Surveying

Fundamental Concepts

Primary Division of surveying:

Surveying is primarily classified as under:

Plane surveying

* curvature of earth is neglected
* only 10mm curvature of earth found at a distance of 18.2km
* Plane survey can safely used within 250 sq. km

Geodetic surveying

* Shape of earth is taken into account
* Preferred for works of large scale with high degree precision.

Classification of surveying based on instruments

(i) Chain surveying: only linear measurements are taken with a chain or tape. Angular measurements are not taken. Generally used when high accuracy is not required.

(ii) compass surveying: Horizontal angles are measured with a compass in addition to linear measurements with a chain or tape. Magnetic compass is not a precise instrument. But it is more precise than chain surveying.

(iii) Levelling: levelling instrument is used for finding difference in elevations and determining elevations with reference to a datum. More precise than compass survey.

What is the angle between chain surveying & leveling? ⇒ 90°

(iv) Plane table surveying: measurements are
→ Both plotting and taking measurements are simultaneous
→ linear measurements with chain or tape
→ less accurate

The type of surveying which requires less office work is Plane table surveying. [BREB]

(v) Theodolite survey:
**→ very precise instrument for measuring horizontal and vertical angles. (objective) [BREB]
→ Useful for the traverse survey and triangulation. Base lines are located using triangulation.

(vi) Tacheometric survey:
→ Theodolite with a stadia diaphragm having two horizontal cross hairs in addition to central horizontal hair is used.

→ Not very accurate - extremely convenient for Topographical details (objective)

(vii) **Photogrammetry:** Using photographs — vast areas — area difficult to reach

(viii) **EDM survey:** Based on triangulation - where all three sides of a triangle are measured with EDM instruments.

Functional classification of surveying:

(i) **Topographical survey**: To show natural features of the country such as rivers, hills, lake etc (BBA) [ইঞ্জিনিয়ার্স কোরের সহায়তায় - topographic survey তৈরি করে]

(ii) **cadastral survey:** to show property lines, boundaries, buildings etc. [BREB]

(iii) Engineering surveys

(iv) mine survey

(v) Hydrographic survey

(vi) Astronomic survey

Based on methods

(i) Travers survey → poligon shape

(ii) Triangulation → create triangular shape

*** The method of measuring distance by pacing (হেঁটে) is chiefly used in reconnaissance surveys (BADC)

*** The surveying used to find depth under water. sounding [BPSC]

(1) Name 5 modern surveying instruments [DWASA'14] [SGCL'14]

(i) Electric Distance measurement (EDM)

→ Distomat
→ Geodimeter
→ Tellurometer

(ii) Total station
(iii) Global positioning system (GPS)
(iv) Automatic level

Difference between a PLAN & a MAP:

→ Plan is constructed by usual orthographic projections, disregarding earth's curvilinear surface. A plan is drawn on a relatively large scale

→ If the scale is relatively small, a plan is called a map. A map generally shows some additional features such as relief and contour lines to indicate undulations on the ground.

☐ Representation of scale in a map:

Representation Factor, $RF = \frac{\text{Distance on the map}}{\text{Distance on the ground}}$

Ex: If 100cm is taken as 1cm in plan.

$\therefore RF = \frac{1}{100}$

MCQ: The representative fraction $\frac{1}{2500}$ means that the scale is ______ (BBA, BADC)

(A) 1cm = 0.25m
(B) 1cm = 25 m ✓
(C) 1cm = 2.5m
(D) 1cm = 250m

Types of measuring scales:

(i) Plain scale: measures two successive dimensions e.g. meters & decimeters (BADC)

(ii) Diagonal scale: measures three successive dimensions e.g. meters, decimeters and centimeters

(iii) Chord scales: Are used to measure angles from 0 to 90°

* A surveyor measured the distance between two points marked on the plan to a scale of 1cm = 1m (RF = 1:100) & found it to be 50m. Later he detected that he has used wrong scale of 1:50

(a) Determine the correct length

(b) Correct area if the measured area is $50m^2$

Solⁿ: Correct length $= \left(\frac{1/50}{1/100}\right) \times 50 = 100m$

Area $= \left(\frac{1/50}{1/100}\right)^2 \times 50 = 200m^2$

* If a line of 5cm has shrunk to 4.5cm, determine

(a) Shrinkage factor

(b) Correct length corresponding to measured length of 90m

(c) Correct area corresponding to a measured area of $81m^2$

Solⁿ: (a) SF $= \frac{4.5}{5} = 0.9$

(b) Correct length $= \frac{90}{0.9} = 100m$

(c) Correct area $= \frac{81}{(0.9)^2} = 100m^2$

Linear measurements
Including chain surveying

Odometer: Used for measuring distance traveled by vehicle (BADC, BREB)

Chains

1. Metric chains (i) 20m → 100 links
   (ii) 30m → 150 links
2. Gunter's chain ⇒ 66ft → 100 links
3. Engineers chain ⇒ 100ft → 100 links

1 yard = 3 ft
1 mile = 8 furlongs
80 Gunter's chain = 1 mile = 8 furlongs
10 sq. Gunter chain = 1 acre
1 acre = 43560 ft^2

Errors due to incorrect chain

⇒ If chain is too long, measured distance will be less. This error is known as negative error (BPSC)
Therefore positive correction required

⇒ If chain is too short, measured distance will be more. It is positive error.
Therefore negative correction needed.

~~*** Always remember: Standard chain length × True distance = faulty chain length × apparent distance~~

* distance বাড়াইতে চাইলে বড় / চেইন
  কমাইতে " চেইন / ছোট

(2) A correct distance of 1000m was measured with a 25m chain which was actually found to be 24.90m. calculate the chained distance.
[DPDC'16] [WRGCL'14] [BWDB'13]

<u>Solnº:</u> Chained distance

$$= \frac{25}{24.9} \times 1000$$

$$= 1004.016m$$ Ans

(chain length যখন বাড়বে measured distance, actual distance থেকে
(ছোট হবে)

(3) The road from Uttara to Kurmitola is actually 25320 ft long. The distance was measured by the <u>engineering</u> defective chain was found to be 25270ft. How much correction does the chain used? [JOCL'18]

<u>Solnº:</u> Engineers chain = 100ft

(mesured distance কম হলে chain বড়)

Actual chain length $= \frac{25320}{25270} \times 100ft$

$= 100.198ft$

correction required $= \frac{0.198}{100.198} \times 100$

$= 0.198\%$

∴ chain should be reduced by 0.198% Ans

(4) The length of a line measured with a 20m chain was found to be 250m. Calculate the true length of the line if the chain was 10cm too long. [BUET]

Soln: True length $= \dfrac{20.1}{20} \times 250$

$= 251.25m$ Ans

(5) 1000m distance is measured by 25m chain. After the work, the chain was found actually 25.15m. What was the corrected length? [Titas '21]

Soln: Corrected length $= \dfrac{25.15}{25} \times 1000 = 1006m$ Ans

(6) The length of a survey line was measured with 20m chain and was found to be 1200m. As a check, the length was again measured with 25m chain and was found to be 1212m. On comparing the 20m chain with the test gauge it was found to be 1 decimeter too long. Find the actual length of the chain. [BUET]

(1 decimeter = 10cm)

Soln: Actual length of survey line $= \dfrac{20.1}{20} \times 1200\ m$

$= 1206m$

25m chain এর length 1206m এর চেয়ে বেশি আসছে। তাই chain ছোট

∴ actual length of 25m chain $= \dfrac{1206}{1212} \times 25\ m$

$= 24.88m$ Ans

(7) A line was measured by a 20m chain which was accurate before starting the day's work. After chaining 900m, the chain was found to be 6cm too long. After chaining a total distance of 1575m, the chain was found to be 14cm too long. Find the true distance of the line. [BUET]

Sol^n: $l' = 20 + \frac{0 + 0.06}{2}$

$= 20.03m$

[যেহেতু temperature এর জন্য continuously elongation হচ্ছে তাই mean ধরে নিচ্ছি, তাই 900m মাপার সময় চেইন এর length]

True length $= \frac{20.03}{20} \times 900 = 901.35m$

Second part

again, $l' = 20 + \frac{0.06 + 0.14}{2} = 20.1m$

measured length $= 1575 - 900 = 675m$

$\therefore$ True length $= \frac{20.1}{20} \times 675m = 678.375m$

$\therefore$ Total true distance $= (901.35 + 678.375)m$

$= 1579.725m$

CamScanner

(8) The length and breadth of a plot of land were measured by an engineers chain exactly 20ft in length at begain. But it was found to be 20.03ft after measurement. calculated area was 50acre. Find the corrected area. [BREB'18]

Soln: temperature এর জন্য elongation হয়েছে এবং এটা একটা continuous process. অর্থাৎ শুরুতে ছিল 20ft শেষে হয়েছে 20.03ft. So, mean elongation নিতে হবে।

$$L' = \frac{20 + 20.03}{2} = 20.015 \text{ ft}$$

$$\text{correct area} = \left(\frac{20.015}{20}\right)^2 \times 50$$

$$= 50.075 \text{ acre} \quad \underline{\text{Ans}}$$

(9) A survey line was measured by means of a gunter's chain and found to be 3400 links. It was also measured with a 100ft chain and the result was 2258ft. If the error in the gunter's chain is +0.3 links. Find the error in 100ft chain? [BB AD'16] [DPDC'16]

Soln: In Gunter's chain,

100 links = 66 ft

$$\therefore 0.3 \text{ links} = \frac{66 \times 0.3}{100} = 0.198 \text{ ft}$$

$$\text{and } 3400 \text{ links} = \frac{66 \times 3400}{100} = 2244 \text{ ft}$$

$\therefore$ True length of line $= \frac{66.198}{66} \times 2244$ ft

$= 2250.732$ ft

or,

Gunter's chain $= 100$ links $+ 3$ links

$\therefore$ True length of line $= \frac{100.3}{100} \times 3400$

$= 3410.2$ links

$= \frac{66 \times 3410.2}{100}$ ft

$= 2250.732$ ft

measured distance using engineer's chain $= 2258$ ft > 2250.732 ft

$\therefore$ actual length of engineer's chain will be less than true length $= 100$ ft

$\therefore$ Actual length of Engineer's chain

$= \frac{2250.732}{2258} \times 100$

$= 99.68$ ft

Negative Error $= 100 - 99.68$ ft

$= 0.32$ ft

objective (chain এর দৈর্ঘ্য বাড়লে পজিটিভ error হবে। ছোট হইলে negative error এর হইলে positive error)

If a chain is used at a temperature lower than the temperature at which it was calibrated, the error in measured length is positive.

explanation: তাপ কমে যাওয়ায় shrinkage হবে chain ছোট হয়ে যায়, ফলে measured distance, actual এর চেয়ে বেশি হবে। আসে +ve error.

(10) stations are measured by means of a Gunter's chain which was 0.4 links too short and the result was 1284 links. What was the true distance between the station?

Solⁿ: Gunter's chain = 100 links

$$\text{True distance} = \frac{99.6}{100} \times 1284 \text{ links}$$

$= 1278.864$ links

$= \frac{66}{100} \times 1278.864$ ft

$= 844.05$ ft Ans

(11) A chain was tested before starting the survey of a field and was found to be exactly 100ft. At the end of survey, it was tested again and was found to be 100ft and 6 inches. Area of a plan was 18.50 inch² drawn a scale of one inch = 66ft. Find the true area of the field.

Solⁿ: Mean elongation = $\frac{0+6}{2} = 3$ inch $= 0.25$ft

$$\therefore \text{True area} = \left(\frac{100.25}{100}\right) \times 18.50$$

$= 18.59$ square inch

1 inch = 66ft

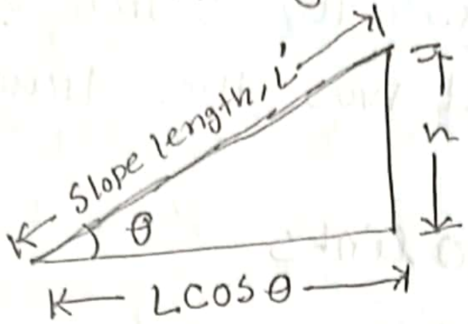
∴ 1 sq. inch = 4356ft

∴ 18.59 sq. inch = 80978.04 sq.ft Ans

$= 1.8$ acre

[∵ 1 acre = 43560ft²]

Correction of length due to slope:

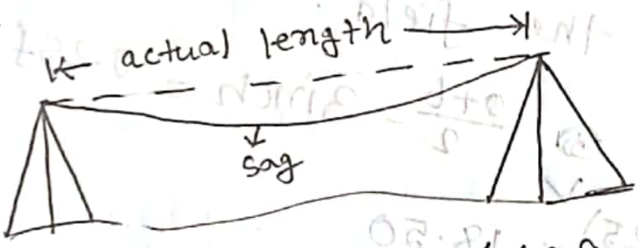


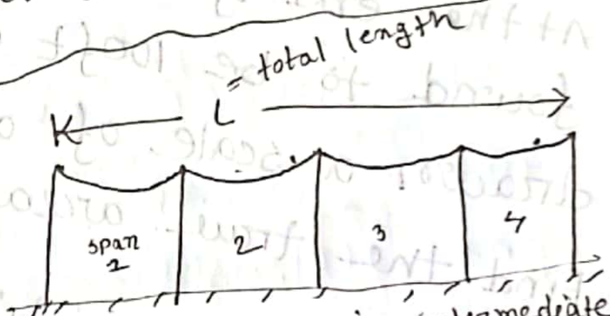
Actual horizontal length, $L = \sqrt{L'^2 - h^2}$
$= L'\cos\theta$

$\therefore$ correction for slope, $C_s = L' - L$

this is always negative ~~because~~ correction. সবসময়ই slope এর actual horizontal length থেকে বেশি হয়।

Correction for sag:





$\because$ actual length < sag length (positive error)

$\therefore$ Negative correction required for sag

$$C_g = \frac{1}{24}\left(\frac{W}{P}\right)^2 \times L$$ (BUET gaps)

If there are intermediate supports

$$C_g = \frac{1}{24}\left(\frac{W}{nP}\right)^2 \times L$$

n = number of equal spans/bays

W = total weight of tape between the span

P = applied pull ~~in~~,

[W ও P এর Unit same থাকতে হবে। W kg এ হলে P ও kg এ, W N এ হলে P ও N এ]

Correction for pull:

If the applied pull to the tape in the field is different from the standardization pull, the pull correction is to be applied to the measured length.

Pull correction, $C_p = \frac{(P-P_0)}{AE} L$

P_0 = standard pull
P = Applied pull
A = x-section area
E = Young's modulus
L = Length

The sign of the correction will depend on the sign of $P-P_0$

* A steel tape was exactly 30m long at 20°C when supported throughout its length under a pull of 10kg. A line was measured with this tape under a pull of 15kg and at a mean temperature of 32°C and found to be 780m long. The cross sectional area of the tape = $0.03 cm^2$ & its total weight = 0.693kg. $\alpha = 11\times10^{-6}/°C$, $E = 2.1\times10^6 kg/cm^2$. Compute the true length of the line.

Ans: Tape length corrections

(i) Temperature corrections, $C_t = 11\times10^{-6}\times(32-20)\times30$

$= 0.00396$ (+ve)

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(ii) Pull correction, $C_p = \frac{(P-P_0)L}{AE}$

[Standard এর চেয়ে বেশি pull দেয়া হয়েছে। তাই length বাড়বে]

$$= \frac{(15-10)}{0.03 \times 2.1 \times 10^6} \times 30$$

$$= 0.0023 \ (+ve)$$

(iii) Sag correction, $C_s = \frac{1}{24}\left(\frac{0.693}{15}\right)^2 \times 30$

$$= 0.00267 \ (-ve)$$

Sag always negative

$\therefore$ Total correction $= 0.00396 + 0.00238 - 0.00267$

$= +0.00367\,m$ (too long)

$\therefore$ actual length of 30m tape is 30.00367m

$\therefore$ True length of line $= \frac{30.00367}{30} \times 780\ m$

$= 780.095\,m$ <u>A</u>

* If the tap were supported at every 15m then calculate sag during measurement correction.

<u>Solⁿ:</u> $C_s = \frac{1}{24}\left(\frac{0.693}{2 \times 15}\right)^2 \times 30$ (2 span: 15m + 15m)

$$= 0.00067\,m \ (-ve)$$

* What is the sag correction for a 30m steel tape under a pull of 100N in three equal spans of 10m each. Unit weight of steel is 78.9 kN/m³. Area of x-section of tape is 8mm².

Soln: Weight per meter length $= 78.9\ kN/m^3 \times (8\times10^{-6})\,m^2$

$= 6.312\times10^{-3}\ kN/m$

$= 6.312\ N/m$

$\therefore$ Sag correction $= \frac{1}{24}\left(\frac{6.312\times30}{3\times100}\right)^2\times30$

$= 0.498\ m$

$W = 6.312\times30$ = total weight

Different Errors in linear measurements

Error বেশিরভাগ দুই ধরনের।

(i) Compensating errors

⇒ দুই direction এই error হয়, কিন্তু final result এ compensate হয়ে যায় error। এতে result বেশিরভাগই accurate হয় — আনুমানিক থাকে।

(ii) Cumulative errors

⇒ একই direction এ হয় বলে cumulate হয়ে তো হয়ে যায়।

Examples

Cumulative errors	Compensating errors
(a) Error in chain/tape lengths temperature, pull, sag, slope, MSL (mean sea level) errors, Bad ranging, Bad straightening	Incorrect holding & marking of the arrows Graduations in tape may not be exactly same throughout

* The error in measuring length due to incorrect holding of chain is compensating error (BADC, BREB)

(12) * Mean sea level (MSL): MSL is the average height of the sea level for all stages of the tides over a long year period i.e. 19 years. MSL is the datum to which elevations and contour intervals are generally ~~reffe~~ referred. [BEPZA'14]

(13) Write down the corrections of chain survey [ISTT'15]

Soln: (i) correction for standarization (length)
(ii) " " slope
(iii) " " pull
(iv) " " sag
(v) " " temperature
(vi) " " MSL
(vii) correction for misalignment

Compass Survey

Compass surveying is a branch of surveying in which directions of survey lines are determined with a compass and lengths of lines are measured with a tape or chain. Generally used to run a traverse (আড়বাধ-survey)

***Meridian & its types:

Meridian: Fixed line of reference about which directions or angles are measured.

4 types — ← (ESTT '15)

(i) **True meridian:** Reference line that joins true north and true south pole of earth. This line is established by astronomical ~~object~~ observations.

(ii) **Magnetic meridian:** Direction shown by a freely floating and balanced magnetic needle free from all other attractive forces.
or, A reference line passing through magnetic north and south pole

(iii) <u>Grid meridian:</u> For survey of a state or country, the true meridian of central place (i.e. Dhaka এর true meridian) is taken as a reference meridian for whole state/country is called grid meridian.

(iv) <u>Arbitrary meridian:</u> Meridian taken towards any permanent and prominent mark or signal to determine relative directions of various lines. Generally used in measuring small areas.

*** <u>Bearing:</u> Bearing of a line is the (horizontal) angle between a meridian and a survey line.

<u>BWDB'20 viva questions:</u> bearing আর angle এর মধ্যে পার্থক্য কী?

<u>Ans:</u> angle হচ্ছে যেকোন দুইটি straight line এর intersecting point আর bearing হচ্ছে meridian এবং survey line এর ~~...~~ মধ্যবর্তী কোণ

P.T.O

Types of bearing:

(true meridian এর সাথে survey line এর angle হলো Azimuth.) ***

(i) <u>True bearing</u>: horizontal angle between true meridian and survey line. ~~As~~ Also known as <u>Azimuth</u>. Doesn't change with time, it is a constant.

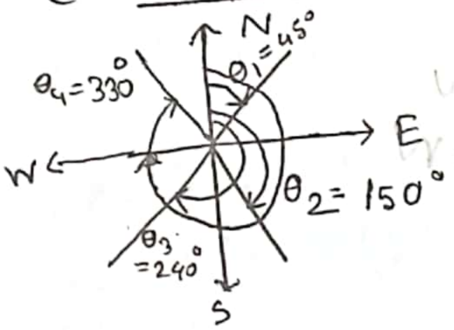
(ii) <u>Magnetic bearing</u>: Horizontal angle between magnetic north and survey line. changes with time. Used for small areas.

(iii) <u>Grid bearing</u>: Horizontal angle between grid meridian and survey line.

(iv) <u>Arbitrary bearing</u>: Horizontal angle between arbitrary ~~bearing~~ meridian and survey line.

System of Bearings:

(a) Whole circle Bearing system (WCB):



* প্রত্যেকটি reference meridian এর North pole থেকে Clockwise angle measure করতে হয়।
* Bearing varies from 0° to 360°
* WCB is measured using <u>prismatic compass</u>
* It is also called "azimuthal system".

(b) Quadrantal Bearing (QB) / Reduced Bearing (RB) System:

⇒ Quadrantal bearing (QB) or reduced bearing (RB) হল reference meridian এর সাথে survey line এর উৎপন্ন সূক্ষ্ম কোণ (acute angle).

⇒ সূক্ষ্মকোণের জন্য reference meridian এর North অথবা South pole থেকে survey line এর উভয় দিকে সেই pole এর সাথে কোণ হিসাব করতে হয়।

survey line এর RB লেখার নিয়মঃ

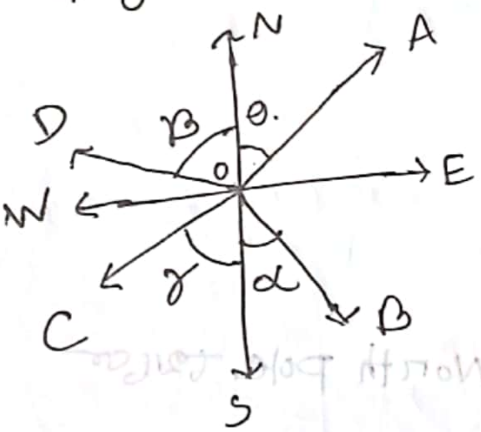
⇒ প্রথমে survey line এর North or South এর

(i) প্রথমে reference pole North or South এর জন্য N or S

(ii) angle of the bearing

(iii) survey line এর পর east or west এর জন্য E or W

(North pole এর সাথে θ কোণে east এর দিকে)



Bearing OA = NθE

OB = SαE

OC = SγW

OD = NβW

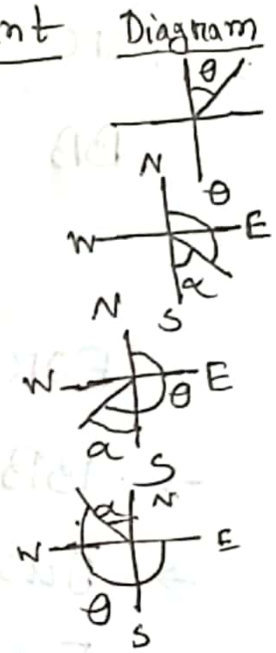
⇒ angles varies from 0 to 90°

⇒ Reduced bearing is measured by surveyors compass

Conversion of WCB to RB :

Case	WCB(θ)	RB	Quadrant
1	0° to 90°	NθE	I
2	90° to 180°	S(180°-θ)E	II
3	180° to 270°	S(θ-180°)W	III
4	270° to 360°	N(360°-θ)W	IV

Diagram



Note: When a line points towards North, East, South or West, it is written as "Due North", "Due east", "Due south" or "Due west" respectively.

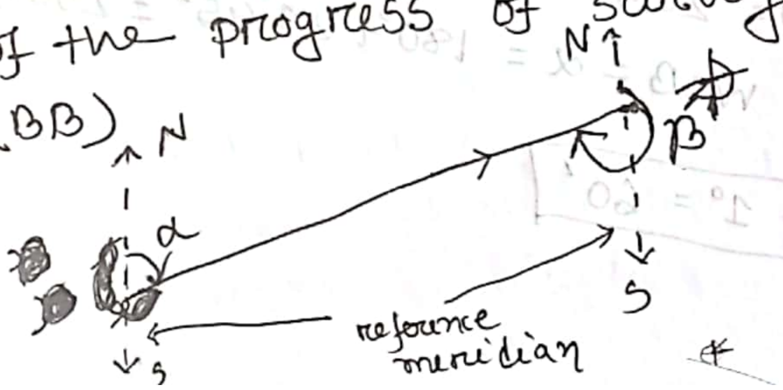
N0° = Due North ; N90°E = S90°E = Due east

S0° = Due south ; N90°W = S90°W = Due west

Fore Bearing & Back Bearing:

→ The bearing of a line in the direction of progress of survey ~~indicated~~ is called fore bearing (FB)

→ The bearing of line in the opposite direction of the progress of survey is called back bearing (BB)



α = FB

β = BB

if FB = 60°

BB = 60 + 180° = 240°

Conversion between FB & BB :

⇒ For WCB system

BB = FB + 180°   if FB < 180°

= FB − 180°   if FB ≥ 180°

⇒ For RB system

→ BB numerically equals to FB

→ Just change N for S & vice versa and E for W & vise versa

Example : N30°E → S30°W

(14) If back bearing of a line AB is 60° then what is the force bearing? [ISTI]

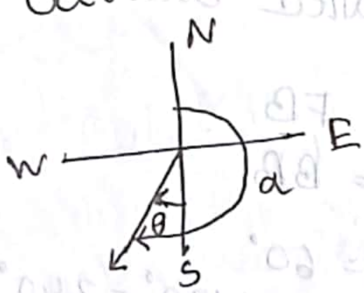
Soln : BB 60° (<180°) আমরা FB 180° যোগ করব [illegible]   [BB = FB − 180° if FB > 180°]

$\therefore$ FB = BB + 180°

= 60° + 180°

= 240° Ans

** Given RB = S20°45′W . convert this into WCB



θ = 20°45′

$\therefore$ WCB = α = 180° + 20°45′ = 200°45′

| * 1° = 60′ |

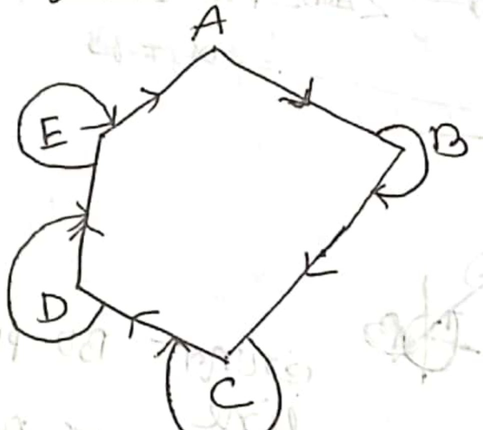
Included angle:

⇒ where two survey lines meet at a point, the angle between them is called as included angle

⇒ angle is always measured in clockwise direction from preceding line to the forward line.
যেমন নিচে দেখানো,

case 1

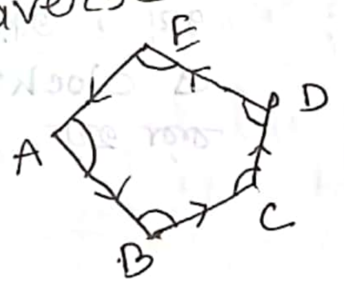
যখন traverse clockwise run করে:-



Included angle clockwise করলে যেটা সবসময় exterior angle হয়, অর্থাৎ angle 180° এর চেয়ে বড় হবে,

Case 2

যখন traverse anti-clockwise run করে:-



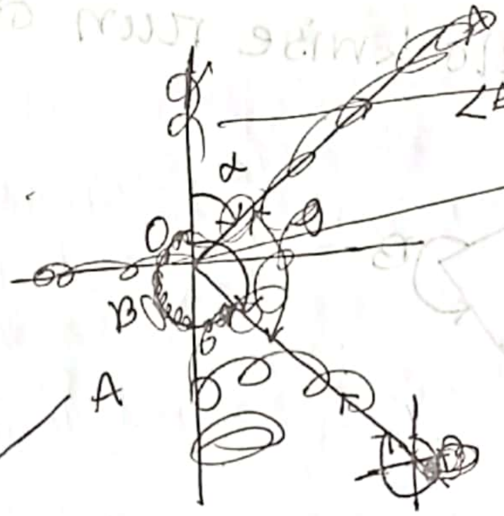
তখন আগের line থেকে পরের line এ clockwise angle মাপলে সেটা interior angle হয়, অর্থাৎ angle 180° এর কম হবে।

Calculation of Included Angles from Bearings:

Case 1 : If Whole Circle Bearing (WCB) of two adjacent line are given,

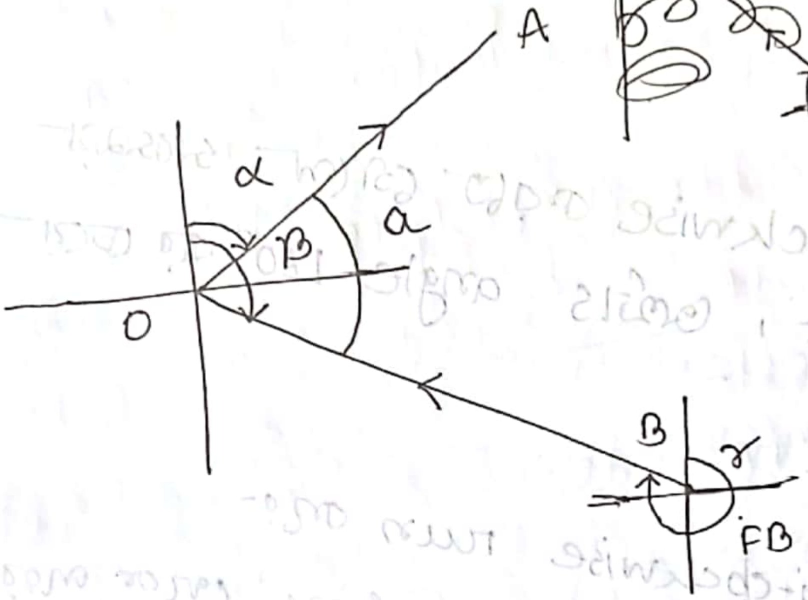
$\therefore$ included angle = FB of forward line − BB of previous line

if the value is negative, add 360° to get the actual included angle (exterior angle in that case)



~~∠AOB = FB of OA − BB of OB~~

= ~~α − β~~



কারণ BO previous line

γ = FB of BO

$\therefore \beta$ = BB of BO

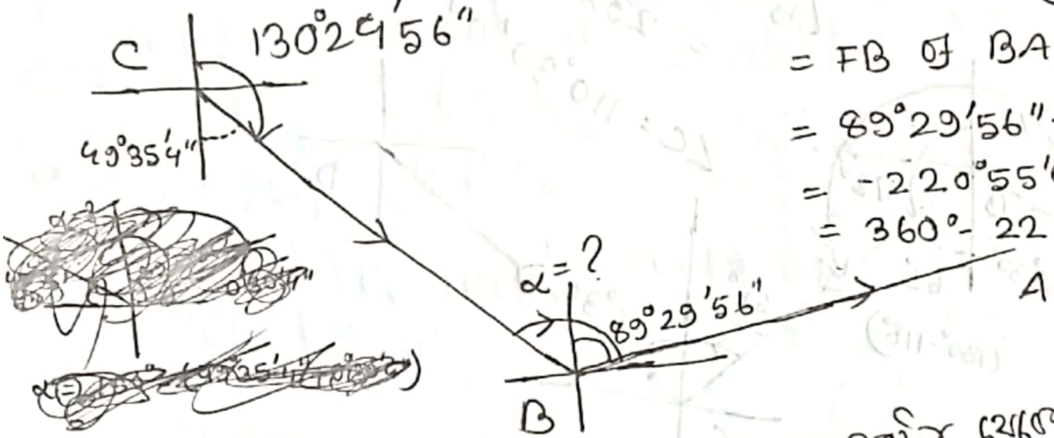
α = FB of OA

FB সবসময় কোনো line এর starting point এ clockwise calculate করা হয়, আর BB end point এ clockwise calculate করা হয়।

$\therefore$ included angle,

$\angle AOB = a = \alpha - \beta$

(15) Find the included angle ABC if forward bearing of both lines CB & BA are 130°24'56" & 89°29'56"? [PGCL'17]



included angle ∠ABC

$= FB \text{ of } BA - BB \text{ of } CB$

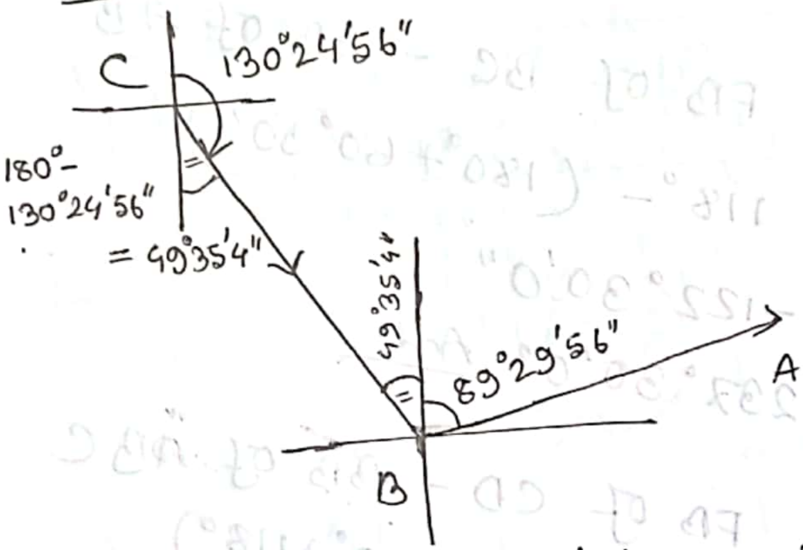
$= 89°29'56" - (180° + 130°24'56")$

$= -220°55'0"$

$= 360° - 220°55'0" = 139°5'0"$ Ans

* included angle সবসময় আগেরটির থেকে পরের লাইনের দিকে clockwise direction এ হবে।
* traversing anti-clockwise হওয়ায় included angle interior হয়েছে।

From figure:



$\therefore \angle ABC = 49°35'4" + 89°29'56" = 139°5'0"$ Ans

(16) calculate included angle ∠B [BPDB'21]

AB	60°30'
BC	118°
CD	48°30'

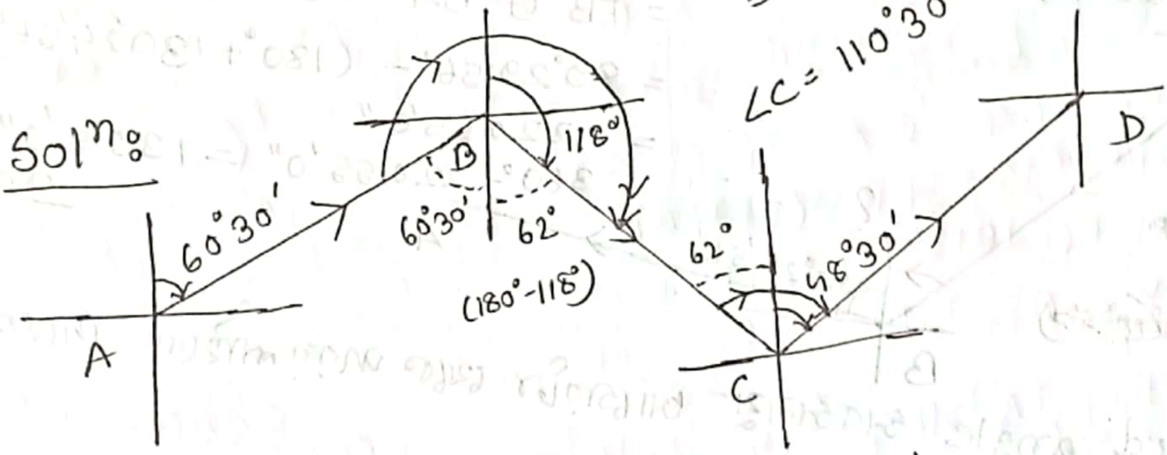
From figure

∠B = 360° − (60°30' + 62')

= 237°30'0"

∠C = 110°30'0"

Solⁿ:



AB থেকে BC তে যেতে clockwise angle

AB ও BC clockwise traversing হওয়ায় included angle exterior হবে।

BC ও CD anti-clockwise হওয়ায় included angle enterior হবে।

included angle, ∠B = FB of BC − BB of AB

= 118° − (180° + 60°30')

= −122°30'0"

= 237°30'0" Ans

included angle, ∠C = FB of CD − BB of BC

= 48°30' − (180° + 118°)

= −249°30'0"

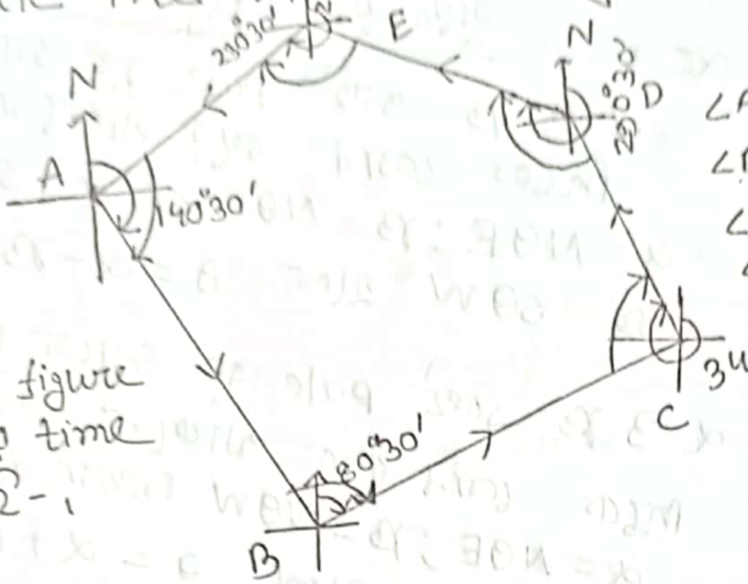
= 110°30'0" Ans

* The following bearings were observed for a closed traverse ABCDEA

Line	AB	BC	CD	DE	EA
FB	140°30'	80°30'	340°0'	290°30'	230°30'

compute the included angles.

Solⁿ:



examএ figure দেখার time নাই।

included angles,

$\angle A = 140°30' - (230°30' - 180°) = 90°$

$\angle B = 80°30' - (140°30' + 180°) = 120°$

$\angle C = 340°0' - (180° + 80°30') = 79°30'$

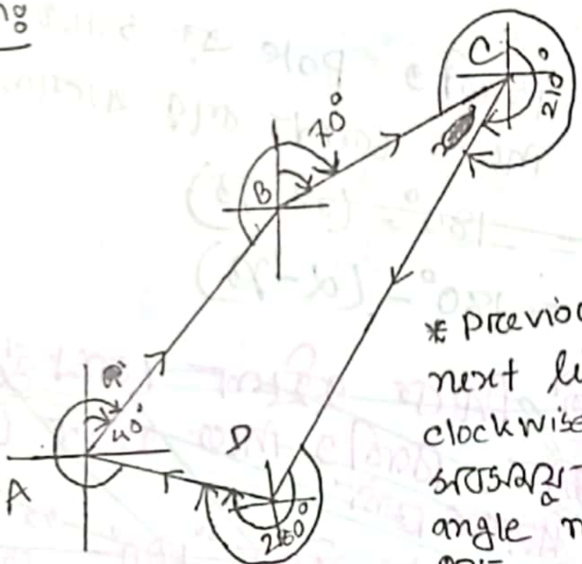
$\angle D = 290°30' - (340°0' - 180°) = 130°30'$

$\angle E = 230°30' - (290°30' - 180°)$
$= 120°$

* Given FB of a closed traverse ABCDA. compute included angles.

Line	AB	BC	CD	DA
FB	40°	70°	210°	280°

Solⁿ:



* Previous line থেকে next line এ clockwise direction এ ঘুরালে included angle measure করা হয়।

$\angle A = 40° - (280° - 180°) + 360°$
$= 300°$

$\angle B = 70° - (180° + 40°) + 360°$
$= 210°$

$\angle C = 210° - (180° + 70°) + 360°$
$= 320°$

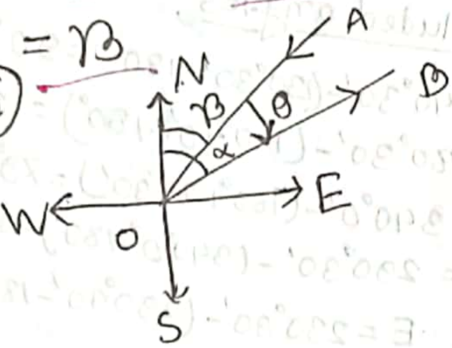
$\angle D = 280° - (210° - 180°)$
$= 250°$

Ans

Case II: If Reduced Bearing (RB) of survey lines are given:

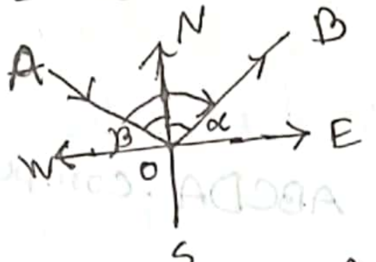
Assume, forward bearing of next line $= \alpha$ & backward bearing of previous line $= \beta$

মুখে মুখে figure ছাড়া calculation

(1) 

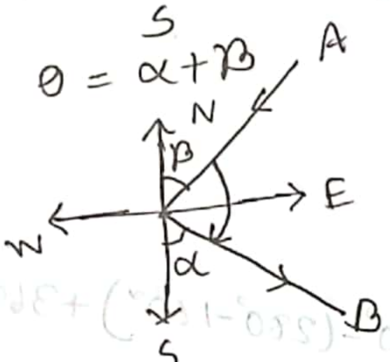
α ও β একই pole এর সাথে একই দিকে কোণ তৈরি থাকলে, i.e., $\alpha = N\theta E$; $\beta = N\theta E$ বা $\alpha = S\theta W$, $\beta = S\theta W$ হলে $\theta = \alpha - \beta$

$\theta = \alpha - \beta$

(2) 

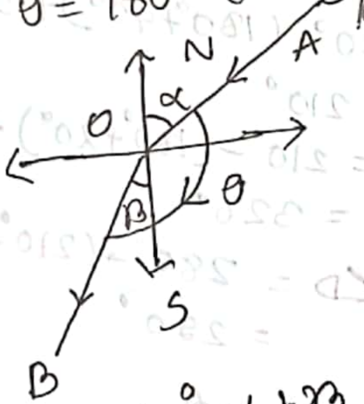
α ও β একই pole এর সাথে বিপরীত দিকে কোণ তৈরি থাকলে অর্থাৎ $\alpha = N\theta E$; $\beta = N\theta W$ অথবা $\alpha = S\theta W$ $\beta = S\theta E$ হলে $\theta = \alpha + \beta$

$\theta = \alpha + \beta$

(3) 

α ও β বিপরীত pole এর সাথে একই দিকে কোণ তৈরি থাকলে অর্থাৎ $\alpha = N\theta E$; $\beta = S\theta E$ বা $\alpha = S\theta W$; $\beta = N\theta W$ হলে $\theta = 180° - (\alpha + \beta)$

$\theta = 180° - (\alpha + \beta)$

(4) 

α ও β বিপরীত pole এর সাথে বিপরীত দিকে কোণ তৈরি থাকলে

~~$\theta = 180° - (\alpha + \beta)$~~

$\theta = 180° - (\alpha - \beta)$

$\theta = 180° - \alpha + \beta$
$= ~~180° - (\alpha + \beta)~~$
$= 180° - (\alpha - \beta)$

~~একই দিকে হইলে যোগ হবে, বিপরীত দিকে হইলে বিয়োগ হবে, বিপরীত pole হইলে "180°" আসবে।~~

(17) Calculate internal angles of a closed traverse from the following bearing

BA = S80°50'30"W

CA = N40°56'55"W

CB = N30°55'51"E

[DICA '18] [PGCB '14] [BIWTA '19] [BADC '20] [BGDCL '21]*** [ERL '22]

BA → AC → CB

BA → AC, CB → BA, AC → CB

Soln: সুবিধার্থে figure আর প্রয়োজন নেই।

CA = N40°56'55"W (এটি AC এর BB)

∴ AC = S40°56'55"E (FB)

BB of BA = N80°50'30"E

BB of CB = S30°55"51"W

∴ internal angle ∠A = F~~B of AC – BB of BA~~

= 180° – (40°56'55" + 80°50'30")

= ~~58°12'35" = 219°53'35"~~ = 58°12'35"

∠B = ~~FB of BA – BB of CB~~

= 80°50'30" – 30°55"51"

= 49°54'39"

∠C = ~~FB of CB – BB of AC~~

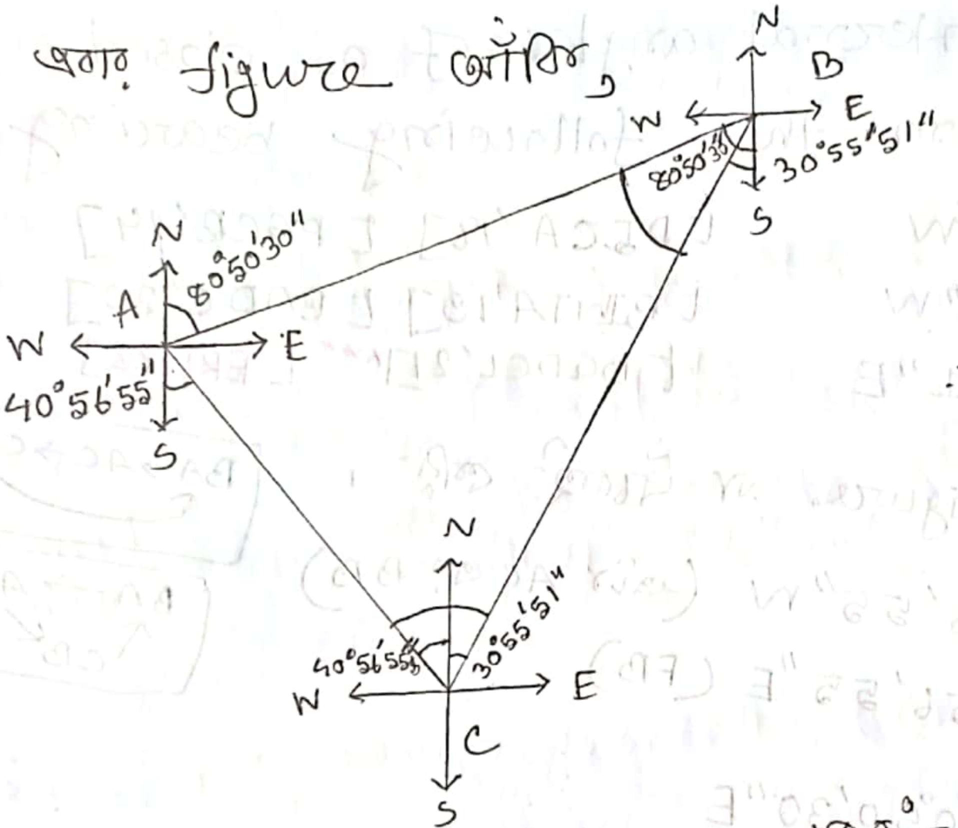
= 40°56'55" + 30°55"51"

= 71°52'46"

Ans

P.T.O

এবার figure আঁকি,



BA = S80°50'30"W

CA = N40°56'55"W

∴ AC = S40°56'55"E

CB = N30°55"51"E

∴ internal angles, $\angle A = 180° - (80°50'30" + 40°56'55")$

$= 58°12'35"$

$\angle B = 80°50'30" - 30°55'51"$

$= 49°54'39"$

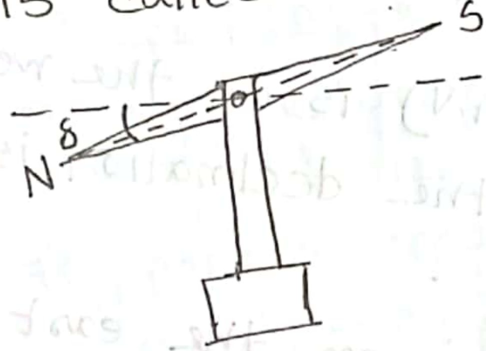
$\angle C = 40°56'55" + 30°55'51"$

$= 71°52'46"$ Ans

Magnetic Bearing & Declination

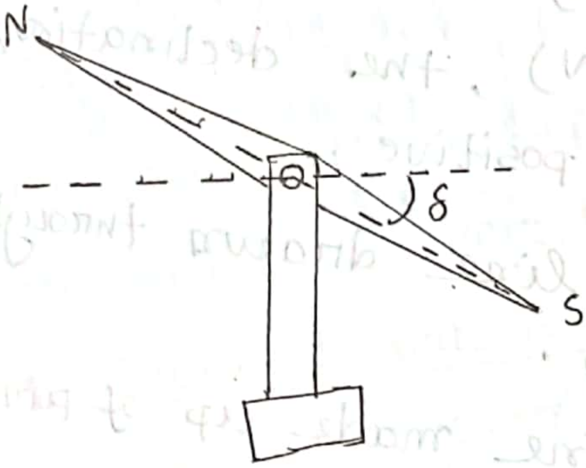
Magnetic bearing: It gives directly the magnetic bearings.

** **Magnetic dip:** The vertical angle between a freely suspended magnetic needle and horizontal is called dip.



⇒ If the compass is in north hemisphere of earth, then north end of the magnetic niddle will deflect downward due to attractive force of north pole of earth.

⇒ তাহলে পৃথিবীর north pole এ নিয়ে গেলে magnetic north end এর deflection 90° হয়ে যাবে।



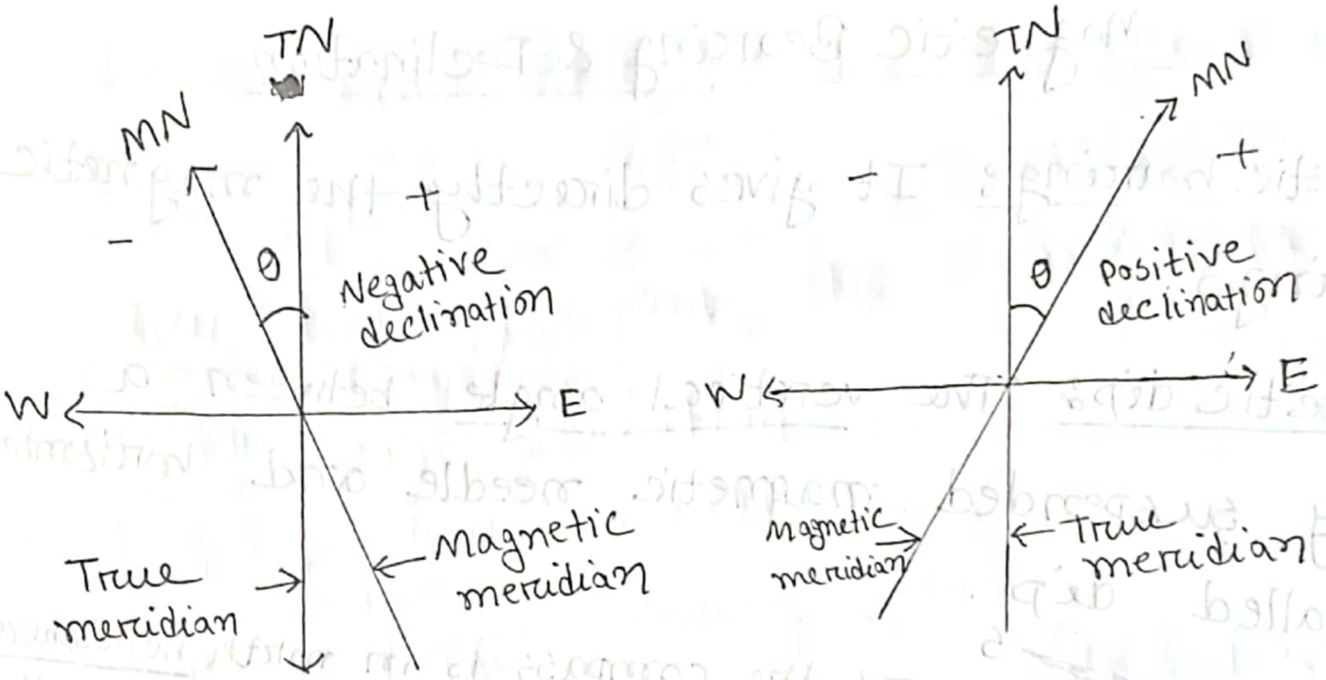
If the compass is in southern hemisphere,

⇒ If the south end of the magnetic niddle will deflect downward.

⇒ পৃথিবীর দক্ষিণ south pole এ নিয়ে গেলে এই deflection 90° হয়ে যাবে,

* The dip is zero at equation (needle will remain horizontal)

Magnetic ~~merid~~ declination: The horizontal angle between magnetic meridian and true meridian is known as magnetic declination.



⇒ If the magnetic north (MN) is on the west side of the true north (TN), the declination is said to be west or negative.

⇒ If the magnetic north (MN) is on the east side of the true north (TN), the declination is said to be east or positive.

*** Isogonic line is the line drawn through points of same declination.

*** Agonic line is the line made up of points having a zero declination.

Therefore we can say, all points on the agonic lines, the true meridian and the magnetic meridian (or 0 declination) coincide with each other.

CamScanner

Determination ~~for~~ of True Bearing:

⇒ For Whole Circle Bearing (WCB),

True Bearing = Magnetic bearing ± declination

\+ for east declination

− for west declination

⇒ For Reduced Bearing (RB)

→ Bearing যদি North pole এর সাপেক্ষে নেয়া থাকে, তবে bearing direction আর declination direction একই হলে '+' হবে। অথবা $N\theta_1W$ ও declination θ_2E যেমন $N\theta_1E$ ও declination θ_2E হলে '+' হবে চিহ্নের, কিন্তু বিপরীত declination θ_2W হলে '+' হবে, যেমন $N\theta_1E$ ও θ_2W দিকে হলে '−' হবে, যেমন $N\theta_1E$ ও θ_2W হলে '−' হবে, অথবা $N\theta_1W$ ও θ_2E হলে

→ Bearing যদি South pole এর সাপেক্ষে হয়— তবে একই দিকে হলে '−', বিপরীত দিকে হলে '+'

যেমন $S\theta_1W$ ও θ_2E এর ক্ষেত্রে অথবা, $S\theta_1E$ ও θ_2W এর ক্ষেত্রে '+'.

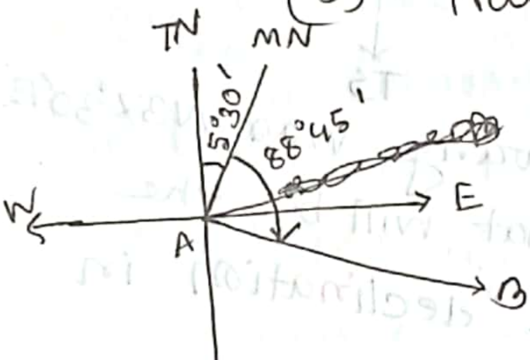
$S\theta_1E$ ও θ_2E হলে ও অথবা কিন্তু $S\theta_1W$ ও θ_2W '−'

(Always draw figure to avoid confusions)

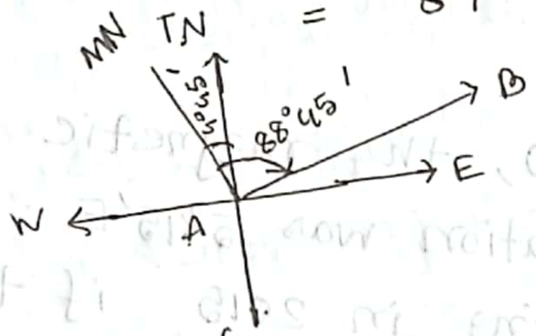
* The magnetic bearing of a line AB is 88°45'. Determine the true bearing if magnetic declination is (a) 5°30'E (b) 4°45'W

Sol^n: (a) True bearing = 88°45' + 5°30'
= 94°15'

(b) True bearing = 88°45' − 4°45'
= 84°



(a)



(b)

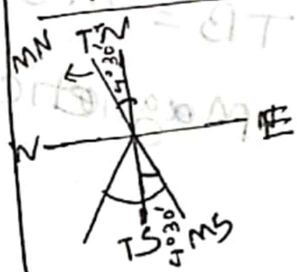
* magnetic bearing সবসময় magnetic meridian থেকে মাপ তবে উৎপন্ন হয়।

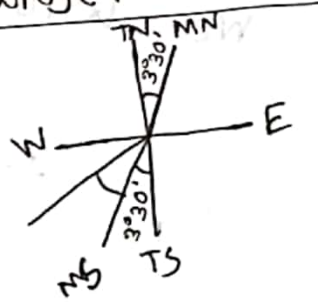
* The magnetic Bearing of a line AB is S38°30'W. Determine the true bearing if the magnetic ~~meridian~~ declination is (a) 4°30'W (b) 3°30'E

Sol^n: (a) True bearing
= ~~S38°30' − 4°30'~~
= S38°30' − 4°30'W
= S34°W

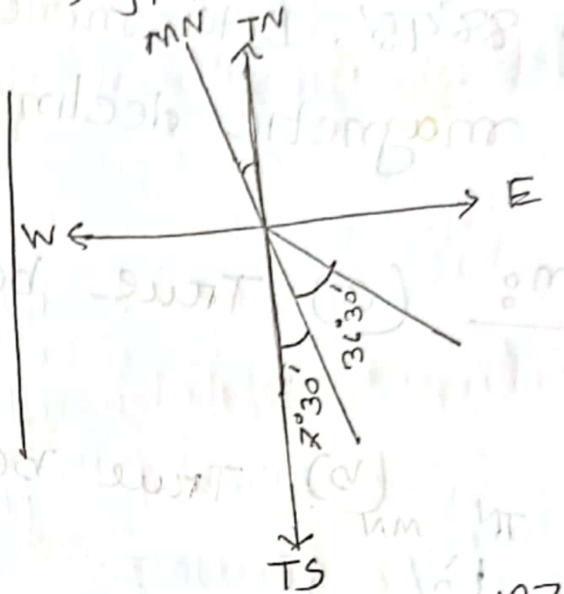
(b) True bearing
= S38°30'W + 3°30'E
= S42°W

2টা চিত্রের মাধ্যমে দেখানো হলো





(18) The magnetic meridian of a line is S 36°30′E, Declination 7°30′W, find true bearing. [MSc' 17]



Soln: True bearing
$= S36°30'E + 7°30'W$
$= S44°E$

(19) In 1920, the magnetic bearing was N37°30′E & the declination was 5°45′E. What will be the ~~true~~ magnetic bearing in 2015 if the declination in 2015 is 3°15′E? [MSc' 18]

Soln: True bearing $= N37°30'E + 5°45'E$
$= N43°15'E$

magnetic bearing in 2015,

we know,
$TB = MB + \text{declination}$
$\therefore$ Magnetic bearing $= N43°15'E - 3°15'E$
$= N40°E$ Ans

* A line AB had the magnetic bearing 44°30′ in 1910 when the declination was 4°30′W. Determine the magnetic bearing of the same line in 1990 if the annual declination change observed as was 6′ eastward

Soln: Total change in declination from 1910 to 1990 = 80 × 6′E = 480′ = 8°E

Declination in 1990 = 8°E − 4°30′W = 3°30′E (4°30′W থেকে 80 বছরে east এ দিকে 8° সরেছে)

In 1910, True bearing = 44°30′ − 4°30′ = 40°

In 1990, True bearing = Magnetic bearing + 3°30′

⇒ 40° = Magnetic bearing + 3°30′

⇒ Magnetic bearing = 36°30′ Ans

4°30′W থেকে 80 বছরে যদি east এ দিকে 8° সরে তাহলে 1990 সালের declination এর অবস্থান কোথায়? 3°30′E

Theodolite Survey

Theodolite is the most precise instrument used for ~~measing~~ measuring horizontal and vertical angles.

Theodolite can be classified as —

(1) **Transit theodolite:** (ISTI '15) A theodolite is said to be a transit one when its telescope can be rotated through 180° in a vertical plane about its horizontal axis, thus directing the telescope in exactly opposite direction. (oppo তে rotate camera phone 😊)

(* horizontal axis is also known as trunion axis - ইহার উপরেই telescope rotate করে।)

(2) **Non transit theodolite:** telescope cannot be rotated through 180°. Such ~~[illegible]~~ theodolites are obsolate nowadays

Line of sight: It is the imaginary line passing through the intersection of the horizontal & vertical cross hairs of the diaphragm and the optical centre of the objective (telescope এর ভেতর থাকে). When line of sight comes in horizontal plane (axis of telescope), it is called as line of collimation.

~~The line of collimation must coincide to the~~

~~axis of telescope [WRGCL'14] [BPDB'15]~~

*** The line of collimation must coincide to the axis of telescope [WRGCL'14] [BPDB'15]

Telescope normal (or Direct): when the face of the vertical circle is to the left and the bubble of telescope up.

Telescope inverted or reversed: when the face of the vertical circle is to the right and the bubble down.

Double sighting: measurement of horizontal or vertical angle twice; once with the telescope in normal condition and once with the telescope in inverted condition. Also called double centering.

**Parallax of theodolite: (ISTI'15)

Parallax is a condition arising when the image formed by the objective is not in the plane of cross hairs. Parallax can be eliminated in two steps:

(i) Focusing the eye piece for distinct vision of cross hairs.

(ii) Focusing the objective to bring the image of the object in the plane of cross hairs.

* What is parallax error in theodolite?

[BEPZA'21]

Parallax is a displacement or difference in the apparent position of an object viewed along two different lines of sight.

Elimination of parallax:

(i) Focusing the eye piece for distinct vision of cross-hairs

(ii) Focusing the eye piece to bring the image of the object,

Levelling.

(21) What is levelling? [44 BMA]

Sol^n: Leveling is to

→ Find the elevation of given points with reference to a given or assumed datum.

→ Establish points at a given elevation or at different elevations with reference to a given or assumed datum.

→ Deals with angular and linear measurements in a vertical plane.

* Datum: Any surface to which elevations are referred (i.e. MSL)

(MSC'16, BEPZA'14)

** Bench Mark: The bench mark (BM) is a fixed point of known elevation above the datum. (BADC) (Obj)

Any point whose elevation is definitely known can be used as a bench mark.

\# কোন সংস্থার তৈরী BM reference হিসেবে ব্যবহার করা হয় (BPSC)

(A) Geological Survey of Bangladesh (B) Zilla Porishad

(C) PWD (D) RHD

* Mean Sea Level (MSL) কেই datum হিসেবে ধরা হয় এবং তা থেকে দেশের বিভিন্ন স্থানের benchmark (BM) নির্ধারণ করা হয়।

Non: Bangladesh = 5 Date: English = 5

MRT = 5 BD affairs = 10

Sun Mon Tue Wed Thu Fri Sat

DMTCL - Line 5S (2023) MIST (Non tech MCQ 23, Depth = 5×13 = 65)

① An open traverse PQRST is surveyed using theodolite and the consecutive coordinates obtained are given in the table.

Line	Consecutive coordinates			
	Northing (m)	Southing (m)	Easting (m)	Westing (m)
PQ	110.2		45.5	—
QR	80.6		—	60.1
RS	—	90.7	—	70.8
ST	—	105.4	55.5	—

If the independent coordinates (Northing, Easting) of station P are (400m, 200m) the independent coordinates (in m) of station T, is what?

Ans:

Coordinates of station T

Northing = 400 + 110.2 + 80.6 − 90.7 − 105.4

= 394.7 m

Easting = 200 + 45.5 − 60.1 − 70.8 + 55.5

= 170.1 m

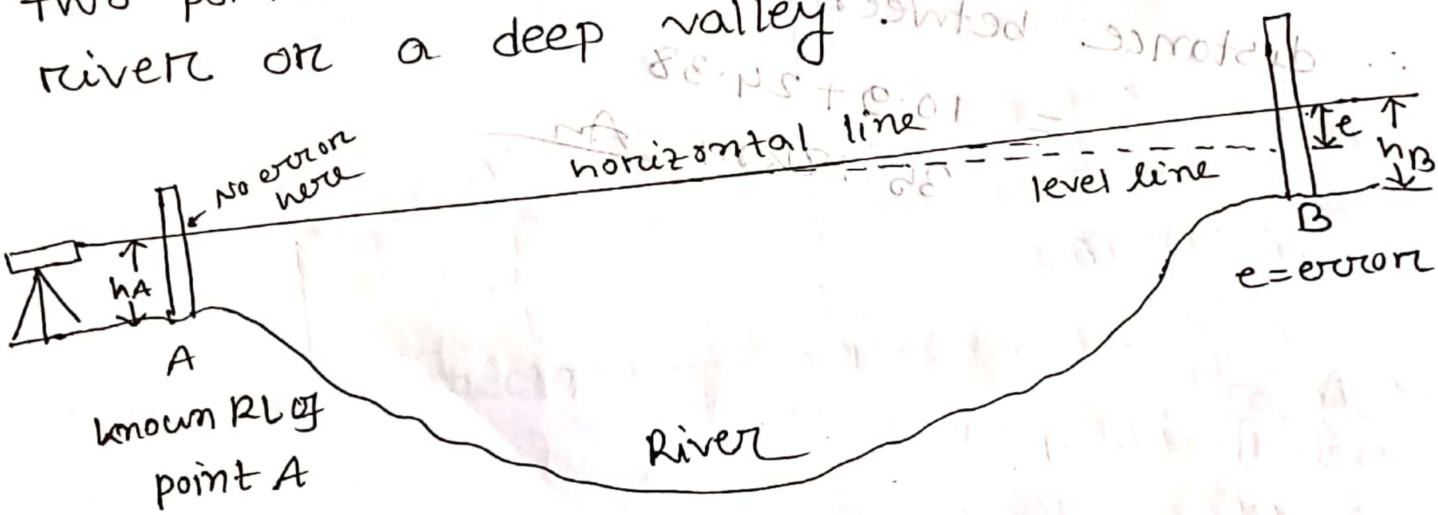
∴ Coordinate of T (Northing, Easting) = (394.7m, 170.1m)

Reciprocal Levelling

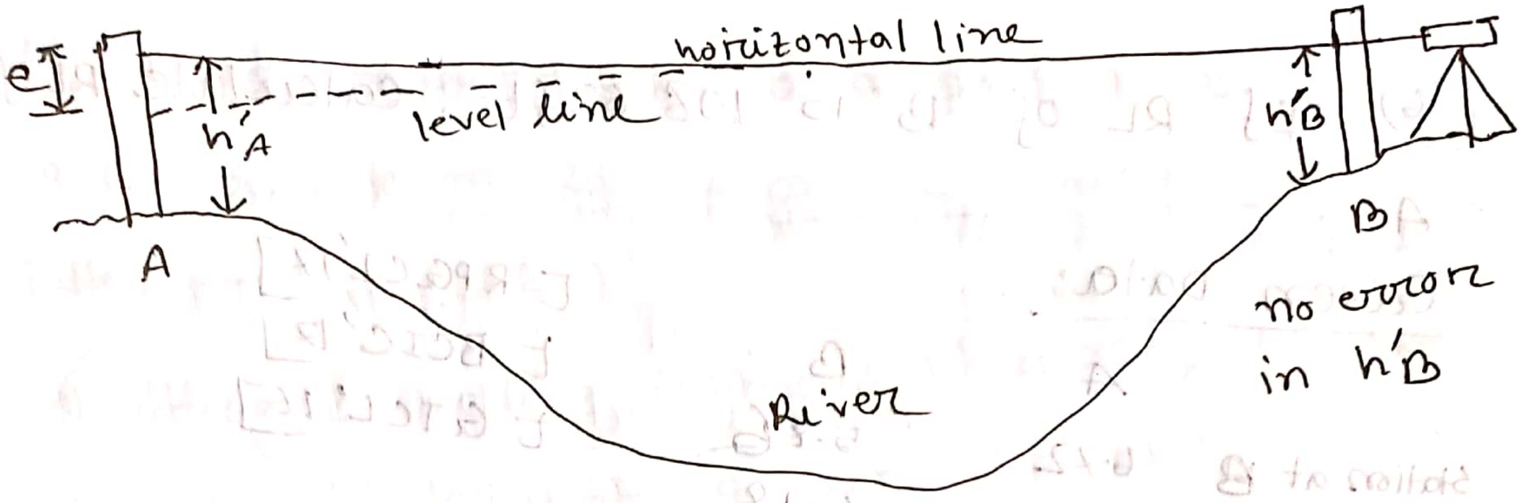
⇒ Reciprocal levelling is used to determine the correct difference in the elevations of two points which are quite a large distance apart and it is not possible to set up the instrument midway between these two points to balance the foresight & backsight.

⇒ Therefore reciprocal levelling is conducted to eliminate the curvature and refraction error due to large distance.

⇒ Reciprocal levelling is generally used to determine the difference in elevations of two points on the opposite banks of a river or a deep valley.



* Short note on reciprocal levelling [PGCL'21]



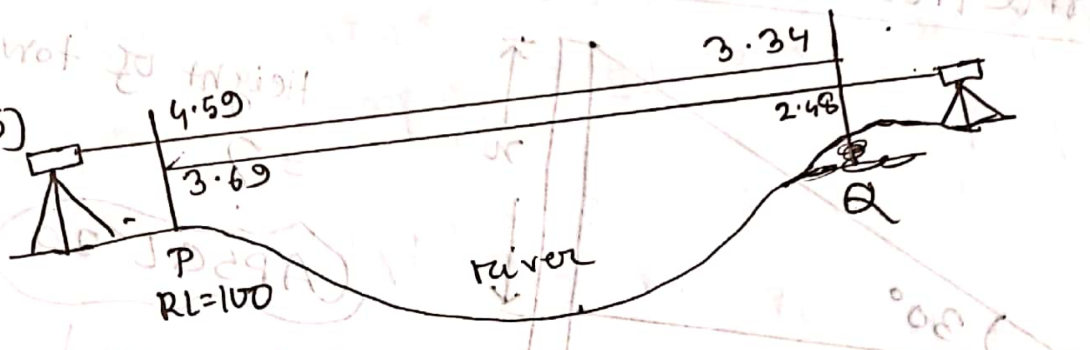
Difference in level between A & B

$$H = \frac{1}{2}\left[(h_A - h_B) + (h'_A - h'_B)\right]$$

* RL of A is known
* H এর মান চিহ্ন সহকারে known RL point
এর reading আগের নিয়মে হবে।

RL of B = RL of A + H

(25)



[PGCL'17]
[PGCB'20]
[KBDCL'21]
[RPGCL'22]
[MGMCL'22]

RL of Q = ?

Soln:

$$\text{RL of Q} = 100 + \frac{1}{2}\left[(4.59 - 3.34) + (3.69 - 2.48)\right]$$

$$= 101.23 \text{ A}$$

(26) If RL of B is 108.82 ft. calculate RL of A.

[RPGCL'17]
+ BCIC'17]
+ GTCL'18]

Given Data:

	A	B
Station at B	6.72	5.86
Station at A	4.96	4.18

Solⁿ: B এর RL দেয়া আছে, তাই B এর সাথে আমরা পাচ্ছি,

$$RL\ of\ A = 108.82 + \frac{(5.86-6.72)+(4.18-4.96)}{2}$$

$$= 108 \quad An$$

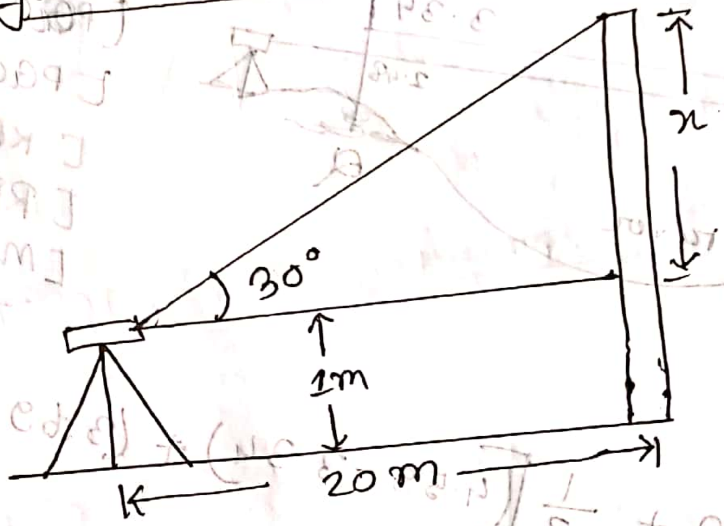
(28)

Trigonometric survey:

(27) Height of tower = ?

(APSCL'20)

[BIWTA'23]



Solⁿ: We know,

$x = D\tan\theta$

$= 20\tan 30° = 11.55m$

∴ Height of tower,

$H = 11.55+1$

$= 12.55m$ An

* . A staff reading taken on a point whose elevation is to be determined as on a change point is called —— (BREB)

(A) foresight reading (b) backsight reading.
(c) intermediate sight (d) none of this

* A fixed point of reference of known elevation is called —— (BADC)

(A) Bench mark (b) Datum point (c) Reduced level
(d)

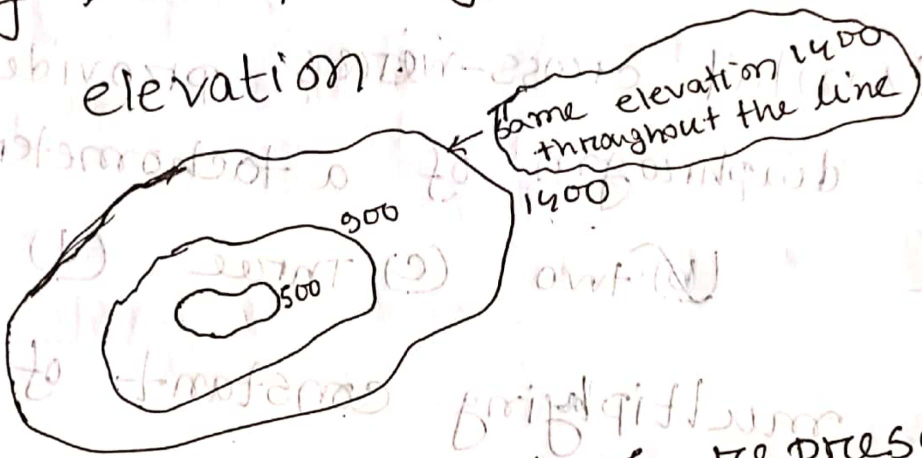
* The angle between the inclined line of sight and the horizontal is called (BADC)

(a) direct angle (b) vertical angle
(c) horizontal angle (d) deflection angle

Trigonometric survey 6422

Contours

Contour: A contour may be defined as an imaginary line passing through the points of equal elevation

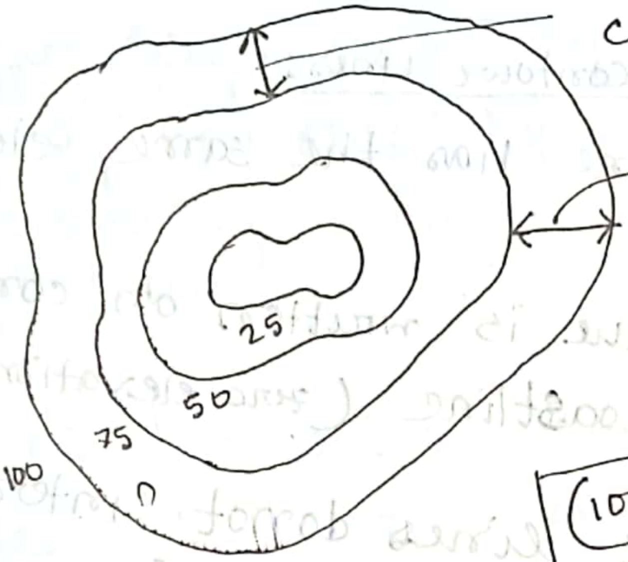


→ This is the best method of representation of features such as hills, depressions, underwaters etc on a two dimensional paper.

*** Contour line is drawn through point of same elevation [BPDB'15]

*** contour map এর এক সুবিধা হলো 2D plain paper এ যে কোন বস্তুর 3D mapping দেখানো যায়। contour line দ্বারা বিভিন্ন point এর elevation নির্ণয় করা যায়। এমন hills, rivers, valleys ইত্যাদির detailed description পাওয়া যায়।

[BD-China'16 → benifits of contour map]



$(100-75) = (75-50) = (50-25)$
$= 25$
constant interval

Contour Interval:

→ The vertical distance between ~~cosec~~ consecutive contour is termed as "contour interval"

→ Contour Interval is constant

1400 – 900 – 700 – 300
throughout throughout throughout throughout

Horizontal Interval:

→ The horizontal distance between consecutive contours is termed as horizontal equivalent
[BPDB'15] [NRGCL'14]

→ Horizontal Interval is not constant

→ steeper the ground, lesser is the horizontal equivalent.

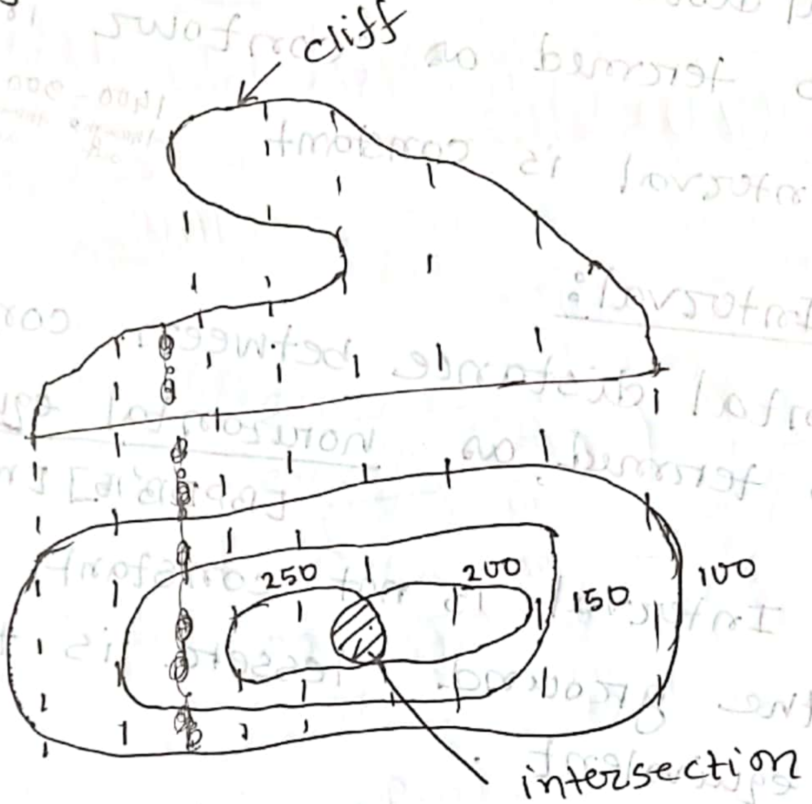
P.T.O

Characteristics of contour Lines:

→ A contour line has the same elevation throughout

→ when no value is written on contour line it represents coastline (zero elevation)

→ Two contour lines donot intersect each other except in the case of an overhanging cliff.



MCQ

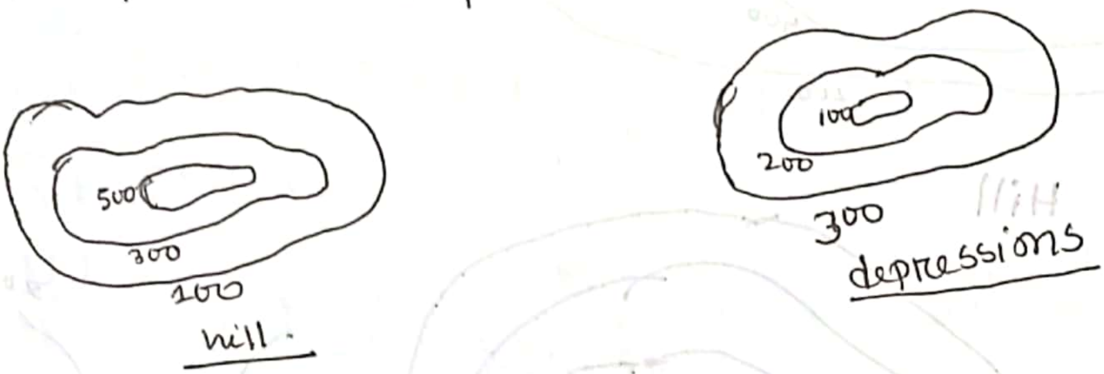
contours of different elevations may cross each other only in the case of ______ (BADC)

(A) overhanging cliff (B) vertical cliff (C) saddle (D) inclined plane

(BREB MCQ)

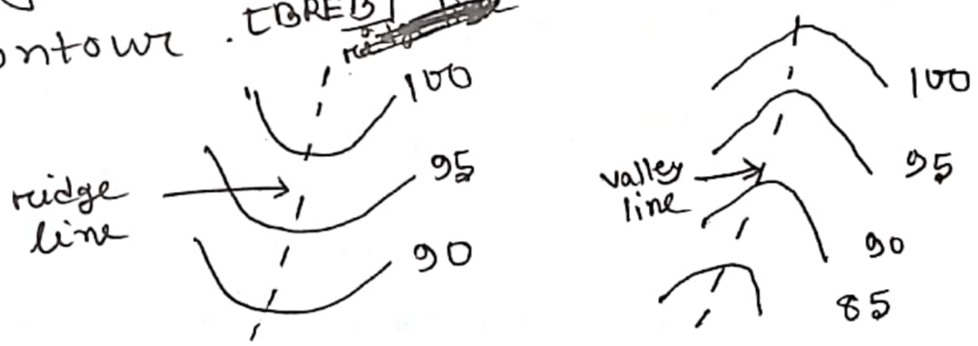
→ Contour lines closed together (Horizontally) indicates steep slope, far apart indicates gentle slope, equally spaced contour indicates uniform slope.

*** → A set of close contours with higher values inside and lower values outside indicates a hill. (MCQ)
lower value inside, higher value outside. indicates depressions, lakes etc. (MCQ)

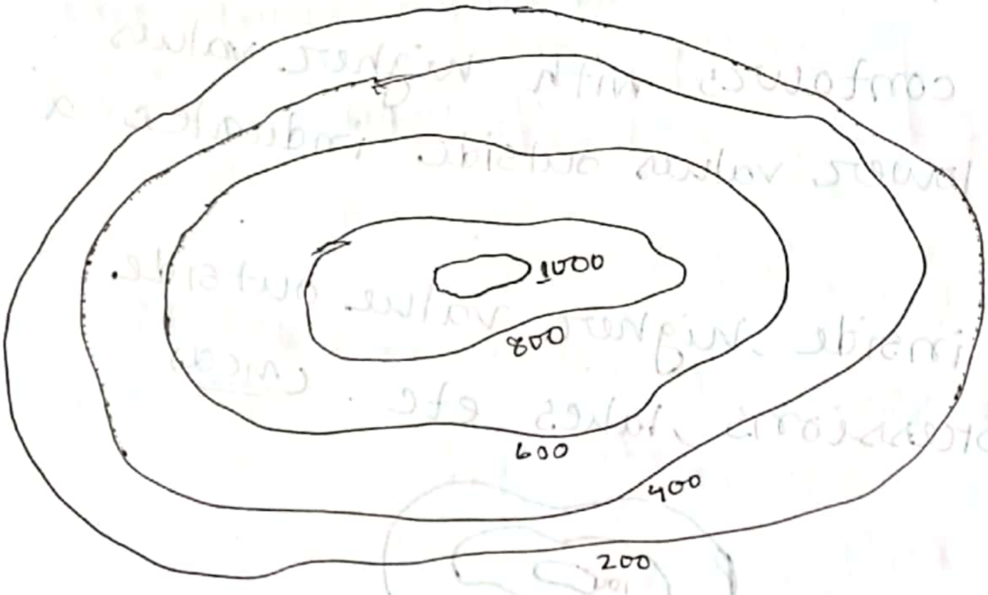


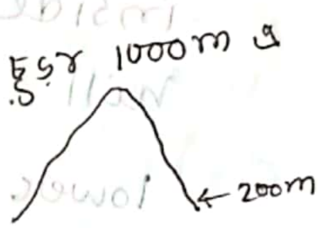
*** → If contour lines cross a ridge or watershed line at right angle (90°) and form a 'U' shaped contour.

*** → If contour lines cross a valley line at right angles (90°) and form 'v' shaped contour. [BREB]

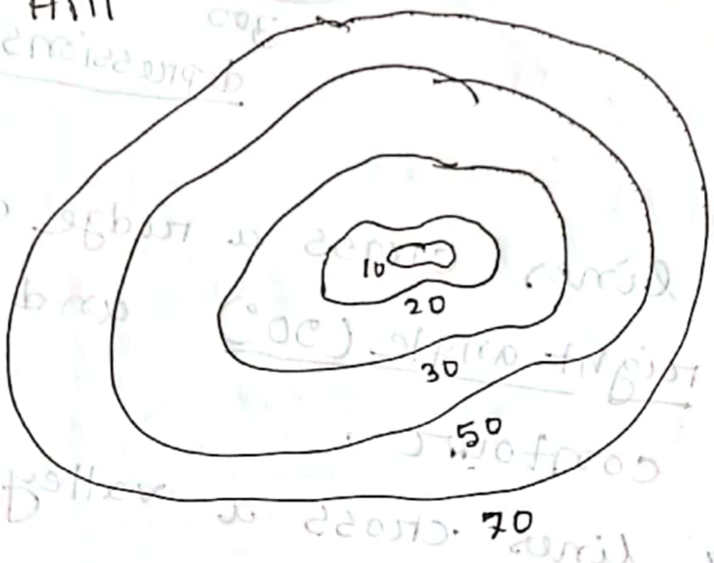


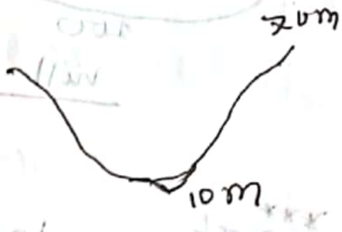
(28) Draw contour for pond and hill. What are the basic difference to these types of contour? [BEPZA'16] [WZPDCL'19] [SGBMA]





Hill





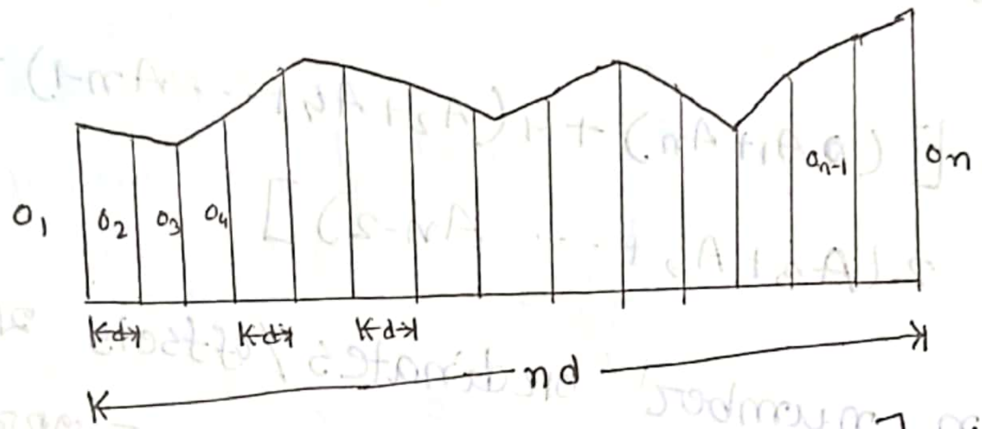
Ponds

Areas & Volumes

Trapezoidal rule:

→ Assumes the area in the forms of trapezoids between the offset's

→



Area, $A = d\left[\frac{o_1 + o_n}{2} + o_2 + o_3 + o_4 + \cdots o_{n-1}\right]$; ~~where o = ordinate~~

where, o = ordinate = RL reading

d = distance

Volume, $V = \left[\frac{A_1 + A_n}{2} + A_2 + A_3 + \cdots A_{n-1}\right] \times L$

where, A = Area

L = distance

Simson's rule / prismoidal rule

→ The boundary between the ordinates is assumed to be parabolic

***→ If the ordinates are odd then only this formula is useful

$$A = \frac{d}{3}\left[(O_1+O_n) + 4(O_2+O_4+\cdots+O_{n-1}) + 2(O_3+O_5+\cdots O_{n-2})\right]$$

4* জোড় ordinates | n বাদে বিজোড় গুলো
2* বিজোড় ordinates | n-2 ও বিজোড়
এবং n-1 জোড়

$$V = \frac{L}{3}\left[(A_1+A_n) + 4(A_2+A_4+\cdots A_{n-1}) + 2(A_3+A_5+\cdots A_{n-2})\right]$$

যদি even number ordinates/offsets থাকে তখন simpson's rule apply করতে বলে তখন এবং simpson's rule ~~[illegible]~~ এইভাবে কাজ করা যেতে পারে -

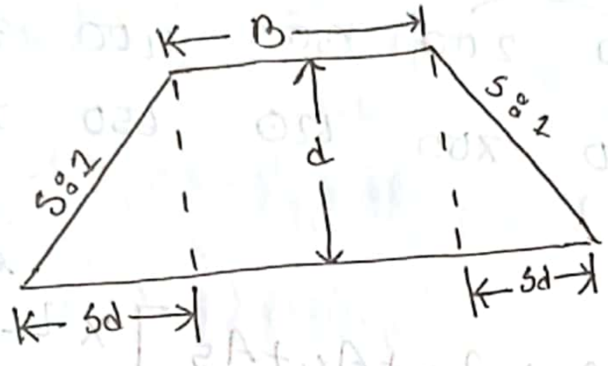
(1) second last ordinate পর্যন্ত (কেননা তখন odd হয়ে যাবে) simpson's rule apply করতে হবে।

(2) last ordinate এর area trapezoidal rule apply করে করতে হবে।

 ট্রাপিজিয়াম এর মতো trapezoidal ও হয় বলে ও বলে

(3) এরপর দুইটির যোগ করে final result বের করতে হবে।

X-sectional Area of Road:

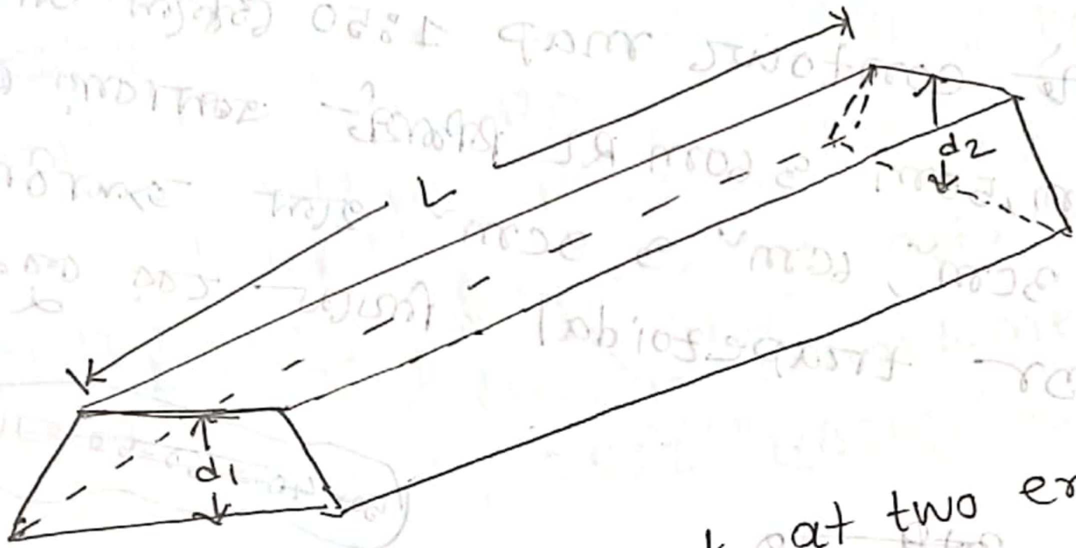


B = width of road

Area of road section $= Bd + 2 \times \left(\frac{1}{2} \times Sd \times d\right)$

$= Bd + Sd^2$

$= (B + Sd)d$



d_1 & d_2 = height of bank at two end portion of embankment

mean depth, $d = \frac{d_1 + d_2}{2}$

~~Area~~ ~~Quantity of~~
volume of earth work $= [(B + Sd)d] \times L$ — mean depth

(30) Find the volume by trapezoidal rule. [BWDB'19]

common difference = L

Chainage (m)	0	100	200	300	400	500
Area (m^2)	560	650	700	620	650	760

Soln:

$$V = \left[\frac{A_1+A_6}{2} + A_2 + A_3 + A_4 + A_5\right] \times L$$

$$= \left[\frac{560+760}{2} + 650 + 700 + 620 + 650\right] \times 100$$

$$= 328000\ m^3 \quad \text{Ans}$$

(31) * একটি contour map 1:50 স্কেলে অঙ্কিত। হইতে 40m, 50m ও 60m RL নির্দিষ্ট এলাকায় ক্ষেত্রফল যথাক্রমে 3cm², 6cm² ও 9cm² হলে কনট্যুরের trapezoidal নিয়মে বের করুন। ঘনফল

~~50 − 40 = 60 − 50 = 10~~

Soln:

~~$V = \frac{3+9}{2} + 6$~~

~~$V = \left[\frac{3+9}{2} + 6\right] \times 10$~~

~~$= 120\ cm^3$~~

∴ ~~Actual~~

P.T.O

Solnº: RF of scale = 1:50

∴ field areas will be,

$A_1 = 3 \times (50)^2 = 7500 cm^2 = 0.75 m^2$

$A_2 = 6 \times (50)^2 = 15000 cm^2 = 1.5 m^2$

$A_3 = 9 \times (50)^2 = 22500 cm^2 = 2.25 m^2$

1:50
1cm : 50cm
∴ 1cm² : 50² cm²

Now, volume = $\left[\frac{0.75 + 2.25}{2} + 1.5\right] \times 10$

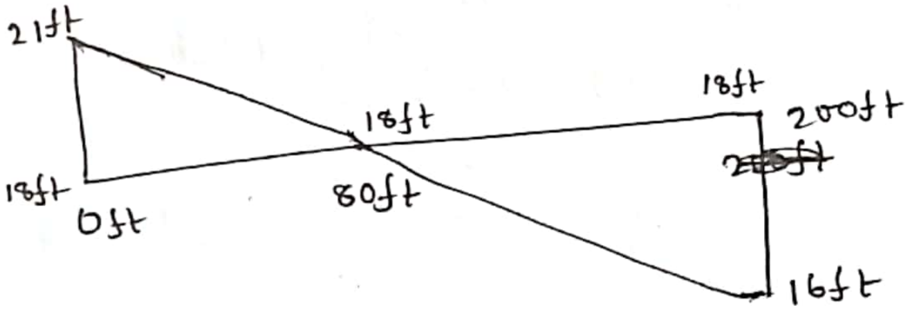
$= 30 m^3$ Ans

60-50 = 50-40 = 10

~~(31) If ground is~~

(31) Estimate the earth excavation. Design RL is 21ft, 18ft. Existing RL of embankment are 21ft, 18ft, 16ft at a distance of 0ft, 80ft, 200ft respectively. Width of embankment is 25ft. ~~H:V~~ slope is 2.5:1 (BGFCL'17, SGFL'17)

Solnº:



Area at 0ft = (b+sh)h
= (25 + 2.5×3)3
= 97.5 ft²

| (21-18) ft
= 3 ft

Area at 80ft = 0 [Existing RL − Design RL = 18 − 18 = 0]

$$\text{Volume of cutting} = \frac{A_1 + A_2}{2} \times \text{distance}$$

$$= \frac{97.5 + 0}{2} \times (80 - 0)$$

$$= 3900 \text{ ft}^3$$

[18 − 16 = 2]

$$\text{Area at 200ft} = (b + sh) \times h$$

$$= (25 + 2.5 \times 2) \times 2$$

$$= 60 \text{ ft}^2$$

(80ft এ 0)

$$\text{Volume of filling} = \frac{0 + 60}{2} \times (200 - 80)$$

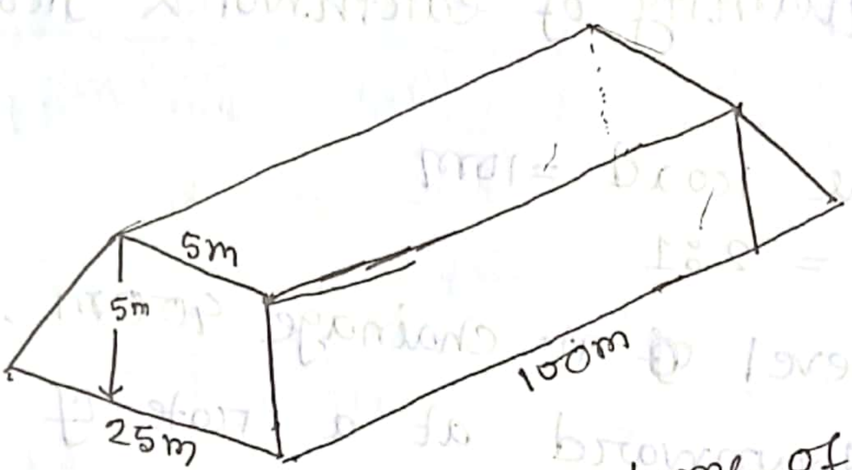
$$= 3600 \text{ ft}^3$$

∴ Volume of cutting = 3900 ft^3

filling = 3600 ft^3

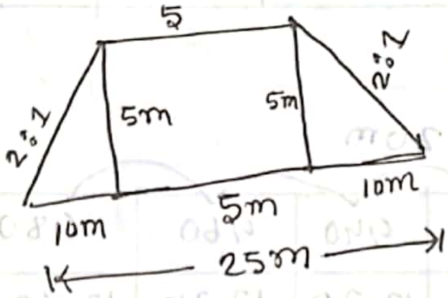
Total earthwork = 7500 ft^3 Ans

(32)



Find the side slope and volume of earthwork required [APSCL'20]

Soln:



Sideslope = 2H : 1V

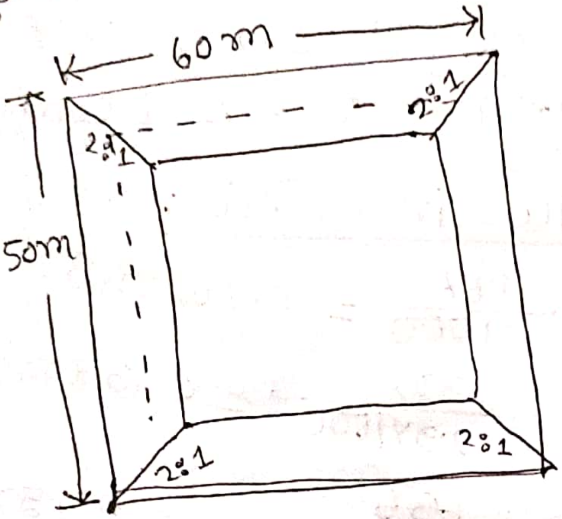
Volume of earthwork = ~~$\left\{\frac{1}{2}(25+6)\times 5\right\}\times 100$~~

= ~~$7500 m^3$ An~~

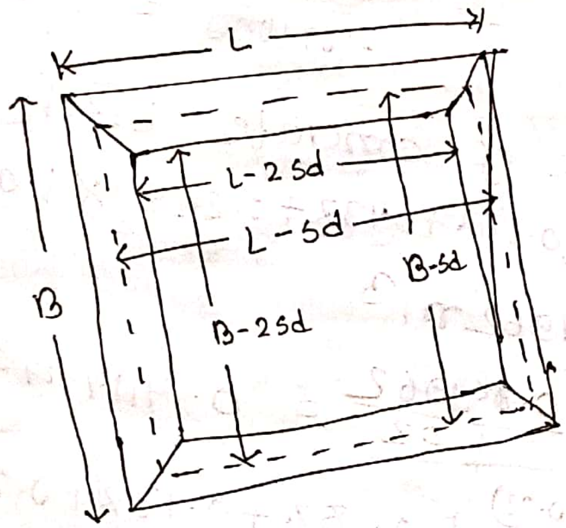
= $\{(25+2\times5)\times5\}\times100$

= $17500 m^3$ A

7) A rectangular pond's x-section is given. Depth of the pond is 5m. Determine the volume of earthwork. [NESCO'18]



Soln:



sd ⇒ slope একেবারে উপর থেকে শুরু হয়ে পুকুরের তলদেশ পর্যন্ত গেছে। তলদেশে d=5 হলে অর্থাৎ তলদেশে সবচেয়ে কম Length/width পাওয়া যাবে। দুই পাশ থেকে sd পরিমাণ কম যাওয়ায় L-sd বা B-sD হবে।

$A_1 = L \times B$; $A_m = (L-sd) \times (B-sd)$; $A_2 = (L-2sd) \times (B-2sd)$

Prismoidal formula, $V = \frac{d}{6}[A_1 + A_2 + 4A_m]$

$\therefore$ volume of earthwork $= \frac{5}{6} \times [3000 + 1200 + 4 \times 2000]$

$= 10166.67 \, m^3$ Ans

A_m = গড় দৈর্ঘ্য x গড় প্রস্থ

Photogrammetry

* A map of the airport area plotted at the scale of 1 in 20,000 is available. If the length of a runway on the map is 120mm, determine the scale of photograph. The photo distance of the runway is 188 mm.

Solⁿ:

$$\text{Scale of photograph} = \frac{\text{Photo distance}}{\text{Ground distance}} \quad \text{—(i)}$$

$$\text{Scale of map} = \frac{\text{map distance}}{\text{Ground distance}} \quad \text{—(ii)}$$

(i) ÷ (ii)

$$\therefore \frac{\text{scale of photograph}}{\text{scale of map}} = \frac{\text{photo distance}}{\text{map distance}}$$

$$\therefore \text{scale of photograph} = \frac{188\text{ mm}}{120\text{ mm}} \times \frac{1}{20,000}$$

$$= 1 \text{ in } 12766$$

A

$$\frac{47}{600,000} = \frac{1}{\frac{600,000}{47}} = 1 \text{ in } 12766$$

Determination of Number of photographs required to cover a given ground area

Method 1 : when ground area "A" is given,

No of photographs Required, $N = \frac{A}{a}$

a = area covered by one photograph

$= (1 - P_l) \times l \times s \times (1 - P_s) \times w \times s$

where,

P_l = longitudinal/end lap [0.6 usually]

P_s = side lap [0.3 usually]

l = length of photograph in the direction of flight

w = width of photograph normal to the direction of flight

s = scale factor

Method 2 : when length (L) & width (W) of the area to be covered is given on ground

No of photographs required, $N = \left[\frac{L_0}{(1-P_l) \times l \times s} + 1\right] \times \left[\frac{W_0}{(1-P_s) \times w \times s} + 1\right]$

* Determine the number of photographs required to cover an area of 500 sq.km if the scale of the photograph is 1 in 10,000 & the photograph format is 230mm x 230mm. Take the longitudinal overlap as 60% and the side overlap as 30%.

Sol^n:

$$a = (1-0.6) \times 0.230 \times 10{,}000 \times (1-0.3) \times 0.230 \times 10{,}000$$

$$= 148120 0\,m^2 = 1.4812\,km^2$$

$\therefore$ Number of photographs required $= \dfrac{500}{1.4812}$

$= 337.56$

≈ 338 NOS

P.T.O

* Determine the number of photographs required to cover an area 25km X 20km if the scale is 1 in 10,000 and the format is 230 X 230mm. Take longitudinal lap as 60% and the side lap as 30%

Soln:

Number of photographs

$$N = \left[\frac{25 \times 10^3}{(1-0.6) \times 0.230 \times 10,000} + 1\right] \times \left[\frac{20 \times 10^3}{(1-0.3) \times 0.230 \times 10,000} + 1\right]$$

= 378 Nos

(??)* For Arial photography, compute the flight plan from the following data for the flight plan:

Length of ground along N-S direction = 40km

Width of ground along E-W direction = 30km

Average elevation above datum = 300m

Focal length of camera, f = 152.4mm

Format = 230mm X 230mm

End overlap = 60%

Side lap = 30%

Average scale = 1 in 10,000

Ground speed of aircraft 240km/hr

Flight strips are to be laid out in N-S direction. Also prepare the flight map on a base map whose scale is 1 in 50,000.

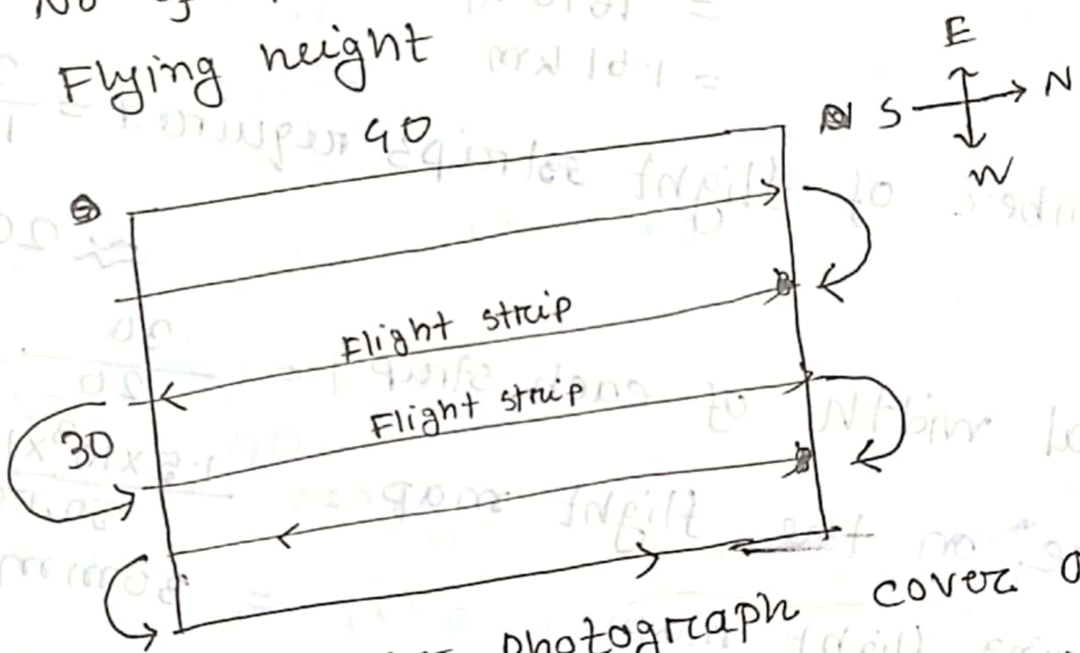
Soln:

Flight ~~map~~ plan বলতে বুঝায় কিছু কাজ করা—

→ No of flight strips

→ No of photograps per strips

→ Flying height



সম্পূর্ণ area ~~~~ এর photograph cover করার জন্য- flight পরিচালনার করে সাজানো N-S বরাবর, বারবার flight ... width (30km) এর দিকে নিচে করতে area এর হবে।

Soln: Flying height above ground, $H' = fS$

$= 0.1524 \times 10{,}000$

$= 1524 m$

Height above datum $= 1524 + 300 = 1824 m$

Width covered on the ground by one flight strip, $W = (1 - P_s) \times w \times S$

$= (1 - 0.3) \times 0.230 \times 10{,}000$

$= 1610 m$

$= 1.61 km$

(width 30km)

$\therefore$ Number of flight strips required $= \frac{30}{1.61} + 1$

≈ 20

$\therefore$ Actual width of each strip $= \frac{30}{20} = 1.5 km$

Distance on the flight map $= \frac{1.5 \times 10^3 \times 10^3}{50{,}000}$

$= 30 mm$

(Preparing flight map km → mm (10^6))

The length covered by each photograph,

$L = (1 - P_l) \times l \times S$

$= (1 - 0.6) \times 0.230 \times 10{,}000$

$= 920 m = 0.92 km$

একটি ছবি 0.92km দূরত্ব অতিক্রম করে। অর্থাৎ প্রতিটি

ছবি তুলতে হইলে 0.92km পর পর তুলতে হবে। এখন একটি ছবি তোলার পর নেক্সট ছবি তোলার জন্য 0.92km যেতে যতসময় লাগে তত সময় পর্যন্ত অপেক্ষা করতে হবে।

∴ Interval between two consecutive photos,

$$T = \frac{0.92\,km}{240\,km/hr} \times 3600\,sec \approx 14\,sec$$

(plane speed)

Adjusted ground distance $= \frac{14}{3600}\,hr \times 240\,km/hr$

$= 0.933\,km$

∴ Adjusted number of photographs per flight line. $= \frac{40}{0.933} + 1 = 44$

∴ Total Number of photographs $= 20 \times 44$

$= 880$ Nos

(33) For aerial photography, determine the number of flight ~~times~~ required to cover this area from following data:

Area = 16×20 miles

Focal length = 12 inch

Photograph size = 9"×9"

Photo scale = 1:10,000

Overlap = 60%

Side lap = 25%

Flight line is in the direction of 20 miles and outer line coincides with boundary. [PGCB'15]

Soln:

Width covered on the ground by one flight strips, $W = (1-P_s) \times w \times S$

$= (1-0.25) \times \frac{9}{12} \times 10,000$

$= 5625$ ft

$= \frac{5625}{5280} = 1.065$ mile

Number of flights required $= \frac{16}{1.065} + 1$

$= 16$ Nos

Ans

* Vertical photographs are to be taken of an area whose mean ground elevation is 2000ft. If the scale of the photographs is approximately 1:15,000, determine the flying height. Focal length of the camera lens is 7.5 in

Solⁿ: $f = 7.5 in = 0.625 ft$

$$S = \frac{f}{H-h}$$

$$\Rightarrow \frac{1}{15000} = \frac{0.625}{H-2000}$$

$\therefore H = 11,325 ft$ Ans

or use,

flying height = elevation + photo scale * focal length

$$\therefore H = 2000 + 15000 * \frac{7.5}{12}$$

$= 11325 ft$

* The elevation of two points A & B on an aerial photograph are 500ft & 565ft respectively. The scales at these points on the photograph are 1:10,000 & 1:9870 respectively. Determine the elevation at point C, if the scale at C is 1:8000.

Solⁿ: at A,

$$\frac{1}{10,000} = \frac{f}{H-500}$$

$\therefore H-500 = 10,000f$ —— (i)

At B, $\frac{1}{9870} = \frac{f}{H-565}$

$\therefore H-565 = 9870f$ —(ii)

CamScanner

Solving these eqns

$f = 0.5 ft$

from eqn (i), $H = 5500 ft$

∴ Elevation at C point,

$$\frac{1}{8000} = \frac{0.5}{5500 - h_c}$$

$\therefore h_c = 1500 ft$ (Ans)

* An aerial photograph is taken from a flight at a height of 3.5km above mean sea level, using a camera of focal length 152mm. If the average ground elevation is 460m above mean sea level, than the photograph scale is _______ ?

Solⁿ:

$$Scale = \frac{152 \times 10^{-3}}{3500 - 460} = \frac{1}{20,000}$$ A