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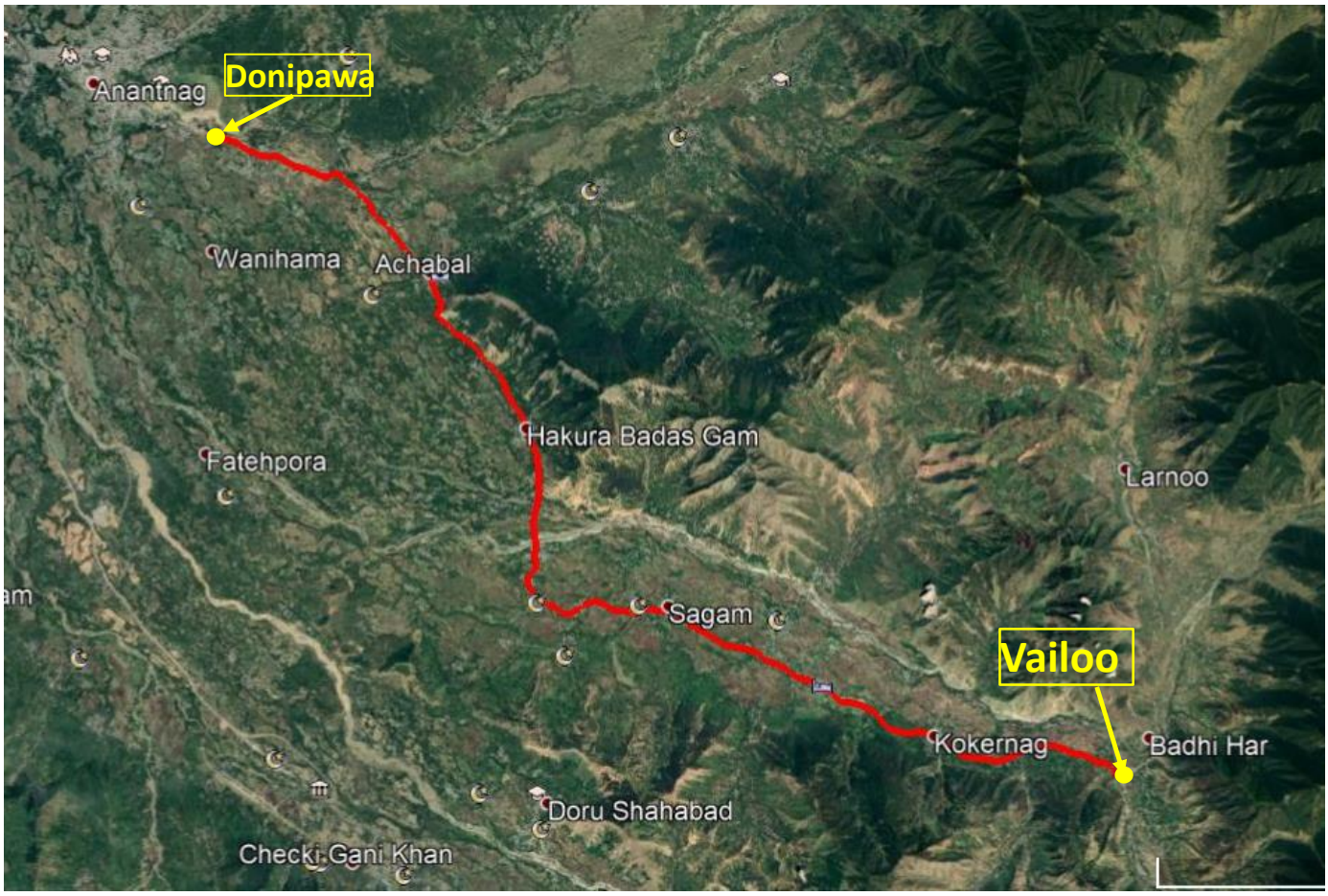
NATIONAL HIGHWAYS & INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

(MINISTRY OF ROAD TRANSPORT & HIGHWAYS, GOVT. OF INDIA)
3RD FLOOR, PTI BUILDING, 4-PARLIAMENT STREET, NEW DELHI – 110001

Consultancy Services for Feasibility Study, Preparation of Detailed Project Report and providing pre-construction services for upgradation to 2 lane with paved shoulder from (i) Km 44.500 to Km 142.000 of Chattroo Village & (ii) Km 235.00 (Vailoo Village) to Km 269.00 (Khanabal) of Khellani- Kishtwar-Chattroo- Khanabal Section of NH 244 in the state of Jammu & Kashmir



FINAL DETAILED PROJECT REPORT
VAILOO TO DONIPAWA SECTION
VOLUME-III: MATERIAL REPORT

NOVEMBER 2020

RODIC CONSULTANTS PVT. LTD.
IN JV WITH
MONARCH SURVEYORS AND ENGINEERING CONSULTANTS PVT. LTD.

Introduction

CHAPTER – 1

INTRODUCTION

1.1 The Project Road

The project road of Vailoo - Khanabal lies entirely in Anantnag district in newly formed Union Territory of Jammu and Kashmir. The project road is part of NH-244 (old NH-1B) which runs from Batote to Khanabal via Khellani, Thatri, Kishtwar, Vailoo, Achabal and Anantnag. The Project Road is located in south-west part of Jammu and Kashmir.

The project road traverses through Hilly/Mountainous & Plain/Rolling terrain . The soil in the district is generally loose silty sand with very low moisture.

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

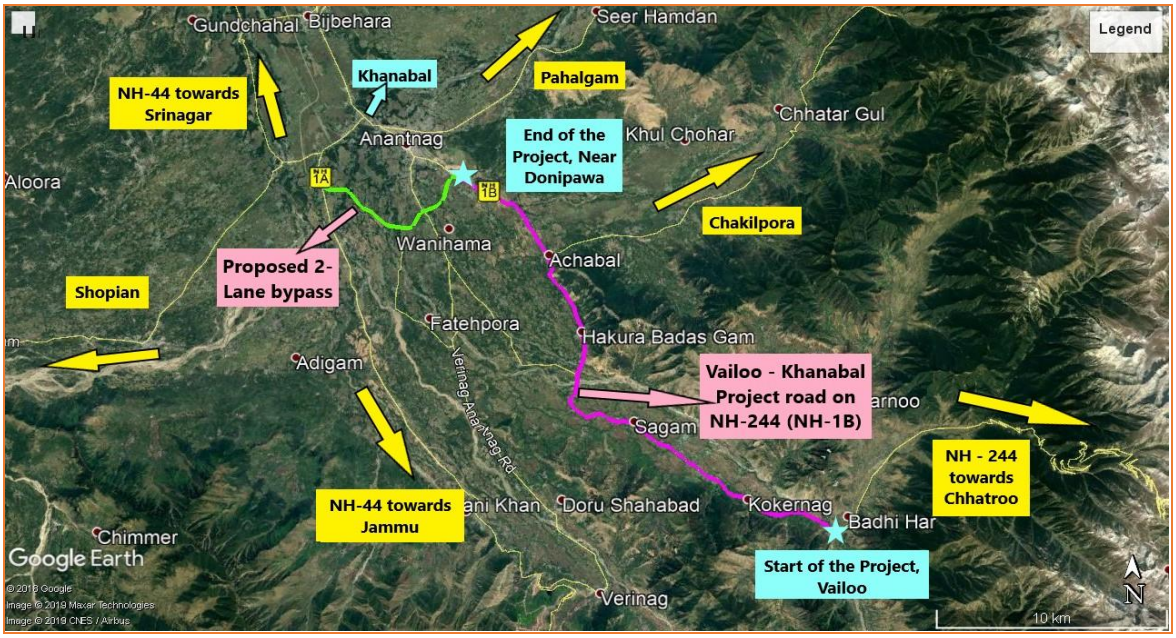


Fig- 1.1- Location Map of the Project

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 km^2 (62 mi) wide and 15,520.3 km^2 (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 meters (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 kilometers 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 33º 20' to 34º 54' North latitude and 73º 55’ to 75º 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.

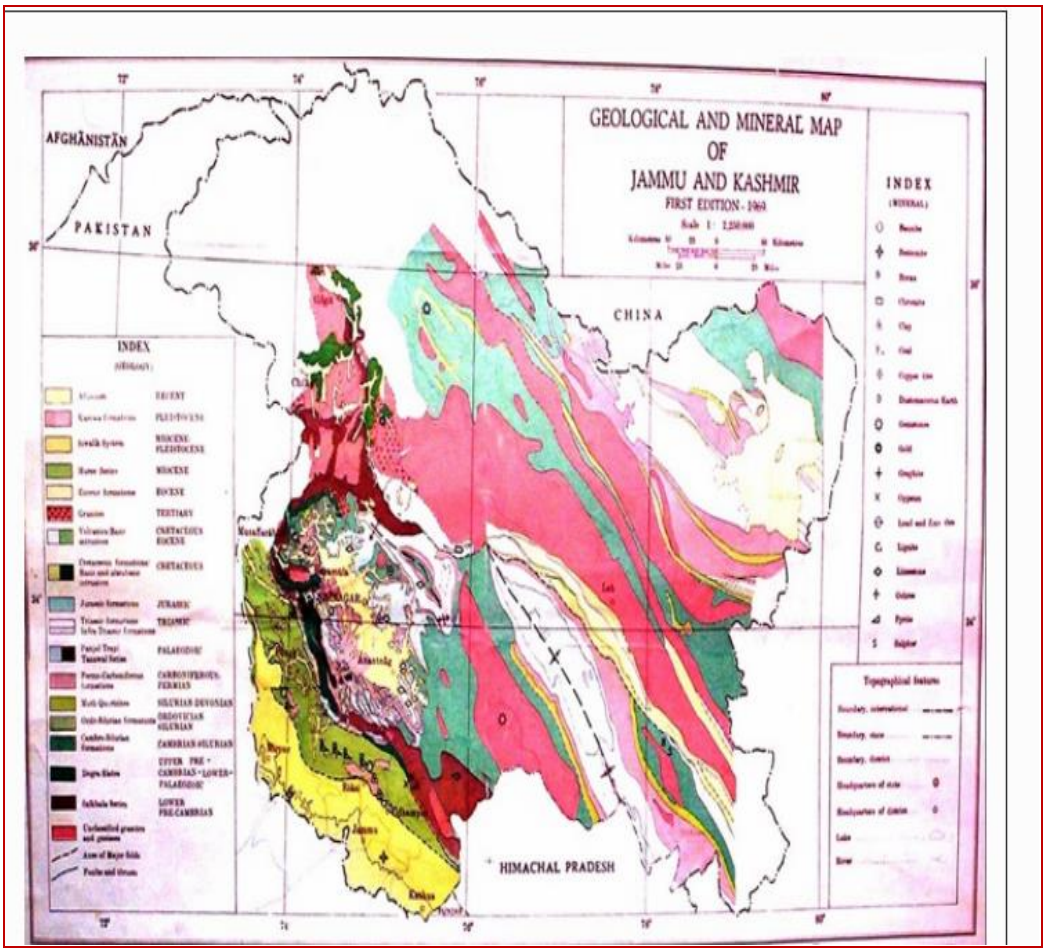


Fig 2.1 Geological Map of India

2.3 Terrain, Soil Type and Geology

Terrain

The project stretch is of total of 28 Km in which initial 16 km have been identified as of Hilly/Mountainous terrain and remaining 12 Km as Plain and Rolling Terrain.

Soil Type

The formation soil type along all the stretches of the Project Road is mostly silty sand with very low moisture.

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 (Including Ladakh UT)

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, and 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.

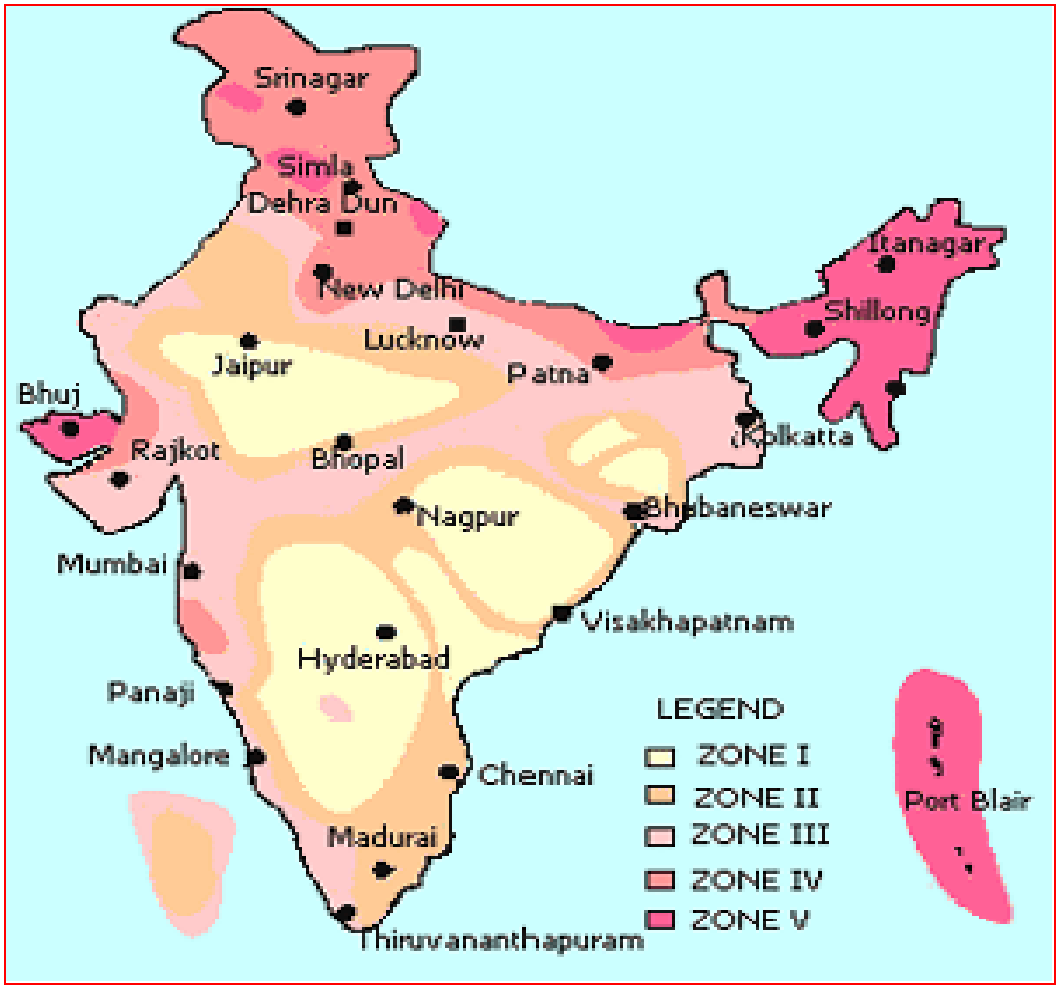


Figure 2.2: Seismic Map of India

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 Anantnag district of Jammu & Kashmir.

Anantnag District

Anantnag is located at about 54 Kms from Srinagar and about 254 Kms from Jammu. The district is well connected with other districts and National Highway NH-1A (44) and NH-1B (244) pass through the district. The district has a good road network. District Anantnag is called the Gateway of Kashmir Valley. The nearest airport is located at Srinagar, which is about 65 Kms. from the District Headquarter and the nearest Railhead is located at Jammu. The general approach to the whole of the District is through road and one can avail the transport facilities like Taxi, Delux Buses etc. both from Jammu and Srinagar. The ambitious project of bringing the Kashmir Valley on the railway network map has been started and hopefully a day will come when the people of the district will see the train passing through their district. Geographically the district lies between 33-20' to 34 -15' north latitude and 74-30 to 75 -35 East Longitude bounded by north west by Srinagar and Pulwama districts and in the north east by Kargil district, in the southeast by district Doda, Khishtwar and in the south and south west by Ramban and kulgam districts respectively.

Rainfall

The Anantnag lies on 1598m above sea level. The climate here is mild, and generally warm and temperate. There is a great deal of rainfall in Anantnag, even in the driest month. The climate here is classified as Cfa by the Köppen-Geiger system. In Anantnag, the average annual temperature is 14.5 °C. About 747 mm of precipitation falls annually.

2.6 Desk Study

The Consultant had detailed interaction with the local authorities about existing database 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.

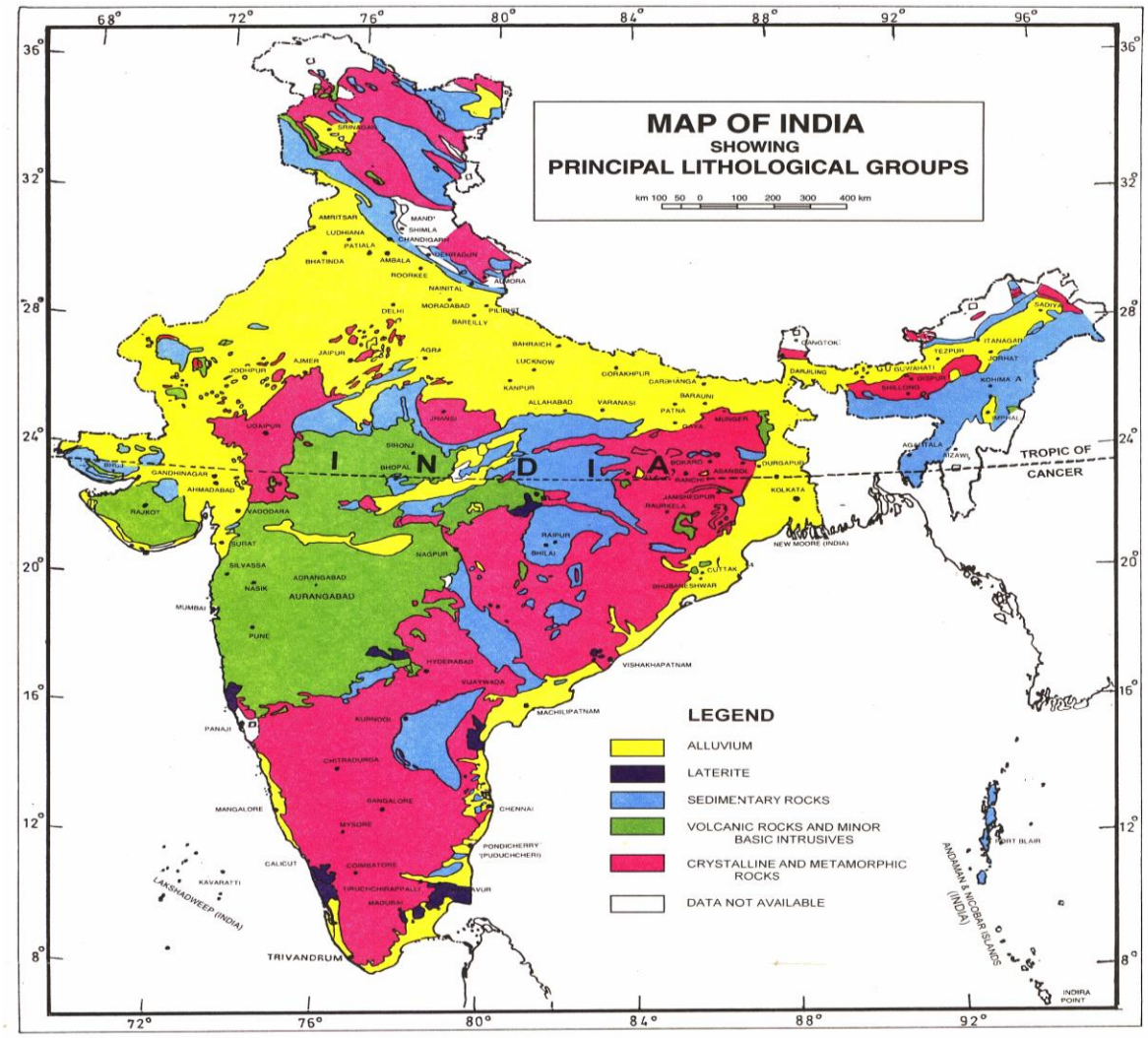


Fig 2.3 Lithological Map of India

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.
- 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	As per IS:2720, Part-8 - 1983

(Heavy compaction)

- 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.	Existing 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 mm	425 µm	75 µm		Gravel	Sand	Silt & Clay
1	235+000	2.099	7.90	10.50	10	NP	NP	NP	100	100	100	95	86	76	36	SM	5	59	36
2	240+000	2.030	8.80	9.35	20	22	14	8	100	100	100	95	89	75	58	CL	5	37	58
3	245+000	2.100	7.00	9.22	18	NP	NP	NP	100	100	100	96	87	67	17	SM	4	79	17
4	250+000	2.080	8.70	10.20	10	NP	NP	NP	100	100	100	94	80	66	36	SM	6	58	36
5	255+000	2.095	7.00	10.60	11	NP	NP	NP	100	100	100	96	84	72	23	SM	5	73	22
6	260+000	2.051	9.40	9.88	12	NP	NP	NP	100	100	100	87	86	83	24	SM	7	63	30
7	265+000	2.075	8.80	10.20	10	NP	NP	NP	100	100	100	97	90	82	41	SM	6	56	38

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	8	2.1	9.40
Minimum	8	2.030	7.00
Average	8	2.076	8.23

It is observed that MDD of subgrade soil is greater than **19.00 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 2.030 to 2.100 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 9.22 to 10.60. Hence minimum CBR value of 10% is taken.

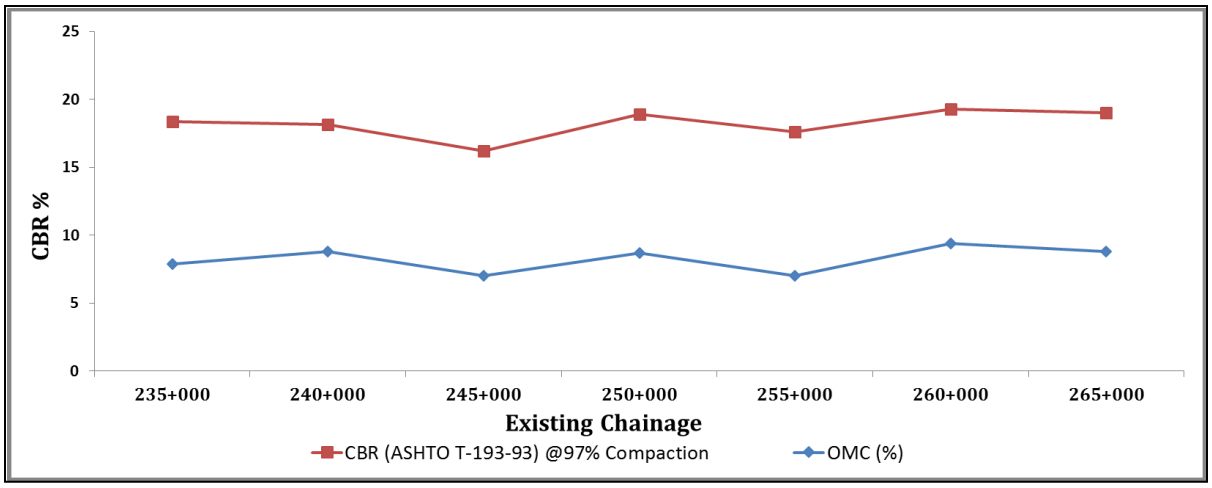


Fig. 3.2 Comparative Plot of Moisture Content & CBR at 97% MDD of Existing Subgrade Soil

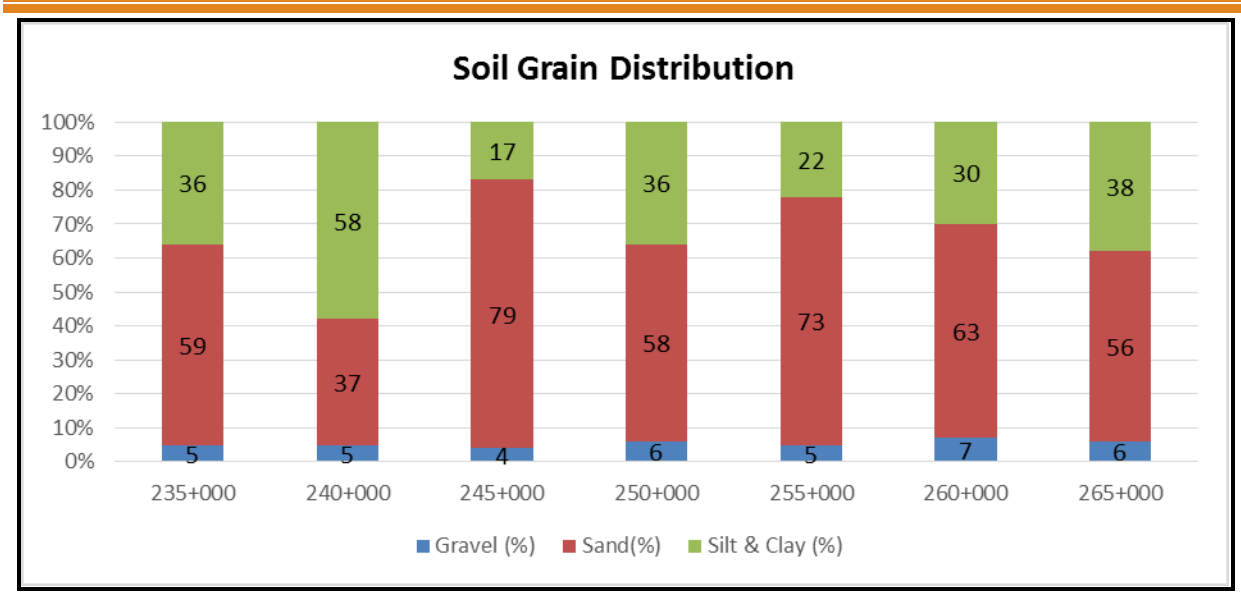


Fig. 3.3 Soil Grain Distribution at different locations

Investigation of Borrow Areas

CHAPTER - 4

INVESTIGATION OF 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, for embankment fill, subgrade fill and Shoulder embankment in road section is proposed to be constructed 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:

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

TABLE 4.1 Test Results for 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 mm	425 µm	75 µm		Gravel	Sand	Silt & Clay
1	235+000	2.099	7.90	10.50	10	NP	NP	NP	100	100	100	95	86	76	36	SM	5	59	36
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6	260+000	2.051	9.40	9.88	12	NP	NP	NP	100	100	100	87	86	83	24	SM	7	63	30
7	265+000	2.075	8.80	10.20	10	NP	NP	NP	100	100	100	97	90	82	41	SM	6	56	38

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 i.e. Silty Sand.

4.4 Evaluation of Test Results

The laboratory test results show that the soil taken for testing fall under SM class as per IS classification. Compaction test (heavy compaction) results indicate that maximum dry density is between 2.03 gm./cc and 2.10 gm./cc and Optimum Moisture Content is between 7.00 % and 9.40 %. 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 9.22 to 10.60.

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, seven locations were used for soil collection and material brought from them for its testing in laboratory. Results from these locations is given in this chapter. The key observation is however given below:

- 4 days soaked CBR for excavated material of four samples is between 9.22% to 10.60 %.

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 several 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 Ashajipora which is around 17 km from the plant location.

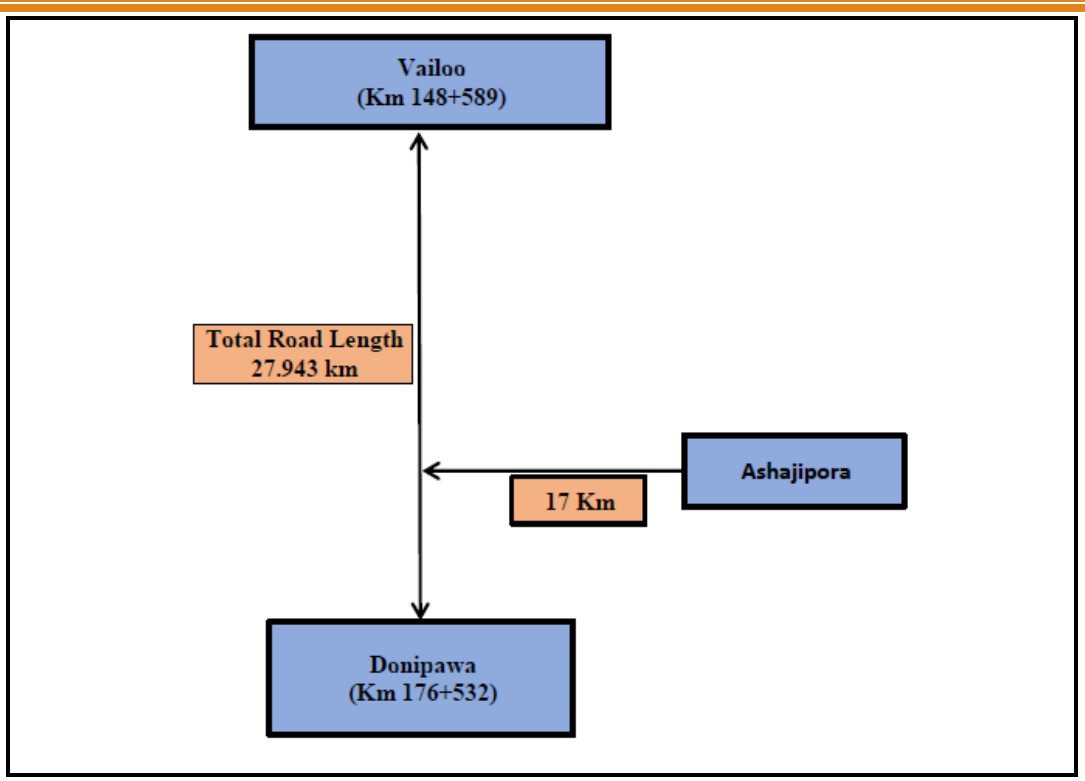


Figure 5.1 : Lead Chart for Aggregates

5.4 Laboratory tests

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

i) Aggregate Impact Value — *As per IS : 2386 (Part – 4)*

ii) Specific Gravity — *As per IS : 2386 (Part - 3)*

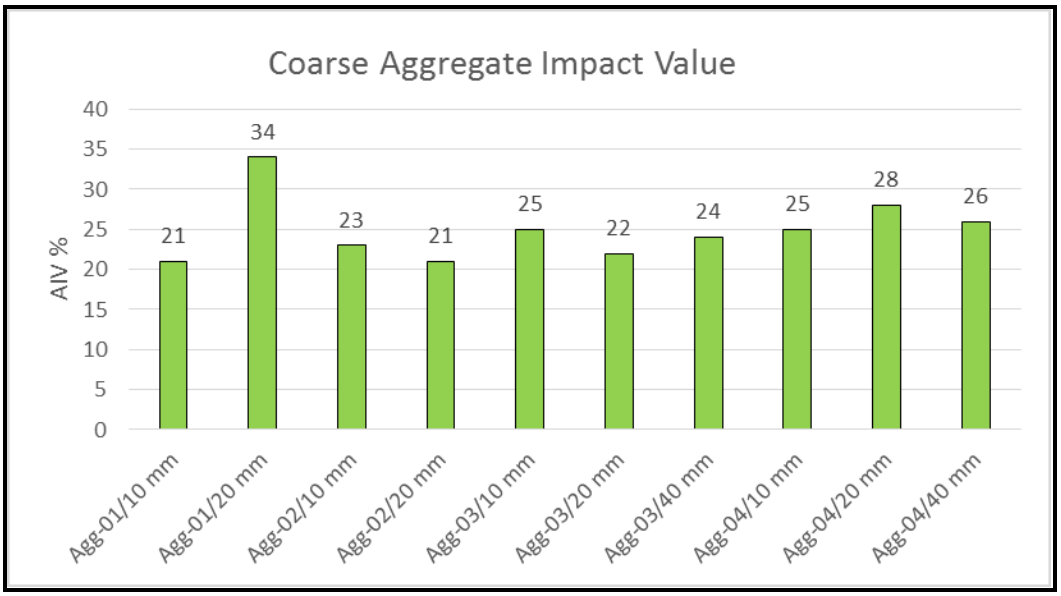
iii) Water Absorption — *As per IS : 2386 (Part – 3)*

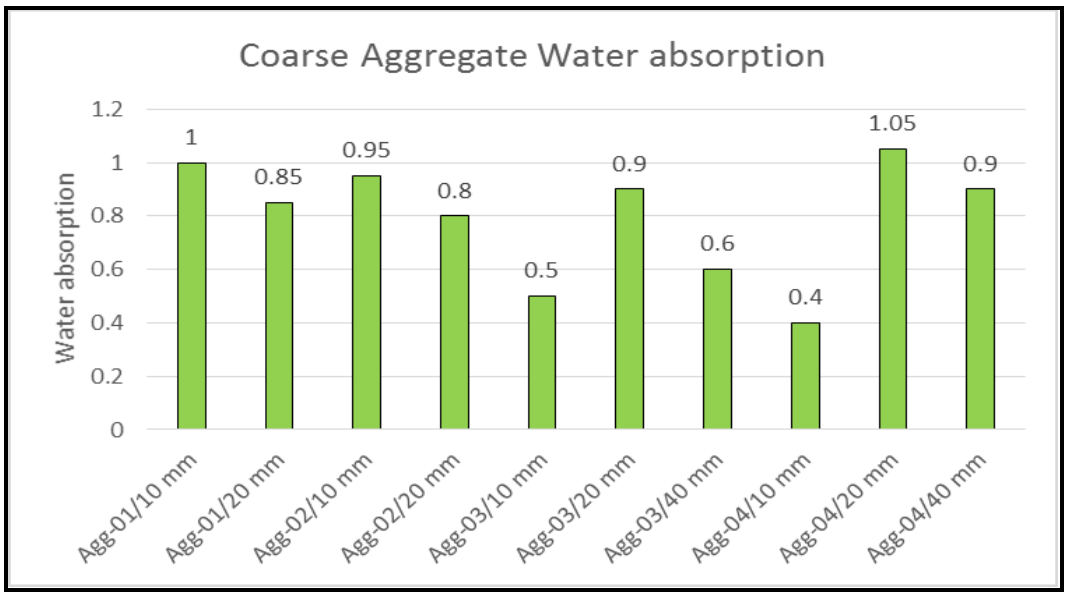
Results of the laboratory tests for coarse and fine aggregates are provided in **Table 5.1 & 5.2 respectively**.

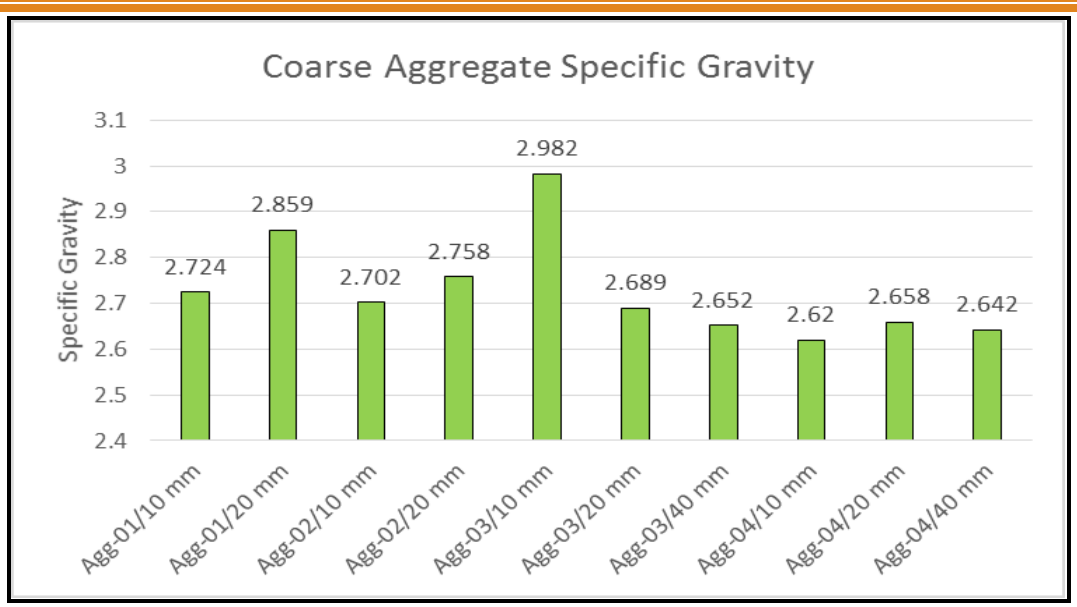
Table 5.1 Test Results of Coarse Aggregates

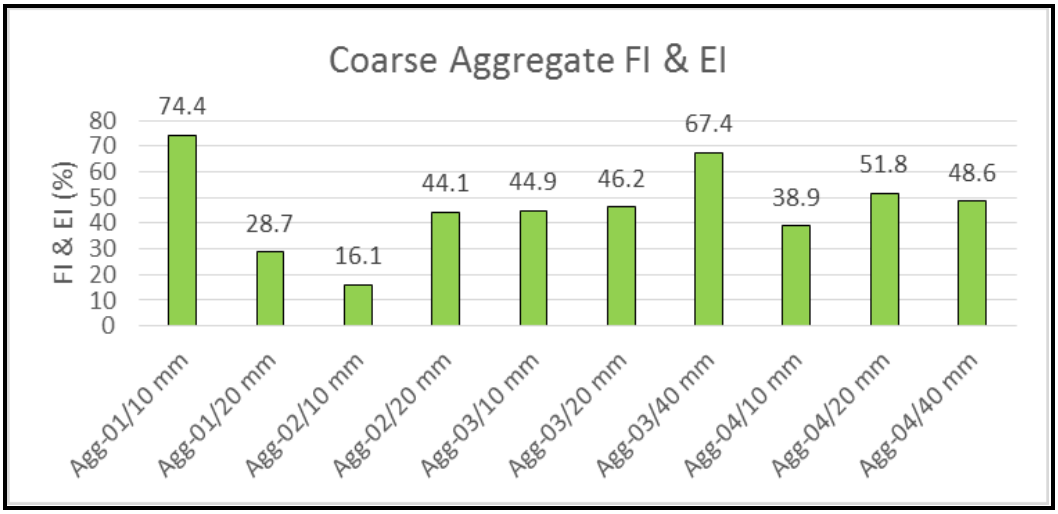
Coarse Aggregate				
Sample ID	**AIV***	**Water Absorption**	**Specific Gravity**	**FI & EI**
Agg-01/10 mm	21	1	2.724	74.4
Agg-01/20 mm	34	0.85	2.859	28.7
Agg-02/10 mm	23	0.95	2.702	16.1
Agg-02/20 mm	21	0.8	2.758	44.1
Agg-03/10 mm	25	0.5	2.982	44.9
Agg-03/20 mm	22	0.9	2.689	46.2
Agg-03/40 mm	24	0.6	2.652	67.4

Coarse Aggregate				
Sample ID	**AIV***	**Water Absorption**	**Specific Gravity**	**FI & EI**
Agg-04/10 mm	25	0.4	2.62	38.9
Agg-04/20 mm	28	1.05	2.658	51.8
Agg-04/40 mm	26	0.9	2.642	48.6









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 **Sangam** which is approximately 24 km from the plant location. Sand samples were collected from this location. Details are provided below.

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.

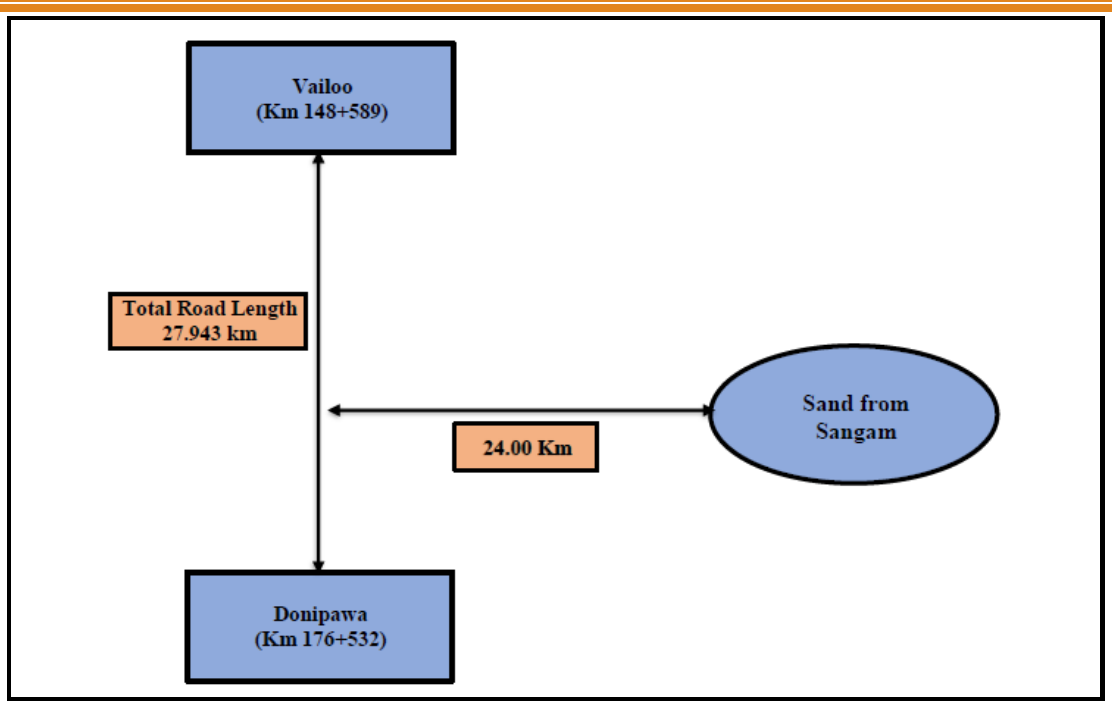
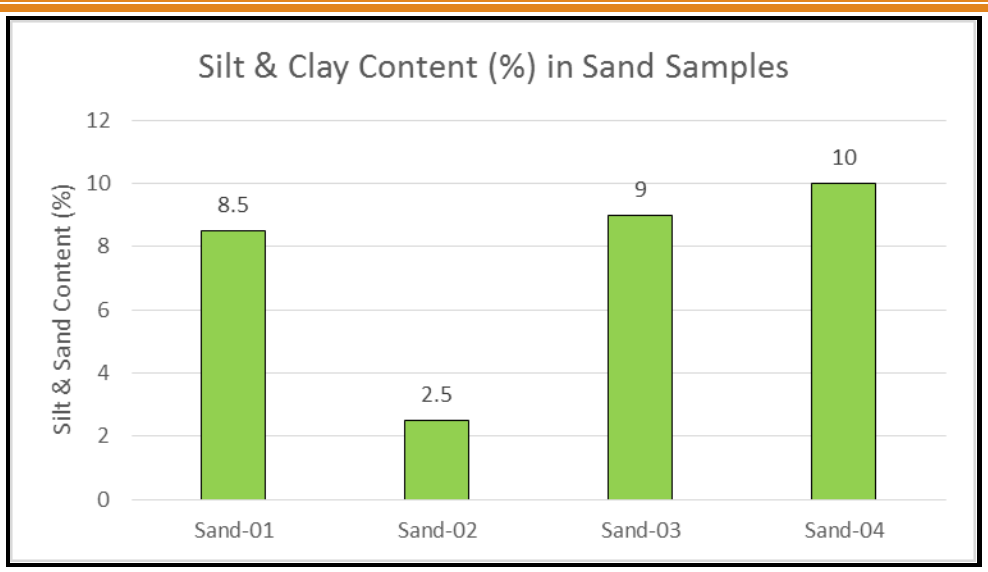
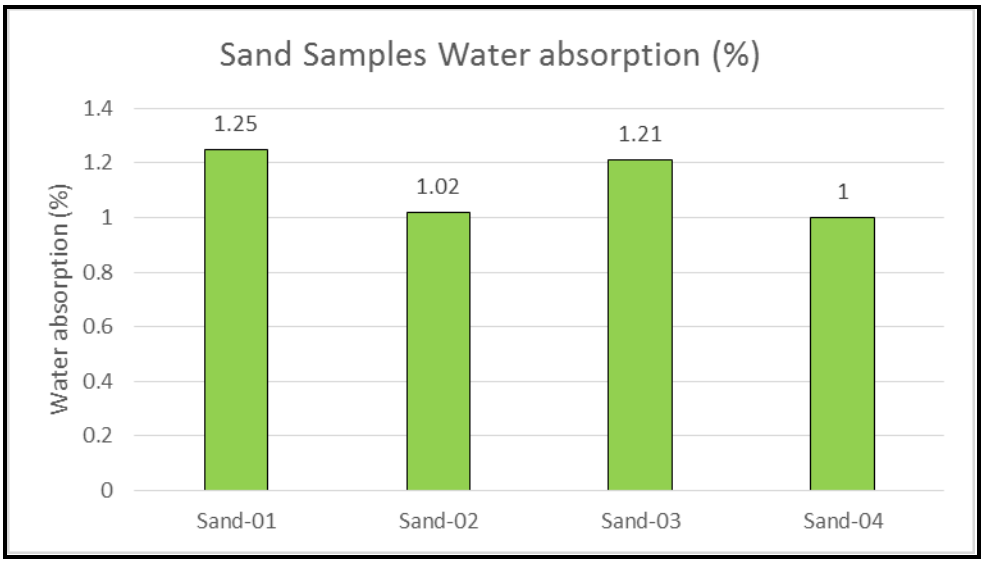
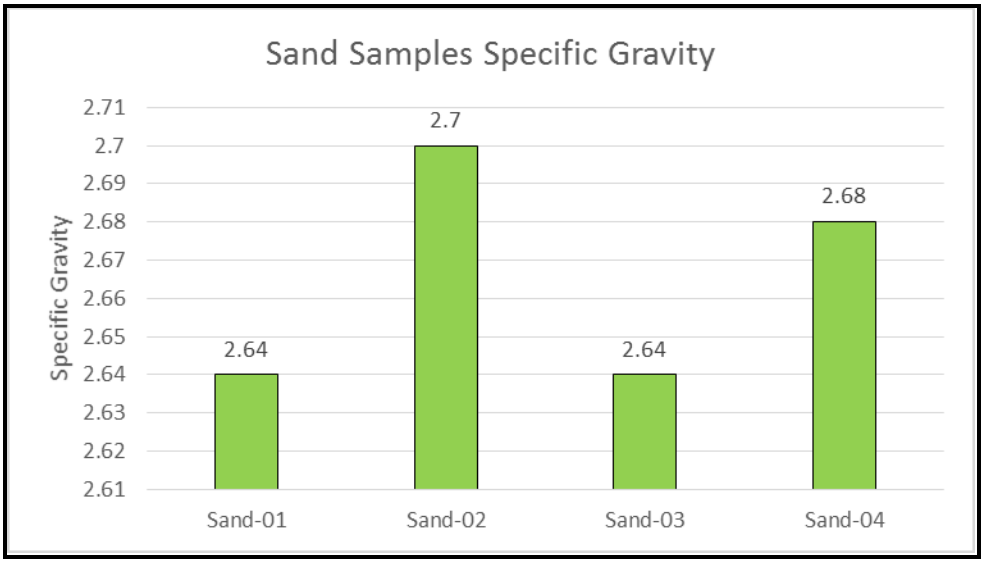


Table 5.2 Test Results of Fine Aggregates

Source of Fine aggregate (sand) – Sangam (Anantnag)											
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	97	89	76	62	32	9	2.3	8.5	1.25	2.64
Sand-02	99	95	87	79	56	13	3	3.4	2.5	1.02	2.7
Sand-03	100	94	88	76	51	27	9	2.5	9	1.21	2.64
Sand-04	100	99	90	73	63	34	10	2.2	10	1	2.68


Silt & Clay Content (%) in Sand Samples
Silt & Sand Content (%)
12
10
8
6
4
2
0
8.5
2.5
9
10
Sand-01
Sand-02
Sand-03
Sand-04


Sand Samples Water absorption (%)
Water absorption (%)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1.25
1.02
1.21
1
Sand-01
Sand-02
Sand-03
Sand-04


Sand Samples Specific Gravity
Specific Gravity
2.71
2.7
2.69
2.68
2.67
2.66
2.65
2.64
2.63
2.62
2.61
2.64
2.7
2.64
2.68
Sand-01
Sand-02
Sand-03
Sand-04

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.

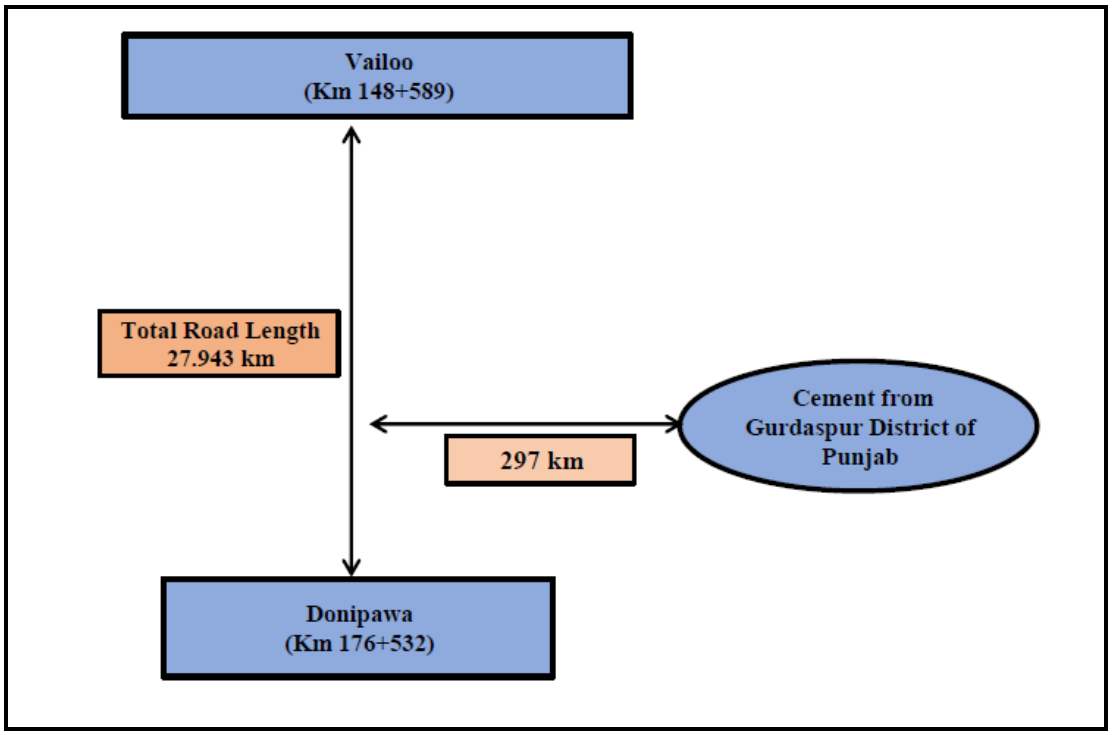


Figure 6.1 : Lead chart for Cement

6.3 Steel

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

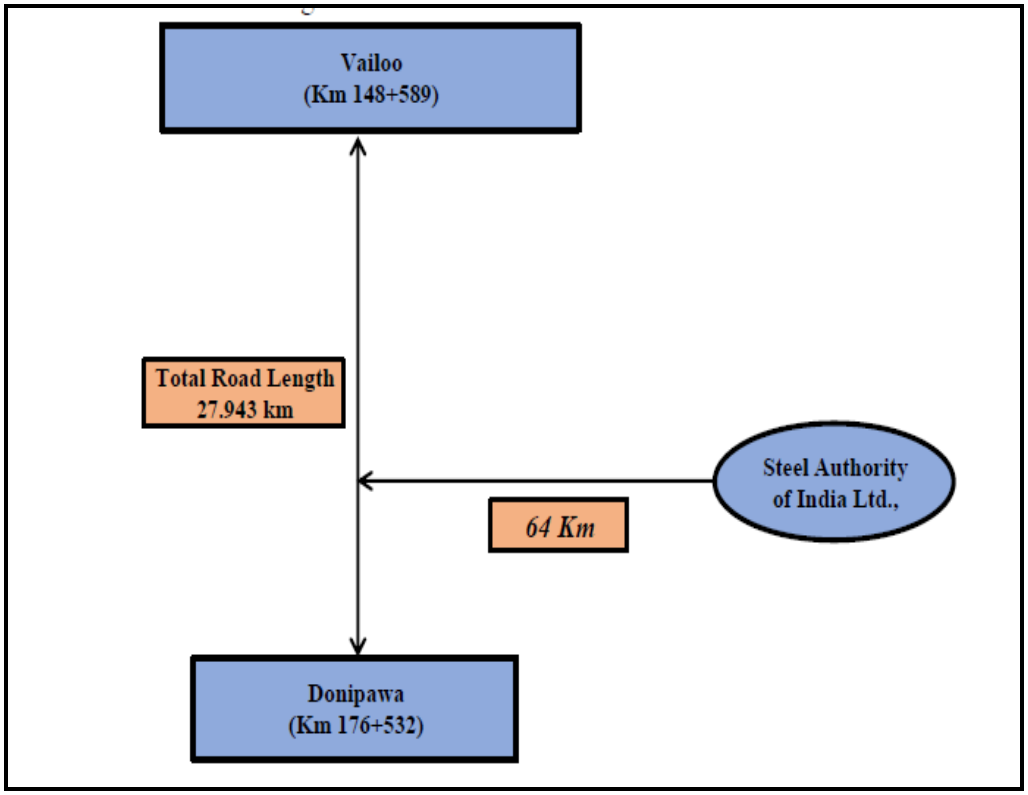


Figure 6.2 : Lead chart for Steel

6.4 Bitumen

Bitumen **(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, Jammu** having lead distance of 215 km from batching plant.

6.6 Bearings

Bearings for the Bridge work is taken from **Sanfield (India) Limited, Bhopal**.

6.7 Expansion joint

Bearings for the Bridge work is taken from **Sanfield (India) Limited, Bhopal**.

6.8 Prestressing System

Prestressing System for Bridge work is taken from **Freyssinet Prestressed Concrete Company Ltd (Maharashtra).**

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, NP-4 Pipes etc. are available indigenously in the major cities and specialized agencies are available to execute such works.