SECTION – 3

ENGINEERING SURVEYS AND INVESTIGATIONS

3.0 ENGINEERING SURVEYS AND INVESTIGATIONS

3.1 TOPOGRAPHICAL SURVEY

a) General

Topographical survey was performed in order to set up a digital terrain model of the area. The survey covered a strip of 30-40 m width with cross sections taken at 20 m intervals.

Topographical surveys included the following:

Control Point Survey
Traversing
Cross-section Survey
Establishing Bench Mark

b) Methodology for Topographical Survey

Topographical survey was carried out with Total Station, Auto level and checked with GPS, state-of-the art instruments. The survey methodology involved the following sequential steps:

Control Points: Establishing control points in the form of temporary bench marks (TBM) at 1 km intervals (approx.) on ground and running traverse along tentative alignment using Total Stations. Reference Pillars consisting cement concrete pillars with central nail point; have been fixed at every 200m to 250m intervals depending upon safe site location.

Traversing**:** Connecting all control points with one or more Benchmarks using precision Auto Level and Total Station.
Cross-section: Taking detailed cross sections at 20 m interval using Total Station. The main features captured in the cross-sections were:

- *all natural ground break-point within the Right-of-Way (ROW)*
- *Property lines within ROW.*

Cross-sections were also taken along intersecting roads to a distance of 200 m for major roads and 50 m for minor roads. 3-point cross-sectional data 100 m upstream and downstream of waterways were also gathered.

The data for each survey point were recorded in terms of Northing and Easting and Elevation to an accuracy of 1 mm.

Establishing Bench Mark: Due to non-availability of Survey of India reference bench mark, bench mark elevation was carried from Singtam Johar Bridge BM pillar. Based on this reference BM, TBMs were established along the proposed road alignment, using auto levels and double leveling method.

In addition, all TS stations were also leveled. Permanent cement concrete pillars were established at 1 km interval.

Chainage Marking : The project road has been marked with chainages on center of pavement at 50 m apart in straight and at 10 m in curve portions. The chainage marking on the road enabled proper inventory of all the items required for design and act as reference points for cross sections.

c) Topographical Survey

Based on the Control / traverse station fixed along the stretch for horizontal and vertical control, surveys using total station were carried out to collect co-ordinate data (Northing and Easting) of all topographical points. The details covered included:

- Road centerline of regrading stretch and trace-cut centerline of re-alignment stretches.
- Left and right edges of existing road pavements
- Connecting roads
- Ground points on both sides of Road centerline and trace-cut centerline for exact computation of quantity.
- Trace-cut in hard rock area is for reference as the alignment points were not approachable due to vertical rock formation.

All man-made features have been surveyed including:

- Water sources including hand pumps, wells, etc.
- CD structures including culverts, bridges, etc
- Slope protection structures such as Retaining wall and Breast walls
- Buildings, huts, boundary walls, etc
- Electric pole, telephone poles , mobile tower etc.

All natural topographical features have been surveyed both in regrading and realignment stretches:

- Streams, channels and water sources
- Ponds and water bodies

Survey for Cross Sections

In order to provide proper design and quantity estimation, cross section survey has been carried out. The cross section survey included collection of elevation and other relevant heights in the corridor width. It contained the topographical survey which is utilized to create a proper Digital Terrain Model (DTM) so as to enable design of road geometrics, plan and profile, cross sections and quantity computations for various items including earth work, sub-grade and pavement.

Plan and Profile

The plan shows the recommended centerline of the regrading and realignment stretches, existing and proposed carriageway structures, drainage courses, intersections, electric and telephone poles, control traverse stations, proposed location of CD works in regrading and realignment stretches. Hill valley sides along with all the villages and habitats coming in proposed route.

The longitudinal section shows the average existing ground level (left and right), the existing centerline levels, the proposed road level, the gradient, details of horizontal alignment and location of cross drainage structures along with cross roads, etc.

3.2 TRAFFIC SURVEYS

In order to establish the traffic characteristics of the project roadway the following traffic surveys were carried out:

i) Classified Traffic Volume Count
ii) Intersection Turning Movement Count Survey
iii) Origin-destination Survey

The methodology of traffic surveys and analysis of results have been presented in "Traffic Surveys and Analyses" in Volume II.

3.3 GEOTECHNICAL INVESTIGATION

Investigation was undertaken to characterise the soil forming the sub-grade by collecting samples by digging pits along the proposed road. Information regarding the top soil strata along the new proposed alignment was also collected.

Laboratory investigations were performed on collected soil samples, according to relevant Indian Standards to determine the engineering properties, namely:

i) Particle size distribution
ii) Atterberg limits
iii) Field density
iv) Field moisture content
v) Compaction characteristics
vi) 4-day soaked CBR

Soil investigation results and analyses have been presented in detail in "Design Report" section.

3.4 MATERIALS INVESTIGATION

Material survey of the area around the project road was conducted to identify the sources of suitable materials which can be used for construction. Samples collected from various sources were tested for their engineering properties and assessed for their suitability to be used in new construction.

Field investigations were performed to gather following information:

i) Identification of suitable sources of granular material for base course.
ii) Testing of physical properties of collected material for granular materials.
iii) Testing of engineering properties for stone aggregates for use in WMM, DBM,BC and cement concrete.

3.5 HYDROLOGICAL INVESTIGATION

Hydrological investigations were carried out for economical design of cross drain structures. These investigations included performance of existing structures, assessment of discharge, HFL and other data as required for design.

Local enquiries were also made regarding HFL and watermarks were observed. For detailed study, site conditions, survey data, meteorological data were studied. Survey for taking cross sections, long sections of existing rivers and drains were carried out as per IRC code requirements.

3.6 ROAD –SIDE GEOTECHNICAL INVESTIGATION

Trial pits were excavated at 5 km intervals in a staggered manner to carry out investigation of field density and moisture content, in-situ CBR, laboratory CBR under control condition and sub grade soil properties.

3.7 ALIGNMENT OPTIONS

3.7.1 Introduction

The objective of the Route alignment study is to determine various alternative alignment options and to identify relative acceptable and preferable alignment. With a view to appreciate the feasibility and relative strength, weakness of the alternative proposals marked on the topo-sheets, and site evaluation of the same have been carried out. This was manifested through identifying the problems, shortcomings along with probable route.

The Project Road from Km 0.00 to Km 32.50 has road geometrics is not upto NH Standards. For the up-gradation of the road to the National Highway Standards, the existing gradients & radius have to be improved for safe and smooth flow of traffic. However, in many stretches, the gradients are very steep and the road has to be realigned. Based on the reconnaissance and other surveys, it is identified that more or less the complete road has to be reshaped. In this effort, there are two situations for improvement of the road geometric:

- Realignment Sections
- Regrading Sections

Re-alignment Sections

The existing road geometric in certain stretches cannot be brought within the permissible level of the road geometric of the National Highway Standards due to several considerations. In view of that, the realignment has been resorted to. We have studied a number of options before finalizing the realignment sections.

Re-grading Sections

The balance portion of the road after realignment is to be regraded in order to remove kinks, undulations, unevenness and fast changing gradients so as to bring the geometrics to the parameters of the National Highway Standards. Efforts have been made to adopt the existing road level in stretches. However, it is to bring it within the parameters of the prescribed geometric standards. In view of that the existing road is to be adopted by cutting, filling and widening as well as by relocation more or less in the same area.

3.7.2 Critical Factors in Alignment Selection

The critical factors to be considered in the selection of the alignment are as follows:

The alignment should meet the geometric standards, particularly the gradients and curvature.
It should avoid acquisition of commercial and residential establishments.
It should avoid costly land acquisition.
It should be as directional as possible, i.e. least distance.
It should facilitate smooth traffic dispersal.
It should be environment friendly.
It should have minimum provision of structures.
During the detailed topographical survey, the existing road centre line has been marked on the ground and details surveys have been obtained on the existing road. However, in hard rock and hazardous areas the trace-cut is serving as reference line only.

3.7.3 METHODOLOGY

The Methodology Adopted Is Described As Follows :

Step – 1: Contour Map Study

Contour sheets are very important for fixing the alignment of the road and to design the road geometric, particularly in the hill road. Based on the contours, approximate alignment options have been studied taking into account the level difference between take-off and the terminal points. This exercise was done with a view to have an approximate understanding of the alignment options. The alignment marked on the contour sheets are planned to achieve the required length

Step-2: Satellite Image Study
Satellite image is very useful for fixing of the new alignment. Satellite image gives three dimension picture of the project area. Based on the contours, clear view of water channel & terrain condition, approximate alignment option has been studied. This exercise was done with a view to have a better understanding of the alignment option.

Step-3: Fly Level Survey

After the detailed study of the contour sheets and the available data, fly level survey of the entire road was carried out by using Auto Levels and the support instruments in order to generate the road profile. The gradients of various alignment options were generated in the shape of strip plan showing gradient of proposed road.

Comparative Statement for Option Study Airport Road

Sr. No.	Description	Option-1	Option-2	Option-3	Option-4	Remarks
	At Ranipool (Intial Stretch)					
1	Take off point	From Ranipool Bridge right bank of Rani khoola	Agriculture college approach road which 700m form Ranipool Bridge	Science centre approach road road which 2100m form Ranipool Bridge	Industrial area approach road which 13 00m form Ranipool Bridge	To Bye pass the heavily built-up Ranipool Bazar Portion
2	Length of alignment	2800 m	2000 m	1000m	800	Follow the Rani khoola RHS Bank then behind the SARAMSA Garden in Option-1
3	Ending point	Km 3.4	Km 2.48	Km 2.48	Km 1.28	On Existing Ranipool – PaKyong road
4	Length of Bridge	(1400+30+42)m	(200+30+42)m	(380+30+42)m	(200+30+42)m	
5	Nos of Bridge	3	3	3	3	1 new bridge & 2 Existing Bridge
6	Alignment passes through	Along the Rani Khoola	Agr Coll. Land & NH 31A Built up portion	Smile Land NH 31A Built up portion	Industrial Area NH 31A Built up portion	Op-2 to Op-5 Land cover building
7	Compensation & LA	Very small	Required	Required	Required	
	At Sinking Portion from Km 7.80 to Km 11.50					
8	Take off point	Km 7.40	Km 7.40	Km 7.40	Km 7.40	Near the 4th Bridge
9	Length of alignment	3.54 Km	3.54 Km	3.54 Km	3.54 Km	Bye the Sinking & Sliding Portion
10	Ending point	Km 12.57	Km 12.57	Km 12.57	Km 12.57	At Pakyong short cut route
11	Total Length of Road	18.70 Km	19.20 Km	18.00 Km	19.36 Km	Including all diversion
12	Total Length of Bridge	1472 m	272 m	322 m	272 m	Including 3rd & 4th existing
13	No of Cross Drainage	90	106	106	106	
14	Rm Protection work	3000	4900	4900	4900	
15	Compensation	Minimum	High	High	High	
16	Geometry	Very good	Zig-zag road	Very good	Zig-zag road	
17	Land acquisition	Very small	Very high	Very small	Very high	