

## SECTION - 8

### MATERIALS, LABOURS AND EQUIPMENTS

#### 8.1 MATERIALS:

This chapter covers the details of test and investigation carried out for evaluating the characteristics of the sub-grade along the project corridor to establish the basis for the design of various elements of the road including pavement and sub grade, embankment and structures.

The main task carried out for soil and material investigation includes:

- Collection and Review of available soil data from various division of Sikkim
- Soil classification along the proposed road
- Investigation of sub grade soil
- Investigation of construction material including identification and inspection of potential source of construction material and extraction sites; testing and evaluating of construction material for suitability for project road construction.
- Geo-technical investigation for bridges and other structures.
- Pit test for foundation of structures

#### Investigations

The detailed investigations include both field and laboratory testing. Field work covered field density test, sub-grade soil sampling by excavating test pits, identification of rock sources and soil borrow sources/ quarries within reasonable short haulage distances of the project road. Test pits were also excavated wherever necessary to obtain samples for testing.

Appropriate laboratory tests were carried out on the representative samples of the soil and material obtained during field investigations to determine relevant engineering properties.

#### Standard Test Procedures

The following standard test procedures were followed for field testing, soil sampling and laboratory testing:

#### Type of Test

| S. No | Type of Test  | Adopted as per   |
|-------|---|------------------|
| 1     | Field Density using Sand Replacement Method                     | IS:2720 Part 28  |
| 2     | Water Content   | IS: 2720 Part 2  |
| 3     | Atterberg limits  | IS: 2720 Part 5  |
| 4     | Sieve Analysis  |                  |
| (a)   | Natural Soil  | IS: 2720 Part 4  |
| (b)   | Rock aggregate  | IS: 2386 Part 1  |
| 5     | Heavy Compaction Test   | IS: 2720 Part 8  |
| 6     | CBR   | IS: 2720 Part 16 |
| 7     | Soundness by Sodium Sulphate (Na <sub>2</sub> SO <sub>4</sub> ) | IS: 2386 Part 5  |
| 8     | Aggregate Impact Value  | IS: 2386 Part 4  |
| 9     | Specific Gravity and Water Absorption of Coarse Aggregate       | IS: 2386 Part 3  |

**Notations**

|     |   |                          |
|-----|---|--------------------------|
| CBR | : | California Bearing Ratio |
| LL  | : | Liquid Limit             |
| PL  | : | Plastic Limit            |
| PI  | : | Plasticity Index         |
| NP  | : | Non – Plastic            |
| MDD | : | Maximum Dry Density      |
| OMC | : | Optimum Moisture Content |
| FMC | : | Field Moisture Content   |
| FDD | : | Field Dry Density        |
| DCP | : | Dynamic Cone Penetration |

**Soil Classification**

In case of hill road, the soil classification of the hill face (hill/ valley side) plays an important part. Soil classifications consist of the following:

- Ordinary Soil
- Soft Rock
- Hard Rock

The classification is mostly done visually. The classification is tabulated as follows:

| Sr.No. | Chainage |      | Classification of Soil in % |               |           | Remarks            |
|--------|----------|------|-----------------------------|---------------|-----------|--------------------|
|        | To       | From | Ordinary soil               | Ordinary rock | Hard rock |                    |
| 1      | 0        | 1    | 40                          | 45            | 15        | Soil Mixed Boulder |
| 2      | 1        | 2    | 39                          | 45            | 16        | Soil Mixed Boulder |
| 3      | 2        | 3    | 36                          | 47            | 17        | Soil Mixed Boulder |
| 4      | 3        | 4    | 37                          | 45            | 18        | Soil Mixed Boulder |
| 5      | 4        | 5    | 36                          | 46            | 18        | Soil Mixed Boulder |
| 6      | 5        | 6    | 38                          | 42            | 20        | Soil Mixed Boulder |
| 7      | 6        | 7    | 36                          | 43            | 21        | Soil Mixed Boulder |
| 8      | 7        | 8    | 35                          | 45            | 20        | Soil Mixed Boulder |
| 9      | 8        | 9    | 36                          | 45            | 19        | Soil Mixed Boulder |
| 10     | 9        | 10   | 38                          | 42            | 20        | Soil Mixed Boulder |
| 11     | 10       | 11   | 35                          | 44            | 21        | Soil Mixed Boulder |
| 12     | 11       | 12   | 37                          | 43            | 20        | Soil Mixed Boulder |
| 13     | 12       | 13   | 36                          | 44            | 20        | Soil Mixed Boulder |
| 14     | 13       | 14   | 36                          | 43            | 21        | Soil Mixed Boulder |
| 15     | 14       | 15   | 39                          | 41            | 20        | Soil Mixed Boulder |
| 16     | 15       | 16   | 37                          | 43            | 20        | Soil Mixed Boulder |

**Inspection of Rock Quarry Areas**

The rock deposits are available along or the vicinity of the project road alignment. Besides, cobbles, pebbles and sand deposits are available in the rivers or streams crossing the main alignment. Construction materials for GSB, Cross drainage & Masonry R/Wall etc. works, will be available at local quarry within the project corridor and WMM, DBM & BC material from Teesta River & LANCO Tunnel excavated mug within the project corridor .Water Absorption and AIV of these quarries are within the limit of the Ministry's Specifications. Bitumen, steel and cement will have to be taken from Siliguri.

## 8.2 LABOURS:

Hilly regions are generally sparsely populated. Sikkim is also one of the lowliest populated states of India and population density in the vicinity of the project road is lowest in Sikkim.

Local as well as imported labourers will be engaged for road construction works. Since the area is malaria infested, medical assistance with qualified practitioners will be required during the execution of the project. Comparatively higher wages (from the National average) and incentives have to be paid to labourers for the work. It is envisaged that equipment / machine intensive method would be adopted for proposed construction works.

## 8.3 EQUIPMENT AND MECHANICAL RESOURCES

Taking into account the above factors and to make the construction cost-effective, the activities which can be mechanized to a great extent are given below :

- a) All earthwork activities to be done by using dozers and graders except earthwork in filling for embankment, which will be very little, can be done manually.
- b) All rock cutting works to be done by using air-compressors, wagon-drills, etc. Blasting operations to be done by adopting modern blasting techniques.
- c) Operations like spreading, grading in ordinary soil to be done by using appropriate type of motor graders.
- d) Dozers with rippers for ripping all types of soft rocks. This would minimize use of compressors and blasting material.
- e) Use of front end loaders for loading operations particularly at quarries and crusher points for increasing the utility of dump-trucks.
- f) Use of water-distributors for proper watering and moisture control of various layers formation filling, sub-base and base activities. Suitable sprinkles to be used for each activity.
- g) Use of suitable type of compactors for various activities.
- h) Centrally operated multi-output primary and secondary crushers to be adopted for operation of large quarries for better gradation, quality and production control. Suitable vibro-screens are also to be used at quarry points for production of natural granular materials to the required gradations.
- i) For bituminous works, hot mix plants, bitumen heating plants, asphalt distributors, spreaders, pavers, gritters and power operated brooms can be usefully deployed.
- j) In large scale concreting works truck mixers can be used. In case of major bridge construction activity at one location, concrete pumps can be used.
- k) For protective works backhoes, berm rollers/plate vibrators can be deployed for controlled excavation and proper compaction.

For the project road, being a trunk route leading to another country, high quality standard required to be achieved in execution of the Work. Therefore, in order to ensure high level of quality control, deployment of modern construction equipment i.e., Hot Mix Plant (HMP – 30/45 TPH), Paver Finisher with Sensor Devise and Vibratory Road Rollers, etc. have been proposed. Minimum requirement of machinery for the project has been listed in Table.

**LIST OF PLANT AND MACHINERY**

| <b>Sn</b> | <b>Description of Machine</b>  | <b>Number</b> |
|-----------|--|---------------|
| 1         | Dozer D-50-A 15  | 2             |
| 2         | Dozer D-80-A 12  | 2             |
| 3         | Hydraulic Excavator of 1 cum bucket  | 8             |
| 4         | Front end Loader 1 cum bucket capacity   | 4             |
| 5         | Motor grader   | 2             |
| 6         | Tipper-5 cum   | 40            |
| 7         | Road Roller  | 2             |
| a         | Vibratory RR Compactor   | 2             |
| b         | Tandem Vibratory Roller  | 2             |
| c         | Pneumatic Tyred Roller   | 2             |
| d         | Static Road Roller - 8 -10 tonne   | 2             |
| e         | Vibratory Earth Rammer / Plate Compactor   | 4             |
| 8         | Primary & Secondary Crusher with Vibratory Screen (50 TPH)   | 2             |
| 9         | Stone Crusher (6/8 TPH)  | 4             |
| 10        | Bitumen Pressure Distributor   | 1             |
| 11        | Water Bounded Macadam Plant  | 1             |
| 12        | Generator Set 160 KVA  | 2             |
| 13        | Generator Set 50 KVA   | 1             |
| 14        | Generator Set 30 KVA   | 1             |
| 15        | Generator Set 11.25 KVA  | 2             |
| 16        | Portable Generator Set (1.5 KVA)   | 4             |
| 17        | Water Tanker   | 10            |
| 18        | Tractor  | 5             |
| 19        | Air Compressor   | 8             |
| 20        | Mixer for WBM  | 1             |
| 21        | Bitumen Pressure Distributor   | 1             |
| 22        | Hot mix Plant ( 30/45 TPH)   | 1             |
| 23        | Mini Hot mix Plant   | 1             |
| 24        | Paver Finisher with Sensor Device  | 1             |
| 25        | Bitumen Boiler Oil Fired   | 1             |
| 26        | Batch type concrete mixer of min. 200 litres capacity with automatic water measuring system and integral weigher | 1             |
| 27        | Concrete Pump of 30 cum capacity   | N/A           |
| 28        | Concrete Bucket  | N/A           |
| 29        | Prestressing Jack with Pump & Access   | N/A           |
| 30        | Grout Agitator and Pump  | N/A           |
| 31        | Welding Machine Sets   | 2             |
| 32        | Oxy-acetylene Torch  | 2             |

| <b>Sn</b> | <b>Description of Machine</b>                         | <b>Number</b> |
|-----------|---|---------------|
| 33        | Winch Machines  | 2             |
| 34        | Grab Shackles and Clamshell buckets crane operated    | 1             |
| 35        | Shear legs  | 1             |
| 36        | Heavy duty dewatering pumps                           | N/A           |
| 37        | Jack Hammer   | 2             |
| 38        | Needle Vibrator                                       | 2             |
| 39        | Plate Vibrator / Screed Vibrator                      | 1             |
| 40        | Rock Cutter   | 2             |
| 41        | Crane of 35 ton capacity                              | 1             |
| 42        | Plate compactor                                       | 4             |
| 43        | Casting truss for span construction                   | N/A           |
| 45        | Work shop   | 1             |
| 46        | Testing and measuring equipments for Field Laboratory | 1 Lot         |