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(MINISTRY OF ROAD TRANSPORT & HIGHWAYS, GOVT. OF INDIA)
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Consultancy Services for Feasibility Study, Preparation of Detailed Project Report and providing pre-construction services for 2-lane with Paved Shoulder of NH configuration for Baramulla-Gulmarg Road in the state of Jammu & Kashmir.



DRAFT DETAILED PROJECT REPORT

VOLUME-III: MATERIAL REPORT

June 2020

Rodic Consultants Pvt. Ltd. In JV with
Monarch Surveyors and Engineering Consultants Pvt. Ltd.



Introduction

CHAPTER – 1

INTRODUCTION

1.1 The Project Road

Project road section falls in the Baramulla District of Jammu and Kashmir. The Project Road starts from junction of Baramulla - Srinagar Road (NH-1) at 34.205061°N and 74.347682°E passing through Kathiyawali, Chandosa, Kalantra, Numbalnaar, Chontipathri, Babareshi and ends at Gulmarg in the district of Baramulla.

The project road traverses through Mountainous & Hilly terrain and is new alignment. The soil in the district is generally loose and sandy with very low moisture. The rate of soil erosion is very high and roads blockage is frequent during the rainy season.

The Index Map showing the stretch, described above as a part of Project Road, is presented in Fig. 1.1.



Fig- 1.1- Location Map of the Project

1.2 Objective of Consultancy Services

The main objective of the consultancy service is to establish the technical, economical, and financial viability of the project and prepare detailed project reports for rehabilitation and upgrading of the existing road to 2 lane with paved shoulder configuration. The viability of the project shall be established taking into account the requirements with regard to rehabilitation, upgrading and improvement based on highway design, pavement design, provision of service roads wherever necessary, type of intersections, rehabilitation and widening of existing and/or construction of

new bridges and structures, road safety features, quantities of various items of works and cost estimates and economic analysis within the given time frame. The Detailed Project Report (DPR) would inter-alia include detailed highway design, design of pavement and overlay with options for flexible or rigid pavements, design of bridges and cross drainage structures and grade separated structures, design of service roads, quantities of various items, detailed working drawings, detailed cost estimates, economic and financial Viability analyses, environmental and social feasibility, social and environmental action plans as appropriate and documents required for tendering the project on commercial basis for international / local competitive bidding.

1.3 Highway Scope of Services

A comprehensive study covers pavement material investigation including investigation on sources of available construction materials near the Project Road.

The report describes material investigation programme conducted by the Consultant, which inter-alia consisted of field investigations, sampling and testing of materials, evaluation of their suitability and availability.

- The work includes collection of the representative samples of construction materials along the Project Road and testing them in laboratory for characterisation of their quality.
- Evaluation of suitability and also the availability for use in construction works.
- Assessment of lead of the quarry locations and quantum of materials available at each location.

These objectives may well be treated as complimentary to each other, since the understanding gained on the behaviour of the materials of existing roads should be of help in selecting materials for new construction and assessing their future performance while the road is in service.

Test results of material are presented in separate tables for existing subgrade, natural ground to accommodate additional lanes, new alignment subgrades, borrow soils, sand and aggregates. Recommendations are made with regard to material parameters for design of pavement as also availability and suitability of the various natural materials for construction purposes.

1.4 Approach to Material Survey

The materials survey started with a study of the geological maps, data and quarry charts available for this purpose. This was followed by a reconnaissance survey of the Project Road.

The Project Road was inspected to ascertain the type, quality, availability, ease of extraction, lead and other related information. Local enquiries, particularly with local road contractors were also made for additional information. Based on detailed survey & investigations and also as per the interaction with the officers, the representative samples from prospective borrow & quarry areas were collected and tested in the laboratory for engineering characteristics. The laboratory test results were then

evaluated for developing recommendations on suitability of the materials for various purposes.

Based on detailed survey and investigations and as per the interaction with the officers, the representative samples of borrow area soil, coarse aggregates, fine aggregates and bricks were collected from the locations mentioned in the Chapter-3 of this report.

1.5 Structure of this Report

The Material Report has been divided into number of chapters to provide details and results of the studies carried out by the Consultant in a logical manner. The chapters are as under:

Chapter – 1: Introduction

Brief description of the project & scope of work for material survey has been dealt in this chapter

Chapter – 2: Preliminary Studies

This provides information on the broad physical set-up of the project and the preliminary desk studies carried out.

Chapter - 3: Investigations along Road Alignment

This describes the investigations carried out along the proposed road alignment and provides the results of tests including evaluation thereof.

Chapter – 4: Investigation of Borrow Areas for Embankment and Sub-grade

This provides details of the soil and material survey carried out for identifying and evaluating the various material sources for extracting soil and other natural materials for use in embankment and sub-grade.

Chapter – 5: Quarry Materials for Construction

This deals with investigations carried out for identifying suitable quarries for rock material and sand.

Chapter – 6: Manufactured Materials

This chapter identified the probable sources for procuring manufactured materials like steel, cement and bitumen.

Chapter – 7: Other Construction Materials

Other construction materials like water, expansion joint, Bearings, Prestressing System, high tensile strands, etc. are dealt with in this Chapter.

Preliminary Survey

CHAPTER-2

PRELIMINARY STUDY

2.1 General

This chapter of the report covers general geology, topography and landscape characteristics of the Project Road area, based on desk study.

2.2 Landscape Characteristics & Physiography

Jammu & Kashmir

The union territory of Jammu and Kashmir covers an area of 42,241 sq.km. Jammu and Kashmir is home to several valleys such as the Kashmir Valley, Tawi Valley, Chenab Valley, Poonch Valley, Sind Valley and Lidder Valley. The Kashmir valley is 100 km² (62 mi) wide and 15,520.3 km² (5,992.4 sq. mi) in area. The Himalayas divide the Kashmir valley from the Tibetan plateau while the Pir Panjal range, which encloses the valley from the west and the south, separates it from the Great Plains of northern India. Along the northeastern flank of the Valley runs the main range of the Himalayas. This valley has an average height of 1,850 metres (6,070 ft) above sea-level, but the surrounding Pir Panjal range has an average elevation of 10,000 feet (3,000 m). The union territory occupies a total area of 42,241 square kilometres and borders with the states of Himachal Pradesh and Punjab in the south and union territory of Ladakh in the east. The Line of Control separates it from the Pakistan occupied regions of Kashmir.

The union territory comprises of 20 districts with two divisions, Jammu and Kashmir, offering a rich diversity of landscapes. The total population of the union territory is 12,258,433 (Census 2011). The recorded forest area of the state is about 20,194 sq.km.

The topography of the union territory is such that low-lying valleys are surrounded by high mountain ranges of the Himalayas. Of all the valleys, the most important one, the Kashmir valley lies between the coordinates 33° 20' to 34° 54' North latitude and 73° 55' to 75° 35' East longitude. It is situated in the lap of the Western Himalayas and decorated by snow-covered, silver headed mountains, magical lakes, green grasslands and has enjoyed the reputation of being home of herbal medicines. The valley is on an average height of 1,700m above the sea level and is encompassed by mighty Himalayan ranges occupying an area of 15,948 sq. km.

There are two parallel belts widely apart from Forest and Hill soils, one stretching from Poonch to Kathua in Jammu province and second North West of Jhelum valley in Kashmir province.

Some of the important passes of the region are Zojial on the Great Himalayas, Banihal on the Pir Panjal and Photula on the Zaskar.

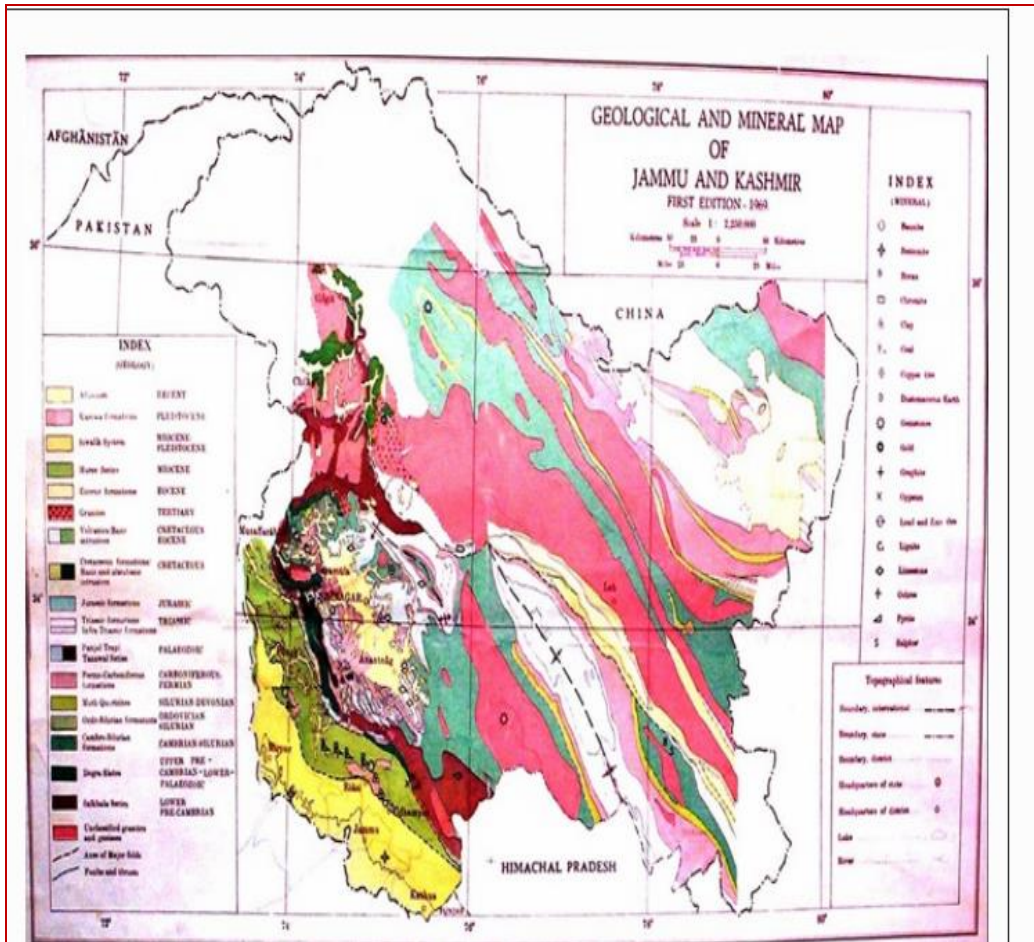


Fig 2.1

2.3 Terrain, Soil Type and Geology

Terrain

The entire stretch of Project Road lies predominantly on mountainous and hilly terrain.

Soil Type

The formation soil type along all the stretches of the Project Road is Silty Clay Loam, Sandy Loam and Silty Loam.

Geology

Geology of Jammu & Kashmir

The Kashmir valley comprises of sedimentary, metamorphic and igneous rocks ranging in age from Salkhala (Precombrian) to Recent.

Outer Hill Division covering Jammu, comprises of Siwaliks, Murrees and Dogra Slates types of Geological Formations.

Mineral Bearing Area:

Area of State : 222236 Sq kms

Mountainous Area : 133346 Sq kms

Mineral bearing Area : 13334 Sq kms

Viability of the deposit : 60% of the deposits are commercially viable for Mining

There is a wide scope of Mineral Resources in J&K State. The important minerals are Limestone, Gypsum, Dolomite, Quartzite besides building stones like, Slate, Marble, Granite etc.

Seismic Characteristics:

India has most tectonically active as well as most stable landmasses. The present location falls into zone IV according to the probability of the earthquake occurrence. Zone 1, 2 are the least active and zone 3, 4, 5 are the most active.

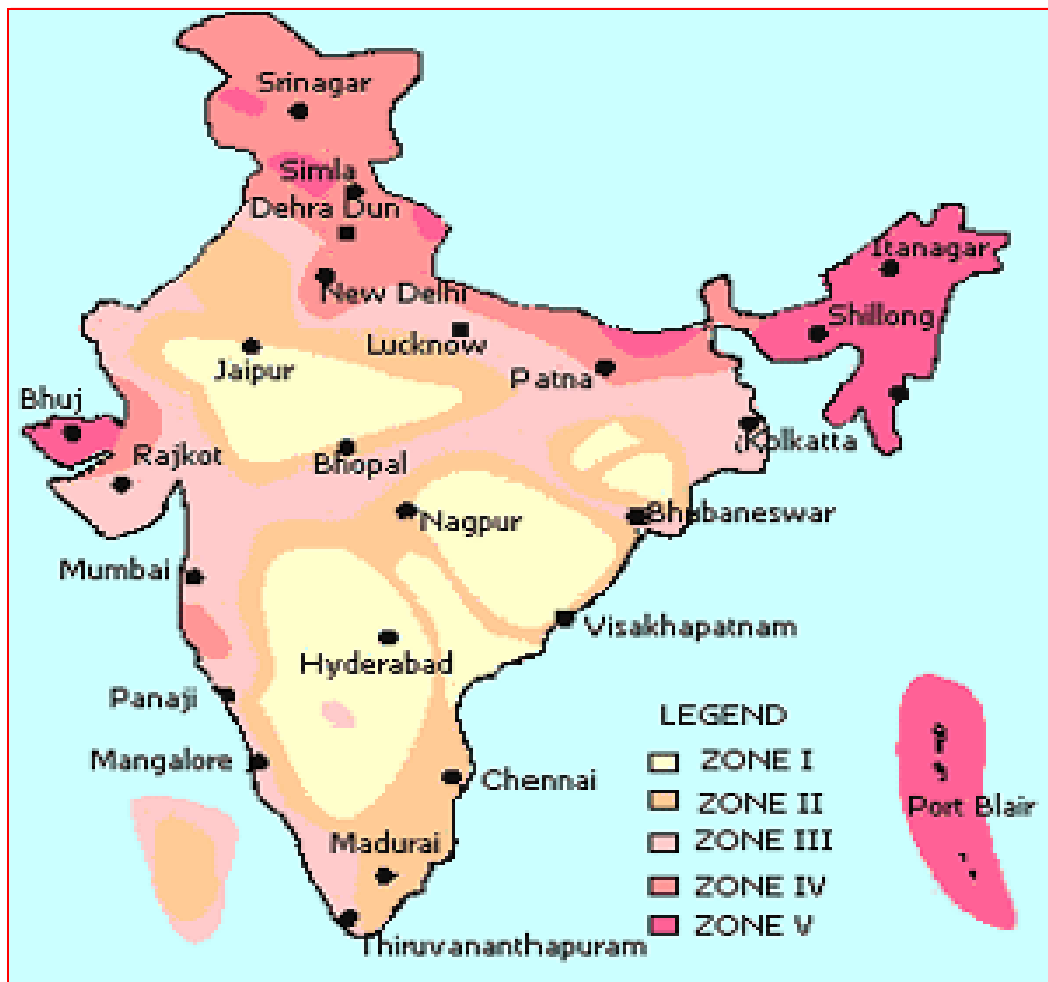


Figure 2.2

2.4 Climate

Jammu is a sub-tropical region. The climate varies in different parts of the division. The southern plains experience a climate similar to Punjab. The summers are hot with rainy seasons. Winters are cool. The mountains regions experience weather similar to that of Kashmir. These regions receive snowfall. While as, the plains receive light to heavy rainfall. Seasonal winds originating from the Mediterranean Sea also influence the weather of division. The temperature dips during the rainy season, however the humidity remains high. Jammu is the hottest of the three divisions in Kashmir. The

average temperature during peak summer may go up to 38°C.

Kashmir has probably the best climate of the state. Its climate is largely regulated by the Himalayas, surrounding mountains and the water bodies. It has four clearly demarcated seasons with distinct features. Each season is moderate and beautiful. The temperature in winters may go down to -15°C in the hilly areas, while as the plains have a comparatively better temperature at -5 to -8°C. The local people wear woollen cloths and a long gown known as Pheran to save them from the chill. They also use a portable fire pot, Kangri to keep warm. The month of July is the hottest month with the temperature going up to just above 30°C in the plains, while the upper reaches remain comparatively cooler, from the heat in the plains, Chinar trees come to the rescue. These huge giant-size trees give a wonderful cool shade in the hottest of summer, so much that you occasionally get chills under them. Autumn and spring have warm days and cool nights. The valley receives rains during the spring season.

The Project road lies in the Baramulla district of Jammu & Kashmir.

Baramulla

The Baramulla district is spread from Srinagar district and Ganderbal district in the east to the line of control in the west and from Kupwara district in the north and Bandipora district in the northeast to Badgam district in the south and Poonch district in the southwest. It is on the bank of the Jhelum River downstream from Srinagar. About 83.05% of the population lives in villages and 16.94% in urban areas. The district Baramulla is located in the northern tip of India which is covered from three sides (North, East and South) by India and one side (West) by Pakistan occupied Kashmir. The district of 4 division which is further divided into 16 tehsils. The district has an area of 3,353 km². The district of Baramulla experiences sub-tropical climate, and as a reason summers are warm, and winters are extremely cold. The destination receives mild rainfall during monsoons.

2.5 Rainfall

Baramulla's climate is classified as warm and temperate. The rainfall in Baramulla is significant, with precipitation even during the driest month. According to Köppen and Geiger, this climate is classified as Cfa. In Baramulla, the average annual temperature is 14.4 °C. Precipitation here averages 798 mm.

2.6 Desk Study

The Consultant had detailed interaction with the local authorities about existing data-base on quarries and material sources. Quarry charts showing quarries normally supplying aggregates to the area were collected. Plenty of identified borrow areas exist along the Project Road. Preliminary information brought about an understanding of the future course of study and investigation along the existing alignment, widening needs, proposed bypass alignments, possible borrow areas, quarry areas, water sources etc.

2.7 Test and Specification

Laboratory tests on representative samples of various materials were performed according to relevant Indian Standard (IS)/Indian Roads Congress (IRC)

Publications. AASHTO/BS Standards have been followed for tests for which IS/IRC standards are not available.

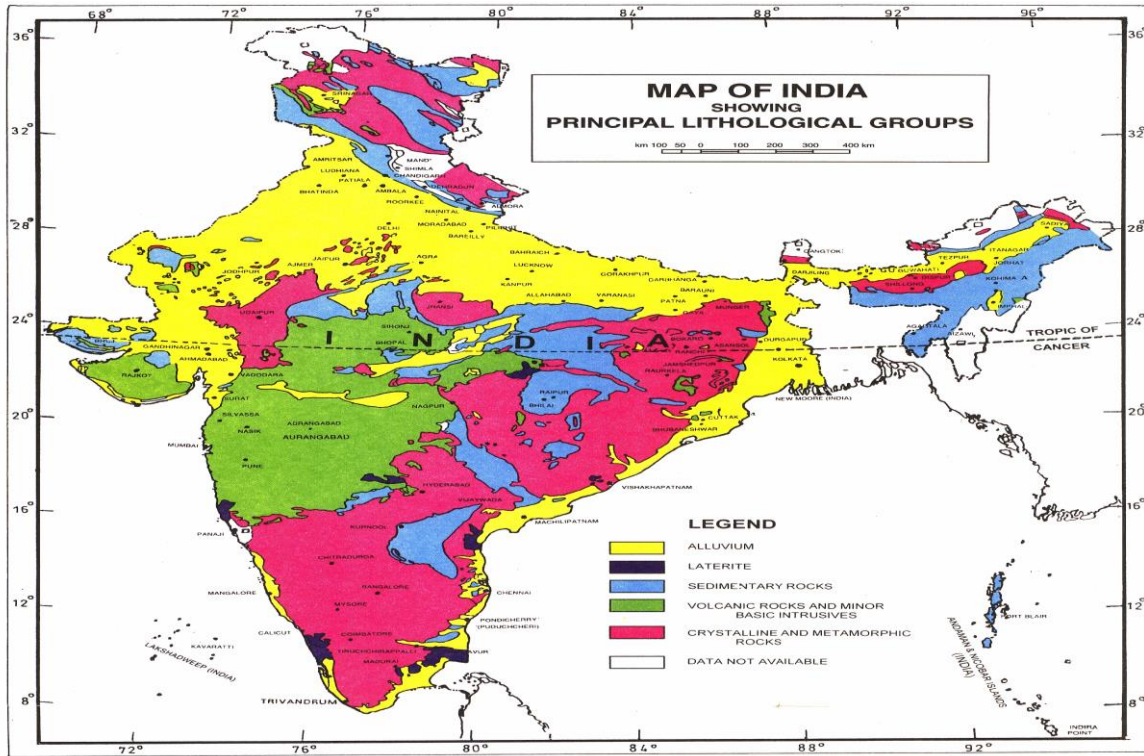


Fig 2.3 Lithological Map of India

Investigation Along Road Alignment

CHAPTER – 3

INVESTIGATIONS ALONG ROAD ALIGNMENT

3.1 General

Investigation of subgrade along proposed road has been carried out to assess the engineering characteristics of the available subgrade soil and of natural ground. This also included determining and evaluating characteristics of available subgrade for design of pavement, by means of in-situ and laboratory tests.

3.2 Scope of Investigation as per TOR

The requirements of TOR were met through the following steps:

- Digging of pits at every 5th km all along the proposed road alignment.
- Evaluation of existing soil underneath the proposed alignment pavement by testing the soil sample in laboratory, collected from each pit.
- Evaluation of Borrow Earth for construction of embankment and subgrade by testing the soil sample in laboratory, collected from each borrow location.
- Collection of aggregates samples (coarse and fine) and testing them in laboratory to determine their engineering properties.

The following laboratory tests were conducted on the soil samples collected from each pit and borrow areas.

- Grain Size Distribution (%age)
- Maximum dry density (MDD) (gm/cc)
- Optimum moisture content (OMC) (%age)
- Atterberg's Limit (LL and PL) (%age)
- Free swelling index (%age)
- 4 days soaked CBR (%age)

3.3 Test pits on natural ground for new carriageway

The natural ground for the proposed new carriageway was investigated by making large pits (1m x 1m) made at pit locations. The pits were dug at every 5-km interval staggered for new carriageway. The test pits were dug for about 0.3 m from the existing ground level and from each pit a sample of about 40 kg was collected for following laboratory tests:

- Field moisture content	As per IS:2720, Part-2	- 1973
- Grain size analysis	As per IS:2720, Part-4	- 1985
- Atterberg Limits	As per IS:2720, Part-5	- 1985
- Maximum Dry density (heavy compaction)	As per IS:2720, Part-8	- 1983
- Optimum moisture content	As per IS:2720, Part-8	- 1983
- CBR (4 days soaked)	As per IS:2720, Part-16	- 1987

Table 3.1 Test Results of Natural Ground Soil

S. No.	Proposed Chainage (km)	Modified Proctor		4-Days Soaked CBR (%)	FSI (%)	Atterberg's limit (%)			Gradation (% passing)							Classification	%		
		MDD (gm/cc)	OMC (%)			W _L	W _P	I _p	100 mm	75 mm	19 mm	4.75 mm	2.00 mm	425 μm	75 μm		Gravel	Sand	Silt & Clay
1	00+000	2.140	7.00	11.20	20	19	12	7	100	100	100	90	70	51	29	SM-SC	10	61	29
2	05+000	2.090	8.00	9.7	15	18	14	4	100	100	94	85	69	57	31	SM-SC	15	54	31
3	10+000	2.070	9.20	10.7	15	19	13	6	100	100	100	97	95	85	32	SM-SC	3	65	32
4	15+000	2.100	7.00	11.0	5	NP	NP	NP	100	100	100	96	87	67	17	SM	4	79	17
5	20+000	2.068	8.70	10.8	10	NP	NP	NP	100	100	100	95	92	86	37	SM	5	58	37
6	25+000	2.180	7.60	10.3	5	NP	NP	NP	100	100	100	91	89	82	29	SM	9	62	29
7	30+000	2.065	8.50	11.20	15	20	13	7	100	100	100	97	95	82	34	SM-SC	3	63	34
8	35+000	2.700	8.90	11.50	10	NP	NP	NP	100	100	100	95	92	86	34	SM	5	61	34
9	40+000	2.190	8.60	11.80	5	NP	NP	NP	100	100	100	91	89	82	30	SM	9	6	30

S. No.	Proposed Chainage (km)	Modified Proctor		4-Days Soaked CBR (%)	FSI (%)	Atterberg's limit (%)			Gradation (% passing)							Classification	%		
		MDD (gm/cc)	OMC (%)			W _L	W _P	I _P	100 mm	75 mm	19 mm	4.75 mm	2.00 mm	425 μm	75 μm		Gravel	Sand	Silt & Clay
10	42+820	2.084	8.40	11.30	5	NP	NP	NP	100	100	100	87	84	77	39	SM	13	48	39

Summary of test results is presented in **Table 3.2**.

Table 3.2 Summary of Test Results on Compaction of Existing Subgrade Soil

Value	Plasticity Index (%)	MDD (g/cc)	OMC (%)
Maximum	7.0	2.70	9.20
Minimum	4.0	2.065	7.00
Average	6.0	2.169	8.19

It is observed that MDD of subgrade soil is greater than **20.065 kN/m³** at all chainages satisfying the design requirements as per MoRT&H clause 305.2.1.5.

Laboratory California Bearing Ratio (CBR)

CBR at 97% of MDD along the chainage varies from 9.70 to 11.80 which is also plotted in **Fig 3.2** for better appreciation of the subgrade strength variations all along the road.

A detailed study of the results of the investigations (data in **Table 3.2**, plot in **Fig. 3.2** and soil grain distribution is given in **Fig. 3.3**) shows that:

- The subgrade soil CBR value varies from 9.70 to 11.80. Hence minimum CBR value of 9% is taken.

Fig. 3.2 Comparative Plot of Moisture Content & CBR at 97% MDD of Existing Subgrade Soil

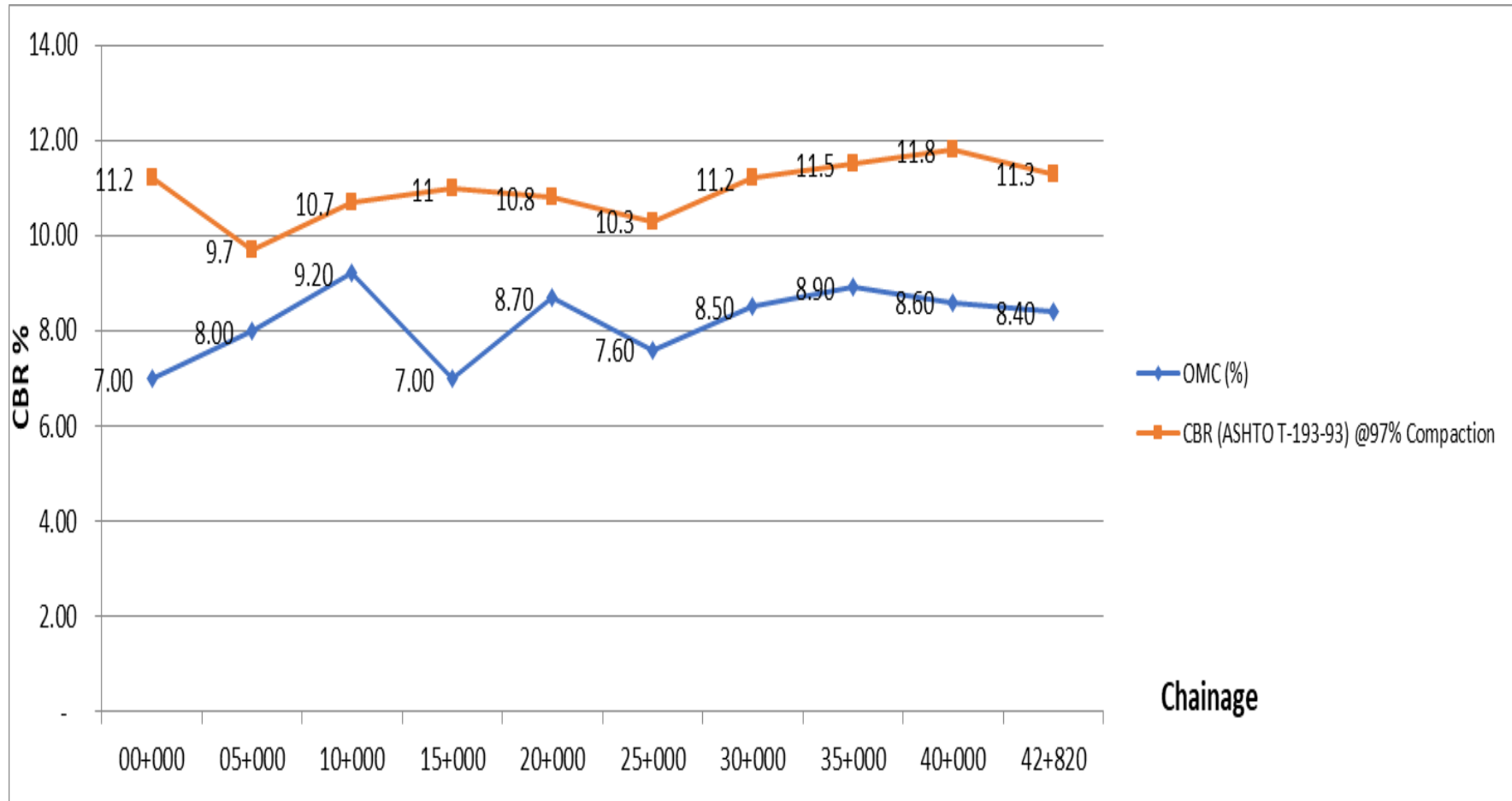
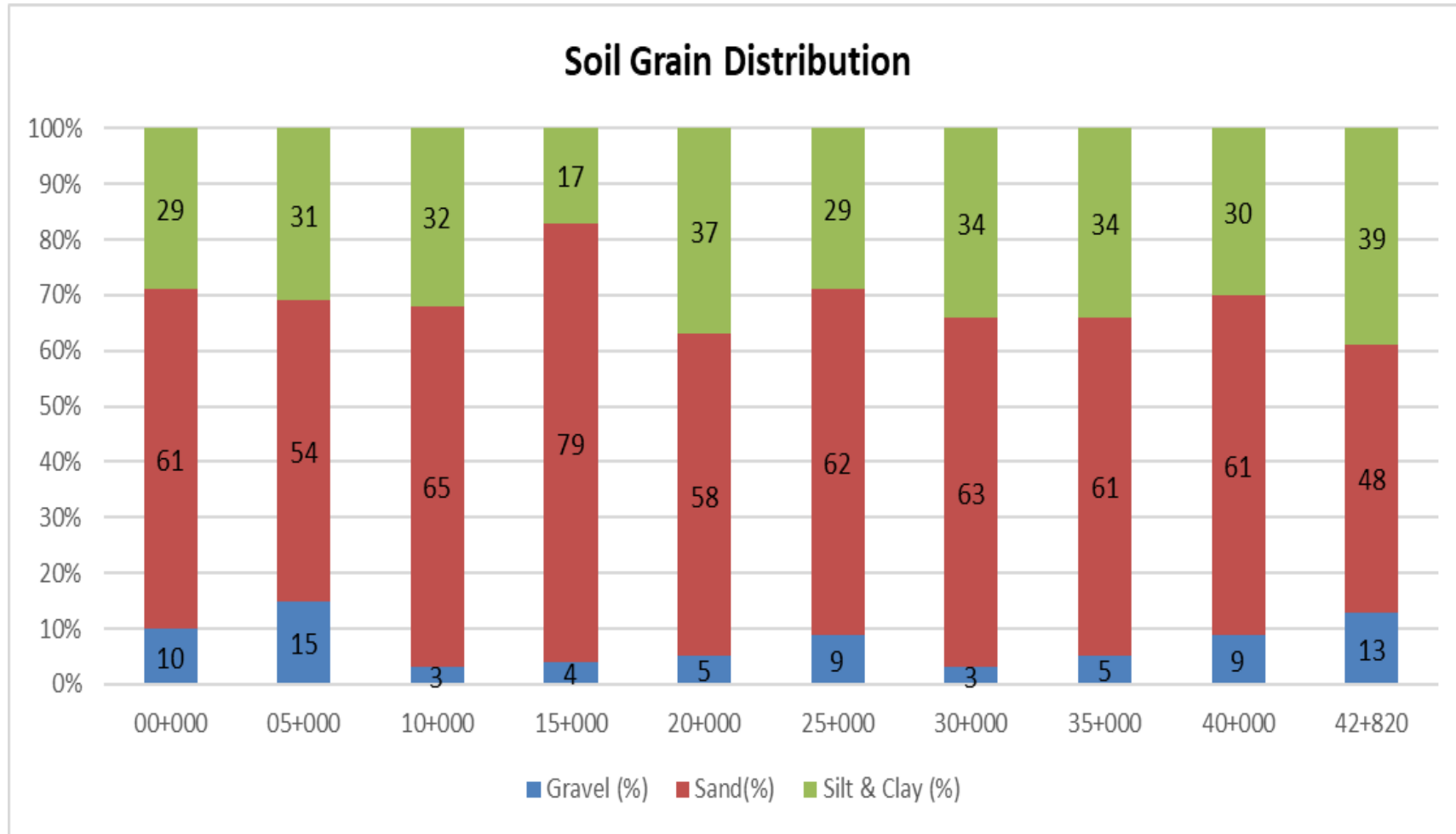


Fig. 3.3 Soil Grain Distribution at different locations



Investigation of Borrow Areas

CHAPTER - 4

INVESTIGATION OF BORROW EARTH FOR EMBANKMENT AND SUBGRADE

4.1 General

Investigation of borrow earth for road construction has been carried out to identify the potential sources of embankment fill material and subgrade material for the new alignment and to assess their general availability and suitability for use in road and construction works.

Since the road section in the project is proposed to be constructed by cutting hills therefore the earth required for embankment fill, subgrade fill and Shoulder fill shall be done by using the cut material from roadway.

Therefore, investigation of soil from the cut has been done.

4.2 Objectives

The investigation on Existing ground soil were carried out with the following basic objectives:

- Source location indicating places, kilometre stone and lead distances.
- Ownership of land (Government or Private).
- Testing of existing ground soil to assess the quality of materials along with their classification details and evaluation for their suitability.
- Probable use indicating the likely use of soils at various stages of construction work, i.e. fill material/ subgrade.

4.3 Laboratory Testing

About 40 kg of representative samples were collected from each borrow area after removing the upper 300mm of natural ground.

Laboratory tests carried out on each borrow sample are as follows:

-	<i>Grain size analysis</i>	<i>As per IS:2720</i>	<i>Part-IV - 1985</i>
-	<i>Atterberg Limits</i>	<i>As per IS:2720</i>	<i>Part-V – 1985</i>
-	<i>Maximum Laboratory Dry Density</i>	<i>As per IS:2720</i>	<i>Part-VIII - 1983</i>
-	<i>Optimum Moisture Content</i>	<i>As per IS:2720</i>	<i>Part -VIII - 1983</i>
-	<i>CBR (4 days soaked) at the specified compaction level of 97% MDD</i>	<i>As per IS:2720</i>	<i>Part-XVI - 1987</i>

TABLE 4.1 Test Results for Borrow Area (Excavated Soil) Material

S. No.	Proposed Chainage (km)	Modified Proctor		4-Days Soaked CBR (%)	FSI (%)	Atterberg's limit (%)			Gradation (% passing)							Classification	%		
		MDD (gm/cc)	OMC (%)			W _L	W _P	I _P	100 mm	75 mm	19 mm	4.75 mm	2.00 mm	425 μm	75 μm		Gravel	Sand	Silt & Clay
1	00+000	2.140	7.00	11.20	20	19	12	7	100	100	100	90	70	51	29	SM-SC	10	61	29
2	05+000	2.090	8.00	9.7	15	18	14	4	100	100	94	85	69	57	31	SM-SC	15	54	31
3	10+000	2.070	9.20	10.7	15	19	13	6	100	100	100	97	95	85	32	SM-SC	3	65	32
4	15+000	2.100	7.00	11.0	5	NP	NP	NP	100	100	100	96	87	67	17	SM	4	79	17
5	20+000	2.068	8.70	10.8	10	NP	NP	NP	100	100	100	95	92	86	37	SM	5	58	37
6	25+000	2.180	7.60	10.3	5	NP	NP	NP	100	100	100	91	89	82	29	SM	9	62	29
7	30+000	2.065	8.50	11.20	15	20	13	7	100	100	100	97	95	82	34	SM-SC	3	63	34
8	35+000	2.700	8.90	11.50	10	NP	NP	NP	100	100	100	95	92	86	34	SM	5	61	34
9	40+000	2.190	8.60	11.80	5	NP	NP	NP	100	100	100	91	89	82	30	SM	9	6	30
10	42+820	2.084	8.40	11.30	5	NP	NP	NP	100	100	100	87	84	77	39	SM	13	48	39

4.3.1 Results

Laboratory test results of soil samples from borrow areas are provided in **Table 4.1**. It is found that the type of soil found are to SM and SM-SC i.e. Silty Sand with gravel & Silty Sand having some portion of clay respectively.

4.4 Evaluation of Test Results

The laboratory test results show that the soil taken for testing fall under SM and SM-SC class as per IS classification. Compaction test (heavy compaction) results indicate that maximum dry density is between 2.065 gm./cc and 2.700 gm./cc and Optimum Moisture Content is between 7.00 % and 9.20%. Laboratory California Bearing Ratio test was carried out on the soaked (4 days) samples compacted to 97% MDD, and the value is found to be varies between 9.70 to 11.80.

From the type of soil locally available in the area, and their engineering characteristics ascertained from laboratory test results (**Tables 4.1**), the following inferences / recommendations are made:

In initial assessment, ten borrow areas were found and material brought from them for its testing in laboratory. Material of borrow areas is also tested for above mentioned tests. Results from borrow area is given in this chapter. The key observation is however given below:

- 4 days soaked CBR for ten samples is between 9.70% to 11.80%.

Quarry Material

CHAPTER – 5

QUARRY MATERIALS FOR CONSTRUCTION

5.1 General

This chapter describes the investigations made by the Consultants for locating suitable quarries/material sources for supply of aggregates and sand for use in different pavement courses. It also brings out the results of laboratory tests carried out on representative samples from the identified quarries / material sources, and based on evaluation of the results, makes recommendations on the suitability of the materials for different purposes.

5.2 Objectives

The investigations for the materials were carried out with the following objectives:

- Source location indicating the place name, the type of access road and the distance of the source from the Project Road.
- Assessing engineering properties of representative samples of materials from the identified sources through laboratory tests.
- Evaluation of test results for making recommendations on the use of the materials for various purposes.

5.3 Location and Description of Aggregate Quarries

The exercise started with a study of the geological and topo maps of the area to identify possible sources for aggregates. Side by side, discussions were also held with the officials of local NH division and local contractors about the traditional sources for supply of aggregates in the project area. This was followed by site visits to possible quarry sites.

The collected information indicated that a number of quarries have been supplying aggregates to recently completed or ongoing major road projects in the area.

And the aggregate quarry selected for the project road is located at **Sheeri** which is around 30 km from the plant location in Sherapora.

5.4 Laboratory tests

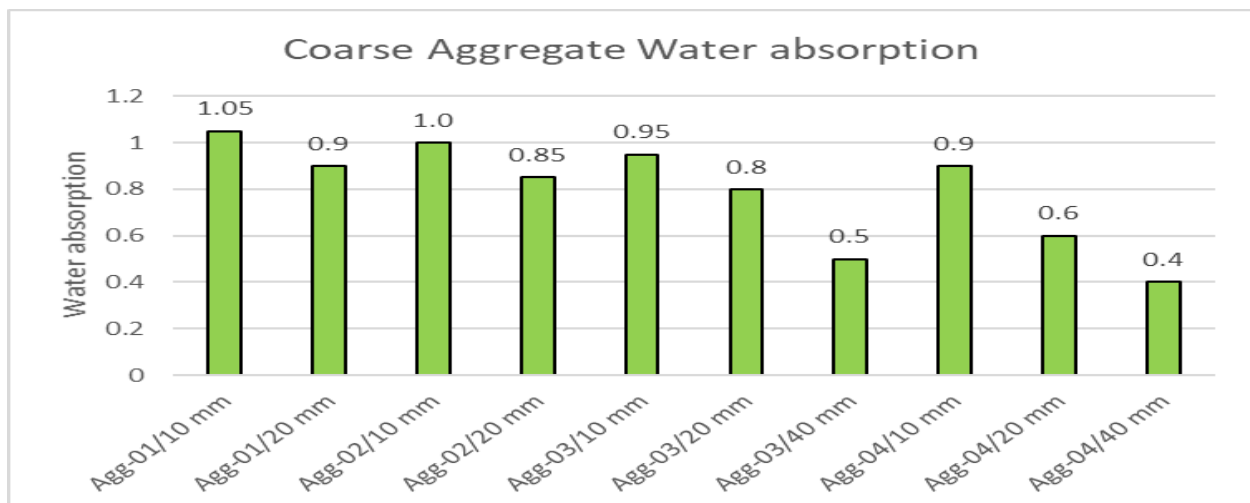
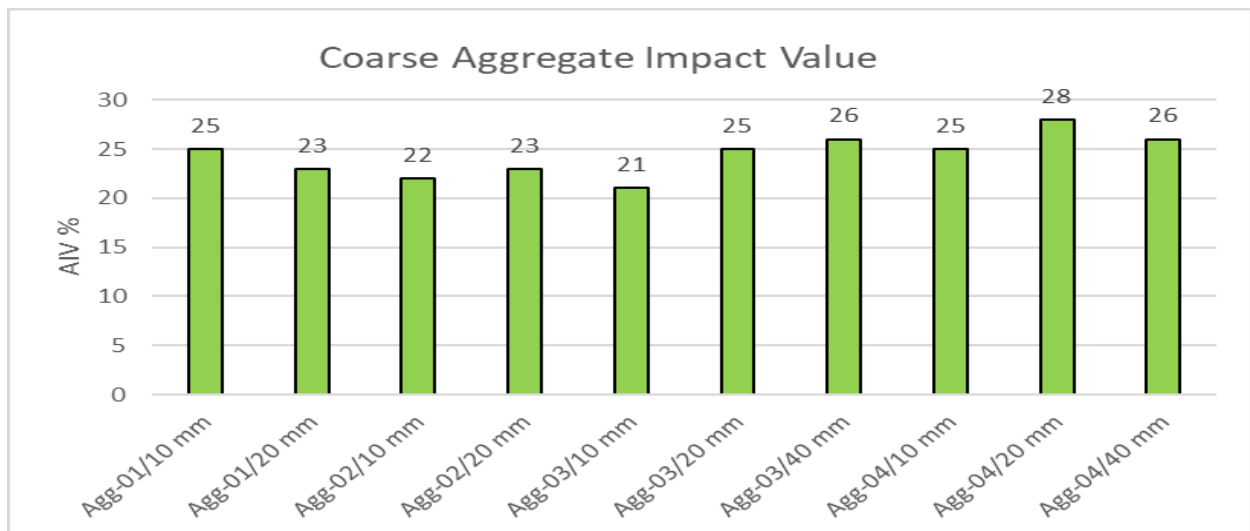
Representative Samples of stone aggregates collected from the quarries have been subjected to the following laboratory tests:

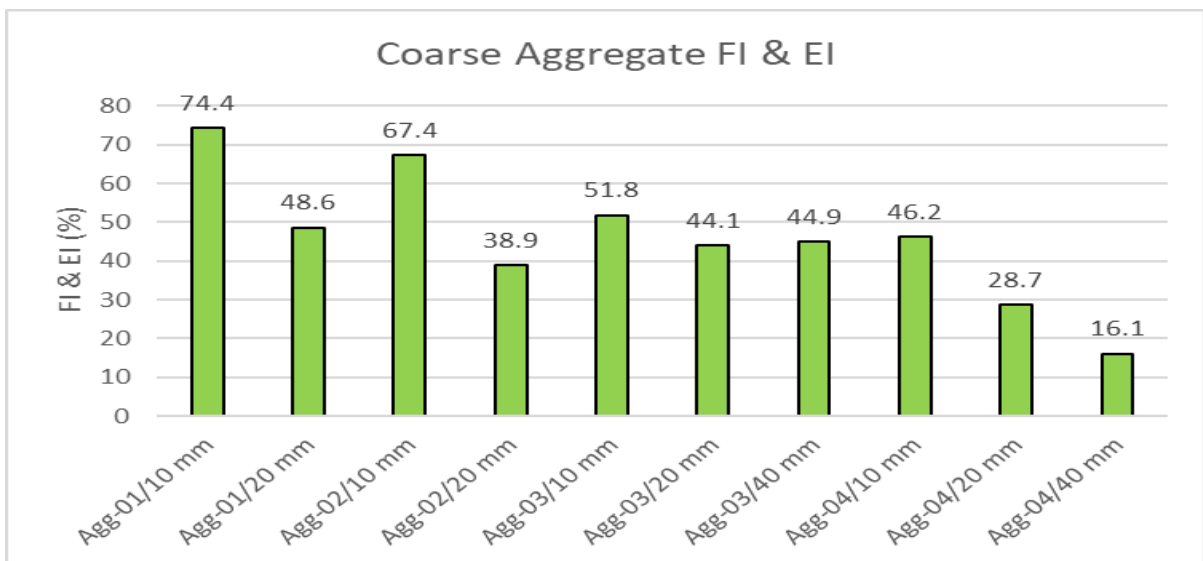
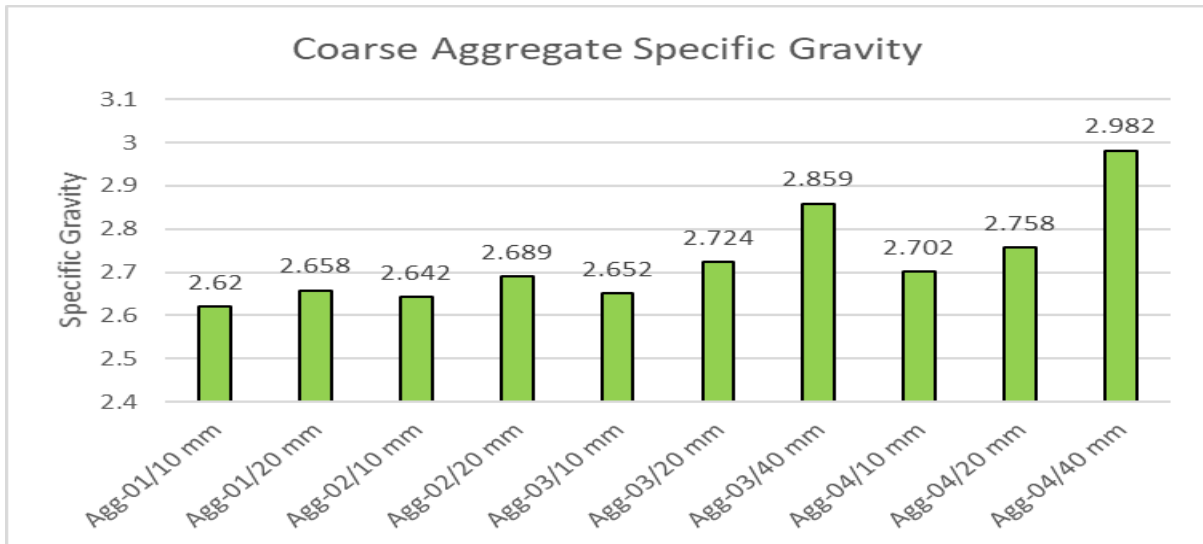
- | | | |
|------|-------------------------------|------------------------------------|
| i) | <i>Aggregate Impact Value</i> | <i>As per IS : 2386 (Part – 4)</i> |
| ii) | <i>Specific Gravity</i> | <i>As per IS : 2386 (Part - 3)</i> |
| iii) | <i>Water Absorption</i> | <i>As per IS : 2386 (Part – 3)</i> |

Results of the laboratory tests for coarse and fine aggregates are provided in **Table 5.1 & 5.2 respectively**.

Table 5.1 Test Results of Coarse Aggregates

Sample ID	Coarse Aggregate			
	AIV*	Water absorption	Specific Gravity	FI & EI
Agg-01/10 mm	25	1.05	2.620	74.4
Agg-01/20 mm	23	0.90	2.658	48.6
Agg-02/10 mm	22	1.00	2.642	67.4
Agg-02/20 mm	23	0.85	2.689	38.9
Agg-03/10 mm	21	0.95	2.652	51.8
Agg-03/20 mm	25	0.80	2.724	44.1
Agg-03/40 mm	26	0.50	2.859	44.9
Agg-04/10 mm	25	0.90	2.702	46.2
Agg-04/20 mm	28	0.60	2.758	28.7
Agg-04/40 mm	26	0.40	2.982	16.1





5.5 Results and Discussion on Aggregate Quarries

Quarry samples of different sizes were tested in laboratory. From the test results it is observed that aggregates from quarry satisfies the specified limit for Aggregate Impact Value and water absorption for use in pavement and concrete construction works. However, combined flakiness and elongation indices poses limitation on choosing quarry material for aggregates.

Flakiness and Elongation are affected by stratification of the rock and method of crushing. In this case highly possible reason of flakiness and elongation is poor machine adjustment or employing a high reduction ratio. However, flakiness has to be properly controlled before use in construction works by adopting the following methods:

- Reducing the crushing ratio
- By fixing serrated type jaw plates

As the aggregates from the selected quarry satisfy the allowable limit of water absorption, aggregate impact value and soundness for cement concrete works, these are suitable for such work after taking precautionary measures for reducing combined flakiness and

elongation index. Hence it can be concluded that aggregates from selected quarries can be used for WMM, BM, DBM, BC wearing course and also for concrete construction based on different considerations for different layers, as per MoRT&H specifications.

In addition, for the interpretation of the test results, the consultants would like to make the following cautionary remarks:

- The resistance to wear depends not only on the hardness of the rock, but also depends on the shape of the crushed material. The obtained shape (flakiness) from the laboratory may differ considerably from the shapes obtained during the execution of the works. On the other hand, samples are taken relatively from the surface of a potential quarry. Normally, the quality improves, when the deeper rock is excavated.
- The 'AIV' depends on the mineral composition and its formation at the stage of solidification. The stripping value is also dependent of mineralogical composition. Hydrophilic aggregates do not adhere to bitumen film causing de-bonding.

Therefore, during construction, all the quarry locations be further investigated to deeper depth and the frequency of these testing to be increased for more accurate interpretation of the properties.

5.6 Sand Quarry

Sand can be made available from **Drangbal** which is approximately 25 km from the plant location Sherapora. Sand samples were collected from this location. Location details and quantity available are tabulated in **Table 5.4**. Representative samples from these sources have been collected and tested for the following properties:

Grain size Analysis As per IS:2720 (Part 4)

Sp Gravity As per IS:2386 (Part 3)

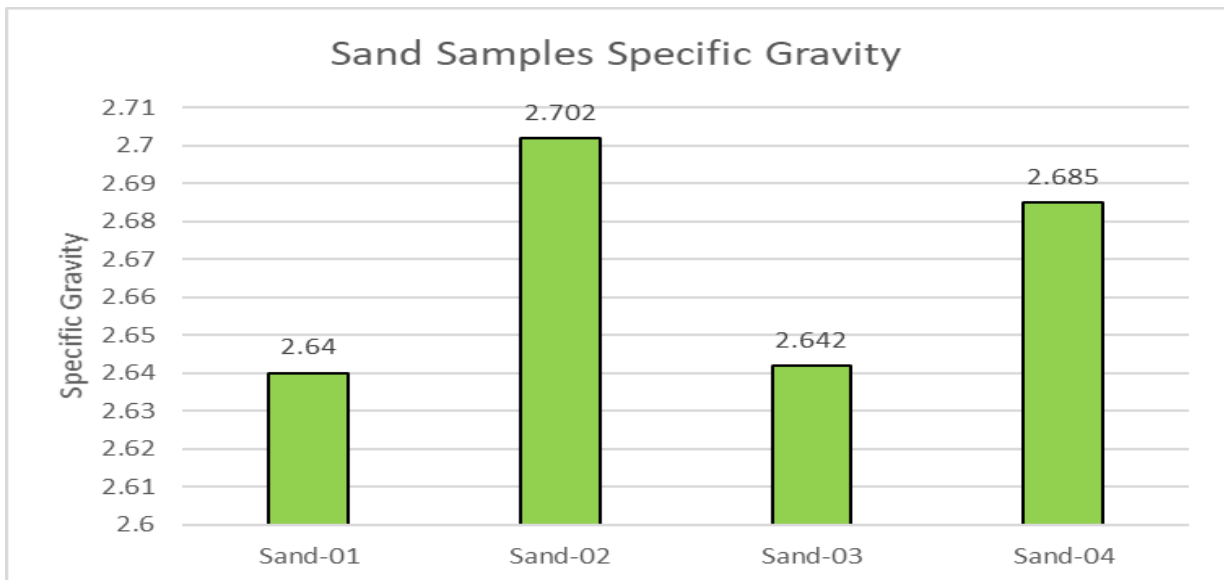
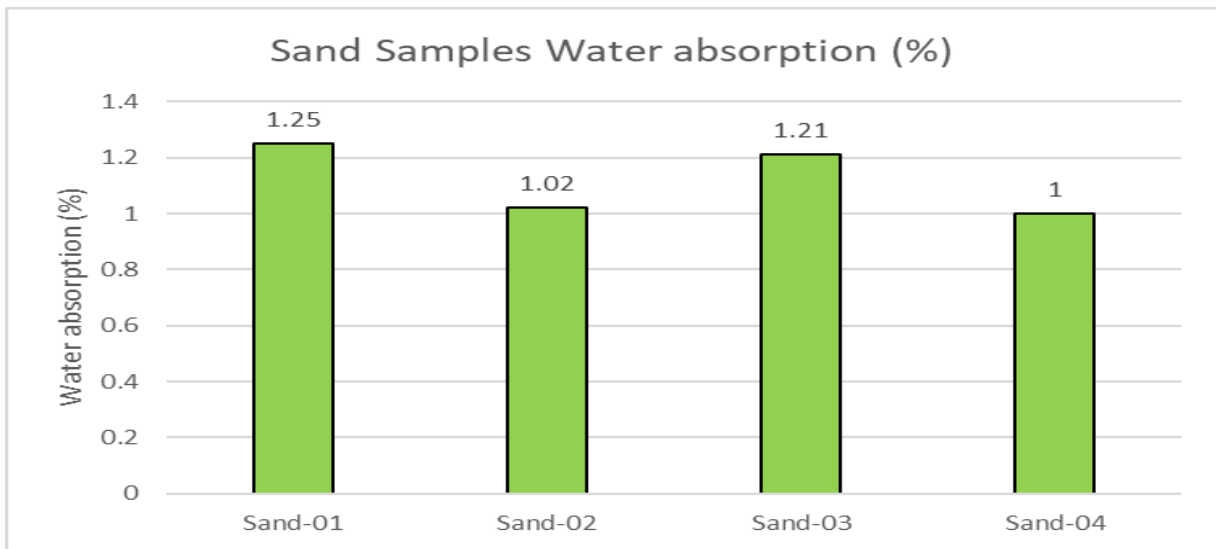
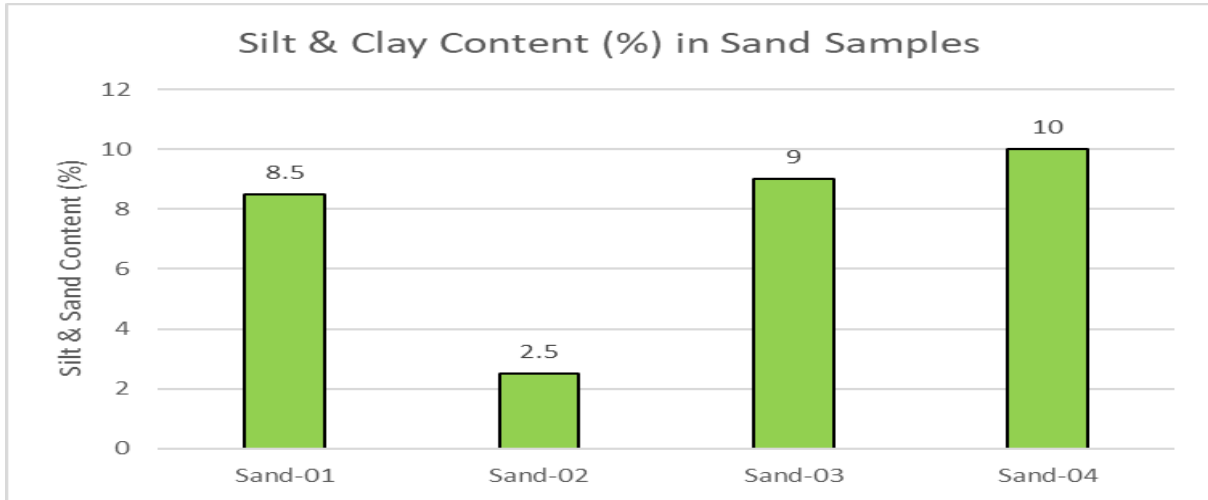
Water Absorption As per IS:2386 (Part 3)

Test results of the sand samples are represented in **Table 5.2**.

From grain size analysis it can be observed that most of the sand samples fall in Zone I as per IS:383 and good for concrete and pavement.

Table 5.2 Test Results of Fine Aggregates

Sample ID	IS Sieve Size in mm (For Sand Gradation)							FM	Silt & Clay Content (%)	Water absorption (%)	Specific Gravity
	10	4.75	2.36	1.18	0.6	0.3	0.15				
Sand-01	100	98	92	76	62	32	9	2.31	8.5	1.25	2.64
Sand-02	99	90	80	43	28	13	3	3.44	2.5	1.02	2.702
Sand-03	100	100	98	70	51	27	9	2.46	9	1.21	2.642
Sand-04	100	99	98	81	63	34	10	2.16	10	1.00	2.685



Manufactured Material

CHAPTER – 6

MANUFACTURED MATERIALS

6.1 General

Manufactured materials like cement, steel and bitumen are required for the construction work. The Consultant has done detailed reconnaissance survey for availability of these materials. Since the total requirement of these materials of this Project Road in comparison to the total production in the country is not significant, the procurement of these materials will not pose any problem.

6.2 Cement

The Cement will be getting from **Gurdaspur District of Punjab**. Ordinary Portland Cement and with various grade of cement like 33, 43 & 53 type of Cement in various brand like Birla, Ambuja, J K etc are available.

6.3 Steel

The required type of Steel is to be procured from the **SAIL Authority in Jammu**.

6.4 Bitumen

Bitumen (**VG-30, VG-10**) will be available from **Panipat Refinery**.

6.5 Bitumen Emulsion

Sufficient quantity of bitumen emulsion for the project work would be available from **VeeKay Industries, SIDCO Industrial Estate, Bari Brahmana, Jammu**.

Other Construction Material

CHAPTER – 7

OTHER CONSTRUCTION MATERIALS

7.1 Water

Water is an important constituent for both road and structural construction works. During reconnaissance survey it was found that ground water was the main source of catering the consumption need of the local population. It is noted that almost at every village along the project road, water is being extracted from bore-wells, which is found to be of potable quality. From all these it is concluded that adequate quantity of suitable water will be available for implementation of project works.

7.2 Other Materials

Other specialized materials like high tensile strands for pre-stressing, bridge bearings, road signs, road marking paints, retro reflective sheets etc. are available indigenously in the major cities and specialized agencies are available to execute such works.