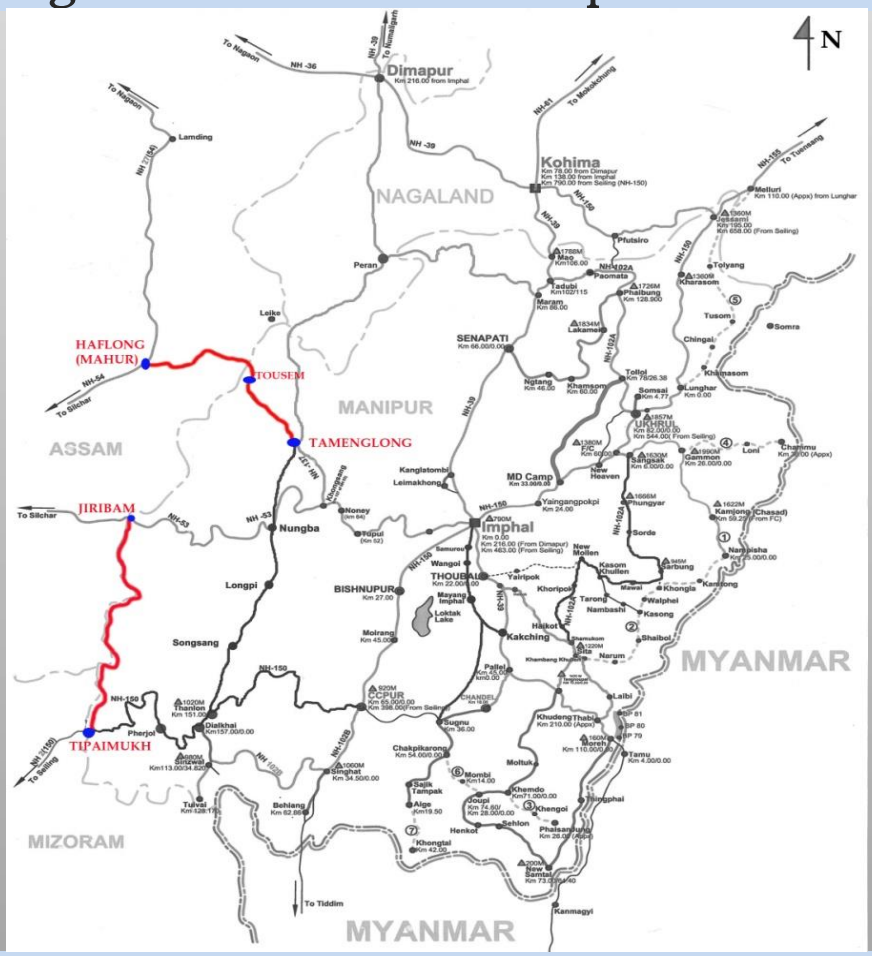
NATIONAL HIGHWAY INFRASTRUCTURE DEVELOPMENT CORPORATION LIMITED

Consultancy Services for preparation of Feasibility Study and Detailed Project Report for Two Lane with Paved Shoulders of Tamenglong-Tousem-Haflong Road in the State of Manipur and Assam.



DRAFT DETAILED PROJECT REPORT
VOL-III MATERIAL REPORT
PKG-9 HEJAICHAK – P. LEIKUL SECTION
(FROM KM 136+500 TO KM 156+489) LENGTH-19.989 KM

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INDEX

CHAPTER 1
INTRODUCTION

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1.1 INTRODUCTION

- GENERAL

The selected National Highway serve as lifeline for population living in rural areas scattered in vast geographical span of districts. In Assam the geographical rough & Hilly terrain demands for an effective road network in order to provide population proper connectivity. The condition of highways has quite improved in past years, however still lot of scope still remains for improvement in road infrastructure network across Manipur.

- PROJECT BACKGROUND

National Highways and Infrastructure Development Corporation Limited.,(NHIDCL) have been constituted by the Government of India in the year 2014 with the purpose of up-gradation and development of National Highways and Strategic Roads including interconnecting roads in parts of the country which share international boundaries with neighboring countries. Private consultants will provide consultancy service to establish the technical, economical and financial viability of the projects with due consideration to environmental and social safeguards and to prepare Detailed Project Reports for widening, relaying and / or reconstruction of roads. LN Malviya Infra Projects Pvt. Ltd., BHOPAL as consultants to provide the Consultancy Services for Preparation of Detailed Project Report for Tamenglong-Mahur Road in the State of Manipur.

1.2 PURPOSE OF MATERIAL INVESTIGATION

The investigation for the soil and other construction material has been carried out to :-

- Determine the natural and physical characteristics of soil and soil profile for design of

embankment and pavement.

- Identify and locate borrow areas for their availability and suitability for use.
- Locate sources for aggregate require for pavement and structures and to ascertain their vitality and suitability for use.
- Locate sources of water suitable for construction.
- Gather general information regarding sub -soil, water level and flooding.
- Identify sources for other construction material such as cement, Sand, Aggregate, bitumen and steel.

1.3 DETAIL OF INVESTIGATION

The detailed investigation included both field and laboratory work. Samples of borrow soils, sand and crushed rock for use in embankment, pavement and in other structure were collected from the existing as well as proposed borrow sources / quarries within reasonable short haulage distance from the project corridor. Auger holes and test pits were excavated where necessary to obtain samples for testing.

The following **Table 1.1** Summarizes the investigation and testing accomplished by the consultant to archive the objective

Table 1.1 Quantum of investigation and Testing

S. No.	Description	Interval	Number
1.	Test pit excavation penetrating pavement structure down to sub-grade to record (a) pavement (b) field density and compaction and (c) collection of sub-grade sample	Min 1 per 5 kms. (Hill Sides)	4
2.	Investigation of (I) Quarry sources (ii) Sand sources	 ------- -------	 1 1

1.4 TEST PROCEDURE

The standard test procedure followed for soil sampling and laboratory testing is given in Table 1.2. All laboratory tests have been performed at our in-house laboratory located at Bhopal (M.P.) and the results are compiled in Annexure.

Table 1.2 Standard Test Procedures

S. No.	Type of Test	Method
1.	Sieve analysis - Natural Soils - Selected Soil	IS: 2720 Part 4 IS: 2386 Part 1
2.	Field Density Test	
3.	Modified Proctor Compaction Tests - OMC - MDD	 IS :2720 Part 2 (Section l) IS :2720
4.	Atterberg Limits	IS :2720 Part 5
5.	CBR Soaked & Unsoaked & Swell Test	IS :2720 Part 16

CHAPTER 2
SOIL PROFILE ALONG THE PROJECT ROAD

CHAPTER 2
SOIL PROFILE ALONG THE PROJECT ROAD

2.1 FIELD AND LABORATORY TESTING

Test pits were excavated on an average at an interval of about 5 kms and at the location where the soil strata changes to perform field density and to collect samples for laboratory tests. They were carefully dug from the pavement surface up to sub grade level, after this they were manually leveled and prepared for field density tests. Field density tests on the sub-grade soil were conducted using the sand replenishment method at each test location and small quantity was collected in airtight containers for deterring the field moisture from each test pit.

Upon completion of field density test, respective sample of sub – grade soil was collected in bulk in gunny bag from each test pit for laboratory tasting. Finally holes were drilled using hand auger from the bottom of the test pit to collect soil samples for identification and laboratory classification test. Respective samples of soil and materials collected from the test pit and auger holes were subjected to various laboratory and field tests as listed below.

The tests performed were

- Grain size distribution
- Atterberg limit
- OMC & Maximum Dry Density for modified proctor Compaction
- CBR tests Soaked and Unsoaked

2.2 TEST RESULTS

The tests results of soil and soil field density are exhibited in Appendix 1 Summary of laboratory soil test result and field test result are given in Tables 2.1 and 2.2 respectively.

Table 2.1 Laboratory Soil test Results

S. No.	Chainage Km	Modified Proctor Compaction Test		Grain Size Analysis			Atterberg Limit			CBR
		OMC %	MDD gm/cc	Gravel %	Sand %	Silt & Clay %	L.L. %	P.L. %	P.I. %	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	139+400	10.90	1.852	17.25	29.65	53.10	27.50	16.85	10.65	16.35
2	146+160	11.30	1.824	22.00	22.10	55.90	24.50	14.11	10.39	13.80
3	152+200	10.45	1.942	30.15	29.95	39.90	26.60	18.47	8.13	10.25
4	158+600	11.20	1.995	19.75	37.80	42.45	27.30	19.26	8.04	9.98

2.3 CONCLUSIONS

Along the entire corridor Four type of soil were encountered, Greyish Silty Sandy Clay, Light Yellow Clayey Silty Sandy clay, Light Brown Clayey Silty Sand & Reddish Clayey Silty Sand with high compressibility (CH) and granular properly and well graded soil. Field density measurements on the existing sub – grade reveals that they are within the acceptable range.

To evaluate the sub-grade strength in it existing condition, the CBR strength of the sub - grade were determine by compacting the samples in soaked (for four days) and unsoaked condition.

The soaked CBR of soil varies from 9.98% to 16.35% out of which 100 % of the results are above 8% CBR. Therefore CBR strength is quite good reflection of their potential strength.

CHAPTER 3
CONSTRUCTION MATERIALS

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CONSTRUCTION MATERIALS

3.1 OBJECTIVE

The objective of the construction material survey was to:

(I) Locate potential sources of soil borrow areas, gravel, rock quarries, water sources and other construction materials with in the project vicinity.

(II) Examine the engineering properties of materials relevant to the project as per MORTH specifications.

As a first step, material surveys were identified with the help of existing data, local enquiry and field assessment. Thereafter soil and aggregate samples were collected from the identified sources for testing.

3.2 BORROW AREAS

3.2.1 Identification

Investigation has been done to locate the potential borrow areas for sub – grade / embankment fill and granular sub- base along the project corridor with economic hauling distance. To achieve the objective the offices of NHIDCL and local people were connected. Based on the information collected, field surveys carried out and personal experience, potential burrow areas have been identified which either existing old borrow areas or new ones are lying in the Existing Road land belonging to government or people.

borrow areas have been identified in existing road side hill portion. These are spread between overall length of the project corridor. The soil from these borrow areas (or existing) is generally of hard moorum type with high CBR Value. The details of these areas i.e., location, distance from the project road, is given Table 3.1 below.

Table 3.1: Borrow Areas Location

Sr. No.	Location	Villages	Distance from project corridor
1.	From Km 139.340 To Km 160.875	-	On Corridor Both Side

All the borrow areas have sufficient quantity of material and can be used in the road. Some of borrow areas are pre-approved by the NHIDCL. Burrowing soil from these areas would require prior notice to the local authorities' private people and permission obtained from them with or without royalties.

Soil samples from these borrow areas were collected by excavating pits down to 1.0 m. depth from the existing surface The top organic layer of 100 mm was removed before sampling.

3.2.2 Sampling and Laboratory Testing

3 borrow areas identified. The following tests were carried out on borrow soil samples

- Grain Size Analysis
- Atterberg Limits
- Proctor Compaction Test
- CBR Test

3.3 AGGREGATES

3.3.1 Quarries for Aggregates

Aggregates for sub- base, base and surface courses are proposed to be utilized from the crusher or quarries under operation within economical haulage distance of the project corridor. Some of these quarries have been leased by Manipur Government and the lessees have installed crusher and sell aggregates. The allotted area is a small fraction of the total area of each quarry. It is learnt that further area can be leased out by the Manipur Government for this purpose.

Table 3.2 : Location of Aggregate Quarries

Sr. No.	Location	Chainage (km.)
1.	At Jiri River	At 15km Lead
2.	At Laisong River	At 18km Lead

Table 3.3: Location of Sand Quarries

Sr. No.	Location	Chainage (km.)
1.	At Jiri River	At 15km Lead
2.	At Maibong	At 70km Lead

3.3.2 Sampling and Testing

The following tests were conducted

3.3.2.1 For Aggregate

- Impact Value
- Specific Gravity
- Water Absorption

3.3.2.2 For Sand

- Grading
- Fineness Modules

Four samples each of aggregates and sand collected from the identified quarries have been tested. The test report is exhibited in Appendix -1. Summary of test results of Aggregates and sand is given in Table 3.4.

Table 3.4 Test Result of Aggregates at Location-1

S. No.	Name of Test	Sample Details / Result
1.	% Impact Value	25.89%
2.	% Specific Gravity	2.58
3.	% Water Absorption	1.40%
4.	CBR	31.46%

Table 3.5 Test Result of Aggregates at Location-2

S. No.	Name of Test	Sample Details / Result
1.	% Impact Value	34.95%
2.	% Specific Gravity	2.47
3.	% Water Absorption	1.83%
4.	CBR	26.16%

3.3.2.3 Aggregates

For the Aggregates tested, the impact value is 25.89 % which is within the permissible limit. The specific gravity varies from 2.58% to which is acceptable. The water absorption varies from 1.4% and less then the permissible limit of 2%. On the basis of this property; all the samples are suitable as aggregate for any of the pavement layers. However it may be pointed out that a change in type of crusher can result in lower flakiness and elongation index. It is therefore expected that with the use of integrated crushing plants (cone crusher as secondary unit), this property will get satisfied.

It therefore reveals that aggregate from the tested quarries, which are with reasonable reach of the projected corridor, after meeting all the engineering requirement and specifications can be used for construction.

3.3.2.4 SAND

The grading and fineness modules of sand samples tested are generally within the permissible limits and as such material from such quarries is fit for use.

3.4 WATER

The potable water from tube well, opens wells, water supply schemes is considered suitable for construction and available in plenty.

3.5 OTHER CONSTRUCTION MATERIALS

Bitumen is to be brought reputed oil refinery or from Distributor of Imphal, Guwahati or near by places. Manufacturer's test / quality certificate is required for each consignment received. Steel of various grade including HYSD steel as per IS specification is available in Imphal, Guwahati & other cities of Assam and can be bought from there or can be arranged from the Manufacturers. Manufacturer's test / quality certificate is needed for each consignment received.

CHAPTER 4
PROCUREMENT OF CONSTRUCTION MATERIALS

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PROCUREMENT OF CONSTRUCTION MATERIALS

4.1 BORROW AREA SOILS

To get the soil, the contractor

- Shall have to meet the owner (Private Person or Government Department) of the borrow area.
- Negotiate the price of the land (for Government area as per notified rules).
- Specifically mentioning the area required, depth of cut, exact time and duration of operation.
- Should make a proper agreement on the stamp paper with all terms and condition mentioned in it.
- Replace the top soil of the borrow area at the time of handing over the borrow pit to the owner, which was removed in the beginning of the operation, of excavation.

4.2 AGGREGATES

To get aggregates, the contractor

- Can purchase the aggregates. from the market as long as the aggregate meet the specification requirements.
- Can set up his own crusher in the quarry area, after taking the quarry area on lease from the revenue / mining department of the state.
- Take NOC from various Government Departments such as Police, Mining, Revenue etc. for new quarries.

4.3 SAND

Sand can be obtained from the natural stream or quarries by paying royalty to the Government.

4.4 WATER

To get Water, the contractor

- Can have it by installing pumps on the existing open well / bore holes along the road and payments may be paid to the owner of the wells / bore holes or
- Can dig his own tube well after taking approval from the state Ground Water Board.

4.5 GRANULAR SUB-BASE

To obtain GSB, the contractor

- Can have it from his own crusher as 'Direct Crusher Run'

4.6 OTHER CONSTRUCTION MATERIALS

To arrange other construction materials like cement, steel etc., the Contractor

- Can buy it directly from the sources / manufacturing unit or
- Can purchase from the local suppliers of nearby cities.

APPENDICES TO CHAPTER 1

Analysis Report

I. SAND

a.Source: Maibong

S. No.	Tests	Test Values
1.	**Sieve Analysis**	
2.	**Sieve size mm**	**% Passing**
3.	10	97.86
4.	4.75	95.58
5.	2.36	95.42
6.	1.18	94.51
7.	600	92.88
8.	300	35.00
9.	150	7.59
10.	75	0.00
11.	Deleterious Material	-
12.	Deleterious Material-Coal & Lignite	-
13.	Deleterious Material-Clay & Lumps	-
14.	Silt & Clay	0.48%
15.	Fineness Modulus	0.55%

IS Codes Followed: 2720(Various parts),2386(Various parts),383

FREE SWELL INDEX OF SOIL (IS : 2720 PART 40) 1977

Sample Location : 139+400 Date Sampling : 04/10/22

Source of Materials : Soil Date of Testing : 10/10/22

Description of Sample :

Observation Sheet

Determination No			1	2
1	Mass of Dry Soil Passing 425 µ Sieve	(gm)	10.00	10.00
2	Volume in Water 24 hrs swell (Vd)	(cc)	11.50	12.00
3	Volume in Kerosene after 24 hrs (Vk)	(cc)	10.50	10.00
4	Free Swell Index [(Vd-Vk)/Vk]x100	(%)	14.29	20.00
5	Average	(%)	17.15%	

GRAIN SIZE ANALYSIS OF SOIL(AS PER IS :2720, PART-4)

Sample Location : 139+400 Date of Sampled : 04/10/22

Source of Materials : Soil Date of Soaking : 10/10/22

Description of Sample : Date of Testing : 11/10/22

Method of Sieving : Wet/Dry Weight of Sample(gm) : 1000

Sieve size	Weight Retained (gms)	Weight Retained (%).	Cumulative weight Retained (%).	Passing (%)	Remarks
100 mm	0	0	0	100	
75 mm	0	0	0	100	Gravel
19 mm	0	0	0	100	
4.75 mm	172.5	17.25	17.25	82.75	
2 mm	132	13.20	30.45	69.55	Sand
425 mic.	102.5	10.25	40.70	59.30	
75 mic.	62	6.20	46.90	53.10	
Pan					Silt & Clay

Gravel 17.25 (%) Sand Content 29.65(%)

Silt/Clay Content 53.10(%)

ATTERBERG'S LIMIT (As per IS 2720, Part - 5) BY CASA GRAND METHOD

Source : Soil

Location : 139+400

Description of Material :

Date of Sampled : 04/10/22

Date of Tested : 11/10/22

Description		LIQUID LIMIT				PLASTIC LIMITS	
Trial No.		1	2	3	4		
Container No.		A21	A22	A23	A24	A25	A26
No.Of Blows		34	28	23	17	-	-
Empty weight container (a)	(gm)	12.83	14.26	15.87	14.06	15.17	12.36
Wt. of container + wet soil (b)	(gm)	32.89	35.45	37.86	36.39	34.12	30.68
Wt. of container + Oven dry soil ©	(gm)	28.93	31.04	32.98	31.21	31.47	27.96
Wt. of Water (b-c)=d	(gm)	3.96	4.41	4.88	5.18	2.65	2.72
Wt. of dry soil (c-a)=e	(gm)	16.10	16.78	17.11	17.15	16.30	15.60
Moisture Percent = d/e x 100	%	24.60	26.28	28.52	30.20	16.26	17.44

LL : 27.50 % **PL: 16.85%** **PI:10.66%**

MOISTURE DENSITY RELATIONSHIP (IS 2720 PART- 7 & 8)

Source : Soil — Date of Sampled : 04/10/22

Location : 139+400 — Date of Tested : 11/10/22

Description of Material :

Type of Compaction : Dynamic — No. of Blows : 25

Type of Method : Standard / Modified — No. of Layers : 5

Wt. of Rammer : 4.89 Kg — Wt. of Original Sample : 3000 gms

S.no	Description	Unit	1	2	3	4	5	6
1	Volume of mould (V)	(cc)	1000	1000	1000	1000	1000	
2	Weight of mould (a)	(gm)	4193	4193	4193	4193	4193	
3	Weight of mould + Wet soil (b)	(gm)	6018	6115	6247	6238	6176	
4	Weight of Wet soil (b-a)=c	(gm)	1825	1922	2054	2045	1983	
5	Wet Density = c/v	(gm/cc)	1.825	1.922	2.054	2.045	1.983	
			Moisture Content Determination					
S.no	Container No.	-	B-24	B-23	B-25	B-26	B-27	
1	Weight of container (1)	(gm)	38.42	37.92	41.33	45.94	47.38	
2	Weight of container + wet soil (2)	(gm)	158.85	151.39	156.90	166.89	168.63	
3	Weight of container + Dry soil (3)	(gm)	151.50	142.29	145.55	153.47	153.48	
4	Weight of water (2-3)=4	(gm)	7.35	9.10	11.35	13.42	15.15	
5	Weight of Dry soil (3-1)=5	(gm)	113.08	104.37	104.22	107.53	106.10	
6	Water Content (4/5x100)	%	6.50	8.72	10.89	12.48	14.28	
7	Dry density	(gm/cc)	1.714	1.768	1.852	1.818	1.735	

RESULTS

MDD (gm/cc) : 1.852

OMC (%) : 10.90

CALIFORNIA BEARING RATIO (CBR) TEST SOAKED (IS : 2720 PART-16/ASTM-1883-99)

Sample Location : 139+400

Source of Materials : Soil

Description of Sample :

Date of Sampled : 04/10/22

Date of Soaking : 17/10/22

Date of Testing : 21/10/22

Observation Sheet

Type of Compaction : Dynamic

Surcharge Weight (gm)

Weight of Original Sample : 6000 gm

Soaking : 96 Hours

MDD : 1.852 gm/cc

OMC : 10.90%

California Bearing Ratio IS : 2720 (Part -16)

Description		Before Soaking			After Soaking		
		10 Blows	30 Blows	65 Blows	10 Blows	30 Blows	65 Blows
Mould No.		25	26	27	25	26	27
Volume of the mould (V)	(cc)	2250	2250	2250	2250	2250	2250
Wt. of mould (m_1)	(gm)	6934	6832	6642	6934	6882	6642
Wt. of mould + Compacted soil (w_2)	(gm)	11144	11258	11205	11187	11330	11268
Wt. of compacted soil ($W_3 = W_2-W_1$)	(gm)	4210	4426	4563	4253	4448	4626
Wet Density of Soil (D_w) = W3/V	(gm/cc)	1.871	1.967	2.028	1.890	1.977	2.055
		Water Container Data					
Container No.		B-42	B-43	B-44	B-46	B-47	B-48
Wt. of container	(gm)	46.46	42.77	47.27	45.47	45.54	46.66
Wt. of container + wet soil	(gm)	224.04	225.12	227.02	221.22	223.76	220.72
Wt. of container + Oven dry soil	(gm)	206.24	207.02	209.28	201.07	204.41	201.27
Wt. of water	(gm)	17.80	18.10	17.74	20.15	19.35	19.45
Wt. of Oven dry soil	(gm)	159.78	164.25	162.01	155.60	158.87	154.61
Water Content	(%)	11.14	11.02	10.95	12.95	12.18	12.58
Dry density of Soil (D_d)=100xDw/(100+w)	(gms/cc)	1.683	1.772	1.828	1.673	1.762	1.826
% of MDD :		90.87	95.68	98.70	90.33	95.14	98.60

CALIFORNIA BEARING RATIO (CBR) TEST SOAKED (IS : 2720 PART-16/ASTM-1883-99)

Source Description :Soil 139+400 — Providing Ring Constant (Kg/Div): 4.31

Proving Ring No : 01842 — Penetration Rate :1.25/min

Sl. No	Penetration (mm)	Mould No.		Mould No.		Mould No.	
		Proving ring Reading (Div)	Load (Kgs)	Proving ring Reading (Div)	Load (Kgs)	Proving ring Reading (Div)	Load (Kgs)
1	0.5	5	21.55	6	25.86	9	38.79
2	1.0	8	34.48	12	51.72	16	68.96
3	1.5	13	56.03	17	73.27	24	103.44
4	2.0	17	73.27	22	94.82	33	142.23
5	2.5	23	99.13	27	116.37	42	181.02
6	3.0	28	120.68	32	137.92	51	219.81
7	4.0	38	163.78	46	198.26	70	301.70
8	5.0	47	202.57	59	254.29	87	374.97
9	7.5	66	284.46	78	336.18	112	482.72
10	10.0	86	370.66	97	418.07	136	586.16
11	12.5	103	443.93	115	495.65	157	676.67
CBR of specimen at 2.5 mm (standard 1370 kg) by graph		7.24		8.49		13.21	
CBR of specimen at 5.5 mm (standard 2055 kg) by graph		9.86		12.37		18.25	
CBR Value of Sample		**@ 5.00 mm CBR Value = 16.35%**					

FREE SWELL INDEX OF SOIL (IS : 2720 PART 40) 1977

Sample Location : 146+160 Date Sampling : 04/10/22

Source of Materials : Soil Date of Testing : 10/10/22

Description of Sample :

Observation Sheet

Determination No		1	2
1	Mass of Dry Soil Passing 425 µ Sieve (gm)	10.00	10.00
2	Volume in Water 24 hrs swell (Vd) (cc)	14.00	13.50
3	Volume in Kerosene after 24 hrs (Vk) (cc)	11.50	11.00
4	Free Swell Index [(Vd-Vk)/Vk]x100 (%)	21.74	22.73
5	Average (%)	22.24%	

GRAIN SIZE ANALYSIS OF SOIL(AS PER IS :2720, PART-4)

Sample Location : 146+160	Date of Sampled : 04/10/22
Source of Materials : Soil	Date of Soaking : 10/10/22
Description of Sample :	Date of Testing : 11/10/22
Method of Sieving : Wet/Dry	Weight of Sample(gm) : 1000

Sieve size	Weight Retained (gms)	Weight Retained (%).	Cumulative weight Retained (%).	Passing (%)	Remarks
100 mm	0	0	0	100	
75 mm	0	0	0	100	Gravel
19 mm	0	0	0	100	
4.75 mm	220	22.00	22.00	78.00	
2 mm	105.5	10.55	32.55	60.45	Sand
425 mic.	69.5	6.95	39.50	60.50	
75 mic.	46.0	4.60	44.10	55.90	
Pan					Silt & Clay

Gravel 22.00 (%) Sand Content 22.10(%)

Silt/Clay Content 55.90(%)

ATTERBERG'S LIMIT (As per IS 2720, Part - 5) BY CASA GRAND METHOD

Source : Soil

Date of Sampled : 06/10/22

Sample Location : 146+160

Date of Tested : 11/10/22

Description of Material :

Description		LIQUID LIMIT				PLASTIC LIMITS	
Trial No.		1	2	3	4		
Container No.		A17	A18	A19	A20	A21	A22
No.Of Blows		33	27	22	17	-	-
Empty weight container (a)	(gm)	14.71	11.89	14.07	14.01	13.57	14.69
Wt. of container + wet soil (b)	(gm)	36.24	35.30	37.74	38.18	33.11	32.82
Wt. of container + Oven dry soil ©	(gm)	32.40	30.83	32.96	33.00	30.66	30.69
Wt. of Water (b-c)=d	(gm)	3.84	4.47	4.78	5.18	2.45	2.21
Wt. of dry soil (c-a)=e	(gm)	17.69	18.94	18.89	18.99	17.09	15.92
Moisture Percent = d/e x 100	%	21.71	23.60	25.30	27.28	14.34	13.88

LL : 24.50% **PL: 14.11%** **PI:10.39%**

MOISTURE DENSITY RELATIONSHIP (IS 2720 PART- 7 & 8)

Source : Soil

Date of Sampled : 06/10/22

Sample Location : 146+160

Date of Tested : 11/10/22

Description of Material :

Type of Compaction : Dynamic

No. of Blows : 25

Type of Method : Standard / Modified

No. of Layers : 5

Wt. of Rammer : 4.89 Kg

Wt. of Original Sample : 3000 gms

S.no	Description	Unit	1	2	3	4	5	6
1	Volume of mould (V)	(cc)	1000	1000	1000	1000	1000	
2	Weight of mould (a)	(gm)	4193	4193	4193	4193	4193	
3	Weight of mould + Wet soil (b)	(gm)	6040	6114	6221	6215	6165	
4	Weight of Wet soil (b-a)=c	(gm)	1847	1921	2028	2022	1972	
5	Wet Density = c/v	(gm/cc)	1.847	1.921	2.028	2.022	1.972	
			Moisture Content Determination					
S.no	**Container No.**	-	B-28	B-32	B-30	B-34	B-38	
1	Weight of container (1)	(gm)	45.15	37.73	48.15	45.30	46.16	
2	Weight of container + wet soil (2)	(gm)	186.33	173.77	180.99	175.84	174.62	
3	Weight of container + Dry soil (3)	(gm)	176.48	162.07	167.61	160.74	157.66	
4	Weight of water (2-3)=4	(gm)	9.85	11.70	13.38	15.10	16.96	
5	Weight of Dry soil (3-1)=5	(gm)	131.33	124.34	119.46	115.44	111.50	
6	Water Content (4/5x100)	%	7.50	9.41	11.20	13.08	15.21	
7	Dry density	(gm/cc)	1.718	1.756	1.824	1.788	1.712	

RESULTS

MDD (gm/cc) : 1.824

OMC (%) : 11.30

CALIFORNIA BEARING RATIO (CBR) TEST SOAKED (IS : 2720 PART-16/ASTM-1883-99)

Sample Location : 146+160

Source of Materials : Soil

Description of Sample :-

Date of Sampled : 04/10/22

Date of Soaking : 16/10/23

Date of Testing : 20/10/22

Observation Sheet

Type of Compaction : Dynamic

Surcharge Weight (gm)

Weight of Original Sample : 6000 gm

Soaking : 96 Hours

MDD : 1.864 gm/cc

OMC : 11.30%

California Bearing Ratio IS : 2720 (Part -16)

Description	Before Soaking			After Soaking		
	10 Blows	30 Blows	65 Blows	10 Blows	30 Blows	65 Blows
Mould No.	37	38	39	37	38	39
Volume of the mould (V) (cc)	2250	2250	2250	2250	2250	2250
Wt. of mould (m_1) (gm)	7198	7134	6840	7198	7134	6840
Wt. of mould + Compacted soil (w_2) (gm)	11334	11513	11349	11399	11562	11426
Wt. of compacted soil ($W_3 = W_2-W_1$) (gm)	4136	4379	4509	4201	4428	4586
Wet Density of Soil (D_w) = W3/V (gm/cc)	1.838	1.946	2.004	1.867	1.968	2.038
	Water Container Data					
Container No.	B-21	B-22	B-23	B-43	B-44	B-45
Wt. of container (gm)	47.39	42.94	37.97	42.72	47.21	46.79
Wt. of container + wet soil (gm)	208.13	211.42	213.08	199.64	206.07	209.48
Wt. of container + Oven dry soil (gm)	191.50	194.22	195.33	180.66	187.59	190.23
Wt. of water (gm)	16.63	17.20	17.75	18.98	18.48	19.25
Wt. of Oven dry soil (gm)	144.11	151.28	157.36	137.94	140.38	143.44
Water Content (%)	11.54	11.37	11.28	13.76	13.16	13.42
Dry density of Soil (D_d)=100xDw/(100+w) (gms/cc)	1.648	1.747	1.801	1.641	1.739	1.797
% of MDD :	90.35	95.78	98.74	89.97	95.34	98.32

CALIFORNIA BEARING RATIO (CBR) TEST SOAKED (IS : 2720 PART-16/ASTM-1883-99)

Source Description :Soil (152+200 LHS)
Proving Ring No : 01842

Providing Ring Constant (Kg/Div): 4.31
Penetration Rate :1.25/min

Sl. No	Penetration (mm)	Mould No.		Mould No.		Mould No.	
		Proving ring Reading (Div)	Load (Kgs)	Proving ring Reading (Div)	Load (Kgs)	Proving ring Reading (Div)	Load (Kgs)
1	0.5	4	17.24	5	21.55	6	25.86
2	1.0	8	34.48	9	38.79	12	51.72
3	1.5	13	26.03	14	60.34	18	77.58
4	2.0	18	77.58	19	81.89	24	103.44
5	2.5	23	99.13	24	103.44	28	120.68
6	3.0	28	120.68	30	129.30	33	142.23
7	4.0	34	146.54	37	159.47	45	193.95
8	5.0	40	172.40	44	189.64	53	228.43
9	7.5	49	211.19	54	232.74	67	288.77
10	10.0	58	249.98	65	280.15	79	340.49
11	12.5	68	293.08	75	323.25	92	396.52
CBR of specimen at 2.5 mm (standard 1370 kg) by graph		7.24		7.55		8.81	
CBR of specimen at 5.5 mm (standard 2055 kg) by graph		8.39		9.23		11.12	
CBR Value of Sample		@ 5.00 mm CBR Value = 10.25 %					

FREE SWELL INDEX OF SOIL (IS : 2720 PART 40) 1977

Sample Location : 152+200 RHS
Source of Materials : Soil
Description of Sample :

Date Sampling : 04/10/22
Date of Testing : 10/10/22

Observation Sheet

Determination No		1	2
1	Mass of Dry Soil Passing 425 µ Sieve (gm)	10.00	10.00
2	Volume in Water 24 hrs swell (Vd) (cc)	18.50	13.00
3	Volume in Kerosene after 24 hrs (Vk) (cc)	11.00	11.00
4	Free Swell Index [(Vd-Vk)/Vk]x100 (%)	22.73	18.18
5	Average (%)	20.46%	

GRAIN SIZE ANALYSIS OF SOIL(AS PER IS :2720, PART-4)

Sample Location : 152+200 RHS
Source of Materials : Soil
Description of Sample :
Method of Sieving : Wet/Dry

Date of Sampled : 04/10/22
Date of Soaking : 09/10/22
Date of Testing : 10/10/22
Weight of Sample(gm) : 1000

Sieve size	Weight Retained (gms)	Weight Retained (%).	Cumulative weight Retained (%).	Passing (%)	Remarks
100 mm	0	0	0	100	
75 mm	0	0	0	100	Gravel
19 mm	0	0	0	100	
4.75 mm	301.5	30.15	30.15	69.85	
2 mm	165.5	16.55	46.70	53.30	Sand
425 mic.	88.0	8.80	55.50	44.50	
75 mic.	46.0	4.60	60.10	39.90	
Pan					Silt & Clay

Gravel 30.15 (%) Sand Content 29.95 (%)
Silt/Clay Content 39.90(%)

ATTERBERG'S LIMIT (As per IS 2720, Part - 5) BY CASA GRAND METHOD

Source : Soil

Location : 152+200 RHS

Description of Material :

Date of Sampled : 06/10/22

Date of Tested : 10/10/22

Description		LIQUID LIMIT				PLASTIC LIMITS	
Trial No.		1	2	3	4	1	2
Container No.		A3	A4	A5	A6	A7	A8
No.Of Blows		34	28	22	18	-	-
Empty weight container (a)	(gm)	14.81	14.34	14.78	13.81	13.18	14.52
Wt. of container + wet soil (b)	(gm)	31.88	32.01	33.16	32.46	33.34	35.67
Wt. of container + Oven dry soil ©	(gm)	28.62	28.43	29.24	28.28	30.22	32.35
Wt. of Water (b-c)=d	(gm)	3.26	3.52	3.92	4.18	3.12	3.32
Wt. of dry soil (c-a)=e	(gm)	13.81	14.09	14.46	14.47	17.04	17.83
Moisture Percent = d/e x 100	%	23.61	25.41	27.11	28.89	18.31	18.62
					Average PL = 18.47%		

LL : 26.60 % **PL: 18.47%** **PI: 8.13%**

MOISTURE DENSITY RELATIONSHIP (IS 2720 PART- 7 & 8)

Source : Soil

Location : 152+200 RHS

Description of Material :

Date of Sampled : 06/10/22

Date of Tested : 10/10/22

Type of Compaction : Dynamic

Type of Method : Standard / Modified

Wt. of Rammer :

No. of Blows : 25

No. of Layers : 5

Wt. of Original Sample : 3000 gms

S.no	Description	Unit	1	2	3	4	5	6
1	Volume of mould (V)	(cc)	1000	1000	1000	1000	1000	
2	Weight of mould (a)	(gm)	4193	4193	4193	4193	4193	
3	Weight of mould + Wet soil (b)	(gm)	6185	6268	6337	6326	6321	
4	Weight of Wet soil (b-a)=c	(gm)	1992	2075	2144	2133	2128	
5	Wet Density = c/v	(gm/cc)	1.992	2.075	2.144	2.133	2.128	
			Moisture Content Determination					
S.no	Container No.	-	B-22	B-23	B-24	B-25	B-26	
1	Weight of container (1)	(gm)	42.93	37.99	38.44	41.34	45.85	
2	Weight of container + wet soil (2)	(gm)	203.67	182.78	180.90	183.34	183.60	
3	Weight of container + Dry soil (3)	(gm)	193.69	171.13	167.48	167.99	166.45	
4	Weight of water (2-3)=4	(gm)	9.98	11.65	13.42	15.35	17.15	
5	Weight of Dry soil (3-1)=5	(gm)	150.76	133.14	129.04	126.65	120.60	
6	Water Content (4/5x100)	%	6.62	8.75	10.40	12.12	14.22	
7	Dry density	(gm/cc)	1.868	1.908	1.942	1.902	1.863	

RESULTS

MDD (gm/cc) : 1.942

OMC (%) : 10.45

CALIFORNIA BEARING RATIO (CBR) TEST SOAKED (IS : 2720 PART-16/ASTM-1883-99)

Sample Location 152+200 RHS

Source of Materials : Soil

Description of Sample :

Date of Sampled : 04/10/22

Date of Soaking : 17/10/23

Date of Testing : 21/10/22

Observation Sheet

Type of Compaction : Dynamic

Surcharge Weight (gm)

Weight of Original Sample : 6000 gm

Soaking : 96 Hours

MDD : 1.942 gm/cc

OMC : 10.45%

California Bearing Ratio IS : 2720 (Part -16)

Description		Before Soaking			After Soaking		
		10 Blows	30 Blows	65 Blows	10 Blows	30 Blows	65 Blows
Mould No.		43	44	45	43	44	45
Volume of the mould (V)	(cc)	2250	2250	2250	2250	2250	2250
Wt. of mould (m_1)	(gm)	7009	7037	7026	7009	7037	7026
Wt. of mould + Compacted soil (w_2)	(gm)	11430	11690	11834	11444	11751	11864
Wt. of compacted soil ($W_3 = W_2-W_1$)	(gm)	4421	4653	4808	4435	7414	4838
Wet Density of Soil (D_w) = W3/V	(gm/cc)	1.965	2.068	2.137	1.971	2.095	2.150
		Water Container Data					
Container No.		B-25	B-26	B-27	B-40	B-41	B-42
Wt. of container	(gm)	41.36	45.96	47.40	41.36	45.97	47.39
Wt. of container + wet soil	(gm)	203.30	215.50	223.02	237.32	236.06	217.76
Wt. of container + Oven dry soil	(gm)	187.74	199.32	206.36	195.96	215.24	198.83
Wt. of water	(gm)	15.56	16.18	16.66	19.65	20.82	18.93
Wt. of Oven dry soil	(gm)	146.38	153.36	158.96	154.60	169.27	151.44
Water Content	(%)	10.63	10.55	10.48	12.71	12.30	12.50
Dry density of Soil (D_d)=100xDw/(100+w)	(gms/cc)	1.776	1.871	1.934	1.749	1.866	1.911
% of MDD :		91.45	96.34	99.59	90.06	96.09	98.40

CALIFORNIA BEARING RATIO (CBR) TEST SOAKED (IS : 2720 PART-16/ASTM-1883-99)

Source Description :Soil (158+600 RHS) Providing Ring Constant (Kg/Div): 4.31

Proving Ring No : 01842 Penetration Rate :1.25/min

Sl. No	Penetration (mm)	Mould No.		Mould No.		Mould No.	
		Proving ring Reading (Div)	Load (Kgs)	Proving ring Reading (Div)	Load (Kgs)	Proving ring Reading (Div)	Load (Kgs)
1	0.5	3	12.93	4	17.24	6	25.86
2	1.0	7	30.17	8	34.48	12	51.72
3	1.5	11	47.41	11	47.41	17	73.27
4	2.0	13	56.03	14	60.34	24	103.44
5	2.5	16	68.96	18	77.58	30	129.30
6	3.0	20	86.20	22	94.82	36	155.16
7	4.0	25	107.75	27	116.37	50	215.5
8	5.0	30	129.30	34	146.54	62	267.22
9	7.5	30	159.47	45	193.95	82	353.42
10	10.0	44	189.64	56	241.36	102	383.59
11	12.5	52	224.12	68	293.08	118	508.58
CBR of specimen at 2.5 mm (standard 1370 kg) by graph		5.03		5.66		9.44	
CBR of specimen at 5.5 mm (standard 2055 kg) by graph		6.29		7.13		13.00	
CBR Value of Sample		@ 5.00 mm CBR Value = 10.10					

FREE SWELL INDEX OF SOIL (IS : 2720 PART 40) 1977

Sample Location : 158+600 LHS — Date Sampling : 04/10/22

Source of Materials : Soil — Date of Testing : 08/10/22

Description of Sample :

Observation Sheet

	Determination No	1	2
1	Mass of Dry Soil Passing 425 µ Sieve (gm)	10.00	10.00
2	Volume in Water 24 hrs swell (Vd) (cc)	13.90	13.50
3	Volume in Kerosene after 24 hrs (Vk) (cc)	10.50	11.00
4	Free Swell Index [(Vd-Vk)/Vk]x100 (%)	23.81	22.73
5	Average (%)	23.27%	

GRAIN SIZE ANALYSIS OF SOIL(AS PER IS :2720, PART-4)

Sample Location : 158+600 LHS	Date of Sampled : 04/10/22
Source of Materials : Soil	Date of Soaking : 09/10/22
Description of Sample :	Date of Testing : 10/10/22
Method of Sieving : Wet/Dry	Weight of Sample(gm) : 1000

Sieve size	Weight Retained (gms)	Weight Retained (%).	Cumulative weight Retained (%).	Passing (%)	Remarks
100 mm	0	0	0	100	
75 mm	0	0	0	100	Gravel
19 mm	0	0	0	100	
4.75 mm	197.5	19.75	19.75	80.58	
2 mm	169.5	16.95	36.70	63.30	Sand
425 mic.	134.0	13.40	50.10	49.90	
75 mic.	74.5	7.45	57.55	42.45	
Pan					Silt & Clay
Gravel	**19.75 (%)**	**Sand Content**	**37.80 (%)**		
Silt/Clay Content	**42.45(%)**				

ATTERBERG'S LIMIT (As per IS 2720, Part - 5) BY CASA GRAND METHOD

Source : Soil

Date of Sampled : 06/10/22

Location : 158+600 LHS

Date of Tested : 10/10/22

Description of Material :

Description		LIQUID LIMIT				PLASTIC LIMITS	
Trial No.		1	2	3	4	1	2
Container No.		A10	A11	A12	A13	A14	A15
No.Of Blows		33	27	22	16	-	-
Empty weight container (a)	(gm)	13.70	14.30	12.93	14.50	13.72	12.95
Wt. of container + wet soil (b)	(gm)	31.17	32.81	32.20	33.99	32.17	31.65
Wt. of container + Oven dry soil ©	(gm)	27.71	28.93	27.96	29.46	29.25	28.57
Wt. of Water (b-c)=d	(gm)	3.46	3.88	4.24	4.53	2.92	3.08
Wt. of dry soil (c-a)=e	(gm)	14.01	14.63	15.03	14.96	15.53	15.62
Moisture Percent = d/e x 100	%	24.70	26.50	28.21	30.28	18.80	19.72
						Average PL = 19.26 %	

LL : 27.30 % **PL: 19.26%** **PI:8.04%**

MOISTURE DENSITY RELATIONSHIP (IS 2720 PART- 7 & 8)

Source : Soil
Location : 158+600 LHS
Description of Material :

Date of Sampled : 06/10/22
Date of Tested : 10/10/22

Type of Compaction : Dynamic
Type of Method : Standard / Modified
Wt. of Rammer : 4.89 Kg

No. of Blows : 25
No. of Layers : 5
Wt. of Original Sample : 3000 gms

S.no	Description	Unit	1	2	3	4	5	6
1	Volume of mould (V)	(cc)	1000	1000	1000	1000	-	
2	Weight of mould (a)	(gm)	4193	4193	4193	4193	-	
3	Weight of mould + Wet soil (b)	(gm)	6272	6344	6409	6403	-	
4	Weight of Wet soil (b-a)=c	(gm)	2079	2151	2216	2210	-	
5	Wet Density = c/v	(gm/cc)	2.079	2.151	2.216	2.210	-	
			Moisture Content Determination					
S.no	Container No.	-	B-14	B-21	B-27	B-28	-	
1	Weight of container (1)	(gm)	48.37	47.31	47.37	45.17	-	
2	Weight of container + wet soil (2)	(gm)	184.50	180.70	178.99	170.27	-	
3	Weight of container + Dry soil (3)	(gm)	174.65	169.25	165.84	155.22	-	
4	Weight of water (2-3)=4	(gm)	9.85	11.45	13.15	15.05	-	
5	Weight of Dry soil (3-1)=5	(gm)	126.28	121.94	118.47	110.05	-	
6	Water Content (4/5x100)	%	7.80	9.39	11.10	13.68	-	
7	Dry density	(gm/cc)	1.929	1.966	1.995	1.944	-	

RESULTS

MDD (gm/cc) : 1.995

OMC (%) : 11.20

CALIFORNIA BEARING RATIO (CBR) TEST SOAKED (IS : 2720 PART-16/ASTM-1883-99)

Sample Location : 158+600 LHS

Source of Materials : Soil

Description of Sample :

Date of Sampled : 04/10/22

Date of Soaking : 17/10/23

Date of Testing : 21/10/22

Observation Sheet

Type of Compaction : Dynamic

Surcharge Weight (gm)

Weight of Original Sample : 6000 gm

Soaking : 96 Hours

MDD : 1.995 gm/cc

OMC : 11.20%

California Bearing Ratio IS : 2720 (Part -16)

Description		Before Soaking			After Soaking		
		10 Blows	30 Blows	65 Blows	10 Blows	30 Blows	65 Blows
Mould No.		46	47	48	46	47	48
Volume of the mould (V)	(cc)	2250	2250	2250	2250	2250	2250
Wt. of mould (m_1)	(gm)	7066	6639	7186	7066	6639	7186
Wt. of mould + Compacted soil (w_2)	(gm)	11665	11477	12240	11715	11540	12307
Wt. of compacted soil ($W_3 = W_2-W_1$)	(gm)	4599	4838	5054	4649	4901	5121
Wet Density of Soil (D_w) = W3/V	(gm/cc)	2.044	2.150	2.246	2.066	2.178	2.276
		Water Container Data					
Container No.		B-28	B-29	B-30	B-10	B-11	B-12
Wt. of container	(gm)	45.20	38.11	44.81	38.09	38.27	40.35
Wt. of container + wet soil	(gm)	202.46	189.78	198.65	196.26	211.88	204.16
Wt. of container + Oven dry soil	(gm)	186.38	174.43	183.18	176.41	190.68	183.98
Wt. of water	(gm)	16.28	15.35	15.47	19.85	21.20	20.18
Wt. of Oven dry soil	(gm)	141.18	136.32	138.37	138.32	152.41	143.63
Water Content	(%)	11.39	11.26	11.18	14.35	13.91	14.05
Dry density of Soil (D_d)=100xDw/(100+w)	(gms/cc)	1.835	1.932	2.020	1.807	1.912	1.996
% of MDD :		91.98	96.84	101.25	90.58	95.84	100.05