UMA CHARAN PATTNAIK ENGINEERING SCHOOL

BERHAMPUR,GANJAM

Lecture note on :-

Chain Surveying

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CHAIN SURVEYING

This is the simplest and oldest form of land surveying of an area using linear measurements only. It can be defined as the process of taking direct measurement, although not necessarily with a chain.

EQUIPMENTS USED IN CHAIN SURVEYING

These equipments can be divided into three, namely :

Those used for linear measurement. (Chain, steel band, linear tape)
(ii) Those used for slope angle measurement and for measuring right angle
(Eg. Abney level, clinomater, cross staff, optical squares)
(iii)Other items (Ranging rods or poles, arrows, pegs etc).

1. **Chain:-**

The chain is usually made of steel wire, and consists of long links joined by shorter links. It is designed for hard usage, and is sufficiently accurate for measuring the chain lines and offsets of small surveys.

Chains are made up of links which measure 200mm from centre to centre of each middle connecting ring and surveying brass handless are fitted at each end. Tally markers made of plastic or brass are attached at every whole metre position or at each tenth link. To avoid confusion in reading, chains are marked similarly form both end (E.g. Tally for 2m and 18m is the same) so that measurements may be commenced with either end of the chain There are three different types of chains used in taking measurement namely:

1. Engineers chain:

2. Gunter's chain

3. Steel bands

2. Steel Bands:-

This may be 30m, 50m or 100m long and 13mm wide. It has handles similar to those on the chain and is wound on a steel cross. It is more accurate but less robust than the chain. The operating tension and temperature for which it was graduated should be indicated on the band.

3. Tapes:-

Tapes are used where greater accuracy of measurements are required, such as the setting out of buildings and roads. They are 15m or 30m long marked in metres, centimeter and millimeters. Tapes are classified into three types;

i. Linen or Linen with steel wire woven into the fabric; These tapes are liable to stretch in use and should be frequently tested for length. They should never be used on work for which great accuracy is required.

ii. Fibre Glass Tapes: These are much stronger than lines and will not stretch in use.

iii. Steel tapes: These are much more accurate, and are usually used for setting out buildings and structural steel works. Steel tapes are available in various lengths up to 100m (20m and 30m being the most common) encased in steel or plastic boxes with a recessed winding lever or mounted on open frames with a folding winding lever.

4. Arrows:-

Arrow consists of a piece of steel wire about 0.5m long, and are used for marking temporary stations. A piece of coloured cloth, white or red ribbon is usually attached or tied to the end of the arrow to be clearly seen on the field.

5. Pegs:-

Pegs are made of wood 50mm x 50mm and some convenient length. They are used for points which are required to be permanently marked, such as intersection points of survey lines. Pegs are driven with a mallet and nails are set in the tops.

6. Ranging Rod:-

These are poles of circular section 2m, 2.5m or 3m long, painted with characteristic red and white bands which are usually 0.5m long and tipped with a pointed steel shoe to enable them to be driven into the ground. They are used in the measurement of lines with the tape, and for marking any points which need to be seen.

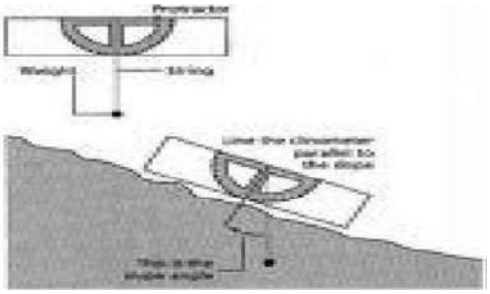
7. **Optical Square:-**

This instrument is used for setting out lines at right angle to main chain line. It is used where greater accuracy is required. There are two types of optical square, one using two mirrors and the other a prism.
The mirror method is constructed based on the fact that a ray of light is reflected from a mirror at the same angle as that at which it strikes the mirror.
The prism square method is a simplified form of optical square consisting of a single prism. It is used in the same way as the mirror square, but is rather more accurate.

8 Cross Staff:-

This consists of two pairs of vanes set at right angle to each other with a wide and narrow slit in each vane. The instrument is mounted upon a pole, so that when it is set up it is at normal eye level. It is also used for setting out lines at right angle to the main chain line.

9. Clinometer



This instrument is used for measuring angles of ground slopes (slope angle). They are of several form, the common form is the **WATKING'S CLINOMETER,** which consist of a small disc of about 60mm diameter. A weighted ring inside the disc can be made to hang free and by sighting across this graduated ring angle of slopes can be read off. It is less accurate than abney level.

NECESSARY PRECAUTIONS IN USING CHAIN SURVEYING INSTRUMENTS

1. After use in wet weather, chains should be cleaned, and steel tapes should be dried and wiped with an oily rag.

2. A piece of colored cloth should be tied to arrow (or ribbon – attached) to enable them to be seen clearly on the field.
3. Ranging rods should be erected as vertical as possible at the exact station point.
4. The operating tension and temperature for which steel bands/tapes are graduated should be indicated.
5. Linen tapes should be frequently tested for length (standardized) and always after repairs.
6. Always keep tapes reeled up when not in use.

GENERAL PROCEDURE IN MAKING A CHAIN SURVEY

1. *Reconnaissance*: Walk over the area to be surveyed and note the general layout, the position of features and the shape of the area.
2. *Choice of Stations:* Decide upon the framework to be used and drive in the station pegs to mark the stations selected.
3. *Station Marking:* Station marks, where possible should be tied - in to a permanent objects so that they may be easily replaced if moved or easily found during the survey. In soft ground wooden pegs may be used while rails may be used on roads or hard surfaces.
4. *Witnessing*: This consists of making a sketch of the immediate area around the station showing existing permanent features, the position of the stations and its description and designation. Measurements are then made from at least three surrounding features to the station point and recorded on the sketch.
The aim of witnessing is to re-locate a station again at much later date even by others after a long interval.
5. *Offsetting:* Offsets are usually taken perpendicular to chain lines in order to dodge obstacles on the chain line.
6. *Sketching* the layout on the last page of the chain book, together with the date and the name of the surveyor, the longest line of the survey is usually taken as the base line and is measured first.

CRITERIA FOR SELECTING A SURVEY LINES/OFFSETS

During reconnaissance, the following points must be borne in mind as the criteria to provide the best arrangement of survey lines,

a. Few survey lines: the number of survey lines should be kept to a minimum but must be sufficient for the survey to be plotted and checked.

b. Long base line: A long line should be positioned right across the site to form a base on which to build the triangles.

c. Well conditioned triangle with angles greater than 30o and not exceeding 150o: It is preferable that the arcs used for plotting should intersect as close as 90o in order to provide sharp definition of the stations point.

d. Check lines: Every part of the survey should be provided with check lines that are positioned in such a way that they can be used for off- setting too, in order to save any unnecessary duplication of lines.

e. Obstacles such as steep slopes and rough ground should be avoided as far as possible.

f. Short offsets to survey lines (close feature preferably 2m) should be selected: So that measuring operated by one person can be used instead of tape which needs two people.

g. Stations should be positioned on the extension of a check line or triangle. Such points can be plotted without the need for intersecting arcs.

Ranging:
Ranging involves placing ranging poles along the route to be measures so as to get a straight line. The poles are used to mark the stations and in between the stations.

ERRORS IN SURVEYING

• Surveying is a process that involves observations and measurements with a wide range of electronic, optical and mechanical equipment some of which are very sophisticated.

• Despite the best equipments and methods used, it is still impossible to take observations that are completely free of small variations caused by errors which must be guided against or their effects corrected.

TYPES OF ERRORS

1. Gross Errors

• These are referred to mistakes or blunders by either the surveyor or his assistants due to carelessness or incompetence.

• On construction sites, mistakes are frequently made by in – experienced Engineers or surveyors who are unfamiliar with the equipment and method they are using.

• These types of errors include miscounting the number of tapes length, wrong booking, sighting wrong target, measuring anticlockwise reading, turning instruments incorrectly, displacement of arrows or station marks etc.

• Gross errors can occur at any stage of survey when observing, booking, computing or plotting and they would have a damaging effect on the results if left uncorrected.

• Gross errors can be eliminated only by careful methods of observing booking and constantly checking both operations.

2. Systematic or Cumulative Errors

• These errors are cumulative in effect and are caused by badly adjusted instrument and the physical condition at the time of measurement must be considered in this respect. Expansion of steel, frequently changes in electromagnetic distance (EDM) measuring instrument, etc are just some of these errors.

• Systematic errors have the same magnitude and sign in a series of measurements that are repeated under the same condition, thus contributing negatively or positively to the reading hence, makes the readings shorter or longer.

• This type of error can be eliminated from a measurement using corrections (e.g. effect of tension and temperature on steel tape).

• Another method of removing systematic errors is to calibrate the observing equipment and quantify the error allowing corrections to be made to further observations.

• Observational procedures by re-measuring the quantity with an entirely different method using different instrument can also be used to eliminate the effect of systematic errors.

3. Random or Compensating Errors

• Although every precaution may be taken certain unavoidable errors always exist in any measurement caused usually by human limitation in reading/handling of instruments.

• Random errors cannot be removed from observation but methods can be adopted to ensure that they are kept within acceptable limits.

• In order to analyze random errors or variable, statistical principles must be used and in surveying their effects may be reduced by increasing the number of observations and finding their mean. It is therefore important to assume those random variables are normally distributed.

Corrections to Linear Measurement and their Application:-

The following corrections are to be applied to the linear measurements with a chain or a tape where such accuracy is required.

(i) Pull correction,

(ii) Temperature correction

(iii) Standard length correction

(iv) Sag correction

(v) Slope correction

(vi) Mean sea level correction.

Pull Correction :-

A chain or tape of nominal length 'L' having cross sectional area of the link or that of a tape, as the case may be, equal to A and standardized under a pull Ps is employed to measure a length at a pull PF. If Young's modulus of elasticity of the material is

E the extension of its length is $= \frac{(Pf - Pl)}{AE} L$

The recorded length is less than the actual by this extension. The error is here, -ve, the actual length is obtained by adding the extension to L. The correction is +ve. If PF is less than PS the error will be +ve and correction –ve.

Temperature Correction :-

A chain or a tape of nominal length 'L' standardized at temperature TS and having cross sectional area A is employed to measured length at temperature TF being the coefficient of linear expansion of the material of the chain or tape per unit rise of temperature, the extension is = (TF – TS)L.

If TF is more than TS, recorded length is less than the actual by the amount of extension. The error is –ve and the correction to the length L is +ve by the amount of extension. If the field temperature TF is less than TS the error is = +ve and the corrections is –ve.

Sag Correction :-

In case of suspended measurement across a span L the chain or tape sag to take the form of curve known as catenary.

$$\text{Cas} = \frac{(wl1\,)^2}{24P^2} l1 = \frac{W^2 l1}{24P^2}$$

Where w= weight of the tape per metre length
W= Total weight of the tape
P=pull applied (in N)
$l1$ = The length of tape suspended between two supports
l = length of the tape = n $l1$ (in m)
Sag correction is always negative.