LAB MANUALS
SURVEYING – II

LAB MANUALS
SURVEYING – II

MGM'S
JAWAHARLAL NEHRU ENGINEERING COLLEGE
N-6, CIDCO, AURANGABAD

CIVIL ENGINEERING DEPARTMENT

LAB MANUALS

(Procedure for Conduct of Practicals/ Termwork)

Subject:- Surveying-II
Class:- (S.E Civil)

Prepared by	Revised and Approved by Head of Department	Issued by MR

CONTENTS

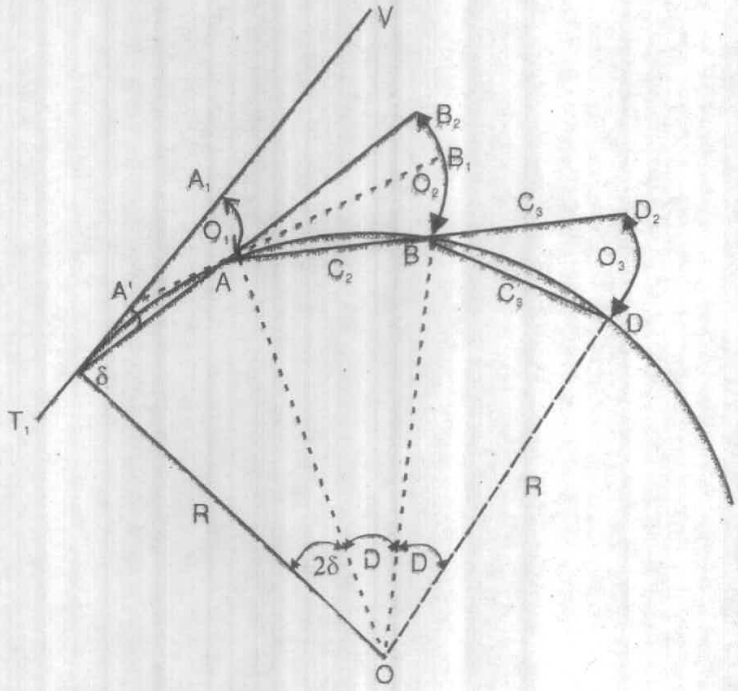
EXPERIMENT NO. 1

1) AIM : Setting of Curves by deflection distances (or offsets from the chords produced)

Definition : The method is very much useful for long curves and is generally used on highway curves when a theodolite is not available.

2) INSTRUMENTS USED : Theodolite, chain, Ranging rods, tape, Pegs, Hammer etc.

3) PROCEDURE :



Procedure for Setting Out the curve

1. Locate the tangent points T_1 and T_1 and find out their chainages as explained earlier. Calculate the length (c) of the first sub-chord so that the first peg is the full station.
2. With zero mark at T1 spread the chain (or tape) along the first tangent to point A1 on it such that T_1A_1=c=length of the first sub-chord.

Procedure for Setting Out Curve

1. Set the theodolite at the point of curve (T_1). With both plates clamped to zero, direct the theodolite to bisect the point of intersection (V). The line of sight is thus in the direction of the rear tangent.
2. Release the vernier plate and set angle ∇_1 on the vernier. The line of sight is thus directed along chord T_1A.
3. With the zero end of the tape pointed at T_1 and an arrow held at a distance = T_1A=c along it, swing the tape around T_1 till the arrow is bisected by the cross-hairs. Thus, the first point A is fixed.
4. Set the second deflection angle ∇_2 on the venire so that the line of sight is directed along T_1B.
5. With the zero end of the tape pinned, at A, and an arrow held at distance AB = C along it, swing the tape around A till the arrow is bisected by the cross-hairs, thus fixing the point B.
6. Repeat steps (4) and (5) till the last point T_2 is reached.

Check : The last point so located must coincide with the point of tangency (T_2) fixed independently by measurements from the point of intersection. If the discrepancy is small, last few pegs may be adjusted. If it is more, the whole curve should be reset.

In the case of the left hand curve, each of the calculated values of the deflection angle (i.e. ∇_1, ∇_2 etc.), should be subtracted from 360^0. The angles so obtained are to be set on the vernier of theodolite for setting out the curve.

EXPERIMENT NO. 2

1) **AIM : Setting of Curves by deflection Rankine's Method.**

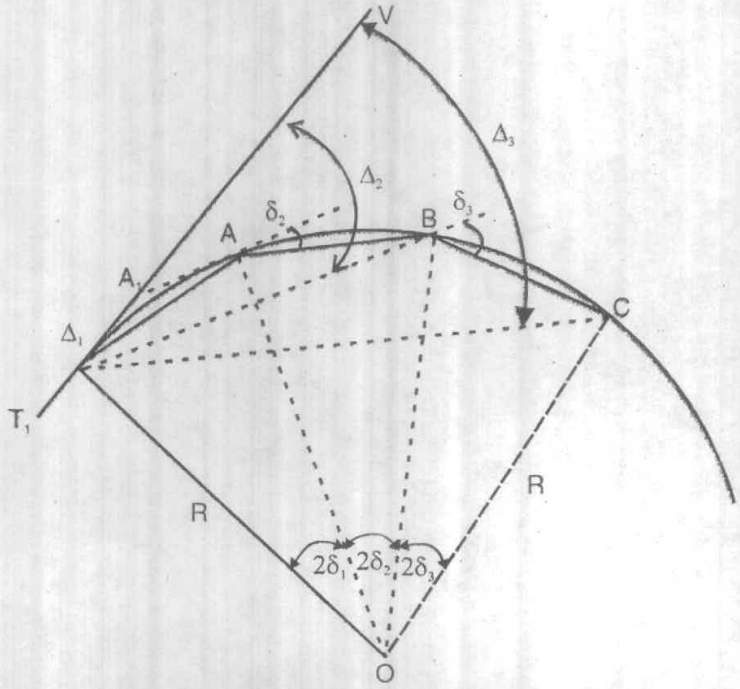
2) **INSTRUMENTS USED :** Theodolite, chain, Ranging rods, tape, Pegs, Hammer etc.

3) **PROCEDURE :**

RANINE'S METHOD OF TANGENTIAL (OR DEFLECTION) ANGLE

A deflection angle to any point on the curve is the angle of P.C. between the back tangement and the chord from P.C. to that point.

Rankine's method is based on the principle that the deflection angle to any point on a circular curve is measured by one-half the angle subtended by the arc from P.C. to that point, It is assumed that the length of the arc is approximately equal to its chord.



3. With T_1 as centre and T_1A_1 as radius, swing the chain such that the arc A_1A=calculated offset O_1. Fix the point A on the curve.

4. Spread the chain along T_1A and pull it straight in this direction to a point B_2 such that the zero of the chain is at A and the distance AB_2=C=length of the normal chord.

5. With zero of the chain centred at A and AB_2 as radius, swing the chain to a point B such that $B_2B=0_2$=length of the second offset. Fix the point B on the curve.

6. Spread the chain along AB and repeat the steps (4) and (5) till the point of tangency (T_2) is reached. All intermediare offsets will be equal to $\frac{C^2}{R}$, while the last offset will be equal to $\frac{c'}{2R}(C+c')$.

The last point so fixed must coincide with the point of tangency (T_2) field originally by measurements from the vertex. If the discrepancy (sometimes called as the closing error) is more, the curve should be reset. If the error is less, it should be distributed to all the points by moving them sideways by an amount proportional to the square of their distance from the point T_1.

The method is mostly used in road surveys and is very satisfactory, specially when a theodolite is not available. However, it has a great defect in that the error in fixing a point is carried forward.

EXERCISE NO : 3

MEASUREMENT OF A BASE LINE

AIM : To measure the distance between two points on a base line by subtense bar method.

EQUIPMENTS : Subtense bar, transit theodolite with tripod, pegs, hammer metallic tape etc.

THEORY : Substnce bar is an instrument by which we can measure horizontal distance on a base line with better accuracy.

A subtance bar of fixed length usually 2m is stationed at one end of the base line to be measured and theodolite at the other end. The bar can be folded at the centre of the bar so as to set the substance bar parallel to the line. The base is supported by a tripod and can be levelled accurately. The angle α subtended by the bar at the instrument station called the parallactic angle is measured by the theodolite (i.e. hori. Angle) between the triangular targets. The Vertical angle is also measured from this the horizontal distance between inst station & substance bar station is calculated.

FIGURE :

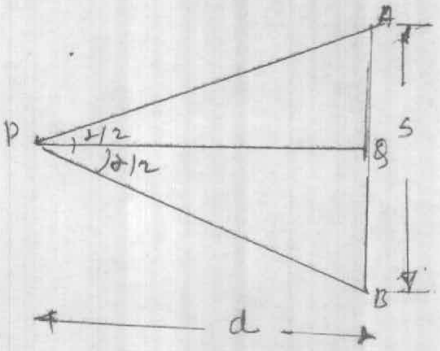


fig No 1

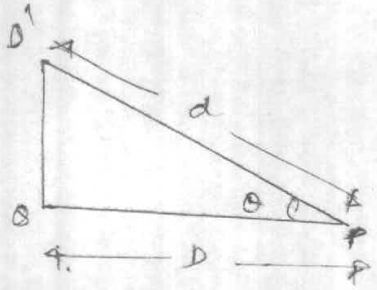


fig No 2.

P = Theodolite station

Q = Substance bar station

~~PK~~ = Horizontal angle APB.

Θ = Vertical angle = QPQ

d = Inclined distance between theodolite & substance bar.

D = Hori. dist bet theodolite & substance bar.

OBSERVATIONS TABLE :

INSTST	OBJECT SIGHTED	FACE	VER 'A' READING			VER 'B' READING			MEAN ANGLE	REMARKS
			IR	F.R.	Q&R	IR	F.R.	D & R		

OBSERVATIONS :

i) Mean Horizontal angle (α) =----------

ii) Mean Vertical angle (Q) = ----------

CALCULATIONS :

From fig. (1)

$$\tan \frac{\alpha}{2} = \frac{AQ}{PO} = \frac{1}{d}$$

$$\therefore d = {}^{1}/\tan \alpha/2 = 1.\cot \frac{\alpha}{2}$$

$$\therefore d = \frac{s}{2} \cot \frac{\alpha}{2} \qquad \text{(I) : s is the stadia dift.}$$

From Fig (2)

$$\cos Q = \frac{PQ'}{PQ} = \frac{D}{a}$$

$$\therefore \quad D = d \cos Q \quad \text{- II}$$

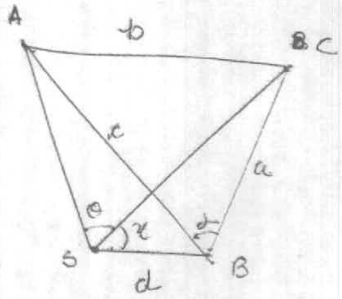
RESULT : Horizontal distance between two points P & Q on a base line by substense bar method is ----------m.

EXRCISE NO. 4

SATELLI E STATION : REDUCTION TO CENTRE

In order to secure well conditioned triangle or better visibility obje ts such as church spires flag poles, towers etc are selected as e triangulation stations. When the observations are taken from such station, i is impossible to set up an inst over it. in such case a subsidiary station known as satellite station or eccentric station is selected as new to the main station as possible and dos are taken to the other triangulation stations. These ang es are later corrected and reduced to what they would have been of the t ue station was occupied. [This operation of applying the corrections due to eccentricity of the st ation is known as 'Reduction to centre'.

Let A, B, C — Triangulation stations
S = Satellite Station for B.
d = BS = eccentric dist bet B & S.
Q = ASC = obs angle at S.
α = True angle at B
Y = LCSB = obs angle at S
β_1 = SAB.
β_2 = SCB
AC = d, AB= C & BC=α



(b) (d)

1) Measure AC & BS.

: BC = a = $\frac{b \sin CAB}{\sin ABC}$.

AB = C = $\frac{b \sin ACB}{\sin ABC}$.

Now ABC = 180 - ∠BAL - ∠BCA

: r = 180 - ∠A ∠C

2) Knowing sides AB & BC and eccentric distance BS, 'S ABS & CBS can be solved by sine rule. to get the values of β_1 & β_2 respectively.

: from ABS :

$\sin \beta_1 = \frac{BS \sin ASB}{ABC} = \frac{d \sin (Q + Y)}{C}$

and from CBS

$\sin \beta_2 = \frac{BS \sin BSC}{BC} = \frac{d \sin y}{a}$

Since BS is very small in comparison to BA & BC the ∠'S β_1 & β_2 are very small, we may write.

B_1 (Seconds) = $\frac{\text{Sin } B_1}{\text{Sin1"}}$

$= d \frac{\sin (Q + Y)}{c} \times 206265$

B_2 (Seconds) = $\frac{\text{SinB}_2}{\text{Sin1"}}$

$= \frac{d \sin Y}{a \sin 1"} = \frac{d \sin Y}{a} \times 206265$

3) After having calculates the B_1 & B_2 the observed angle q at s is reduced to that at B as follow.

ABC = AOC - β_2

= $(\beta_1 + Q) - \beta_2$

= $Q + B_1 + E$

RESULT = ABC : _____

EXERCISE NO .5

STUDY OF WILD T-2

AIM : To study wild T-2 theodolite and measurement of horizontal & vertical angles, by it.

INSTRUMENTS : WILD-T2 Theodolite with tripod. peg, hammer, ranging rods.

THEORY : Wild T2 is an universal instrument of 1" sec accuracy and used for dif trents kinds of surveying.

i) Triangulations survey
ii) Asthonomical surveying can be done accurately.
iii) Extremely used in hydrographic, surveying
iv) In photogrammetry as a photo theodolite, The camera is fixed at upper part and photographs in required angles are taken.

Parts of WILD -T2 Theodolite :

a) Optical Plummet : used for accurate centering
b) Selector Knob : For measurement of horizontal and vertical angle, the red line on selector knob is kept horizontal & vertical respectively.
c) Circular Drive Knob : Used to adjust the initial reading, (generally 0° 0'0") on horizontal scale for measurement of angle.
d) Horizontal drive knob: Used for bisection of object by horizontal direction.
e) Vertical drive knob: Used for bisection of object by Vertical direction.
d) Micrometer Knob:

OBSERVATION TABLE

Inst station	abject sighted	Face	Horizontal			Mori Angle	Vertical duce			Ver Angle	Remarks
			Initial	Final	Diff		Initial	Final	Diff.		

Diaphragm of wild T2

Scales of wild T2

DESCRIPTION OF THE INSTRUMENT WILD T2

1) Tribrach : The tribrach is the base of the inst, It has 3 foot square for setting the U.A. Vertical and an optical plummet for centering, It also has a circular level for leveling.

2) Lower Part : This campuses the centering flange, the standing ones system. the horizontal wide and associated parts. While using electric illumination, the mirror must be replaced by a plug in lamp. The socket to the left of the mirror must be connected to a battery box.

3) Alidade : The alidade is the upper part of the inst which rates around the standing axis. The telescope and reading micros are mounted. The plate level (21) is for levelling (up). The left standard with illuminating mirror (9) houses the vertical acre automatic indere. On the largest standard are the micrometer drive knob (15) and selector knob (20). If the red line on the selector knob is horizontal, the hore circle is seen the tricycles appears yellow the vertical white; The hori clamp & drive (5,22) & vertical clamp & drive (8,6) are used for setting the telescope to the largest, the press button checks the functioning of the automatic index.

4.Telescope : The telescope transet at both ends the image is erect. The eyepieces is used for to cussing the cross hairs. The optical sights (7) are used for initially pointing to a largest.

USE OF THE INSTRUMENT

1] Centering & Leveling :

2] Focus sing & sightings : Pt telescope to sky or price of paper town eyepiece (19) until cross hauls are seen shop Target Image fours sing : Slacken horizontal & vertical clamps (5,8) point telescope to largest. by means of

11

optical sight (7) tightens the clamps, look through telescope eyepiece & turn focusing sleeve (screw) in till target is seem. Set cross hairs close to target by leveling the horizontal & vertical drives (6,22).

3] Circle Readings : For day light work is the elimination nurrors (3,9) are opened. The eyepiece (18) of the reading microscope is turned until the circle graduation lines (top window) are in focus.

In the top window of the reading microscope, image of graduation lines of diametrically opp. parts of the XXXXx are seem. The two images appear to be separates by a fire line.

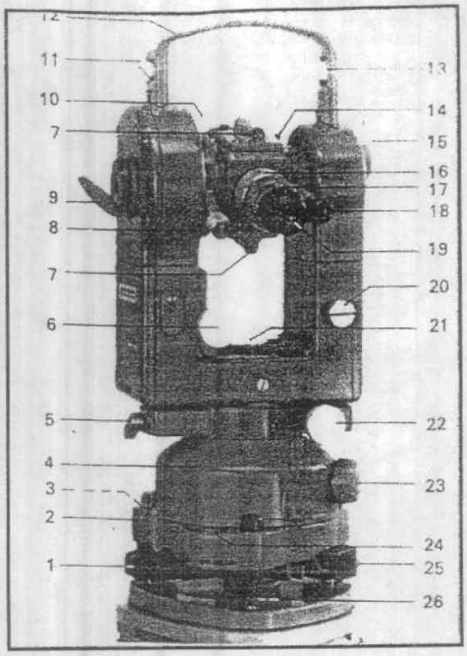
In the upper part of the central window all are seem the whole degree numbers. reach no has a triangular index beneath it Below this indere is the row of numbers for tens of minutes.

In the bottom window is the micrometer scale. The value of one scale interval is 1"

4] setting the horizontal circle to Zero regained scales .

Assume that after pointing to the reference object it is regained to set $94^{\circ}12'44''$. The 2'44" are set against the index of the micrometer scales by leavening the micrometer knob (15). the cover (23) is then opened and the circle drive to wined in till 94° appears & triangle is over no number.

1 Optical plummet
2 Tribrach GDF22
3 Illumination mirror for horizontal circle
4 Lower part of T2
5 Horizontal clamp
6 Vertical drive screw
7 Optical sight, with point for centring under roof points
8 Vertical clamp
9 Illumination mirror for vertical circle
10 Telescope objective
11 Safety catch for carrying handle
12 Carrying handle
13 Locking screw for carrying handle
14 Lever for field of view (reticle) illumination. When using electric lighting, move lever towards objective until it reaches its stop.
15 Micrometer knob
16 Focusing sleeve
17 Bayonet ring, locks eyepiece in position
18 Eyepiece of reading microscope
19 Telescope eyepiece with dioptric scale
20 Selector knob for Hz and V reading
21 Plate level
22 Horizontal drive screw
23 Cover for circle drive knob
24 Circular bubble
25 Swivel locking knob
Arrow DOWN = locked
Arrow UP = unlocked
Knob is secured in arrow DOWN position by recessed screw when instrument leaves factory
26 Footscrew



PROJECT NO. 1

TACHEOMETRIC CONTOURING

A tacheometer is a theodolite fitted with a sladia a diaphragm so that staff readings against all three hairs may be taken. In case of trilly terrain the tacheometric method can be used with advantage. The line of sight can make any inclination with the horizontal, thus increasing the range of instrumental observations. The horizontal distances need not to be measured, since the tacheometer provides both horizontal as well as vertical control.

A tacheometer is set on a pt. Where greater control is obtained. Radial lines can then be set making different angles with either the magnetic meridian or with the 1st radial line. On each radial line readings may be taken on leveling staff at different points. Thus on the same radial line the horizontal equivalent will be smaller for those two points the vertical difference in elevation of which is greater or vice-versa.

Tacheometry Observations :

Sr. No.	Hori. Angle	Vert. Angle	Stadia Readings			Staff Intercept	Hori. Dist.	Vert. Dist.	Plane of Coll R.L.	Reduced Level of Staff Stn.	Remarks
			Upper	Middle	Lower						
1	2	3	4	5	6	7	8	9	10	11	12

PROJECT NO.2.

SETTING OUT A RESIDENTIAL BUILDING

AIM : To set out a building Plan on ground.

EQUIPMENT :

Metallic tape (30m), pegs, hammed, cross staff etc.

THEORY : The object so setting out a building is to clearly define the outline of excavation on the ground for the guidance of contractor.

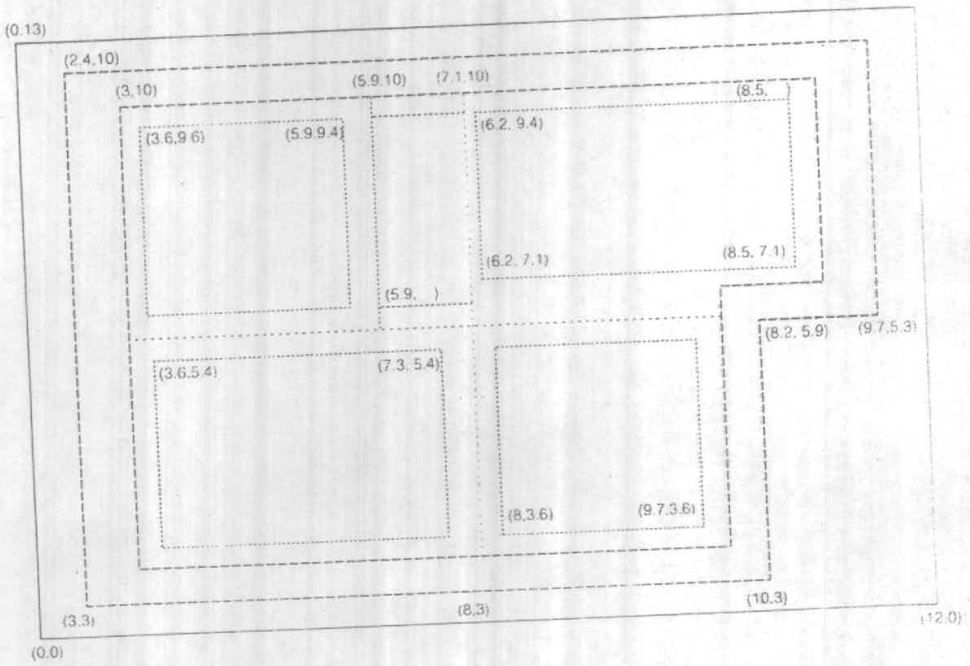
The site plan & detailed plan are studied Thoroughly. Then to set out a reference rectangle, outside, the limits of excavations, say, about 5m from the building line. So that the reference pts A,B,C,& D will not be disturbed during excavation & then to locate each corner by means of coordinates with reference to the sides of the rectangle.

PROCEDURE:

i) Two stakes A & B are accurately driven at the required distance.
ii) A cord is then stretched, the ends being secured to the wire nails drivers in the center of the stakes.
iii) At A set out a line ar to AB, The right angle being set out with the tape by 3-4-5 methods.
iv) On this line a stake is driven at D at a dist equal to the length of AD
v) The work is checked by measuring the diagonal BD & comparing it with calculated length, the error if any should be corrected.
vi) Similar procedure, is followed at B to set the stake at C.
vii) As a check, the diagonal AC is measured. The distance ED should now be exactly equal to dist AB.
viii) A cord is then passed round the periphery of the rectangle ABCD. Having set out the reference rectangle each corner is fixed by measuring. Its coordinates, from the sides of the reference rectangle & a stake is then driven to mark its exact position.
ix) When all the corners have been staked, a cord should be run round the periphery & the outline of the foundations marked with lime powder.

FIGURE :

4) FIGURE :


(0.13)
(2.4,10)
(3,10)
(5.9,10)
(7.1,10)
(8.5,
(3.6,9.6)
(5.9,9.4)
(6.2, 9.4)
(6.2, 7.1)
(8.5, 7.1)
(5.9,
(8.2, 5.9)
(9.7,5.3)
(3.6,5.4)
(7.3, 5.4)
(8,3.6)
(9.7,3.6)
(10.3)
(3.3)
(8,3)
(12.0)
(0.0)

4) OBSERVATION TABLE :

1	2	3	4	5	6	7	8
Page NO.	Chainage ft.	Chord Length ft. of Meters	Tangential Angle	Total Tangential or defection angle	Actual Theodolite Reading	Offset Length	Remarks
			O ' "	O ' "	O ' "		

CED273 LAB VIII: SURVEYING – II

Teaching Scheme **Examination Scheme**

Practical: 2Hrs /week **Term work: 25 marks**

Oral Examination: 25 marks

Term Work:(A) The term work shall consist of Experiments given below (any seven)

1. Setting out simple circular curve by offset from long chord method.
2. Setting out simple circular curve by offset from chord Produced.
3. Setting out simple circular curve by Rankine's method.
4. Measurements of base line by subtense bar method.
5. Satellite station and reduction to center
6. Study of one second Theodolite and measurement of horizontal angle by repetition method.
7. Study of Nautical sextant and measurement of angle by nautical sextant.
8. Determination of elevations and distances by Trignometrical observations

(B) Projects : - Any Two

1) Tachometric contouring.
2) Geodetic Quadrilateral Adjustments
3) Setting out building / culvert.

The assessment of term work shall be done on the basis of the following:

- Continuous Assessment
- Performing the experiment given in Laboratory

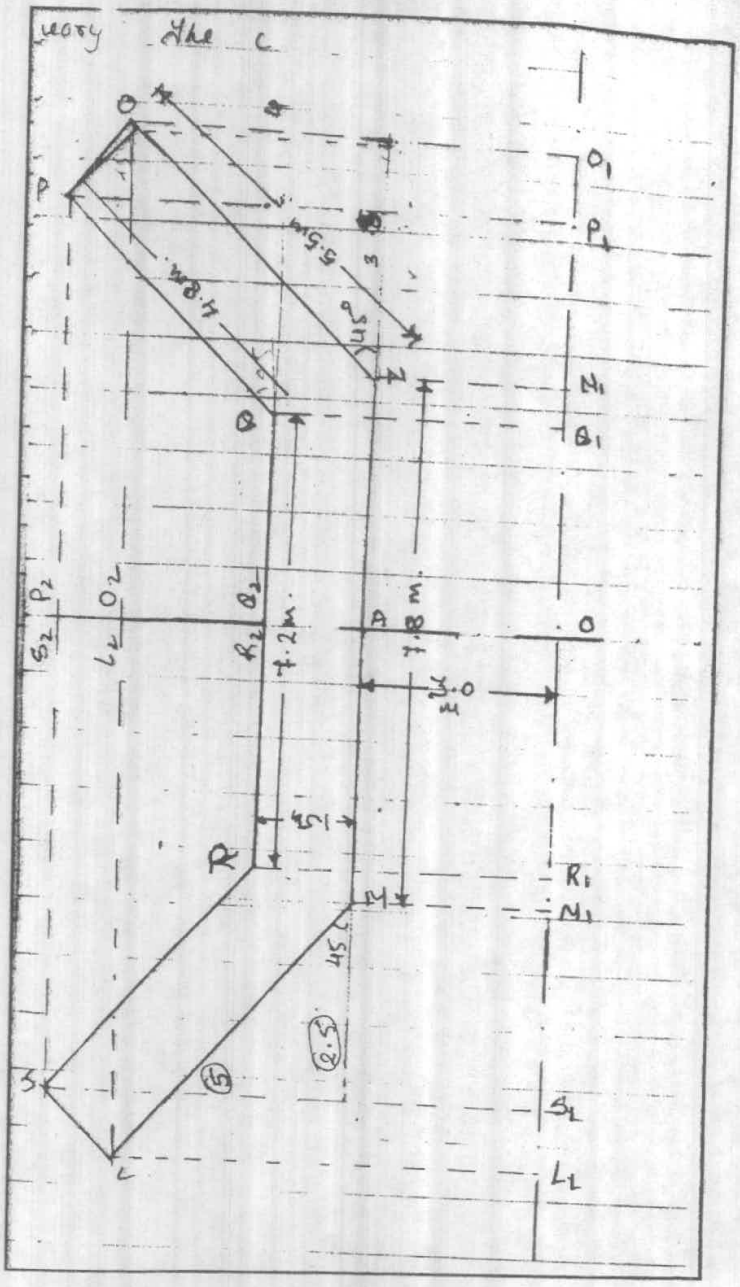
Oral Examination

The practical examination shall consists of performing an exercises based on the practical work done during the course. The record of the exercises submitted by the candidate and viva – voce on the syllabus. The assessment will be based on

1) Performing an exercise
2) Record of exercise submitted by the candidate.
3) Viva – voce on the syllabus.

S.E shirke. A-Batch. 1/2/13
2,9,

FIGURE :



18

PROJECT NO.3

SETTING OUT A CULVERT

AIM : To set out a culvert on roads or railways & nallahs.

EQUIPMENTS : Chain, tapes, pegs, tress staff, hammser etc.

THEORY : The centre of the culvert is taken as the origin and the center lines of the roads, raelways, etc and the mullahs are considered as the axes of coordinates. As in case of Buildings the foundations trench peon is proposed after the telans & estimates of the work are finalized and the chenille lines of the road or railway and the nallah are marled. The coordinates of all the crones are actually arced from the peon & the salutes are entered in a tabular form given below.

Sr.No.	Point	Coordinates	Remarks
1	A	(X_1, Y_1)	
2	B	(X_2, Y_2)	
3	C	(X_3, Y_3)	

PROCEDURE :

i) To proceed with the setting out of work, centre O (See fig of the culvert is located on the ground, AB is the centre size of the road & CD the centre line of the nallah.)

ii) Set up a theodolite at point O and levelly et accurately

iii) Set out lines AB & CD at right angle to each other

v) Locate the corners L,M,N, etc along line AB and M2, R2 etc along line CD Drive pegs at these points & stretch cords.

vi) Fix up L,M, etc by means of distances L1L, L2L, M1M, M2M, etc from pts. L1,L2, M1,M2, etc measured from plan. secularly fix up other points also fix pegs at these points.

vii) Stretch a cord round the periphery LMNOPQRS.

viii) the outlines may be market by line or by culling, a narrow trench along the cord.

The other abutment and the wing walls are also se t out in the same manner & uneven ground levels may be taken at all the pegs to determine the correct depths of excavation & to calculate the quantities of east work.