SITE SURVEYING

A rather wide definition of surveying is the determination of boundaries, size, position, quantity, condition and value of land, estates, buildings etc. To this you can also add the measurement and setting out of roads, buildings, etc.

In general the purpose of a site survey is to prepare:

- maps and plans
- the setting out of proposed construction work
- the quantities of earthworks (areas and volumes) To achieve this, your survey falls into three stages.

1. The initial reconnaissance of the site. This allows you to formulate how to tackle the job and any likely problem areas.

2. The actual measurement of the work which determines the position, size and any other features, either manmade or natural.

3. The final presentation of the data in the form of maps, plans, calculations or reports.

LINEAR SURVEYING

PROCEDURE FOR CARRYING OUT A LINEAR SURVEY

Using the diagrams of Hays Farm (which can be found at the end of your assignment) as an example, let us go through the various aspects of the work.

- Walk over the area to be surveyed noting the general layout, the position of the features and the shape of the area.
- Decide upon the framework, position the station pegs, and where possible, tie them into permanent objects.
- When selecting the station positions you need to consider the following.
- At least one base line, ideally a long straight line, to develop the framework
- Survey lines to form well-conditioned triangles
- Survey lines as close as possible to boundaries, features etc
- Stations should be visible across site
- Use as few lines as possible
- Make use of check lines
- Avoid obstacles if possible
- Keep lines within the area being measured

Sketch an index map in the field book (Diagram 1)

Your index map should show all the stations identified with a capital letter, the direction of measurement of each line and the order of measurement.

To measure a line, first of all set up ranging poles at each end. This shows you clearly what you are going to do. The chain or tape is stretched out, straightened and ranged in on the line.

From this line all measurements are taken, including offsets.

OFFSETS ARE MEASUREMENTS TAKEN TO THE VARIOUS FEATURES AND ARE PERPENDICULAR TO THE BASE LINE OR SURVEY LINE

At the bottom of the page (Diagram 2), identify the line being measured. The starting station is circled to show it is a station and any other lines coming into it are shown. Start at the bottom of the page and 'walk' it up entering your chain measurements and offset lengths. Rectangular offsets are simply shown as a measurement against the feature. All stations are identified by circling and all measurements are running dimensions.

IF THE OFFSETS ARE FAIRLY LONG, A GOOD RULE OF THUMB GUIDE IS 15 M OR MORE, THEN THEY MAY NEED TO BE LINED IN WITH AN OPTICAL SQUARE.

Referring to Diagram 4 you can see TIE-LINES have been used to fix the corner of the building. The important point to notice here is that the inclined dimension line is shown. It is this that identifies it as TIE-LINE.

This procedure is repeated along every line until all the lines have been measured. The fieldwork has now been completed and you are ready to plot the survey. Make sure that when you are plotting, your survey conforms to **BS1192**.

Before starting to plot the survey a little thought must be given to setting it out on the paper. A good guide is to position the base line so that the entire framework of triangles can be built up from it. I would suggest to start with that it is done in pencil.

Once the framework of lines has been fitted on to the drawing sheet, work your way along each line plotting your offsets so that all the features can be drawn in. Once this has been done, complete it by inking in and detailing etc. Whether you

ink in the chain lines or not is a personal choice, but certainly the stations should be shown.

There are a number of sources of error that can occur in linear surveys which can be grouped under three separate headings.

It must be emphasised that good surveying practice will keep errors and their effects to a minimum. Errors will occur in all types of surveying work and it is important that you know the type of error that may occur and whether its effect is acceptable within the methods being used.

1. Systematic errors

These errors are cumulative in effect and may be positive or negative. They can have an appreciable effect on the survey.

- wrong length of tape : Due to stretching/contraction/damage
- poor ranging - line deviates from the straight
- poor straightening - the tape is not pulled tight
- slope - no allowance made for sloping ground
- sag - in step chaining where the step is too long
- temperature variation - expansion/ contraction of metal tape due to temperature

2. Compensating errors

These errors tend to be accidental and may be positive or negative in effect. Generally they are less important than systematic errors and often cancel each other out.

- reading and marking - reading and marking distances incorrectly
- tension - varying tension when straightening and holding the tape

3. Gross errors

These errors are simply mistakes usually due to carelessness or lack

of experience.

- displacement of station - stations are removed for some reason
- miscounting chain or tape lengths
- misreading the tape
- incorrect booking of measurements

When carrying out a survey, you have to achieve an acceptable degree of accuracy. This means you can allow a certain amount of tolerance, either positive or negative, in your work. The type of survey will have some bearing on this but in simple terms if you cannot plot, say, to millimetres because of the scale, there is not much point in measuring to millimetres. Always bear in mind that to achieve a high degree of accuracy it will take time, effort and good equipment.

DEFINITION OF TERMINOLOGY

Alignment	**The adjustments required to bring points on to a straight line**
Base Line	**The main line, usually the longest, on which the framework of triangles can be built**
Boning	**The sighting of the top of the traveller/boning rod between two sight rails**
Check Line	**Additional lines measured across the triangles as a check for accuracy when plotting**
Coordinates	**The measurements to a point from a reference point, usually rectangular**
Grid	**A series of point set out at right angles to each other to form a square or rectangular pattern**
Line Points	**Points of importance at the end or on the chain lines**
Linear Measurement	**The measurement of the distance between two points**
Stations	**The position of points which will control the survey and where measurements will be taken from**
Triangulation	**The location of a third point from two known points by the measurement of ANGLES**
Trilateration	**The location of a third point from two known points by the measurement of DISTANCES**
Chaining	**The practice of direct linear measurement of a line using a land chain**
Offsets	**Short linear measurements taken from the Base line at right angles**
Ranging	**The placing of ranging poles between two points and sighting them on line by eye**
Taping	**The practice of direct linear measurement using a steel tape or measuring band**
Tie Lines	**Measurements taken at an angle from the base line to locate a point of detail**

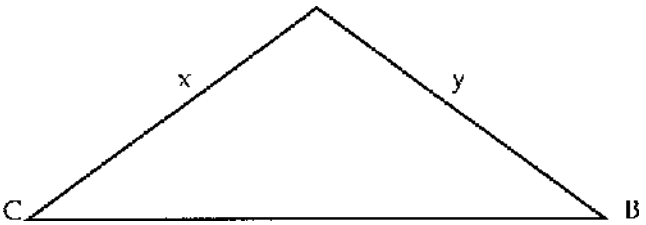
PURPOSE OF LINEAR MEASUREMENT

Linear measurement means having only one dimension, a straight line between two points.

In surveying its purpose is to give accurate measurements between two points. This will allow you to calculate the dimensional coordinates of different points so that they can be related to each other.

For example in the triangle shown if you know the lengths of x, y and z then you have dimensional coordination between A, B and C.

A



Dependent on the method of linear measurement used depends the dimensional control you can hope to achieve.

Referring to the triangle, again ask yourself:

How accurate are the measurements x, y and z?

What degree of accuracy are you looking for?

METHODS OF LINEAR MEASUREMENT

There are three methods of linear measurement that you can choose from in order to answer the above questions.

1 Direct measurement using land chain, tape or steel measuring band.

2 Optical measurement (tacheometry) using specialised equipment such as tacheometers or subtense bars.

3 Electromagnetic Distance Measurement (EDM) where the measurement is obtained by timing electromagnetic radiation transmitted between two points.

Methods 2 and 3 are outside the scope of this unit so we will be concentrating on direct measurement which is the oldest and most elementary method of surveying and is generally referred to as chain surveying.

A chain survey involves the direct measurement of horizontal length and the principle of triliteration.

Triliteration means finding a third point from two other points by linear measurement. Referring to the triangle again, finding point A by measuring x and y from C and B where z is known.

Note that no angles are measured

When setting up the triangles for triliteration try and make sure they are all well conditioned triangles. The ideal well conditioned triangle is an equilateral triangle. By avoiding small angles the effects of any acceptable error in the survey are reduced.

When measuring between two points you can use:

1 A metric chain to BS4484:1969 which is 20 m long and divided into 100 links. The chain has swivel handles which are included in its length with unmarked yellow tallys at each metre along the chain. At the 5 m mark from each end there is a red tally, numbered 5 and a red tally at the centre numbered 10 m.

The chain is a robust piece of equipment that can be dragged through rough terrain without damage, although it should be checked at regular intervals so that any strained links can be corrected.

2 A steel measuring band which is a robust steel tape 30-100 m long wound onto a winding frame. The band is lighter than a chain and a higher degree of accuracy can be obtained.

3 Tapes which may be either synthetic material or steel, and are usually 20, 30 m or 50 m long. Tapes are generally used for offsetting.

OFFSETS

Offsets are measurements taken to the side of the main line of measurement (Base Line). They are taken at right angles to the chain line and strictly speaking should be called rectangular offsets, but in practice they are simply referred to as offsets.

There is a second type of measurement known as an inclined offset or **TIE-LINE** and these are used to pick up features of particular importance. When using these types of offsets always measure two offsets forming a well conditioned triangle to give improved accuracy.

SLOPING GROUND

A plan is a projection on a flat, horizontal surface. All measured distances on sloping ground must be reduced to the horizontal before being used for plotting, etc.

This can be done in one of two ways.

1 Directly, that is step chaining. This consists of stretching the chain horizontally clear of the ground and plumbing down. The series of steps formed as shown in the following diagram are summed up to give the horizontal length of the sloping ground.

2 Indirectly, that is by calculating the horizontal equivalent of the measured line. By measuring the angle of slope with a clinometer (a hand held instrument for measuring angles) you can calculate the horizontal distance using the following formula.

$$h = s \cos \varphi$$

where h = horizontal distance

s = slope length

$\cos \varphi$ = cosine of the angle of slope (φ)

When measuring between two points, a straight line is required. The lines are defined by ranging poles, which are round, wooden or metal poles usually two metres in length and painted with red, white and black bands, 500 mm wide. The process of placing ranging poles on a straight line is known as ranging. This is done by eye, where ranging poles are placed at each end of the chain line and intermediate poles are sighted in on the line.