



# Welcome

## LATEST TECHNIQUES IN SURVEYING WITH TOTAL STATION

**Prafulla Kumar Panda**  
Assistant Professor



**Centurion University of Technology and  
Management**

Contact: 9438269572

E-mail: [prafullapanda@cutm.ac.in](mailto:prafullapanda@cutm.ac.in)

# Contents

- What is a Total Station?
- Capability of a Total Station
- Important Operations of Total Station
  - Distance Measurement
  - Angle Measurements
  - Data Processing
  - Display
  - Electronic Book
- Uses of Total Station
- Advantages of Using Total Stations
- Applications

# What is Survey?

It is Process of determining earthen features and recording its relative position on to the paper

# Types of survey

Traverse survey

Triangulation survey

Plane table survey

Which includes:

1. Linear Measurements
2. Angular Measurements
3. Height Measurements

## Linear measurements we usually do with:

chain

Tape

Substance bar

EDM (Electronic distance measurement instrument)

GPS (Global Positioning System)

## Angular measurements we usually do with:

Compass

Theodolite

## Height we usually do with:

Dumpy level

Auto level

Theodolite & Digital leveler

# What is a Total Station?

- **Total station** is a surveying equipment combination of **Electromagnetic Distance Measuring Instrument** and **electronic theodolite**.
- It is also integrated with microprocessor, electronic data collector and storage system.
- The instrument can be used to measure horizontal and vertical angles as well as sloping distance of object to the instrument.

## PRIMARY FEATURES



Fig: Total station

# ACCESSORIES FOR TOTAL STATION



Tripods



Batteries & Chargers

Data & Power  
Cables



Prisms



Prism Poles



Tribraches





# ACCESSORIES FOR TOTAL STATION

- ❖ Depending upon the prism measuring distance vary Lengths up to about 2 km can be measured with a single prism, and up to about 6 to 7 km with triple prism.



single prism



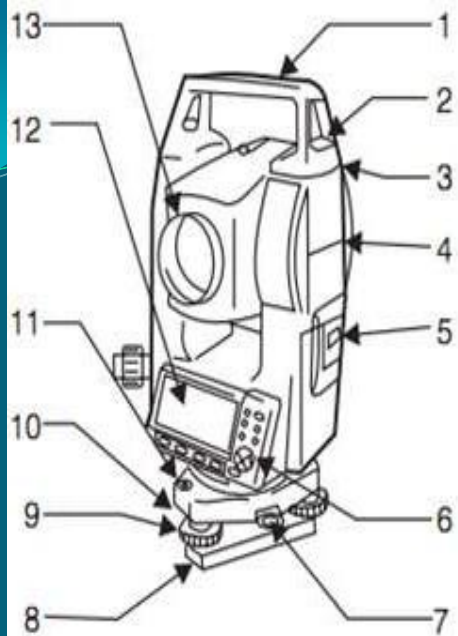
triple prism

# Capability of a Total Station

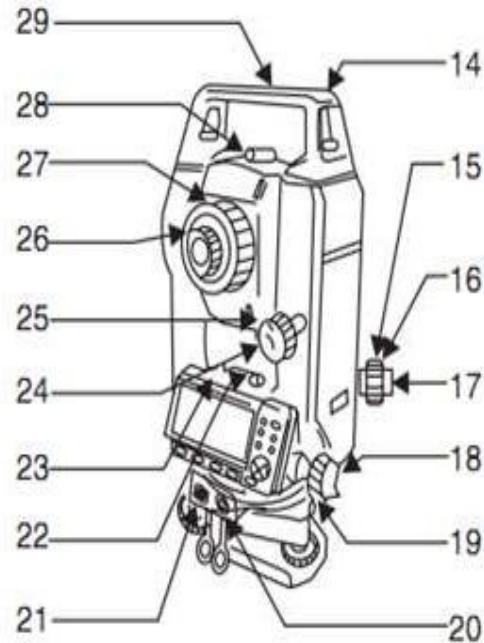
**Microprocessor unit in total station processes the data collected to compute:**

1. Average of multiple angles measured.
2. Average of multiple distance measured.
3. Horizontal distance.
4. Distance between any two points.
5. Elevation of objects and
6. All the three coordinates of the observed points.

- Data collected and processed in a Total Station can be downloaded to computers for further processing.
- Total station is a compact instrument and weighs 50 to 55 N.
- A person can easily carry it to the field.
- Total stations with different accuracy, in angle measurement and different range of measurements are available in the market.
- One such instrument manufactured by SOKKIA Co. Ltd. Tokyo, Japan.



1. Handle
2. Handle securing screw
3. Data input/output terminal  
(Remove handle to view)
4. Instrument height mark
5. Battery cover
6. Operation panel
7. Tribrach clamp  
(SET300S/500S/600S: Shifting clamp)
8. Base plate
9. Levelling foot screw
10. Circular level adjusting screws
11. Circular level
12. Display
13. Objective lens



14. Tubular compass slot
15. Optical plummet focussing ring
16. Optical plummet reticle cover
17. Optical plummet eyepiece
18. Horizontal clamp
19. Horizontal fine motion screw
20. Data input/output connector (Besides  
the operation panel on SET600/600S)
21. External power source connector  
(Not included on SET600/600S)
22. Plate level
23. Plate level adjusting screw
24. Vertical clamp
25. Vertical fine motion screw
26. Telescope eyepiece
27. Telescope focussing ring
28. Peep sight
29. Instrument center mark

**Fig: Parts of total station**

# Important Operations of Total Station

- **Distance Measurement**
- **Angle Measurements**
- **Data Processing**
- **Display**
- **Electronic Book**

# Basic components of Total station

- Prism reflector:

It is a combination of ranging rod, staff and optical cuboidal mirror.

having 2/3 lifts with 5cms interval graduations.

adjustable height from 1.5m to 3.75m.

More number of prisms, will give more accuracy.

- GUN: data screen LCD  
eye piece  
telescope 24x to 43x  
environmental box  
microprocessor with memory card of 1 or 2 GB capacity  
1MB can store 800 points.
- Tripod: with different material  
Aluminum tripod weighs 13 to 14lbs  
Wooden tripod will be about 18 lbs.
- Optical and Laser plumb bobs.
- Battery –as an external attachment  
with indicators  
1.5hours charged battery can work for 3to 5 hours

# ACCURACY OF TOTAL STATION

## More accuracy can be achieved by :

1. Careful Centering
2. Accurate pointing target
3. Average of multiple points
4. Better optical lens
5. Strong Tripod
6. Verticality of prism pole

1. Angular accuracy is from 1 to 20 Sec.
2. Linear accuracy is from 2mm to 10mm/per KM
3. Different instruments have different accuracy

	Angular	Linear	
		With 1 Prism	With 3 prisms
NIKON	1 Sec	$\pm 2$ mm	$\pm 1$ mm
LIEKA	1 Sec	$\pm 2$ mm	$\pm 1$ mm
SOKKIA	1 Sec	2 mm	$\pm 1$ mm

## Accuracy varies with Price

### Distance measure with:

1. Single Prism – up to 2.5 Km
2. Two prisms - 5 to 7 Km
3. Three prisms - 10 to 12 Km



## Functions of T.S:

1. It simultaneously measures angles & distances and Record
2. Correcting the measured distance with:
  1. Prism constant
  2. Atmospheric Pr.
  3. Temperature
  4. Curvature of earth
  5. Refraction correction
3. Computing the point elevation
4. Computing the coordinates of every point
5. Remote elevation measurement
6. Remote distance measurement
7. Area calculations
8. Data Transferring facility from instrument to S/W and S/W to instrument
9. Format of conversion of units

# Distance Measurement

- Electronic distance measuring (EDM) instrument is a major part of total station.
- Its range varies from **2.8 km to 4.2 km.**
- The accuracy of measurement varies from 5 mm to 10 mm per km measurement.
- They are used with automatic target recognizer.
- The distance measured is always sloping distance from instrument to the object.

# Angle Measurements

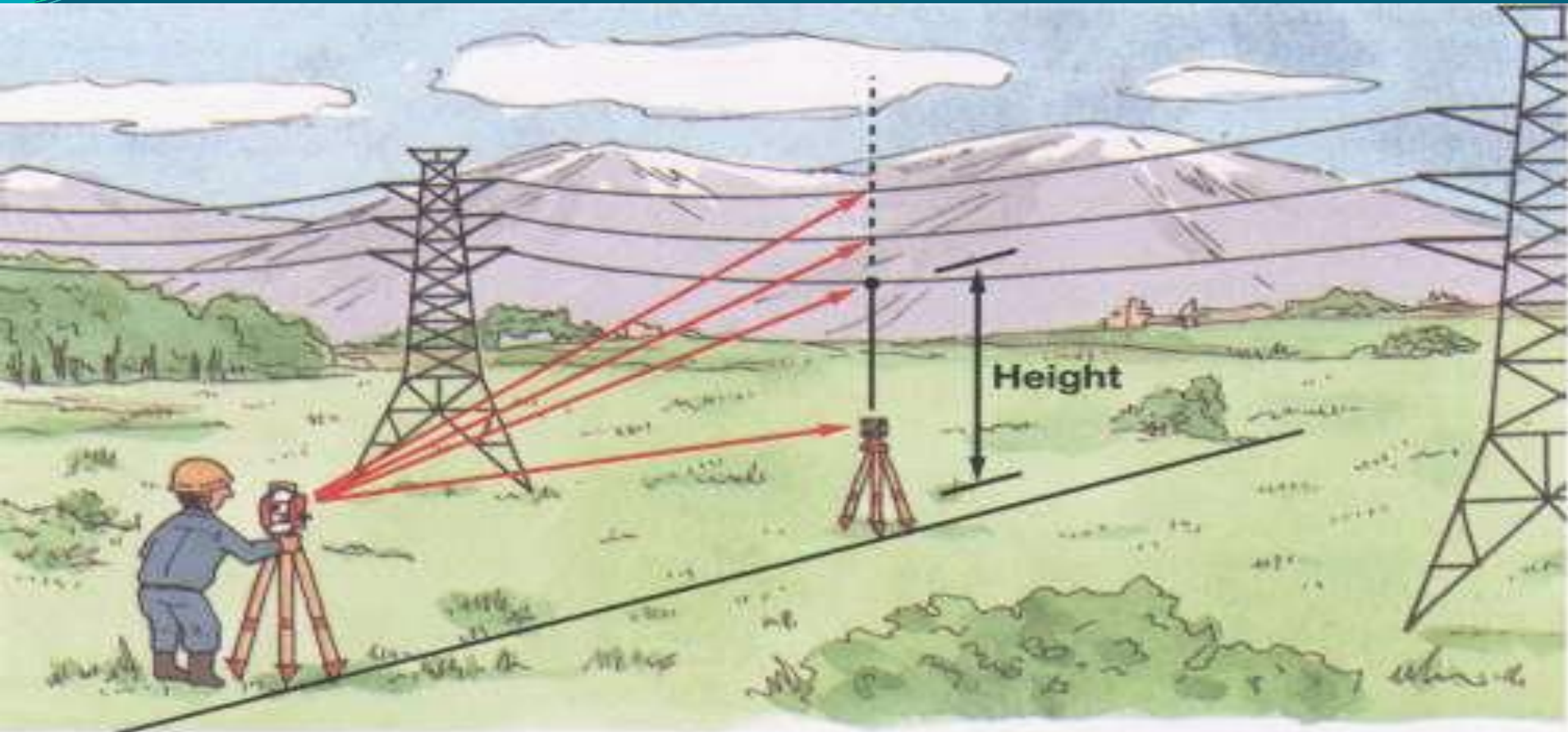
- The electronic theodolite part of total station is used for measuring vertical and horizontal angle.
- For measurement of horizontal angles any convenient direction may be taken as reference direction.
- For vertical angle measurement vertical upward (zenith) direction is taken as reference direction.
- The accuracy of angle measurement varies from 2 to 6 seconds.

**Measure Heights of Points  
Which are Inaccessible**



# REM

Remote Elevation Measurement

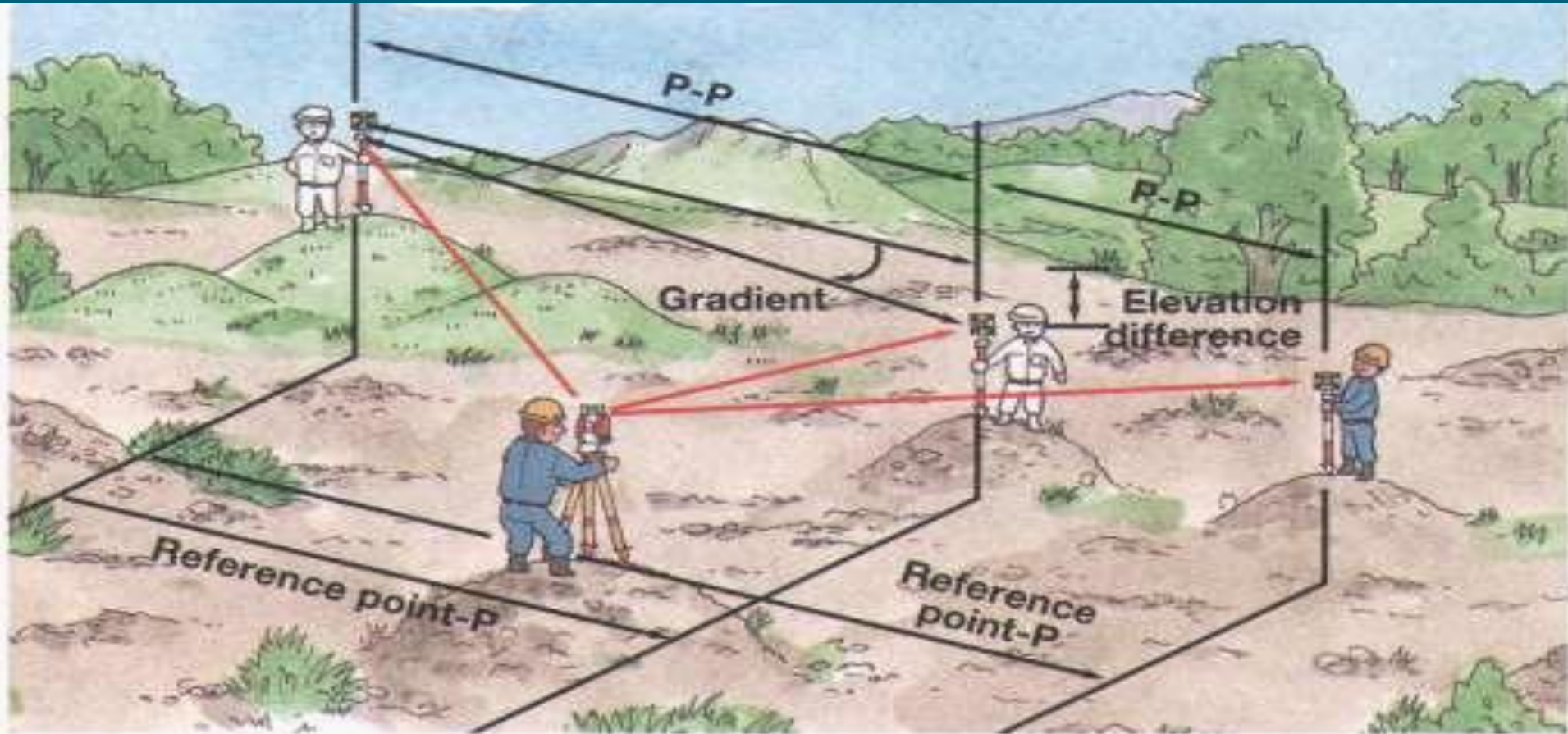


## REM

With REM measurement, a Prism (reference point) is set directly below the place to be measured, and by measuring the Prism, the height to the Target object can be measured. This makes it easy to determine the heights of electric power lines, bridge suspension cables, and other large items used in construction.

# RDM

Remote Distance Measurement



## RDM

With RDM measurement, the horizontal distance, slope distance, difference in height and percentage of slope between the reference point and the observation point are measured. The distance between one observation point and another one is measured as well.

# Data Processing

- This instrument is provided with an inbuilt microprocessor. The microprocessor averages multiple observations. With the help of slope distance and vertical and horizontal angles measured, when height of axis of instrument and targets are supplied, the microprocessor computes the horizontal distance and X, Y, Z coordinates.
- The processor is capable of applying temperature and pressure corrections to the measurements, if atmospheric temperature and pressures are supplied.

# Display

- Electronic display unit is capable of displaying various values when respective keys are pressed.
- The system is capable of displaying horizontal distance, vertical distance, horizontal and vertical angles, difference in elevations of two observed points and all the three coordinates of the observed points.



# Electronic Book

- Each point data can be stored in an electronic note book (like compact disc).
- The capacity of electronic note book varies from 2000 points to 4000 points data.
- Surveyor can unload the data stored in note book to computer and reuse the note book.

# Uses of Total Station

- The total station instrument is mounted on a tripod and is levelled by operating levelling screws. Within a small range instrument is capable of adjusting itself to the level position. Then vertical and horizontal reference directions are indexed using onboard keys.

- It is possible to set required units for distance, temperature and pressure (FPS or SI). Surveyor can select measurement mode like fine, coarse, single or repeated.

- When target is sighted, horizontal and vertical angles as well as sloping distances are measured and by pressing appropriate keys they are recorded along with point number. Heights of instrument and targets can be keyed in after measuring them with tapes. Then processor computes various information about the point and displays on screen.

- This information is also stored in the electronic notebook. At the end of the day or whenever electronic note book is full, the information stored is downloaded to computers.

- The point data downloaded to the computer can be used for further processing.
- There are software like auto civil and auto plotter clubbed with Auto Cad which can be used for plotting contours at any specified interval and for plotting cross-section along any specified line.

# Advantages of Using Total Stations

- The following are some of the **major advantages of using total station** over the conventional surveying instruments:
- Field work is carried out very fast.
- Accuracy of measurement is high.
- Manual errors involved in reading and recording are eliminated.

- Calculation of coordinates is very fast and accurate. Even corrections for temperature and pressure are automatically made.
- Computers can be employed for map making and plotting contour and cross-sections. Contour intervals and scales can be changed in no time.



- However, surveyor should check the working condition of the instruments before using. For this standard points may be located near survey office and before taking out instrument for field work, its working is checked by observing those standard points from the specified instrument station.

## Application of Total station:

1. Updating mapping
2. Topographic survey
3. Hydrographic survey
4. Cadastral survey
5. Project construction survey
6. Road, Rail Survey
7. Mining survey

# Applications

- Total stations are mainly used by land surveyors and civil engineers, either to record features as in topographic surveying or to set out features (such as roads, houses or boundaries).
- They are also used by archaeologists to record excavations and by police, crime scene investigators, private accident reconstruction and insurance companies to take measurements of scenes.

# Mining

- Total stations are the primary survey instrument used in mining surveying.
- A total station is used to record the absolute location of the tunnel walls, ceilings (backs), and floors as the drifts of an underground mine are driven.
- The recorded data are then downloaded into a CAD program, and compared to the designed layout of the tunnel.

- The survey party installs control stations at regular intervals. These are small steel plugs installed in pairs in holes drilled into walls or the back. For wall stations, two plugs are installed in opposite walls, forming a line perpendicular to the drift. For back stations, two plugs are installed in the back, forming a line parallel to the drift.

# Mechanical and electrical construction

- Total stations have become the highest standard for most forms of construction layout.
- They are most often used in the X and Y axis to lay out the locations of penetrations out of the underground utilities into the foundation, between floors of a structure, as well as roofing penetrations.

- Because more commercial and industrial construction jobs have become centered around building information modeling (BIM), the coordinates for almost every pipe, conduit, duct and hanger support are available with digital precision.
- The application of communicating a virtual model to a tangible construction potentially eliminates labor costs related to moving poorly measured systems, as well as time spent laying out these systems in the midst of a full blown construction job in progress.

# Meteorology

- Meteorologists also use total stations to track weather balloons for determining upper-level winds.
- With the average ascent rate of the weather balloon known or assumed, the change in azimuth and elevation readings provided by the total station as it tracks the weather balloon over time are used to compute the wind speed and direction at different altitudes.

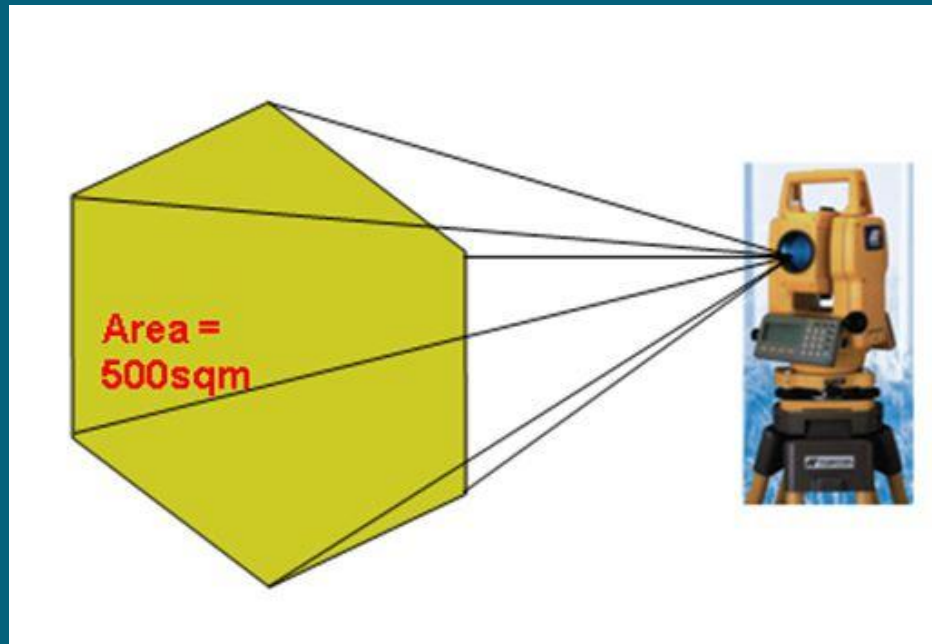


- Additionally, the total station is used to track ceiling balloons to determine the height of cloud layers.
- Such upper-level wind data is often used for aviation weather forecasting and rocket launches.

## Applications of Total Station in surveying

### AREA CALCULATION:

- Area can be computed of any figure just by giving the coordinates of the corner of the figure.
- Area Calculation.
- Process of finding the area of a closed figure.



# Computer software packages

The following post processing computer software packages are in use for various engineering applications.

1. Arc Pad, arc view, arc info  
-conversion from raster to vector form
2. Micro Station - Map generation
3. Erdas – Image processing s/w
4. Surfer, Auto plotter, Civil cad, Pythagarus  
– preparation of contours
5. Survey aid – to draw c/s and l/s

The information received is to be analyzed depending on the users requirement.

## Limitations:

1. It is not a Rugged instrument (Sensitive).
2. Prism verticality is questionable.
3. Visibility is must.
4. More Expensive.
5. Requires calibration at every six months.
6. Amount of error is greater at short distances.
7. Height of instrument and prism is to fed.
8. Awareness on battery maintenance.
9. To establish north- compass is required.

# SAFETY PRECAUTIONS

1. Focusing directly at the sun, can result - loss of eyesight on the spot. Use a filter when observing the sun.
2. Never remove the hand grip carelessly. If the grip is loosely or incompletely attached, the instrument could fall and may cause a serious injury.
3. Make sure not to short the battery terminals. If these are shorted, the resulting high current would not only damage to the battery, but also start a fire.
4. If the instrument or battery comes in contact with water, wipe it off as quickly as possible and set it in a dry place for a while. When it is completely dry, put it back in the case.
5. Never disassemble the instrument, if you find a problem. Contact the dealer.

# HOW TO SUPERVISE THE TOTAL STATION WORK

- Have keen observation on the prism boy's attitude. When high precision is required, use the prism tripod, to avoid human error.
- The position of prism shall always be on hard surface instead of soft soil.
- Focusing shall be exactly at the centre of prism, with the help of cross hairs and prism plate.
- While measuring the instrument height and prism height, enough attention shall be diverted. Also, have keen observation while entering the above data.
- Note the location and coordinates of station point and back sight so that specified intermediate points can be checked at later date.
- Obtain a soft copy of field work raw data from the survey agency so that the results can be checked at any time.
- Obtain more number of points to get an average.



Thank you for your attention