BUILDING INFRASTRUCTURE - BUILDING THE NATION

राष्ट्रीय राजमार्ग एवं अवसंरचना विकास निगम लिमिटेड

NATIONAL HIGHWAYS & INFRASTRUCTURE DEVELOPMENT CORPORATION LTD.

FINAL DETAILED PROJECT REPORT
SUDHMAHADEV - DRANGA TUNNEL

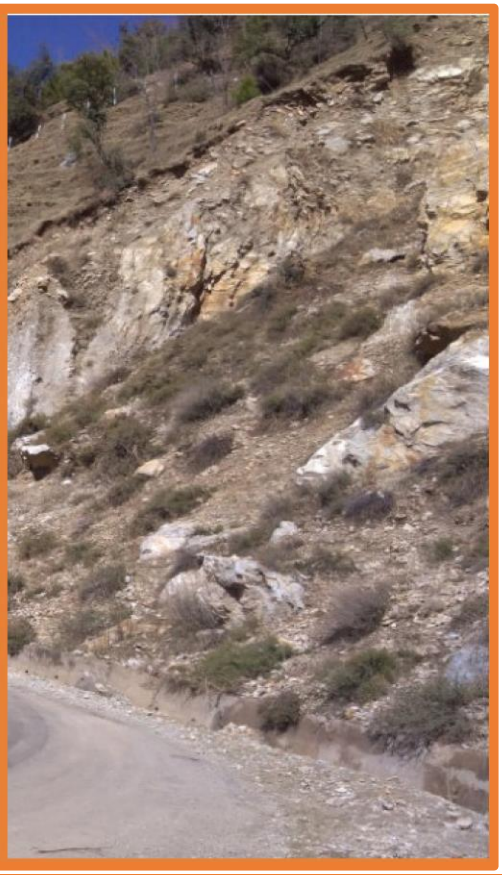
CONSULTANCY SERVICES FOR PREPERATION OF DETAILED PROJECT REPORT AND PROVIDING PRE-CONSTRUCTION ACTIVITIES IN RESPECT OF THE FOLLOWING STRETCH ON NH-244 (OLD NH-1B) IN THE STATE OF JAMMU AND KASHMIR.

(1) SUDHMAHADEV- DRANGA TUNNEL OF APPROX. LENGTH 4.5 KM AND ITS APPROACH ROAD ON CHENANI - SUDHMAHADEV- GOHA ROAD PORTION.

(2) VAILOO TUNNEL OF APPROX. LENGTH 10.0 KM UNDER SINTHAN PASS AND ITS APPROACH ROAD ON GOHA-KHELLANI- KHANABAL ROAD PORTION.

(3) ROAD PORTION FROM 82.675 TO 82.925 AT KM 83 ON BATOTE-KISHTWAR ROAD SECTION OF NH-244.

(4) EXTENDED ROAD SECTION FROM GOHA TO KHELLANI OF 30 KM LENGTH



PACKAGE-1 – KM 0+000 TO KM 6+405
PACKAGE-2 – KM 6+405 TO KM 12+850
VOLUME - III - MATERIAL REPORT

FEBRUARY 2020

getinsa-euroestudios

tpf INGENIERÍA

IN ASSOCIATION WITH

Rodic

TPF GETINSA EUROESTUDIOS S.L.
Unit 305, Suncity Business Tower, Golf Course Road,Sector 54 Gurgram Haryana - 122002 India
Email : indiacentral@tpfingeneria.com

RODIC CONSULTANTS PRIVATE LIMITED
1, Jai Singh Marg (First Floor), YMCA Cultural Centre Building, New Delhi – 110001 (INDIA)
Email :contact@rodicconsultants.com

TABLE OF CONTENTS

1. INTRODUCTION

1.1 The Project Road

Project road section falls in the Udhampur and Doda Districts of Jammu and Kashmir. The project road starts at approach road of Sudhmahadev – Dranga Tunnel and runs North east till Dranga village.

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.

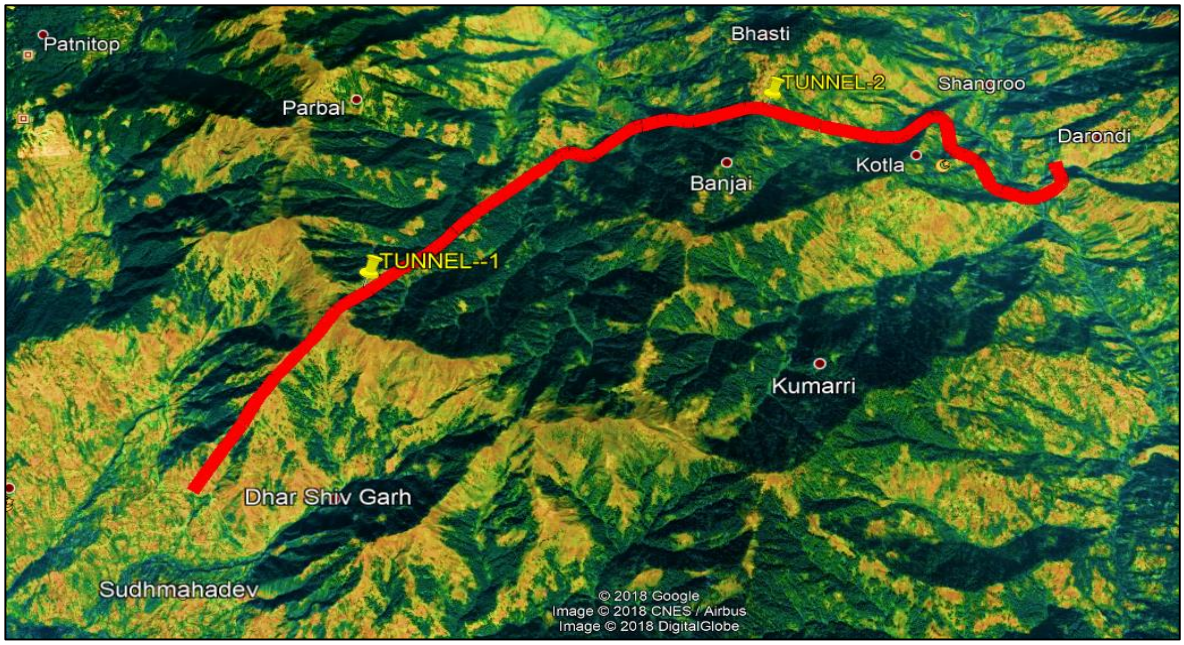


Fig- 1.1- Location Map of the Project

1.2 Objective of Consultancy Services

The main objective of the consultancy is to establish the technical, economic and financial viability of the project and prepare Detailed Project Reports for development and construction of Project Tunnels and approach roads. The viability of the project shall be established taking into account the requirements with regard to construction of project tunnels as per Annexure-I based on Tunnel alignment & design, approach

roads and design of new bridges and structure, quantities of various items of works, cost estimates and economic analysis.

The Detailed Project Report would inter-alia include detailed Tunnel alignment design, Geotechnical studies and design report, Bore log report, Topographic Survey report, Study of Seismicity, Study of Water samples, Chemical analysis of water samples, Detailed Tunnel design report, design of approach roads, Design of Structures, Technical specification for road tunnels, E & M lighting and other fixed operating equipment, Snow & Avalanche protection measures if any, 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.

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 characterization 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 behavior 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:

1. Introduction

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

2. Preliminary Studies

   This provides information on the broad physical set-up of the project and the

preliminary desk studies carried out.

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.

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.

5. Quarry Materials for Construction

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

6. Manufactured Materials

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

7. Other Construction Materials

   Other construction materials like water, fly ash, high tensile strands, etc. are dealt with in this 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 entire proposed project road is in the state of Jammu and Kashmir. The state occupies a total area of 222,236 square kilometers. Jammu and Kashmir borders with the states of Himachal Pradesh and Punjab to the south. Jammu and Kashmir has an international border with China in the north and east, and the Line of Control separates it from the Pakistan. Jammu and Kashmir consist of three divisions: Jammu, Kashmir Valley and Ladakh, and is further divided into 22 districts.

In southern part of Udhampur and Doda district brown soil under Deciduous Forest are found. Colour of the soil is dark-brown and varies from dry loams to silt loams with gravels in a small percentage.

In Kathua and Jammu mainly alluvial soils are found, which are loamy with little clay content and contain small quantity of lime with high magnesium content.

There are three parallel belts widely apart from Forest and Hill soils, one stretching from Poonch to Kathua in Jammu province second North West of Jhelum valley in Kashmir province and the third belt stretching from south eastern part of Ladakh range. The soils are generally mixed with pebbles.

In middle Ladakh range two isolated patches (one in Ladakh and another in Doda district) of Podzolised soil occur over a long stretch.

In Poonch, Udhampur and Anantnag district sub-mountain soils are mainly found. In the valley this soil is cultivated intensively, and rice is the main crop.

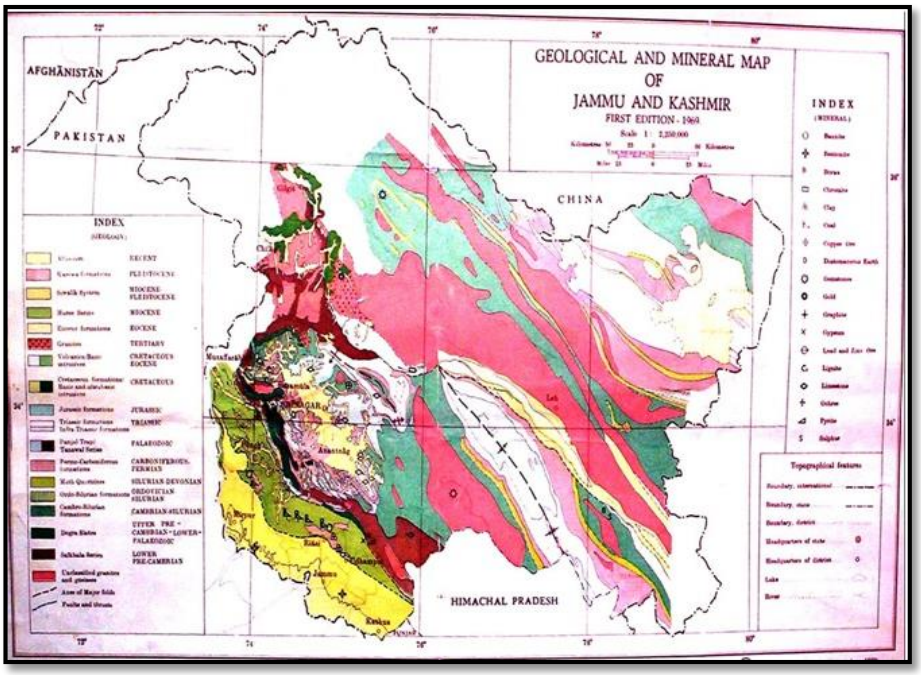


Fig 2.1

2.3 Terrain & Soil Type

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 mostly loose and silty sand & gravel with very low moisture.

2.4 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.

Indus valley (Ladakh) Comprises Crystalline complex of rocks ranging in composition from sedimentary igneous and metamorphic in characteristics.

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.

Geology of Project Area

In this valley, the project area around tunnel 1 has exposed limestone, dolomitic limestone, quartzite and calcareous quartzite belonging to Gamir Formation (Raina and Gupta 1985-86). These are best exposed along the road section between the Gauri Kund Temple and Gau Karan in this valley. The total length of this tunnel is about 5400m. Western portal of this tunnel is placed at an elevation of El. 1719m and its co-ordinate is N 3654820.2900, E 533679.4208. Eastern portal of this tunnel 1 is placed at an elevation of El. 1640m and its co-ordinate is N 3658906.1040, E 537193.3143.

Along the tunnel 1 alignment, grey platy limestone and calcargillite with occasionally thin bands of carbonaceous phyllite of Baila Formation may be encounter after Gamir Formation. Baila Formation is considered to be Precambrian in age on the basis of its stratigraphic position between Gamir and Ramban formations, both regarded to be Precambrian in age.

Ramban Formation represents an important Lithostratigraphic constituent of the 'Parautochthon' in this part of Lesser Himalaya where it is present throughout the belt. This formation is underlying by Baila Formation. Phyllite, slate, carbonaceous shale and limestone of Ramban Formation is expected to be encountered along tunnel alignment.

Stratigraphically Sincha Formation is the uppermost formation of the 'Parautochthon' in the area. Northern and eastern part of this formation is bounded by the regional tectonic plane namely the Panjal Thrust which juxtaposes it against the Salkhalas. Its contact with the underlying Ramban Formation is inferred to be disconformable,

though in the Ramban and Chenab valley section it is a tectonic contact (Digdaul Thrust) (Raina and Gupta, 1985-86). Dolomite, dolomitic limestone, limestone and quartzite of this formation may be encountered along the tunnel alignment.

Highly crushed, fragmented, disturbed zone etc. are usually associated Panjal Thrust in the Chenab valley is observed and projected in tunnel alignment. This plane has a NW-SE trend, moderate to steep dip due northeast and juxtaposed the Salkhalas of the Kashmir Synclinorium zone against the Sincha Formation to the south.

Entire length of tunnel 2 falls in Salkhala formation. The total length of this tunnel is about 2670m. Western portal of this tunnel is placed at an elevation of El. 1590m and its co-ordinate is N 3659480.7971, E 538218.5068. Eastern portal of this tunnel is placed at an elevation of El. 1500m and its co-ordinate is N 3659358.8211, E 540885.6060. Rock types expected to be encountered are mica schist, phyllite, carbonaceous phyllite, quartzite with patches of metavolcanis of Salkhala formation.

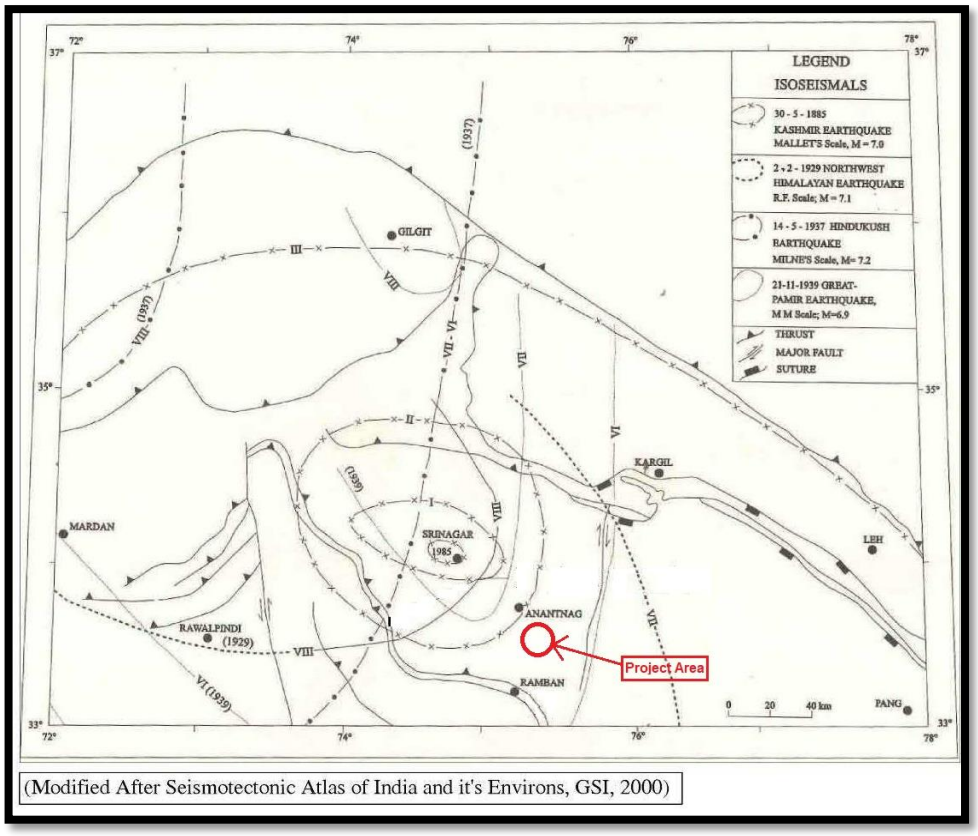
2.5 Seismotectonic & Seismicity

Classically, the 'Parautochthonous zone in the Jammu and Kashmir lesser Himalaya is bounded by two important and regional tectonic plates, namely Murree Thrust in the south and Panjal Thrust in the north. However, formational names like 'Gamir and 'Baila' as assigned by Rao et al, (1975) to the lower part of 'Parautochthon' in the Poonch sector, are adopted in the present area in lieu of 'Chandrakot Formation and the 'basal unit' of limestone – argillite of the Ramban Formation respectively. The various formations met with the 'Parautochthon' from south to north and in the ascending order of stratigraphy, therefore, are Sauni Volcanic, Ranbhirpura Quartzite, Gamir, Baila, Ramban and Sincha. In addition, Rajpur Formation (Eocene) is found as linear, disconnected strips over Sauni Volcanics and occasionally over Gamir Formation as outliers.

Muree Thrust is a regional tectonic plane which delimits the 'Parautochthon' to the south. It is a moderate to steep angle, sometimes sub vertical, reverse strike faults, along which the Precambrian Sauni Volcanics are juxtaposed against the Murrees to the south. The northern limit of Parautochthon' is defined by an important tectonic plane of

regional magnitude, namely Panjal Thrust. This plane is traced from west/south – west of Sanikund in the northwest through west/southwest of .2866 and .2833, Smel, northeast of Shurmug an upper reach of Chhamp Nallah in the southeast. This plane has a NW-SE trend, moderate to steep dip due northeast and juxtaposed the Salkhalas of the Kashmir Synclinorium zone against the Sincha Formation to the south.

The project area lies in a seismically active region affected by several earthquakes of varying magnitude. With respect to large magnitude earthquakes, it lies between iso-seismal I and II of the M=7.0 Kashmir Earthquake of 30th May, 1885 with the epicenter at Jampur, 19.5 km west of Srinagar (Figure 2.2.). More recently, the project area was affected by the M=7.6 Muzaffarabad Earthquake of 8th October 2005 and it fell between iso-seismal VI and VII. With respect to other important earthquakes in the region, the project area lies close to the iso-seismal VII of 21st November 1939 Great Pamir Earthquake (M=6.9) and iso-seismal VI-VII of the 14th May 1937 Hindukush Earthquake (M=7.2).



(Modified After Seismotectonic Atlas of India and it's Environs, GSI, 2000)

Figure 2.2: Iso-Seismal Map of Project Area

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.

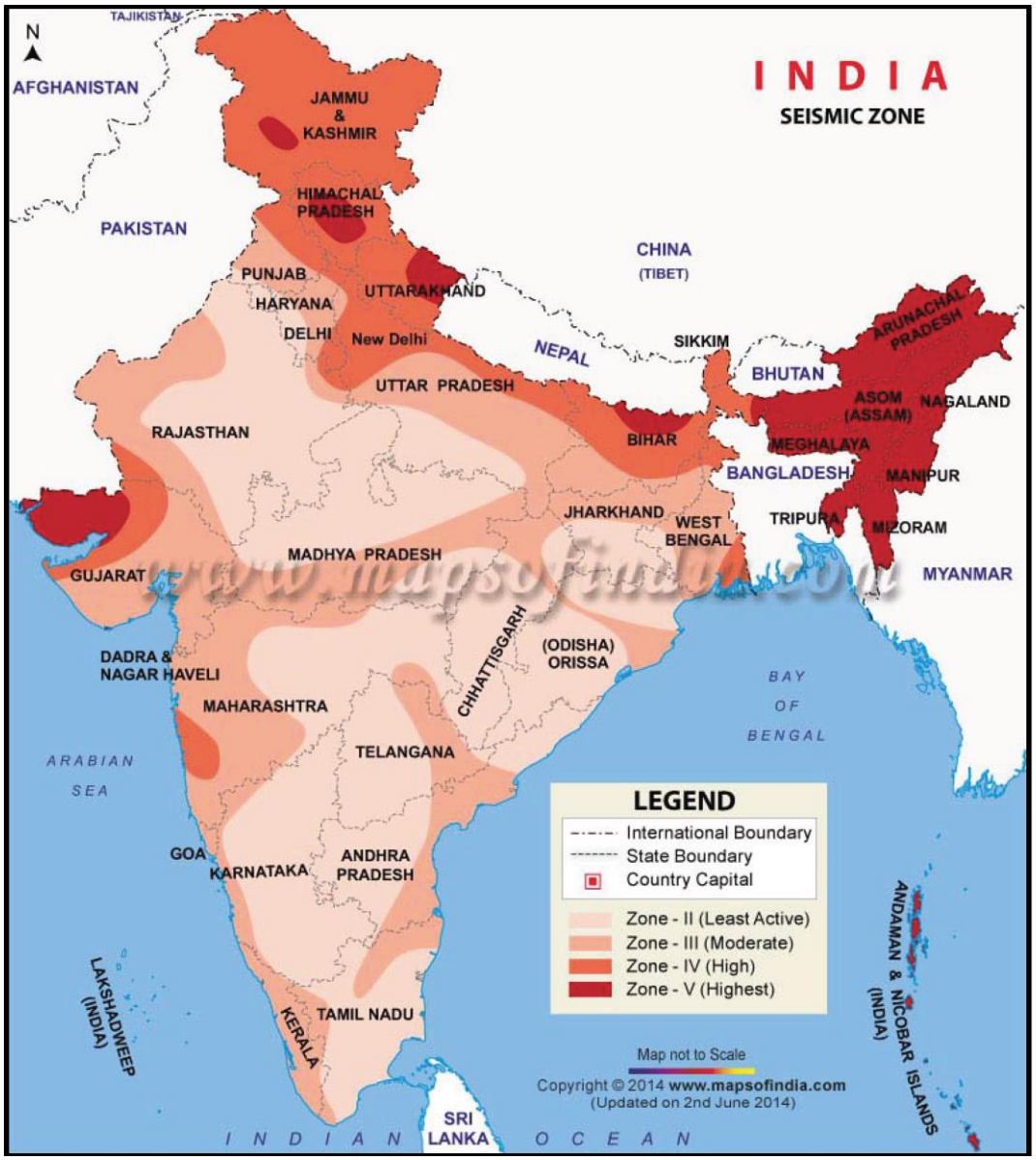


Figure 2.3: Seismic Zones

2.6 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.

Ladakh is the coldest place of Jammu and Kashmir. The climate is very dry and climate. The place has a long and severe winter with the temperature going down to more than 40 degree below zero. River Zanskar, with its fast and furious waters and huge waterfalls freezes completely and huge ice sheets hang much to the astonishments of the beholders. Drass in Ladakh is the coldest place. Due to heavy snowfall, Ladakh remains cut off for the major part of the year. The night temperature usually remains below zero from September to May. The temperature in summers however soars to 45 degrees making it extremely hot. The mountains are bare and barren.

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 Udhampur and Doda district of Jammu & Kashmir.

Doda

Doda District is situated at 33.0845°N, 75.3252°E. Doda is a District in eastern part of Jammu Division of the Indian state of Jammu and Kashmir. The district consists of 8

Tehsils: Bhagwa, Assar, Doda, Gundana, Marmat, Bhaderwah, Gandoh (Bhalessa), and Thathri. The district is surrounded by Anantnag district of Kashmir Division on its north, Kishtwar district in the northeast, Chamba area of Himachal Pradesh in the south, Kathua district in the south, Udhampur district in the southwest and Ramban district in the west. It has an area of 2625 Sq Kms. The district can be classified by its climate as humid subtropical. There are most famous mountain peaks in District Doda like Marble Pass, Nunkun on the Suru Border which rise to a height of 2300 ft. above sea level. Two other famous peaks are Brahma and Moon Sikle. It is the third largest in terms of Area after Leh & Kargil.

The District is endowed with vast wealth of natural beauty and resources. Full with natural endowments, scenic splendour, places of tourist interest, Worship, round the year snow cladded mountain peaks and challenging tracks allure the adventurers and trekkers not only from India but also from abroad. The District has good potential for tourism including pilgrim and adventure tourism owing to its captivating scenic splendour, pilgrim centers and lofty mountain peaks. Monuments of archaeological importance in the district include a fort at Bhaderwah, Bhandharkot fort in Kishtwar and Ghajpat Qila at Ramban.

Udhampur

Udhampur District covers an area of 4,550 square kilometers (1,760 Sq.m) in the Himalayan Mountains. The upper reaches of the district experience snowfall in the winter season. The city of Udhampur is located at 32.93°N 75.13°E in a relatively flatter part of the district at an elevation of 756 meters (2480 feet) and rarely experience any snowfall. Temperature varies considerably in the Udhampur District, as the altitude ranges from 600–3,000 meters (2,000–9,800 ft.). Chenab, Ans, Tawi and Ujh are the main rivers. The district is rich in minerals such as coal, bauxite, gypsum and limestone.

2.7 Rainfall

Across from the Pir Panjal range, the South Asian monsoon is no longer a factor and most precipitation falls in the spring from southwest cloud bands. Because of its closeness to the Arabian Sea, Srinagar receives as much as 635 millimeters (25 in) of rain from this

source, with the wettest months being March to May with around 85 millimeters (3.3 inches) per month. Across from the main Himalaya Range, even the southwest cloud bands break up and the climate of Ladakh and Zanskar is extremely dry and cold. Annual precipitation is only around 100 mm (4 inches) per year and humidity is very low. In this region, almost all above 3,000 meters (9,750 ft) above sea level, winters are extremely cold. In Zanskar, the average January temperature is −20 °C (−4 °F) with extremes as low as −40 °C (−40 °F). All the rivers freeze over and locals Make River crossings during this period because their high levels from glacier melt in summer inhibits crossing. In summer in Ladakh and Zanskar, days are typically a warm 20 °C (68 °F), but with the low humidity and thin air nights can still be cold.

2.8 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.

2.9 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.

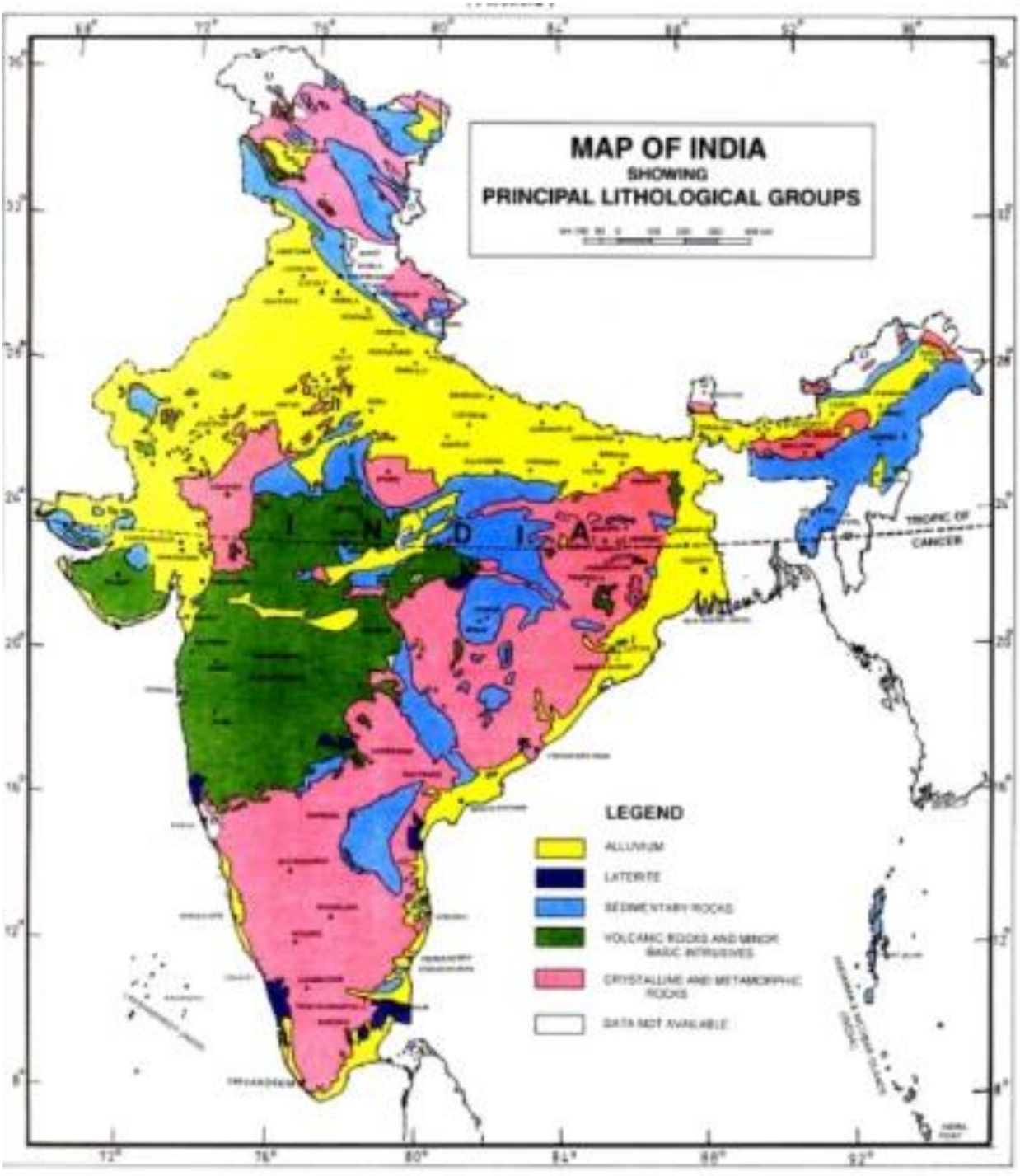


Fig 2.3 Lithological Map of India

3. SURVEY AND 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 Topographical Survey

Topographical Survey has been carried out of the project area and it is covered in detail in Volume -I Main Report.

3.3 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)

3.4 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.	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+050	2.140	7.00	11.20	20	19	12	7	100	100	100	90	70	51	29	SM-SC	10	61	29
2	05+450	2.090	8.00	9.7	15	18	14	4	100	100	94	85	69	57	31	SM-SC	15	54	31
3	06+700	2.070	9.20	10.7	15	19	13	6	100	100	100	97	95	85	32	SM-SC	3	65	32
4	09+370	2.100	7.00	11.0	5	NP	NP	NP	100	100	100	96	87	67	17	SM	4	79	17
5	10+000	2.068	8.70	10.8	10	NP	NP	NP	100	100	100	95	92	86	37	SM	5	58	37
6	10+500	2.180	7.60	10.3	5	NP	NP	NP	100	100	100	91	89	82	29	SM	9	62	29
7	11+000	2.065	8.50	11.20	15	20	13	7	100	100	100	97	95	82	34	SM-SC	3	63	34
8	11+500	2.700	8.90	11.50	10	NP	NP	NP	100	100	100	95	92	86	34	SM	5	61	34
9	12+000	2.190	8.60	11.80	5	NP	NP	NP	100	100	100	91	89	82	30	SM	9	6	30
10	12+500	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 10% is taken.

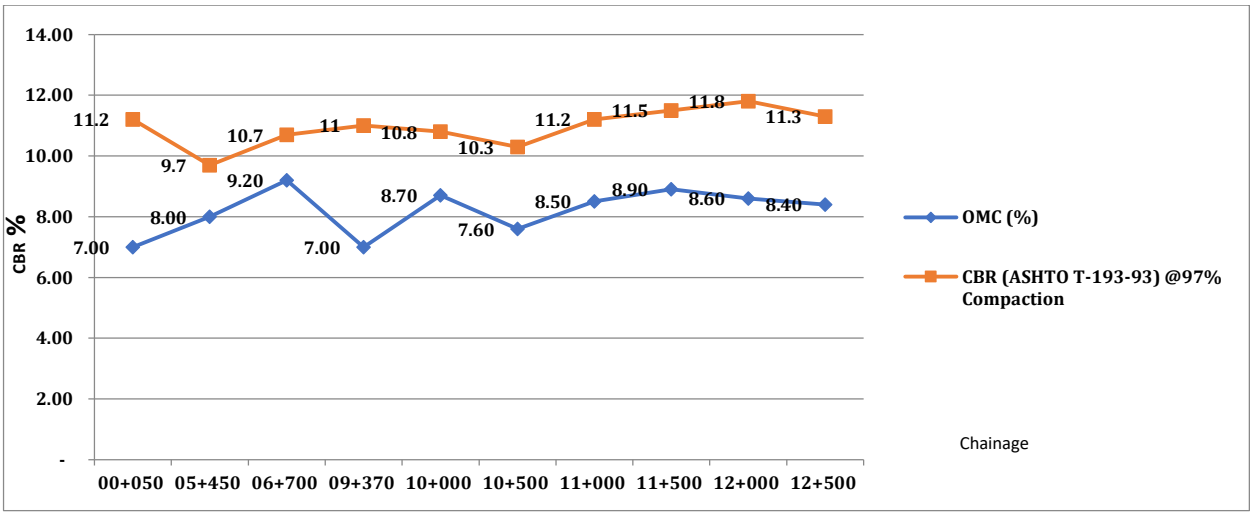


Fig. 3.2 Comparative Plot of Moisture Content & CBR at 97% MDD of Existing Subgrade Soil

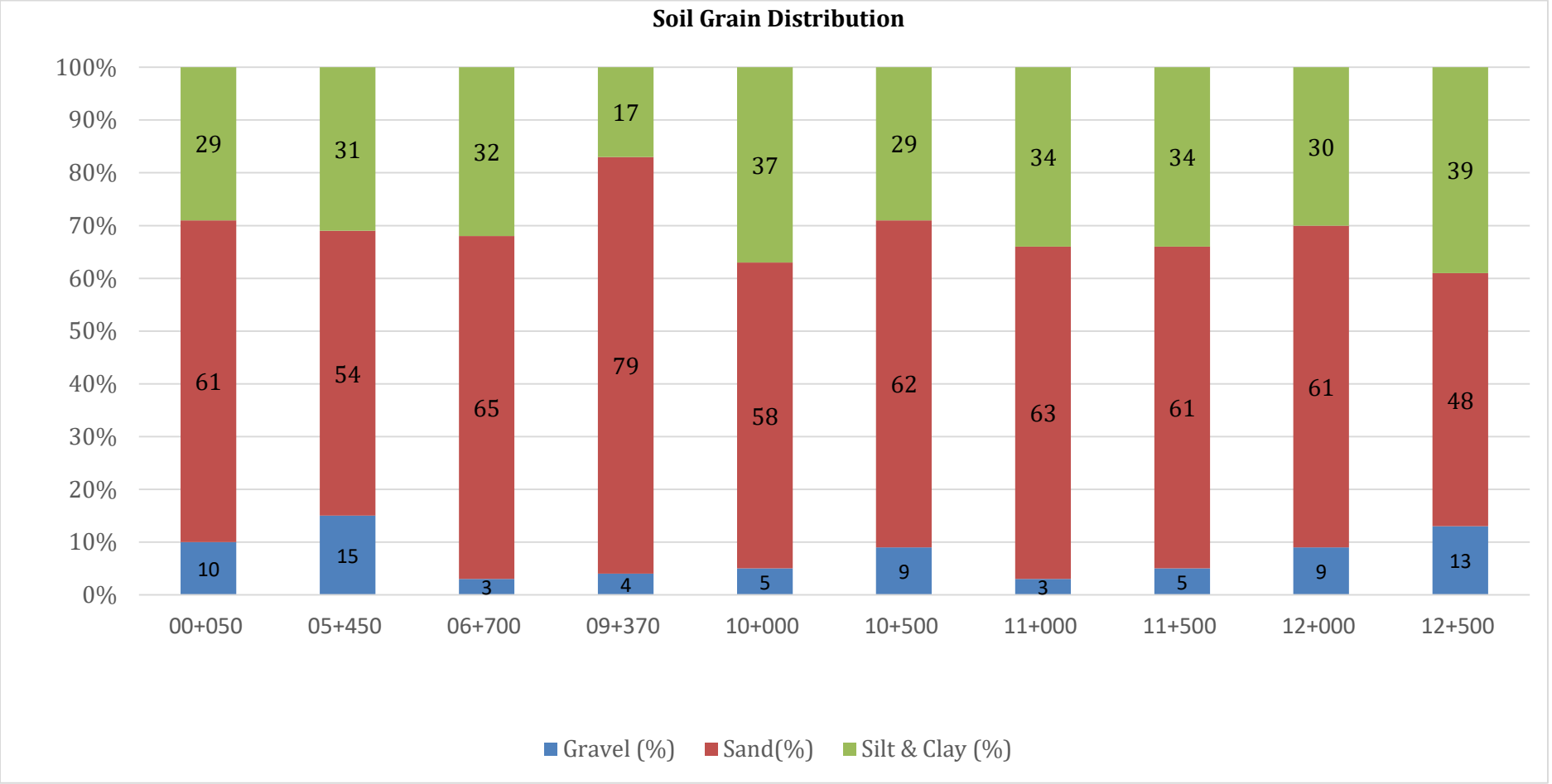


Fig. 3.3 Soil Grain Distribution at different locations

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, kilometer 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 Borrow Area (Excavated Soil) Material

S. No.	Proposed Chainage (km)	Modified Proctor		4-Days Soaked CBR (%)	FSI (%)		Atterbergs 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+050	2.140	7.00	11.20	20	19	12	7	100	100	100	90	70	51	29	SM-SC	10	61	29
2	05+450	2.090	8.00	9.7	15	18	14	4	100	100	94	85	69	57	31	SM-SC	15	54	31
3	06+700	2.070	9.20	10.7	15	19	13	6	100	100	100	97	95	85	32	SM-SC	3	65	32
4	09+370	2.100	7.00	11.0	5	NP	NP	NP	100	100	100	96	87	67	17	SM	4	79	17
5	10+000	2.068	8.70	10.8	10	NP	NP	NP	100	100	100	95	92	86	37	SM	5	58	37
6	10+500	2.180	7.60	10.3	5	NP	NP	NP	100	100	100	91	89	82	29	SM	9	62	29
7	11+000	2.065	8.50	11.20	15	20	13	7	100	100	100	97	95	82	34	SM-SC	3	63	34
8	11+500	2.700	8.90	11.50	10	NP	NP	NP	100	100	100	95	92	86	34	SM	5	61	34
9	12+000	2.190	8.60	11.80	5	NP	NP	NP	100	100	100	91	89	82	30	SM	9	6	30
10	12+500	2.084	8.40	11.30	5	NP	NP	NP	100	100	100	87	84	77	39	SM	13	48	39

4.4 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.

4.5 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%

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 near Kah Mod (on NH-44) which is around 37 km from the plant location.

5.4 Requirement of Aggregate for concrete work

Based on the estimation of concrete and shotcrete quantities, the total requirement of

coarse and fine aggregates shall be as follows,

- Coarse Aggregates 4.25 Lakh m^3
- Fine Aggregates 2.75 Lakh m^3

The total losses are to be accounted in the quantity estimation of raw material from quarry site to batching plant for producing aggregates for the following.

- Rejection at Quarry Site
- Transit losses from quarry to aggregate processing plant
- In process rejection
- Transit losses from aggregate processing plant to batching plant

Total losses have been considered as 50%. The total quantity of raw material for production of coarse & fine aggregate shall be as follows,

- For coarse aggregates 6.38 Lakh m^3
- Fine aggregates 4.12 Lakh m^3
- Total Qt. 10.50 lakh m^3

With the consideration of 60% as swelling factor, the total requirement of raw material shall be **16.80 Lakh m^3**.

It is proposed to use the tunnel excavated material for the production of aggregate. As per the preliminary analysis of rock along the tunnel alignment, 25% of excavated material of tunnel can be utilized for the aggregate production.

- Total Tunnel excavation quantity 15.54 Lakh m^3
- Considering swelling factor 24.86 Lakh m^3
- Usable quantity (25%) 6.21 Lakh m^3
- Remaining requirement of raw material 10.59 Lakh m^3

Remaining requirement of raw material shall be fulfilled through the identified quarries.

5.5 Laboratory tests

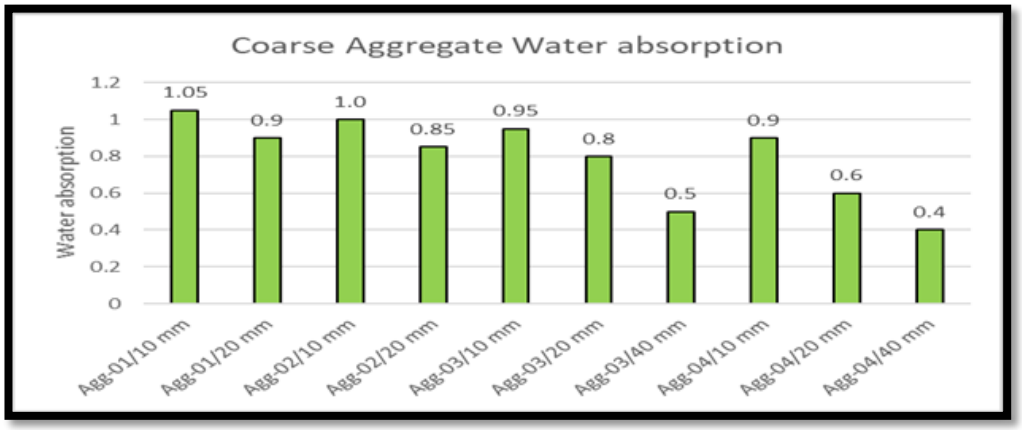
Representative Samples of stone aggregates collected from the quarries have been subjected to the following laboratory tests:

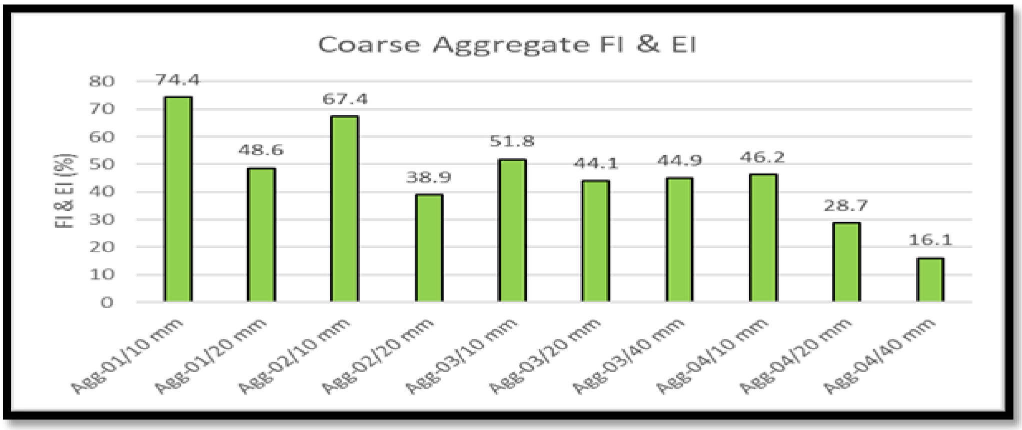
- Aggregate Impact Value — As per IS : 2386 (Part – 4)
- Specific Gravity — As per IS : 2386 (Part - 3)
- Water Absorption — As per IS : 2386 (Part – 3)

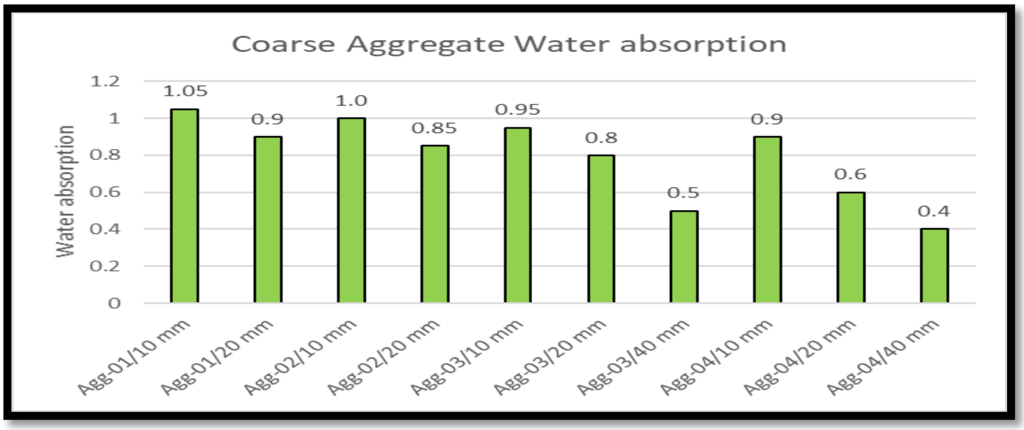
Results of the laboratory tests for coarse and fine aggregates are provided in Table 5.1 & 5.2 respectively.

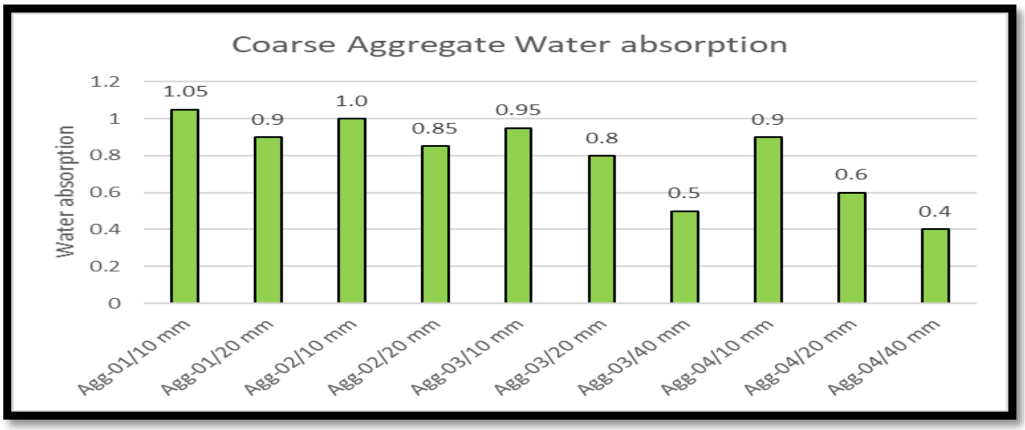
Table 5.1 Test Results of Coarse Aggregates

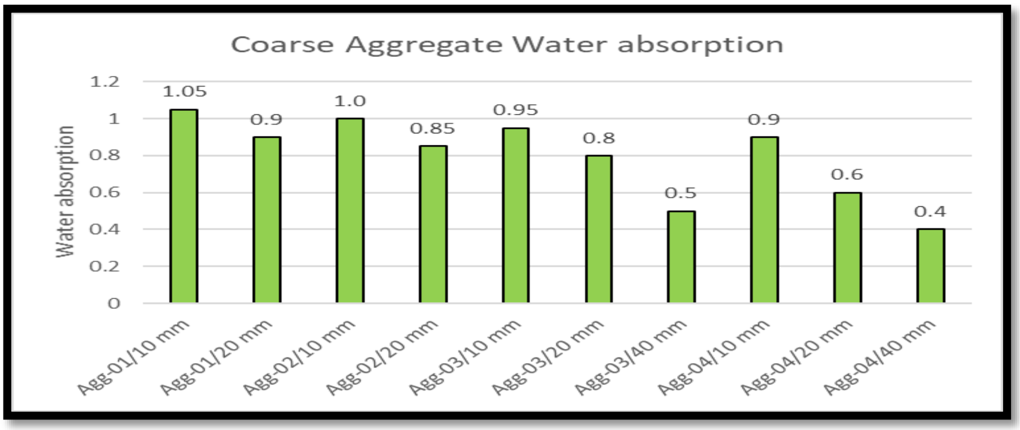
Sample ID	AIV*	Water absorption	Specific Gravity	FI & EI
Agg-01/10 mm	25	1.05	2.620	74.4
Agg-01/20 mm	23	0.90	2.658	48.6
Agg-02/10 mm	22	1.00	2.642	67.4
Agg-02/20 mm	23	0.85	2.689	38.9
Agg-03/10 mm	21	0.95	2.652	51.8
Agg-03/20 mm	25	0.80	2.724	44.1
Agg-03/40 mm	26	0.50	2.859	44.9
Agg-04/10 mm	25	0.90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

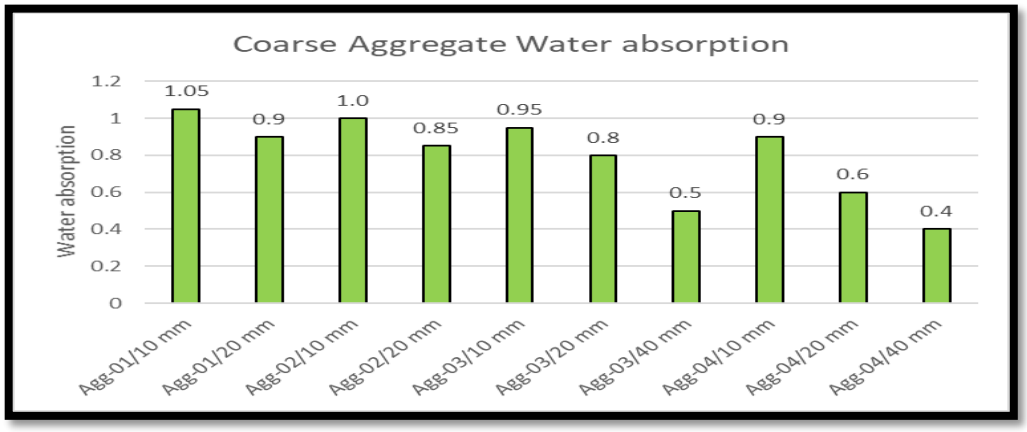



Coarse Aggregate FI & EI
FI & EI (%)
74.4
48.6
67.4
38.9
51.8
44.1
44.9
46.2
28.7
16.1
Agg-01/10 mm
Agg-01/20 mm
Agg-02/10 mm
Agg-02/20 mm
Agg-03/10 mm
Agg-03/20 mm
Agg-03/40 mm
Agg-04/10 mm
Agg-04/20 mm
Agg-04/40 mm


Coarse Aggregate Water absorption
Water absorption
1.05
0.9
1.0
0.85
0.95
0.8
0.5
0.9
0.6
0.4
Agg-01/10 mm
Agg-01/20 mm
Agg-02/10 mm
Agg-02/20 mm
Agg-03/10 mm
Agg-03/20 mm
Agg-03/40 mm
Agg-04/10 mm
Agg-04/20 mm
Agg-04/40 mm


Coarse Aggregate Water absorption
Water absorption
1.05
0.9
1.0
0.85
0.95
0.8
0.5
0.9
0.6
0.4
Agg-01/10 mm
Agg-01/20 mm
Agg-02/10 mm
Agg-02/20 mm
Agg-03/10 mm
Agg-03/20 mm
Agg-03/40 mm
Agg-04/10 mm
Agg-04/20 mm
Agg-04/40 mm


Coarse Aggregate Water absorption
Water absorption
1.05
0.9
1.0
0.85
0.95
0.8
0.5
0.9
0.6
0.4
Agg-01/10 mm
Agg-01/20 mm
Agg-02/10 mm
Agg-02/20 mm
Agg-03/10 mm
Agg-03/20 mm
Agg-03/40 mm
Agg-04/10 mm
Agg-04/20 mm
Agg-04/40 mm



5.6 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.

5.7 Sand Quarry

Sand can be made available from Nud (Sambha, Jammu) which is approximately 100 km from the plant location. 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

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**.

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).**

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 ground water has been found to be the main sources 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 Test of Water Sample

Water used for mixing and curing should be clean and free from injurious amount of oils, acids, alkalis, organic material and any other substances that may deleterious to concrete or steel. To check its suitability for the construction purpose, chemical analysis of water has been carried out. For this, samples of water are collected from following three locations and tested in the laboratory to determine the chemical properties.

- Thanda Pani
- Singpora
- Vailoo

Summarized Laboratory Test Results are given below:

Table7.1: Results of Chemical Analysis

Test Name	Sample ID			Specification As per IS:456-2000(Max)
	Thandha Pani	Singpora	Vaildo	
pH	7.5	8.2	7.8	>6
Chloride Content (mg/l)	332	282	405	500 mg/l for R.C.C. 2000 mg/l for P.C.C.
Sulphate Content (as SO_4) (mg/l)	103	219	232	400 mg/l
Organic (mg/l)	101	70	85	200 mg/l
Inorganic (mg/l)	213	150	198	2000 mg/l
Total Suspended Solids (mg/l)	12	22	17	2000 mg/l
Acidity as mg/l $CaCo_3$	15	20	12	Not require more than 5ml of 0.02 normal NaOH
Alkalinity as mg/l $CaCo_3$	32	40.5	27	Not require more than 25ml of 0.02 normal H2SO4

7.3 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.