Government of Zimbabwe

Guidelines for the

Design and Construction *of* Suspension Footbridges

International Labour Office (ILO)
Advisory Support, Information Services, and Training (ASIST)

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Contents

Glossary of Terms

Whenever encountered in these guidelines, the following abbreviations stand for the defined terms.

BS	–	British Standards
CAS	–	Central African Standards
DCP	–	Dynamic Cone Penetrometer
DL	–	Dead Load
DoR	–	Department of Roads in The Ministry of Transport and Communications, Zimbabwe Government
FOS	–	Factor of Safety
HFL	–	Highest Flood Level
ILO/ASIST	–	International Labour Organisation: Advisory Support, Information, Services and Training
LL	–	Live Load
RDC	–	Rural District Council
SAZ	–	Standards Association of Zimbabwe
SDC	–	Swiss Agency for Development and Cooperation
Sida	–	Swedish International Development Agency
SKAT	–	Swiss Centre for Development Cooperation in Technology and Management

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Eng. V. E. Chipuru
Harare

Preface

In 1997 a Rural Travel Study (RTS) was carried out in Zimbabwe. A pilot project was implemented with financial backing from Sida and technical and advisory support from the Rural Travel and Transport Component of ILO/ASIST. The implementation involved support to three rural district councils in Zimbabwe. The major intervention involved construction of footbridges in rural areas. The knowledge and skills required for the construction of these footbridges are not available at District Council level. This expertise, which exists in Government of Zimbabwe provincial offices, is limited and over subscribed while the Government has a blue print for standard suspension footbridges, these standard designs need to be adapted for each site.

It was decided, with concurrence of the Government of Zimbabwe, to develop standard designs at twenty metre span intervals from twenty (20) to one hundred and sixty (160) metres. The standard designs were to be used mainly by Rural District Council engineers with minor design adaptation on site. The ultimate goal was to build capacity at district level for construction of suspension footbridges. The ILO/ASIST was requested by the Government to develop guidelines for site investigations and the construction of suspension footbridges based upon the actual construction of at least one suspension footbridge.

This *Guideline* was developed from a variety of sources, including: previous experience in Zimbabwe and Asia; information gained from interviewing the users of footbridges; and notes and observations taken during the construction of the pilot suspension footbridge in Zaka Rural District in the Masvingo Province of Zimbabwe. This document is intended to be used for guidance only and should not be used as a 'bible' on suspension footbridge design the district engineers should complement this manual with sound engineering judgement.

Foreword

This *Guideline* is based on both the experience gained during the construction of suspension footbridges in Zimbabwe and the technical documents of SKAT. The latter documents are based on the SDC'S experience in Nepal.

The *Guideline* covers various aspects of suspension footbridge construction including site investigations, estimation of quantities, tendering for contractor execution, construction procedures, resource management and maintenance of the structure once it is in service. It is intended to complement standard procedures and drawings of footbridges in Zimbabwe.

The procedures recommended in the *Guideline* may not be applicable in all countries. It is therefore important that the structural strength and construction procedures are verified by a qualified engineer before the commencement of construction.

Chapter 1

Preamble

1.1 Suspension and Suspended Footbridges

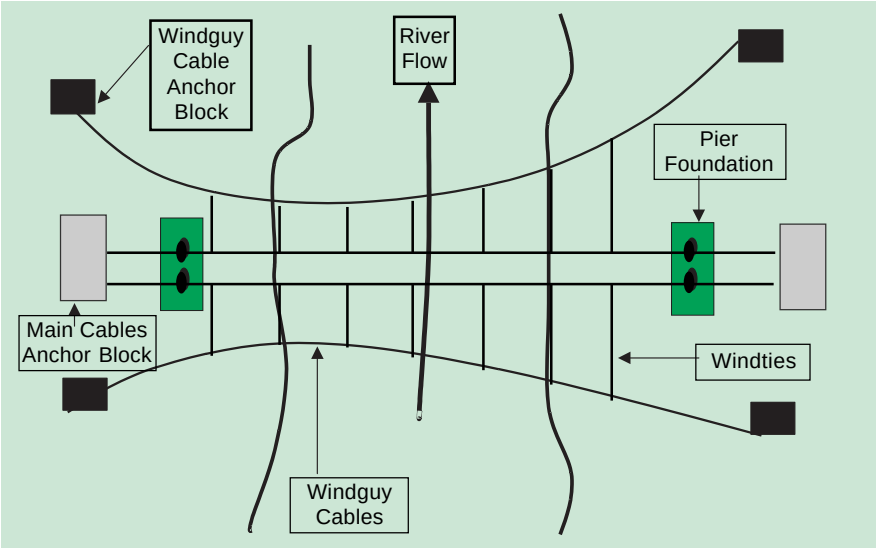
Two cable-supported footbridges are commonly used:-

- The Suspended Footbridge; and
- The Suspension Footbridge.

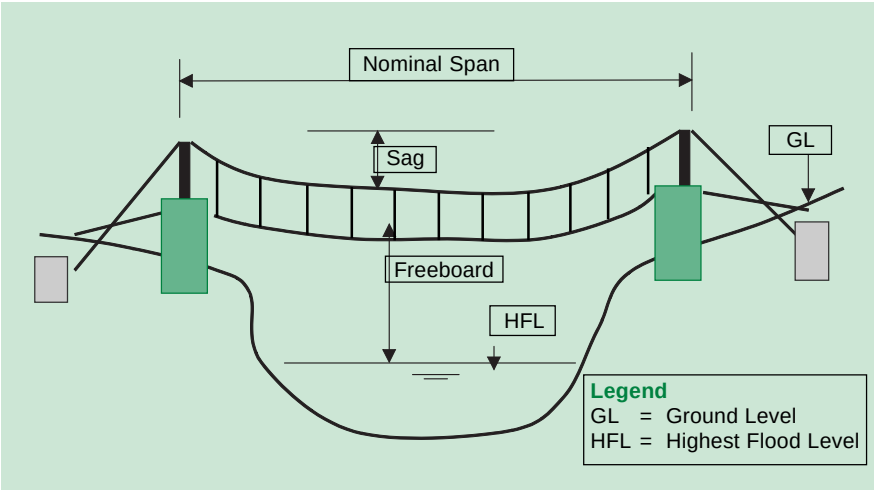
A brief comparison of the two footbridge types is given below.

1.1.1 Suspended Footbridge

Typical Layout



Plan of Suspended Footbridge



Side Elevation of Suspended Footbridge

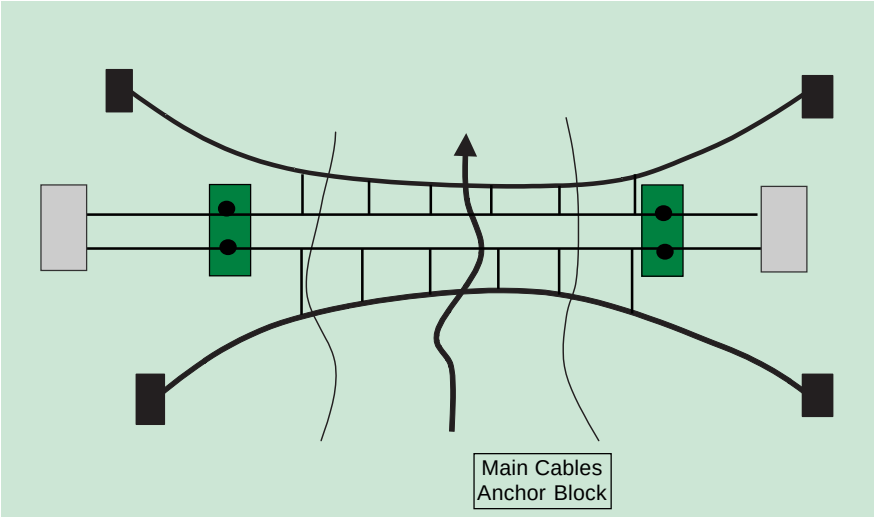
Major Features of the Suspended Footbridge

The major features of the suspended footbridge are:-

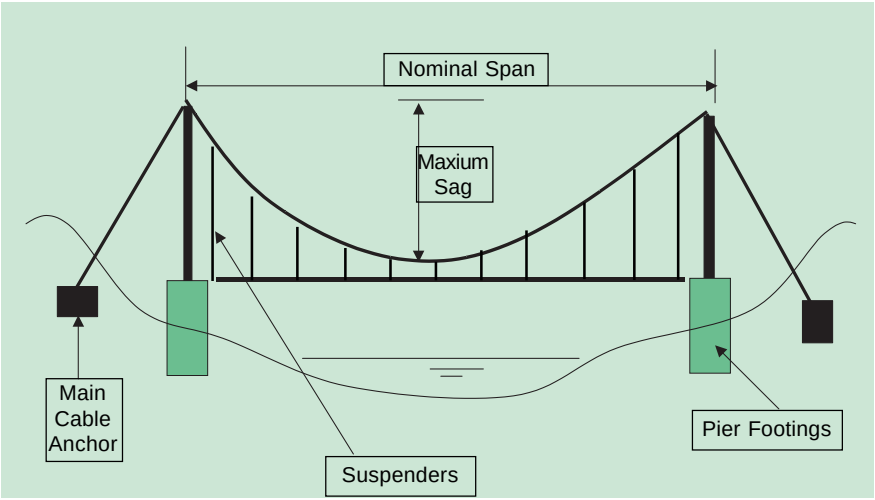
- The deck walkway sags. The deck walkway takes the same shape as the main cables. The main cables usually carry their load below their anchorages. The foundations may or may not be at the same level.
- The vertical cable hangers are the same height throughout the span length.
- The pier supports may be at different elevations at cable sitings levels.
- Spans of more than fifty (50) metres require stabilising against wind load by construction of windguy cable. For spans less than fifty metres, no wind braces are required.
- Wherever freeboard is achievable and founding conditions permit, the suspended footbridge is usually the most economical option.

1.1.2 Suspension Footbridge

Typical Layout



Plan of Suspension Footbridge



Side Elevation

Major Features of the Suspension Footbridge

Some of the distinguishing features of the suspension footbridge are:-

- The main cables are supported on elevated towers with the deck walkway being horizontal or with a convex upward camber.
- The cable seating levels on top of the piers should have the same elevation.
- Towers generally consist of two legs interconnected by lateral bracing for stability. The towers may be constructed of steel sections or reinforced concrete. Reinforced concrete is considered easier to handle on site and requires less long-term maintenance. This option is considered in detail in this guideline.
- The heights of the suspenders or hangers vary with the variation in the sag of the main cables along the span.
- For spans less than fifty (50) metres, no wind braces are required. For spans greater than fifty (50) metres, wind stabilisation is provided by windguy systems.
- For spans greater than one hundred and twenty (120) metres, diagonal stabilisers (stabilising cables) damp longitudinal oscillations.

1.1.3 Special Designs

In some instances it may not be possible to adapt any of the standard designs. However special designs need more of the engineer's attention. Therefore special designs are only recommended where substantial cost savings can be made.

Examples of special footbridge designs include:-

- Suspension footbridge combining main foundations with approach ramps or staircases.
- Suspension footbridge with one tower.
- Suspension footbridge without towers.
- Suspension footbridge with a double span.
- Suspension footbridge with a side span.

- Windguy cable foundations combined with tower or main cable foundations.
- A steel truss footbridge may be ideal for shorter spans (<25 metres).

1.2 Basic Concepts and Inputs

The aspects of footbridge design covered in this section are of a brief and general nature for information only. For detailed design methodologies and sample calculations, reference should be made to the guidelines, "*Detailed Design of Eight (8No.) Standard Suspension Footbridges*", which is obtainable from the Department of Roads of The Ministry of Transport and Communications, Zimbabwe Government.

1.2.1 Live Load

The live load to be considered depends on the traffic characteristics expected and the materials to be adopted. The human traffic on the footbridge plays a major part in determining this live load. The following points determine the live loads to be carried by any footbridge.

- The load carrying capacity of the footbridge is determined from the safety properties of the main cables chosen, and the number of people allowed on the footbridge at any one time is restricted based on the chosen factor of safety.
- The main cable size is chosen to accommodate a certain number of people on the footbridge. The load limit of the footbridge is thus fixed and then a cable size capable of safely supporting this load is chosen. The size and cost of cables available on the local market determine the choice of the main cables.
- Design economics and safety requirements normally determine the live load to be adopted at a particular site. Providing a high footbridge carrying capacity for a footbridge with low pedestrian traffic or for a footbridge where traffic can be controlled is unnecessary. On the other hand, it is not prudent to provide an expensive structure whose capacity to service the traffic requirements is limited.
- Live load is calculated from the formula, $p = (3 + 50/L)$, where p (KN/m^2) is the live load uniformly distributed along the span L (m)

greater than fifty (50) metres. For spans of fifty (50) metres or less, $p = 4.0KN/m^2$. This live load becomes excessive for shorter spans which are not heavily trafficked.

- The Ministry of Transport and Communications' *Bridges Design Manual* recommends a footwalk loading of $4KN/m^2$ on a footbridge footwalk 0.5 metres wide. This is for a footwalk on a footbridge carrying vehicular loads.

1.2.2 Dead Load

- The dead load is the total weight of all the permanent components of the footbridge structure. These include: self-weight of the main cables; deck (steel or timber); cross bracings; side wiremesh; suspenders; handrails; windguy cables; diagonal stabilisers; connections; etc. The dead load of the components is calculated from the material properties of the constituent elements or from data provided by the suppliers or fabricators of the elements. Where a choice exists, it is prudent to choose light but safe building materials to increase the live load carrying capacity of the footbridge.

1.2.3 Wind Load

- For larger spans (greater than fifty metres), wind causes serious sway and longitudinal oscillations. Thus wind effects cannot be neglected. The wind load is calculated from the assumed wind velocity and is taken as a uniformly distributed load with a predominately horizontal component. The vertical component is neglected for footbridge analysis. The wind speed is obtained from records of the meteorological data for the particular area.

1.2.4 Temperature Effects

- A change in temperature will cause a change in the main cable length and hence a change in the cable tension. Temperature effects, varying from very low to high (from veld fires), on the main cables should be calculated and the sag versus tension relationships resulting from these temperatures changes should be incorporated into the detailed design. The minimum sag in the main cables at any particular operating temperature is calculated from the tension curves.

1.2.5 Snow and Seismic Loads

- As these are not commonly encountered in this region of Southern Africa, they will not be considered in the detailed designs. In some countries however, it is applicable and should be taken into consideration during the detailed design phase.

1.2.6 Design Principle

- The design principle adopted is the serviceability state method where the allowable stresses in the members are compared with the calculated stresses.

1.2.7 Foundation Design

- The greatest variation from the standard design will be found in the geological and topographical conditions at the site. Individual foundation designs need to be produced for each site under consideration. The foundations have to be checked against the common failure modes, viz. sliding (FOS $\geq$1.5), ground shear failure (FOS$\geq$2.0) and toppling (FOS$\geq$1.5). Typical foundation types are: the gravity foundation (most common); tunnel foundation (in medium to highly weathered rock); 'deadman' anchorage (strength derived from passive earth pressure); and combined tower/approach ramp foundation (with steps). The design of the foundations to suit geotechnical conditions at the local site should follow the same principles given in the standard design calculations for each footbridge span.

1.2.8 Choice of Materials

- The choice of materials to use for the footbridge elements will affect the final project cost and construction methodology. The choice of materials is governed by local availability, the cost and ease of the transportation to the site, the degree of workmanship to be employed, the degree of supervision (quality control) available, safety, durability (maintenance), and funding available. However, the engineer should make sure that all materials to be used meet the basic minimum requirements of safety and performance as set by the *Standards Association of Zimbabwe (SAZ)*.

1.2.9 Commonly Used Cable Sizes

❖ The cables commonly used for footbridge construction are the nominal sizes 13 mm, 19 mm, 26 mm, 32 mm and 48 mm. The strengths and properties of each cable depend on the properties of the individual wires comprising the rope as well as the rope construction. It is important to seek confirmation from the suppliers that the cables ordered meet the minimum specifications (especially as regards maximum allowable tension) specified in the drawings.

1.2.10 Cable and Member Connections

❖ Many different combinations of cable and member connections are available and it is possible for the engineer to choose an option which is not specified on the drawings. However, it is important that the connections so chosen meet the safe load limits. Common connections encountered on footbridges include: ordinary nuts and bolts; 'D' shackles; turnbuckles; sockets; thimbles and bulldog grips; forged eyes; etc. The cable overlapping lengths and number of members to be connected for various cable sizes are given in the literature.

1.2.11 Concrete Specifications

❖ The grade and specifications to be used for the concrete depend on the expertise of the supervising officers and the degree of control expected during construction of the footbridge. A medium strength concrete (C25) has been adopted for the standard designs. A higher strength may be specified if the construction and supervision is to be carried out by well-qualified and experienced personnel. The concrete quality may be difficult to monitor for remote projects, where access to laboratory testing facilities is limited. In this case prescribed common mixes maybe used. The common prescribed mixes are given in later sections of this guideline.

1.2.12 Masonry

❖ The approach ramp, staircases or erosion protection works may be constructed from rock or brick masonry or from mass concrete with

either rockfill or compacted earthfill between the masonry walls. The choice of masonry materials depends mostly on the availability of the construction materials in the locality. In all cases the engineer should satisfy himself that the materials used are of an acceptable quality and are mixed in the prescribed proportions. The content of the masonry will depend on the availability of materials around the footbridge site and the associated procurement costs.

Chapter 2

Selecting Footbridge Location

2.1 Initial Considerations

Factors to be considered in the preliminary siting of a suspension footbridge are governed (but not necessarily limited) by the guidelines laid out below. It is recommended that a river analysis is carried out in the vicinity of the proposed initial site. The study should be carried out about three hundred (300) to four hundred (400) metres both downstream and upstream of the initially proposed crossing site, and should cover all the points set out below.

2.1.1 Width of River

- It is generally recommended that the footbridge is sited at the narrowest point of the river in the vicinity of the proposed location. The narrower the river crossing, the shorter the span of the footbridge and the less erosion protection required, hence the footbridge construction costs are cheaper. The river channel is likely to be deeper at the narrowest point, enhancing the chances of achieving the required freeboard. Care should be taken however to ensure that the river is not 'growing' at the chosen crossing. Riverbank erosion on a 'growing' river may lead to future scouring around the substructures.

2.1.2 Highest Flood Level

- In all cases – even where accurate hydrological data is unavailable – a freeboard of at least two metres must be left above the calculated or estimated High Flood Level (HFL). This requirement has a bearing on the elevation of the footbridge. The freeboard requirement guards

against debris reaching the deck level and pulling the superstructure with the flood. It is prudent to site the footbridge at a crossing point where the HFL is well contained in the active river channel. This reduces the need for ancillary erosion protection works and enhances the safety and stability of the substructures. The HFL can be determined by interviewing members of the local community or by physical observations along the river. Debris deposited in trees or on rocks on the riverbanks gives an indication of the flood levels. If more accurate data is available, there is scope for reducing the freeboard. More accurate information is obtained by carrying out a detailed flood and hydraulic study of the site. The study is based on the river catchment characteristics as obtained from the Surveyor General's 1 in 50 000 scale ordinance maps as well as the detailed localised topographic survey undertaken at the footbridge site. The hundred-year return flood may be taken as the highest flood level and an appropriate freeboard applied to guard against the flood effects of the maximum probable flood (normally taken as the one thousand-year return flood).

- In flat terrain, where an increase in flooding will not cause an equivalent increase in flood level, the freeboard maybe reduced. This applies to relatively flat flood plains where the water spreads out over a wide area.
- Where river siltation is ongoing the freeboard may be increased. Where possible, it is advisable to avoid siltation points to guard against the future blockage of the active waterway under the footbridge. A reduction of the footbridge waterway due to siltation leads to inundation and ultimately erosion of the substructures. The reduction of the waterway may lead to high floods inundating the footbridge deck, hence increasing the possibility of the footbridge being washed away in high floods.
- It is generally recommended that conservative assumptions regarding the freeboard are made during the design phase in order to minimise the risk of the footbridge being washed away by high floods. The capital construction costs for a relatively high footbridge are less than the footbridge replacement costs once the footbridge is washed away. It is advisable therefore to invest wisely at the construction phase.

2.1.3 Flow Direction and Water flow Speed

- The direction of the flow of the river and the speed of the water in the river channel have a bearing on the degree of erosion to which the substructures will be exposed, as well as the degree of siltation likely to be encountered in the future.
- Very fast flowing rivers have a higher tendency for erosion and extensive erosion protection works may need to be carried out for the substructures. On the other hand, very slow and sluggish rivers tend to have greater river siltation due to a higher load of deposited material. An average flow between very fast and very slow is recommended. The engineer has to use his own discretion regarding the possible effects of the two processes.
- A river which meanders is more likely to be still actively defining its channel, and riverbank cutting maybe very high. The river channel may ultimately change its course due to the bank cutting. It is recommended that the footbridge crossing is not sited where the river meanders a lot. Ultimately the footbridge may be left outside the active river channel or the substructures eroded away. It may be necessary as part of the erosion protection works to construct expensive river training works to try to keep the active channel within the footbridge limits. Avoid curvatures in the river channel where possible. However, in mountainous areas, it may be impossible to avoid the meanders in which case adequate erosion protection works have to be carried out.
- A confluence is a point along a river where two or more rivers join each other. The footbridge should never be sited within the vicinity of such points. It is recommended that the footbridge is not sited within one hundred (100) metres either downstream or upstream of a confluence. Where two rivers meet there will be a sudden increase in the flood level of the river. This rise in flood level has a backwater effect, which extends from the meeting point upstream. The backwater effect tends to reduce the freeboard of the footbridge and may lead to deck inundation. This backwater effect is enhanced by clogging of debris in the rivers as debris and boulders block each other's flow. On the other hand, a sudden increase in flow and strong erosion may wash away a footbridge downstream of a confluence. In general, the upstream option is better than the downstream option when siting near a confluence.

2.1.4 Site Geology and Bank Stability

- It is prudent to place the footbridge on a site with visibly stable and well-defined banks. The stability of the riverbanks reduces the tendency for erosion around the substructures and decreases the erosion and siltation effects of the riverbed. Stable but decomposed rock, good gravels and sands provide good founding. Avoid siting the footbridge on soft silts or active clays, especially where there is evidence of underground water movements. The footbridge foundations should never be supported on potentially expansive clays. As a guideline, potentially expansive clays are treated as clays with the following combination of indicator indices:-

  (i) The Liquid Limit of the whole sample exceeds 55%

  (ii) The Clay Fraction (size less than 2 mm) exceeds 20%

  (iii) The Free Swell exceeds 60%

  (iv) The Plasticity Product of the whole sample is greater than 2 000

- Avoid placing the footbridges on sites with visible evidence of landslides and rockfalls. The presence of such geological processes shows unstable ground, which may adversely affect the serviceability of the substructures during the life of the footbridge.

2.1.5 Presence of Tributaries

- Rivulets, springs, drains, irrigation canals, etc., which drain into the river channel should be avoided. These water sources have a tendency to grow and may ultimately add a significant water load to the river channel, thereby greatly altering the hydraulic and flood characteristics. Sites with such flood sources should be avoided if possible. The adverse effects are magnified if the sources are located upstream of the proposed footbridge site. The erosion from the tributaries as they grow may also lead to significant siltation under the footbridge, thereby reducing the freeboard.

2.1.6 Existing Trail System

- Traditional crossing points should be taken into consideration in choosing a footbridge site. In reality this criteria should be the first

consideration, especially for a rural community. The beneficiaries should be consulted during this phase of footbridge siting. It is possible to erect a footbridge which will be shunned by the intended beneficiaries if the footbridge site is considered unacceptable. The crossing point may be linked to strong social and cultural practices of the community and deviations from these practices may not be acceptable. For example, the crossing may lead to local traditional leaders, sacred community sites, meeting points, social amenities, close acquaintances or service points. Never antagonise the local community in placing a rural pedestrian footbridge. A consensus should always be reached with the community leaders before adopting a final footbridge site.

- If a new site is to be adopted, the expected timesaving, cost implications and accruing benefits must be highlighted and be accepted by the intended users. It is of paramount importance to ensure that the intended community or beneficiaries recognise and accept the intended purposes for such a development in their locality.
- If different footbridge sites are possible, feasible and accepted within an intended study area, then a cost comparison for the proposed sites should be made and the most cost effective adopted.

2.2 Final Footbridge Location

In addition to any other outside considerations, the following guidelines for choosing the route crossing should be taken into account.

- Choose a site with foundations on alluvial soils (gravels), slightly weathered to fresh rock without structural slopes. Deep foundations are more expensive though stability of anchor blocks may require deep foundations for stability against sliding.
- If the geotechnical investigations reveal varying fine and coarse strata, found the structures in the coarser material below the fine layers (in alluvial soils).
- Where rock can be encountered at reasonable depths, strive to found the substructures on top of this rock. It is prudent to anchor the footings into the rock by providing dowel bars.

- Avoid siting foundations on wet areas with visible water seepage. These areas tend to have unstable founding characteristics, resulting in the substructures built on them failing prematurely.
- Avoid siting the footbridge immediately upstream or downstream of a confluence to avoid backwater and scour effects.

Chapter 3

Site Topographical Survey

3.1 General

3.1.1 Purpose of Topographical Survey

The detailed topographic or tache survey of a footbridge site serves two most important functions:-

- The survey provides a detailed map of the footbridge site and surrounding areas, giving all the details of those features which are important to footbridge design. Any adjoining structures, obstructions, terrain characteristics, footbridge axis longitudinal and river transverse sections are obtained from the detailed site tache map.
- The site tache survey provides definite, secured and well-documented axis pegs and footbridge benchmarks with reduced or assumed levels. The footbridge pegs will be used in the construction of the footbridge and the footbridge setting out will be based on these pegs.

A brief walkover survey of the footbridge site and a preliminary footbridge design prepared before a detailed tache survey will give an indication of the area to be covered by the detailed topographical survey as well as indicating probable difficulties in location and siting of anchorages and foundations.

3.1.2 Pegs and Bench Marks

- The footbridge longitudinal axis should be fixed by at least two permanent benchmarks on either side of the river. The benchmarks should be labelled peg BMA and peg BMB respectively (or some other appropriate nomenclature). The benchmarks should be placed about ten metres away behind the estimated positions of the tower

foundations. The pegs should be placed offset from the footbridge axis in such a position that construction is unlikely to interfere with them. The footbridge benchmarks should be protected to ensure that they are still in place two to three years after erection. The benchmarks should be complemented by two pegs, Peg A and Peg B, placed along the footbridge axis and behind the tower foundations. The bench marks should be given reduced levels which are tied in to the national grid if possible otherwise an isolated assumed reduced level should be used and be clearly marked on the benchmark or peg. The benchmarks may be made by chiselling into rock or by marking with non-destructible paint where rock is available, otherwise a steel peg in concrete should be erected as a benchmark.

- The details of each peg or benchmark should clearly be shown on a plotted tache survey map. For each peg, the distance (chainage) from an assumed datum should be given, the construction of the peg (materials used), the reduced level on the pegs as well the offsets from the footbridge longitudinal axis should be shown. In addition, a note should be given indicating whether the peg reduced levels are tied to the national grid or are isolated and the assumptions made should be noted.

3.1.3 Measuring Distances Across the River

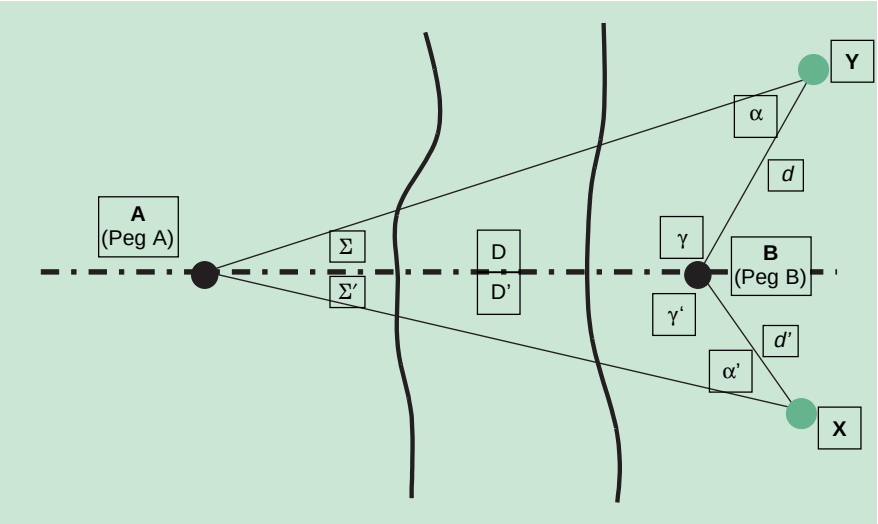
- *By Tape:-*

  If the river channel is not very deep or the water is not fast flowing, distances of up to fifty (50) metres may be measured by steel or flexible thirty or fifty metre tapes. The measurement should be done carefully along the longitudinal axis of the footbridge. Ranging rods with the aide of a dumpy level or theodolite may be used to maintain straightness along the footbridge axis. The measuring tapes should be kept horizontal to avoid sag inaccuracies and at least two independent measurements should be made with varying intermediate change points.

- *By Triangulation:-*

  This method is suitable for distances of up to one hundred and fifty (150) metres. The triangulation method uses the sine formula to calculate the distances (sides) of a triangle. The principle used is

that if one side and two angles of a triangle are known, then the third angle and the other two sides can be calculated. The method is illustrated below.



The method involves first setting out footbridge pegs A and B.

- Set out peg Y such that the distance d between B and Y can be accurately measured. This distance, d, should be at least 20% of the distance between A and B (distance D). Measure the distance d as accurately as possible making the necessary temperature and sag corrections if necessary.
- Set up the theodolite at peg B and measure the angle ABY (angle γ).
- Set up the theodolite at peg Y and measure the angle AYB (angle α).
- Set up the theodolite at peg A and measure the angle BAY (angle Σ). Check that the sum of the three angles $\gamma + \alpha + \Sigma = 180°$.
- Calculate the distance D from the formula, $D = \frac{d\mathrm{Sin}\alpha}{\mathrm{Sin}\Sigma}$
- Carry out the same procedure with the other triangle and X, γ', α', Σ' and obtain the distance D'.
- Final distance between A and B is ½(D + D').

For distances greater than one hundred and fifty metres, the distance should be divided into two sections and the same principle applied to each section.

3.1.4 High Flood Level

- In remote areas, meteorological data allowing an accurate assessment of the hydrological data may not be available. The design flood is therefore based on the highest historical flood level given by the local community, complemented by observations on site of flood marks such as deposited debris. The uncertainty in this flood level measurement is compensated for by adding a conservative margin to the freeboard.

3.1.5 Preliminary Footbridge Layout

- Measure the ground profile along the footbridge longitudinal axis A – B.
- Draw a sketch of the footbridge site and the footbridge to a scale of, for example, 1 in 500 in plan and section, highlighting all the important information.
- The plan should show the permanent pegs A and B and the benchmarks BMA and BMB, the level of flood marks on the river banks, the high flood level, the flood level on day of survey and the low flood level (for perennial rivers), the span, the tower height, the approximate dead load sag, the positions of the foundations and anchorage blocks, the windbracings and the windguy cable anchorages.
- The plan should also show the positions of all rivulets, swamps, irrigation canals, rock outcrops, anthills, houses and other relevant topographical information.

3.2 Detailed Topographical Survey

3.2.1 General

There are two main reasons for a detailed topographical survey:-

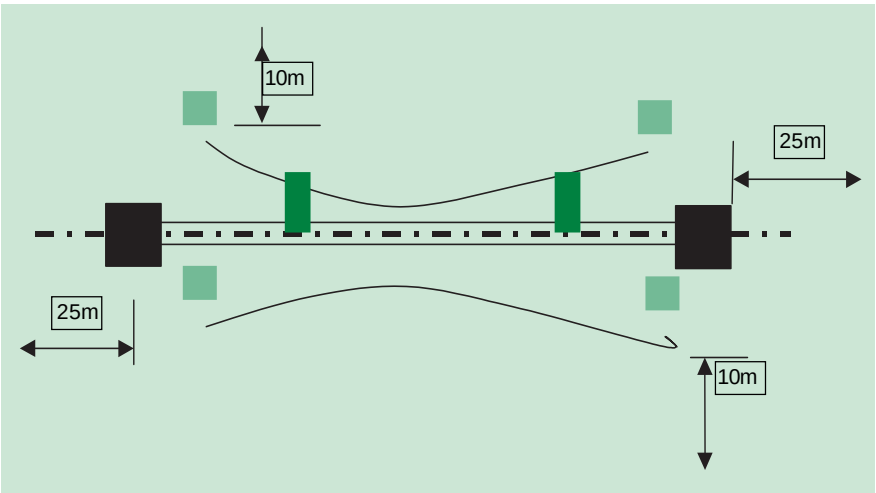
(i) To show the positions of natural and artificial details in relation to the pegs and bench marks.

(ii) To represent the relationships between the various elevations encountered in the surveyed area, allowing the shape of the terrain to be identified easily on a map using contour lines. In difficult terrain, photographs may be used to complement the preparation of contour maps.

3.2.2 Survey Area

The preliminary footbridge design should give an indication of the survey area to be covered. As a general rule:-

- The extreme positions along the river are defined by at least ten (10) metres upstream and downstream of the windguy cable anchorages. In cases where windguys are not provided, ten metres each side of the tower foundations should be adequate.
- The extreme area along the footbridge axis should be a minimum of twenty-five (25) metres behind the main cable anchorages.
- In the survey area, as many points as possible should be taken to plot a correct and detailed contour map. Special care has to be taken around the anchorages and foundations as well as the points where the slope of the ground changes.
- The approximate survey area is illustrated below.



Area of Detailed Topographical

3.2.3 Survey Methods

- The dumpy level or the theodolite are the most commonly used survey instruments. They are used in association with measuring tapes, ranging rods and the graduated staff. The survey for a footbridge site should not involve any complex survey techniques since the data required is very basic.

3.2.4 Photographs

The following photographs should be taken during the site survey:-

(i) The footbridge site from downstream and upstream locations.

(ii) The right and left banks.

(iii) The positions of the main anchorages, foundations and windguy anchorages.

(iv) Any other additional pictures that will enhance the topographic survey. The photographer's position and the direction in which the photograph is taken should be indicated on a sketch.

3.2.5 Topographic Survey Check List

The following list is a guideline of the items required at this stage of the survey. This list is not exhaustive and additions may be made.

- Clip board (22 x 30 cm)
- Field survey book
- Drawing and graph paper
- Protractor (360° or 400° gradient)
- Pocket calculator
- Steel tape – 30 metres
- Steel tape – 2 metres or 3 metres
- Chisel
- Hammer
- Spirit level
- Plumb-bob with string
- Paint

- Brush
- Roll of cord
- Handpick
- Nails
- Theodolite or Dumpy level with tripod and accessories
- Graduated staff, 4 metres long
- Survey manual
- Pencils
- Erasers
- Scale

Chapter 4

Soil Investigations

4.1 Technical Approach and Methodology

4.1.1 Preliminary Reconnaissance and Desk Study

- For sites which are not very remote and where accessibility is not a problem, a preliminary site walkover survey should be conducted prior to site soil investigations. For sites where a preliminary site visit is likely to be too expensive, then the walkover survey may be done prior to the detailed soil investigations but on the same visit. Alternatively, this survey may be carried out as part of the footbridge crossing location.
- The accessibility of the site will be investigated and the proposed positions of the trial holes located. Any constraints to investigating equipment will be noted and appropriate mitigative measures taken. The effects of the investigations on nearby structures will be investigated as well. Any road closures, deviations, advertisements and statutory notices must be checked and the client advised accordingly.
- Existing records, where available, will be studied to determine the necessary extent of investigations. The study involves examining the local geological maps and any available literature. If any similar construction has been done in the area, the available records should be used as a basis for determining the scope of investigations for the footbridge.

4.1.2 Referencing and Positioning of Trial Holes

- The simplest method for carrying out the subsoil investigations is by trial pitting. This method involves manually excavating trial holes at the

identified test points. The subsoil will then be investigated by carrying out field strength tests as well as by visual assessments of the trial holes.

- The positions of the trial holes should be determined from the preliminary footbridge design and site walkover survey. The holes will be referenced and their positions indicated on the site plan as plotted from the detailed topographical survey.
- The trial pitting method of ground investigation has the disadvantage that the subsoil is disturbed and will not be rehabilitated to its original condition on site restoration after the investigations. Therefore it is recommended that trial holes are not placed directly over the positions of the proposed foundations or anchorages. The trial holes should be placed approximately two to three metres away from the proposed locations of the substructures.
- The number of trial holes to be dug will depend on the variability of the subsoil around the site and the experience and judgement of the investigating engineer. In general, a maximum of two trial holes for each of the foundations and anchorages should suffice, one on either side or diagonally opposite. The trial holes may be reduced or increased if the investigating engineer feels that adequate subsoil information can be obtained by fewer or more trial holes respectively.

4.1.3 Equipment and Resources

- For remote sites, it may be necessary to use a four-wheel drive vehicle to gain access to the site. In general, a light truck should be adequate for transportation to the site.
- It is suggested that the main investigations are carried out by manually excavating trial holes on site. The excavations should be carried out using ordinary handpicks and shovels.
- The soil bearing capacities will be assessed from the field Dynamic Cone Penetrometer (DCP) test. The test will be carried out preferably using the portable DCP test machine.
- Footbridges are relatively small structures and do not require extensive investigations. The use of heavy machinery for subsoil investigations is out of proportion to the information required.

4.1.4 Field Investigation Procedures

- The position of each trial hole should be confirmed before commencing excavations. The trial holes will be hand excavated using handpicks and shovels. The local community may be mobilised to carry out this work either for payment or as community participation in the project.
- Each trial hole should be at least one metre by one metre in plan. The excavation sides should be kept vertical. The soil profile should be visually assessed and logged by the engineer during the course of the excavations. These visual assessments will determine the need for further tests on the soil samples in the laboratory for Atterberg limits and indicator indices.
- The DCP test is carried out at one-metre depth intervals from ground level until such point as the required strength is recorded or until the danger of the sides collapsing make the excavations unsafe for those people digging. The ground strength should be deemed adequate if the required DCP penetration rate is achieved for at least three sets of 10 blows before each reading. The required soil strength should be determined from the adapted standard drawings. In general, a DCP penetration of 8 to 10 mm per blow gives adequate founding ground, (this translates to about 200 to 300KPa). If the soil strength is still very low at depths greater than three metres, then the foundations should be treated as given on the standard drawings for poor soils. The empirical relationship between DCP penetration (SPT penetration) and equivalent ground bearing capacity are given in Table 4.1.4 on page 28.
- With loose sands and silts there is a greater danger of the excavation sides collapsing, especially if there is a flow of underground water. The sides of the excavations should be braced with timber or steel sections to avoid the soil from collapsing into the water. The investigating engineer should design a suitable and safe shoring method on site.
- If the water table is high and there is a continuous inflow of water into the excavations, the water should be pumped out using ordinary buckets with a strong rope. If the flow rate is too high for the use of buckets a portable water pump should be employed.

- The visual assessment by the investigating engineer will determine whether disturbed soil samples need to be recovered from the field for further testing in the laboratory. While laboratory tests on sands and gravels will not give any useful information for the construction of footbridge foundations, the tests are important for silts and clays. Metals determine whether the silt or clay subsoil is potentially expansive, and this allows the appropriate ground treatment to be carried out during construction. Representative soil samples should be taken for each layer which may affect the construction of substructures. Enough material should be recovered to allow for all the tests to be carried out in the laboratory.
- On completion of the field investigations, the trial holes should be backfilled to ground level with the excavation spoil. The site should be rehabilitated to its original state as much as possible and all the excess excavation material should be spread neatly over the excavation.

Table 4.1.4 Empirical relationship between DCP penetration per blow, SPT penetration and equivalent ground bearing capacity. Intermediate values may be extrapolated.

D.C.P. Penetration (mm/blow)	S.P.T. Penetration (blows/300 mm)	Design Pressure (KN/m^2)
5	50	580
6	44	460
7	38	380
8	33	320
9	28	280
10	24	250
12	22	210
14	18	170
16	16	150
18	15	130
20	14	120

4.1.5 Laboratory Tests

In cases where visual assessment on site have shown potentially active subsoils, the soil activity should be assessed further by carrying out laboratory tests on the soil samples. The disturbed soil samples recovered from the field should be tested in the laboratory according to the relevant section of CAS 185 Part 1 as amended in 1998 ('Methods for Testing Soils for Civil Engineering Purposes').

The tests to be carried out will include, but not necessarily be limited to, the following:-

(i) ***Particle Size Distribution:***- The tests will be carried out from the wet and dry sieve analysis methods combined with the hydrometer analysis for the clay fractions if necessary. The grading envelope will be plotted from these tests. The coarseness index, fineness index and clay fraction will be determined from the particle size distribution tests.

(ii) ***Plasticity Index Test:***- The liquid and plastic limit tests will be carried out to give the plasticity index. The plasticity product will be determined accordingly.

(iii) ***Free Swell Test:***- This test will be used to determine the free swell of the clay samples.

(iv) The criteria for potentially active clay will be checked from the above tests. If the soil is expansive, it is highly recommended that the site is changed and the footbridge relocated, otherwise extensive subsoil treatment maybe required under the footings and anchor blocks.

4.2 Soil Investigation Results

4.2.1 Proposed Soil Report Layout.

There are many ways of presenting the soil investigation results. For this guideline, the following main report layout is recommended.

The final soil investigation report may be presented in chapters as set out below.

Title Page and Abstract

- These pages will give the project details as well as a brief description of the terms of reference and general findings.

List Of Contents

- The contents will be tabulated in chronological order with the page numbers included.

Chapter 1: Introduction

- The chapter will give the site location, terms of reference, scope and purpose of investigation, methodology and general findings.

Chapter 2: General Site Layout and Geology

- An engineering summary of the nature of the site, its surroundings and geology will be given. This chapter will include details of nearby structures, drainage, access, etc.

Chapter 3: Field Investigations

- The chapter will give the details of the fieldwork done on site. The details will include trial pits, sampling, field-testing, ground water observations, and instrumentation (if any) and site restoration. The constraints and problems encountered during the investigations will be recounted.

Chapter 4: Laboratory Tests

- The tests carried out in the laboratory will be given with reference to standard methods where appropriate. A preliminary interpretation of the results will be given.

Chapter 5: Discussion of Investigations

- This chapter forms the main body of the report. This will be a summary of the results of field and laboratory tests and other observations in

relation to the project, the site and its geology with reference to graphs and tables. A reasoned discussion of the proposed design and construction in relation to the site and ground engineering characteristics will be detailed. The drainage, water tables, soil properties, ground strength, geology, appropriate foundation types, founding depths, preliminary design information for foundations, geomorphology and any other features affecting the project will be discussed in detail.

Chapter 6: Recommendations

- The chapter will give a brief but clear statement of what is recommended for the design and construction. This will include ground improvements, types of foundations, allowable bearing pressures, predicted settlements, dewatering, temporary supports, effects on nearby properties, etc.

Appendices

- The worksheets from the field and laboratory tests will be appended to the soil investigation report for completeness. An example of the worksheets listed below is attached in Appendix A of these guidelines.
  - Appendix A1: Site Plan and Trial Hole Layout
  - Appendix A2: Soil Profile and Trial Pit Logs
  - Appendix A3: Field DCP Tests Results
  - Appendix A4: Laboratory Tests results

4.2.2 Soil Investigation Check List

The following generally makes up the requirements for a soil investigation, the list is not exhaustive and alternatives and additions may be made.

- Portable Dynamic Cone Penetrometer (DCP) machine
- Push and pull or metric tape
- Geological hammer
- Sample bags (at least 10 per site)
- Labels for the sample bags
- Camera

- Site investigation manual
- Soil survey field book
- Knife, pencils, erasers, scale

Chapter 5

Adapting Standard Designs and Estimating Quantities

5.1 Adapting Standard Design

5.1.1 List of Standard Drawings

- For suspension footbridges with spans ranging between twenty (20) and one hundred and sixty (160) metres, at twenty metre intervals, a set of standard working drawings is available from the Department of Roads in The Ministry of Transport and Communications, Zimbabwe Government. Each set should be made up of the following drawings:-
  (i) Footbridge General Arrangement and Layout
  (ii) Materials Specifications and Steel Deck Materials Schedule
  (iii) Connection Details and Specifications

5.1.2 Adapting the Superstructure

- The footbridge deck length and the height of the towers for each footbridge span is fixed from the standard drawings. The dimensions and layouts of the deck structure will not change irrespective of site subsoil conditions. This part of the footbridge is therefore adopted as it is from the standard drawings and no major alterations to the design need be done for each site. Minor changes may need to be done on the connection details to suit available materials and expertise.
- The footbridge foundations were designed assuming a footing height of one metre above ground level and this is the height given on the standard drawings. The freeboard requirements may dictate that this height be increased, resulting in the total height of footings and towers above ground level being increased. This affects the backstay distances

to the main cable anchorages. The length of the main cables will therefore be affected and adjustments will need to be made to the total cable lengths. The minimum height of one metre under the deck ensures easy access below the deck for maintenance purposes.

- The engineer may decide to do away with the bottom handrail cable. A suitable alternative method should be adopted for fixing the protective side wiremesh to the longitudinal angle iron which supports the deck chequer plates.
- The handrail cables are anchored to the last vertical hanger cables which puts some extra lateral loading on these hangers. The engineer may decide to stiffen these hangers by increasing the diameter of the last hangers or by welding an extra reinforcement bar to these hangers.

5.1.3 Adapting the Tower Foundations

The tower foundations were designed making assumptions on the ground strength, the subsoil activity characteristics and the freeboard requirements, which allow the design of the elevation of the footing top above ground level. For each site these characteristics will vary and the substructure will have to be re-designed to suit local conditions. The following items of the design have to be re-checked after the soil and topographic surveys.

- The loads transmitted to the footing from the tower legs are considered to be the same as the loads calculated from the design of the standard drawings. If these loads are not available (from the design report), then the engineer has to rework the loads transmitted from the superstructure from first principles.
- The minimum freeboard requirements (minimum of 2.0 metres above the HFL) have a bearing on the projecting height of the footing above ground level. If the freeboard required is such that the footings have to be elevated, then the height of the footing should be automatically increased. This will mean that the footing dead load will change from that used in the design of the standard working drawings. The amount of concrete in the footings may be reduced by incorporating rock plums in the mass concrete.
- The dimensions of the footing in plan were fixed making assumptions on the ground strength. The site conditions may have a lower or higher bearing strength than the assumed ground strength. In cases

where the ground strength is lower than that assumed on drawings (as calculated from the recommended DCP penetration per metre), the footing size has to be increased to suit the ground bearing strength without the possibility of failure. For sites where the ground strength is higher than the assumed ground bearing capacity, the footing dimensions may be left unaltered. If the engineer judges that there is scope of cost savings in materials, the dimensions may be reduced to suit the ground bearing strength thereby saving on concrete provided the footing stability checks set out below are all complied with.

- The depth of embedment of the footing into the ground affects the stability of the footing. The passive earth pressure mobilised by the footing to resist sliding depends on the embedded depth. The depth of footing embedment shown on the standard drawings is based on assumed subsoil conditions. The subsoil may have adequate strength at a shallow depth, allowing the depth of embedment to be reduced. The passive earth pressure is consequently reduced. The sliding check for the footing should be re-checked if embedment depths are reduced.
- The dimensions of the footings may become too great, resulting in the volume of concrete in the footings becoming excessive. The amount of concrete may be reduced by incorporating solid rock plums in the concrete. The amount of rock plums should not exceed forty percent (40%) of the total volume of concrete. The plums should not be placed above the construction joint where the vertical starter bars of the pier stem are anchored.
- It is preferable to maintain a minimum footing top level of one metre above ground to allow easy access under the footbridge deck for maintenance and inspection of the deck underside.
- In general, the footings should be checked for the following conditions:-

  (i) ***Ground Bearing Capacity:***- The pressure transmitted to the ground from the imposed loads must be less than the safe soil bearing capacity as recorded from the DCP test, i.e.,

  p_{max} (= z R_v/(B'L') < p_{perm} (from DCP test).

  If this condition is not satisfied, the footing dimensions in the plan may be increased to reduce the pressure transmitted to the ground.

(ii) ***Sliding Check:***- The earth in front of the footing must be able to mobilise enough passive resistance to prevent the footing from being pulled out by the cables. The factor of safety of the passive earth pressure against the horizontal load component in the cables must be $\geq$ 1.5. If the passive earth mobilised is not enough to meet the above safety factor, the depth of embedment of the footing may be increased. This sliding safety condition may override the ground bearing strength requirements.

(iii) ***Ground Shear Failure***:- The ground ultimate shear strength, p_u [= $B\{(rt + q)N_q + 1/2BrN_g + cN_c\}$] as calculated from the soil parameters should have a factor of safety of at least two over the ultimate vertical load, i.e., $p_u/R_v \geq 2.0$. The factor of safety may be increased by increasing the depth of embedment, t.

5.1.4 Adapting the Anchorage and Cable Foundations

- The anchor bars for the main cables can be modified by the engineer before adopting the system on the standard drawings. The standard drawings show the anchor bars consisting of two anchor bars with forged eyes at each end with the bars linked by a tubular pipe embedded in concrete. This system may be replaced, for example, by a U-shaped continuous anchor bar with only two forged eyes at the ends or by two L-shaped bars, which overlap in the concrete.
- The anchor bars given on the drawings are generally long (greater than five metres). These may be difficult to handle both in the workshop and on site. There may be scope for reducing the lengths of these anchor bars especially where the embedment depths of the footings are shallower than that given on the drawings.
- Turnbuckles are indicated on the drawings on both sides of each main cable. This may not be necessary especially in shorter spans (less than sixty metres) in which case the cables may be tensioned from one side only thereby doing away with the other set of turnbuckles.

The cable anchor blocks were designed making assumptions on the ground strength, the subsoil activity characteristics and the depth of footing buried below ground level. For each site these characteristics will vary, which may mean that the anchor blocks have to be re-designed to suit

the prevailing local conditions. The following aspects of the anchor block design have to be checked after the subsoil and topographic surveys.

- The loads transmitted to the anchor blocks are basically the tension in the cables as well as the self-weight of the footing. The tension in the cables as supplied may differ from that specified on the standard drawings in which case the stability of the anchor block with the new tension has to be checked.
- The footing self-weight and depth of embedment will change depending on modifications made to suit the ground strength. If the dimensions of the anchor block are changed, then the self-weight has to be recalculated accordingly.
- The dimensions of the anchor blocks in the plan were fixed making assumptions of the ground strength. The site conditions may have a lower or higher bearing strength than the assumed ground strength. In cases where the ground strength is lower than that assumed on the drawings (from the recommended DCP penetration per metre), the footing size has to be increased. For sites where the ground strength is higher than the assumed ground bearing capacity, the anchor block dimensions may be left unaltered. If the engineer judges that there is some scope to make cost savings in materials, the dimensions may be reduced to suit the ground bearing strength (thereby saving on concrete) provided all the checks below comply.
- The depth of embedment of the footing into the ground has a bearing on the stability of the footing. The permanent earth pressure mobilised by the footing to resist sliding depends on the embedded depth. The depth of footing embedded as given on the standard drawings was based on assumed subsoil conditions. The subsoil may have adequate strength at shallow depth, allowing the depth of embedment to be reduced. The passive earth pressure is consequently reduced. The sliding check for the footing should be re-checked if embedment depths are reduced.
- In general, the footings should be checked for the following conditions:-

  (i) ***Ground Bearing Capacity:***- The pressure transmitted to the ground from the imposed loads must be less than the safe soil bearing capacity of the soil as recorded from the DCP test, i.e., p_{max} $(= R_v\{(1 + 6e'/B\}/B'L') < p_{perm}$ (from DCP test).

(ii) ***Sliding Check:***- The earth in front of the footing must be able to mobilise enough passive resistance to prevent the footing being pulled out by the cables. The factor of safety of the passive earth pressure against the horizontal load component in the cables must be $\geq$ 1.5. This requirement may entail founding the anchor blocks deeper than the ground strength requirements.

(iii) ***Ground Shear Failure:***- The ground ultimate shear strength, p_u [= $B\{(rt + q)N_q + 1/2BrN_g + cN_c\}$] as calculated from the soil parameters should have a factor of safety of at least two over the ultimate vertical load, i.e., $p_u/R_v \geq 2.0$.

(iv) ***Anchor Block Toppling:***- Factor of safety against toppling should be checked if the block dimensions are altered. The restoring moments must be at least 1.5 times the overturning moment, i.e., $M^+/M^- \geq 1.5$.

5.2 Estimating Quantities

5.2.1 Preliminary and General Costs

These costs will include soil and topographic surveys, haul of material to site, mobilisation to site, establishment on site and demobilisation. For remote or isolated footbridge sites, the haul of materials to site has to be considered carefully since this contributes greatly to the establishment costs.

5.2.2 Quantities from the Deck

The quantities will be extracted from the standard drawings as detailed on the working drawings. The estimates will include but not necessarily be limited to the following items:-

- Iron hangers
- Flat iron cross bracings
- Angle iron runners
- Hook bolts
- Mild steel chequer plates
- Steel bolts

- Wiremesh
- Gauge wire
- Connections

5.2.3 Quantities from the Main Cable Anchorage System

The quantities should be estimated from the re-designed substructures. The excavation quantities and concrete volumes should be calculated from the footbridge drawings. The items will include:-

- Anchor Block foundations and casings
- Mass concrete in blinding, cable protection walls and anchor blocks
- Anchors pipes, anchor bars, turnbuckles, 'D' shackles
- Bolts, nuts, washers, bulldog grips, etc.

5.2.4 Quantities from the Windbracing System

The quantities should be estimated from the original and re-designed substructures. The items will include:-

- Anchor Block foundation excavations and casings
- Mass concrete in blinding, cable protection walls and anchor blocks
- Anchors pipes, anchor bars, turnbuckles, 'D' shackles
- Bolts, nuts, washers, bulldog grips, etc.

5.2.5 Quantities from the Approach Ramp System

The quantities should be estimated from the re-designed substructures. The items will include:-

- Foundation excavations
- Rock or concrete masonry
- Mass concrete in approach slab
- Wiremesh reinforcement in approach ramp slab
- Compacted earthfill in-between the masonry walls

5.2.6 Quantities from the Cables

The quantities should be estimated from the original standard drawings.

The quantities should be estimated for main cables, windguy cables and stabilising cables (where necessary). The items will include:-

- 32 mm diameter multi-strand main and windguy steel cables
- 26 mm diameter multi-strand windguy steel cables
- 13 mm (or 19 mm) diameter multi-strand steel cables in windties and handrails
- 'Crosby' clamps and other connections

5.2.7 Quantities from the Piers

The quantities should be estimated from the original drawings for the substructures. The items will include:-

- Tower foundation excavations
- Mass concrete in blinding, footings and towers
- High tensile steel reinforcement in tower stems
- Cast iron saddles
- Mass concrete in the blinding and pier footings
- Reinforced concrete in the pier stems

5.2.8 Quantities for Ancillary Items

Extra items not included in the actual footbridge design will be added to construction cost of the footbridge. The items will include:-

- Excavations for erosion protection walls and stone pitching
- Supply and construction of gabion wiremesh
- Supply and placing of rock cladding (stone pitching)
- Backfill behind erosion protection walls
- Fabrication and installation of load restriction signs

5.2.9 Bill of Quantities Check List

The following main items should be included in the Bill of Quantities. This list is not exhaustive and the engineer should satisfy himself that all aspects are adequately covered.

- Preliminary and General Costs
  - Establishment and demobilising from site
  - Insurances
  - Site visits
- Site Clearance and Preparation
- Anchorage system – main cables, windguy cables
- Procurement of Steel Cables – main cables, handrails, windguy cables
- Construction of Piers
- Construction of Deck
- Construction of Windguy system
- Ancillary items – approach ramp, erosion protection, signs, painting, etc.

A sample of the Bill Of Quantities is shown in Appendix B. Variations or additions to the provided format may be made to suit the engineer's own requirements.

Chapter 6

Preparing Tender Documents

6.1 Invitation to Bid

The invitation to bid or tender should clearly spell out the following:-

- The client's intentions with spelt out client name, summarised scope of works, location of project (district, province) and name of project.
- The targeted contractors, i.e., registered company, affiliation to registered body, experience field and category if registered under a body.
- Length of validity of the bids from last date of submission.
- Bidding documents to be supplied and the cost of the tender documents. The place(s) where tender documents may be obtained and the contact person.
- Bid bond amount to accompany the tenders on submission as well as the address to which the bid bond and tenders must be addressed with the contact person. The closing date and time for the bids must be clearly specified.
- The bid opening times and place as well as the people invited to witness the opening must be given.
- The 'Ruling Language' and the language of the bids must be specified. The ruling language must be used for all correspondence and meetings related to the project.

6.2 Instructions to Bidders

6.2.1 General

This section will give the following information:-

- Description of the works

- Preferred bidders (if any)
- Responsibility of bidding costs
- Site visits and certification of site visits

6.2.2 Bidding Documents

The section will give details of the following:-

- Content of the bidding documents
- Clarification of bidding documents
- Amendments of bidding documents

6.2.3 Preparation of Bids

The following items should be included in this section:-

- Documents comprising the Bid
- Bid Prices
- Price adjustment
- Currencies of Bids
- Bid validity
- Bid Bond
- Alternative offers
- Pre-bid meetings
- Format and Signing of Bids

6.2.4 Submission of Bids

The following items must be specified in this section:-

- Sealing and Marking of bids
- Deadline for Submission of Bids
- Late Bids
- Modification and Withdrawal of Bids

6.2.5 Bid Opening and Evaluation

This section must specify the following items:-

- Bid Opening
- Process Confidentiality
- Clarification of Bids
- Determination of Responsiveness
- Correction of Errors
- Evaluation and Comparison of Bids

6.2.6 Award of Contract

The following information should be included in this section:-

- Award criteria
- Client's Right to Accept or to Reject any or all Bids
- Notification of Award
- Signing of Contract Agreement
- Performance Bond

6.3 Annexes

The tender documents will contain an annex at the end with the following items:-

- Form of Bid
- Appendix to the Form of Bid
- Form of Bid Bond
- Provision of a Banker's reference
- Provision of Insurances
- Provision of a Performance Bond or Guarantee
- Annexure A:- Form of Performance Bond or Guarantee
- Annexure B:- Certificate of Insurance Cover

The samples for the annexes above are appended in Appendix C of this guideline.

Chapter 7

Invitation, Adjudication and Award of Tender

7.1 Invitation to Tender

7.1.1 Advertisements

The following items will be considered at this stage:-

- ***Responsibility for advertising:***- the client may place the advertisements himself or he may delegate a consultant to do so on his behalf.
- ***Open tender or short list:-*** Depending on the complexity of the project and the time scale available for the tender process, the client may wish to advertise as an open tender or may shortlist approved contractors who will be invited to tender.
- ***Advertising Media:***- the client will spell out the media in which the client intends to place the advertisements for the tender.
- ***Number of Insertions and Duration:***- the client will also spell out the number and date of insertions of the advertisement as well as giving a time scale for receiving the bids.

7.2 Adjudication of Tenders

7.2.1 Adjudication Committee

- The client in consultation with the engineer will organise an adjudication committee to evaluate the bids. Most District Councils already have standing committees tasked with this responsibility. The engineer may be an addition to this committee.

7.2.2 Evaluation Criteria

- The client in consultation with the engineer will give evaluation criteria to be adopted for the submitted bids. The evaluation is normally split between the technical evaluation and the financial evaluation.
- The technical evaluation is carried out first to assess the technical competency of the contractors. A performance limit from the technical evaluation is then drawn with each contractor's score. A cut-off point is agreed as part of the evaluation process.
- The financial proposals for the short-listed 'technically sound' bids are then opened. The financial proposals for the unqualified technical bids are returned to the contractors unopened.
- The technical evaluation is based on agreed criteria with weighting factors given for each criterion.
- The criteria may include but will not necessarily be limited to the following:-
  - Presentation format
  - Understanding of the scope of works
  - Methodology of works execution
  - Equipment and resources mobilised for the project and their location
  - Curriculum Vitae of key staff
  - Past Performance appraisal
  - Contactable Referees

7.3 Award of Tender

7.3.1 Award Criteria

- The award of the contract should be made to the contractor whose bid has been determined to be substantially responsive to the bidding documents and who has offered a reasonable cost, provided further that the bidder has the capability and resources to effectively carry out the contract works.
- The client may request an inspection of the resources as tendered by the contractor, to satisfy himself as to the capability of the contractor to carry out the said works.

7.3.2 Client's Right to Accept any Bid and to Reject Any or All Bids

- The client reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids, at any time prior to award of contract, without thereby incurring any liability to the affected Bidder or Bidders or any obligation to inform the affected Bidder or Bidders of the grounds for the client's action.

7.3.4 Notification of Award

- Prior to the expiration of the period of validity of the bids specified by the client, the client will notify the successful Bidder by fax, e-mail or telex, confirmed in writing by registered letter, that his bid has been accepted.
- The notification of the award will constitute the formation of the contract.
- Upon the furnishing of a performance bond by the successful bidder, the client will promptly notify the unsuccessful Bidders that their bids have been unsuccessful.

7.3.5 Signing of Contract Agreement

- Subsequent to the notification of award, the client will send to the successful Bidder a Contract Document provided in the bidding documents, incorporating all agreements between the parties.
- Within twenty (20) days or some other specified time, of receipt of the Contract Document and at a stipulated time and venue, the client and the successful Bidder shall sign the Form of Contract Agreement.

7.3.6 Performance Bond

- The successful contractor shall furnish the client a security in the form of a performance bond or bank guarantee of contract in an amount equal to ten percent (10%) of contract sum within fourteen (14) days of notification of acceptance of contract. The performance bond shall be in the form of a certified cheque, bank draft, bank guarantee in original or irrevocable Letter of Credit in Zimbabwe dollars or freely

convertible currency and shall be payable to the client. The performance bond shall be released upon final completion of the contract including the period of maintenance.

- Failure by the successful Bidder to lodge the required performance bond or bank guarantee may constitute sufficient grounds for the annulment of the award and forfeiture of the bid bond in which event the client may make the award to the next ranked evaluated Bidder or call for new bids.

A sample of the contract agreement layout is given in Appendix D.

Chapter 8

Procurement of Materials

8.1 Materials to be Procured

8.1.1 Anchorage System: Main Cables and Windguy Cables

The materials to be procured for this substructure component are:-

- Concrete – cement, stone aggregate, river sand, construction water.
- Hollow steel pipes for cable anchorages.
- Anchor bars with forged eyes.
- Turnbuckles, 'D' shackles, bulldog grips, thimbles, etc.

8.1.2 Approach Ramp

The approach ramp is constructed from the following materials:-

- Masonry – stone, gravel, brick, cement
- Concrete slab – cement, stone, river sand, construction water, wiremesh.

8.1.3 Steel Cables and Connections

These components of the footbridge deck are obtained from specialist suppliers and may not be available in the locality of the project. The items will include:-

- Main cables – 32 mm, 26 mm, 19 mm and 13 mm.
- Crosby clamps, thimbles, bulldog grips, etc.

8.1.4 Piers

The piers will be constructed from ordinary reinforced concrete with the following constituents:-

- Concrete – cement, stone, river sand and water.
- High tensile steel reinforcement bars.
- Cast iron saddles.
- Rock plums for mass concrete footings.

8.1.5 Deck Construction

The deck constituents will be made up of the following items:-

- 16 mm diameter mild steel hangers complete with bolts and nuts.
- Flat iron braces for cross members.
- Angle iron channels, 50 mm x 50 mm x 10 mm sections.
- Mild steel hook bolts.
- 4.5/6.0 gauge chequer plates for deck walkway.
- Mild steel bolts, wiremesh, 3 mm gauge wire.

8.2 Sources of Construction Materials

8.2.1 Ordinary Construction materials

- Ordinary construction materials like cement, stone, sand, water, nuts and bolts may be sourced within reasonable distances from the project site. The possible suppliers in a project area may be shortlisted and the prices compared.

8.2.2 Special Construction Materials

- Specialised materials like steel cables, chequer plate deck, cast iron saddles, high tensile steel reinforcement bars, mild steel hangers, forged eye anchor bars, thimbles and bull dog grips may not be available easily. These materials have to be sourced from specialist suppliers and may require long haul distances to site.

8.2.3 List of Material Suppliers

- The list of possible suppliers and the items they supply is given in Appendix E. This is a list of the suppliers contacted during construction of the pilot footbridge and is not exhaustive. The list can be easily expanded and the engineer should make every effort to locate suppliers in the area.
- In general most engineering companies can supply the footbridge materials and they will only need to subcontract out specialised operations like the construction of forged eyes for the anchor bars.

Chapter 9

Construction of Piers and Anchor Blocks

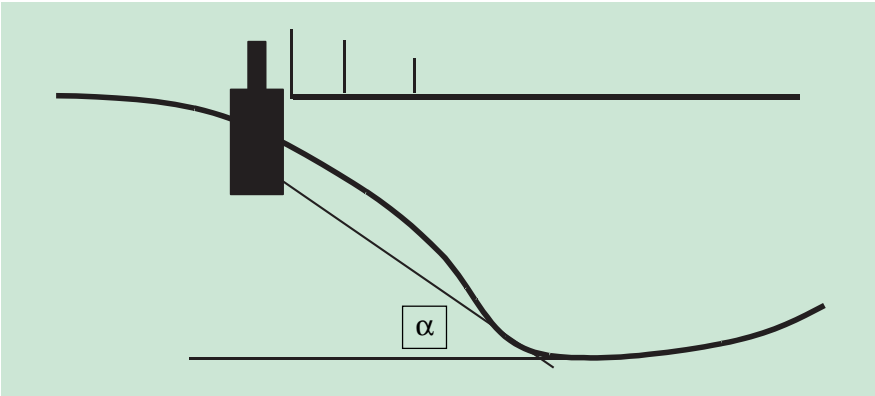
9.1 Placing of Foundations

9.1.1 Flood Requirements

- The footbridge should freely discharge the fifty-year return flood and remain undamaged by higher floods. The fifty-year return flood is calculated from the formulae given in the literature on hydraulics studies and flood estimates (The Ministry of Transport and Communications manual, *Bridges Design Part JD*, has a section on flood calculations).
- The footbridge must extend the full width of the river to a point either side of the channel banks where the footings and embankments are not continuously inundated by water. The embankments should be well protected. The twenty-year return flood should be taken as the normal flow.
- The requirements for freeboard should be taken into consideration as well in accommodating the High Flood Level.

9.1.2 River Bank Slope Stability

The minimum distances of the foundation faces from the riverbanks depend very much on the soil/rock type and the minimum footing embedment depth. Without a detailed investigation and slope analysis the following minimum angles between the foundation front base and the riverbank slope foot have to be maintained as a first assumption to placing the footing.



As a guideline, with a soil of internal angle of friction, γ, the angle α generally varies from $1/2\gamma$ to γ for loose alluvial soil to highly compacted alluvium and from 30° to about 45° in weathered to sound rock.

- In rivers where river undercutting and bed erosion is active, protective measures need to be taken since the river may change its channel quite significantly. Gabion mattresses built in front of the foundations are the recommended protection.
- For both economic and footbridge serviceability reasons, it is wiser to adopt a longer span than to carry out extensive erosion protection works.
- It should be emphasised that the assumptions made regarding the soil parameters or topographical information have a large bearing on the foundation design. Therefore due care needs to be taken in making these assumptions. Where there is a deficiency of information, the engineer has to make conservative assumptions or otherwise seek further survey information.

9.1.3 Minimum Embedment Depth

All corners of the footings or anchorage blocks need to be sufficiently embedded into the existing ground. The minimum embedment depth is necessary as a safety measure for the following reasons:-

(i) The earth pressure in front of the footings is not considered during the footing design, therefore the embedment depth provides an

additional safety margin for construction.

(ii) Due to unforeseen circumstances during investigation and design, erosion may take place around the footing and the minimum embedment depth is there to provide additional tolerances.

(iii) While the footbridge foundation design is based on technical information gathered at the site, the topsoil is normally loose due to erosion and does not provide much strength. Therefore the footings have to be founded at particular depths from the ground level.

The table below gives the guidelines for minimum embedment depths.

Foundation Type and Span length	Minimum Embedment Depth in Soil	Minimum Embedment Depth in Rock
Tower Foundations:-		
Span < 75m	1.00 to 2.00	0.50
Span up to 150m	1.50 to 2.50	1.00
Span above 150m	2.50 to 3.50	1.50
Main Cable Foundations:-		
Span < 75m	1.00 to 1.50	0.50
Span up to 150m	1.50 to 2.50	1.00
Span above 150m	2.00 to 3.00	1.50

9.2 Clearing the Footbridge Site

- The footbridge site should be cleared over a width of ten metres either side of the footbridge axis across the full width of the river and to points twenty-five metres behind the tower footings.
- The contractor must clear the site of all roots, timber, bush, grass and debris to the satisfaction of the engineer.
- The timber cleared from the site is to be corded immediately adjacent to the cleared area. The ownership of all cleared timber and grass rests with the landowner who shall give instructions as to its disposal.
- On completion of the project, the cleared area shall be left clean and tidy.

9.3 Excavations for Foundations and Anchor Blocks

9.3.1 General

- When excavating in decomposed rock or firm ground only the plan area of the footing or anchor block should be excavated to save on excessive spoil material as well as avoid the use of shutters for concrete casting. For unstable sides, the excavation dimensions may be increased from bottom outwards by stepping (berming) or sloping the excavation sides.
- When an excavation reveals a need to go deeper than the recommended founding level to reach competent ground, then only mass concrete backfill should be used to bring the levels back to footing soffit level.
- The reinforcement bars extending into the footing must be placed according to the working drawings and checked by the engineer before casting concrete.

9.3.2 Excavation in Soil

- Foundation excavations should not be left exposed for a long time before applying blinding. The final 100 mm of the excavations should only be done once concrete is about to be poured. The foundation bed should be protected against rain or foreign matter by placing at least 100 mm of blinding concrete.
- Excavations deeper than 1.5 metres, especially in unstable soils, should be braced or shored using an approved method. The slopes may be banked if shoring is not possible but a safe back slope must be maintained. A minimum slope of 1: 1 in non-cohesive materials to a slope of 1:3 in well-consolidated material should be adopted.

9.3.3 Excavation in Rock

- The use of explosives for excavations in soft weathered rock should be avoided as these tend to weaken the surrounding ground and may cause slipping of the anchorages.
- Excavating in hard rock using explosives should only be carried out by a qualified person.

- When founding on rock, the exposed rock should be cleaned and all loose material should be removed and the rock left without any debris before casting concrete.

9.4 Mixing, Placing and Curing Concrete

9.4.1 Placing Steel Reinforcement

- Steel will only bond well to concrete if the steel is clean and free of grease and scaling rust. The steel reinforcement should be cleaned using a wire brush to remove any scaling rust.
- Ensure that minimum lap lengths – as recommended in the codes – are achieved. The minimum lap lengths ensure that the steel bars join and perform as continuous bars in load transmission. The steel bars which are used as starter bars ensure monolithic behaviour between the footings and the pier stem.
- The steel reinforcement bars should be tied as shown on the engineer's working drawings. The reinforcement should be tied and placed by a qualified or experienced steel fixer. The engineer should inspect all the steel fixing before concrete is placed.
- The vertical reinforcement should be provided with L-shaped toes on construction joints to ensure the stability of the steel cage during the pouring of concrete, as well as the proper anchorage of the steel into the concrete.

9.4.2 Concrete Constituents

Concrete is composed of three constituents: the binder, the aggregate and water. The binder creates adhesion between the concrete components as well as filling the voids between the components. The aggregate forms the main body of the concrete, whilst water acts as a catalyst and allows the mix to be worked. The aggregate and cement together provides the concrete strength.

Cement

- Cement must meet the required Central African Standards (CAS). The cement should not be exposed to moisture or be stored for a lengthy

period, otherwise it will deteriorate. Ordinary Portland cement should be used with weigh or volume batching in whole numbers of sacks.

Aggregate

- The aggregate can be sourced from river deposits. The sand may not be a problem but the coarse (stone) aggregate may not be available in the right quality or quantity from the river deposits, in which case crushed stone aggregate should be obtained from commercial quarries. For the stone aggregate, the parent rock quality should be suitable for concrete and be approved by the engineer. The aggregate from rocks like mica, sandstone, marl, conglomerates, decomposed rock, gypsum, coal, slag, salts, etc., are not suitable. These rocks tend to either reduce the strength and weather resistance of the concrete or reduce the hardening qualities of the concrete.
- Purity of aggregates is of prime importance to the quality of concrete. Clayey and loamy material cling to the aggregate thereby reducing the bonding strength of concrete. The sand must not contain more than 3% of dust. The sand must not contain organic impurities like humus, peat, plant remains, wood, coal, etc. As a quick check, a sample when squeezed together in the hand should crunch. If the sample sticks together or leaves a powdery trace in the hand, then the sample is either contaminated with loam or contains too many fine grained components. The presence of organic impurities may be checked in the laboratory using the method outlined by CAS specifications.
- The coarse aggregate should either be screened from river deposits or be quarried from commercial sources. The coarse aggregate should meet the grading and strength specifications as given in SAZ specifications. For remote sites however, these comprehensive tests may not be readily available and the engineer has to use his own judgement as to the quality of the aggregate.

Water

Water must act as a catalyst to the concrete chemical reactions as well as ensure the workability of the concrete mix. Points to note:-

- Suitability – river water, (especially flowing) may be used. Water which contains organic matter should not be used. Mineral water may

jeopardise the bonding and the stability of the concrete depending on the mineral dosages. Sulphates, chlorides, sugar, organic impurities, oil and grease all reduce the quality of the concrete and should be avoided. Generally, water which is suitable for drinking is suitable for concrete.

- Water content – the water content of a concrete mix is the combined sum of the mixing water and the moisture content of the aggregates. The water content is normally specified from the cement water ratio for a particular concrete grade and the vibration method used.
- Consistency and Workability – the consistency of concrete is the degree of density and liquidity and has a bearing on the workability. The workability is the ease with which the concrete can be made to fill the formwork shapes. The workability depends on the water content and is controlled from the slump test.

9.4.3 Mixing of Concrete

Weigh Batching of Constituents

- The various concrete constituents may be mixed in proportions defined by masses. The ratios of the constituents are given from the mix design in mass per sack mix (50 kg) of cement. The various proportions required to come up with a targeted strength of concrete as obtained from the mix design are specified as masses per one sack (bag) of cement. The proportions of sand and stone required will then be weighed using scales to give the mix proportions. The mass of water may also be weighed. For remote sites, it may be difficult to use this method of mixing proportions.

Volume Batching of Constituents

- The mix proportions may be specified per cubic metre of concrete in which case the mix proportions are given as volumes to make up a specified target strength. This method is not ideal because of the uncertainties in calculating exact volumes, especially with the implements to be used on site for volume batting. Wooden boxes, shovels, and wheelbarrows have been used as measuring devices for volume batching. The 'levelling off' and 'heaping' specifications for each volume batch are at the discretion and judgement of the operator

and concrete of varying quality is likely to be produced. River sand shows a very high degree of bulking with moisture with the result that the volume of sand used in volume batching very much depends on the sand moisture content. Though the uncertainties are greater, this method of mixing maybe the only appropriate method for use at isolated footbridge sites.

Concrete Mixing Methods

The quality and consistency of concrete will depend on the method of mixing adopted. Two options exist for rural footbridge sites:-

- Mechanical mixing – the concrete constituents may be mixed using portable motorised concrete mixers. The concrete mixers should be portable enough to be brought to site easily with manual handling. For remote sites the mixers will most likely be diesel or petrol driven, unless a site motorised diesel generator is provided.
- Manual mixing – the concrete may be mixed by hand using ordinary hand shovels. The consistence and uniformity of the concrete mix will depend on the degree of control and experience of the labour force. Hand mixing method are very unlikely to produce concrete of uniform quality. This method is only suitable for low volume pours and is not suitable where substantial concrete has to be placed.

9.4.4 Placing of Concrete

- Concrete should be placed immediately after mixing, at least within one to two hours of mixing. Before placing the concrete, the formwork should be cleaned thoroughly and be made moist by applying water. On construction joins the previously concreted surfaces must be cleaned and made damp. Loose stones and debris must be removed. Ideally the surface should be rough, clean and damp.
- Concrete may be carried from the mixing plant to the substructure locations by hand using wheelbarrows. This is the ideal method for remote sites. For small concrete volumes the concrete may be carried manually in steel dishes. This method is too labour intensive and may lead to congestion on site.
- The concrete should be placed in the excavations in such a way that the concrete does not fall freely for heights of more than one and

half metres. Concrete falling from greater heights leads to the segregation of the aggregates and a loss in consistency of the concrete mix. Guiding chutes should be used when large heights are to be poured.

- The concrete should be vibrated during placing. There are two possible methods for compacting the concrete.

  (i) The concrete may be vibrated using portable poker vibrators, which are easily handled on site. The mechanical vibrators ensure a more adequate compaction of the concrete and give a uniformly treated mix. Layers up to 700 mm thick may be vibrated. The compaction should be carried out by experienced and reliable operators to ensure optimum mixing.

  The vibration should be carried out until the surface closes and cement mortar rises to the surface near the vibrator. The vibrator should be withdrawn slowly. Under vibration of the concrete may leave air pockets leading to honeycombing, whereas over vibration leads to segregation of the cement mortar and the aggregate.

  (ii) The concrete may be hand tamped using pieces of timber or steel pokers. The degree of compaction is not very good with this treatment method and it may lead to poorly treated concrete. A high degree of control is required for acceptable concrete quality. The layers should be placed 150 to 200 mm thick and be tamped until a closed surface is achieved.

9.4.5 Curing Concrete

- When concrete sets it releases a lot of heat. The chemical reactions which take place when concrete sets are exothermic, and the concrete dries quickly and may develop shrinkage cracks. The concrete needs to be kept wet until the setting is complete.

  There are two practical methods for curing concrete at remote sites. These are:-

  (i) For horizontal or near horizontal surfaces, the concrete surface is covered with river sand and the sand is kept wet by applying water at suitable intervals.

  (ii) For vertical or sloping surfaces, the concrete is covered by a suitable water absorbing material like hessian sack or paper

cement bags and again the material is constantly wetted until the concrete cures.

9.4.6 Concrete Quality Control Tests

- The concrete mix design is supplied by the engineer will give a target strength for the concrete, as well as specifing the recommended slump. The slump will depend on the concrete vibration method used. The concrete workability is monitored by adjusting the slump of the wet concrete until it meets the specifications. The slump is monitored by adjusting the water content on site and depends on the moisture content of the aggregates, especially the sand.
- The concrete strength is monitored by taking and crushing concrete cubes as specified in the Central African Standard (CAS). The concrete strength may be checked by crushing the concrete cubes at three (3), seven (7) and twenty eight (28) days. If the concrete is well outside the margin either way then the mix design should be adjusted until the targeted strength is obtained. A sample of the concrete quality control test sheet is shown in Appendix F.

9.4.7 Shuttering and Formwork for Pier Stems

- The pier stems have vertical and sloping faces and care needs to be taken in erecting the formwork. The staging should be made sufficiently firm to prevent any movements that would otherwise occur with the dead weight of concrete.
- The shutters should be made from either wooden or steel panels. The shutter material should be approved by the engineer before erection on site. The shutter panels should be fixed to prevent movement occurring during concrete placing and vibration. The shutter joints should be properly sealed so that no cement mortar seeps through the joints before concrete has hardened. The stagework and formwork should be inspected and be approved by the engineer before concreting commences.
- The shutters should be kept in place for a period of not less than 24 hours after the pouring of the concrete.

9.4.8 Prescribed Concrete Mixes

- In most cases, there is lack of expertise in the Rural District Councils to calculate a proper concrete mix design. In this case prescribed mixes commonly used in the construction industry may be adopted. The mixes do not give an accurate grade of concrete but the results are generally accepted as being within reasonable target strengths. The commonly used mixes are specified in terms of fixed volumes. The volumes are fixed by standard wooden boxes with specific volumes.
- The concrete mix is thus specified in ratios of cement: sand: stone. The grade of concrete and the mix proportions are summarised in Table 9.4.8 below.

Target Grade	Classification	Mix Proportions*	Comments
C15	Low strength	1:3:5	Normally used as mass concrete
C20	Standard concrete	1:2:4	Most commonly used mix for ordinary works
C30	High Strength	1:1.5:3	Used for specialised works where high strength is required.

* The mix proportions denote the volume ratios of cement to sand to stone.

Chapter 10

Erection of Cables

10.1 Footbridge Cables

10.1.1 Handling of Cables

- Cables are the most important parts of suspension footbridges and therefore great care must be taken when handling them, in order to avoid kinks and splicing. Kinks and splices reduce the cable breaking tension. Cable accessories must meet the required standards, and together with the cables, must be transported and handled carefully.
- Do not attempt to unreel cables from a stationary coil or reel since this tends to lead to kinking. Rotating wheel drums should be used.

10.1.2 Cable Specifications

- The nominal cable sizes usually available locally are the 13, 19, 26 and 32 mm diameter cables. Cable size greater than 32 mm is imported and this makes it very expensive for small projects. The use of cable sizes greater than 32 mm is not recommended.
- The cable construction and wire strength components will vary according to the supplier. It is important to check that the cable breaking tension and Elasticity Modulus meet the minimum requirements as specified on the drawings.
- Before the cables are transported to the site, the cables should be checked for diameters, construction, core, lay, length and galvanisation.

10.1.3 Cable Terminals

- Cables may be terminated using thimble and bulldog grips with cable clamps.
- The thimbles and bulldog grips should be checked for dimensions and quality conformity before use. The thimbles must be the open types, forged and galvanised.
- Before tensioning the ropes, the nuts on bulldog grips must be tightened. The nuts should be re-tightened after cable tensioning to take care of cable diameter reduction due to tensioning. The nuts for the bulldog grips must not be placed on the 'live' side of the rope connections.
- All bulldog grips must be tightened again after completion of the footbridge construction.

10.2 Erection of Cables

10.2.1 Hoisting of Main Cables

Marking of Cables

- Before the cables are pulled across the river, control points should be marked on the cables preferably by paint.
- The control points could, for example, be the positions of the bulldog grips towards the anchors, the tower saddle summit and the point of maximum sag.
- Leave enough cable lengths at each end to allow for lapping and joint connections

Carrying Main Cables across the River

- The cables may be carried across the river by walking across the river bed in dry bed rivers, by using temporary footbridges if any, or by using paddle boats in flowing or deep water rivers. If no footbridge exists, the cable may be pulled through the river using rope attached to the cable end.

Hoisting Cables on Towers

The cables may be hoisted on the towers by one of two methods.

(i) Hoisting from the Tower Sides

- The method is suitable for towers not more than twenty metres high.
- The cables are taken across the river and anchored into the blocks taking the marks into consideration.
- The ropes are then elevated over the saddles and lowered into position using pulleys on top of the towers and pulling machines with auxiliary ropes used as lifting hooks.
- This method is not easy to use and is not ideal for simple construction.

(ii) Hoisting from Tower Front

- The main cables are pulled over the tower saddles using rope-pulling machines at each side of the footbridge. The cables are pulled using auxiliary ropes fastened at each end.
- Keep the friction between cables and saddle low by using lubricants like oil or grease.

Checking of Sag

❖ The sag during and after cable hoisting can be monitored by taking the levels of the marked maximum sag position with a levelling machine or theodolite in relation to the tower top.

Chapter 11

Erection of Deck

11.1 Fitting the Suspenders and Walkway

11.1.1 Construction Sequence

- The suspenders (hangers) and deck may be erected by either starting at midspan and working outwards or by starting at the ends and working towards the centre from both ends. The deck is erected by using fitter platforms, which should be approved by the engineer before use.
- The distance between the suspenders should be measured carefully and the distance from the towers confirmed after every tenth suspender.

11.1.2 Working from Towers towards Footbridge Centre

Advantages

The supply of parts to the fixing crew is easy. The fitters may work in an almost upright position especially towards the towers. The distance between the suspenders is easily measured.

Disadvantages

Due to unavoidable errors in the setting out of the span as well as the cumulative errors in the measurements between the suspenders, the remaining spacing at the footbridge centre will either be too long or too short. Adjustment of the crossbeams to take care of this error is difficult.

11.1.3 Working from Footbridge Centre towards Towers

Advantages

Working from the footbridge centre has the advantage of easier adjustments at the ends if the finish is not symmetrical.

Disadvantages

The major disadvantage is that supply of parts is not easy and pulleys and ropes may be required to aid erection. The erectors will have to work in a bending position.

11.2 Fitting Stabilising Cables and Diagonal Stabilisers

Long span footbridges have diagonal stabilisers and stabilising cables as shown on the working drawings.

11.2.1 Construction Sequence

- Fit the stabilising clamps and the main cable clamps of the diagonal stabilisers simultaneously with the suspender fitting.
- Cut the stabilising cables to the correct lengths after making provision for lapping.
- Fit the stabilising cables to the main cable clamps.
- After completion of the footbridge erection, including steel deck, wire mesh netting, fit the bottom clamps of the diagonal stabilisers
- Stretch the cables using the turnbuckles so that the cables are not loose and take care not to overtension.

11.3 Fitting the Windbracings

11.3.1 Preparation of Windties

- Cut the windties to the correct lengths according to the drawings making provision for lapping (cutting length = centre to centre length + 600 mm).
- Measure and mark the far ends of the cables and mark as points 1 and 2.

- Fit the thimbles, bulldog grips and eye-bolts at both ends.

11.3.2 Hoisting of Windbracings

There are two methods for hoisting the windbracings. The first method is to fix the windguy cable first and then the windties, and the second method is fixing the windties first and then the windguy cable to the anchorage blocks.

Fixing the Windguy Cables First

- Mark the positions of the windties on the windguy cables and fix the windties to the windguy cables.
- Take the windguy cables across the river and fit the cables into their anchorages. The cables will then hang between the anchorages.
- Immediately after the suspender/walkway connections are complete, connect the windties to the walkway bracings as shown on the drawings.
- Start with the centre windties and work outwards. Using two pulling machines, one upstream and the other downstream, pull the cables simultaneously towards the walkway and connect the windties.
- Check whether the footbridge is still straight. Always pull the cables simultaneously and remember to check the footbridge alignment.

Fixing the Windties First

- Mark the positions of the windties on the windguy cables and fix the windties to the windguy cables.
- Bring the windguy cables into position along the deck but outside the suspenders and fix the windties to the deck cross bracing.
- Fix the two ends of the windguy cable to the anchorages and apply the required cable tension using the pulling machines.
- Tension both windguy cables simultaneously to avoid an unsymmetrical load on the footbridge.

After fixing the cables as above tighten the windties with the turnbuckles.

11.4 Finishes

11.4.1 Handrail Cables, Wiremesh and Steel Deck

- Fix the handrail cables to the vertical suspenders as shown on the drawings.
- Fix the wiremesh to the handrail cables and to the vertical suspenders using binding wire.
- Fix the steel chequer plate deck to the crossbracings as shown on the drawings.

11.4.2 Test Loading

- The footbridge has to be test loaded with at least three people per metre of footbridge length.
- After test loading, retension the main cables.
- Align the whole footbridge using the turnbuckles to ensure that the walkway is exactly straight, the windguy cables form a continuous curve and the dead load sag is accurate as per the drawings.
- Re-tighten all the nuts and locknuts on the whole footbridge.
- Protect all non-galvanised threads with coal tar and repaint the steel parts where necessary.

Chapter 12

Ancillary Works

12.1 Construction of the Approach Ramp

12.1.1 Construction Materials

The approach ramp may be constructed from the following materials, subject to the availability of the materials locally.

Masonry Walls

- The masonry walls may be constructed from either burnt clay brick or rock with cement mortar. The rock masonry wall is likely to be cheaper if rock is available in abundance locally. The rock wall has also the added advantage that the construction is stronger and less prone to weathering deterioration. If these two relatively cheap materials are not available, then mass concrete may be used for the masonry walls, but this option is more expensive and should only be used as a last resort.

Approach Ramp Backfill

- The void between the approach ramp masonry walls should be backfilled with the cheapest locally available material. The materials may be bits of brick, rock or concrete blocks embedded in a well-compacted earth fill. In cases where it is deemed cheaper, the backfill may consist of earthfill only, in which case the backfill should be well rammed to avoid significant fill settlement after construction. The earth excavated from the foundations and anchor blocks may be used for this purpose if approved by the engineer.

Approach Slab

- The approach ramp should be finished by constructing a mass concrete approach slab as indicated on the working drawings. The approach slab should be inclined at the correct slope and the slab must be reinforced by at least a single layer of wiremesh. The slab surface finish should be roughened to enhance frictional grip.

12.1.2 Construction Sequence

- The length and height of the approach ramp will be determined by the height of the footings above ground level and on the ground geometry. The amended standard working drawings will show this detail.
- Mark out the excavation area bound by the length of the approach ramp given on the drawings and a width given by making an allowance of 0.5 metres each side of the footbridge walkway.
- Excavate the foundations for the masonry walls to a depth at least 0.5 metres below ground level. Excavate the humic topsoil from under the ramp area.
- Construct the masonry walls from the sourced materials taking the final slope of the approach ramp into consideration. Allow enough time for the masonry walls to set before placing the backfill.
- Place the backfill in between the masonry walls using the material selected by the engineer. Leave sufficient depth for the concrete slab above the backfill.
- Construct the approach slab on top of the backfill to give the final approach ramp slope and finish. The concrete should be left roughened to avoid the surface becoming slippery when wet.
- For the other concrete sections the concrete slab should be cured and must not be loaded before the concrete has gained sufficient strength.

12.2 Erosion Protection Works

- It is prudent during construction to avoid placing the substructures in areas where the river channel is active and the water constantly inundates. The amount of damage caused by erosion and the need for continuous maintenance may necessitate that the footbridge span

be made slightly longer during the design stage. This way the amount of damage to the substructures and erosion is minimised.

12.2.1 Construction of Gabion walls

- The main method of slope and erosion protection is the construction of gabions and ordinary stone pitching.
- Gabions are gravity walls which support those embankments or slopes which have a potential to slip.
- The slope of the gabions should be in the ratio of at least 1 vertical: 2 horizontal. Flatter slopes may be adopted depending on the site terrain.
- The filling of the gabions should be from strong and competent rock which is laid very closely packed to maximise the weight.
- Bracing wire should be used to prevent the gabion bulging out. The bracing wire should be placed at each third of the gabion height.
- The gabions should be tied together during filling to give a monolithic finish.
- The gabions should be firmly anchored into the ground by founding the gabions below the expected scour depth level.
- In cases where stone pitching is not provided, the top layer should be covered by soil to encourage the growth of grass and the stabilisation of the slopes.

12.2.2 Rock Cladding or Stone Pitching

- Rock cladding or stone pitching may be provided as the only erosion protection measure in those cases where the erosion potential is deemed minimal.
- Stone pitching is not very resistant to strong water currents and is mainly used as the top finish on gabion walls.
- The extent and need for stone pitching is normally determined on site by the engineer.
- Stone pitching may not be ideal in those areas where rock is not readily available. In such cases, the cladding may be made from ordinary cement mortar or weak concrete.

12.3 Painting

- The structural components of the footbridge should be painted to protect the elements from weathering. It is preferable that silver or aluminium paint is used.
- In addition to protection, the coat of paint gives the footbridge a uniform colour thus increasing the aesthetics of the footbridge.

Chapter 13

Labour Resources and Scheduling

13.1 Sources of Labour

13.1.1 Sources of Skilled Labour

Skilled labour is defined as those people with a certain level of qualification and experience in a particular operation. The skilled labour needed during footbridge construction would include steel fixers, concrete mixer and poker vibrator operators, cable tensioners, drivers and quality control checkers.

It is not likely that this manpower is available within the locality of the project, except perhaps for drivers. The contractor usually has to bring his own skilled manpower. The skilled manpower needed has to be specified in the list of manpower and resources, which are a requirement of the tender and bidding process.

13.1.2 Sources of Unskilled Labour

The footbridges are likely to be erected in areas where there are abundant unskilled labour resources. For use as extra hands, the contractor should hire the local people at agreed rates (or minimum Government statutory rates).

No formal training or experience is required for footbridge operations, which are labour intensive. It is possible to hire and train on the job the unskilled component of labour resources.

13.2 Labour Scheduling

13.2.1 Individual Time Inputs

The time inputs of the various labourers required depend upon the overall work programme and the time scheduling. Each operation is first programmed and the inputs in labour resources are then estimated from the quantity of work to be carried out. The time inputs are then converted into man hours depending on the assumed working day and expected individual output. The number of people required for each operation and the time taken for each task are then reconciled to give the number of people required for each operation.

13.2.2 Overall Time Inputs

The overall time inputs for each skilled or unskilled operator can be tied in to the overall work programme and presented as a bar chart. The bar chart will show the level of skill required for each operation and the expected time each operative will be involved in a task.

13.2.3 Time Sheets

- The time and activity of each worker on site is monitored by the use of time sheets. The main components of the time sheet are:-
  - (i) Date:- the date (day, month and year) for each day of operation is recorded.
  - (ii) Activity:- this describes in detail the work done on the particular day. When different tasks have been performed on the same day, the tasks are separated with the time inputs on each operation being detailed separately.
  - (iii) Manpower and Time:- the number and grade of people involved on the particular operation are detailed. The number of people for each grade is included. The time spent by each number and grade of people in a particular operation is given as a total.
  - (iv) Production:- the quantifiable output for each particular task is given. The output is quoted per unit rate for each operation.

(v) Remarks:- This section allows for any comments or remarks pertinent to the task.

- The time sheets will be used to calculate the total wages bill for the project. Individual time sheets for officers may be filled in separately from the collective time sheets. There are many versions of time sheets which can be adopted. Two samples for the officers and the general time sheets are shown in Appendix G.

Chapter 14

Construction Records

14.1 List of Construction Records

14.1.1 Completion Drawings

- No matter how dependable and accurately the design and working drawings have been made, it is unavoidable that some changes will be made on site as construction progresses.
- All those changes made to the design and working drawings during the footbridge construction should be noted and amended clearly on the drawings with amendment numbers.
- The amended design and drawings together with any site instructions thereof will constitute the 'As Built' or Completion Drawings.

14.1.2 Site Instruction Book

- During construction, a site instruction book must be kept on site to record those instructions issued by the engineer to the contractor. The site instruction book is a very important document, especially in cases where disagreements occur and liability has to be determined. This book is filled in triplicate. A sample layout for a site instruction book is given in Appendix H1.

14.1.3 Site Diary

- The site clerk should keep a site diary where every daily operation is documented. The diary will also include records of visitors to the site and any occurrences likely to affect the administration of the project, e.g., rainfall, climatic conditions, etc. An example of a site diary is shown in Appendix H2.

14.1.4 Labour and Plant Returns

- The contractor will, from time to time, submit to the engineer the list of staff and machinery on site. These documents augment the engineer's determination of the progress of work as per construction schedule and the costing of the project. The amount and type of labour and machinery on site at any one time has a bearing on the construction cost and site cash flow.

14.1.5 Construction Returns

- During construction the contractor may be requested to submit to the engineer weekly or monthly work programmes, labour and plant returns, cashflow projections, results of quality control tests, etc.

14.2 Disposal of Construction Records

14.2.1 Client's Files

- Depending on the client's practice, the construction records should be filed and kept in the client's projects filing system. For Government projects, the construction records will ultimately be sent to the National Archives for storage. This is normally done after the projected design life of the project.

14.2.2 National Archives

- Depending on the magnitude and importance of the project nationally, the construction records may be forwarded to the National Archives for storage after an agreed time in the client's files.

Chapter 15

Footbridge Maintenance Procedures

15.1 Inspection and Maintenance of Steel Parts

15.1.1 General

It is recommended that standard steel inspection forms are used for monitoring the footbridge components. The use of standard forms is meant to systematise the maintenance of steel parts and to set out proper procedures for inspection and acceptance of steel components.

Inspection of the steel and filling in of the forms must be carried out carefully by a qualified person.

15.1.2 Inspection Procedures

Anchorages

The anchorages are easy to inspect because they are exposed above the ground. The anchorages will be inspected for rusting of the turnbuckles and hooks, functionality of the threads and integrity of the individual members. The anchorages are exposed to vandalism and may be adversely affected by misuse.

Steel Cables

The steel cables, especially the main cables, may not be easy to inspect – particularly between the towers. The erection platform may be used as an inspection platform if it is still available. The cables should be checked for rusting, spalling of the steel threads and general loss of tension. The loss of tension is not easily quantifiable but should be apparent from loss of structural integrity or deformation of the footbridge. Hand testing may also be used as general check for cable tautness.

Cable Connections

The live load from pedestrian traffic and wind effects tends to impose stresses on the connections. The connections may loose functionality as a result of shearing of bolts and rivets, unscrewing of nuts or slackness in grips and studs. Each joint should be examined visually for any such failures and the defects repaired.

Cable Seating

The cable seating over the deck is exposed to movement of the rope over the saddles. This movement may lead to deterioration of the saddle seating. The saddles may be moved out of position and the anchor bolts may be sheared. The movement of the cable over the saddle is enhanced by greasing the saddle seating.

Vertical Suspenders

The vertical hangers are subject to vertical and horizontal oscillations as well as to human activity at the supports. The hangers may then deteriorate in tautness and may be displaced from their vertical orientation. It is easy to recognise a malfunctioning suspender by the loss of straightness and alignment. In exceptional circumstances, the hangers may actually be bent from vandalism.

Steel Deck

The steel deck is exposed to live loads from pedestrian activity. The deck may be subjected to unusual loads leading to localised failure of the deck walkway. The deck may fail if concentrated live loads are imposed. The deck is also prone to normal wear and tear from human activity leading to the wearing off of the deck connections as well as the general deterioration of the steel components. The deck should also be inspected for any signs of rusting.

Wire mesh

The side wire mesh is the most vulnerable component of the deck due to the flexibility of the construction materials. The wire mesh may be vandalised by pedestrians. In some cases, portions of the wiremesh may

actually be removed for use by local people. The wiremesh is also prone to normal rusting and to disfigurement due to deterioration of the other adjoining footbridge components.

15.1.3 Maintenance Procedures

Anchorages, Steel Cables and Cable Connections

Those steel components showing advanced rusting should be repaired by painting the parts with approved weather resistant paint or bitumen seal. The connections should be retightened where they are loose. In cases where the components are no longer functional, the connections should be replaced completely by new parts. If the cables are slack, then retensioning should be done by adjusting the turnbuckles, care being taken not to overtension the cables. The sag may be monitored as a check for the main cables.

Cable Seating

The bearings are greatly affected by friction generated from cable movements over the supports. The friction should be minimised by applying a lubricant, e.g., grease.

Vertical Suspenders

The hangers should be realigned and fixed into place by securing the joints and connections. The steel should also be repainted if rusting has been observed. If the hanger has deteriorated beyond functionality, then that particular hanger should be replaced. Care should be taken to ensure that the hanger is of the right length and that the hanger is in tension to operate in tandem with the rest of the hangers.

Steel Deck

The steel deck should be painted in places where advanced rusting is observed. If an individual panel has deteriorated to such an extent that it is now unsafe, then the panel should be removed and be replaced by a new one. Take care not to weaken the adjoining panels and to secure the panel correctly.

Wire mesh

The wiremesh should be repainted in places where rusting is not severe. The mesh may also be patched by fixing a piece over any deteriorated section. Replacement of the whole wiremesh should only be done in cases where it is uneconomic to patch the mesh.

15.2 Inspection and Maintenance of Concrete and Foundations

15.2.1 General

The concrete component is the most durable part of the footbridge – providing the concrete was correctly placed and properly treated during construction. The concrete normally does not deteriorate to unserviceable levels unless a sever failure occurs.

15.2.2 Inspection Procedures

- The concrete parts should be checked for spalling of concrete. This will be apparent if the concrete has honeycombs, which tend to expose the steel reinforcement to rusting. Spalling of concrete may also occur if the concrete is exposed to extreme heat, e.g., from veld fires. The concrete surfaces should therefore be checked for spalling and exposure of steel. Rusting of steel reinforcement is shown by brown stains on the concrete surface.
- The concrete may also develop cracks either from applied stresses or from incomplete curing or from bad workmanship during construction. The concrete surfaces should be examined for such cracks however minute. The use of hand-held binoculars might be used for those concrete sections which are not easily accessible.
- Concrete is also prone to chemical attack. Chemical attack results from the chemical reactions occurring in the hardened concrete, the chemicals having been components of either the construction water or aggregate. Chemical attack is evidenced by whitish slay deposits on the concrete surface. The sulphate attack is the most common chemical attack on concrete.

- The foundations fail mainly as a result of the pulling out or tilting of the footings or anchor blocks. Pulling out is evidenced from ground heave around the anchor blocks. Tilting is evidenced from loss of straightness by the concrete surfaces. These failure modes are easily assessed visually.

15.2.3 Maintenance Procedures

- The cracks on concrete should be made good by sealing. The cracks should be sealed by a cement paste. If the cracks are too wide or the concrete looks unserviceable, then an analysis and detailed assessment of the failure may need to be done to avoid covering over a hazardous failure.
- If steel reinforcement is exposed from spalling, the rust should be cleaned from the steel surface and the surface thoroughly cleaned before sealing with cement mortar.
- Efflorescence resulting from chemical attack should ideally be washed by water jetting or the scrubbing the concrete surface. No major works can be done on the chemical composition of the concrete.
- The heaving or shifting of the footings show a major failure of the footbridge and ordinary remedial works are not adequate to redress the problem. The engineer may have to re-design the footings to add stability to failed components.

15.3 Inspection and Maintenance of Ancillary Works

15.3.1 Approach Ramp

- The approach ramp may lose some of its structural integrity as a result of either human activity or flood action. The dimensional tolerances of the ramp should be checked to see whether they are still as built. Any deformities should be made good by reconstructing the failed sections.

15.3.2 Erosion Protection Works

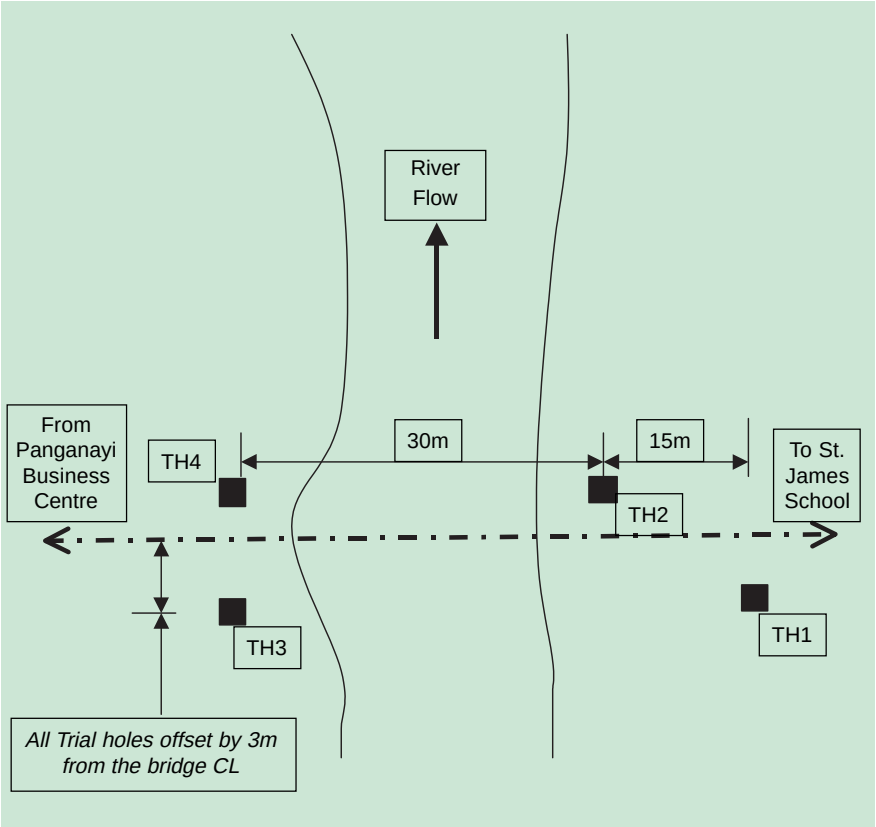
- The erosion protection works may be damaged from river scour due to high floods. The gabion mattresses may be washed away or the supports maybe be undercut by water, leading to loss of support.
- Similarly the rock cladding may be washed away. The damage should be repaired by replacing those sections washed away or by reconstructing the works.

15.3.3 Anti-Vandalism Works

- Vandalism of the footbridge components is one of the main problems associated with footbridge maintenance. A lot of money may be lost in replacing footbridge components, especially connections lost due to vandalism.
- Those components which are most prone to vandalism are the bolts and nuts, and the side wiremesh. The nuts and bolts should be protected by damaging the threads on the bolts so that the nuts cannot be removed. The wiremesh is very difficult to protect. One method of protecting wiremesh would be to paint the wiremesh in a bright conspicuous paint which is easily recognisable.
- Educating the community about the importance of the footbridge, and the risks associated with removing or damaging footbridge components, could help reduce vandalism.

Appendices

Appendix A1 – Site plan and Trial Hole Layout



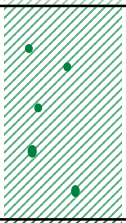
Typical Site Plan and Trial Hole Layout

Appendix A2 – Soil Profile Logs

TRIAL PIT LOG SHEET

PROJECT No.	FUVE CANAL SUSPENSION FOOTBRIDGE	**DATE:**	27/05/00
CLIENT NAME:	ZAKA RURAL DISTRICT COUNCIL	**OUR REF:**	ZKA/01

TYPICAL PROFILE

DEPTH B.G.L (m)	PROFILE	PROFILE DESCRIPTION	OTHER TESTS
0.4		Greyish humic fine loose sandy TOPSOIL	LL = 45.0 PL = 25.0 PI = 20.0 CI = 3.3 FI = 75 PP = 1500
1.6		Moderately strong highly weathered clayey granitic GRAVEL	LL = 35.3 PL = 17.8 PI = 17.5 CI = 7.8 FI = 55 PP = 960
2.5		Very strong residual but decomposing granite ROCK	

COMMENTS:-

Groundwater was encountered at 1.8 metres below ground

PROJECT No.	**DATE:**
CLIENT NAME:	**OUR REF:**

TYPICAL PROFILE

DEPTH B.G.L (m)	PROFILE	PROFILE DESCRIPTION	OTHER TESTS

COMMENTS:-

Appendix A3 – Field DCP Test Results

Project: Fuve Canal Suspension Footbridge
Date: 27/05/00

Client: Zaka Rural District Council
Our Ref: ZKA.01

		TEST POINT	TH 1				
Test Level mm BGL	No. of Blows (mm)	Gauge Reading	Difference (mm)	Penetration/ Blow (mm) (mm)	Cumulative Difference	Cumulative Blows	Depth BGL (mm)
0	0	10			0	0	0
	5	280	270	54	270	5	270
	5	392	112	22	382	10	382
	5	494	102	20	484	15	484
	10	710	216	22	700	25	700
	10	923	213	21	913	35	913
	10	957	34	3	947	45	947
1000	0	5	0	0	947	45	947
	15	442	437	29	1384	60	1384

	8	497	55	7	1439	68	1439
	20	565	68	3	1507	88	1507
	20	690	125	6	1632	108	1632
	30	971	281	9	1913	138	1913
2000	0	0	0	0	1913	138	1913
	15	222	222	15	2135	153	2135
	8	245	23	3	2158	161	2158
	20	320	75	4	2233	181	2233
	20	415	95	5	2328	201	2328
	20	521	106	5	2434	221	2434
	20	563	42	2	2476	241	2476
	20	582	19	1	2495	261	2495
	20	584	2	0	2497	281	2497
SUMMARY:		Depth B.G.L.(m)		0.2 - 1.4	1.4 -2.2	2.2 - 2.5	>2.5
		Bearing Cap.KPa		120	200	460	Rock

Project: Fuve Canal Suspension Footbridge
Date: 27/05/00

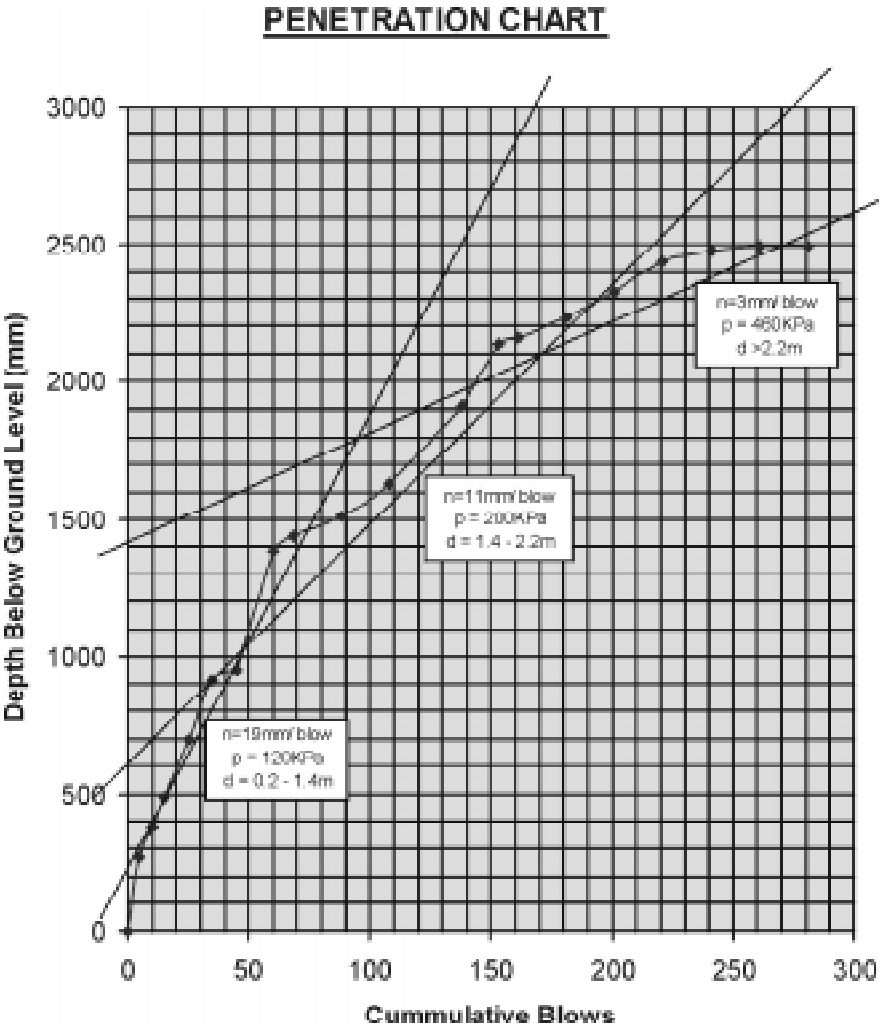
Client: Zaka Rural District Council
Our Ref: ZKA.01

		TEST POINT	TH 1				
Test Level mm BGL	No. of Blows (mm)	Gauge Reading	Difference (mm)	Penetration/ Blow (mm) (mm)	Cumulative Difference	Cumulative Blows	Depth BGL (mm)

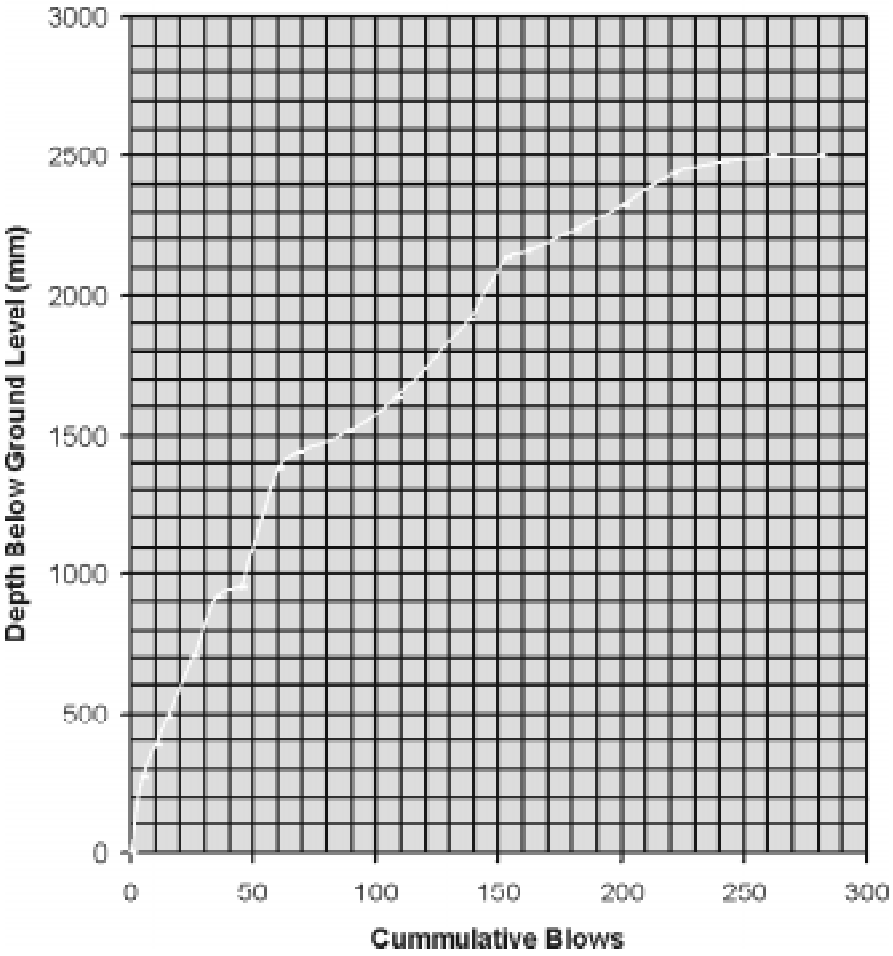
SUMMARY		Depth B.G.L.(m)					
		Bearing Cap.KPa					

DCP Test – Strength Variation with Depth

Results



PENETRATION CHART



Appendix A4 – Sheet 1 – Laboratory Test Results

Project: Fuve Canal Suspension Footbridge
Job Ref: ZKA 01

SAMPLE No.	Liquid Limit Wl	Plastic Limit Wp	Plasticity Index Ip (Wl - Wp)	Coarseness Index Ic < 37.5, >2.36	Finess Index Fl < 75 um	Plasticity Product, PP (Ip x Fl)	Activity Ip/Clay Frac.	% AGE CBR	Water Level B.G.L.
TH1 (0 -0.5)	35.2	22.1	13.1	3.0	56	734			
TH1 (0.5 -1.5)	45.3	25.3	20.0	8.5	75	1500			
TH2 (0.2 - 1.2)	47.3	26.8	20.5	3.0	65	1333			

Comments:

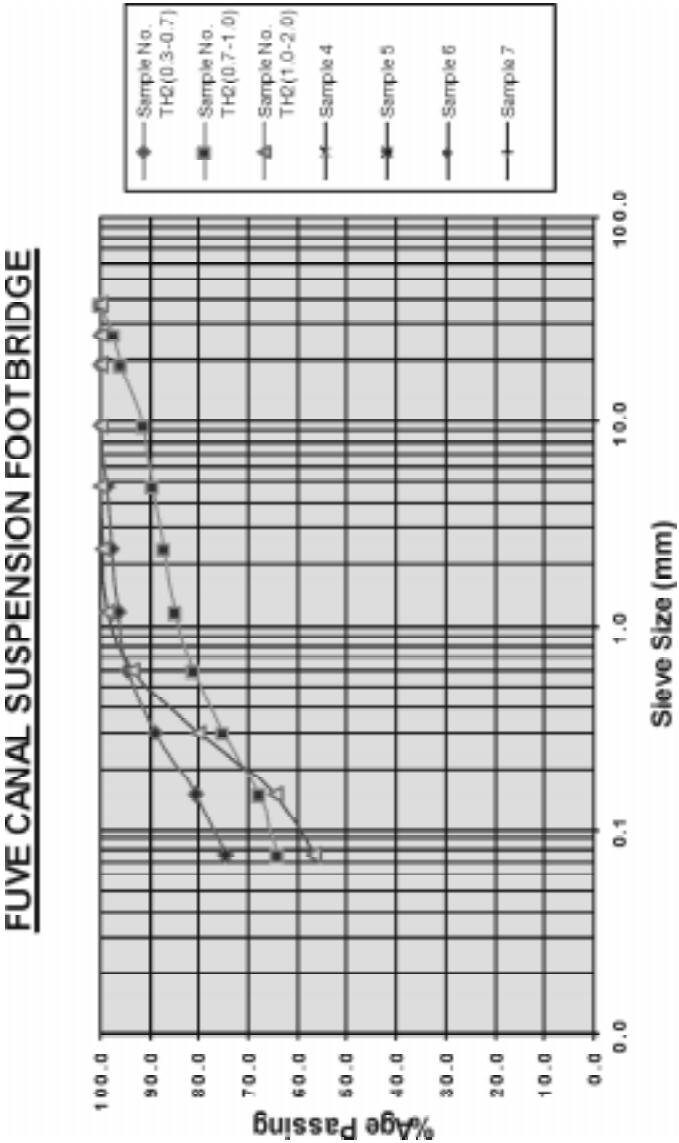
Project: Fuve Canal Suspension Footbridge
Job Ref: ZKA 01

SAMPLE No.	Liquid Limit Wl	Plastic Limit Wp	Plasticity Index Ip (Wl - Wp)	Coarseness Index Ic < 37.5, >2.36	Finess Index Fl < 75 um	Plasticity Product, PP (Ip x Fl)	Activity Ip/Clay Frac.	% AGE CBR	Water Level B.G.L.

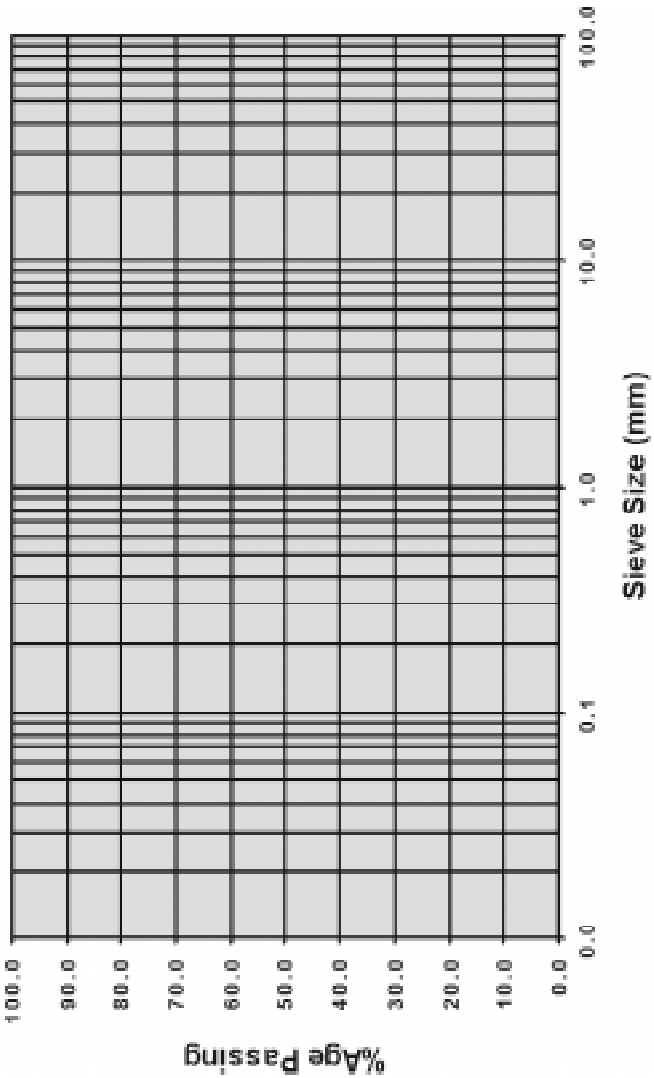
Comments:

Appendix A4 – Sheet 2 – Laboratory Test Results

	Cumulative %Age Passing						
Sieve Size (mm)	**Sample No. TH2(0.3-0.7)**	**Sample No. TH2(0.7-1.0)**	**Sample No. TH2(1.0-2.0)**	**Sample 4**	**Sample 5**	**Sample 6**	**Sample 7**
37.5	100.0	100.0	100.0				
26.5	100.0	97.1	100.0				
19.0	100.0	95.8	100.0				
9.5	100.0	91.1	100.0				
4.75	98.5	89.3	100.0				
2.36	97.5	87.0	99.6				
1.18	96.4	84.7	98.5				
0.600	94.4	81.1	93.5				
0.300	89.1	75.1	80.2				
0.150	80.8	67.6	64.3				
0.075	74.5	63.9	56.5				


FUVE CANAL SUSPENSION FOOTBRIDGE
%Age Passing
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0.0
0.1
1.0
10.0
100.0
Sieve Size (mm)
Sample No. TH2(0.3-0.7)
Sample No. TH2(0.7-1.0)
Sample No. TH2(1.0-2.0)
Sample 4
Sample 5
Sample 6
Sample 7

	Cumulative %Age Passing						
Sieve Size (mm)							
37.5							
26.5							
19.0							
9.5							
4.75							
2.36							
1.18							
0.600							
0.300							
0.150							
0.075							


100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
%Age Passing
0.0
0.1
1.0
10.0
100.0
Sieve Size (mm)

Appendix B – Bill of Approximate Quantities

ITEM	Operation and Description	Unit	Est. Quantity	Rate	Total Amount
PG	**PRELIMINARY AND GENERAL**				
PG-A	**Establishment and General**				
PG-A(1)	Provision of Insurance	Sum			
PG-A(2)	Provision of Performance Bond	Sum			
PG-A(3)	Establishment on site	Sum			
PG-A(4)	General Costs	Sum			
PG-A(5)	Provision of water supplies	Sum			
PG-A(6)	Variation of Price	Sum			
PG-A(7)	Allowance for Extra work	Sum			
	TOTAL PG-A CARRIED TO WORKS SUMMARY				
SCP	**SITE CLEARANCE AND PREPARATION**				
SCP-1	Clearing of site	Sum			
SCP-2	Construction and Maintenance of access roads to Bridge site, water points and aggregate deposits	D/work			

SCP-3	Keeping excavations free of water, including construction of coffer Dams and any other works	Sum			
	TOTAL SCP CARRIED TO WORKS SUMMARY				
AS	**ANCHORAGE SYSTEM**				
AS(A)	**Anchorage for Main Cables**				
AS (A)1	Excavate to maximum depths of 1.5 metres foundation pits for anchor blocks	m^3			
AS (A)2	Extra over item P1 for hard excavation	m^3			
AS (A)3	Extra over item P1 for rock excavation	m^3			
AS (A) 4	Supply, mix and apply concrete blinding grade C10 to excavations	m^3			
AS (A) 5	Supply, mix and apply mass concrete grade C25 to anchor blocks	m^3			
AS (A) 6	Supply and place on site 3 000mm long, 250mm Outside Diameter with 4.5mm thick walls steel pipes for anchors	No.			
AS (A) 7	Excavate to maximum depths of 2.0 metres for anchor bar casing	m^3			
AS (A) 8	Supply, mix, place and compact mass concrete grade C25 in cable protection walls and anchor bar casing	m^3			

ITEM	Operation and Description	Unit	Est. Quantity	Rate	Total Amount
AS (A) 9	Supply and place on site Anchor Bars 5.6 metres long diameter 50mm with forged eyes 130mm and 235mm inside diameters at either end to take maximum tension of 694.7KN	No.			
AS (A) 10	Supply and place on site Turnbuckles 1.0 metres long, 20mm bolt diameter, 100 x 15mm mild steel body plate welded to bolts at ends with 130mm inside diameter forged eyes at both ends to support 32mm diameter cable with breaking tension of 694.7KN	No.			
AS (A) 11	Supply and place on site high tensile steel 'D' shackles to take minimum tension of 694.7KN in cables 32mm nominal diameter, complete with bolts and washers	No.			
AR	**APPROACH RAMP**				
AR 1	Excavate to maximum of 500mm for approach steps foundations	m^3			
AR 2	Supply materials and construct on site rock masonry approach steps to the footbridge deck	m^3			
AR 3	Supply and lay on site 150mm thick cast in situ grade C25 concrete in approach slab	m^3			

AR 4	Supply and lay on site S193 wiremesh in slab as reinforcement	m^2			
	TOTAL AR CARRIED TO WORKS SUMMARY				
SC	**STEEL CABLES**				
SC (A)	**MAIN CABLES**				
SC (A) 1	Supply and erect on site 32mm diameter multi-strand steel cables 6x7(6/1)WMC - STANDING ROPE (Breaking Tension of 694.7KN with wires 1600MPa strength)	m			
SC (A) 2	Supply and place 'Crosby' clamps at 250mm centres for 32mm diameter cable (to take maximum tension of 629.4KN)	No.			
SC (A) 3	Supply and place clamps complete with nuts and U-bolts at top of hanger - main cable connections.	No.			
SC (D)	**HANDRAILS**				
SC (D) 1	Supply and erect on site 13mm diameter multi-strand steel cables for the hand rails 6x7(6/1)WMC - STANDING ROPE (Breaking Tension of 114.0 with wires 1600MPa strength)	No.			
SC (D) 2	Supply and place mild steel clamps complete with locking nuts and bolts for top and bottom handrail connections	No.			
	TOTAL SC CARRIED TO WORKS SUMMARY				

ITEM	Operation and Description	Unit	Est. Quantity	Rate	Total Amount
P	**PIERS**				
P 1	Common excavation to maximum of 1.5 metres for pier foundations	m^3			
P 2	Extra over item P1 for hard excavation	m^3			
P 3	Extra over item P1 for rock excavation	m^3			
P 4	Supply, mix, place and compact mass concrete grade C10 in blinding to foundations	m^3			
P 5	Supply, mix, place and compact mass concrete grade C25 in footings to foundations	m^3			
P 6	Supply, mix, place and compact reinforced concrete grade C25 in pier stems	m^3			
P 7	Supply and erect on site Y14 and over reinforcement bars to pier stems	tonne			
P 8	Supply and place on site Y12 and under steel reinforcement to pier stems	tonne			
P 9	Supply and place cast iron saddles 250mm outside diameter on top of piers with 26mm groove for cables	No.			
P 10	Supply and place on site formwork (shutters) to pier exposed surfaces	m^2			
	TOTAL P CARRIED TO WORKS SUMMARY				

DC	DECK CONSTRUCTION				
DC 1	Supply and place on site 16mm iron hangers	tonne			
DC 2	Supply and place on site 1 200mm long angle iron braces 50mm x 50mm x 10mm section	m			
DC 3	Supply and place on site 6mm diameter iron hook bolts to braces and hangers	No.			
DC 4	Supply and place on site 1 200mm long flat iron braces 25mm x 10mm section	m			
DC 5	Supply 4.5/6.0x1.2mx2.4m long chequer plates for deck walkway	No.			
DC 6	Supply and place on site 6mm diameter steel bolts for fixing the deck to cross braces	No.			
DC 7	Supply and place on site 3mm gauge wiremesh on deck parapets	sq. m			
DC 8	Supply and place on site 3mm gauge wire for securing side wiremesh	m			
	TOTAL DC CARRIED TO WORKS SUMMARY				
AW	**ANCILLARY WORKS**				
AW 1	Common excavation for gabion foundations	m^3			
AW 2	Supply and erect on site gabion erosion protection works	m^3			
AW 3	Supply and erect on site rock cladding (stone pitching) erosion protection works			m^2	
	TOTAL AW CARRIED TO WORKS SUMMARY				

ITEM	Operation and Description	Unit	Est. Quantity	Rate	Total Amount
WS	**WORKS SUMMARY**				
WS 1	*TOTAL PG-A CARRIED TO WORKS SUMMARY*				
WS 3	*TOTAL SCP CARRIED TO WORKS SUMMARY*				
WS 5	*TOTAL AS CARRIED TO WORKS SUMMARY*				
WS 6	*TOTAL AR CARRIED TO WORKS SUMMARY*				
WS 7	*TOTAL SC CARRIED TO WORKS SUMMARY*				
WS 8	*TOTAL P CARRIED TO WORKS SUMMARY*				
WS 9	*TOTAL DC CARRIED TO WORKS SUMMARY*				
WS 10	*TOTAL AW CARRIED TO WORKS SUMMARY*				
	TOTAL BRIDGE COST				

Appendix C1 – Form of Bid Bond

TENDER NUMBER:- .....

RE: The Construction of the ..... Suspension Footbridge across the ..... River.

FORM OF BID

TO: The Chief Executive Officer, ... Rural District Council
Ministry of Local Government and National Housing

Sir;

1. Having examined the current Conditions of Contract issued by the Client,

   Specification and Bill of Approximate Quantities for the construction of the above-named works, we offer to construct, complete and maintain the whole of the said works in conformity with the said Conditions of Contract, drawings, Specification and Bill of Approximate Quantities for the sum of

   Z$ ..... (in words)

   or such other sum as may be ascertained in accordance with the said Conditions.

2. We undertake to complete and deliver the whole of the Works in the Contract within the time stated in and in accordance with the provisions of the Appendix hereto.

3. If our bid is accepted Messrs

   .....

   have agreed to provide a 'Performance Bond or Guarantee' in the form annexed to Part 4 (Annexure A) of this bid whereby they will be jointly and severally bound by us in a sum equal to ten per centum of the above named sum for the due performance of the Contract. In addition, if our bid is accepted we will within seven (7) days of acceptance by you of our bid, comply with all the provisions of the Conditions of Contract relating to insurances.

4. Unless and until a formal agreement is prepared and executed this Bid, together with your written acceptance thereof, shall constitute a binding contract between us.

5. Provided that should the Performance Bond or Guarantee mentioned above not have been obtained by us or should all the provisions of the Conditions of Contract relating to Insurances not have been complied with by us within seven days of the date of the acceptance by you of this bid, then you should have the right to cancel the Contract. On your so cancelling the Contract, the Contract shall become entirely null and void.

6. We understand that you are not bound to accept the lowest or any bid you may receive, and that in determining the bid price, the sum of the products of the quantities and the unit rates entered in the Bill of Approximate Quantities, shall govern, and not the stated total bid sum, should there be any discrepancy.

We are Sir,

Yours faithfully,

Signature: .....

Address: .....

Date: .....

Appendix C2 – Appendix to the Form of Bid

ZIMBABWE GOVERNMENT
MINISTRY OF LOCAL GOVERNMENT AND NATIONAL HOUSING

…….. RURAL DISTRICT COUNCIL

TENDER NUMBER:- .....

APPENDIX TO FORM OF BID

CONTRACT APPENDIX

1.	Minimum amount of Third Party insurance	Z$ .....
2.	Time within Works to be commenced after Order	.....days
3.	Time for Completion	..... Days Maximum
4.	Liquidated damages	Z$ ..... per day
5.	Period of Maintenance	..... months
6.	Percentage of Retention Money	..... %
1.	Limit of Retention Money	Z$ .....
2.	Minimum Amount of Interim Certification by the Engineer	Z$ .....
3.	Payment Certification after certification by the Engineer	..... days
4.	Bid Bond	Z$ .....

SIGNATURE:

DATE: .....

Appendix C3 – Form of Bid Bond

ZIMBABWE GOVERNMENT
MINISTRY OF LOCAL GOVERNMENT AND NATIONAL HOUSING

…….. RURAL DISTRICT COUNCIL

TENDER NUMBER:- .....

FORM OF BID BOND

The Construction of the .....Suspension Footbridge across the ..... River in Ward .....of .....Rural District Council in .....Province.

BY THIS BOND WE .....
of .....
(herein after called 'the Bidder')

and .....
of .....
(herein after called 'the Surety/Sureties')

are held and firmly bound unto the Chief Executive Officer, ...Rural District Council, P.O. Box ..... , ..., Zimbabwe (herein after called 'the Client') in the sum of
..... (Zimbabwe Dollars) (Z$)

for the payment of which sum the Bidder and the Surety/Sureties bind themselves their successors and assigns jointly and severally by those present.

WHEREAS the Bidder has submitted a bid for the construction and maintenance of certain works in accordance with the provisions of the Bid Documents namely:

The Construction and successful completion of the .....Suspension Footbridge across the ..... River in Ward .....of .....Rural District Council in .....Province at prices listed in the Bill of Approximate Quantities.

NOW THE CONDITION of the written Bind Bond is such that if the Bidder shall hold the bid prices valid for a period of sixty (60) days from the last date for submission of bids and be willing to enter into a contract for the construction and maintenance of these works within the time stated in the bid appendix from receipt of the Contract at the Bid Prices recorded in the Bid Documents, then this obligation shall be null and void, but otherwise shall be and remain in full force and effect.

SIGNED SEALED AND DELIVERED BY .....
THE SAID

IN THE PRESENCE OF .....
FOR AND ON BEHALF OF THE "SURETIES/SURETY

THE COMMON SEAL OF:
WAS HEREUNTO AFFIXED IN
THE PRESENCE OF: 1 ..... 2 .....

Appendix C4 – Provision of a Banker's Reference

ZIMBABWE GOVERNMENT
MINISTRY OF LOCAL GOVERNMENT AND NATIONAL HOUSING

…… RURAL DISTRICT COUNCIL

TENDER NUMBER:- .....

PROVISION OF A BANKER'S REFERENCE

The tender shall provide hereunder the name of their Bankers/Brokers, to whom reference can be made, should this be required.

NAME OF BANKERS .....

ADDRESS .....

.....

The Bidder shall also provide information on his Credit Line

.....

PROVISION OF PERFORMANCE BOND OR GUARANTEE

CERTIFY THAT I/WE .....

Of .....

Shall, if this Tender is accepted, provide a Performance Bond or Guarantee I favour of

Messrs. .....

Of .....

In the form annexed to the Conditions of Contract.

SIGNED .....

Appendix C5 – Provision of Insurances

ZIMBABWE GOVERNMENT
MINISTRY OF LOCAL GOVERNMENT AND NATIONAL HOUSING

…… RURAL DISTRICT COUNCIL

TENDER NUMBER:- .....

PROVISION OF INSURANCES

THIS IS TO CERTIFY THAT if this Bid is accepted the under mentioned shall provide

Messrs. .....

Of ..... and the

Client where applicable, with the insurances required inclusive of all Conditions of Contract.

1. Insurance of Works, etc. .....

2. Damage to Persons Property .....

3. Third Party Insurance .....

4. Accident or Injury to Workmen .....

NOTE: If completed by either an insurer or registered insurance broker, the undertaking will be acceptable.

Appendix C6 – Form of Performance Bond or Guarantee

ZIMBABWE GOVERNMENT
MINISTRY OF LOCAL GOVERNMENT AND NATIONAL HOUSING

…….. RURAL DISTRICT COUNCIL

TENDER NUMBER:- .....

ANNEXURE A: FORM OF PERFORMANCE BOND OR GUARANTEE

A (I) PERFORMANCE BOND

WHEREAS the ..... Rural District Council of the Ministry of Local Government and National Housing (hereinafter called the Client) has awarded the Contract for construction of the ……Suspension Footbridge across the ……. River in Ward ……..of .....Rural District Council in .....Province, Zimbabwe (herein after called the Contract) to: -

.....

(herein after called the Contractor)

AND WHEREAS THE Contractor is bound by the said Contract to submit to the Client a Bond in an amount equal to 10% of the Accepted Bid Sum for the due and full performance of the Contract named above;

NOW WE THE UNDERWRITERS, the legal representatives of the Sureties:

..... in .....

do hereby bind ourselves as sureties and co-principal debtors for the due and full performance of the Contract by the Contractor named herein, and for all losses, damages and expenses that may be suffered or incurred by the Client provide however that our liabilities as sureties shall be limited to the sum of Z$ .....

..... (amount in words),

provided that the liability of the undersigned under this guarantee shall last thirty days after the issue of the Final Certificate for the whole Works in terms of the Contract, unless the Sureties are advised in writing by the Client before expiration of the said thirty days of his intention to instigate claims and the particulars thereof, in which event this guarantee shall remain in force until all such claims are paid or settled.

FOR AND ON BEHALF of the sureties

AT ..... ON THIS ..... DAY OF .....

1 ..... 2 .....

ADDRESS .....

AS WITNESS

1 ..... 2 .....

A (ii) Guarantee

WHEREAS the ..... Rural District Council of the Ministry of Local Government and National Housing (herein after called the Client) has awarded the Contract for the construction of the ……Suspension Footbridge across the …….. River in Ward ……..of .....Rural District Council in .....Province (herein after called the Contract) to:

.....
(herein after called the Contractor)

AND WHEREAS the Contractor is bound by the said Contract to submit to the Client a Guarantee for a total price of ten percent (10%) of the total Accepted Bid Sum;

NOW WE THE UNDERWRITERS, the legal representatives of the Guarantor

..... in .....

(herein after called the Guarantor) and fully authorised to sign and to incur obligations in the name of the Guarantor, hereby declare that this Guarantor will guarantee the Client the full amount of the Guarantee stated above.

After the Contractor has signed the aforementioned Contract with the Client, the Guarantor is engaged to pay the Client any amount up to and inclusive of the aforementioned full amount upon any written order from the Client, to indemnify the Client for any liability or damage resulting from the defect or shortcomings of the Contractor or the debts he may have incurred to any parties involved in the Works under the Contract mentioned above, whether these defects or shortcomings or debts are actual, estimated or expected. The Guarantor shall deliver the money required by the Client immediately without delay and in freely convertible currency without the necessity of a previous notice or of judicial or administrative procedures in Zimbabwe or elsewhere and without it being necessary to prove to the Guarantor the defects or shortcomings or debts to the Contractor.

This Guarantee is valid for the entire stipulated construction time and any time and any time extensions approved by the Client, and until thirty (30) days after the Contractor has received from the Client, Final Certificate for the whole of the Works, unless the underwriters are advised in writing by the Client before the expiration of the said thirty (30) days of his intention to institute claims and the particulars thereof, in which event this guarantee shall remain in force until all such claims are paid or settled.

FOR AND ON BEHALF OF THE GUARANTOR

AT ..... ON THIS ..... DAY OF .....

1 ..... 2 .....

ADDRESS .....

AS WITNESS

1 ..... 2 .....

Appendix C7 – Certificate of Insurance Cover

ZIMBABWE GOVERNMENT
MINISTRY OF LOCAL GOVERNMENT AND NATIONAL HOUSING

…… RURAL DISTRICT COUNCIL

TENDER NUMBER:- .....

ANNEXURE B: CERTIFICATE OF INSURANCE COVER

THIS IS TO CERTIFY THAT the under mentioned insurance cover is held by or being negotiated for

Messrs .....

Of .....

In terms of the Conditions of Contract and that the Policies cover the full duration of the Contract, together with any extensions thereof, subject to the premiums being paid, and for the Period of Maintenance where required.

INSURANCE OF WORKS, ETC.

.....

.....

DAMAGE TO PERSON AND PROPERTY

.....

THIRD PARTY INSURANCE

.....

ACCIDENT OR INJURY TO WORKMEN NOT COVERED BY THE WORKMEN'S COMPENSATION ACT

.....

DATE: .....

SIGNED: .....
Insurer/Insurance Broker

ADDRESS: .....

.....

Appendix D – Contract Agreement

ZIMBABWE GOVERNMENT
MINISTRY OF LOCAL GOVERNMENT AND NATIONAL HOUSING

…….. RURAL DISTRICT COUNCIL

TENDER NUMBER:- .....

AGREEMENT

AN AGREEMENT MADE THIS ..... DAY OF 2000

BETWEEN ..... , Chief Executive Officer, acting for and on behalf of the .....Rural District Council, Ministry of Local Government and National Housing (herein after called the Client)

AND .....

FOR .....
(herein after called the Contractor)

WHEREAS the Client is desirous that certain works should be constructed viz.: -

The Construction of the .....Suspension Footbridge across the ..... River in Ward .....of .....Rural District Council in .....Province and has accepted a Bid by the Contractor for the construction, completion and maintenance of such works:.

NOW IT IS HEREBY AGREED as follows:-

1. In this Agreement words and expressions shall, unless the context otherwise requires, have the same meaning as are respectively assigned to them in the Conditions of Contract herein referred to.

2. The following documents shall be deemed to from, be read and construed as part of this agreement, viz.:
   - (a) The said Bid (Tender)
   - (b) The Drawings
   - (c) The Conditions of Contract
   - (d) The Specifications
   - (e) The Bill of Approximate Quantities
   - (f) The Schedule of Dayworks Rates and Prices
   - (g) The Certificate of Visit to Site
   - (h) Any covering letters or orders in writing subsequently supplied to the Contractor and signed by or on behalf of the Client.

3. In consideration of the payments to be made by the Client to the Contractor as herein after mentioned the Contractor hereby agrees with the Client to construct, complete and maintain the Works in conformity in all respects with the provisions of the Contract.

4. The Government hereby agrees to pay the Contractor in consideration of the construction, completion and maintenance of the Works in conformity in all respects with the provisions of the Contract and in the Contract Price at the times and in the manner prescribed by the Contract.

IN WITNESS whereof the parties thereto have hereunto set their hands at

..... On this ..... day of ..... 2000.

Signed by the said .....
(for and on behalf of ..... Rural District Council)

.....
(for ..... RDC)

DATE: .....

In the presence of Witness:

SIGNED: .....

(Witness) 1. ..... 2. .....

DATE: .....

Signed by the said .....
(Contractor)

.....
(Contractor)

DATE: .....

In the presence of Witness:

SIGNED: .....

(Witness) 1. ..... 2. .....

DATE: .....

NOTE: Where either part is a Company, either the authority for the person signing on behalf of the Company to do so should be annexed to this agreement, or the seal of the Company should be impressed on the agreement in place of the signatures and witnessed by the proper officers of the Company in terms of the Articles of the Company.

Appendix E – List of Material Suppliers

NAME OF SUPPLIER	ADDRESS	ITEMS ON SUPPLY
TAUTE ENGINEERING	P.O. Box 119, Chinhoyi, 067-23531	· Anchor bars · Turnbuckles · Cast iron saddles · Hangers · U-bolts
COLUMBIA ENGINEERING	Montagu Investments Bay 6, 43 Highfields Road, Southerton, Harare 04-665806	· Anchor bars · Turnbuckles · Cast iron saddles · Hangers · U-bolts
CENTRAL AFRICA FORGE	Stand Number 83, 7 Galloway Road, P.O. Box 167, Norton, Zimbabwe 062-3219/3354	· Anchor bars · Turnbuckles · Cast iron saddles
GLYNNS BOLTS	18 Bristol Bolts, Workington, Harare	· Hangers · U – bolts
SAMBURN PRESSING	Spurn Road, Ardbennie, P.O. Box 2133, Harare 04-665335	· Cast Iron Saddles · Hangers · U-bolts
MODCRAFT ENGINEERING	Cnr Willow Rd/ Harare Drive, New Ardbennie, P.O. BOX BE 104/170, Belvedere, Harare	· Anchor bars · Turnbuckles · Cast iron saddles · Hangers · U-bolts

NAME OF SUPPLIER	ADDRESS	ITEMS ON SUPPLY
HENRY DUNN STEEL	Plymouth Rd, Southerton, P.O. Box ST69, Southerton, Harare	· Chequer plates · Reinforcement steel · Angle irons · Steel plates
ZIMBABWE SPRING STEEL	P.O. Box 528, Harare, 41 Plymouth Rd, Southerton, 04-664418	· Anchor bars · Turnbuckles · Cast iron saddles · Hangers · U-bolts
HAGGIE RAND ZIMBABWE	1 Bourgward Rd, Beverly, Msasa, Harare 04-487811/2	· Steel cables · D Shackles · Thimbles · Crosby Clamps · Wire mesh · Turnbuckles
WESTGATE INVESTMENTS	25 Fort Street, Bulawayo, 09-77554/75187/011213383	· Anchor bars · Turnbuckles · Cast iron saddles · Hangers · U-bolts
COLUMBUS McKINNON	P.O. Box ST 399, Southerton, Harare, 04-620445	· Steel cables · D Shackles · Thimbles · Crosby Clamps · Wire mesh · Turnbuckles

Appendix F – Concrete Cube Test Certificate

Project: **Our Ref:**
Client:

LOCATION IN STRUCTURE:	**GRADE**

MATERIALS		Stone	Sand	Cement	Water
	Quantities				
	Type/Size				
	Source				

Cement: Water ratio = Slump(mm) =

Cube size: **150 X 150 X 150mm**

CUBE No.				
Date Made				
Date Tested				
Age at Test (days)				
Mass (kg)				
Density (kg/m3)				
Breaking Load (KN)				
Compr. Strength MPa				
Mean Strength MPa				
Specified Strength MPa				

REMARKS:

RECOMMENDATIONS:

SIGNATURE: ..... DATE;

Appendix G1 – Time Sheets

Month: **Officers' Name:**

DATE	CLIENT	DETAILED WORK DONE	TRAVELLING TIME (hrs)	FIELD TIME (hrs)	DIST.(km) TO & FRO	COMMENTS

Appendix G2 – Time Sheets

DATE	ACTIVITY	MANPOWER & TIME	PRODUCTION	REMARKS

Appendix H1 – Site Records

SITE INSTRUCTION

CONTRACT No. .....

CONTRACT: .....

DATE: .....

INSTRUCTION No .....

SUPERVISING CONSULTANT: .....

ENGINEER'S REPRESENTATIVE: .....

We confirm the following instructions:

From: .....

To: .....

On: .....

Issued By: ..... Received: .....

Appendix H2

DATE	NAME	COMPANY & ADDRESS	POSITION	PURPOSE OR REMARKS	SIGNATURE
8/25/00	E.J CHEKENYERE	ZAKA RDC P.O. BOX 500, JERERA	COUNCILLOR WARD 15	SITE VISIT - mobilisation of manpower for the contractor	
8/27/00	B. JASI	ZAKA RDC P.O. BOX 500, JERERA	VIDCO Chairman	Supervise construction of access road to site	
9/2/00	M. NYAMUNDURU	SWAT CONSTRUCTION P.O. BOX BE 330, BELVEDERE, HARARE	PROJECTS ENGINEER	Supervise steel fixing and excavations for approach ramps	