وزارة التعليم العالي والبحث العلمي

الجامعة التقنية الجنوبية

المعهد التقني العمارة

قسم تقنيات المساحة

Advance Surveying/2

Surveying Department

Second Stage

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تفاصيل المفردات النظرية	الأسبوع
التعريف بطرق قياس الزوايا الافقية والرأسية من خلال الاجهزة الالكترونية(Total Station)	1
قياس إرتفاع نقطة عن بعد (Remote Hight) باستخدام العاكس وبدون عاكس.	2
حساب المسافات المائلة والعمودية بين نقطتين (Tie Distance) وبطريقتين : 1- Polygon. 2-Radial.	3
إيجاد إحداثيات مجموعة نقاط (Reference Element) إذا كان المرجع (خط) Reference Line 1-تسقيط نقطة واحدة . 2-تسقيط مجموعة نقاط بشكل شبكة (Grid) . .	4
Extension : إيجاد نقطة تقع على إمتداد خط مستقيم معلوم .	5
حساب المساحات والحجوم (Area & Volume).	6
التسقيط المساحي (Stakeout)	7
الرفع المساحي (Surveying)	8
التسقيط من خلال خط الانشاء (Construction) وبطريقة Layout . والرفع المساحي(Data collect)	9
كيفية أجراء حسابات التقاطع الاول .	10
كيفية أجراء حسابات التقاطع الثاني .	11
كيفية أجراء حسابات التقاطع الثالث .	12
شبكات الضبط الأفقية، أنواعها، درجاتها، دقتها وطرق تصنيفها، استخداماتها، مدياتها، إنشاء خط قاعدة (Base Line) ، مواصفات نقاط الضبط وكيفية انتخابها.	13
تعلم الطالب كيفية احتساب قوة الشكل لمختلف أنواع الشبكات وشروط تحقيق الزوايا والأضلاع والمحطات، إيجاد أفضل المسارات (R1, R2) من المسارات المحتملة للشبكة التثليثية المختلفة.	14
التصحيحات المتبعة في الشبكات التثليث المختلفة والأشكال ذات النقطة المركزية المختلفة بطرق مختلفة .	15

-الفئة المستهدفة

طلبة المرحلة الثانية في قسم تقنيات المساحة.

اهداف المقرر : ان يكون الطالب بعد دراسته للمقرر قادرا على

أولاً: التعرف جهاز المحطة المتكاملة Total Station

ثانياً: تعلم كافة الحسابات الهندسية التي نحتاجها في تنفيذ الاعمال المساحية

ثالثاً: اتقان شبكات التثليث وتصحيحها

رابعا: ايجاد البيانات المجهولة بأستخدام التقاطعات.

Lecture (1) to (9)

Total Station

Total Station is a lightweight, compact and fully integrated electronic instrument combining the capability of an EDM and an angular measuring instrument such as wild theodolite.

Total Station can perform the following functions:

- Distance measurement
- Angular measurement
- Data processing
- Digital display of point details
- Storing data is an electronic field book.

The important features of total station are,

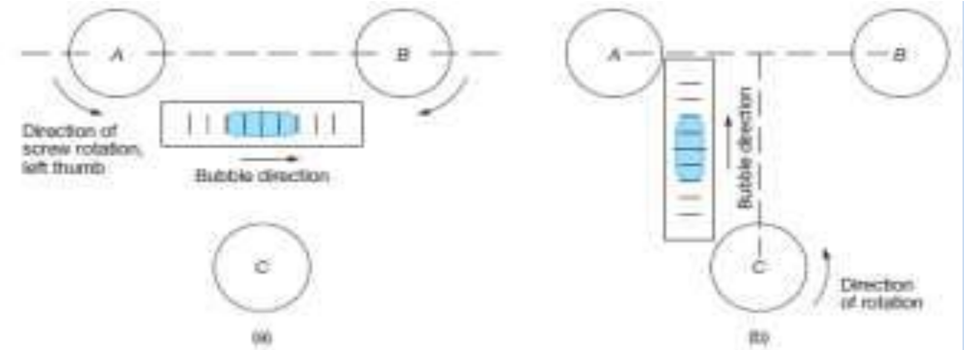
1. Keyboard-control – all the functions are controlled by operating key board.
2. Digital panel – the panel displays the values of distance, angle, height and the Coordinates of the observed point, where the reflector (target) is kept.
3. Remote height object – the heights of some inaccessible objects such as towers can be read directly. The microprocessor provided in the instrument applies the correction for earth's curvature and mean refraction, automatically.
4. Traversing program – the coordinates of the reflector and the angle or bearing on the Reflector can be stored and can be recalled for next set up of instrument.

5. Setting out for distance direction and height -whenever a particular direction and horizontal distance is to be entered for the purpose of locating the point on the ground using a target, then the instrument displays the angle through which the theodolite has to be turned and the distance by which the reflector should move.

Handling and Setting up a Total Station Instrument

A total station instrument should be carefully lifted from its carrying case by grasping the standards or handle, and the instrument securely fastened to the tripod by means of the tribrach. For most surveys, prior to observing distances and angles, the instrument must first be carefully set up over a specific point. The setup process using an instrument with an optical plummet, tribrach mount with circular bubble, and adjustable-leg tripod is accomplished most easily using the following steps: (1) extend the legs so that the scope of the instrument will be at an appropriate elevation for view and then adjust the position of the tripod legs by lifting and moving the tripod as a whole until the point is roughly centered beneath the tripod head2 (beginners can drop a stone from the center of the tripod head, or use a plumb bob to check nearness to the point); (2) firmly place the legs of the tripod on the ground and extend the legs so that the head of the tripod is approximately level; repeat step (1) if the tripod head is not roughly centered over the point; (3) roughly center the tribrach leveling screws on their posts; (4) mount the tribrach approximately in the middle of the tripod head to permit maximum translation in step (9) in any direction; (5) focus the plummet properly on the point, making sure to check and remove any parallax; (6) manipulate the leveling screws to aim the plummet's pointing device at the point below; (7) center the circular bubble by adjusting the lengths of the tripod extension legs; (8) and levelthe instrument using the plate bubble and leveling screws; and (9) if necessary, loosen the tribrach screw and translate the instrument (do not rotate it) to carefully center the plummet'spointing device on the point; (10) repeat steps (8) and (9) until precise leveling and centering are accomplished. With total stations that have their plummets in the tribrach, the instrument can and should be left in the case until step (8). The videos ***Leveling an Instrument*** and ***Centering an Instrument over a Point***, which are available on the companion website of this book, demonstrate the process of leveling an instrument and setting an instrument with an optical plummet and adjustable leg tripod over a point.

To level a total station instrument that has a plate-level vial, the telescope is rotated to place the axis of the level vial parallel to the line through any two leveling screws, such as the line through *A* and *B* in Figure 8.4(a). The bubble is centered by turning these two screws, then the instrument is rotated 90°, as shown in Figure 8.4(b), and centered again using the third screw (*C*) only. This process is repeated in the initial two positions and carefully checked to ensure that the bubble remains centered. As illustrated in Figure below, ***the bubble moves in the direction of the left thumb when the foot screws are turned***. A solid tripod setup is essential, and the instrument must be shaded if set up in bright sunlight. Otherwise, the bubble will expand and run toward the warmer end as the liquid is heated.



Bubble centering with three-screw leveling head.

Many instruments do not have traditional level vials. Rather, they are equipped with an electronic, dual-axis leveling system in which four probes sense a liquid (horizontal) surface.
After preliminary leveling is performed by means of the tribrach's circular bubble, signals from the probes are processed to form an image on the LCD, which guides an operator in performing rough leveling. The three leveling screws are used, but the instrument need not be turned about its vertical axis in the leveling process. After rough leveling, the amount and direction of any residual dislevelment is automatically and continuously received by the microprocessor, which corrects observed horizontal and vertical angles accordingly in real time. As noted earlier, total stations are controlled with entries made either through their built-in keypads or through the keypads of handheld data collectors. They are covered in the manuals provided with the purchase of instruments. When moving between setups in the field, proper care should be taken. Before the total station is removed from the tripod, the foot screws should be returned to the midpoints of the posts. Many instruments have a line on the screw post that indicates the halfway position. The instrument should NEVER be transported on the tripod since this causes stress to tripod head, tribrach, and instrument base.

Total Stations, with their micro processors, can perform a variety of functions and computations, depending on how they are programmed. The capabilities vary with differentinstruments, but some standard computations include:

• Averaging multiple angle and distance measurements.

• Correcting electronically measured distances from prism constant, atmospheric pressure, and temperature.

• Making curvature and refraction corrections to elevations determine by trigonometric levelling.

• Reducing slope distances to their horizontal and vertical components.

• Calculating point elevations from the vertical distance components (supplemented with keyboard input of instrument and reflector heights).

Averages multiple **angle** measurements.

o **Averages** multiple **distance** measurements.

o Computes **horizontal** and **vertical distances.**

o **Corrections** for temp, pressure and humidity.

o **Computes** inverses, polars, resections.

o **Computes** X, Y and Z **coordinates.**

• Computing coordinates of survey points from horizontal angle and horizontal distance.

Operation of Total Station

Because the Total Station contains delicate electronic components they are not as rugged as ordinary Theodolite. They must be packed and transported carefully, handled gently and carefully removed form their cases.

The setting of Total Station over the station mark is similar to an ordinary Theodolite. This Includes.

• Centering
• Levelling
• Removal of parallax

Total Stations are controlled with entries made either through their built-in keyboards or through the keyboards of hand-held data collectors.Details for operating each individual total station vary somewhat and therefore are not described here.

The accuracy achieved with total station is mainly depends on operator procedure of Careful centering and levelling of the instrument

• Accurate pointing at targets.
• Taking averages of multiple angle measurements made in both direct and reverse positions

Peripheral equipment that can affect accuracy includes

• Tribrachs
• Optical plummets
• Prism and
• Prism poles

Tribrachs must provide a snug fit without slippage. Optical plummets that are out of adjustment cause instruments to be set up erroneously over the measurement point. The prism poles should be perfectly vertical and prism should be well fitted on that. Prisms should be checked frequently to determine their constants.

Applications of Total Station

There are many other facilities available, the total station can be used for the following purposes.

- Detail survey i.e., data collection.
- Control Survey (Traverse).
- Height measurement (Remove elevation measurement- REM).
- Fixing of missing pillars (or) Setting out (or) Stake out.
- Resection.
- Area calculations, etc.
- Remote distance measurement (RDM) or Missing line measurement (MLM).

Data Collection Option

Measurements can be stored "on board" with all the total stations. The two options that are available are

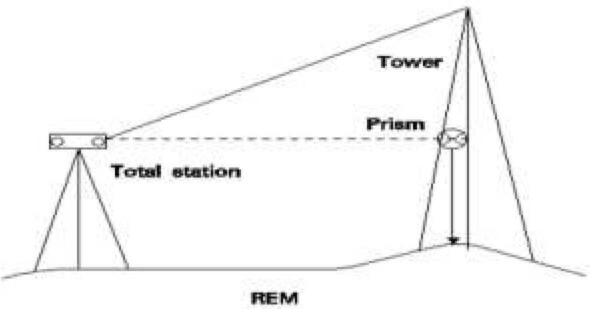
- Data can be stored directly in the memory of the microcomputer, and later downloaded to an external storage device via a RS – 232 connections.
- The second option is the removable memory card. When one card is full, it can be removed and another card can be quickly installed.

Detail Survey

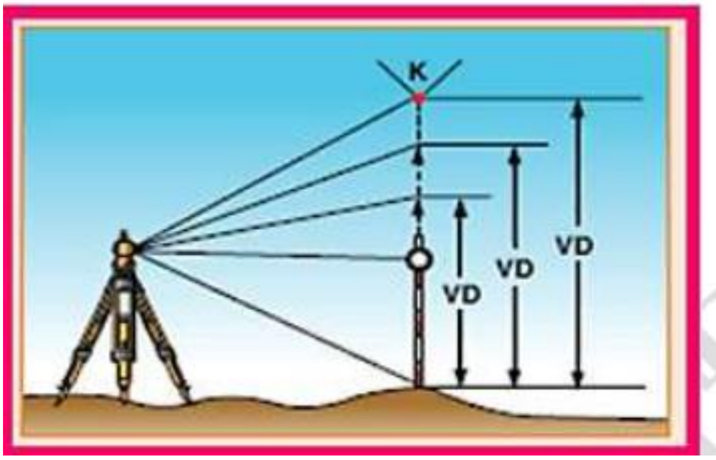
Given two points whose coordinates are known, a total station can be used to get the coordinates of various other points based upon those two co-ordinates. Care should be takenthat the new points survey are carefully coded. The Map of the area can be obtained afterdownloading and processing.

Remote Elevation Measurement (REM)

The process of finding the height of objects without actually going to the top of the object is known as Remote Elevation Measuring (REM) i.e., a total station placed remotely (faraway) from the object is used to measure the heights.

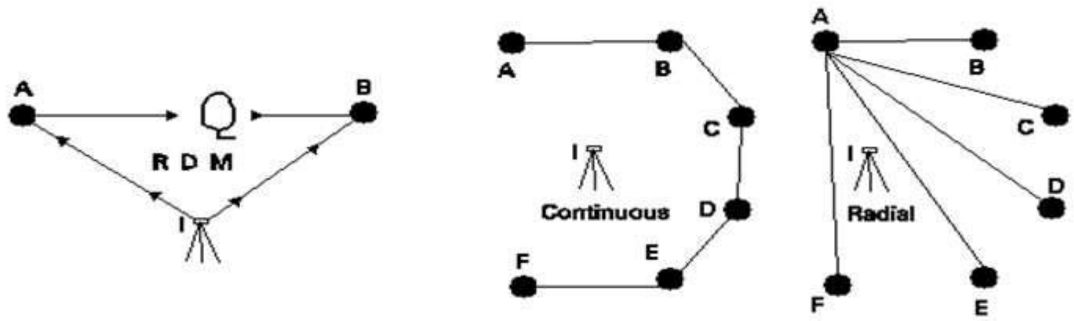


Method: The prism is kept at the base of the object sight the telescope to the prism, and measure the slope distance 'd', now tilt the telescope up-to the tip of the object. The height of the object is displayed, from the bottom of the prism depending upon the instrument. This feature measures the elevation of a point where a prism can not be placed directly. The measurement is extended along the plumb line while the elevation is continuously displayed



Remote distance measurement (RDM) or Missing line measurement (MLM):
The process of finding the distance between two points A & B (which are not inter-visible from each other) from another point 'I' (instrument position) is known as RDM.
This method is very useful for finding distances between two points which has an obstruction between them. It is of two types:

- Continuous
- Radial



Distances can be obtained either in the **continuous mode** i.e., AB, BC,CD, DE,EF etc., or in the **radial mode** i.e., AB,AC,AD,AE,AF etc., however, the field procedure is same for both only the selection of operation varies. This is required when there are obstructions in between survey line.

Fixing of missing pillars (or) Setting out (or) Stake out:

The process of fixing missing pillars on the ground using its theoretical coordinates is known as STAKE OUT. Here two other known coordinates are required.

• Process of finding the positions of known coordinates points e.g. missing boundary pillars.

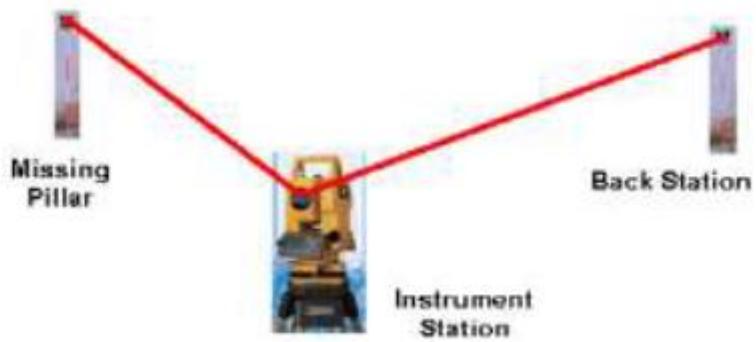


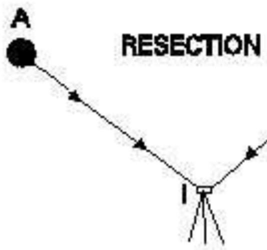
Figure 7: Stake Out

Surveying by coordinate measurement

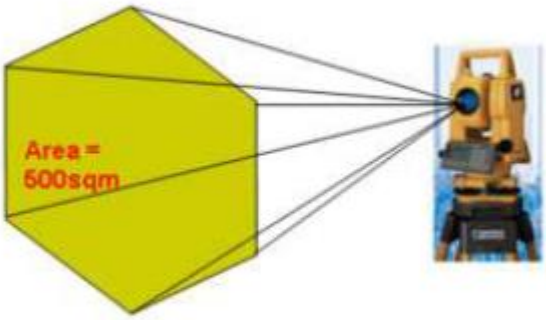
The coordinates of an unknown point relative to a known coordinate can be determined usingthe total station as long as a direct line of sight can be established between the two points.Angles and distances are measured from the total station to points under survey, and the coordinates (X, Y, and Z or easting, northing and elevation) of surveyed points relative to thetotal station position are calculated using trigonometry and triangulation. To determine anabsolute location a Total Station requires line of sight observations and can be set up over a known point or with line of sight to 2 or more points with known location called Resection

Resection:

The process of finding the coordinate of the instrument position making use of other control points (points whose coordinates are known) is known as RESECTION



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.



Uses of Total Station

The uses of Total Station are as follows:

- Mine Survey
- Cadastral Survey
- Engineering Survey
- Large Scale Survey
- Road / Rail / Canal Survey

Some total stations also have a **GNSS interface** which combines the advantages of these two technologies (GNSS – line of sight not required between measured points; Total Station – high precision measurement especially in the vertical axis compared with GNSS) and reduce the consequences of each technology's disadvantages (GNSS – poor accuracy in the vertical axis and lower accuracy without long occupation periods; Total Station – requires line ofsight observations and must be set up over a known point or with line of sight to 2 or more points with known location).

Surveying by Total Station

Total station surveying - defined as the use of electronic survey equipment used to perform horizontal and vertical measurements in reference to a grid system (e.g. UTM, mine grid).

Types of Total Station Surveying

➢ Slope Staking

➢ Topographic surveys
➢ Construction project layout
- building corners
- control and offset lines

➢ Leveling
➢ Traverse surveys and adjustments
➢ Building Face Surveys
➢ Resections
➢ Areas
➢ Intersections
➢ Point Projections
➢ Taping from Baseline
➢ Road (Highway) Surveys

CONSTRUCTION SURVEYS USING TOTAL STATION INSTRUMENTS

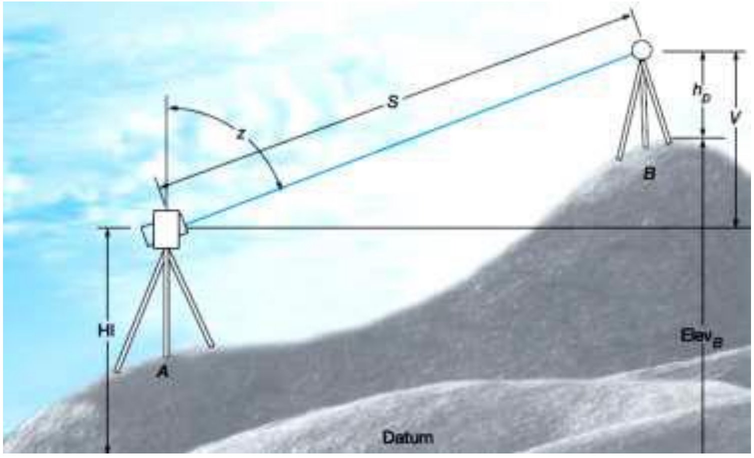
The procedures described here apply to most total station instruments, although some may require interfaced data collectors to perform the operations described. Before using a total station for stakeout, it is necessary to orient the instrument. Depending on the type of project,*horizontal* or both *horizontal and vertical* orientation may be needed. For example, if just thelot corners of a subdivision are being staked, then only horizontal orientation (establishing the instrument's position and direction of pointing) is needed. If grade stakes are to be set, then the instrument must also be oriented vertically (its *HI* determined).

With total station instruments, three methods are commonly used for horizontal orientation: (1) *azimuth*, (2) *coordinates*, and (3) *resection*. The first two apply where an existing control point is occupied, and the latter is used when the instrument is set up at a noncontrol point.In azimuth orientation, the coordinates of the occupied control station and the known azimuth to a backsight station are entered into the instrument. If the occupied station's coordinates have been downloaded into the instrument prior to going into the field, it is only necessary to input its point number. The backsight station is then sighted, and when completed, the azimuth of the line is transferred to the total station by a keyboard stroke, whereupon it appears in the display.

The coordinate method of orientation uses the same approach, except that the coordinates of both the occupied and the backsight station are entered. Again these data could have been downloaded previously so that it would only be necessary to key in the numbers identifying the two stations. The instrument computes the backsight line's azimuth from the coordinates, displays it, and prompts the operator to sight the backsight station. Upon completion of the backsight, the azimuth is transferred to the instrument with a keystroke and it appears on the display.

In the resection procedure, a station whose position is unknown is occupied and the instrument's position determined by sighting two or more control stations. This is very convenient on projects where a certain point of high elevation in an open area gives good visibility to all (or most) points to be staked. As noted, two or more control points must be sighted. Observations of angles, or of angles and distances, are made to the control stations. The microprocessor then computes the instrument's position.

Project conditions will normally dictate which orientation procedure to use. Regardless of the procedure selected, after orientation is completed, a check should be made by sighting another control point and comparing the observed azimuth and distance against their known values. If there is a discrepancy, the orientation procedure should be repeated. It is also a good idea to recheck orientation at regular intervals after stakeout has commenced, especially on large projects. In fact, if possible a reflector should be left on a control point just for that purpose.



Vertical orientation of a total station (i.e., determining its *HI*) can be achieved using one of two procedures. The simplest case occurs if the elevation of the occupied station is known, as then it is only necessary to *carefully* measure and add the *hi* (height of instrument above the point) to the elevation of the point. If the occupied station's elevation is unknown, then another station of known elevation must be sighted. The situation is illustrated in Figure, where the instrument is located at station *A* of unknown elevation, and station *B* whose elevation is known is sighted. From slope distance *S* and zenith angle *z* the instrument computes *V*. Then its *HI* is

$$HI = elev.B + hr - V$$

where hr is the reflector height above station *B.* As with horizontal orientation, it is a good practice to check the instrument's vertical orientation by sighting a second vertical control point. Once orientation is completed, project stakeout can begin. In general, staking is either a two- or three-dimensional problem. Staking lots of a subdivision or layout of horizontal construction alignments is generally two dimensional. Slope staking, blue-top setting, pipeline layout, and batter-board placement require both horizontal position and elevation and are therefore three dimensional. For two-dimensional stakeout, after the file of coordinates for all control stations and points to be staked is downloaded and the instrument is oriented horizontally, the identifying number of a point to be staked is entered into the instrument through the keyboard. The microprocessor immediately calculates the horizontal distance and azimuth required to stake the point. The difference between the instrument's current direction of pointing and that required is displayed. The operator turns the telescope until the difference becomes zero to achieve the required direction. With total stations having robotic capabilities, the instrument will swing in direction to the proper azimuth without any further operator intervention..Following azimuth alignment, the distance to the point must be laid out. To do this, the reflector is directed onto the azimuth alignment and a horizontal distance reading taken, whereupon the difference between it and that required is displayed. The reflector is then directed inward or outward, as necessary, until the distance difference is zero and the stake placed there.

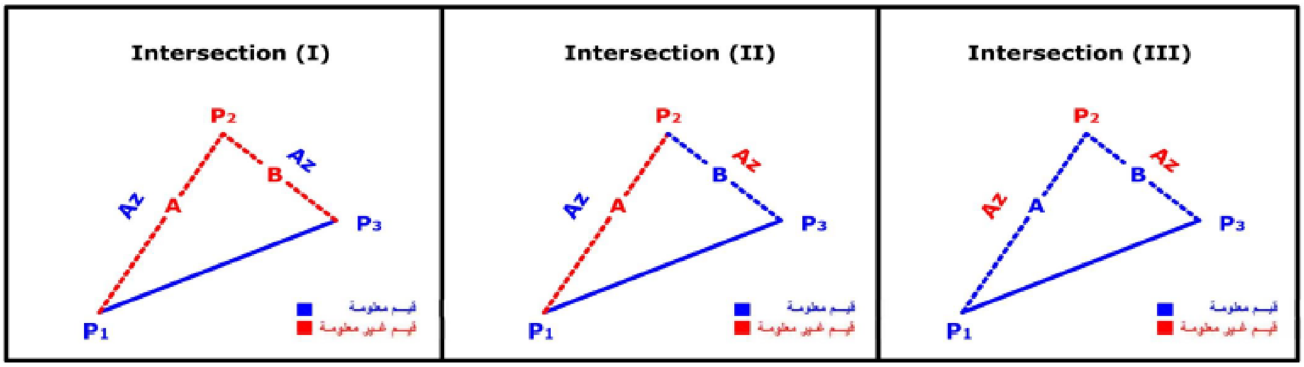
Lecture (10)

(Intersections or Omitted Measurement) التقاطعات أو القياسات المجهولة

في كافة الاعمال المساحية يحدث أن تعرقل عملية المسح بعض المعوقات ، سواء كانت هذه المعوقات للرؤيا أو للقياس ، وتتضح هذه المشاكل جلياً في أعمال التضليع للمضلعات الكبيرة وأعمال تقسيم الاراضي ، فضلا عن المضلعات الناتجة من حسابات المحطات الرئيسة للمنحنيات الافقية .. وغيرها . وقد لا تكون هنالك عوائق، بل العمل الحقلي يحتم علينا عمل هذه الحسابات بمقابل ضياع الوقت والجهد المبذول.

في الغالب تتفاوت المجاهيل في حسابات التقاطعات بين أن تكون أطوال أو إتجاهات مجهولة ، وتلافيا للإشكالات وحدوث الاخطاء فقد تم تقسيم تلك الحسابات الى ثلاثة أقسام ، وسميت مجازيا بما يلي :

- التقاطع الاول (Intersection I) .
- التقاطع الثاني (Intersection II) .
- التقاطع الثالث (Intersection III) .



Intersections I

هنالك ثلاثة طرق لحساب المجاهيل في هذا النوع من التقاطعات :

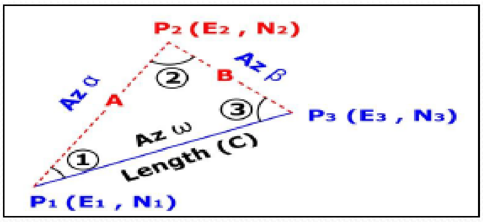
أولاً : طريقة المثلثات (Triagnometric Method) :

يستخدم في هذه الطريقة قانون الجيوب (Sin Law) . وكما يلي :

١- يحسب إتجاه الضلع ($P_1 \rightarrow P_3$) ($Az\ \omega$) وطوله (C) بالعلاقتين التاليتين : :

$$Az\ \omega = \tan^{-1}\left(\frac{E_3 - E_1}{N_3 - N_1}\right)$$

$$Length\ (C) = \left(\frac{E_3 - E_1}{Sin\ Az\ \omega}\right) = \left(\frac{N_3 - N_1}{Cos\ Az\ \omega}\right)$$



٢- تحسب الزوايا الداخلية للمثلث ، وهي : (<1 , <2 , <3)

- الاتجاهان (α,ω) لحساب (<1) .
- الاتجاهان (α, β) لحساب (<2) .
- الاتجاهان (ω, β) لحساب (<3) .

٣- يحسب طولا الضلعين المجهولين (A , B) بإستخدام قانون الجيوب (Sin Law) ، وكما يلي :

$$\frac{A}{Sin\ <3} = \frac{B}{Sin\ <1} = \frac{C}{Sin\ <2}$$

٤- يحسب موقع النقطة (P_2) (E_2 , N_2) بإستخدام الحسابات الامامية ، وكما يلي :

$$E_2 = E_1 + A \cdot \sin(Az\ \alpha) \quad , \quad N_2 = N_1 + A \cdot \cos(Az\ \alpha)$$

٥- يتم التحقق من النقطة (P_3) بإستخدام الحسابات الامامية ، وكما يلي :

$$E_3 = E_2 + B \cdot \sin(Az\ \beta) \quad , \quad N_3 = N_2 + B \cdot \cos(Az\ \beta)$$

ثانياً : طريقة قوانين التضليع (Travers Equations Method) :

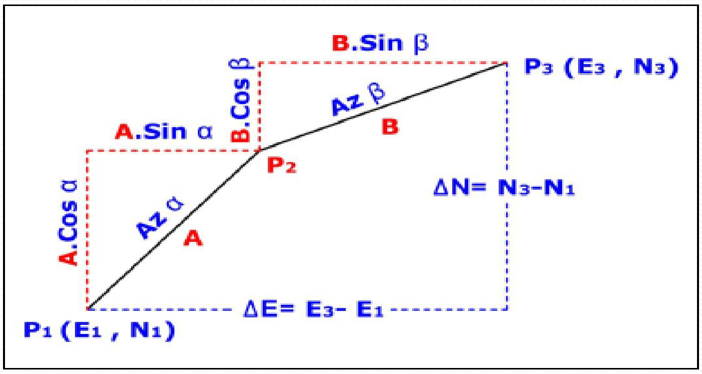
تستخدم في هذه الطريقة المفاهيم المستخدمة في التضليع وبالتحديد (المركبات الافقية والرأسية) لأيجاد أطوال الاضلاع المجهولة (A , B) ، وكما في المعادلات و الشكل التالي :

$$\Delta E = A \cdot \sin\alpha + B \cdot \sin\beta$$

$$\Delta N = A \cdot \cos\alpha + B \cdot \cos\beta$$

$$A = \frac{\Delta E \cdot \cos\beta - \Delta N \cdot \sin\beta}{\sin(\alpha - \beta)}$$

$$B = \frac{\Delta E \cdot \cos\alpha - \Delta N \cdot \sin\alpha}{\sin(\beta - \alpha)}$$



ثالثا : طريقة الهندسة التحليلية (Analytic Geometry Method) :

نظراً لكون الضلعين معلومي الاتجاه يمثلان خطين مستقيمين متقاطعين في نقطة ، فإنه من منظور الهندسة التحليلية بحل معادلتي هذين المستقيمين آنياً يمكن الحصول على إحداثيات نقطة تقاطعهما ، ولأن هذه الطريقة تعطي إحداثيات النقطة بشكل مباشر وبخطوة واحدة فإنها الطريقة المحبذة في حسابات هذا النوع من التقاطعات . أما العلاقات الرياضية لهذه الطريقة كما يلي :

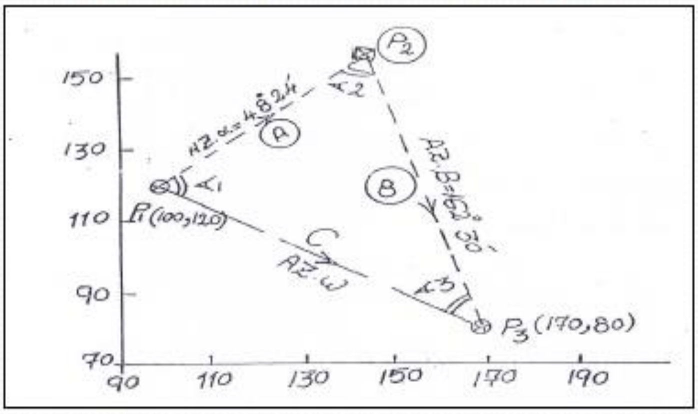
$$N_2 = \frac{(E_3 - E_1) + N_1 \cdot \tan\alpha - N_3 \cdot \tan\beta}{\tan\alpha - \tan\beta}$$

$$E_2 = E_1 + (N_2 - N_1)\tan\alpha$$

$$B = \frac{(E_3 - E_2)}{\sin Az\ \beta} = \frac{(N_3 - N_2)}{\cos Az\ \beta}$$

$$A = \frac{(E_2 - E_1)}{\sin Az\ \alpha} = \frac{(N_2 - N_1)}{\cos Az\ \alpha}$$

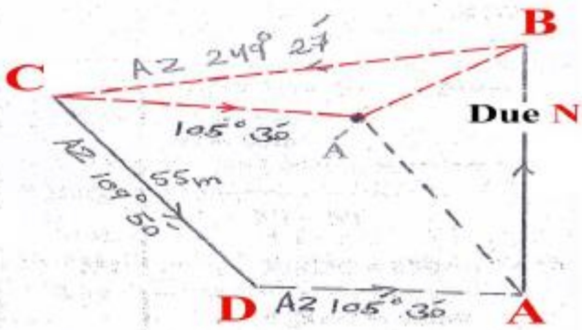
Ex : Find the lengths (A , B) and the Coords. Of point (P2) for the fig. Below . By a different methods :



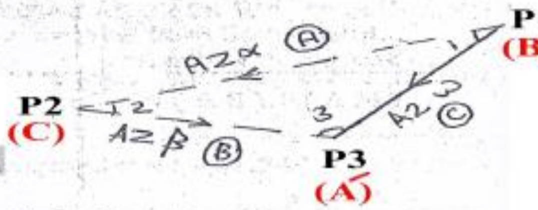
Sol :

* Compute the coordinates of points B,C,D of traverse ABCD , A = (850,300)
B = (850,400)
* Solution *

* $E\bar{A} = EA + L \sin Az\,(109^\circ\,50' + 180^\circ)$
* $E\bar{A} = 850 + 55 * \sin(289^\circ\,55') = 798.26$ m
* $N\bar{A} = 300 + 55 \cos(289^\circ\,55') = 318.66$ m



* $\text{Berg } w = \tan^{-1} \dfrac{E_3 - E_1}{N_3 - N_1}$
* $\text{Berg } w = \tan^{-1} \dfrac{798.26 - 850}{318.60 - 400}$
* Berg w = S 32° 28′ W
* **Azw = 212° 28′**
* $\text{Length } C = \sqrt{(\Delta E)^2 + (\Delta N)^2}$
* **Length C** $= \sqrt{(-51.74)^2 + (-81.34)^2}$ = **96.40 m**



* $\angle 1 = Az\alpha - Azw = 249^\circ\,27' - 212^\circ\,28' = 36^\circ\,59'$
* $\angle 2 = Az\beta - B.Az\alpha = 105^\circ\,30' - (249^\circ\,27' - 180^\circ) = 36^\circ\,03'$
* $\angle 3 = Azw - Az\beta = 212^\circ\,28' - 105^\circ\,30' = 106^\circ\,58'$

$\sum$ Angles Δ = 180

$$\frac{C}{\sin \angle 2} = \frac{A}{\sin \angle 3} = \frac{B}{\sin \angle 1}$$

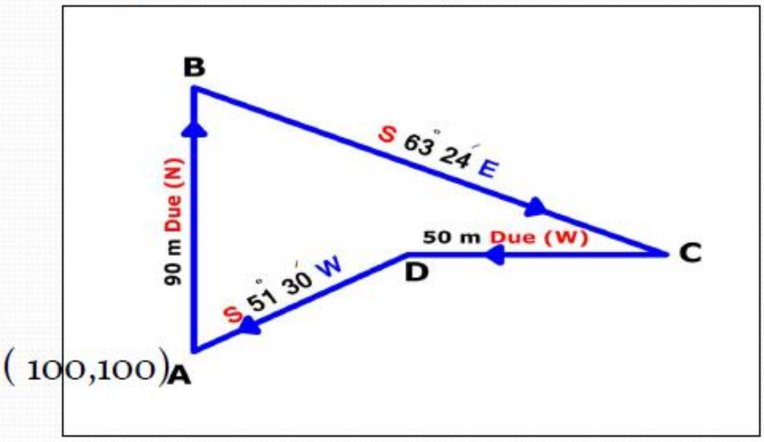
$< 3 = 360 - (\text{Back } Az\ \beta - \text{Fore } Az\ \omega)$ طريقة الرسم

$\text{Fore } Az\ \omega = \text{Back } Az\ \beta + < 3$ الطريقة الرياضية

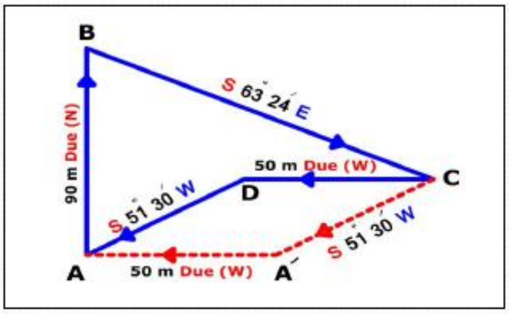
* $A = \dfrac{C}{\sin \angle 2} \times \sin \angle 3 = \dfrac{96.40}{\sin 36^\circ\,03'} \times \sin 106^\circ\,58'$ = **156.88 m**
* $B = \dfrac{96.40}{\sin 36^\circ\,03'} \times \sin 36^\circ\,59'$ = **98.54 m**

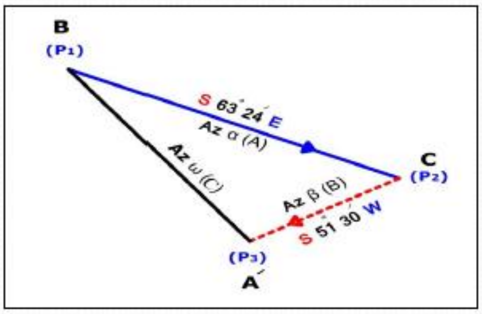
ملاحظة : طريقة العمل تكون كما يلي :
النقطة المعلومة الاولى يحرك لها الضلع المعلوم (الطول والإتجاه) والثانية يتم وصلها بالضلع المعلوم (الاتجاه) .

Home Work : Compute the missing lengths & Coords. of traverse points



Sol :





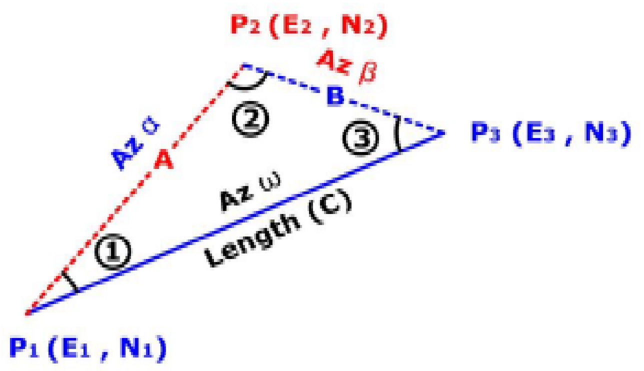
Lecture (11)

Intersections (II)

- التقاطع الثاني (II) Intersection :

يمثل هذا التقاطع هندسيا بتقاطع خطين مستقيمين أحدهما معلوم الطول والثاني معلوم الاتجاه ، وبالتالي فإنه بمعلومية ميل أحدهما وطول الاخر يمكن تحديد نقطة تقاطعهما المجهولة (P_2) .

ولتبسيط هذا النوع من التقاطعات ، في حال عدم تجاور الاضلاع الحاوية على المجاهيل (كما في الاشكال الرباعية والخماسية والسداسية .. وغيرها) يتم رسم موازيات بحسب الحالة المتوفرة بهدف تكوين حالة التقاطع الثاني ، بحيث يكون الضلعين الحاويين على تلك المجاهيل متجاوران وتشكل نقطتي بدايتيهما خطاً معلوما بالاسم (P_1 , P_3) ويتقاطعان من طرفهما الاخر في النقطة المجهولة (P_2) . وكما في الشكل التالي :



Known :

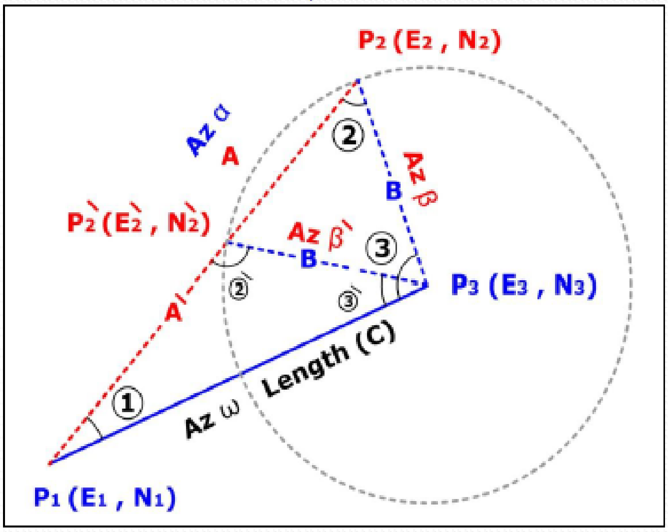
- Position of (P_1) : (E_1 , N_1)
- Position of (P_3) : (E_3 , N_3)
- Dirdction of (P_1 >>> P_2) : Az α
- Length (P_2 >>> P_3) : B

Required :

- Position of (P_2) : (E_2 , N_2)
- Length (P_1 >>> P_2) : A
- Dirdction of (P_2 >>> P_3) : Az β

٤- تحسب الزاوية الثالثة للمضلع (3>) وتساوي : $\boxed{<3 = 180 - (<1 + <2)}$

هنا يجب التنبيه الى أمر ، وهو : أن الضلع المعلوم الطول (B) يحتمل إتجاهين ، وكما في الشكل :



٥- يتم إيجاد (’2 >) وتساوي : $\boxed{<2' = 180 - <2}$

٦- يتم إيجاد (’3 >) وتساوي : $\boxed{<3' = 180 - (<1 + <2')}$

٧- يتم إيجاد $\boxed{Az\,\beta \quad , \quad Az\,\beta'}$ من خلال العلاقات التالية :

$$\boxed{Az\,\beta' = Back\,Az\,\alpha \pm <2'} \qquad \boxed{Az\,\beta = Back\,Az\,\alpha \pm <2}$$

٨- يحسب طول $\boxed{A\,,A'}$ بإستخدام قانون الجيوب (Sin Law) :

$$\boxed{\frac{B}{Sin\,<1} = \frac{A}{Sin\,<3} = \frac{A'}{Sin\,<3'}}$$

٩- يحسب موقع (P2) من خلال $\boxed{Az\,\alpha\,/\,A\,/\,P_1}$ ويتم التحقق من (P3) بواسطة $\boxed{Az\,\beta\,/\,B\,/\,P_2}$

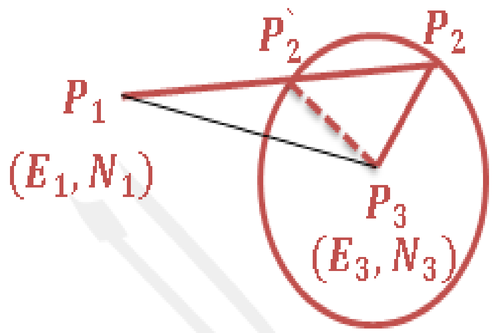
١٠- يحسب موقع (P2’) من خلال $\boxed{Az\,\alpha\,/\,A'\,/\,P_1}$ ويتم التحقق من (P3) بواسطة $\boxed{Az\,\beta'\,/\,B\,/\,P_2'}$.

١١- يتم إختيار أحد الاحتمالين اعلاه وبما نطبق مع رسم المضلع على الورق ، أو الواقع الحقلي لمخطط الموقع .

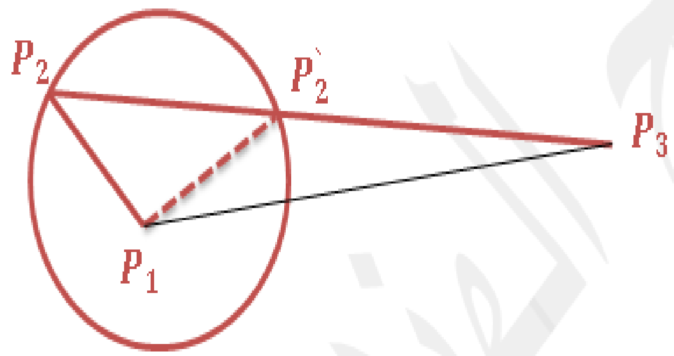
والشكل التالي يوضح المفهوم العام للتقاطع الثاني .

Intersection(II): two lengths of side and Azimuth on other are unknown

الحالة الاولى: يكون اتجاه الضلع الاول وطول الضلع الثاني معلومات



الحالة الثانية: اذا كان طول الضلع الاول واتجاه الضلع الثاني معلومات



*Known

1- $P_1((E_1, N_1), P_3((E_3, N_3)$

2- $AZ.\alpha, \beta$

(Intersections II)

$Az_{BC} = 90^o - 72^o\,10' = 17^o\,50'$

$Az_{CD} = (17^o\,50' + 180^o) - 107^o\,50' = 90^o$

Coords. Of (B) : (215 , 350)

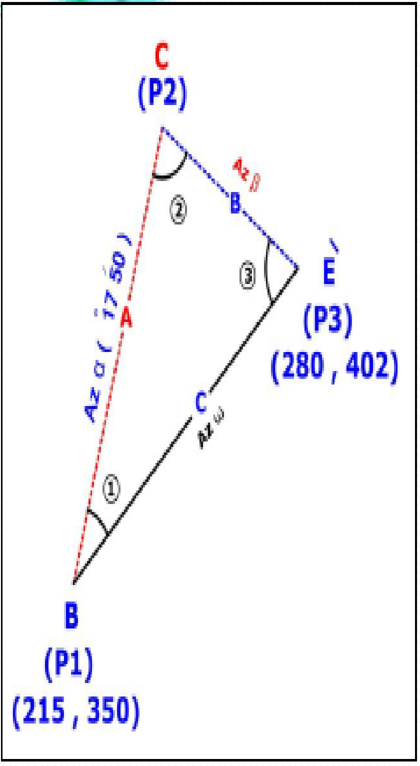
Coords. Of (E) : (340 , 402)

Coords. Of (E') : (280 , 402)

$Az\ \omega = \tan^{-1}(\frac{E_3 - E_1}{N_3 - N_1}) \rightarrow \tan^{-1}(\frac{280-215}{402-350}) = 51^o\,20'$

$C = \sqrt{(280-215)^2 + (402-350)^2} = 83.24\ m$

$< 1 = Az\ \omega - Az\ \alpha \rightarrow 51^o\,20' - 17^o\,50' = 33^o\,30'$



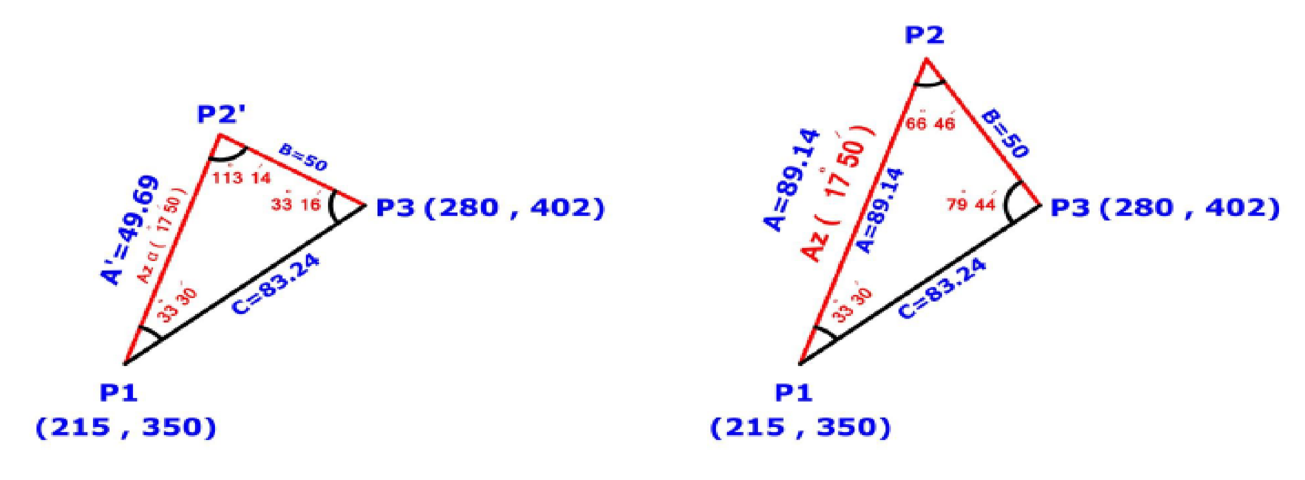
By Sin Law :

$\frac{B}{Sin <1} = \frac{C}{Sin <2} \rightarrow \frac{50}{Sin\,33^o\,30'} = \frac{83.24}{Sin <2} \rightarrow Sin < 2 = 0.92 \rightarrow < 2 = 66^o\,46'$

$< 3 = 180^o - (< 1 + < 2) \rightarrow 180^o - (33^o\,30' + 66^o\,46') = 79^o\,44'$

$\frac{50}{Sin\,33^o\,30'} = \frac{A}{Sin\,79^o\,44'} = 89.14\ m$

$Az\ \beta = Back\ Az\ \alpha - < 2 \rightarrow (17^o\,50' + 180^o) - 66^o\,46' = 131^o\,04'$



$< 2' = 180^o - < 2 \rightarrow 180^o - 66^o\ 46' = 113^o\ 14'$

$< 3' = 180^o - (< 1 + < 2') \rightarrow 180^o - (33^o\ 30' + 113^o\ 14') = 33^o\ 16'$

$$\frac{50}{Sin\ 33^o\ 30'} = \frac{A'}{33^o\ 16'} = 49.69\ m$$

$Az\ \beta' = Back\ Az\ \alpha - < 2' \rightarrow (17^o\ 50' + 180^o) - 131^o\ 04' = 84^o\ 36'$

Coords. Of P_2 :

$E_{P_2} = E_{P_1} + A\,.Sin\ Az\ \alpha \rightarrow 215 + 89.41\ Sin\ 17^o\ 50' = 242.30\ m$

$N_{P_2} = N_{P_1} + A\,.Cos\ Az\ \alpha \rightarrow 350 + 89.41\ Cos\ 17^o\ 50' = 434.86\ m$

Check P_3 From P_2 :

$E_{P_3} = E_{P_2} + B\,.Sin\ Az\ \beta \rightarrow 242.30 + 50\ Sin\ 131^o\ 04' = 280\ m$

$N_{P_3} = N_{P_2} + B\,.Cos\ Az\ \beta \rightarrow 434.86 + 50\ Cos\ 131^o\ 04' = 402\ m$

...... Checked ......

Coords. Of P_2 ' :

$E_{P_2}' = E_{P_1} + A'.Sin\ Az\ \alpha \rightarrow 215 + 49.69\ Sin\ 17^o\ 50' = 230.22\ m$

$N_{P_2}' = N_{P_1} + A'.Cos\ Az\ \alpha \rightarrow 350 + 49.69\ Cos\ 17^o\ 50' = 397.30\ m$

Check P_3 From P_2 ':

$E_{P_3} = E_{P_2}' + B\,.Sin\ Az\ \beta' \rightarrow 230.22 + 50\ Sin\ 84^o\ 36' = 280\ m$

$N_{P_3} = N_{P_2}' + B\,.Cos\ Az\ \beta' \rightarrow 397.30 + 50\ Cos\ 84^o\ 36' = 402\ m$

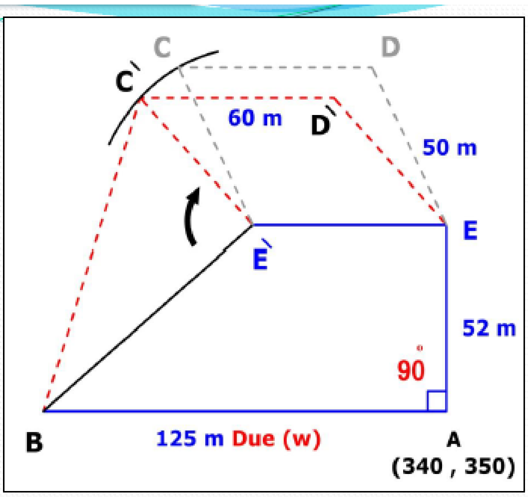
...... Checked ......

Coords. Of (C) (P2) : (242.30 , 434.86)

Coords. Of (C ') (P2') : (230.22 , 397.30)

Coords. Of (D) From (C) : (302.30 , 434.86)

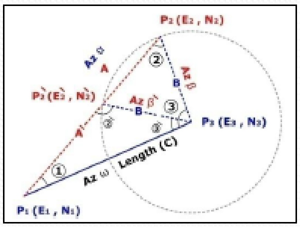
Coords. Of (D') From (C ') : (290.22 , 397.30)



ength of DE :

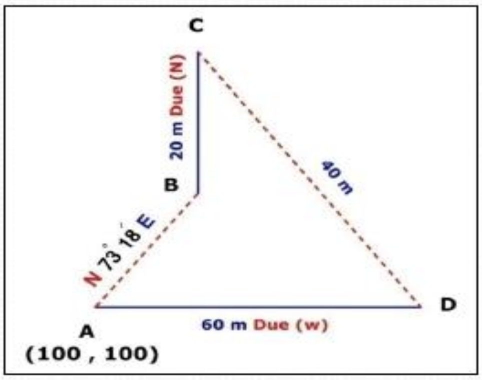
$$D - E = \sqrt{(340 - 302.3)^2 + (402 - 434.86)^2} = 50.01\ m$$

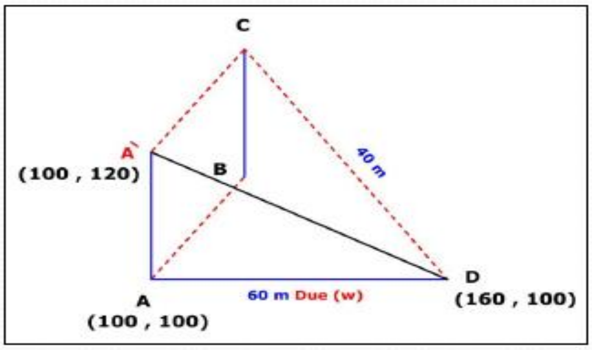
$$D' - E = \sqrt{(340 - 290.22)^2 + (402 - 397.3)^2} = 50.00\ m$$

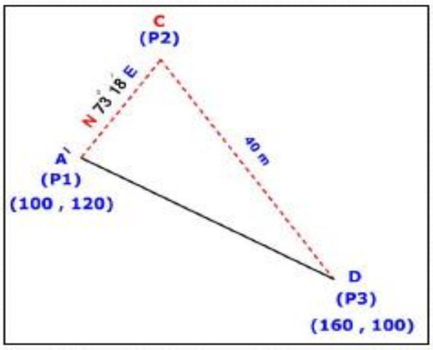


وهذا يعني أنه إذا تبين إختلاف في طول الضلع لأحدى الحسابات عن (**50 m**) فإن النقطة المحسوبة منها تهمل

Home work : Find the Coords. of the following TraversePoints by a triagnometric method :





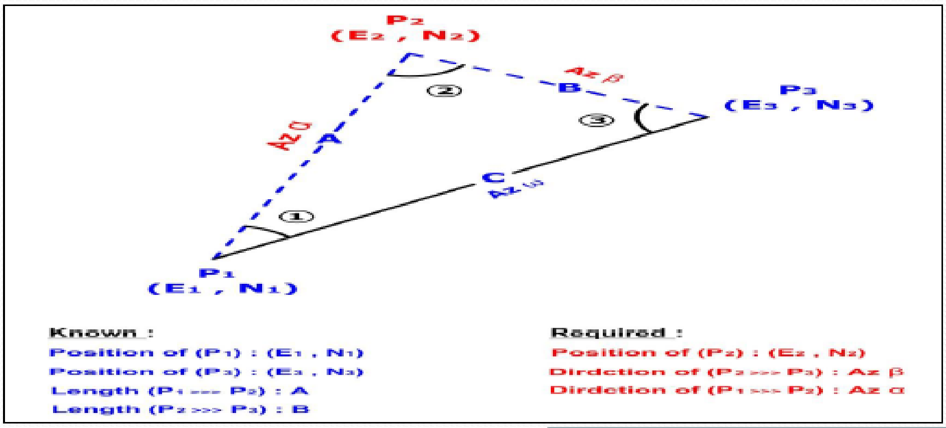


Lecture(12)

- التقاطع الثالث (Intersection (III :

يمثل هذا التقاطع هندسيا بتقاطع خطين مستقيمين معلومي الطول ومجهولي الاتجاه ، وبالتالي فإنه بمعلومية طوليهما يمكن تحديد نقطة تقاطعهما المجهولة (P_2) .

ولتبسيط هذا النوع من التقاطعات ، في حال عدم تجاور الاضلاع الحاوية على المجاهيل (كما في الاشكال الرباعية والخماسية والسداسية .. وغيرها) يتم رسم موازيات بحسب الحالة المتوفرة بهدف تكوين حالة التقاطع الثالث ، بحيث يكون الضلعين الحاويين على تلك المجاهيل متجاوران وتشكل نقطتي بدايتيهما خطاً معلوما بالاسم (P_1 , P_3) ويتقاطعان من طرفهما الاخر في النقطة المجهولة (P_2) . وكما في الشكل التالي :



هنالك طريقتين لحساب المجاهيل في هذا النوع من التقاطعات :

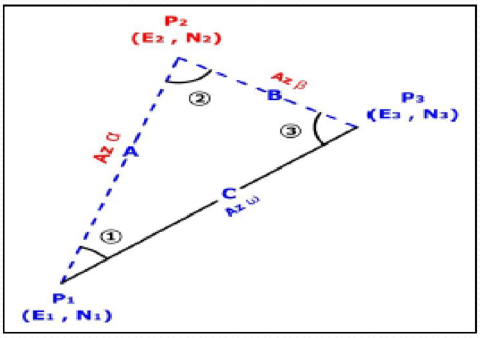
أولاهما (وهي الطريقة المهمة) : طريقة المثلثات (Triagnometric Method) :

يستخدم في هذه الطريقة قانون جيب التمام (Cos Law) . وكما يلي :

١- يحسب إتجاه الضلع ($P_1 \rightarrow P_3$) ($Az\ \omega$) وطوله (C) بالعلاقتين التاليتين :

$$\boxed{Az\ \omega = \tan^{-1}\left(\frac{E_3 - E_1}{N_3 - N_1}\right)}$$

$$\boxed{Length\ (C) = \left(\frac{E_3 - E_1}{Sin\ Az\ \omega}\right) = \left(\frac{N_3 - N_1}{Cos\ Az\ \omega}\right)}$$



٢- تحسب الزوايا الداخلية للمثلث (3> , 2> , 1 >) بإستخدام قانون جيب التمام .

$$\boxed{B^2 = A^2 + C^2 - 2A.C.Cos < 1}$$

$$\boxed{Cos < 1 = \frac{A^2 + C^2 - B^2}{2A.C}} \quad \boxed{Cos < 2 = \frac{A^2 + B^2 - C^2}{2A.B}} \quad \boxed{Cos < 3 = \frac{B^2 + C^2 - A^2}{2B.C}}$$

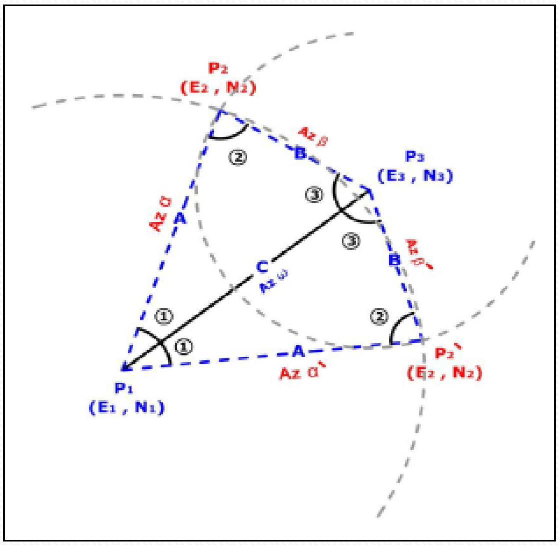
٣- يحسب الاتجاهان المجهولان ($Az\ \beta$, $Az\ \alpha$) من الزوايا الداخلية التي تم حسابها في الخطوة السابقة ، والاتجاه ($Az\ \omega$) .

$$\boxed{Az\ \alpha = Az\ \omega \pm \angle 1} \qquad \boxed{Az\ \beta = Back\ Az\ \alpha \pm \angle 2}$$

٤- يحسب الاتجاهان المحتملان ($Az\ \beta'$, $Az\ \alpha'$) وهما نفس الزوايا السابقة ، لكن بالاتجاه المعاكس لخط القاعدة ، وكما في الشكل التالي .

$$\boxed{Az\ \alpha' = Az\ \omega \pm \angle 1}$$

$$\boxed{Az\ \beta' = Back\ Az\ \alpha' \pm \angle 2\ ...(or)...\ Back\ Az\ \omega \pm \angle 3}$$



٥- يحسب الموقع (P2) من خلال (P1 , A , Az α).

ويتم التحقق من (P3) بواسطة (P2 , B , Az β) .

٦- يحسب الموقع المحتمل ('P2) من خلال (P1 , A , Az α')

ويتم التحقق من (P3) بواسطة (P2' , B , Az β') .

٧- يتم إختيار أحد الاحتمالين إما بالاعتماد على الرسم أو الواقع .

Ex : Find the coords. of the traverse (J , K , L , M) by using triagnometric method .

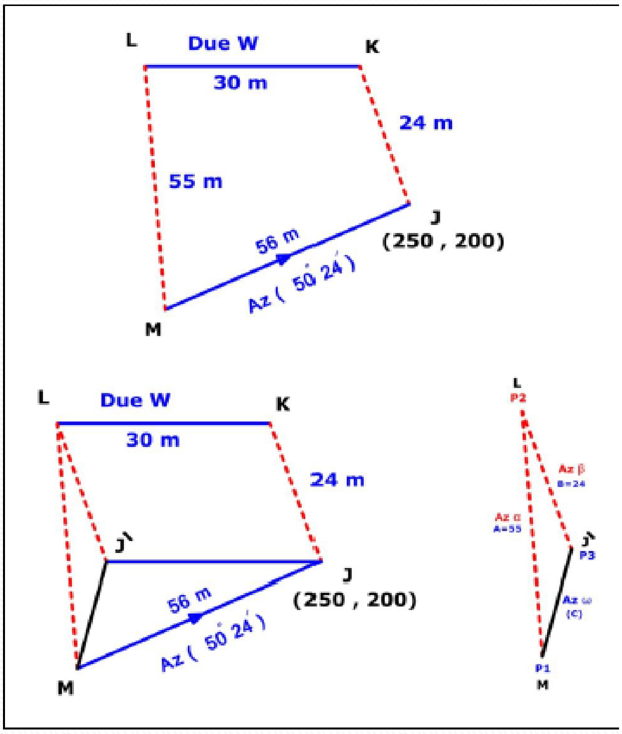
Sol : **Coords. Of (M) :**

$$E_M = E_J + L_{(J\to M)} Sin\ Az_{(J\to M)}$$

$$E_M = 250 + 56\ Sin\ (50^o\ 24^o + 180^o) = 206.85\ m$$

$$N_M = N_J + L_{(J\to M)} Cos\ Az_{(J\to M)}$$

$$N_M = 200 + 56\ Cos\ (50^o\ 24' + 180^o) = 164.30\ m$$



Coords. Of (J ') : (220 , 200)

$$length_{(C)} = \sqrt{(220-206.85)^2 + (200-164.30)^2} = 38.05\ m$$

$$Az_\omega = tan^{-1}\frac{(220-206.85)}{(200-164.30)} = 20^o\ 13'$$

$$Cos < 1 = \frac{A^2 + C^2 - B^2}{2A.C} \to \frac{55^2 + 38.05^2 - 24^2}{2\times 55\times 38.05} = 21^o\ 24'$$

$$Cos < 2 = \frac{A^2 + B^2 - C^2}{2A.B} \to \frac{55^2 + 24^2 - 38.05^2}{2\times 55\times 24} = 35^o\ 21'$$

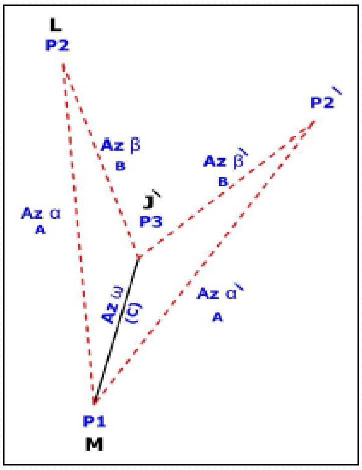
$$Cos < 3 = \frac{B^2 + C^2 - A^2}{2B.C} \to \frac{24^2 + 38.05^2 - 55^2}{2\times 24\times 38.05} = 123^o\ 15'$$

$$Az_\alpha = Az_\omega - < 1$$

$$Az_\alpha = 20^o\ 13' - 21^o\ 24' \to -1^o\ 11' + 360^o = 358^o\ 49'$$

$$Az\ \beta = Back\ Az\ \alpha - < 2$$

$$Az_\beta = (358^o\ 49' - 180^o) - 35^o\ 21' = 143^o\ 28'$$



Coords. Of (P2) From (P1) :

$$E_{P2} = E_{P1} + A.Sin\ Az_\alpha \to 206.85 + 55\ Sin\ 358^o\ 49' = 205.71\ m$$

$$N_{P2} = N_{P1} + A.Cos\ Az_\alpha \to 164.30 + 55\ Cos\ 358^o\ 49' = 219.29\ m$$

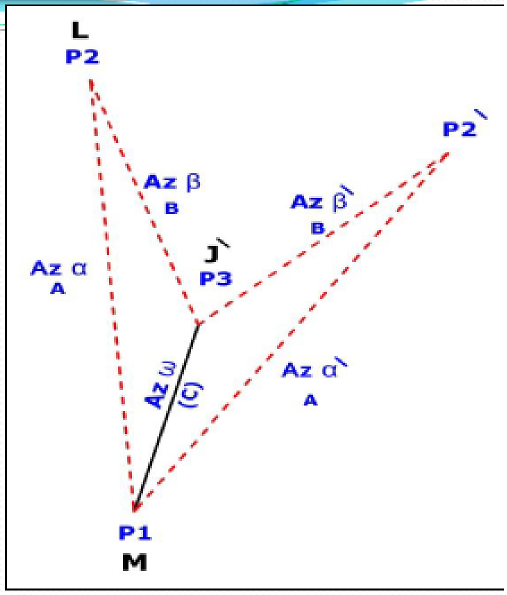
Check Of (P 3) From (P2) :

$$E_{P3} = E_{P2} + B.Sin\ Az_\beta \to 205.71 + 24\ Sin\ 143^o\ 28' = 220\ m$$

$$N_{P3} = N_{P2} + B.Cos\ Az_\beta \to 219.29 + 24\ Cos\ 143^o\ 28' = 200\ m$$

(((Checked)))

(((الاحتمال الثاني)))



$\boxed{Az_{\alpha}{}' = Az_{\omega} + <1}$

$\boxed{Az_{\alpha}{}' = 20^{o}\,13' + 21^{o}\,24' = \mathbf{41^{o}\,37'}}$

$\boxed{Az_{\beta}{}' = Back\ Az_{\omega} - <3}$

$\boxed{Az_{\beta}{}' = (20^{o}\,13' - 180^{o}) - 123^{o}\,15' = \mathbf{76^{o}\,58'}}$

$\boxed{(or)\ Az_{\beta}{}' = Back\ Az_{\alpha}{}' + <2 - 180^{o}}$

$\boxed{Az_{\beta}{}' = (41^{o}\,37' + 180^{o}) + 35^{o}\,21' - 180^{o} = \mathbf{76^{o}\,58'}}$

Coords. Of (P2 ') From (P1) :

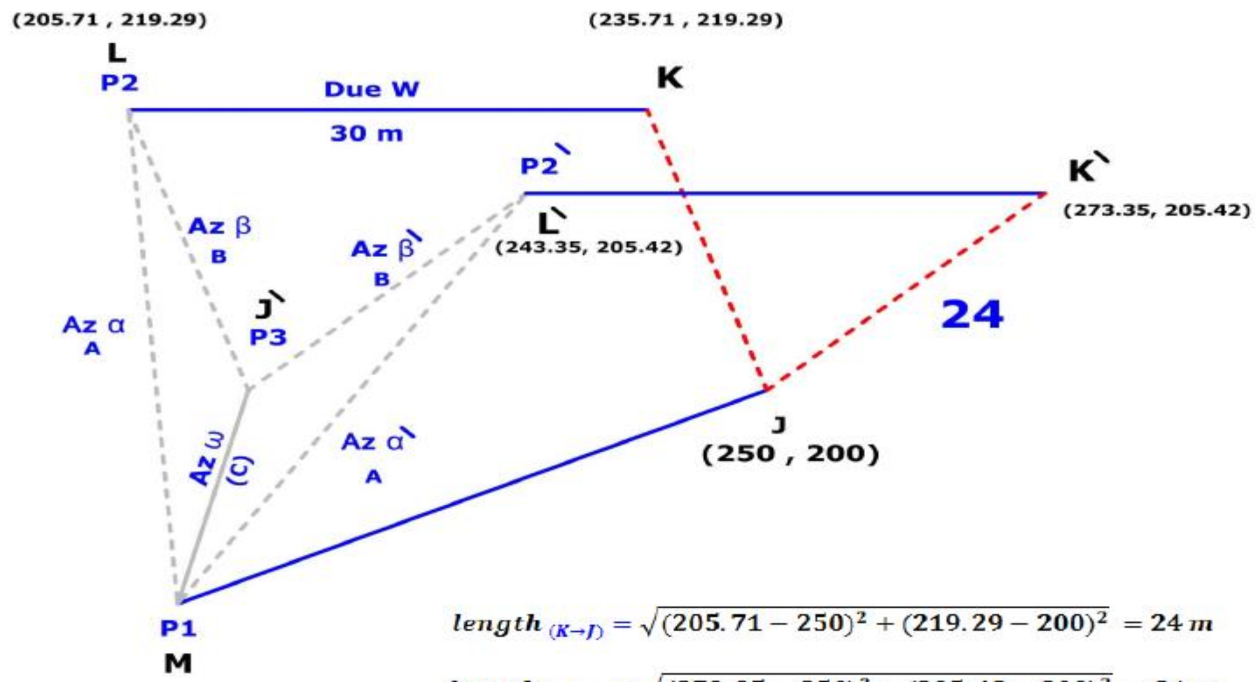
$\boxed{E_{P2}{}' = E_{P1} + A.Sin\ Az_{\alpha}{}' \rightarrow 206.85 + 55\ Sin\ 41^{o}\,37' = \mathbf{243.38\ m}}$

$\boxed{N_{P2}{}' = N_{P1} + A.Cos\ Az_{\alpha}{}' \rightarrow 164.30 + 55\ Cos\ 41^{o}\,37' = \mathbf{205.42\ m}}$

Check Of (P3) From (P2 ') :

$\boxed{E_{P3} = E_{P2}{}' + B.Sin\ Az_{\beta}{}' \rightarrow 243.38 + 24\ Sin\ (76^{o}\,58' + 180^{o}) = \mathbf{220\ m}}$

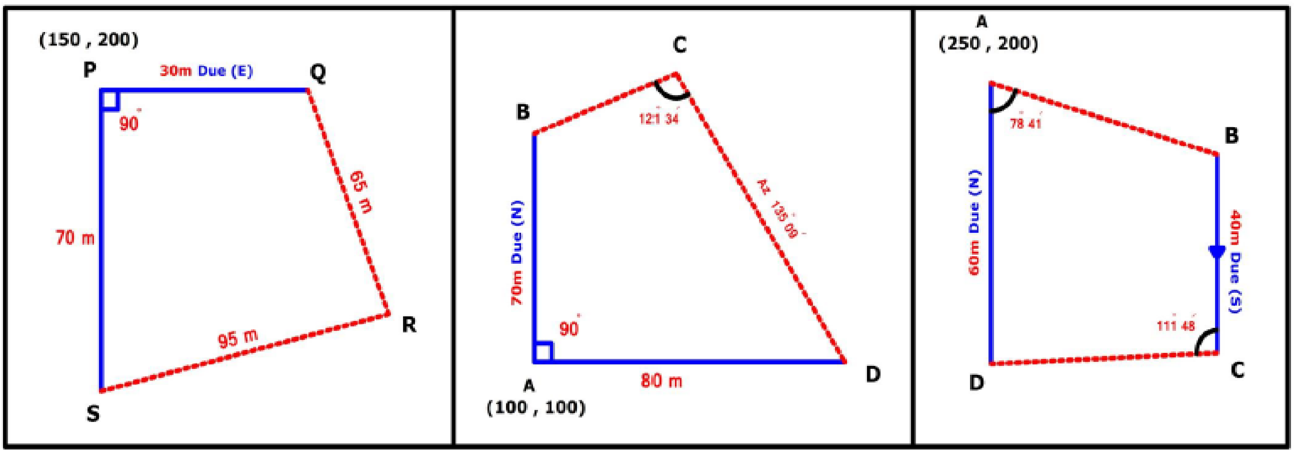
$\boxed{N_{P3} = N_{P2}{}' + B.Cos\ Az_{\beta}{}' \rightarrow 205.42 + 24\ Cos\ (76^{o}\,58' + 180^{o}) = \mathbf{200\ m}}$



$$length_{(K \rightarrow J)} = \sqrt{(205.71 - 250)^2 + (219.29 - 200)^2} = 24\ m$$

$$length_{(K' \rightarrow J)} = \sqrt{(273.35 - 250)^2 + (205.42 - 200)^2} = 24\ m$$

Examples : Find the solving triangle of the traverses .



Lecture(13)to (15)

Triangulation

Triangulation Nets in general are two types:-

a-Arc or chain Nets :-greater lengths and for main horizontal control of the country .

b-Area triang. Nets:- Smaller length and for municipal or city survey .

Purposes of Triangulation:-

1-To establish precise horizontal control for large area and for later surveying work .

2-To establish control for the locations of large construction ,projects (Bridges, Dams ,Irrigation ,Roads ….).

Classes of Accuracy:-

1-First order :

Length of side (10 – 60 Km)

Max error (±3``)

Angle accuracy(±0.5``- ±1.5``)

2-2 nd order

Length of side (5 – 10 Km)

Max error (±5``)

Angle accuracy(±1``)

3-3rd order

Length of side (5– 10 Km)

Max error (±10``)

Angle accuracy(±10``)

$$R = \frac{D - C}{D} * f$$

$R = strength\ of\ figure$

$D = no\ of\ Directions\ without\ Baseline$

$C = conditions\ of\ figure$

$C = (n` - s` + 1) + (n - 2s + 3)$

$n` = no\ of\ side\ observed\ two\ direction$

$s` = no\ of\ station$

$n = no\ of\ totalside$

$s = no\ of\ total\ station$

C=(N´-S+1) + (N – 2S + 3)

D : هو عدد الاتجاهات المرصودة في الشبكة ما عدا خط القاعدة

C=(N S+ 1) + (N – 2S + 3)

N عدد الخطوط المرصودة باتجاهين

S عدد المحطات المشغولة

N : عدد الخطوط الكلية

S : عدد المحطات الكلية

نسبة قوة الشكل = $\frac{D - C}{D}$

R قوة الشكل = $\frac{D-C}{D} \times f$

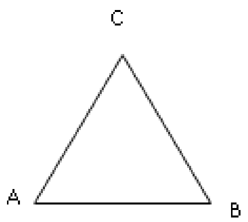
f=معامل القوة الشكل

D=4

C=(3-3+1) + (3-2*3+3)

C=(3-3+1) (3-6+1) = 1

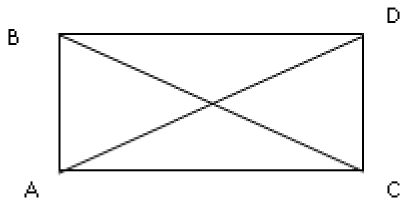
$\frac{4-1}{4} = 0.75$



D=10

C=(6-4+1) + (6-8+3) = 4

$\frac{10-4}{10} = 0.6$

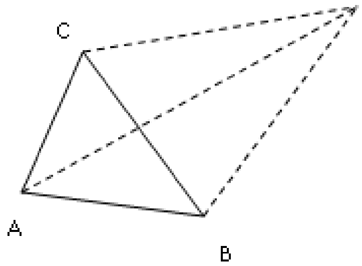


D=7

C=(3-3+1) + (6-2*4+3)

C = 1 + 1 = 2

$\frac{7-2}{7} = 0.714$



——— الخط المرصود باتجاهين

------- خط مرصود باتجاه واحد

محطة لايمكن الوصول اليها لايمكن اشغالها أي لايمكن الرصد منها ولكن يمكن الرصد عليها D

EX1:

Compute R1, R2 for the figure show if is known and (AB) is required BD ?

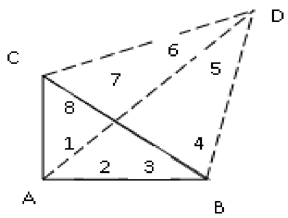
D=7

$C=(N^{-} - S^{-} + 1) + (N - 2S + 3)$

C=(3-3+1) + (6-2*4+3)

C= 1+1 = 2

$\frac{7-2}{7} = 0.714$



No.	Value of angle
1	40°
2	50°
3	60°
4	25°
5	45°
6	75°
7	35°
8	30°

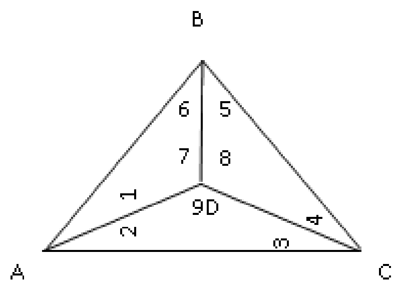
N0.	Triangle	Known side	Side to be compute	Distance angle	f	$\frac{D-C}{D}$	R
1	ABC	AB	BD	45,50	11	0.714	7.85
2	ABC BCD	AB CB	CB BD	30,90 120,35	13 7 ------ 20	0.714	14.28
3	ABC ACD ABD	AB AC AD	AC AD BD	30,60 75,65 85,50	19 2 3 ------- 24	0.714	17.14
4	ABC ACD CBD	AB AC CD	AC CD BD	30,60 75,40 25,35	19 8 43.5 ------ 70.5	0.714	50.357

$R_1 = 7.85$

$R_2 = 14.28$

EX2:

Compute R1,R2 for the figure shown if (AB) is known and(BC) required



D= 10

C=(N' – S' + 1) + (N – 2S + 3)

C=(6-4+1) + (6-2*4+3)

C= 3

$$\frac{10-4}{10} = 0.6$$

No.	Value of angle
1	20°
2	35°
3	30°
4	25°
5	30°
6	40°
7	120°
8	125°
9	115°

N0.	Triangle	Known side	Side to be compute	Distance angle	f	$\frac{D-C}{D}$	R
1	**ADC** **BDC**	**AD** **DC**	**DC** **BC**	**30,35** **30,125**	**33** **10** **--------** **43**	**0.6**	**25.8**
2	**ADB** **BDC**	**AD** **BD**	**DB** **BC**	**40,20** **25,125**	**54** **16** **-------** **70**	**0.6**	**42**
3	**ADC** **ABC**	**AD** **AC**	**AC** **BC**	**30,115** **70,55**	**11** **4** **-------** **15**	**0.6**	**9**
4	**ADB** **ABC**	**AD** **AB**	**AB** **BC**	**40,120** **55,55**	**5** **7** **--------** **12**	**0.6**	**7.2**

عند حساب 125و25

$R_1 = 7.2$

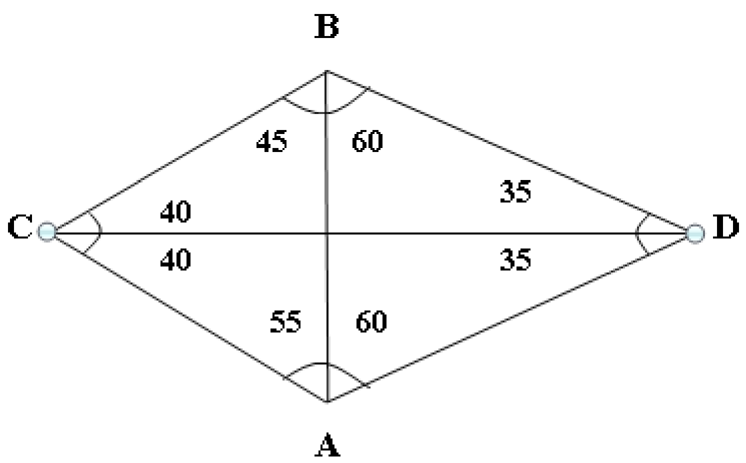
نأخذ 24 مع 125 وكذلك 26 مع 125 ثم نجمعها ونقسمها على 2

$R_2 = 9$

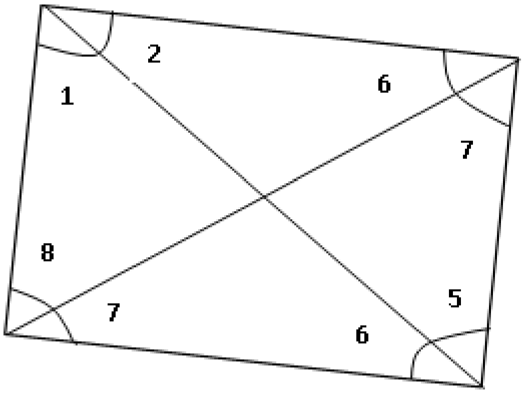
أي $\frac{18+14}{2} = 16$

H.W

Compute R1,R2 for the figure shown if (AD) is known and(CD) is required .



EX:: Adjust the follwing quadrilateral



Angle	Value from steady	For 180 (n-2)	For apposite
1	38 44 06	38 44 05	38 44\` 05.5\`\`
2	23 44 38	23 44 37	23 44\` 35\`\`
3	42 19 09	42 19 08	42 19\` 06\`\`
4	44 52 01	44 52 00	51 59\`. 05\`\`
5	69 04 21	69 04 20	69 04\` 10.5\`\`
6	39 37 48	39 37 47	39 37\` 49\`\`
7	26 25 51	26 25 50	26 25\` 52\`\`
8	75 12 14	75 12 13	75 12\` 13.5\`\`

2+3= 66 03 45 , 6+7= 66 03 37

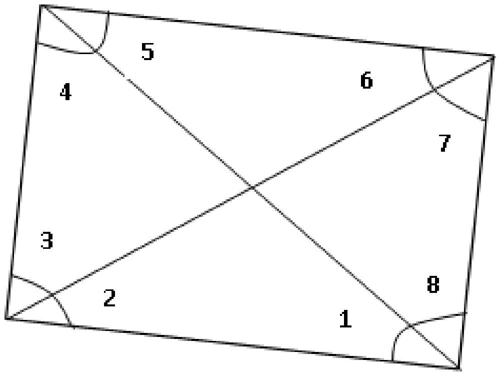
Difference = 8 ⟶ ÷ 4 = 2\`\`

نطرح 2 من 2 و3 القيمة الاكبر تضاف 2 الى 7و6 القيم الاصغر

1+8= 11 56 18 , 4+5 = 11 35 20

وتضاف 0.5 الى 1 و 8 ونطرح من 5 و 4

H.W: Adjust the follwing quadrilateral



Angle	Value from station
1	27 02 13
2	53 41 9.1
3	55 25 25.1
4	43 51 16
5	56 11 57.3
6	24 31 26.2
7	39 53 1,4
8	59 23 35.7

References

-Engineering Surveying, Zeyad AL Bakr, 1989,Baghdad ,Technical Institute.

-Web sites