

Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

TABLE OF CONTENTS

4.1	GENERAL.....	3
4.2	INVENTORY AND CONDITION SURVEY OF ROAD AND PAVEMENT	4
4.2.1	ROAD INVENTORY	4
4.2.2	PAVEMENT CONDITION SURVEYS	4
4.3	TOPOGRAPHIC SURVEY	5
4.3.1	BROAD OBJECTIVE	5
4.3.2	SCOPE	6
4.3.3	EQUIPMENT/INSTRUMENTS DEPLOYED	6
4.3.4	METHODOLOGY	6
4.3.5	CONTROL TRAVERSE SURVEY.....	6
4.3.6	SPECIFICATIONS:	7
4.3.7	PERMANENT MARKERS:	7
4.3.8	INFORMATION:.....	7
4.3.9	PRESENTATION SYMBOLS:	8
4.3.10	CADASTRAL SURVEY:	8
4.4	PAVEMENT INVESTIGATION	8
4.4.1	GENERAL	8
4.4.2	PAVEMENT ROUGHNESS SURVEY.....	9
4.4.3	BENKELMAN BEAM DEFLECTION TEST.....	9
4.5	SUB-GRADE INVESTIGATION	9
4.5.1	TEST PIT FOR SUB-GRADE INVESTIGATION	9
4.5.2	EXISTING PAVEMENT COMPOSITION	9
4.5.3	LABORATORY TEST ON TEST SAMPLES	11
4.6	MATERIAL INVESTIGATIONS	14
4.6.1	TYPE OF MATERIALS	14
4.6.2	SOURCE OF MATERIALS	15
4.6.3	TESTING OF MATERIALS	15
4.6.4	FINDING	16
4.7	AXLE LOAD SURVEY	16
4.8	INVENTORY AND CONDITION SURVEY OF BRIDGES AND CULVERTS.....	16
4.8.1	INVENTORY AND CONDITION SURVEY OF BRIDGES.....	16



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

4.8.2	INVENTORY OF CULVERTS	17
4.8.3	INVENTORY OF OTHER TYPE OF STRUCTURES	17
4.9	HYDROLOGICAL AND HYDRAULIC INVESTIGATIONS.....	17
4.9.1	PROJECT AREA OVERVIEW	17
4.9.2	HYDROLOGICAL DESIGN METHODOLOGY	18
4.9.3	FINDINGS OF INVESTIGATIONS	19
4.10	GEO-TECHNICAL INVESTIGATION FOR BRIDGES AND STRUCTURES	19
4.10.1	METHODOLOGY OF INVESTIGATIONS.....	19
4.11	WATER FOR CONSTRUCTION PURPOSE.....	21



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura**.

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

4. ENGINEERING SURVEYS, INVESTIGATIONS AND ANALYSIS**4.1 GENERAL**

Various engineering surveys and investigations are planned for carrying out the feasibility study & preparation of detailed project report for construction of 2-lane / 2-lane with paved shoulder configuration of as per the 'Terms of Reference' and guidelines given in IRC publications.

The methodology adopted for these studies have been in consonance with the methodology and formats as proposed in the Final Inception Report submitted by the Design Consultants. The present Chapter brings out the salient features in respect of the major field studies taken up by the Design Consultants to generate adequate database for preparing the most appropriate proposal for rehabilitation and up-gradation 2-lane with paved shoulder configuration.

Following engineering surveys and investigations have been carried out till the submission of this report:

- Reconnaissance and review of secondary data
- Alignment Study;
- Topographical Survey;
- Traffic Survey;
- Environmental screening and preliminary environmental assessment;
- Road and Structure Inventory;
- Sub-grade Investigation;
- Soil and Material Investigation;
- Survey for Trees cutting and Re-plantation
- Survey for Utility Services;
- Geotechnical Investigation;
- Hydraulic and Hydrological Investigations & Geological survey

Basic data collected from different engineering surveys is presented separately as Annexure to this Report and methodology, results of the surveys and investigations are presented in this Chapter.



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

4.2 INVENTORY AND CONDITION SURVEY OF ROAD AND PAVEMENT**4.2.1 Road Inventory**

Detailed road inventory surveys have been carried out at project site to collect details of road and pavement features along the existing road sections. The inventory data shall include but not limited to the following:

- i) Terrain (flat, rolling, mountainous) as per IRC guidelines;
- ii) Land-use (agricultural, commercial, forest, residential etc) @ every kilometer;
- iii) Carriageway width, surfacing type @ every 500m and every change of feature whichever is earlier;
- iv) Shoulder surfacing type and width @ every 500m and every change of feature whichever is earlier;
- v) Sub-grade / local soil type (textural classification) @ every 500m and every change of feature whichever is earlier;
- vi) Horizontal curve; vertical curve;
- vii) Road intersection type and details, at every occurrence;
- viii) Retaining structures and details, at every occurrence;
- ix) Location of water bodies (lakes and reservoirs), at every occurrence;
- x) Height of embankment or depth of cut @ every 200m and every change of feature whichever is earlier;
- xi) Land width i.e. ROW;
- xii) Culverts, bridges and other structures (type, size, span arrangement and location);
- xiii) Roadside arboriculture;
- xiv) Existing utility services on either side within ROW;
- xv) General drainage conditions;
- xvi) Design speed of existing road;
- xvii) Inventory of all road sides facilities for the public including educational, health, communication facilities and road user based facilities such as tea shops, dhaba, vehicle service shops etc.

Details in the desired format have been presented in **Annexure 1.2 “Road Inventory”**.

4.2.2 Pavement Condition Surveys

Detailed field studies have been carried out at site to collect road and pavement surface conditions. The data should generally cover:

- *Pavement condition (surface distress type and extent);*
- *Shoulder condition;*
- *Embankment condition; and*
- *Drainage condition*



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura**.

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

Pavement

- *cracking (narrow and wide cracking),*
- *% of pavement area affected; ravelling,*
- *% of pavement area affected; potholing,*
- *% of pavement area affected; edge break, length (m); and rut depth, mm.*

Shoulder

- *Paved: Same as for pavement*
- *Unpaved: material loss, rut depth and corrugation, Edge drop, mm.*

Embankment

- *General Condition; and*
- *Extent of slope erosion*

Drainage

- *General Condition;*
- *Connectivity of drainage turnouts into the natural topography*
- *Condition in cut sections*
- *Condition of high embankments*
- *Local (village/local area level) drainage and flooding problem*

Details in the desired format have been presented in **Annexure 1.3 “Visual Pavement Condition”**.

4.3 TOPOGRAPHIC SURVEY

4.3.1 Broad Objective

The Topographic Survey being the most critical activity for any Detailed Engineering Study, ensuring accuracy of the topographic survey is of vital importance to the correctness of all designs. This can be achieved in each of the topographic activities (i) along the ROW (ii) fixation of all cardinal points, referencing the same with a pair of reference pillars on either side of centerline (iii) establishing benchmarks at site connects to GTS Bench Marks (iv) collection of details of all features such as structures, utilities, electric and telephone installations etc and (v) obtaining longitudinal section along final centerline at 25 m intervals and cross-sections at 50 m intervals.



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

4.3.2 Scope

Detailed Topographic Survey was undertaken by the Consultants for capturing all the physical features along the project corridor. The survey covered a strip of 30 m from valley edge with cross sections taken at 50 meter intervals to form a Digital Terrain Model (DTM). The width of survey corridor have taken into account the layout of the existing alignment including the extent of embankment and cut slopes and the general ground profile. While carrying out the field surveys, the widening scheme (i.e. right, left or symmetrical to the centre line of the existing carriageway) should be taken into consideration so that the topographic surveys cover sufficient width beyond the centre line of the proposed carriageway. The details i.e. spot levels, typical features, habitation; and streams etc. have been mapped during topographic survey. In case of land slide locations, entire land slide zone shall be covered irrespective of NH boundary. The plan covers all permanent features near the alignment, the existing road, foot track, cart track, well, shops, house /building, temple, community structure, retaining structure, cross drainage structure, utility services etc.

The project road alignment was surveyed and Reference / Bench Mark pillars for horizontal and vertical control were fixed on the ground along the project road as per TOR.

4.3.3 Equipment/Instruments deployed

The equipment/instruments considered essential for carrying out topographic surveys are Total Station, Global Positioning System (GPS) besides the prismatic compass and digital level etc. for carrying out road alignment survey and establishing Bench Marks.

4.3.4 Methodology

A systematic and schematic approach has been adopted to ensure the desired accuracy of data collected. The following activities have been completed / in progress:-

- Fixing and Location of Bench Marks, along the ROW/Alignment as per TOR.
- Traverse and Leveling Survey carried out using Total Stations and closed at horizontal control points and checked for accuracy in position and bearing within the order of 1 in 10,000.
- The Total Stations and Digital Levels/Auto Levels have been checked by the Survey Engineer for permanent and temporary adjustments before use on the project.

4.3.5 Control Traverse Survey

The control traverse (closed polygon) is the base framework for all the further survey work. This provides a coordinated horizontal grid and a level reference system to ensure accuracy. Thus the measured coordinates of these survey grids (Northing and Easting) and



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

the levels are tied to GTS benchmark, to verify the accuracy of survey. The GPS/ Benchmark Pillars and Reference Benchmark Pillars established as specified in TOR to act as both horizontal and vertical control points. Control points/ Reference beacons, consisting (of cement concrete pillars with central nail point, have been fixed at every 250m intervals depending upon site conditions. Three coordinates (X, Y and Z / easting, northing and altitude) of control beacons, with respect to the cumulative chainage of alignment are being prepared.

The survey data thus collected by the topographic survey was processed and converted to graphic files using Highway Design software.

4.3.6 Specifications:

Specifications of MOST / IRC / BS shall be followed:

✓ Survey Control Points:

- It will be located on the fundamental criteria based on those stations for further survey work at every stage.
- A stable constructed station will be used as control points and will not be disturbed for further survey.
- Pillars with nails on them will be used as control stations.

✓ Height Control Points:

- All plannemetric stations shall be used for height also and referred to MSL data.
- Apart from horizontal control stations additional height control stations shall be made throughout the stretch.

✓ Co-ordinate System:

- Arbitrary value will be used and the same shall be noted as rectangular co-ordinate system oriented to geographic North. Similarly height control will be referred to MSL.

4.3.7 Permanent Markers:

Permanent markers will be made using RCC pillars. This shall be maintained for further survey also to facilitate the construction. All these shall have X, Y, Z values.

4.3.8 Information:

The details of the following will be collected for 30 m corridor width or 12.5 m on either side of the centerline of the proposed road alignment as per the site condition.



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

- Buildings, hutments, statues and all such objects
- Boundary lines or extents
- Temples, Mosques, Churches, Gurudwaras and other places of worship.
- Electric poles, telephone poles etc.
- Water pipeline, cable crossing etc.
- Trees above girth of 30 cm
- Solitary tree
- Vegetation/cultivation within 100 m corridor
- Low land, water bodies
- River and canals within the area
- Protective Items, if any
- Other important features existing

4.3.9 Presentation symbols:

Conventional signs by Survey of India / IRC: SP-19 will be followed and all such will be shown in the drawings and topo-sheets. Details of drawing sheets shall be as under:

Size of Sheet	: 297 x 640 mm
Scale	: H:: 1 : 2500 & V:: 1 : 250
Match lines	: Linear line showing grid values shall be marked
Grid	: Shall be marked at every 200 m interval
Stretch on a sheet	: One Km. per sheet.

Digital Terrain Model: All the data obtained from field will be fed in the computer for processing in computer, coded and production of final drawings. All data shall be coded layer wise for each field information.

4.3.10 Cadastral Survey:

All the cadastral maps have been collected and the area for land acquisition with reference to cadastral maps and design plan have been shown in notification under section 3A of LA Act 1956.

4.4 PAVEMENT INVESTIGATION**4.4.1 General**

The broad objectives of carrying out this Investigations include, inter-alia, (i) to identify the various defects and sections with similar characteristics (ii) to determine if a non-overlay rehabilitation approach is to be adopted e.g., if the existing defects can be



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura**.

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

attributed to only say lack of proper drainage and erosion control measures etc. and not to any deficiency in pavement crust and (iii) to ascertain that deficiency in pavement crust and (iii) to ascertain that the existing defects are due to structural deficiency and if so, to determine the type and thickness of overlay required. It may be pertinent that none of the below investigations are envisaged on the existing Kumarghat – Kailashahar road project.

4.4.2 Pavement Roughness Survey

Roughness survey cannot be carried out on the project road section because the road surface is mostly distressed which has been found out during the reconnaissance survey.

4.4.3 Benkelman Beam Deflection Test

Though the existing pavement is composite of 20 -40 mm thk bituminous layer over brick work and the maximum length of proposed alignment is new alignment, so the BBD survey could not done for this road section and entire road length is proposed as new pavement.

4.5 SUB-GRADE INVESTIGATION**4.5.1 Test pit for Sub-grade Investigation**

We have carried out sub-grade investigation by collecting soil sample and doing test like in-situ density and moisture content at each test pit location. Details are provided in para 4.5.3 of this report.

4.5.2 Existing Pavement Composition

We have collected data pertaining to pavement composition by digging test pit at desired interval along the road. Following are the details:-

Table 4.1 :- Pavement Composition Site Survey

<i>Existing Chainage (Km)</i>	<i>Position of Pit</i>	<i>Pavement Composition</i>			<i>Total (mm)</i>
		<i>Bitumen Layer</i>	<i>Brick Soling</i>	<i>Sub base Course</i>	
		<i>(mm)</i>	<i>(mm)</i>	<i>(mm)</i>	
0+000	RHS	40	180	-	220
0+500	LHS	30	150	-	180
1+000	RHS	35	160	-	195



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

<i>Existing Chainage (Km)</i>	<i>Position of Pit</i>	<i>Pavement Composition</i>			<i>Total (mm)</i>
		<i>Bitumen Layer</i>	<i>Brick Soling</i>	<i>Sub base Course</i>	
		<i>(mm)</i>	<i>(mm)</i>	<i>(mm)</i>	
1+500	LHS	40	145	-	185
2+000	RHS	45	170	-	215
2+500	LHS	40	205	-	245
3+000	RHS	30	255	-	285
3+500	LHS	30	225	-	255
4+000	RHS	30	240	-	270
4+500	LHS	40	170	-	210
5+000	RHS	30	210	-	240
5+500	LHS	40	190	-	230
6+000	RHS	45	160	-	205
6+500	LHS	35	235	-	270
7+000	RHS	40	255	-	295
7+500	LHS	40	155	-	195
8+000	RHS	45	260	-	305
8+500	LHS	35	165	-	200
9+000	RHS	40	225	-	265
9+500	LHS	40	160	-	200
10+000	RHS	45	200	-	245
10+500	LHS	30	150	-	180
11+000	RHS	40	180	-	220
11+500	LHS	35	155	-	190
12+000	RHS	30	245	-	275
12+500	LHS	35	255	-	290
13+000	RHS	40	160	-	200
13+500	LHS	35	170	-	205
14+000	RHS	40	185	-	225



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

<i>Existing Chainage (Km)</i>	<i>Position of Pit</i>	<i>Pavement Composition</i>			<i>Total (mm)</i>
		<i>Bitumen Layer</i>	<i>Brick Soling</i>	<i>Sub base Course</i>	
		<i>(mm)</i>	<i>(mm)</i>	<i>(mm)</i>	
14+500	LHS	40	160	-	200
15+000	RHS	45	190	-	235
15+500	LHS	45	205	-	250
16+000	RHS	35	260	-	295
16+500	LHS	40	180	-	220
17+000	RHS	35	240	-	275
17+500	LHS	40	200	-	240
18+000	RHS	35	230	-	265
18+500	LHS	40	210	-	250
19+000	RHS	45	165	-	210
19+500	LHS	35	235	-	270
20+000	RHS	35	175	-	210
20+500	LHS	30	150	-	180
21+000	RHS	40	200	-	240

4.5.3 Laboratory Test on Test samples

The Soil samples for sub-grade collected along the Project road as per ToR clause 4.11.3.3, page no. 51. The details of tested samples are tabulated below –



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)**Table 4.2:- Test Result of Soil Samples****NORTH EAST SOIL TESTING (NEST)**

Regd. Office : Ujan Abhoynagar,
Opp. Post Office, Agartala ,
West Tripura, PIN – 799005 ,

**TEST REPORT**

Ref No.:- Nil dated:- 19.07.2018
Issue Date : 30.07.2018
Issued To : TASPL
Sample Deposited by : Representative
Sample Description : Soil

Job No. : NEST/2018/B-206
Date of Sample received : 19.07.2018
Page :1.....

Chain- age No. (Km)	Soil Clas- sificati on	Insitu Dry density (g/cc)	Insitu Moist- ure (%)	Sand (%)	Silt (%)	Clay (%)	Liquid Limit (%)	Plastic Limit (%)	Plasti- city Index (%)	MDD (g/cc)	OMC (%)	Unsoa- ked CBR (%)	Soaked CBR (%)	Swelling Index (%)
7+000	CL	1.14	14.15	39	41	20	26	18	08	1.84	14.9	21.5	12.4	4.76
14+000	CL	1.13	18.15	37	23	40	29	19	10	1.808	15.6	19.7	10.25	5.26
20+500	SM	1.27	12.33	77	13	10	19	16	03	1.82	16.9	21.85	11.7	4.35

Prepared by

Shank

30/07/18

L. B. M. BHOWMIK
(s. Tech, NITA)
Technical Manager,
North East Soil Testing
Agartala-799005

(1) This test report pertains only to the sample tested. (2) This test report is valid at the time of and under the conditions specified here in. (3) Any correction invalidates this test report. This test report should not be published in part or in full by any body without written permission from 'NEST'. (4) Samples will be destroyed after 90 days from the date of reporting unless otherwise specified. (5) This report not to be reproduced wholly or in part & can not be used as an evidence in the court of Law & should not be used in any advertising media without our special permission in writing.



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

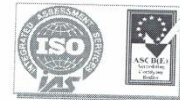
Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

NORTH EAST SOIL TESTING (NEST)



ISO 9001 : 2015 Certified

Regd. Office : Ujan Abhoynagar,
Opp. Post Office, Agartala ,
West Tripura, PIN – 799005 ,
License No. 02/15/185



TEST REPORT

Ref no:- Nil Date:- 19.07.2018

Issue Date : 30.07.18 Job No. : NEST/2018/B-206
Issued To : TASPL Date of Sample Received : 19.07.18
Sample Deposited by : Representative Page : 3....of....30
Sample Description : SOIL

Sample:- 1 (Chainage No.- 7+000 Km)**Grain Size Analysis**

IS Sieve (mm)	Percent Finer(%)	Test Method
2	99.27	IS 2720(Part 4)-1985
1.18	98.94	
0.6	98.41	
0.425	93.18	
0.3	89.34	
0.15	62.81	
0.075	60.77	

Sand (%)	39
Silt (%)	41
Clay (%)	20

Reviewed by

[Signature]
Er. B. C. BHOWMIK
30.07.18
Technical Manager,
North East Soil Testing



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

4.6 MATERIAL INVESTIGATIONS

Various field and laboratory investigations will include interalia, the following:

- Identifying sources of hard stone aggregates, marginal aggregates, gravels, sands and other soil types which could be incorporated in road works, through soil and materials surveys.
- Obtaining representative samples of local soils, gravels, hard stone and marginal aggregates etc.
- Subjecting representative samples collected from different sources to the relevant laboratory tests.
- Estimating quantities of various road materials available from different sources for use in road works.
- Determining, on the basis of laboratory test data, the suitability of various soils, gravels, hard stone aggregates, marginal aggregates etc. which could be incorporated in road works, keeping the techno-economic considerations in view.
- Preparing charts showing all sources/quarries from where the soils, gravels and aggregates are to be obtained for the project road.

All procedures adopted for sampling and testing of soils, gravels, aggregates and other materials will be as per relevant Indian/IRC Standards/Codes.

Before taking up the various field and laboratory investigations, all relevant available information like (i) Maps/Charts of approved quarries and other material sources (ii) Soil map of the area (iii) Geological map of the area (iv) Land use map (v) Available reports on survey and evaluation of locally available materials from the NHIDCL scheme R-1, will be collected. Also any information on available sources of road materials in the area will be collected through discussions with Contractors working on nearby road projects.

After identifying the various sources of suitable soils, gravels and stone aggregates etc. in the area, the Geotechnical/Materials Engineer of the Consultant's team will visit these sources for visual assessment in regard to their suitability and equipment needed for extraction etc.

4.6.1 Type of materials

Preliminary survey for naturally occurring road construction materials like moorum, gravel, sand and stone aggregates was carried out. Information regarding the material quarries was also collected from PWD, NH Division and surrounding areas.



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

4.6.2 Source of materials

During the preliminary surveys it was observed that important construction material like stone and sand are available along the Project road.

Aggregate quarry for structure works and road works is identified at Silchar (Assam) which is Approx 170 km away from kumarghat & approx same from the kailashahar.

Sand source has been located from Local River with average lead of 15 km.

Borrow earth can be obtained from number of locations along the project road, however the road excavated earth may also use for embankment & subgrade as its CBR found more than 8,

Cement for concrete works may purchase from local vendors of different grades of OPC & PPC.

Steel for concrete work May also use from local suppliers.

Bitumen supply is considered from Haldia IOCL with lead of approx. 1550 km.

4.6.3 Testing of materials

For each of the identified borrow areas for use in embankment, sub-grade and GSB, the team will grid the borrow area at 25 m centre-to-centre to full depth of proposed working. These pits will be logged and plotted for proper identification of suitable sources of material. The following tests on representative samples will be carried out:

- i) Sand content (IS:2720 Part 4)
- ii) Liquid and Plastic Limits (IS:2720 Part 5)
- iii) Heavy Compaction Test (IS:2720 Part 8)
- iv) Deleterious Content Test (IS:2720 Part 27)
- v) Natural Moisture Content Test (IS:2720 Part 2)
- vi) CBR Test on materials to be incorporated in the sub-grade on soaked samples (IS 2720 Part 16)
- vii) Soluble Sulphate (IS:2720 Part 27)
- viii) Free Swelling Test (IS:2720 Part 40)
- ix) PH Value (IS:2720 Part 26)

From each of the identified quarries of road aggregates for use in base and wearing courses, representative samples will be subjected to the following tests:

- i) Particle size and shape (IS:2720 Part 1) (Grading , Flakiness and Elongation Indices)
- ii) Deleterious Materials and Organic Impurities (IS:2720 Part 2)
- iii) Specific Gravity and Water Absorption (IS:2720 Part 3)
- iv) Soundness Test (IS:2720 Part 5)
- v) Aggregate Impact Value (IS:2720 Part 4)



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

- vi) Wet Aggregate Impact Value for Soft Course Aggregate/Marginal Aggregates (IS:5640)
- vii) Bitumen Stripping Test (IS:6241)

The natural sand will be tested for its gradation, fineness modulus and deleterious constituents while the water for construction purposes will be tested for its PH value and chemical contents.

All laboratory test results are recorded on standard Performa.

The Geotechnical/Materials Engineer of the Consultants team will review all the best results for consistency and compatibility.

4.6.4 Finding

The Results of Subgrade soil is shown in para 4.5.3 of this report, the material like sand, aggregate may use from local quarries and these are approved by PWD. The department is using these materials for their road works also. The sufficient quantity is available at these sources.

4.7 AXLE LOAD SURVEY

Though CVPD (as per above table) on one locations are found very less (211), so the Axle load survey could not carry out and the default values of VDF as per table 4.2 of IRC - 37:2018 is considered 3.9 (for initial traffic volume 150-1500).

4.8 INVENTORY AND CONDITION SURVEY OF BRIDGES AND CULVERTS**4.8.1 Inventory and condition survey of Bridges**

Inventory and condition survey of all the structures (major/minor bridges, viaducts etc.) have been carried out along the project road. The inventory for the bridges, viaducts have been included the parameters required as per the guidelines of IRC-SP: 35-1990.

For the bridges identified to be in a distressed condition based upon the visual condition survey, supplementary testing shall be carried out as per IRC-SP: 35 and IRC-SP: 40. Selection of tests may be based on the specific requirement of the structure.

The evaluation of the load carrying capacity of the bridge shall be carried out as per IRC-SP: 37 (Guidelines for Evaluation of Load Carrying Capacity of Bridges).



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura**.

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

All necessary surveys and investigations to establish the remaining service life of each retainable bridge or structure with and without the proposed strengthening and rehabilitation according to acceptable international practice in this regards shall be carried out.

The detailed inventory, conditions and structural assessment of bridges have been presented in a desired tabular form covering relevant physical and hydraulic parameters and annexed in **Annexure 1.5 “Bridge Inventory”**.

4.8.2 Inventory of Culverts

Inventory and condition survey of all type of culverts have been carried out along the project road. The inventory has been included the parameters required as per the guidelines of IRC-SP: 35-1990.

Detailed inventory and condition survey data of culverts have been presented in a desired tabular form covering relevant physical and hydraulic parameters and annexed in **Annexure 1.4 “Culvert Inventory”**.

4.8.3 Inventory of other type of structures

Detailed inventory of other type of structures has also been carried out along the project road which broadly includes Temple, School, and Ponds etc.

The detailed inventory and conditions data of the above structures have been presented in a desired tabular form and annexed in **Annexure 1.7 & 1.8**.

4.9 HYDROLOGICAL AND HYDRAULIC INVESTIGATIONS**4.9.1 General**

Generally Design discharges for bridges and culverts are computed by using various methods as recommended by IRC: 5 and IRC-SP-13. Methods adopted in any particular case vary depending on available data. Various methods which can be used for calculating the design discharge (As per IRC: 5 & IRC – SP: 13) are given below:

4.9.2 Project Area Overview

The project road is from Kumarghat to Kailashahar. Deo river is running parallel to the project road in a short length. During rainy season the river is flooded with high velocity of water flow which causes cutting and erosion in some section of adjoining road. Major submergence caused by flash flood observed during this year 2018 near km 5+0 to km 7+0.



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

4.9.3 Hydrological Design Methodology

Empirical Formula (Dicken's and Ryve's Formula)

Dicken's and Ryve's formula are commonly used in India for computation of flood discharge based on catchment area of the stream.

(i) Dicken's Formula:

$$Q = C_1 A^{0.75} \quad (1)$$

(ii) Ryve's Formula:

$$Q = C_2 A^{0.67} \quad (2)$$

Where:

A = Catchment area in Sq. km.

C₁ and C₂ = Run-off coefficients which depends on the topography, type of soil, vegetation, ground slope, climate of the region, etc.

Because of the varying topography, C₁ and C₂ values will vary appreciably and since these formulas do not take rainfall into account, discharges computed are not reliable.

(iii) Rational Formula

$$Q = 0.028 P_f A I_c \quad (3)$$

Where:

Q	=	Maximum runoff in cumecs
A	=	Catchment area in hectares
I _c	=	Critical intensity of rainfall in cm/ hr.
P	=	Coefficient of run off for the given catchment characteristics.
f	=	Spread factor for converting point rainfall into areal mean rainfall.
I _c	=	$F/T[(T+1)/(T_c+1)]$
F	=	Total Rainfall of T hours duration (24 hrs.) in cm corresponding to either 25 yrs (for culverts) or 50 yrs (for bridges) return period.
T	=	Duration of total rainfall (F) in hours= 24 hrs.
T _c	=	Time of concentration in hour.



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura**.

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

(iv) WATER CURRENT FORCE

HFL, velocity of flow, scour depth has been taken as per past data received and hydraulic calculations. The water current forces on substructure and foundation have been calculated as per IRC: 6-2010.

On piers parallel to the direction of water current, the intensity of pressure is given by following equation.

$$p = 52 K V^2$$

Where,

p = intensity of pressure in kg/m²

K = a constant, value depends on shape of pier

V = velocity of current at point where pressure intensity is to be determined in m/s. (which is zero at the point of deepest scour and sqrt (2) times maximum mean velocity at the free surface).

(v) BUOYANCY FORCES

Full buoyancy (100%) has been considered for checking the stability of foundations. For checking stresses of the substructure components, 15% pore pressure uplift is considered in the design.

4.9.4 Findings of Investigations

The details will be described in next stage submission.

4.10 GEO-TECHNICAL INVESTIGATION FOR BRIDGES AND STRUCTURES**4.10.1 Methodology of Investigations**

Detailed Geotechnical and sub-surface investigations conforming to the established standards and based on approved GAD has been conducted for the proposed Bridge and high embankments locations. A detailed drawing will be prepared by Bridge Engineer showing the plan of all bore hole locations with appropriate notation and depth of boring.

The data of particular importance for the design of structures includes:

- soil profile;
- foundation stratum;
- Strength characteristics; and
- safe bearing capacity;



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura**.

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

The minimum scope of geo-technical investigations for bridge and structures shall be as under:

Table 4.2:- Geotechnical Investigation for bridges

Sl. No.	Description	Location of Boring
1.	Overall length = 6 – 30 m	One abutment location
2.	Overall length = 30 – 60 m	One abutment location and at least one intermediate location between abutments for structures having more than one span.
3.	Overall length >60 m	Each abutment and each pier locations.

The strength of soil layers will be evaluated in the field using SPT tests. The laboratory testing of soil samples will normally include:

- Soil characterization (grain size distribution and Atterberg Limits);
- moisture content, natural density and chemical tests;
- shear strength parameters; and,
- Consolidation parameters.



Consultancy services for feasibility study, preparation of DPR & providing pre-construction services for up-gradation of selected road stretches/corridors to Two lane with paved shoulder NH configuration under BHARATMALA Project and National Highways connectivity to Backward areas/Religious/Tourist places of the country **in the state of Tripura.**

Section IV: Kumarghat - Kailashahar section (Design Length – 18.620km)

Sub-soil investigations will be done as per IRC 78-2000.

The scheme for the borings locations and the depth of boring shall be prepared by the Consultants and submitted to NHIDCL for approval. These may be finalised in consultation with NHIDCL. However, in case refusal strata or a rocky stratum is encountered before the specified depth bore shall be advanced further by 5m into the refusal soil strata or 3m in rocky strata.

The bore-holes shall be advanced by rotary method up to refusal ($N \geq 100$) up to rocky strata. While advancing the borehole standard penetration test shall be conducted at regular intervals of 1.5 m and undisturbed soil samples shall be collected at regular intervals of 3m. Representative samples shall be collected at 1.5m intervals for soil classification.

Beyond refusal / rocky strata the borehole shall be advanced by rotary drilling using Nx size DC/ TC bits with single tube/ double tube barrel. The rock core samples shall be placed lengthwise in G.I. Box (18G) of suitable size. The samples and cores shall be labeled and shall identify the borehole number, sampling dept, etc.

In case of core recovery is nil in the borehole, representative samples / wash samples shall be collected. Water level in each borehole shall be measured and recorded during drilling and after completion of the boreholes.

For the road pavement, bore holes at each major change in pavement condition or in deflection readings or at 2 km intervals whichever is less shall be carried out to a depth of at least 2 m below embankment base or to rock level and are to be fully logged. Appropriate tests to be carried out on samples collected from these bore holes to determine the suitability of various materials for use in widening of embankments or in parts of new pavement structure.

The soil testing reports shall be in the format prescribed in relevant IRC Codes.

4.11 WATER FOR CONSTRUCTION PURPOSE

Water is available in more than sufficient quantum along the Project Road. The source may be parallel river/nala/pond etc.

