and approximate cost and a letter for octroi exemption.

8.7 Safety/Environmental Considerations

The boring area including the space where the boring equipment is positioned will be suitably barricaded with fixed barriers. Suitable banners notifying the working will be displayed on either side.

8.8 Data Verification

The Geo-technical Engineer will pay periodic visits to the boring sites. An Assistant Bridge Engineer experienced in geo-technical investigations will be positioned at site for entire duration of the boring work to have constant check on the work.

The Geo-technical Engineer will examine the results of the sub-surface investigation, for consistency and compatibility before acceptance.

8.9 Documentation

All the data / documents received from the consultants will be suitably numbered for usage, storage and retrieval in future.

8.10 Laboratory Analysis

Calibration

The Geotechnical Engineer will ensure that all the laboratory instruments are pre-calibrated as per laboratory's Quality Procedures. The calibration logs are to be properly maintained and be made available for inspection by the client.

Operating Procedures

Before accepting the samples for analysis, the concerned analyst will check for the integrity of the sample. The measurement and analysis are to be carried out as per the standard operating procedures. Any deviations from the set procedures are to be recorded in the logbooks.

Data Checks

The concerned laboratory in-charge will check and validate the raw data generated by the laboratory assistants. To include the analysis of a sample, he is to do the quality check of minimum one sample of each test result.

CHAPTER – 9

PREPARATION, CHECKING, APPROVAL AND FILING OF CALCULATIONS

9.1 Purpose

The purpose of this document is to provide guidance to all concerned in verification and amendment to design calculations.

9.2 Abbreviations

- DH/DD : Design Head/ Design Director
- DE : Discipline Expert
- DRC : Discipline Reviewer / Checker
- SP : Specialist

9.3 Procedure

General

The cover sheet of design calculation files will have all the information relating to the project and the subject of design calculations. Each set of design calculations will have a REVISION DETAILS sheet, which will be used for control of revisions. A copy of the related Form is enclosed. In case calculations are prepared in pencil, photocopy of the same will be maintained in the calculation/computation file for presentation whenever required with the verifying authority's signatures in ink of any color other than black on all Design Calculation sheets.

9.4 Preparation of Design Calculations

All design calculations (except for results of computer outputs will be prepared by the Specialist(s) of the respective discipline(s) on Calculations sheet based on the input requirements of the project. The design calculation file(s) will be numbered and these will comply with the compilation requirements given in DESIGN VERIFICATION AND REVIEW REPORT Form.

9.5 Review, Verification and Approval of Design Calculations

The DE will get the design calculations verified through a DRC. The DRC will note all the findings of verification done on DESIGN VERIFICATION REPORT. The non-conforming design calculations along with the DESIGN VERIFICATION REPORT will be sent back by the DRC to the originator SP for taking appropriate action(s).The designated DRC will mark all corrections in the design calculations after cutting the incorrect computations so as to establish that the same have undergone checking. The record of such calculations with the corrections will be maintained. The originating SP will make the necessary corrections and take appropriate actions so as to close all non-conformities by producing the acceptable design calculations. These corrected calculations will then be sent again to DRC for review / approval.

The DRC will re-inspect the corrected calculations and verify the conformances with his/her previous comments in the manner explained in the forgoing paragraphs. The verified design

calculations will be reviewed by the DE reconsidering the various aspects mentioned under checking/verification requirements in REVIEW REPORT.

The conforming calculations will be marked as APPROVED on the report by the DE. The DE in the appropriate space will initial the cover sheets of conforming calculations. Copies or approved calculations and the compliance report will be passed onto the TL for maintenance of project records. If it is required to be submitted to the Client, a concise design calculation will be written out from the detailed design calculations, verified and approved by the appropriate functionaries prior to the submission to the Client. Any request for acceptance of deviations due to imposition of impracticable requirements by the Client which cannot be complied with, will be referred to the DH. DH will then coordinate with the Client and obtain necessary concessions. On acceptance of the deviation by the Client, the DH will maintain a record of the same.

9.6 Final Inspection

On receiving the calculations from DE, the DH will carry out the final inspection and release the calculations as per laid down procedure. The DH will retain the record of compliance report of the drawing laid down as quality records.

9.7 Client Approval

In case design calculations are also required to be approved/reviewed by the Client/AE, the cover sheet of the file will be clearly marked as FOR APPROVAL OF (CLIENT'S NAME) by the DE. On getting clients approval, the Status of the same will be identified as APPROVED BY CLIENT on the cover sheet.

9.8 Amendments / Changes

Revision Status

The first formal issue of calculation will be marked as R0 and subsequent revisions, if any, will be marked R1, R2 etc. by the DE. The details of amendments will be given in the Revision Details.

9.9 Updating of Master List(s) Status

On each amendment in the design calculations, the DE will update the revision status of calculations in the Master List(s) and send the copy of the same to the TL for information.

CHAPTER – 10

DESIGN, DRAWING AND DOCUMENTATION

10.1 General

ECI-SRM PROJECTS has laid down consistent and time-tested procedures for control of designs, drawings and documents and other activities as per International Standards. The objective is to ensure that the related activities are planned and controlled, the output in the form of designs, drawings and documents are verified and the final products satisfy the specified project requirement. The quality assurance system involves several step-by-step procedures, and these are brought out in the following paragraphs.

10.2 Planning and Design Development

For guiding activities on a project, a detailed work plan is prepared. This defines the responsibility for implementation of the various activities, the time and duration for performing the activities. The codes/Standards to be followed, the review/verification system, the input resource required the output to satisfy project requirements etc. The work teams from the various disciplines assigned to the project prepare their own work plans for their activities consistent with overall development plan.

Table 10-4 Work Team

Position (name)	ID	Accountable to	Liaise with
Team Leader	TL	The Client	Clients, Heads of various disciplines, project functionaries, suppliers and external technical services.
Project Manager	PM	Team Leader	Clients, Heads of various disciplines, project functionaries, suppliers and external technical services
Highway Engineer	HE	TL	Specialists of project and suppliers of external technical services
Pavement Specialist	PS	TL	
Traffic Expert	TE	TL, PS	
Sr Bridge Engineer	SBE	TL, HE	

Position (name)	ID	Accountable to	Liaise with
Material-cum-Geo- technical Engineer	MGE	TL, HE, SBE	Suppliers of external technical services
Senior Survey Engineer	SSE	HE	Suppliers of external technical services
Hydrologist	HYD	SBE, MGE	
Environmental Specialist	ES	TL	
Senior Quantity Surveyor	QS	TL, HE, SBE	
Resettlement & Rehabilitation Specialist	RR	TL	
Financial analyst	FS	TL	

10.3 Organizational and Technical Interfaces

Organization

As **ECI-SRM PROJECTS**, is a multi-disciplinary consultant and for operational purposes, it is divided into number of disciplines, each headed by a Discipline Head (DH). For executing a project, key personnel (Discipline Expert, i.e. DE and Specialists i.e. SP) are drawn from various disciplines as appropriate.

Technical Interfaces

The technical interfaces of the major activities have been identified as under:

Table 10-5 Technical Interface of Major Activities

Major Activity	Technical Interfaces
Geometric Design	Topographic survey, design location and deck level of bridges.
Pavement Design	Traffic and axle load analysis, soil / material investigations.
Structural Design	Topographic survey, geo-technical investigations, road design, hydrological study.
Quantity / Cost Estimation	Detailed design and drawings, BOQ.

10.4 Design Execution

Design Criteria

Before the design work is taken up, the TL will discuss with all the DEs and finalize the design parameters to be adopted for the work. TL will approve the design parameters before commencement of design activities. The software to be used for design will also be finalized at this stage to ensure data compatibility.

Checking of Survey Data

The topographic Survey will be carried out as per the Quality Assurance Plan for survey. The survey data is generally received in Point No., Northing, Easting, Elevation, Description format. On receipt of survey data, the same will be plotted in AutoCAD. The checking of data will include the following:

- Completeness of survey to ensure that there are no data gaps.
- Correctness of alignment with respect to SOI map or index map.
- Correctness of codes adopted for survey
- Spacing of cross-sections
- Extent of cross-sections to ensure that sufficient width has been covered to study different options.
- All features / structures have been picked up with respect to inventory survey
- All utilities including underground have been picked up correctly and shown in the drawings
- All bench mark / traverse station locations are available

Design Activities

Design activities will commence in the stretch when the survey data is approved by TL/HE. Based on the total length and the length for which data is available, the HE will assign different Assistant Highway Engineers (AHE) for each section to be taken up. Each specialist will first create the Surface/Digital Terrain Model for the section. While preparing the surface, care should be taken to provide wall faults at culverts and other locations where there is a vertical drop. At location of bridges, the fault lines will be suitably placed so as to ensure a realistic river profile. The surface can be finalized only after a few trial and error exercises are done and plotting of profiles at critical locations. After generation of Digital Terrain Model, the existing profile will be generated. The HE and TL will inspect the profile and give comments; the TL will re-check the profile and give comments/approval. The design of horizontal and vertical alignment will be done in line with the approved design criteria. After the design is complete, the proposed alignment along with the existing profile will be given to the CAD operator for preparation of drawings. Particular attention will be paid to take into consideration, the level of structures along the alignment. The HE will co-ordinate with the other disciplines to finalize the road levels to be adopted.

At suitable intervals decided by the TL, regular Design Review Meetings will be arranged, involving all the key personnel and sub-professionals.

10.5 Drawings

The TL will decide and coordinate with the different key personnel whenever required for deciding the size(s) of drawings to be adopted in the project considering scale requirements as per TOR and IRC Standards. The drawings will be of standard size(s) as mentioned in the following table:

Table 10-6 Standard Drawing Size

S. No.	Conventional Size	Dimension
1	A0	(840mm x 1188mm)
2	A1	(594 mm x 840 mm)
3	A2	(420 mm x 594 mm)
4	A3	(420 mm x 297 mm)
5	A4	(297 mm x 210 mm)

Sincere efforts will be made by TL to ensure that concerned functionaries all through the project use a uniform size of drawings. In unavoidable circumstance, when consistency of size cannot be maintained for any genuine reason(s) the TL will accept variation in Length of drawings only without any deviations in the width.

A standard title block as per IRC-SP: 19 will be prepared for use in all drawings. The designated spaces for signatures will be filled out as the drawing progresses through issue cycle. The wording of title of drawing will be finalized in consultation with the concerned key personnel.

All drawings will be numbered thus:

TTS/0167/ XX / YY-ZZ

Where,

- TTS/0167 indicates the project code
- XX indicates the discipline code
- YY indicates the type drawing
- ZZ indicates the drawing number

The drawings will contain and/or make reference to the appropriate inputs documents / assumptions made in the space allocated for NOTES. The input documents may be in any of the following forms:

Concept drawing(s), general arrangement plans furnished or accepted by Client and / or developed in house by the other member(s) of the project team during currency of the project

Client / Sub Consultant furnished data

Design basis/philosophy document identifying design parameters, characteristics of selected materials, loading details, description of implementation scheme of design if any, etc.

Reference to Bench Marks and reference coordinates.

The completed drawings will be checked by the HE and approved by the TL from within the project organization as per the guidelines given hereinafter:

For systematic comprehensive checking, a check print will be taken and checking functionary will use a checklist. Marking thus 'J' in the appropriate columns identifying OK or Not Applicable (NA) on the report will indicate the conformance and non-conformance to the quality aspects. A typical drawing compliance report for plan and profile drawing is enclosed at Table-11.7. Similar checklist / compliance report will be prepared for different categories of drawings.

The conforming dimensions, levels and other requirements will be marked with yellow color on the drawing while non-conformance will be marked with necessary correction on the drawing in red color.

The reworked drawing after corrections will be verified again and the corrections marked in red will be encircled with green color to indicate the same have been incorporated. The checked print of the drawing duly signed and dated by the checking functionary will then be passed on to the approving authority (TL) for record.

Approval

If TL is satisfied with the contents and quality, he will approve the same. The drawing issued from a discipline will contain approval signature of concerned key personnel to indicate technical adequacy of design. When the drawing is to be issued the same will also contain signature or initial of TL in the title block to indicate that the same meets the project requirement.

CHAPTER – 11

IDENTIFICATION AND TRACEABILITY OF PROJECT DOCUMENTS

11.1 Introduction

The purpose of this Quality Plan is to provide guidance to all concerned project staff for numbering of project and quality system documents for ease of identification.

11.2 Procedure

General

The document(s) / service for the project will be identified by the respective functionaries through all of the following methods:

- Title of the document / project
- Job number of project
- Numbering of documents
- Date or period of development and delivery of service
- Identity of persons performing the various activities of project execution
- Reference to other relevant documents

11.3 Project Identification

All documents related to this project would have the number starting with DT /D1007, which would indicate, the identification number or job number of the project.

11.4 Identification of Project Drawing/Document

Unless specified otherwise by the Client or mutually agreed between ECI-SRM PROJECTS and the Client, the documents will be numbered as indicated below:

DT / D1008/ XX / YYY / ZZZ Where,

DT / D1008 indicate specific assignment number of the company.

XX indicates the discipline code as below:

- General : GN
- Highway & pavement Engineering : HW
- Bridges / Foundation Engineering / Structures : BR
- Environmental Studies : EE
- Traffic and Transportation : TT
- Geotechnical and Materials Investigations : GM
- Resettlement & Rehabilitation : RR
- Economic & Project Finance : PF

YYY indicates the type of document, viz.

- REP : Reports
- DEG : Drawings
- EST : Estimates Cost
- BID : Bid Documents

ZZZ indicates the serial number of the category of the document.