2. PRELIMINARY SITE INVESTIGATION

2.1 INTRODUCTION

2.1.1 Feasibility Criteria

For a bridge site to be technically feasible, the following criteria shall be fulfilled.

1. The span of the bridge and its type is within the limit of the present day design scope of the trail bridge.
2. The river flow, its discharge, its direction. Its meandering tendency, its width, its high flow level and bank conditions must be favorable for a durable bridge.
3. The tendency of the river to erode its banks, its bed erosion, its silting and filling up of the bed has to be studied and evaluated.
4. The presence of rivulets, springs, drains, irrigation channels in the vicinity of the bridge site has to be marked and their effect on the bridge design shall be considered.
5. Vegetation should be present on the bank and slope area around the site.
6. The access trail to the site should not be too long or unjustifiable by cost analysis.
7. The bridge site should not be far away from the existing traditional crossing and trail.
8. The steepness of a soil slope should be less than 35°, while that of a rock slope should be less than 50°.
9. In case of a rock slope, the site should be free of signs of highly fractured or highly jointed planes and rock falls or loose rocks (boulders or blocks) deposits at the foot of the slope.
10. The bedding of the rock slope is not parallel or nearly parallel to the slope direction.

The preliminary technical feasibility study of a site is usually done at the office through desk study. And in detail it is also done at the site.

2.1.1.1 Desk Study

The study of a bridge site is carried out at the office:
1. for evaluating the technical feasibility of the site and
2. for preparing a preliminary survey report before going to the site for a detailed survey.

The studies are done on the basis of the following materials:

i. Literature Review

It is required to collect all the papers concerning the bridge site. It may be reports on the traditional crossing at the site or any technical data may be published by different institutions regarding its hydrology, metrology, geo-morphology, etc.

ii. Topographic Maps

There are different topographic maps published in the country by different offices. They are generally used for specific purposes like administrative, political, agricultural, other development projects, etc. The Trail Bridge Section (TBS), formerly the Suspension Bridge Division with the support of Suspension Bridge Project, Helvetas has published and is updating the *Main Trail Map, *Central Service Map and the *Population Density Map. There are also several detailed topographic maps produced by the Survey Department. These maps can be used as such:

1. Topographic Maps

This maps are produced by Department of Survey of HMG/N in cooperation with Government of Finland. With the help of this map, the following knowledge about the site can be gained:

the trail network and the settlements of the area,

the general trend of the river course, its width, its gradient and its catchment area,

The steepness of the slope, its morphology and profile,
The presence of rivulets, crest, trough, rocky cliffs, scarps, land slides, forestation,
With the above information, the bridge axis and bridge type can be proposed.

2. Main Trail Map (Transport Infrastructure Map)

This map is in the scale 1:125,000. This main trail map (Transport Infrastructure Map) was prepared in 1988-1989 by the SBD with the support of Helvetas for planning trail bridge constructions in the country. Trails linking regional, zonal and district headquarters connected to places with dense infrastructure and population, and also trails linking other important places with motor road-heads are defined as main trails.

With the help of this map, the following information can be collected:

The main and local trails,
The river system, major crossings, existing crossing facilities and the area of influence of the proposed bridge,
For construction management, the location of road-heads, road types, portering days, stations for stores, etc.
For the design load, evaluation of settlements, places of Melas, Bazaar and temples, etc.

iii. Air Photographs

Aerial photos are in the scale 1:50,000 or sometime 1:10,000. Care should be taken about the changes, especially in the land use, residence extension, morphology, etc. if the photos are old. Photos for some projects or land use may be of larger scale such as 1:10,000. These days, there are photos taken from satellites. With the help of aerial photos, the following information can be visualized:

- The topography and the steepness of the slopes and their approximate relief,
- The slope morphology. The constituents of the slope, e.g., rock, soil and other details
- The river course and its meandering nature,
- In rock slope, the formation layers approximate dip and strike of structural planes,
- Possible location of bridge site, bridge type and even the approximate span.

iv. Geological Maps

Geological maps can be made available from the topographical department. With the help of these maps, the following information can be drawn:

- The general geological formation of the area,
- The rock types of the area,
- The structural formation of the rock mass, i.e., the bedding, the folds, the anticline, the syncline and uniformity, etc.,
- The soil type and the relief, etc.

v. Checklist and Desk Study Report

There are separate Survey Forms and Checklists for the SSTB and LSTB standard bridges.
The SSTB Survey Form and Checklist is prepared in a way that even a technical person of lower academic qualification (Sub-Overseers) can conduct the site assessment work after a short-term training for the job. The guidelines are practical, illustrative and lead to the conclusion through a step-by-step assessment of the necessary conditions for a good bridge site. The form includes notes, guidelines, instructions and a list of all the required equipments, forms and survey instruments for a survey.

The Survey Form and Checklist for the LSTB is prepared for experienced engineers. The engineer should be familiar with the LSTB standard bridge. He must be able to judge the site on the basis of facts, revealed by a geo-technical survey. An engineer geologist should carry out the survey in exceptional cases, when the geology of the site is complicated.

The checklists are the following:

- Form 1 - Preliminary study for alternative sites
- Form 2 - Slope study and site selection
- Form 3 - Rock investigation
- Form 4 - Geological Plane investigation
- Form 5 - Transit cross profile
- Form 6 – Soil Investigation
- Form 7 – Triangulation
- Form 8 – Summary of triangulation and elevations
- Form 9 – Tachometry
- Form 10 – Design parameters

vi. Preliminary Survey Report

Before going to the site for a detailed survey, it is recommended that an engineer geologist prepare a "Preliminary Survey Report". This report is in fact a technical feasibility report with further instructions for a detailed site survey. This report is prepared on the basis of all available relevant reports, topographic maps, aerial photographs, geological maps, Main trail Maps or Transport Infrastructure Maps and district maps.

The report, in general consists of :

1. General information of site location and adjoining trails
2. River system,
3. The geomorphology and three probable sites,
4. Probable bridge type and its approximate span,
5. Recommendations and Instructions for necessary studies at site,
   e.g. required checklists, soil and rock investigations and photographs

2.1.1.2 Preparation for Survey

The following preparatory work must be completed before going to the field for the survey:

- Collect maps with tentative location of the bridge and any available background information.
- Collect the survey equipment.

Survey equipment consists of the following materials:

For Survey by Abney Level
- Abney Level, Survey Form and Checklist
- Measuring Tape (50 or 100 m and 3 m)
- Red Enamel Paint and Paint Brush
- Marker Pen, Scale and A3 Graph Paper
- Camera and Film Roll
- Hammer
- Ranging Rod (prepared at site)
- Calculator, Note Book and Pencil
- Nylon Rope (min. 50 m) Masons Thread

For Survey by Theodolite
- Theodolite, Tripod and Staff
- Measuring Tape (50 m and 3 m)
- Red Enamel Paint and Paint Brush
- Marker Pen, Scale and A3 Graph Paper
- Camera and Film Roll
- Hammer
- Survey Form and Checklist
- Calculator, Note Book and Pencil
- Thread and Plumb Bob

2.1.1.3 Site Reconnaissance

During the site reconnaissance survey, the following work shall be done:

1. Make sure of the location of the traditional crossing point,
2. A meeting with local inhabitants has to be conducted, and their ideas on site conditions, river flow nature, high flood level, traffic flow, slope stability and material availability, etc. shall be discussed. Particularly, in the case of the SSTB standard site survey methodology, such communication with local people is a must.
3. The follow-up of instructions and recommendations, stated in the preliminary report, shall be performed at the site.
4. Walkover observation of the site 500 m up and downstream of the crossing point shall be done. Check if the recommended sites in the preliminary report are the same.
5. Mark the bridge span, bridge type and slope stability at the initial stage. And after self judgment of appropriate sites, make a detailed observation of the conditions defined by the technical feasibility criteria
6. Study of site condition as per checklist recommended in the preliminary report.

The main features of the observation are:

a. Hydrological condition

By hydrological condition of the site, we understand the following:

1. The rainfall or precipitation at the site area.
2. The catchment area, the discharge and the high flood level of the river.
3. The presence of forestation in the valley and basin upstream of the site
4. The frequency of high floods
5. Number of rivulets, their sizes
6. The presence of seepages

b. River Morphology

Regarding river morphology, we study the shape of the river.

1. Whether the river flow is 1) Perennial or non-perennial and 2) Calm or turbulent
2. Whether the river is fordable / non-fordable / fordable in dry season
3. Whether the river is highly / moderately / non-erosive or filling up
4. How is the river contour at the river banks?

c. Geological Condition

Regarding geological condition of the site, we should study the general geomorphology and geology of the site. There are separate standard Survey Checklists prepared by the Trail Bridge Section for SSTB and LSTB standard trail bridges.

The general geological conditions of a site must reflect, at least, an area covering 300 - 400 meters from the proposed bridge site. A general sketch of the area shall be drawn. The location of any landslide, fault or scarp shall be marked on the sketch. The limits of rock, soil and alluvial deposits have also to be marked. Photographs of the site corresponding to the area shall be taken accurately. Checklist No. 2: Slope study and site selection provides information about slope and bank morphology.

For a study of the geological condition, test pits shall be dug in case of soil slope. The pit size should be 0.80 x 1.5 m^2. The depth of the pit shall be at least 1.5 m. For tower foundation, it should be 2 m. In case of highly weathered rock or fractured rock, the depth must be up to the fresh rock.

For a study of the soil, Checklist No. 2 and 6 have to be used. For a rock study, Checklist No. 2, 3, 4, 5 and 6 should be used.

Samples from the rock site for each location of the anchorage blocks shall be collected for study at the office. Similarly, samples from the soil site shall include a mixed sample from the top to the bottom soil, and one sample from the bottom layer of each pit has to be collected.

d. Topographical Condition

- Study of bridge site slopes: Should be stable, free of landslides, rivulets, seepage, rock fall or debris slide, erosions, etc. The bridge axis should be selected along the crest of the slope as far as practicable.
- The bridge should have the shortest possible span and sufficient freeboard (generally $\geq$ 5.0 m or even more in a deep gorge) from the highest flood level to the lowest point of any bridge anchorage foundation or the cable alignment, whichever is lower.
- Tributary: Select a site far from confluences, delta formation should be avoided.
- Excavation for the anchorage foundation should be minimum and should not disturb the stability of the natural slope.
- Possible type of bridge, i.e., suspended or suspension, which also affects the site selection.
- Structural features: Weathering, fracture, developments, opening of fractures should be minimum. Planes dipping along the direction of the slope or development of wedge patterns, folded and faulted rocks should be avoided as far as possible.
- River bank morphology: Should be stable, free of erosion or landslides, transverse bank profile preferably straight or convex towards the river, smooth bank, etc.
- The river flow direction should preferably be parallel to the bank to avoid bank erosion, should not have meandering tendency.
- The bridge site should be selected within the trail system, at or near the traditional crossing .Any deviation from the traditional crossing point should be acceptable both to the traffic and from the socio-economic point of view.