Nile Higher Institute for Engineering & Technology

Department of Civil Engineering

”Survey Engineering Project”

"مشروع الهندسة المساحية"

Cadastral Survey for Nile Higher Institute for Engineering and Technology El-Mansoura - Egypt

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Acknowledgments

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The Nile Institute for Engineering and Technology's laboratory of materials is where the experimental portion of this work was conducted. Special thanks go out to all of the laboratory personnel who helped with this study project.

ABSTRACT

This initiative aims to free up underutilised space for the owner of the Nile Higher Institute of Engineering and Technology in Mansoura. Where the owner built a building in the institute area and needs to determine the size and shape of the vacant spaces, a cadastral survey for the building and all details in the institute area "as built" must be made using surveying instruments and processes. This assignment was completed in four steps. The first step was to distribute many fixed points around the institute buildings using surveying closed traverse and accurate devices, the second step was to correct the observations of the closed traverse according to "Egyptian General Survey Authority" regulations, the third step was to use the traverse points "fixed points" with total station SOKKIA "cx105" to observe all buildings and details in the institute area, and the final step was to draw the institute using all observatories.This study was carried out according to the **Egyptian General Survey Authority.**

Chapter 1 Initial Report

1.1 Project Definition

Measurements of land, airspace, and water areas are just one of the many tasks carried out by surveyors. They give the location of a specific piece of land. They compute, portray and explain what it looks like, and how much is there. They put these facts in deeds, leases, and other legal documents. The Nile Higher Institute for Engineering and Technology was surveyed using the total station, and a detailed map was drawn showing all the details of the institute.

1.2 The Problem

There aren't many cadastral points The institute has many details. Good planning to the real area of the institute and making a survey on the actual area and how to expedite it .

1.3 Study Objectives

In this research, the concentration was on:

- ✓ Coordinate and Plan our Work
- ✓ Study properties of land
- ✓ Using Total Station
- ✓ Observing and recording of information

1.4 Existing Solutions

Using the whole station equipment to locate the institute in order to determine the precise area and the best way to utilize the open space.

1.5 Design Constraints

The primary constrains faced during our research work are classified into these stages:

1.5.1 Economic

The Survey analyses the trends in agricultural and industrial production, infrastructure, employment, money supply, prices, imports, exports, foreign exchange reserves and other relevant economic factors that have a bearing on the Budget.

1.5.2 Environmental

Environmental surveyors use surveying techniques to understand the potential impact of environmental factors on real estate and construction developments, and conversely the impact that real estate and construction developments will have on the environment.

1.5.3 Sustainability

We have a strong focus on sustainability. Among the products and services we offer to promote this effort is environmental surveying. Environmental surveyors use general surveying techniques to investigate and identify the potential impact of environmental factors on construction and real estate developments, and vice versa. In other words, environmental surveying seeks to understand the symbiotic relationship that exists between the environment and architectural development.

1.5.4 Ethical

Survey respondents should be informed of risks and must voluntarily consent to participating. For example, ensuring respondent privacy and confidentiality can help build trust with your respondents. Informed consent can also entail what data is being collected, stored, and used.

1.5.5 Health and Safety

A surveyor who is giving health and safety advice and is deemed to be in control of a building or workplace may be subject to legal obligations for health and safety. This will include advice given to landlords and tenant/occupiers. The nature of advice a surveyor may provide to a property owner is likely to reflect such things as the type, condition and age of the building and the purpose for which the building is to be put.

1.5.6 Social and Political

The establishment of a number of seminars and meetings involving students and professors, which pose academic and administrative problems and everyone, is working to provide appropriate solutions, which increase the bond between students and their teachers.

1.5.7 Development:

Good planning to the real area of the institute and making a survey on the actual area and how to expedite it.

1.6 CUSTOMER NEEDS:

Spotting the Nile institute to know the actual area and surveying on the empty space and how to make the best use of it to construct other buildings.

1.7 GENERATED CONCEPTS:

. Calculate the information of an in access point through choosing a helping point through which we can see the points which the device can't detect due to an obstacle

. Orientation process and measuring the triple coordinates of the point:

The purpose of this step is to input the static coordinates and the sight back if it was known by deviation from the magnetic north. This step is considered the most important work that should be applied during the process of detection either detailed or topography and also when signing.

1.8 FINAL CONCEPT:

The final selection protocol to carried out the cadastral survey for the "Nile Higher Institute for Engineering and Technology" was consider an accurate protocol, where the distributing of the fixed points using closed surveying traverse decrease the equal in coordinates of fixed point ,also many fixed points in area decrease the temporary points finally using the totalstion sokkia ((cx l05)) increase the accuracy because it is accuracy equal S" and T 2mm

Chapter 2 Introduction to the Surveying

2.1 Introduction:

Due to the quick development of the engineering surveying industry, the previous version underwent a number of substantial modifications and revisions. The authors, who have made both minor and large changes along the way, have carefully reviewed all preceding content. As always, decisions must be taken regarding what information should be deleted to create room for new content outlining emerging technologies and what information should be maintained that is still current and pertinent.

The treatment of survey control has become significantly more in-depth. A brand-new chapter on rigorous methods of control, or the use of the least squares methodology in the determination of coordinates and their quality, follows the chapter on traditional methods still in use today. This subject was dropped from the fifth edition of the book, but it has been brought back in a chapter that has been completely rewritten to reflect contemporary software applications of a method that forms the basis for much of satellite positioning, inertial navigation, and stringent survey control.

Satellite placement updates the numerous developments made in the creation of GPS and its applications while also looking ahead to the current developments with the GLONASS and the European GALILEO systems.

An expanded section on gyrotheodolites is included in the chapter on underground surveying, which takes into account both newly developed methods and the use of automation in contemporary instrumentation. The concluding chapter on mass data approaches combines significant portions on basic photogrammetric applications with the ground-breaking new technology of laser scanning by aerial and terrestrial means.

Aerial photogrammetry and laser scanner control are assisted by aircraft location and orientation systems, which are utilised as a form of inertial technology that was originally thought to be an emerging standalone surveying technology.

Despite the inclusion of all this additional material, the authors were nevertheless able to keep the same level of worked examples and test questions present in past editions. We are confident that this new version will be well received by both students and professionals in the domains of engineering and construction surveying, civil engineering, mining, and several local authority applications. This book will be useful for undergraduate education as well as professional growth.

2.2 Basic concepts of surveying:

This chapter's goal is to familiarise the reader with the fundamental ideas behind surveying. As a result, it is the most significant chapter and merits serious attention.

2.3 DEFINITION:

Surveying is the study of locating both natural and man-made features on or below the surface of the Earth in three dimensions. These features may be depicted analogously, such as on a contoured map, plan, or chart, or digitally, such as in a digital ground model (DGM). Both of the aforementioned formats may be used in engineering surveying for the planning, design, and building of works both above and below ground. Surveying procedures are employed afterwards for deformation movement monitoring, dimensional control, or putting out of intended constructional pieces.

In the first place, surveying calls for management and decision-making to select the best techniques and equipment needed to finish the assignment satisfactorily, with the requisite level of precision, and within the allotted time frame. Only after doing an extremely thorough and in-depth reconnaissance of the region to be surveyed can this initial step be carried out successfully.

After the aforementioned logistics are finished, the field work, which entails the collection and storage of field data, is done using the tools and methods necessary for the job.

The operation's next step is to process the data. Calculation tools like pocket calculators and personal computers will be used for the bulk, if not all, of the computation. The techniques used will be determined by the scope and accuracy of the survey as well as how it is recorded, whether in a field book or a data logger. Nowadays, it is possible to represent data in analogue or digital form using either a traditional cartographic plotting method or a fully automated computer-based system that produces a paper- or screen-based plot. When preparing to plan and design a construction project, engineers use the plan or DGM. The undertaking could involve building a bridge, a dam, a railroad, or even an entirely new town.

No matter how complex the job is, it must be laid out on the ground in the proper location, with the precise dimensions, and within the allowed tolerances. Depending on the job at hand, various surveying techniques and equipment with varied degrees of precision and complexity are used to this goal. Because surveying is crucial to the engineer during the planning, designing, and construction of a project, all engineers should be well versed on the accuracy ranges allowed during the manufacturing and construction processes. With the aid of this information, together with a similar understanding of the limitations and capabilities of surveying instrumentation and procedures, the engineer will be able to execute the project effectively in the most cost-effective manner and in the shortest period.

2.4 PRINCIPLES:

Every profession, including engineering surveying, must be founded on moral behaviour. So, practise must be based on accepted ideas. In this section, the concepts of survey are examined, their relationships are explained, and examples of how to use them in practice are provided. A surveyor who fails to take into account the majority of the following principles when planning, carrying out, computing, and presenting the survey work's results is being imprudent and unprofessional. The concepts discussed here can be used for the entire spectrum of surveying tasks, including field work, photogrammetry, mining surveying, metrology, hydrography, cartography, cadastral surveying, and construction surveying.

2.5 Control:

A control network is a system of survey stations with precisely known coordinates that are frequently regarded as being infallible. The stations serve as the reference monuments to which lower-quality survey work is related. A control survey must by its very nature be accurate, comprehensive, and dependable, and it must be easy to demonstrate that these attributes have been met. Using equipment with a track record of accuracy, principles-compliant processes, and data processing that not only computes the right values but also provides quantifiable measures of their precision and reliability, this is accomplished.

Because control must be provided with care, it must be planned to guarantee that it meets the quantitatively stated objectives of precision and reliability. It must also be completed because it will be required for all subsequent and dependent survey work. Other survey activities that may employ the control are often less exact but of greater quantity. Setting out for earthworks on a construction site, detail surveys of a greenfield site or an as-built development, and monitoring multiple points on a structure suspected of deformation are a few examples.

Working from the whole to the part refers to the process of employing a control framework as a foundation for subsequent survey operations. If working outside the control framework becomes necessary, it must be expanded to include the expanded field of operations. Even if the quality of survey observations is maintained, failure to do so will reduce the accuracy of subsequent survey work.

It is not strictly necessary to observe the control before any survey activities for operations other than setting off. The observations could be synchronous or even sequential. However, before any subsequent work is based on the control survey, it must be thoroughly computed.

2.6 Economy of accuracy:

Surveys are always conducted for a specific purpose and should be as precise as necessary, but not more so. Despite contemporary technology, automated methods, and statistical data processing, surveying is still a labor-intensive enterprise that must be kept to an economic minimum. Once a survey or other setting out is required, the job specification must include a declaration of the relative and absolute accuracies to be accomplished. A specification for the control survey may be created from this, and once this standard is met, no further work is required.

Whereas control includes working from 'the whole to the part' the specification for all survey products is achieved by working from 'the part to the whole'. The control specification can be derived from experience using knowledge of the survey methods to be employed, the instruments to be utilised, and the capabilities of the persons involved . Such a specification defines the expected quality of the output by defining the quality of the work that goes into the survey. Alternatively a statistical analysis of the proposed control network may be used and this is the preferable approach. In practice a good specification will involve a combination of both methods, statistics tempered by experience. The accuracy of any survey work will never be better than the control upon which it is based. You cannot set out steelwork to 5 mm if the control is only good to 2 cm.

2.7 Consistency:

Any 'product' is only as good as its most shoddy execution. Whether the 'product' is a washing machine or open heart surgery, a flaw or inconsistency in the endeavour could result in a disastrous failure. The same may be said for surveys, especially when it comes to control. Assume that the majority of control on a construction site is established to a specified level of precision. Later, one or two additional control points are less well established, but all control is believed to be of equal quality. When holding-down bolts for a steelwork fabrication are placed out from the incorrect control, the later phases of the steelwork may require a good nudge from a JCB.

This is the traditional understanding of consistency. Modern survey network adjustment methods allow for considerable flexibility in the application of the principle, and it is not always necessary for all stages of a survey to be of equal quality. If error data for the computed control are not made accessible, consistency in observing methodology and procedure is the only way to ensure quality. Such a quality assurance is therefore only second hand. With positional error statistics the quality of the control may be assessed point by point. Only least squares adjustments can ensure consistency and then only if reliability is also assured. Consistency and economy of accuracy usually go hand in hand in the production of control.

2.8 The Independent check:

The independent check is a quality assurance technique. It is a safeguard against a mishap or major error, and it must be implemented at all stages of a survey. Failure to do so will increase the chance, if not the probability, of the survey work failing catastrophically. If the observations are made with optical or mechanical instruments, they must be documented. A uniform format should be utilised, with enough arithmetic checks on the booking sheet to ensure that no computational errors occur. To verify that the observations are in sync, they should be repeated or, better yet, done in a different way. For example, if a rectangular building is to be laid out, the opposite sides and diagonals should be the same length once the four corners have been laid out. The sides and diagonals should also be related through Pythagoras' theorem. Such checks and many others will be familiar to the practising surveyor.

Checks should be applied to ensure that stations have been properly occupied and the observations between them properly made. This may be achieved by taking extra and different measurements beyond the strict minimum required to solve the survey problem. An adjustment of these observations, especially by least squares, leads to misclosure or error statistics, which in themselves are a manifestation of the independent check.

Transcription errors are likely to cause obvious problems in data abstraction, preliminary computations, data preparation, and data entry. Ideally, all of these operations should be performed by more than one person to avoid duplicating labour and to uncover problems. In short, there is room for error anywhere there is human involvement with data or data gathering.

Every human activity needs to be duplicated if it is not self-checking. Wherever there is an opportunity for an error there must be a system for checking that no error exists. If an error exists, there must be a means of finding it.

Safeguarding:

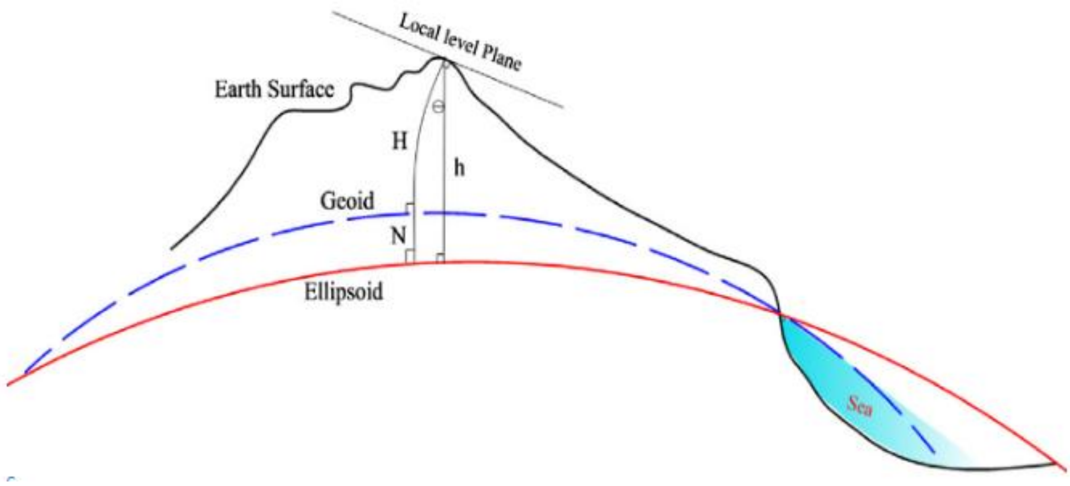
Since survey can be an expensive process, every sensible precaution should be taken to ensure that the work is not compromised. Safeguarding is concerned with the protection of work. Observations which are written down in the field must be in a permanent, legible, unambiguous and easily understood form so that others may make good sense of the work. Observations and other data should be duplicated at the earliest possible stage, so that if something happens to the original work the information is not lost. This could be accomplished by photocopying field sheets or creating backup copies of computer files. When data is in a unique form or when all forms of data are stored in the same location, it is subject to inadvertent deletion.

In the case of a control survey, the protection of survey monuments is most important since the precise coordinates of a point which no longer exists or cannot be found are useless.

2.9 BASIC MEASUREMENTS:

Because surveying deals with fixing position, whether it be control points or points of topographic detail, it need some kind of reference system.

Real survey measurements are made on the actual surface of the Earth, which cannot be quantified. Because of this, it cannot be used as a reference datum for calculating position.



As an alternative, visualise a flat surface that is perpendicular to the direction of gravity at all places. Assuming that the oceans are free from any outside forces, such as tides, currents, winds, etc., such a surface would be closed and could be constructed to meet the average location of the oceans. The equipotential surface that most nearly resembles mean sea level in open waters is known as the geoid, and it has this name. An equipotential surface is one from which it would require the same amount of work to move a given mass to infinity no matter from which point on the surface one started. Equipotential surfaces are surfaces of equal potential; they are not surfaces of equal gravity. The positioning of survey instruments in relation to an equipotential surface that passes through an observer is the most important factor. Their vertical axes are therefore pointing in the direction of the gravitational pull there. A surface that passes through a point level or equipotentially is normal to the direction of gravity, or at a right angle to it. In fact, by projecting along their gravity vectors, the sites measured on the actual surface of the Earth are frequently first reduced to their equivalent position on the geoid.

The reduced level or elevation of a point is its height above or below the geoid as measured in the direction of its gravity vector, or plumb line, and is most commonly referred to as its height above or below mean sea level (MSL). This is based on the reasonable assumption that the geoid passes across the MSL of the local area. The geoid, albeit relatively smooth, is nevertheless an irregular surface and cannot be used to calculate position due to fluctuations in the mass distribution throughout the Earth.

The simplest mathematically definable figure which fits the shape of the geoid best is an ellipsoid formed by rotating an ellipse about its minor axis. Where this shape is used by a country as the surface for its mapping system, it is termed the reference ellipsoid.

The majority of engineering surveys are carried out in areas of limited extent, in which case the reference surface may be taken as a tangent plane to the geoid and the principles of plane surveying applied. In other words, the curvature of the Earth is ignored and all points on the physical surface are orthogonally projected onto a flat plane as illustrated in Figure 1.2. For areas less than 10 km square the assumption of a flat Earth is perfectly acceptable when one considers that in a triangle of approximately 200 km2, the difference between the sum of the spherical angles and the plane angles would be 1 second of arc, or that the difference in length of an arc of approximately 20 km on the Earth’s surface and its equivalent chord length is a mere 8 mm.

Even if the aforementioned assumptions of a flat Earth are valid for some positional applications, the geoid deviates from the tangent plane by approximately 80 mm at 1 km or 8 m at 10 km from the point of contact. As a result, elevations are conceptually described in terms of the geoid, but practically, MSL.

2.10 Basic concepts of surveying

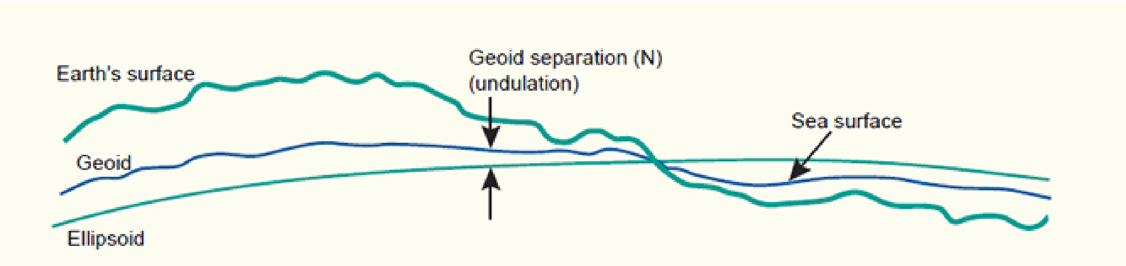


Fig. 2.1 Geoid, ellipsoid and physical surface

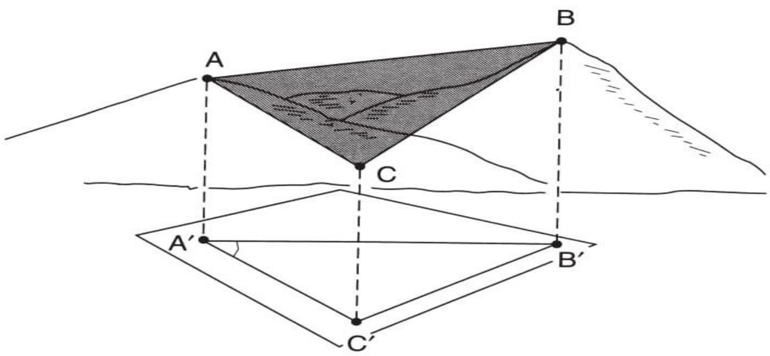


Fig. 2.2 Projection onto a plane surface

The fundamental surveying measurements required to find points A, B, and C and plot them orthogonally as A, B, and C are clearly displayed in Figure 2.2. The measured slope distance AB and the vertical angle to B from A will be required to determine the position of B relative to A, assuming that the direction of B from A is known. To convert the slope distance AB to its equal horizontal distance A B for charting purposes, the vertical angle from A to B is required. While identical measurements will fix C in relation to A, fixing C in relation to B additionally requires the horizontal angle at A measured from B to C (B A C). The slope distance, vertical angle, or direct levelling (Chapter 3) relative to a particular reference datum can also be used to determine the vertical distances defining the relative elevation of the three sites. The five measurements mentioned above comprise the basis of plane surveying and are illustrated in Figure 2.3, i.e. AB is the slope distance, AA the horizontal distance, A B the vertical distance, BAA the vertical angle (α) and A AC the horizontal angle (θ).

Chapter 3 Control Traverse

3.1 Introduction

A traverse is a series of connected lines whose lengths and directions are to be measured and the process of surveying to find such measurements is known as traversing. In general, chains are used to measure length and compass or theodolite are used to measure the direction of traverse lines. The types of traverse and methods of traversing are discussed in this article.

3.2 Types of Traverse:

Traverses are classified as either closed or open.

3.2.1 The Closed Traverse:

A traverse is considered closed if it moves from one coordinated (fixed) location to another. Keep in mind that a closed traverse might end at either its beginning point or any other coordinated point. As a result, it may be verified and modified to precisely fit between these known positions.

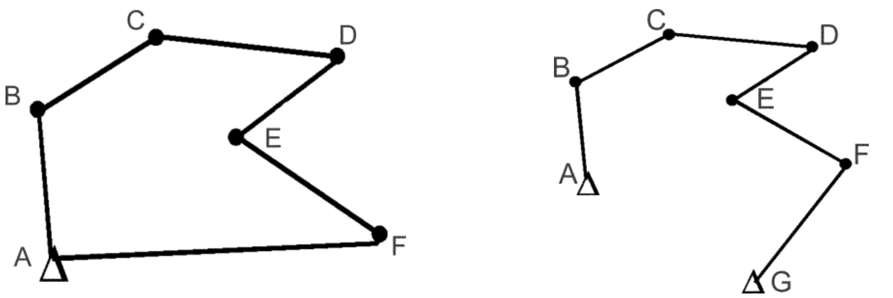


Fig 3.1 Examples of closed traverses

3.2.2 The Open Traverse:

A traversal that is open does not end at a known location. Point F at the end of the traverse is left to "swing" because there is no precise way to verify for any possible angular or linear inaccuracies between A and F. The only way to verify would be to repeat the entire trip or conduct a new survey in the other direction.

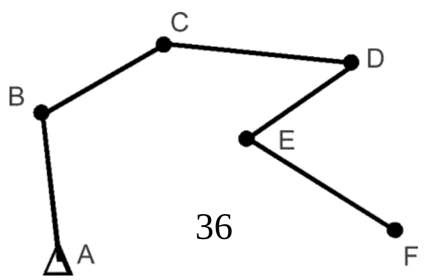


Fig 3.2 Examples of an open traverse

3.2.3 A Control Traverse:

Traversing is employed to extend coordinates from one point to another. This is achieved by starting the observations at a control point of known coordinates and with a known bearing, measured from another control point, carry forward the coordinated along a traverse by measuring a series of angles and distances or a series of bearings and distances and then closing onto a final control point.

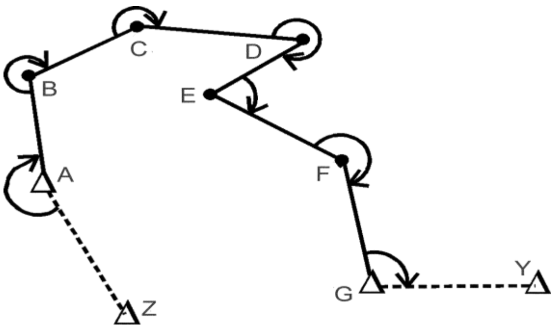


Fig 3.3 A control traverse

The normal practice in surveying is to measure the clockwise angles along a traverse using a theodolite, or total station. With a known initial bearing and a series of clockwise angles, the bearings between each of the points can be calculated.

Any inaccuracies in monitoring the angles or bearings can be corrected by closing upon a known bearing (in Figure 13.3, the line GY).

Either the conventional steel tape method or an electronic distance measuring equipment can be used to measure distances.

Calculating the differences in coordinates from the bearings and distances allows one to determine the coordinates of each point along the traverse.

3.3 The Purpose of Traversing:

These situations call for traversing:

Establishing a horizontal control system for planning and surveying specific engineering or mining projects.

2. Outlining the locations of design elements such roadways, structures, sewage, and drainage lines.

3. Detailed observation of both natural and man-made factors in relation to control.

4. The creation of initial borders and the partition of land into parcels by cadastral records.

5. Major control is provided by geodetic traversing for mapping vast areas.

3.4 Traverse Accuracy:

The accuracy of a traverse is dependent on the type of equipment used and the measuring technique employed, which in turn is dependent on the purpose of the survey. It is also dependent on the accuracy of the original control that is used as the basis of the traverse.

For general engineering and site work the range of accuracy could vary between 1:5 000 to 1:20 000 depending on the individual specifications for the job, with, perhaps, 1:10 000 being a fairly common traverse accuracy.

3.5 Field Work Procedures:

The initial part of all survey traverses is the reconnaissance. In its simplest form, the reconnaissance may only be a ‘walk around’ the job; or it may become involved to the stage where aerial photography of the area is studied in conjunction with associated maps.

Essentially the site is examined to determine the most suitable position to place traverse stations in the form of posts, pegs, concrete blocks, iron spikes or rock marks.

This examination should consider the following factors.

3.6 Application:

Survey traverses are run for many reasons. For example:

- . Topographical engineering
- . cadastral and
- . geodetic surveys.

During the reconnaissance we must look for any existing survey marks so that the traverse connects to these marks.

Existing surveys should also provide start and finish bearings.

3.7 General Survey Requirements:

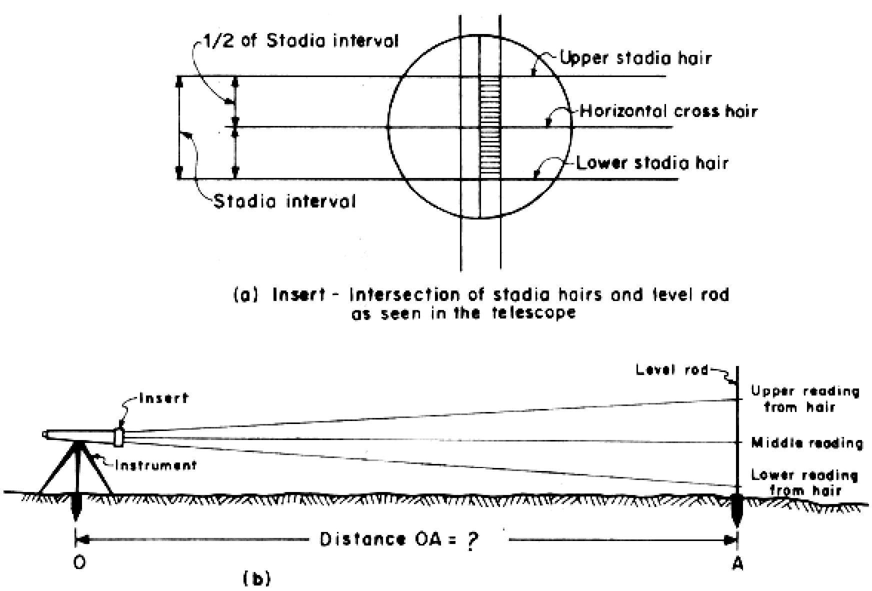
3.7.1 Line length:

Lines should be sufficiently long to minimise sighting (random) errors in the angular work.

3.7.2 Lines of Sight:

The distance between stations ought to be easily visible. Because of the shimmering effects of refraction, traverse lines should be much above ground level and away from major trees and structures (0.5 - 1 metre clearance).

3.8 Durability of Station Positions:



Traverse stations should be located in positions of good accessibility but also where they are least likely to be disturbed.

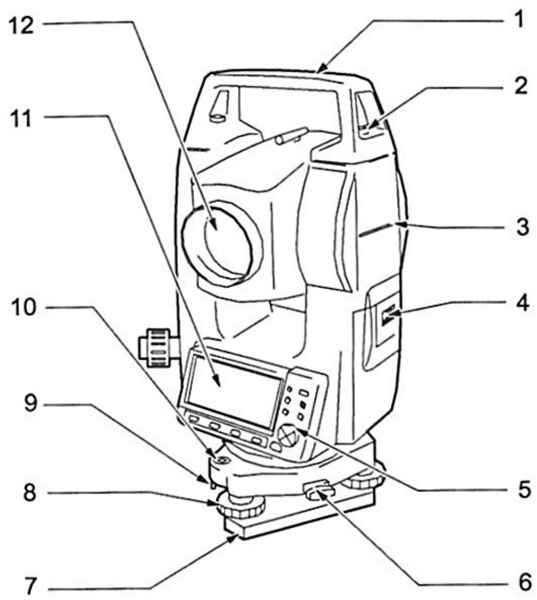
3.9 Equipment Requirements:

Even though a theodolite, an EDM, or a total station would often be utilised, brief measurements and mark referencing would still require the usual tapes and accessories. Tribrachs may need to be added if forced centring is to be used. Communication between stations may also require the use of two-way radios.

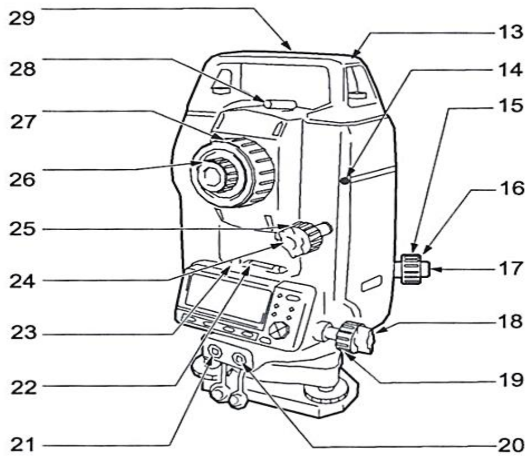
Chapter 4 TOTAL STATION

4.1 Introduction

4.1.1 Parts of the SET Total Station:



1 Handle
2 Handle securing screw
3 Instrument height mark
4 Battery cover
5 Operation panel
6 Tribrach clamp (SET310S/510S/610S: Shifting clamp)
7 Base plate
8 Levelling foot screw
9 Circular level adjusting screws
10 Circular level
11 Display
12 Objective lens



13 Tubular compass slot
14 Beam detector for wireless keyboard (Not included on SET610/610S)
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 (Beside the operation panel on SET610/610S)
21 External power source connector (Not included on SET610/610S)
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 4.1 Total station components

4.1.2 PRECAUTIONS:

4.1.2.1 Charging Battery:

Make sure you charge the battery within the permitted temperature range. Charger temperature range: 0 to 40°C

Because a battery is a consumable, it has a short warranty. The warranty does not cover retained capacity loss brought on by frequent charging and discharging cycles. The CX Calendar & Clock function is maintained by the lithium battery. When used and stored normally, it can retain data for roughly 5 years (20° Fahrenheit, 50% relative humidity), albeit this depends on the environment.

4.1.2.2 Bluetooth Wireless Technology

Bluetooth function may not be built in depending on telecommunications regulations of the country or the area where the instrument is purchased. Contact your local dealer for the details.

4.1.2.3 Tribrach Clamp:

The tribrach clamp is held firmly in place by a locking screw when the instrument is shipped to prevent the instrument from slipping on the tribrachs. Loosen this screw using a screwdriver before using the instrument for the first time. Before transporting it, tighten the locking screw to secure the tribrach clamp in place and prevent it from shifting on the tribrachs.

When rotating the instrument or telescope, always fully release the vertical/horizontal clamps. Rotating with the clamp(s) partially applied may reduce accuracy.

4.1.2.4 Precautions concerning water and dust resistance:

When the battery cover and external interface hatch are closed and connector caps are properly fitted, CX meets IP66 requirements for waterproofing and dust resistance.

It is recommended that you change the rubber packing every two years to maintain the waterproof feature. Contact your local dealer to replace the packing.

To protect the CX from moisture and dust particles, seal the battery cover and external interface hatch and correctly instal the connector covers. Make sure that moisture or dust particles do not come in contact with the inside of the battery cover, terminal or connectors. Contact with these parts may cause damage to the instrument.

Before sealing the case, make sure the inside of the carrying case and the instrument are both dry. If moisture becomes trapped inside the case, the instrument may corrode.

4.1.2.5 General

- **Use nothing with a pointed tip to press the speaker hole. This will result in the degradation of the waterproof property of an inside waterproof sheet.**
- **Replace the rubber packing for the battery cover or external interface hatch if it develops a crack or distortion.**
- **Data should be backed up (transfered to an external device etc.) on a regular basis to prevent data loss.**
- **Close the external interface hatch before starting measurement. Otherwise, ambient light entering the USB port may adversely affect measurement results.**
- **Never place the CX directly on the ground. Sand or dust may cause damage to the screw holes or the centering screw on the base plate. ï Do not aim the telescope directly at the sun.**
- **Also, attach the lens cap to the telescope when not in use. Use the Solar filter to avoid causing internal damage to the instrument when observing the sun.**
- **Protect the CX from heavy shocks or vibration.**
- **Never carry the CX on the tripod to another site.**
- **Turn the power off before removing the battery.**
- **When placing the CX in its case, first remove its battery and place it in the case in accordance with the layout plan.**
- **Consult your local dealer before using the instrument under special conditions such as long periods of continuous use or high levels of humidity. In general, special conditions are treated as being outside the scope of the product warranty.**

4.1.3 Maintenance:

- **Always clean the instrument before returning it to the case. The lens requires special care. First, dust it off with the lens brush to remove tiny particles. Then, after providing a little condensation by breathing on the lens, wipe it with the wiping cloth.**

- **If the display unit is dirty, carefully wipe it with a soft, dry cloth. To clean other parts of the instrument or the carrying case, lightly moisten a soft cloth in a mild detergent solution. Wring out excess water until the cloth is slightly damp, then carefully wipe the surface of the unit. Do not use any alkaline cleaning solutions, alcohol, or any other organic solvents, on the instrument or display unit**
- **Store the CX in a dry room where the temperature remains fairly constant.**

- **Check the tripod for loose fit and loose screws.**
- **If any trouble is found on the rotatable portion, screws or optical parts (e.g. lens), contact your local dealer.**
- **When the instrument is not used for a long time, check it at least once every 3 months.**
- **When removing the CX from the carrying case, never pull it out by force. The empty carrying case should be closed to protect it from moisture.**
- **Check the CX for proper adjustment periodically to maintain the instrument accuracy.**

4.2 Sighting collimator

Use sighting collimator to aim the CX in the direction of the measurement point. Turn the instrument until the triangle in the sighting collimator is aligned with the target.

4.2.1 Instrument height mark

The CX's height is as follows:

192.5mm (from tribrach mounting surface to this mark) (from tribrach mounting surface to this mark)

236mm (measured from the tribrach dish (TR-102) to this point) "Instrument height" is the height from the measurement point (where CX is mounted) to this mark while setting instrument station data.

4.2.2 Trigger Key

Press the trigger key when the CX is in the OBS mode or when [MEAS]/[STOP] is indicated on the display unit. You can start/stop measurement.

In the screen displaying [AUTO], press trigger key to perform automatic operation from distance measurement to recording.

4.2.3 Laser-pointer Function

A target can be sighted with a red laser beam in dark locations without the use of the telescope.

4.3 Operation panel:

Figure 4.2. Shows the control panel

4.4 Point guide:

Fast and simple to use, the Point Guide feature is useful when doing setting-out work. The Point Guide System on the instrument telescope assist the poleman to get on-line. When using with the Point Guide System, the operating time of internal power source will become short.

Figure 4.3. Shows the point guide in TS

Looking at the objective lens of the telescope, the right LED will blink and the left LED will stay lit.

The Point Guide should be utilised within a 100m radius (328 feet). The quality of its results will be determined by the weather and the user's eyesight.

The poleman's purpose is to examine both LEDs on the device and move the prism until both LEDs are equally bright.

Move right if the solid LED is brighter. Move to the left if the blinking LED is brighter.

Once you've confirmed that both LEDs are equally bright, you're ready to use the instrument.

Centering:

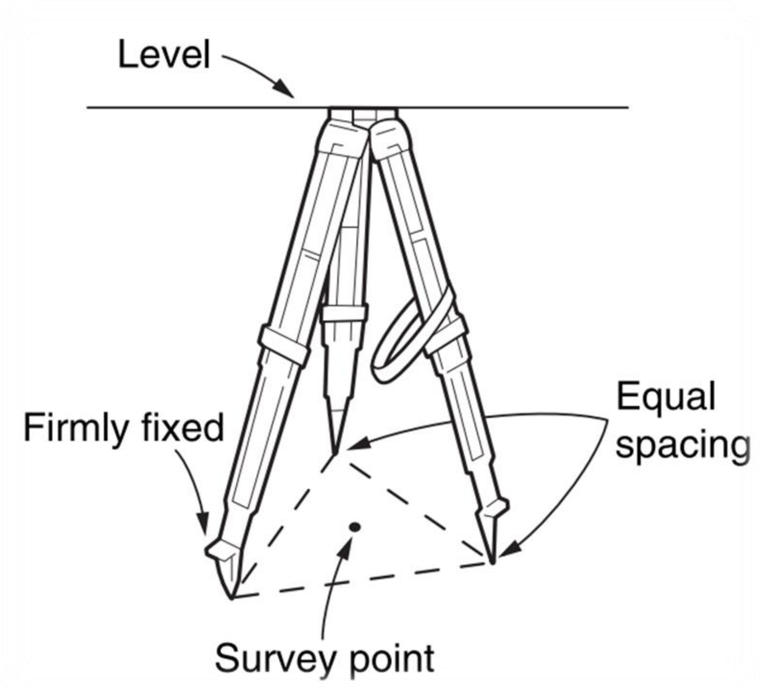


Figure 4.4 Centering with the optical plummet eyepiece

Check that the legs are evenly spaced and that the head is roughly level. Position the tripod such that the head is over the survey point. Check that the tripod shoes are securely fastened to the ground.

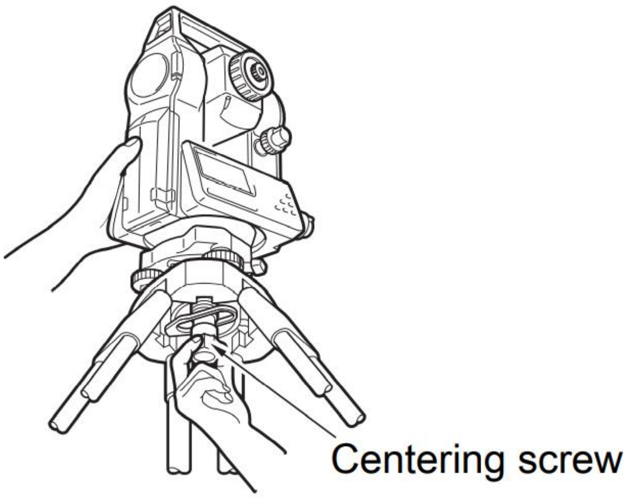


Figure 4.5. Shows the centering screws

Place the instrument on the tripod head. Supporting it with one hand, tighten the centering screw on the bottom of the unit to make sure it is secured to the tripod.

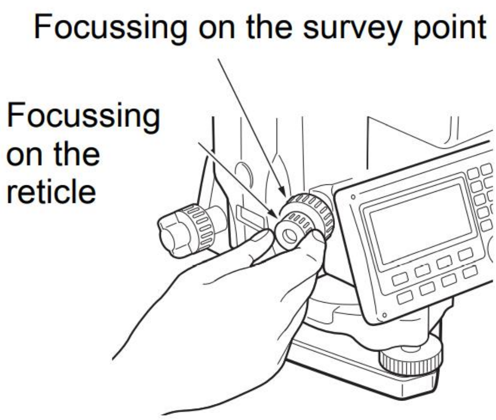


Figure 4.6. Shows the focusing secrews

Looking through the optical plummet eyepiece, turn the optical plummet eyepiece to focus on the reticle. Turn the optical plummet focussing ring to focus on the survey point.

4.5 Setting Up the Instrument:

PROCEDURE: Centering with the laser plummet

- **Adjust the levelling foot screws to center the survey**
- **point in the optical plummet reticle.**
- **Continue to the levelling procedure.**
- **Set up the tripod and affix the instrument on the tripod head.**

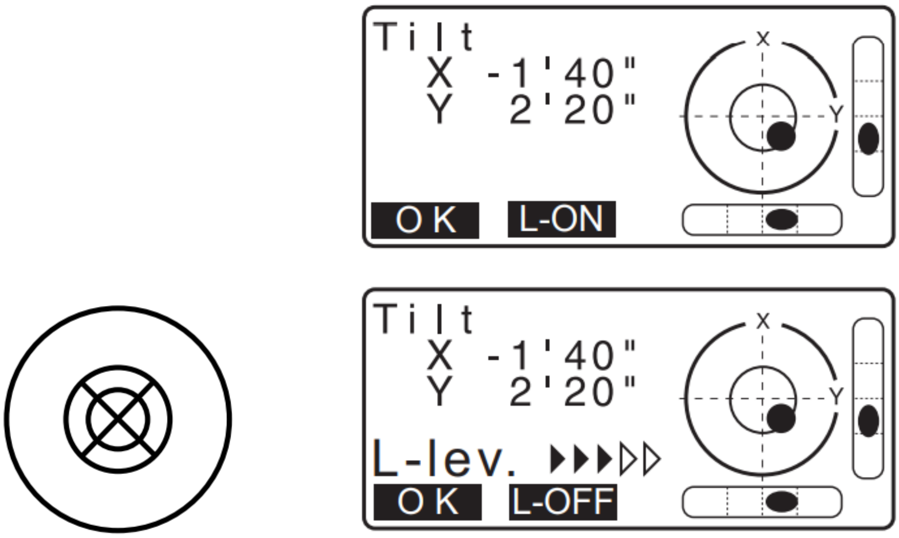


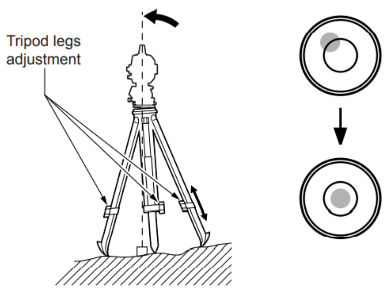
Figure 4.7. Shows centering with the laser plummet

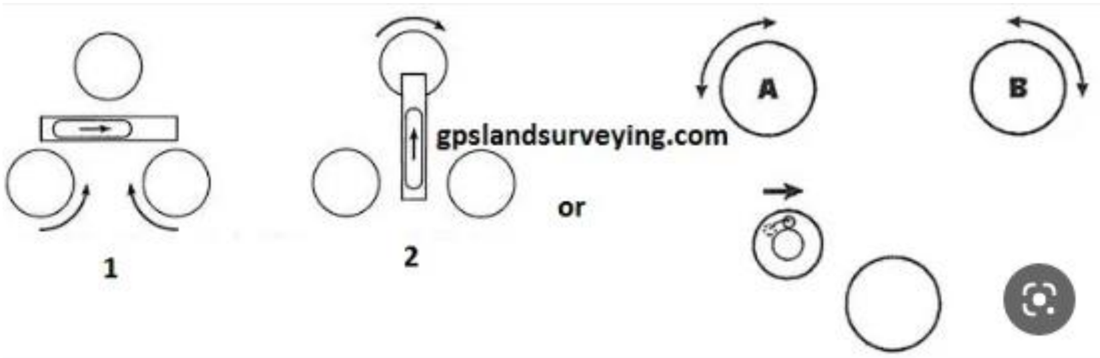
- **Press {ON} to power on The circular level is displayed on the screen.**

- ❖ **Press [L-ON]. The laser plummet beam will be emitted from the bottom of the instrument.**
- ❖ **Use to adjust the brightness of the laser.**
- ❖ **Adjust the levelling foot screws to align the laser beam with the center the survey point.**
- ❖ **Press [L-OFF] to turn the laser plummet off. Alternatively,**
- ❖ **press {ESC} to return to the previous screen.**
- ❖ **The laser plummet will switch off automatically.**
- ❖ **Continue to the levelling procedure.**

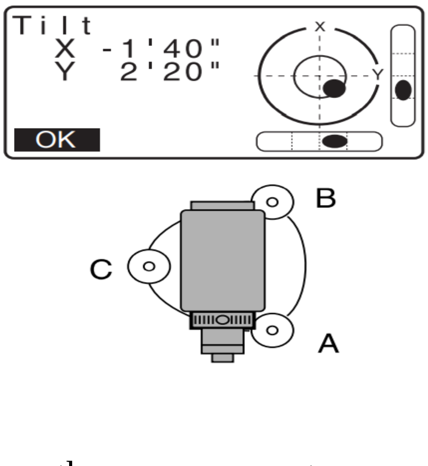
4.6 PROCEDURE:

- ✓ . Perform the centering procedure.
- ✓ Center the bubble in the circular level by either shortening the tripod leg closest to





- ✓ the offcenter direction of the bubble or by lengthening the tripod leg farthest from
- ✓ the offcenter direction of th**e** bubble.
- ✓ Adjust one more tripod leg to center the bubble.
- ✓ Turn the levelling foot screws while checking the circular level until the bubble is centered in the center circle.
- ✓ SETTING UP THE INSTRUMENT
- ✓ Press {ON} to power on
- ✓ The circular level is displayed on the screen.
- ✓ indicates bubble in circular level. The range of the inside circle is ±4' and the range of the outside circle is ±6'.
- ✓ Tilt angle values X and Y are also displayed on the screen.
- ✓ If it is not displayed when the tilt of the instrument exceeds the detection range of the tilt sensor. Level the instrument while checking the air bubbles in the circular level until is displayed on the screen.



- ✓ When executing the measurement program, if measurement starts with the instrument tilted, the circular level is displayed on the screen.

- ✓ Center in the circular level α steps 1 to 2
- ✓ If the bubble is centered, move to step 9.
- ✓ Turn the instrument until the telescope is parallel to a line between levelling foot screws A and B, then tighten the horizontal clamp.
- ✓ Set the tilt angle to 0° using foot screws A and B for the X direction and levelling screw C for the Y direction.
- ✓ Loosen the centering screw slightly. Looking through the optical plummet eyepiece, slide the instrument over the tripod head until the survey point is exactly centered in the reticle. Retighten the centering screw securely.
- ✓ When the instrument was centered using the laser plummet, emit the plummet beam again to check position over the survey point.
- ✓ Centering with the laser plummet.
- ✓ Confirm that the bubble is positioned at the center of the circular level on the screen. If not, repeat the procedure starting from step 6.
- ✓ When levelling is completed, press [OK] to enter into the OBS mode.

4.7 BASIC OPERATION:

Learn basic key operations here before you read each measurement procedure.

- **Power ON / OFF**

{ON}	Power On
{ON} (Press and hold: About 1 second)	Power Off

- **Lighting up the display unit and key**

{}	Switch the screen/key backlight and Reticle il- lumination On / Off

- ***Switching target type***

Target type can be switched only on the screen where the target symbol (ex.) is displayed.

{SHIFT}	Switches between target types (Prism/ N-Prism (reflectorless)/LN-Prism (long range reflectorless))

Target symbol displayed:

Switching between target types in the Star Key mode:

Switching the target type in Config mode":

- ***Switching the Laser-pointer/Point guide ON/OFF***

{} (Press and hold)	To turn the laser-pointer/point guide

	ON/OFF, press and hold until a beep sounds.

□Selecting laser-pointer/point guide:

After turning ON the laser-pointer/point guide, the laser beam is emitted for 5 minutes, and then automatically switches OFF. But in the Status screen and when target symbol (ex.) is not displayed in the OBS mode, the laser beamis not automatically turned off.

.Softkey operation

Softkeys are displayed on the bottom line of the screen.

{F1} to {F4}	Select the function matching the softkeys
{FUNC}	Toggle between OBS mode screen pages (when more than 4 softkeys are allocated)

- **Inputting letters/figures**

{SHIFT}	Switch between numeric and alphabetic characters.
{0} to {9}	During numeric input, input number of the key. During alphabetic input, input the characters displayed above the key in the order they are listed.
{.}/{±}	Input a decimal point/plus or minus sign during numeric input. During alphabetic input, input the characters displayed above the key in the order they are

	listed.
{□}/{□}	Right and left cursor/Select other option.
{ESC}	Cancel the input data.
{B.S.}	Delete a character on the left.
{ENT}	Select/accept input word/value.

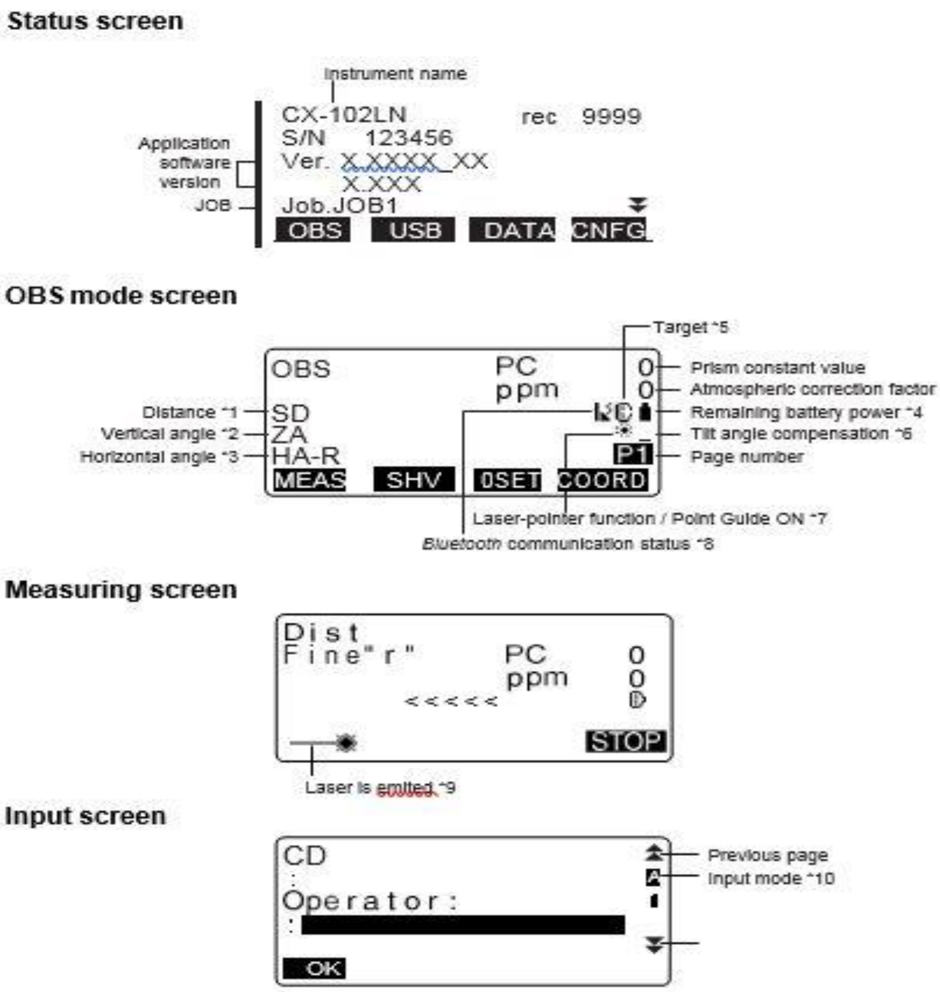
● **Switching modes**

[★]	From OBS mode (Observation Mode) to Star Key Mode
[CNFG]	From Status mode to Config Mode (Configuration Mode)
[OBS]	From Status mode to OBS mode (Observation Mode)
[USB]	From Status mode to USB Mode
[DATA]	From Status mode to Data Mode
{ESC}	Return to the Status mode from each Mode

● **Other operation**

{ESC}	Return to the previous screen

4.8 Display Functions:



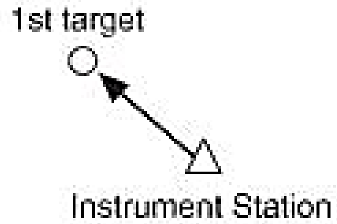
4.9 ANGLE MEASUREMENT:

This section explains the procedures for basic angle measurement.

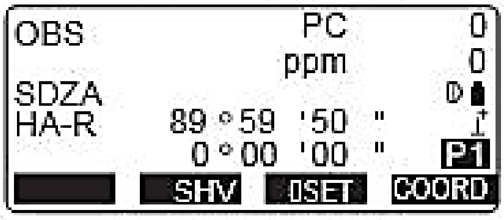
Use the “0SET” function to measure the included angle between two points. The horizontal angle can be set to 0 at any direction.

PROCEDURE:

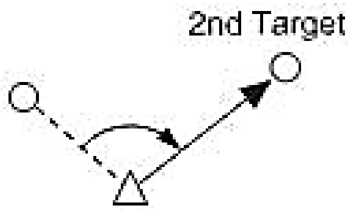
1. Sight the first target as at right.



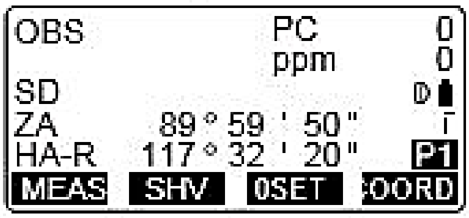
2. In the first page of the OBS mode screen, press **[0SET]**.
[0SET] will flash, so press **[0SET]** again.
The horizontal angle at the first target becomes 0°.



3. Sight the second target.



The displayed horizontal angle (HA-R) is the included angle between two points.



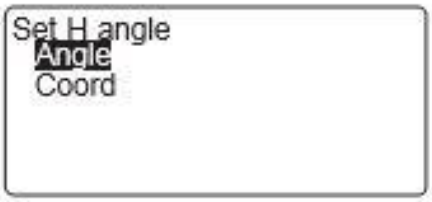
Setting the Horizontal Angle to a Required Value (Horizontal Angle Hold):

You can reset the horizontal angle to a required value and use this value to find the horizontal angle of a new target.

PROCEDURE: Entering the horizontal angle

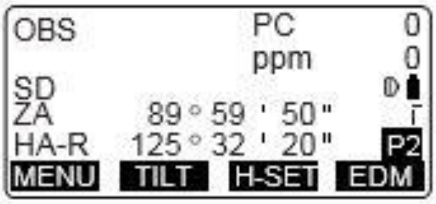
1. Sight the first target.

2. Press **[H-SET]** on the second page of the OBS mode and select "Angle."



3. Enter the angle you wish to set, then press **[OK]**.
   The value that is input as the horizontal angle is displayed.

   • Press **[REC]** to set and record the horizontal angle.
   ☐"28.2 Recording Backsight Point"



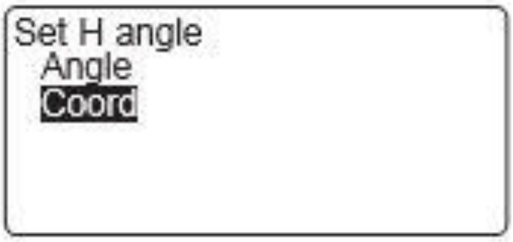
4. Sight the second target.
   The horizontal angle from the second target to the value set as the horizontal angle is displayed.

☐

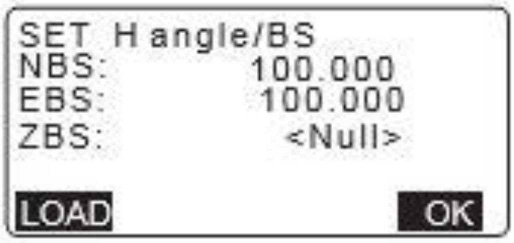
• Pressing **[HOLD]** performs the same function as above.
• Press **[HOLD]** to set the displayed horizontal angle. Then, set the angle that is in hold status to the direction you require.
  ☐Allocating **[HOLD]**: "33.3 Allocating Key Functions"

PROCEDURE: Entering the coordinate:

1. Press **[H-SET]** on the second page of the OBS mode and select "Coord."



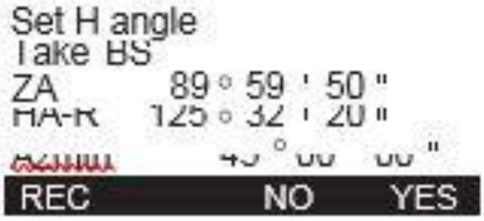
2. Set the known point coordinate. Enter the coordinate for the first point, and press **[OK]**.



Press **[YES]** to set the horizontal angle.

- Press **[REC]** to set and record the horizontal angle.

Point"



3. Sight the second target. The horizontal angle from the set coordinate is displayed.

4.10 . Angle Measurement and Outputting the Data:

The sections that follow explain angle measurement and the features that are utilised to output measurement data to a computer or auxiliary equipment.

Bluetooth connectivity: "10, CONNECTING TO OUTSIDE DEVICES"

"36.2 Optional accessories": communication cables

"Communication manual" output format and command operations

PROCEDURE

1. Connect CX and host computer.

2. Allocate the [HVOUT-T] or [HVOUT-S] softkey to the OBS mode screen.

3 Allocating Key Functions"• Pressing the softkey outputs data in the following format. [HVOUT-T] : GTS format [HVOUT-S] : SET format

3. Sight the target point.

4. Press [HVOUT-T] or [HVOUT-S]. Output measurement data to peripheral equipment.

4.11 DISTANCE MEASUREMENT:

Perform the following settings as preparation for distance measurement.

• Distance measurement mode

• Target type

• Prism constant correction value

• Atmospheric correction factor

□"33.1 Configuration -Config Mode-"/"33.2 EDM Settings"

□ CAUTION

When using the Laser-pointer function, make sure to turn off the output laser after measuring the distance. Even if the distance measurement is turned off, the Laser-pointer function remains active and the laser beam continues to be emitted. (After turning on the Laser-pointer, the laser beam emits for 5 minutes before switching off automatically. However, the laser beam is not automatically turned off in the Status screen or when the target symbol (for example) is not displayed in the OBS mode.)

• Make sure that the target setting on the instrument matches the type of target used. CX automatically adjusts the intensity of the laser beam and switches the distance measurement display range to match the type of target used. If the target does not correspond to the target settings, accurate measurement results cannot be obtained.

• Accurate measurement results cannot be obtained if the objective lens is dirty. Dust it off with the lens brush first, to remove minute particles. Then, after providing a little condensation by breathing on the lens, wipe it off with the wiping cloth.

• During reflectorless measurement, if an object obstructs the light beam used for measurement or an object is positioned with a high reflective factor (metal or white surface) behind the target, accurate measurement results may not be received.

• Scintillation may affect the accuracy of distance measurement results. Should this occur, repeat measurement several times and use the averaged value of the obtained results.

Precautions for use of Long range reflectorless measurement

CX made reflectorless measurement possible to reach the distance that had never been achieved before.

In the Long range reflectorless measurement, the following attentions need to be paid because the farther the target object be, the weaker the reflection from the target and the larger the beam diameter become.

Measurement Time:

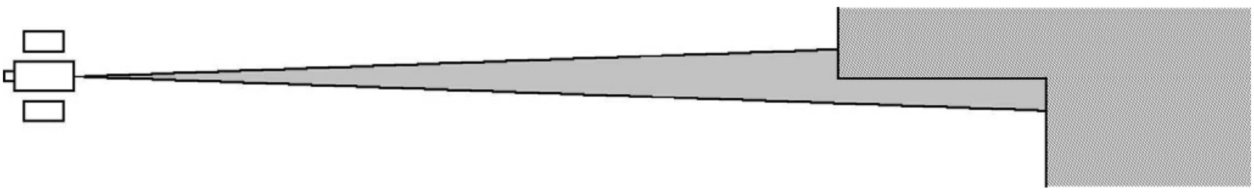
In the LN-Prism mode, the measuring time largely depends on a distance to the target object and the color (or reflectance) of the object. Especially when the measurement distance is far, or when the reflectance of the measured surface is low, measuring time will become longer.

Beam Diameter:

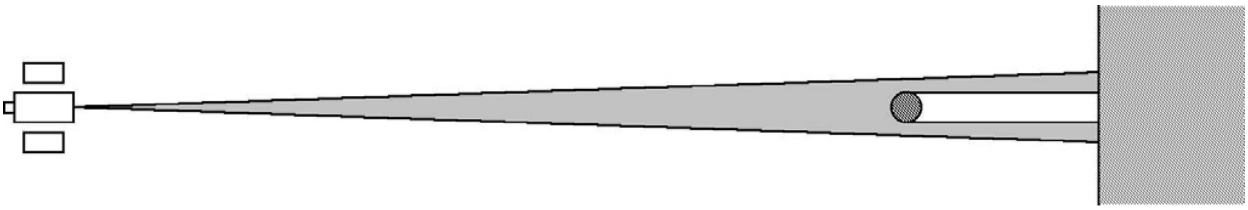
Beam diameter becomes large in the long distance. Try to bring as much beam as possible to the measured surface.

If the beam is not lased rightly as in the cases below, may cause incorrect measurement.

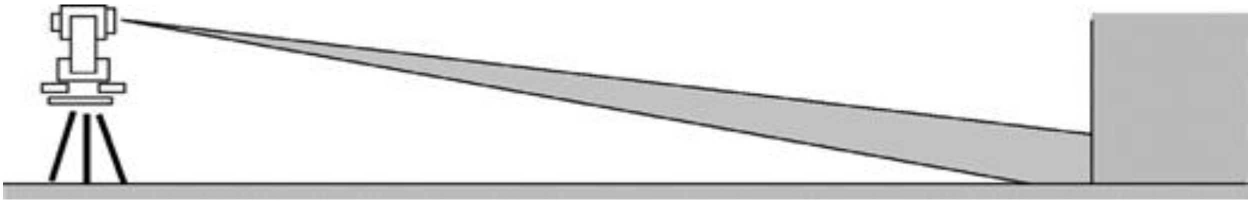
In such cases, collimate the position where the beam is not fallen besides the measured surface, set measurement distance range ("33.2 EDM Settings LNP range"), or operate the plane offset measurement (20.4 Plane Offset Measurement).



(e.g.1) the beam also reaches the wall either before or behind the object



(e.g.2) the beam reaches the wall behind due to the size of the object



(e.g.3) the beam is thrown on the ground before the object

4.12 Cutoff during Measurement:

Use the instrument in LN-Prism mode in a place where no vehicles or people will be in the way of the light path. If it is regularly interrupted, it's possible that you won't be able to gather accurate data.

Re-measuring

You might experience a brief suspension if the reflectance of the measured surface changes substantially, for as when looking quickly from a white object to a dark object or if the object's distance changes noticeably. After some time, if you are still unable to measure, press [MEAS] to begin the process again.

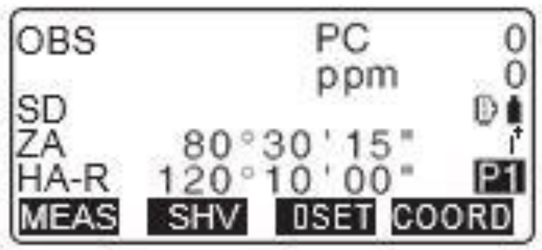
Distance and Angle Measurement:

An angle can be measured at the same time as the distance.

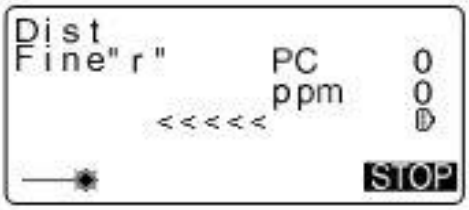
PROCEDURE

1.Sight the target.

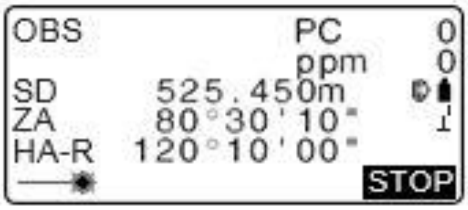
2. In the first page of Obs Mode, press [MEAS] to start distance measurement



When measurement starts, EDM information (distance mode, prism constant correction value, atmospheric correction factor) is represented by a flashing light.

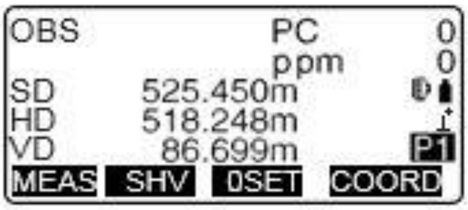


A short beep sounds, and the measured distance data (SD), vertical angle (ZA), and horizontal angle (HA-R) are displayed.



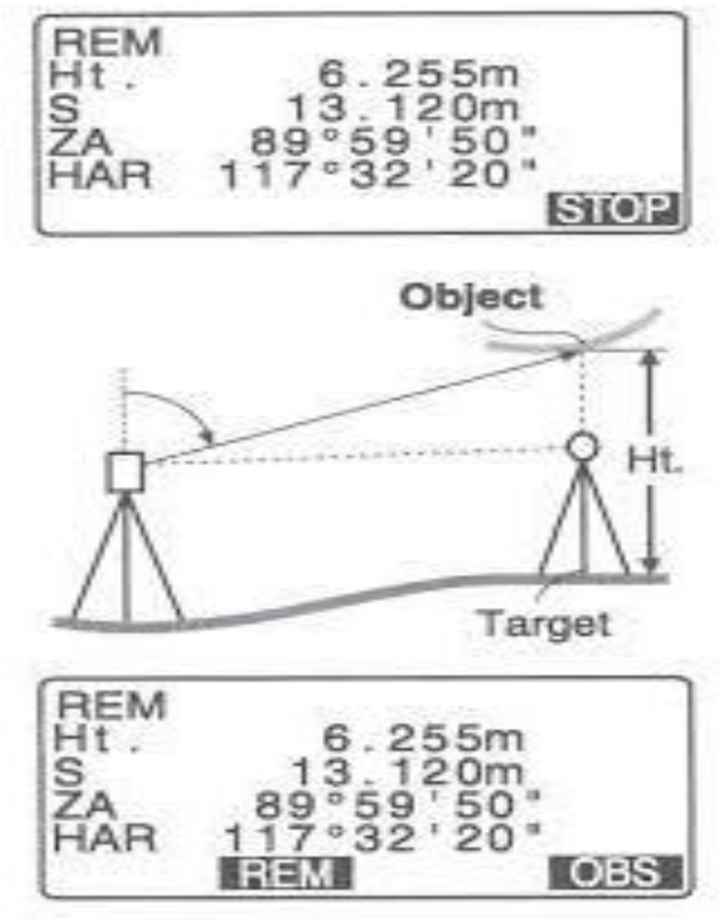
3. Press **[STOP]** to quit distance measurement.

   - Each time **[SHV]** is pressed, SD (Slope distance), HD (Horizontal distance) and VD (Height difference) are displayed alternately.



- If the single measurement mode is selected, measurement automatically stops after a single measurement.
- During fine average measurement, the distance data is displayed as S-1, S-2, ... to S-9. When the designated number of measurements has been completed, the average value of the distance is displayed in the [S-A] line.
- The distance and angle that are most recently measured remain stored in the memory until the power is off and can be displayed at any time.
  ☐"12.3 Recalling the Measured Data"
- If the tracking measurement is conducted with the target type "reflectorless", the measured data for a distance exceeding 250m is not displayed.

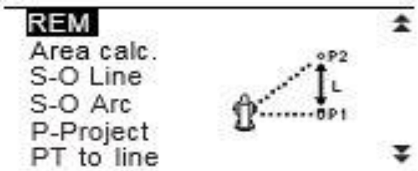
4.13 REM Measurement:



PROCEDURE

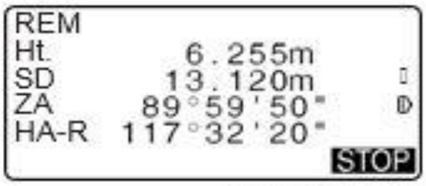
The measured distance data (SD), vertical angle (ZA), and horizontal angle (HA-R) are displayed.
Press **[STOP]** to stop the measurement.

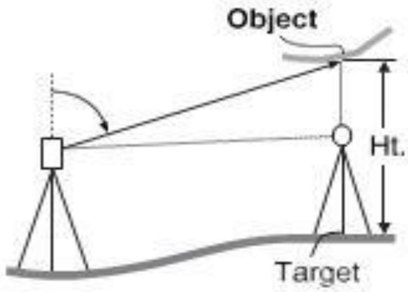
3. In the second page of OBS mode screen, press **[MENU]**, then select "REM".



4. Enter into the REM menu. Select "REM."

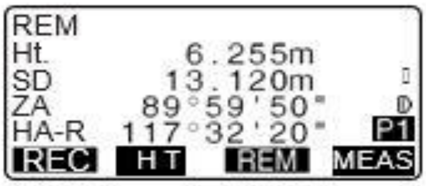
5. Sight the target.
Pressing **[REM]** starts REM measurement.
The height from the ground to the object is displayed in "Ht.".



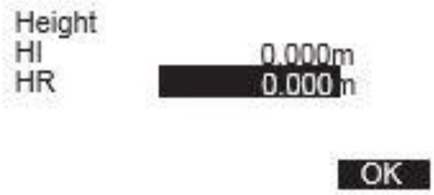


6. Press **[STOP]** to terminate the measurement operation.

- To re-observe the target, sight the target, then press **[MEAS]**.



- Press **[HT]** to enter an instrument height (HI) and a target height (HR).



- When **[REC]** is pressed, REM data is saved.
  ☐"28. RECORDING DATA - TOPO MENU -"
- Press **[HT/Z]** on the second page of the REM measurement to display the Z coordinate for the height from the ground to the target. Pressing **[HT/Z]** again returns to the height display.

7. Press **{ESC}** to finish measurement and return to the OBS mode screen.

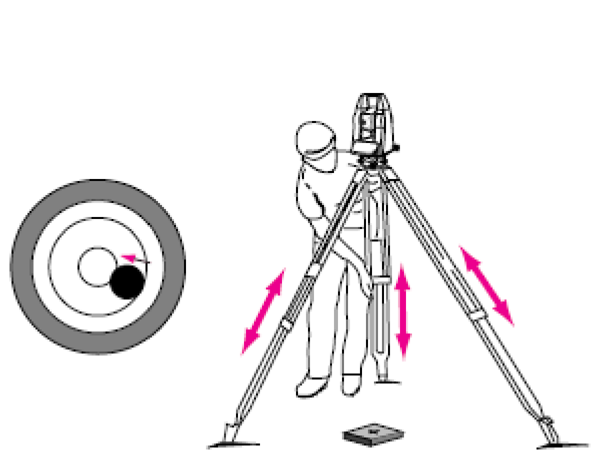
- It is also possible to perform REM measurement by pressing **[REM]** when allocated to the OBS mode screen.
  ☐"33.3 Allocating Key Functions"
- Inputting instrument and target height: Press **[HT]** to set instrument and target height. It can be set also in "Occ. Orientation" of coordinate measurement.
  ☐"13.1 Entering Instrument Station Data and Azimuth Angle"

4.14 SETTING INSTRUMENT STATION:

It is possible to set from the instrument station data to the backsight angle in a series of procedures

• Key input:

- ✓ Entering Instrument Station Data and Azimuth Angle" Step 3
    - Reading the registered coordinate:
- ✓ Entering Instrument Station Data and Azimuth Angle" PROCEDURE Reading in Registered Coordinate Data
    - Calculating data by resection measurement:
- ✓ Setting Instrument Station Coordinate with resection measurement"
    - Inputting the backsight angle:
- ✓ Entering Instrument Station Data and Azimuth Angle" Step 3
    - Calculating from the backsight coordinate:



- ✓ Entering Instrument Station Data and Azimuth Angle" Step 3
- ✓ Calculating the direction angle by assuming the known point (first point) at the time of resection measurement as the backsight point.
- ✓ Setting Instrument Station Coordinate with resection measurement"

Step 9

- When performing measurement in which the reduced data is output, be sure to record the instrument station data before the measurement. If a correct instrument station data is not recorded, it may cause output of an unintended measurement result.

4.15 TRAVERSE ADJUSTMENT:

Measurement of a traverse begins with observation of the backsight station and foresight station. The instrument station is then moved to the foresight station and the previous instrument station becomes the backsight station. Observation is performed again at the new position. This process is repeated for the length of the route.

This adjustment function is used to calculate the coordinates of such a sequence of consecutively-observed points (traverse points and points observed from traverse points (see P3-1 to P3-3 below)). When calculation is complete, the CX displays the precision of the traverse and, when necessary, traverse adjustment can be performed.

PROCEDURE

Before starting traverse calculation, observe the sequence of traverse points and record the results.

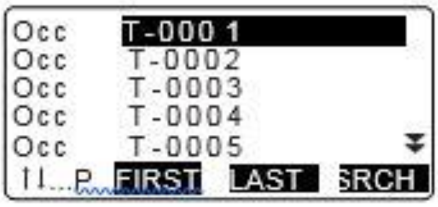
"28.4 Recording Distance

Measurement Data"/

"28.6 Recording Distance and Coordinate Data"

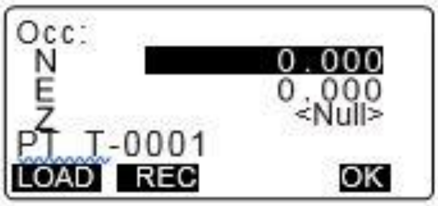
1. Enter the start point name and press **{ENT}**.

- When **[LIST]** is pressed, a list of instrument stations saved in the current JOB is displayed. A point from this list can be recalled and used.

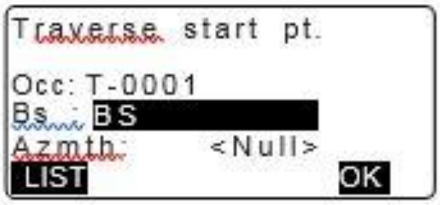


☐For using softkeys in this screen, see "13.1 Entering Instrument Station Data and Azimuth Angle PROCEDURE Reading in Registered Coordinate Data"

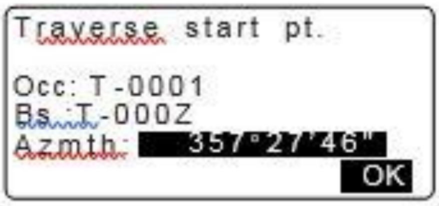
- Enter values manually when there are no coordinates saved for the specified instrument station.
  Press **[OK]** to proceed to step 4.



2. Enter the point name of the backsight station for the start point and press **{ENT}**.



When there are saved coordinates for the backsight station, the calculated azimuth angle is displayed.



- Enter values manually when there are no coordinates saved for the specified start point backsight station.
  Press **[OK]** to display the calculated azimuth angle.

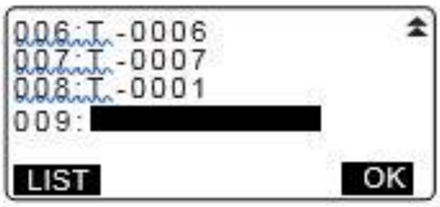
- To enter azimuth angle without entering backsight station coordinates, press {□} to move the cursor down to "Azmth" then enter an angle value.

3. When **[OK]** is pressed in the screen in step 4, the CX will search for a traverse route. The points from step 1 will be displayed in the order in which they were observed.

- This search can be stopped by pressing **{ESC}**. If **{ESC}** is pressed, a route can be computed using only the points found prior to the search being stopped.

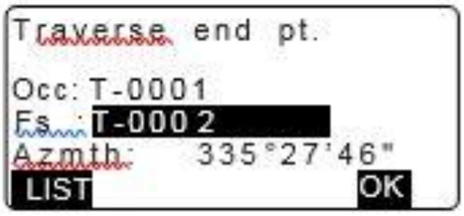
- When a traverse point with recorded known point coordinates is found, or there are multiple foresight stations for a point, the automatic route search will stop. Press **[LIST]** and select which foresight station to use as the next point.
  □"□ Automatic route search"

4. Press **[OK]** to confirm the traverse route.

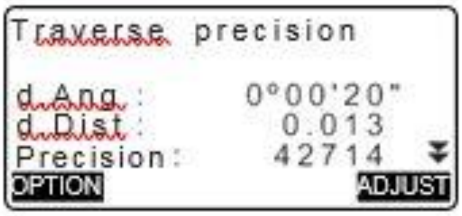


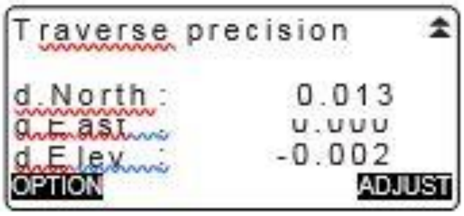
5. Enter the point name of the backsight station for the end point and press **{ENT}**.
The calculated azimuth angle is displayed.

Enter the azimuth angle when there are no recorded coordinates for the end point backsight station.



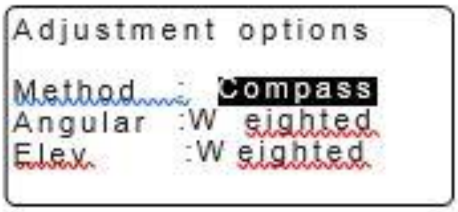
6. When **[OK]** is pressed in the screen in step 7, the CX will display the precision of the traverse.





d.Ang:	Angular closure error
d.Dist:	Horizontal closure distance
Precision:	Precision of the traverse as a ratio of the total horizontal distance traversed to the closure distance
d.North:	Closure distance in Northing coordinates
d.East:	Closure distance in Easting coordinates
d.Elev:	Closure distance in elevation

- Press **[OPTION]** to change the method by which the traverse adjustments are distributed.



(*:Factory setting)

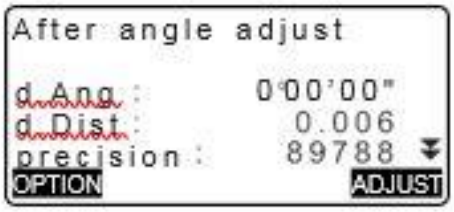
(1) Method (coordinate adjustment):
Compass*, Transit

(2) Angular:
Weighted*, Linear, None

(3) Elev (Elevation):
Weighted*, Linear, None

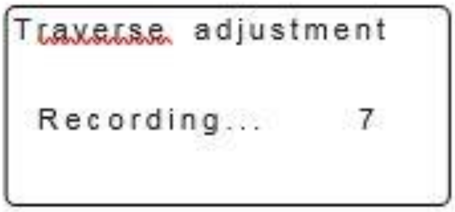
☐ For all options, see "☐ Adjustment methods"

7. Angular adjustment will be performed first. Press **[ADJUST]** to start adjustment using the method selected in "(2) Angular" in step 8.



- When "None" is selected in "(2) Angular" in step 8, only coordinate and elevation adjustment will be performed.

8. After confirming the results, press **[ADJUST]** again to start coordinate and elevation adjustment using the methods selected in "(1) Method" and "(3) Elev" respectively. All adjusted instrument data will be in saved in the currently selected JOB and traverse adjustment will be finished.



• It is also possible to perform traverse adjustment by pressing [TRAV] when allocated to the OBS mode screen.

 Allocating [TRAV]: "33.3 Allocating Key Functions"

• Traverse adjustment results of traverse points, points observed from traverse points and traverse adjustment data will be saved in the currently selected JOB as Notes data. Data including the distributed closure error will also be saved in the currently selected JOB as ordinary coordinate data.

Traverse line record:

1. point names of start and end points
2. backsight station name and azimuth to said backsight station
3. foresight station name and azimuth to said foresight

Adjustment setting record:

The selected method for distributing closure error.

Closure error record (2x2):

1. precision and closure error for angle/distance
2. coordinate closure error

Coordinate adjustment record

(No. of included points between start and end points):

Coordinates

 Types of traverse

CX can calculate closed-loop and closed traverses. In both cases, the azimuth for the start point (and for the end point in the case of a closed traverse) must be set.

 Automatic route search

This function searches for consecutively-observed traverse points already stored on the CX and presents them as potential traverse routes.

This function is activated when the following conditions are met. When a point has been observed more than once, the most recent data will be used for the search.

•From an instrument station, at least one backsight station and one foresight station are viewed.

•The foresight station is converted into an instrument station for further measurement.

For the succeeding measurement, the instrument station serves as the backsight station.

The automatic route search will be terminated if one of the following conditions is met. By specifying the name of the next point on the route, the same search can be resumed.

An instrument station may have more than one potential foresight station. (The route search ends when a junction emerges in the path.)

•The preceding measurement's foresight station was the Start pt. (The route search ends when this measurement is assessed to have completed a closed-loop traverse.)

•The most recently measured point shares the same name as a previously reported recognised point. (The route search is terminated because this point is determined to be the End pt.)

In the following circumstances, the automatic route search function cannot be used.

•The final measurement is to a traverse point other than the Start pt on the traverse path.

 Adjustment methods:

Adjustment is applied to results for traverse points and points observed from
traverse points.

Adjustment methods and distribution options selected in step 8 are described below.

4.16 USING USB MEMORY DEVICE:

It is possible to read in/output data from/to a USB memory device.

•When using a USB memory device, data is stored in the root directory. You cannot read/write data from/to subdirectories.

•When using the CX, an MS-DOS-compatible text file can be input/output.

•When "S type" is selected, only files with an extension of "SDR" can be input/output. The CX cannot display files with an extension other than "SDR" stored in a USB memory device. Also, an output code data file can be displayed only when "T type" is selected. (The same will apply to a case for saving a code while "S type" is selected.)

•You can neither save a file under the same name as a read-only file, nor change/delete the name of a read-only file. (However, this varies depending on the model or software you are using.)

•For "Communication Manual" that describes details on the communication formats used for inputting/outputting data to/from a USB memory device, please consult with your local dealer.

•When using the CX, you can use a USB memory device with the capacity of up to 8GB.

Inserting the USB Memory Device:

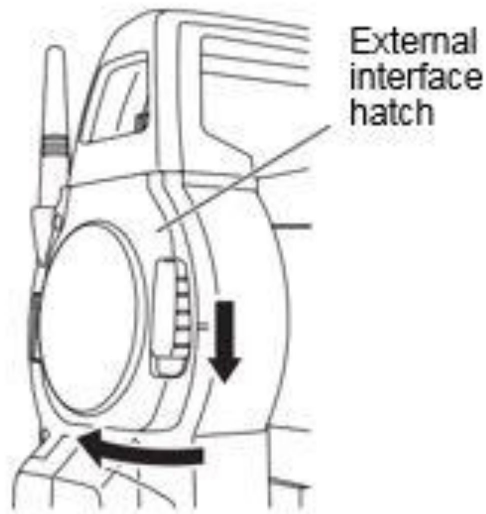
•Do not remove the USB memory device during data read/write. Doing so will

cause data stored in the USB memory device or the CX to be lost.

• During data read/write operations, do not remove the battery or turn off the power. This will result in the loss of any data on the CX or USB memory device.

•Unless the external interface hatch and battery cover are closed and the

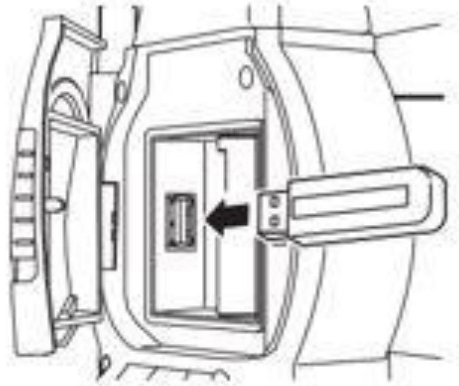
1. Slide the catch on the external interface hatch cover down to open.



2. Insert the USB memory device in the respective slot.

□

- When using a USB memory with 4 metal terminals on the surface, insert it with the terminal facing backwards to avoid damaging the USB port.



3. Close the cover.
   Listen for the click to ensure that the cover is properly closed.

connector caps are properly fastened, this instrument's waterproofing property is not guaranteed. In the event that water or another liquid spills over the instrument, do not use it with these exposed or loose.PROCEDURE:

Selecting T type/S type:

1. Press **[USB]** on the status screen.

2. Select "T type" or "S type".
   Press **[ENT]** after selection.

- Select either "T type" or "S type" according to the communication format used.

☐"33.1 Configuration -Config Mode-" Communication Setup

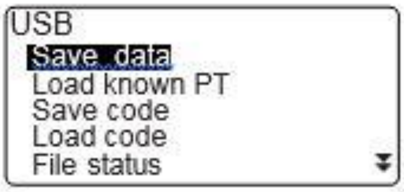
Storing JOB Data to USB Memory device

The measurement data (distance, angle, coordinate), known point data input on the CX, station point data and note stored in a JOB of the CX can be saved to the USB memory device. Also, if multiple JOBs are selected, they can be saved to one file.

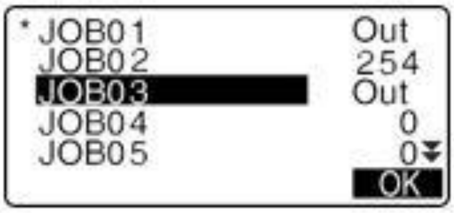
- When selecting S type, the data is saved as a file with an extension corresponding to the output communication format.
- When selecting T type, a file extension is automatically set corresponding to the output communication format, but it can be deleted or changed to any other extension.

PROCEDURE Data saving

1. Select "Save data" in USB mode.

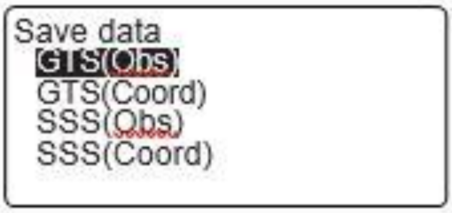


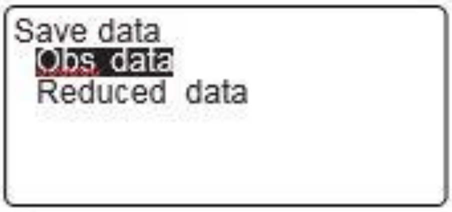
2. In the list of JOBs, select the JOB to be recorded and press **{ENT}**. "Out" is displayed to the right of the selected JOB. Multiple JOBs can be selected.



3. After selecting the JOB(s), press **[OK]**.

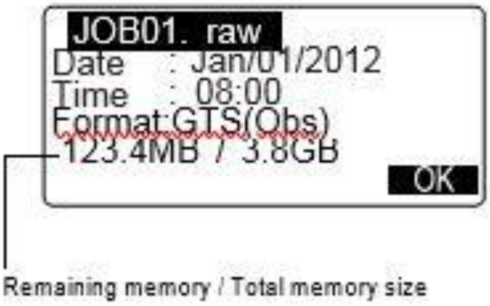
4. Select output format.
   (When T type is selected.)





5. Enter the file name. Press **{ENT}** to set the data.

   • File extension name can be entered when T type is selected. After entering file name, press **{ENT}**/**{▫}** to move the cursor to the extension name.



6. Select output format.
   (When S type is selected)
   Align the cursor with "Format" to select the output format.

   • Selecting "Yes" for "Send RED data" on the second page outputs the horizontal distance data converted from the slope distance.

7. Press **[OK]** to save the JOB to the external memory media. After saving a JOB, the screen returns to the JOB list.

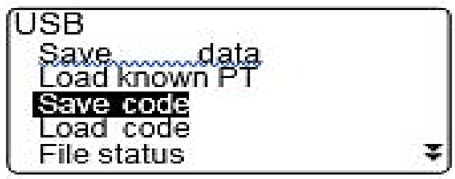
   If **{ESC}** is pressed while data is being recorded, data recording is canceled.

- Maximum size of file name: 8 characters (alphanumeric) excluding the file extension.
- Characters used to make File name: Alphabet (capital letters only), special characters (-)
- Output format
  T type: GTS (Obs), GTS (Coord), SSS (Obs), SSS (Coord)
  S type: SDR33, SDR2x
- Maximum size of extension name: 3 characters (only when T type is selected)
- When a file is overwritten, the overwritten file is deleted.

PROCEDURE Code saving

- When saving the code, it is necessary to select "T type" in the communication setting. ☐"33.1 Configuration -Config Mode-" Communication Setup

1. Select "Save code" on the first page of the USB mode.



2. Specify a file name and press **{ENT}**.
   ☐Entering extension name:
   " PROCEDURE Data saving step5"

3. Pressing [OK] starts saving the code. When saving is completed, the screen returns to the list of JOBs.

Pressing {ESC} stops saving.

Chapter 5 EXPERIMENTAL WORK

5.1 Introduction

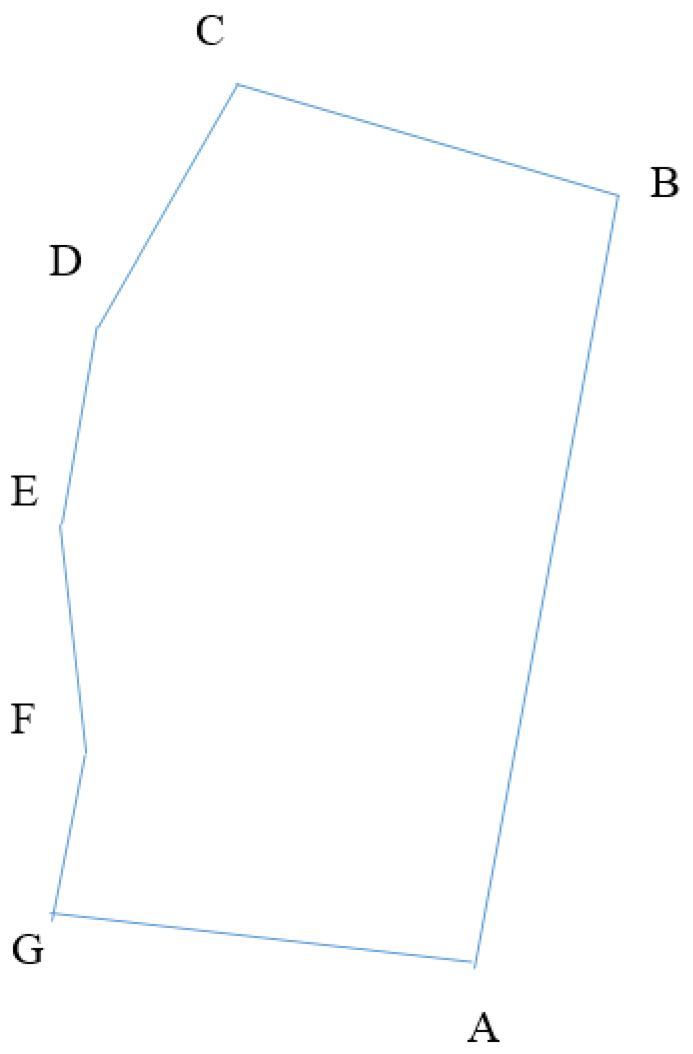


Figure 5-1 points of survey

The final points and data taken from the total station for the given space can be shown in figure (5-1) and table (5-1)

Table5-1 points of survey

Point	x	y	Δ X	ΔY
A	1000	1000	63.076	35.081
B	1063.076	1035.081	-3.118	23.56
C	1059.958	1058.641	-44.262	11.574
D	1015.696	1070.215	-26.33	14.551
E	989.366	1084.766	-21.057	7.907
F	968.309	1092.673	-9.792	-28.005
G	958.517	1064.668	41.413	-64.686
A	999.930	999.982		
∑			-.07	-.018

Linear misclosure = $\sqrt{(.07)^2 + (.018)^2} = 0.072$ m

Error Percentage = 0.072/300.74 = 1/4177

L AB = 72.175 m

L BC = 23.765 m

L CD = 45.750 m

L DE = 30.083 m

L EF = 22.493 m

L FG = 29.667 m

L GA = 76.807 m

∑ L = 228.565 m

Point	Δx	Δy	X	Y
A			**1000**	**1000**
B			**1063.076**	**1035.081**
C	**-3.11**	**23.561**	**1059.966**	**1058.642**
D	**-44.248**	**11.577**	**1015.718**	**1070.219**
E	**-26.32**	**14.553**	**989.398**	**1084.772**
F	**-21.05**	**7.908**	**968.348**	**1092.68**
G	**-9.783**	**-28**	**958.565**	**1064.68**
A	**41.436**	**-64.68**	**1000**	**1000**

5.2 As built for Nile Higher Institute for engineering and technology, Mansoura.

Some of the actual points and data taken from the total station for the given space can be shown in table (5-2), the rest of the table can be found in Appendix A

Table5-1 points of survey

Point coordinates	x	y	z
8	**8.973**	**50.539**	**13.588**
9	**30.473**	**35.349**	**13.52**
10	**28.442**	**32.248**	**13.578**
11	**38.003**	**19.028**	**13.545**
12	**40.082**	**16.044**	**13.474**
13	**39.109**	**17.289**	**13.543**

14	**20.555**	**4.375**	**13.702**
15	**22.814**	**4.744**	**13.653**
16	**-4.073**	**9.297**	**14.42**
17	**-4.161**	**8.071**	**14.506**
18	**-4.525**	**7.277**	**14.509**
19	**-4.745**	**6.078**	**13.472**
20	**-10.608**	**2.225**	**14.342**
21	**-5.738**	**1.007**	**14.278**
22	**-9.898**	**0.281**	**14.726**
23	**-6.018**	**0.982**	**14.979**
24	**-6.022**	**-0.956**	**14.978**
25	**-0.685**	**-2.344**	**14.891**
26	**-0.469**	**-1.631**	**14.887**
27	**1.933**	**-0.399**	**14.445**
28	**7.702**	**-10.208**	**14.209**
29	**7.265**	**-1.211**	**14.434**
30	**8.836**	**-0.075**	**14.411**
31	**44.303**	**-12.533**	**14.048**
32	**44.972**	**-11.038**	**14.044**
33	**47.151**	**-10.83**	**13.338**
34	**47.001**	**-10.484**	**13.42**
35	**46.72**	**-10.95**	**13.372**
36	**47.561**	**-10.189**	**13.333**
37	**57.906**	**-10.158**	**13.194**
38	**63.346**	**-10.52**	**13.253**
39	**63.166**	**-11.51**	**12.856**

40	**58.875**	**-10.37**	**13.346**
41	**44.622**	**12. 728**	**13.491**
42	**44.521**	**20.76**	**13.707**
43	**44.002**	**21.45**	**13.714**
44	**40.179**	**18.762**	**13.655**
45	**37.494**	**22.498**	**13.687**

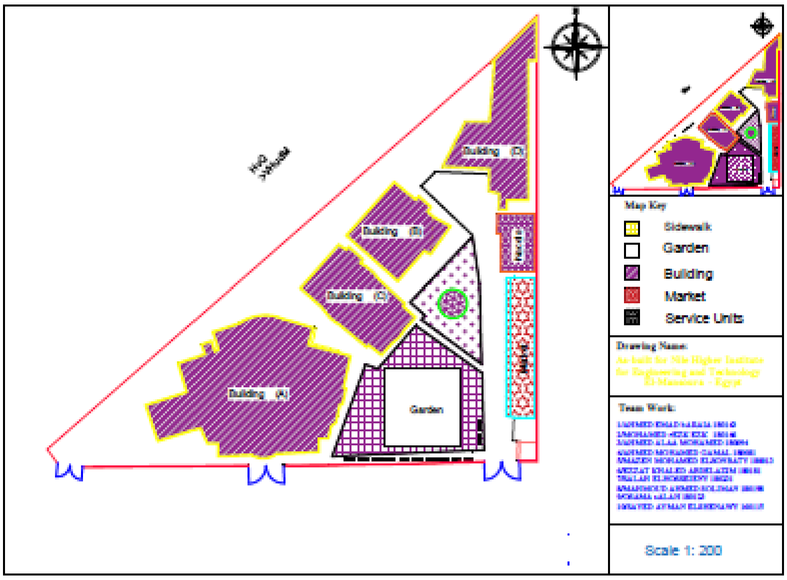


Figure 5-2 shows the layout of the location

Field investigation

Figure 5-3 Field investigation

Figure 5-4 Field investigation

Figure 5-5 Field investigation

5.3 Conclusion:

The precise cadastral survey for the Nile higher institute of engineering and technology in Mansoura, "asbult," was completed in four steps. The first step was to distribute many fixed points around the institute buildings using surveying closed traverse and accurate devices, the second step was to correct the observations of the closed traverse according to "Egyptian General Survey Authority" regulations, the third step was to use the traverse points "fixed points" with total station SOKKIA "cx105" to observe all buildings and details in the institute area, and the final step was to draw the institute using all observatories.At the compulsion between the dimension of the resulted cad drawing and the dimensions of the buildings of institute in nature the accuracy was about ± 2mm which it equal to the accuracy of the used total station. So the observations are accurate.

5.4 Recommendations

Based on our study and result, we recommend the following:

• When accurate reflectorless observations are required, always test the instrument first.

• If feasible, avoid targets with a higher angle of incidence for reflectorless measurement.

• KTH-TSC software can be used to calibrate your instrument by measuring slope distance, horizontal and vertical angles towards targets.

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- Leica Prism Constant,http://geomatics360.com/wpcontent/themes/lifestyle/pdfs/Accessories/Prisms/Leica_Prism_Constant.pdf (visited on June 2012)

- Total Station www.faculty.evc.edu/z.yu/nsf2/Curriculum%20modules/Module%201.pdf (Visited on Feb 2012)
- Trimble Prism Constant, http://www.geosoft.ee/UserFiles/File/Juhendid/Tahhumeetrid/Elta_CU_User.pdf (visited on June 2012

APPENDIX A

TABLE (5-2) points of survey

Point coordinates	**x**	**y**	**z**
46	**34.653**	**26.662**	**13.686**
47	**32.033**	**30.327**	**13.865**
48	**35.601**	**33.234**	**13.795**
49	**35.121**	**33.902**	**13.794**
50	**33.703**	**38.761**	**13.835**
51	**43.473**	**46.745**	**14.574**
52	**41.777**	**47.582**	**13.958**
53	**25.339**	**32.662**	**13.818**
54	**24.98**	**42.082**	**13.804**
55	**20.614**	**44.124**	**13.806**
56	**20.785**	**44.824**	**13.809**
57	**19.716**	**45.4**	**13.81**
58	**17.634**	**46.363**	**13.8**
59	**16.126**	**47.026**	**13.802**
60	**15.384**	**48.593**	**13.798**
61	**12.105**	**50.19**	**13.785**
62	**9.993**	**53.667**	**13.809**
63	**0.421**	**8.79**	**13.79**
64	**-0.841**	**9.958**	**14.024**
65	**0.257**	**36.941**	**24.014**
66	**5.015**	**51.814**	**13.872**

67	**8.794**	**62.101**	**13.812**
68	**8.18**	**64.231**	**14.568**
69	**9.84**	**66.127**	**14.575**
70	**9.642**	**66.842**	**14.974**
71	**65.099**	**-2.237**	**13.222**
72	**64.938**	**12. 728**	**13.853**
73	**66.367**	**-18.164**	**15.003**
74	**63.639**	**-13.799**	**15.319**
75	**64.267**	**-13.459**	**14.944**
76	**68.685**	**-10.903**	**14.797**
77	**70.023**	**-12.11**	**14.79**
78	**76.086**	**-10.281**	**14.817**
79	**79.723**	**-10.931**	**15.006**
80	**56.512**	**2.07**	**15.024**
81	**62.862**	**7.488**	**15.019**
82	**66.354**	**4.66**	**15.187**
83	**68.44**	**8.694**	**15.358**
84	**69.37**	**9.261**	**15.034**
85	**72.959**	**8.468**	**15.035**
86	**78.47**	**9.958**	**14.884**
87	**75.699**	**15.966**	**15.184**
88	**78.839**	**9.21**	**14.822**
89	**74.821**	**4.06**	**14.832**
90	**80.558**	**-10.66**	**14.819**
91	**51.235**	**15.908**	**15.2**
92	**35.063**	**11.198**	**15.017**

93	**85.337**	**-1.245**	**14.73**
94	**64.938**	**5.686**	**15.142**
95	**65.099**	**-2.237**	**13.222**
96	**87.029**	**-3.572**	**16.666**
97	**90.94**	**-7.422**	**16.652**
98	**100.385**	**-17.714**	**16.785**
99	**105.153**	**-19.058**	**16.791**
100	**105.39**	**-18.354**	**15.982**
101	**65.099**	**-1.237**	**13.222**
102	**65.099**	**-10.237**	**13.222**
103	**68.732**	**33.605**	**17.095**
104	**85.337**	**5.686**	**15.142**
105	**79.12**	**18.076**	**18.506**
106	**75.614**	**23.224**	**18.511**
107	**66.877**	**32.362**	**18.639**
108	**64.725**	**35.186**	**18.667**
109	**62.852**	**33.481**	**18.275**
110	**63.49**	**32.546**	**18.259**
111	**59.203**	**29.534**	**18.228**
112	**58.407**	**30.541**	**19.242**
113	**52.658**	**26.305**	**18.387**
114	**65.558**	**41.427**	**18.657**
115	**61.366**	**49.173**	**18.671**
116	**55.345**	**48.337**	**18.642**
117	**60.079**	**51.776**	**18.659**
118	**59.601**	**51.527**	**18.676**

119	**58.556**	**53.818**	**18.678**
120	**57.588**	**55.327**	**18.646**
121	**66.646**	**57.382**	**18.641**
122	**55.917**	**59.197**	**19.789**
123	**54.9**	**61.174**	**19.793**
124	**55.36**	**61.63**	**19.779**
125	**57.272**	**52.822**	**18.645**
126	**68.732**	**33.605**	**17.095**
127	**54.95**	**52.983**	**20.14**
128	**52.224**	**51.125**	**21.281**
129	**48.819**	**48.297**	**21.262**
130	**47.196**	**46.881**	**20.271**
131	**42.713**	**43.573**	**20.501**
132	**35.789**	**41.713**	**21.205**
133	**35.968**	**41.921**	**20.731**
134	**35.304**	**41.821**	**20.906**
135	**36.919**	**44.032**	**20.243**
136	**43.848**	**47.269**	**22.478**
137	**48.219**	**55.149**	**19.826**
138	**50.593**	**61.238**	**20.146**
139	**49.767**	**67.621**	**20.164**
140	**52.473**	**68.591**	**20.155**
141	**49.089**	**75.448**	**20.164**
142	**49.714**	**75.63**	**20.225**
143	**48.994**	**43.801**	**20.098**
144	**42.94**	**39.91**	**20.005**

145	**48.821**	**76.726**	**20.107**
146	**57.272**	**52.822**	**18.645**
147	**46.336**	**79.445**	**21.641**
148	**43.446**	**79.107**	**22.857**
149	**43.634**	**75.954**	**22.135**
150	**46.701**	**76.234**	**22.094**
151	**42.584**	**86.961**	**21.763**
152	**42.728**	**85.292**	**19.873**
153	**38.13**	**102.454**	**21.786**
154	**18.739**	**120.981**	**22.372**
155	**48.821**	**76.726**	**20.107**
156	**34.147**	**86.385**	**26.637**
157	**33.172**	**98.489**	**24.93**
158	**22.207**	**97.401**	**24.936**
159	**23.093**	**84.995**	**26.432**
160	**18.417**	**84.048**	**24.63**
161	**14.175**	**81.974**	**24.642**
162	**11.936**	**75.989**	**27.319**
163	**11.809**	**75.029**	**24.642**
164	**10.56**	**71.199**	**25.323**
165	**10.663**	**70.532**	**25.303**
166	**12.34**	**81.747**	**24.646**
167	**13.992**	**92.146**	**24.762**
168	**16.288**	**102.728**	**25.099**
169	**20.029**	**119.575**	**24.347**
170	**20.346**	**120.442**	**24.343**

171	**20.623**	**121.178**	**24.356**
172	**21.979**	**124.785**	**24.364**
173	**22.359**	**125.359**	**24.341**
174	**22.592**	**126.387**	**24.344**
175	**24.935**	**127.386**	**24.066**
176	**27.59**	**126.564**	**24.136**
177	**32.999**	**114.514**	**23.85**
178	**48.821**	**76.726**	**20.107**
179	**-10.93**	**128.134**	**24.522**
180	**-10.315**	**128.021**	**24.536**
181	**27.739**	**120.981**	**22.372**
182	**19.432**	**119.007**	**26.025**
183	**18.228**	**119.385**	**25.95**
184	**9.903**	**121.571**	**26.076**
185	**-02.845**	**75.644**	**26.074**
186	**9.485**	**75.987**	**28.598**
187	**10.783**	**74.507**	**28.625**
188	**7.15**	**63.775**	**28.999**
189	**5.53**	**64.004**	**28.711**
190	**-10.753**	**65.826**	**25.883**
191	**-19.155**	**13.097**	**28.493**

Engineering standards

- All surveying investigative activity, from planning to field work to production, is carried out in accordance with the Egyptian General Survey Authority (ESA). Furthermore, all Egyptian standards in the field are almost identical to international, European, or foreign standards.

- ESA can be viewed as the Egyptian society's data supply backbone. In reality, it is currently the only governmental body in charge of covering Egypt with basic topographic maps at various scales. It is also in charge of assisting with national cadastre and land registration in collaboration with the Real Estate Office of the Ministry of Justice.Moreover, ESA is a solid candidate in the Egyptian Geography Network (EGN), Egyptts National Geospatial Infrastructure (NSDI). As part of its national mission, ESAA established the Geographic Information Management System (ESA GIM). This article will provide a summary of the main business requirements and obstacles that ESA GIM can help to overcome. It also provides a full explanation of the system built, including the system concept, system architecture, data model, and the various modules that form the system . The proposed system architecture is based on building ESA GIM Data Warehouse, which is the data repository populated from three main data sources: the topographic department, the ECIM (Egyptian Cadastral Information Management) project and the cadastre project in Cairo province.