NRI INSTITUTE OF INFORMATION SCIENCE & TECHNOLOGY, BHOPAL (M.P.)

Subject: Basic Civil Engineering & Engineering Mechanics
BT-204

Practical Lab Manual

NRI INSTITUTE OF INFORMATION SCIENCE & TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING

List of Experiments

Tests on Bricks:

1. Shape and size of brick.
2. Water absorption of brick.

Tests on Cement:

3. Standard consistency of cement.
4. Setting Time of Standard Cement Paste.

Test of Surveying:

5. Setting Time of Standard Cement Paste.
6. Study of Compass Surveying
7. Compass Traversing – Measuring Bearings & Arriving Included Angles
8. Traversing – Plane Table
9. Fly Levelling
10. Study of Theodolite

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ExperimentNo:1 **Date:**

Title: Shape and size of supplied brick

Objective: To determine the shape and size of the supplied brick.

Apparatus: Scale

Material required: Bricks

Procedure:

1. 20 bricks are taken randomly from a stack. The bricks should be rectangular in shape with sharp edges and smooth surface.
2. Dimension i.e length, breadth, & height of the bricks are measured by scale and recorded.
3. For good quality bricks, the dimension of 10 bricks should be within the following limits.
   Length 3680mm to 3920mm
   Width 1740 mm to 1860mm
   Height1740mm to1860mm

Observation:

SLNO	Length(mm)	Breath(mm)	Height(mm)
1			
2			
3			
4			
5			
6			
7			
8			
9			

Calculation:

Sum of the length of 20 bricks = mm
Sum of the breadth of 20bricks = mm
Sum of the height of 20 bricks = mm

Conclusion/ Result :

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ExperimentNo:2 **Date:**

Title: Water absorption of brick Objective:

Objective: To determines water absorption of brick.

Apparatus:

1. Dry bricks
2. Weighing machine

Material required: Bricks

Theory: Brick for external use must be capable of preventing rain water from passing through them to the inside of wall so reasonable thickness. A good brick should absorb water maximum 1/7 th of the weight of the brick.

Procedure:

1. 20 bricks are taken randomly from a stack.
2. The bricks are put in an oven at a temperature of 105 for drying. C
3. Bricks are weighed in a digital weighing machine and is record as W1
4. The bricks are immersed in water at room temperature for24 hours.
5. After 24 hours immersion, the bricks are taken out of water and wiped with a damp cloth for 3 minutes.
6. The bricks are weight again and recorded as W2.
7. Calculate water absorption of brick

Observation:

Sl No	Weight W1(Kg)	WeightW2(Kg)	Waterabsorption in %	Remarks
1				
2				
3				

Conclusion/Result: Water absorption in % is calculated as.....

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ExperimentNo:3 **Date:**

Title: Standard consistency of cement

Objective: To determine the normal consistency of a given sample of cement.

Reference: IS:4031(Pat4)-1988,IS:5513-1976

Theory: For finding out initial setting time, final setting time and soundness of cement, and strength a parameter known as standard consistency has to be used. The standard consistency of a cement paste is defined as that consistency which will permit a Vicat plunger having 10 mm diameter and 50 mm length to penetrate to a depth of 33-35 mm from the top of the mould.

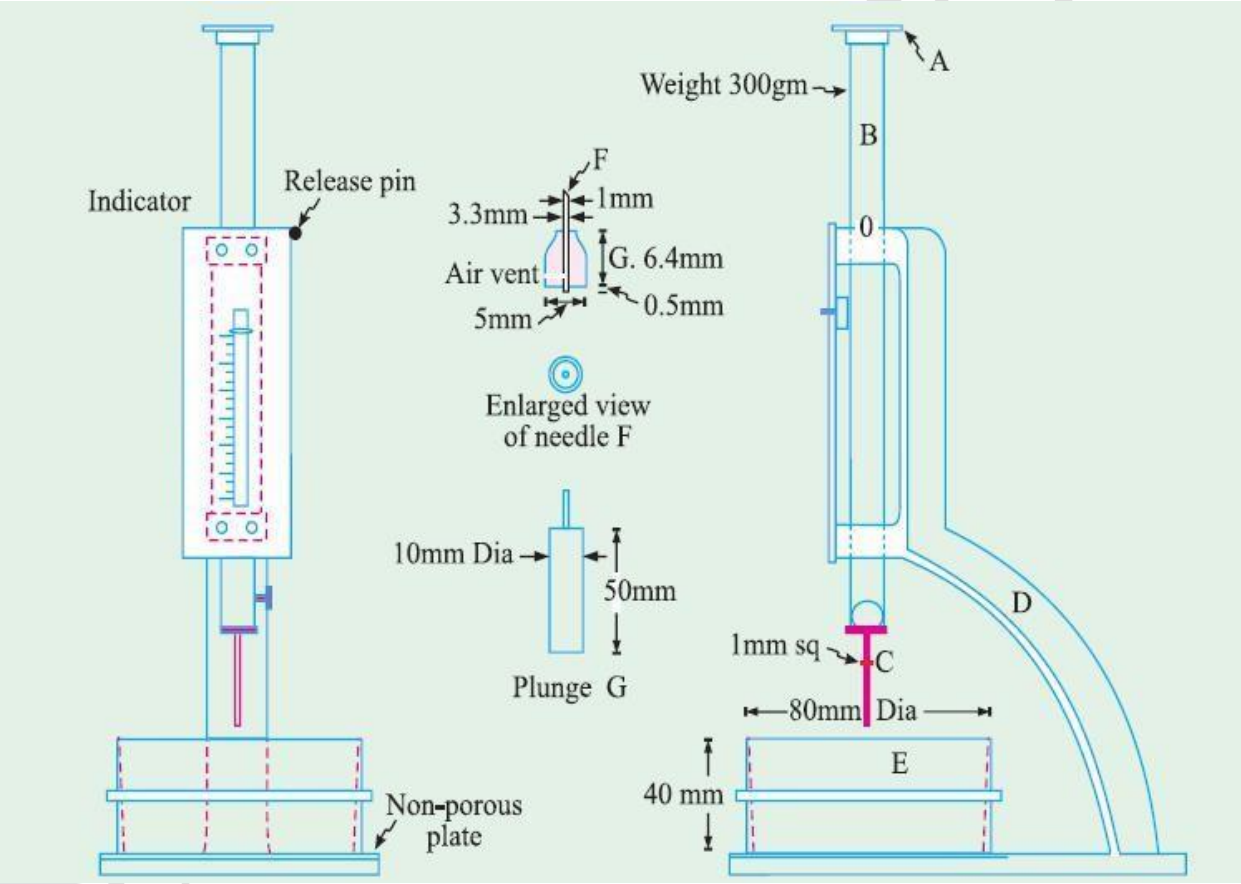

Figure:

Apparatus: Vicat apparatus conforming to IS:5513-1976,Balance,GaugingTrowel,Stop Watch, etc.

Procedure:

1. The standard consistency of a cement paste is defined as that consistency which will permit the Vicat plunger to penetrate to a point 5 to 7 mm from the bottom of the Vicat mould.
2. Initially a cement sample of about 300 g is taken in a tray and is mixed with a known percentage of water by weight of cement, say starting from 26% and then it is increased by every 2% until the normal consistency is achieved.
3. Prepare a paste of 300 g of Cement with a weighed quantity of potable or distilled water, taking care that the time of gauging is not less than 3 minutes, nor more than 5 min, and the gauging shall be completed before any sign of setting occurs. The gauging time shall be counted from the time of adding water to the dry cement until commencing to fill the mould.
4. Fill the Vicat mould (E) with this paste, the mould resting upon a non-porous plate. After completely filling the mould, smoothen the surface of the paste, making it level with the top of the mould. The mould may be slightly shaken to expel the air.
5. Place the test block in the mould, together with the non-porous resting plate, under the rod bearing the plunger; lower the plunger gently to touch the surface of the test block, and quickly release, allowing it to sink into the paste. This operation shall be carried out
6. Immediately after filling the mould.
7. Prepare trial pastes with varying percentages of water and test as described above until the amount of water necessary for making up the standard consistency as defined in Step 1 is found.

Observation: Express the amount of water as a percentage by mass of the dry cement to the first place of decimal.

Sl. No.	Weight (gm)	Percentageby weightofdry Cement(%)	Amountof water added (ml)	Penetration (mm)
1				
2				
3				
4				

Conclusion/Result: The normal consistency of a given sample of cement is _%

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ExperimentNo: 4 **Date:**

Title: Setting Time of Standard Cement Paste

Objective: To determine the initial and final setting time of a given sample of cement.

Reference: IS:4031(Part4) -1988, IS:4031 (Part5)–1988,IS:5513-1976

Theory: For convenience, initial setting time is regarded as the time elapsed between the moments that the water is added to the cement, to the time that the paste starts losing its plasticity.Thefinalsettingtimeisthetimeelapsedbetweenthemomentthewaterisaddedtothe cement, and the time when the paste has completely lost its plasticity and has attained sufficient firmness to resist certain definite pressure.

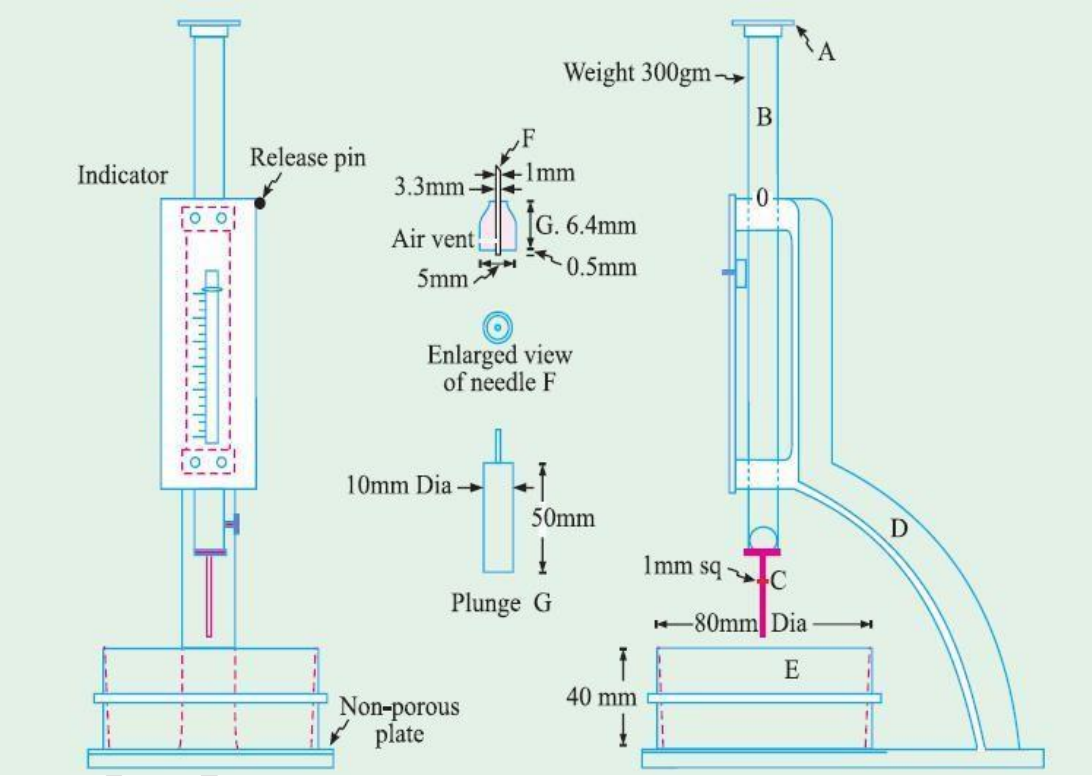

Figure:

Apparatus: Vicat apparatus conformingtoIS:5513-1976,Balance,GaugingTrowel,Stop Watch, etc.

Procedure:

1. **Preparation of Test Block -** Prepare a neat 300 gms cement paste by gauging the cement with 0.85 times the water required to give a paste of standard consistency. Potable or distilled water shall be used in preparing the paste.

2. Start a stop-watch at the instant when water is added to the cement. Fill the Vicat mould withacementpastegaugedasabove,themouldrestingonanonporousplate.Fillthemould completelyandsmoothoffthesurfaceofthepastemakingitlevelwiththetopofthe
3. mould.
4. Immediatelyaftermoulding,placethetestblockinthemoistclosetormoistroomandallow it to remain there except when determinations of time of setting are being made.

5. **Determination of Initial Setting Time** - Place the test block confined in the mould and resting on the non-porous plate, under the rod bearing the needle (C); lower the needle gently until it comes in contact with the surface of the test block and quickly release, allowing it to penetrate into the test block
6. Repeat this procedure until the needle, when brought in contact with the test block and released as described above, fails to pierce the block beyond 5.0 ± 0.5 mm measured from the bottom of the mould shall be the initial setting time.

7. **Determination of Final Setting Time -** Replace the needle (C) of the Vicat apparatus bythe needle with an annular attachment (F).
8. The cement shall be considered as finally set when, upon applying the needle gently to the surface of the test block, the needle makes an impression thereon, while the attachment fails to do so.
9. Theperiodelapsingbetweenthetimewhenwaterisaddedtothecementandthetimeat
10. whichtheneedlemakes animpressionthesurfaceoftestblockwhiletheattachmentfails to do so shall be the final setting time.

Observation :

1. Weight of given sample of cement is gms
2. The normal consistency of a given sample of cement is %
3. Volume of water added (0.85times the water required to give a paste of standard consistency) for preparation of test block _____ ml

Sr.No.	Setting Time(Sec)	Penetration (mm)	Remark
1			
2			
3			

Conclusion/ Result : i) The initial setting time of the cement sample is found to be …..
ii) The final setting time of the cement sample is found to be …..

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ExperimentNo:5 **Date:**

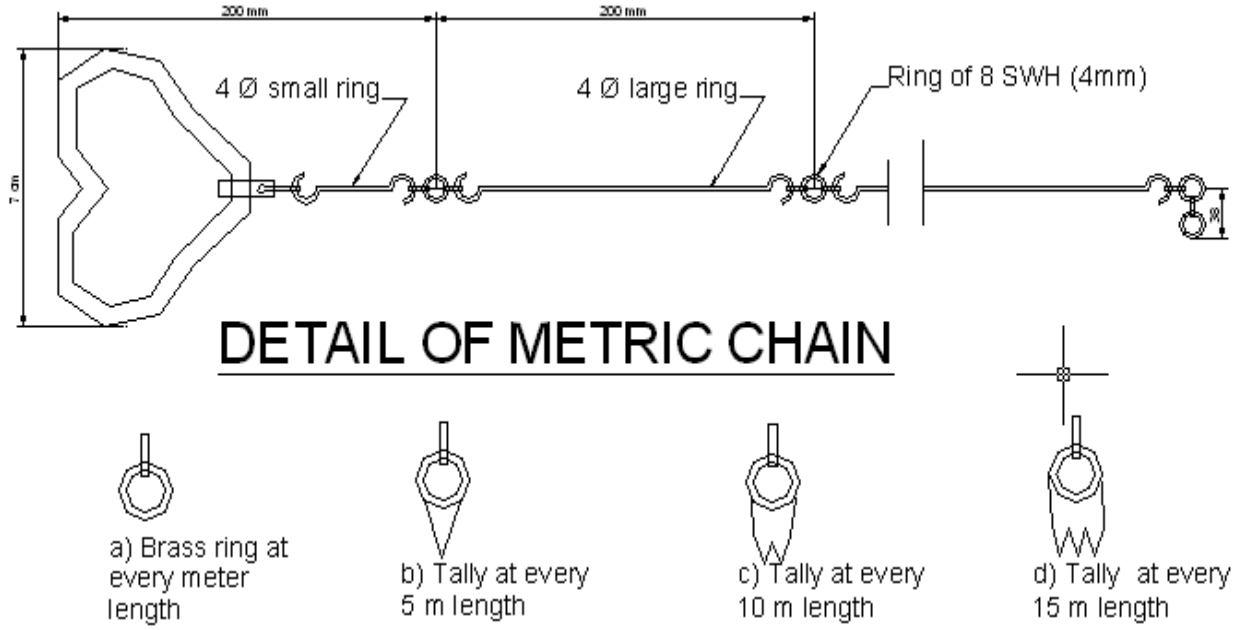
Title: Measurement of distance by Ranging and Chaining

Objective: Measurement of distance by Ranging and Chaining

Apparatus: Chain, Arrows, Tapes, Ranging Rods, Offset Rods, Cross staff or optical square,

Plumb bob, wooden mallet, pegs.

Material required:



Theory: By the various methods of determining distance the most accurate and common method is the method of measuring distance with a chain or tape is called Chaining. For work of ordinary precision a chain is used. But where great accuracy is Required a steel tape is invariably used.

The term chaining was originally applied to measure Distance with a chain. The term chaining is used to denote measuring distance with either chain or tape, In the process of chaining, The survey party consists of a leader (the surveyor at the forward end of the chain) a follower (the surveyor at the rare end of the chain and an assistant to establish intermediate points) .

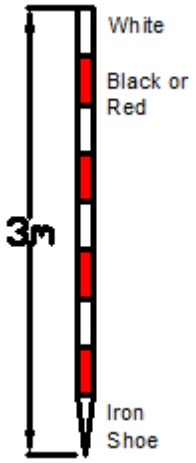
The accuracy to which measurement can be made with chain and tape varies with the methods used and precautions exercised. The precision of chaining. For ordinary work, ranges from 1/1000 to 1/30,000 and precise measurement such as Baseline may be of the order of 1000000 in diameter called links. The end of each link is bent into a loop and connected together by means of three oval rings which afford flexibility To the chain and make it less liable to become kinked. The ends of chain are provided with brass handles for dragging the chain on the ground, each with a swivel Joints so that the chain can be turned round without twisting. The length of the A link is the distance

between the centres of the two consecutive middle rings. The end links include the handles metallic rings indicators of distinctive points of the Chain to facilitate quick reading of fractions of chain in surveying measurements.

RANGING RODS:

The ranging rods are used for marking the positions of Stations conspicuously and for ranging the lines. Io order to make these visible at a distance, they are painted alternately black and white, or red and white or red White and black successively.The adjustment of the chain should as far as possible be affected symmetrically on either side of the middle so as that the position of central tag remains unaltered.

In measuring the length of survey line also called as chain line. It is necessary that the chain should be laid out on the ground in a straight line between the end stations.



Two men are required for chaining operation; The chain man at the forward end of chain is called the leader while the other man at the rear end is known as the follower.

Duties of leader &follower

Leader:- 1) To put the chain forward

2) To fix arrows at the end of chain

3) To follow the instruction of the followers.

Follower:- 1) To direct the leader to the line with the ranging rod.

2) To carry the rear end of the chain.

3) To pick up the arrows inserted by the leader.

Chaining 1) The follower holds the zero handle of the chain against the peg &directs the leader to be in line of the ranging rod.

2) The leader usually with to arrows drags the chain alone the line.

3) Using code of signals the follower directs the leader as required to the exactly in the line.

4) The leader then fixes the arrows at the end of chain the process is repeated.

Ranging 1) Place ranging rods or poles vertically behind each point

2) Stand about 2m behind the ranging rod at the beginning of the line.

3) Direct the person to move the rod to right or left until the three ranging rods appear exactly in the straight line.

4) Sight only the lower portion of rod in order to avoid error in non-vertically.

5) After ascertaining that three rods are in a straight line, ask the person to fix up the rod.

RESULT : By Chaining and ranging the total distance is found to be_____

ExperimentNo:6 **Date:**

Title: STUDY OF COMPASS SURVEYING
Objective: Study of prismatic Compass

DESCRIPTION OF THE INSTRUMENTS

A. Prismatic Compass:-

1. A magnetic needle is attached to the circular ring made up of aluminum.
2. The needle is on the pivot to orient N and S ends.
3. The line of sight is defined by object vane and eye slit both attached to the compass bar.
4. The object vane consists of a vertical hair attached to a suitable frame while the eye slit consist of a vertical slit above the prism unit.
5. When the object is sighted, the sight vanes will rotate with respect to the NS end of the ring through an angle which the line makes with the magnetic meridian.
6. The reading increase in clockwise direction from 0˚ at south and to 90˚ at west end 180˚ at north end and 270˚ at east end.
7. Break- pin is placed at the base of the object vane to clamp the oscillation of the needle while taking reading.
8. To sight the objects, which are too high or too low, a hinged mirror is placed.
9. Dark glasses are used to sight bright objects.

Adjustments of prismatic compass:-

(A) Centering:-

a) It is the process of keeping the instrument exactly over the station.
b) It is done by dropping a pebble from the centre of the bottom of the instrument.

(B) Leveling:-

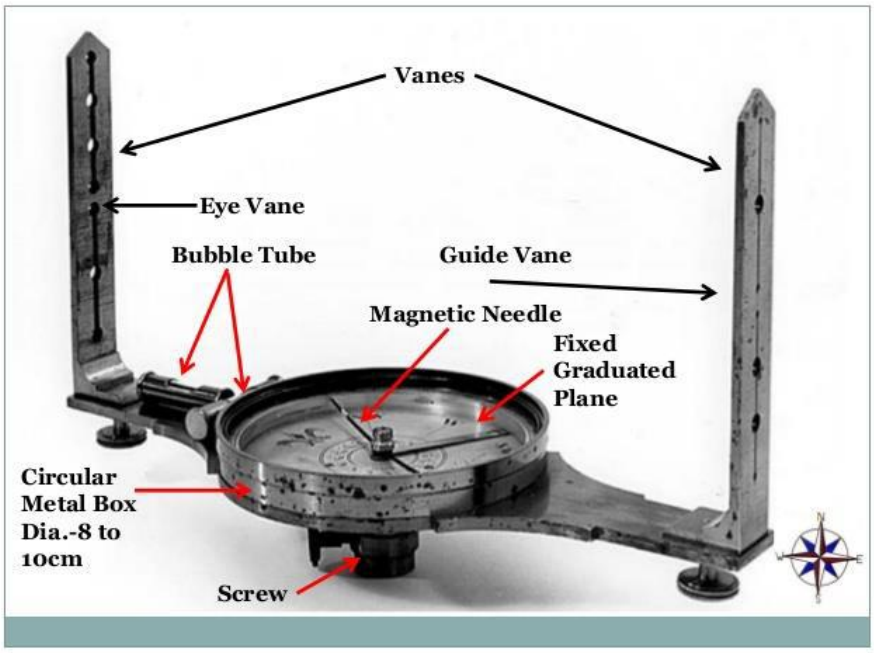
a) For which the tripod is provided with ball and socket arrangement to fix the compass on level.
b) Adjust the box in such a way that the graduated disc is swinging freely and appears to be level.

(C) Focusing the Prism:-

a) The prism attachment is sided up or down till the readings are seen to be sharp and clear.

B.Surveyors Compass:-

a) The object vane is similar to that of prismatic compass.
b) The eye vane consists of a simple metal vane with the fine slit without the prism.
c) The graduation ring is directly attached to the box and not with needle.
d) The object is to be sighted first with the object and eye vanes and reading is taken against the north end of the needle by looking vertically through the top glass.
e) The card is graduated in quandrantal system having 0˚ at N and S ends & 90˚ at west and east ends.



Parts of Compass

ExperimentNo:7 **Date:**

Title: COMPASS TRAVERSING – MEASURING BEARINGS & ARRIVING INCLUDED ANGLES

Objective: Measurement of bearings of sides of traverse with prismatic compass and computation of correct included angle..

Apparatus: Prismatic compass, ranging rod, chain, tape, peg Tripod stand

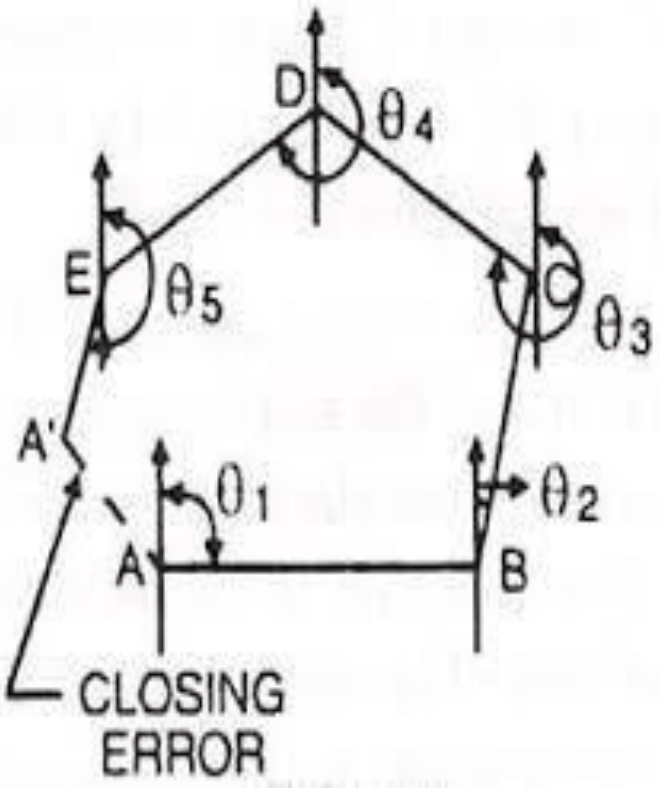
Procedure:

1) Four ranging rods are fixed at different points i.e. A, B, C, D etc. such that it should be mutually visible and may be measured easily.

2) Measure the distance between them. 1) At point A the prismatic compass is set on the tripod Stand, centering and leveling is then properly done. 2) The ranging rod at B is ranged through sighting slits and objective vane attached with horse hair and reading on prismatic compass is noted down.

3) It is fore bearing of line AB. Then the prismatic compass is fixed at B and ranging rod at C and A are sighted. And reading is taken as forbearing of BC and back bearing of AB.

4) Repeat the same procedure at the stations C, D etc.



Observation:

Inst. Station	Line	Observed bearing	bearing Local attraction	error	Correction	Corrected bearing	Included angle
A	A D						
	A B						
B	B A						
	B C						
C	C B						
	C D						
D	D C						
	D A						

Sample Calculation: Error = observed bearing –corrected bearing

Check:=(2n-4)x900

Result: The prismatic compass is studied and bearing of lines of traverse are Observed, the correction due to local attraction at affected station is done and corrected bearings are written in tabular form.

ExperimentNo:8 **Date:**

Title: TRAVERSING – PLANE TABLE

Objective: To survey a small piece of land by closed traverse technique using plane table

Equipment and Accessories:

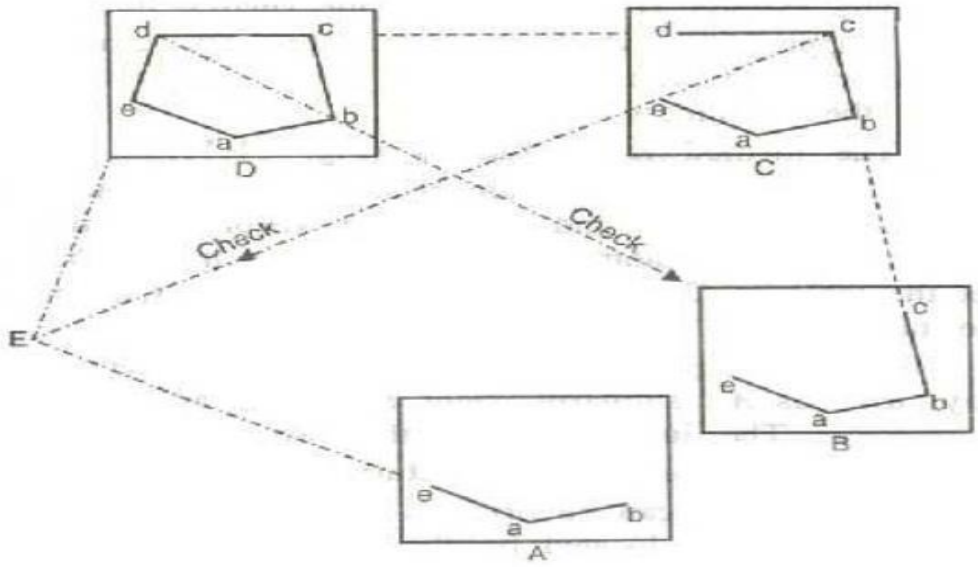
Plane table and its accessories (tripod, alidate, trough compass, plumbing fork, spirit level, drawing sheet, cello- tape, pencil, eraser and dusting cloth), chain, tape, ranging rods, pegs, hammer and field-book.

Principle:

Traversing is that of survey in which a number of connected survey lines form a framework. The directions and lengths of the survey lines are measured with the help of an angle (or direction) measuring instrument and a tape respectively. If the framework formed by the lines closes at the starting station, that is, if they form a closed polygon, it is called closed traverse. In plane table traversing, at each successive station the table is set, a foresight is taken to the following station and its location is plotted by measuring the distance between the two stations as in the radiation method.

Procedure:

1) Select the traverse stations A,B,C,D and E on the ground.
2) Set the table at A. Use plumbing fork and transfer A on to the sheet and name it ‘a’. On the top right corner of the sheet mark the direction of magnetic north with the help of trough compass.
3) With the alidade pivoted about a, sight it to B and draw the ray. Measure AB and scale of ab to a suitable scale. Similarly draw a ray towards E, measure AE and mark ‘e’.
4) Shift the table to B and set it. Orient the table accurately by back sighting A. Clamp the table.
5) Pivoting the alidade about b, sight to C. Measure BC and plot it on the drawn ray to the same scale. Similarly, the table can be set at other stations and the traverse is completed.



Note: While being at each station, take measurements by radiation to any details that are to be included in the plan.

Observations and Calculations: 1) Measure the distance DB and EC on the ground. 2) Scale the distance db and ec on the drawing sheet.

Result: Compare the ground distances DB and EC with corresponding plan distances db and ec.

Experiment No: 9 **Date:**

Title: FLY LEVELLING

Objective: Fixing bench mark with respect to temporary bench mark with dumpy level by fly levelling

APPARATUS REQUIRED: Dumpy level, leveling staff, tripod stand, arrows, pegs.

INTRODUCTION:

Differential Leveling is Applied to determine the elevation of point which is some distant apart from B.M i.e., the unknown elevation of a point cannot be determined in a single set up of an instrument. Thus, in this method, instrument gets setup number of times to observe reading along a route in between observed points. For each set up, staff readings are taken back to a point of known elevation (first sight from the B.M and forward to a point of unknown elevation) final sight to the terminal station. This type of Leveling is also known as "fly-levelling".

Fly leveling: - It is a very approximate from of levelling in which distances are not measured and sights are taken as large as possible. In this method a line of levels is run to determine approximately reduced levels of the points carried out with more rapidly and less precision.

Dumpy level;

The dumpy level is a simple, compact and stable instrument. the telescope is rigidly fixed to its supports. hence it cannot be rotated about horizontal axis.

Tilting level: it is also known as I.O.P. level (Indian office pattern). in this level the telescope tilts about its horizontal axis hence it is called tilting level.

Check leveling: The main purpose of this type of leveling is to check the values of the reduced levels of the bench marks already fixed. In this method only back sight and foresight are taken. There is no need of intermediate sights. However great care has to be taken for selecting the change points and for taking reading on the change points because the accuracy of leveling depends upon these

PROCEDURE:

1) Instrument level is setup at convenient positions near first point (ay A).

2) Do all the initial adjustments.

3) Direct the telescope towards the First sight of B.M (point of known elevation) is taken and reading is entered in back Sight column. Enter the reading of the last visible point from the instrument stations as F.S and of all other points as I.S.

4) If distance is large instrument is shifted, the instrument becomes turning point (or) changing point. Don't change the position of the staff until the back staff reading is taken on the staff held at the last required point.

5)After setting up instrument at new position, performing temporary adjustment and Take back sight as turning point.

6) Thus turning point will have both back sight and fore sight readings.

7) Link wise the process is repeated till last point (B) is reached.

8) The above procedure is shown in fig. Readings are entered in a tabular form is given below and Reduced levels are calculate either by height of instrument method (or) rise and fall method.

Table 1.Level book note for Rise and Fall method

	Staff Reading		Difference in Elevation		Elevation	
Points	B.S (m)	F.S.(m)	Rise (m)	Fall (m)	R.L (m)	Remark
A					100.000	B.M.
S_1						T.P1
S_2						T.P2
S_n						T.Pn
B						

Arithmetic Check: Σ B.S - ΣF.S = ΣRISE – ΣFALL = Last RL - First R.L

Table 2.Level book note for Height of instrument method

	Staff Reading			Height of Instrument (m)	R.L. (m)	Remarks
Points	B.S (m)	I.S (m)	F.S.(m)			
A					100.000	B.M.
S_1						T.P1
S_2						T.P2
S_n						T.Pn
B						

Arithmetic Check: Σ B.S - ΣF.S = Last RL - First R.L

RESULT:

Difference of elevation between two given point is _____ M. Elevation/R.L of point B = _____ M.

ExperimentNo:9 **Date:**

Title: STUDY OF THEODOLITE

Objective: To study about the Temporary and Permanent adjustments of a Theodolite.

Instrument used:

Theodolite

Procedure:

ADJUSTMENTS OF THEODOLITE

The Theodolite should be properly adjusted to obtain accurate observations. The adjustments are mainly of two types. They are as follows:

1. Permanent adjustments and
2. Temporary adjustments.

1. Permanent adjustments

The permanent adjustments are to be done to maintain the required standard relationship between the fundamental lines (axes) of a Theodolite. The fundamental lines are as follows:

a. Vertical axis
b. Horizontal axis or trunnion axis
c. Line of collimation or line of sight
d. Axis of plate level
e. Axis of altitude level.

Required relations between the fundamental lines (axes)

i) The axis of plate level must be perpendicular to the vertical axis.
ii) The line of collimation must be perpendicular to the horizontal axis
iii) The horizontal axis must be perpendicular to the vertical axis.
iv) The axis of the altitude level must be parallel to the line of collimation.
v) The vernier reading of vertical circle must read zero when the line of collimation is horizontal.

The permanent adjustments of a Theodolite are:

Adjustment of plate level.
Adjustment of line of sight
Adjustment of horizontal axis
Adjustment of altitude bubble and vertical index frame.

2. Temporary adjustments

The adjustments which are carried out at every setting of the instrument before the observations are referred as temporary adjustments. There are three types of temporary adjustments as follows.

a. Setting up
b. Levelling up
c. Elimination of parallax.

a) Setting up

This adjustment includes the following two operations.

i. Centering the Theodolite over the instrument station.
ii. Approximate leveling of Theodolite with the help of the tripod legs only.

Centering

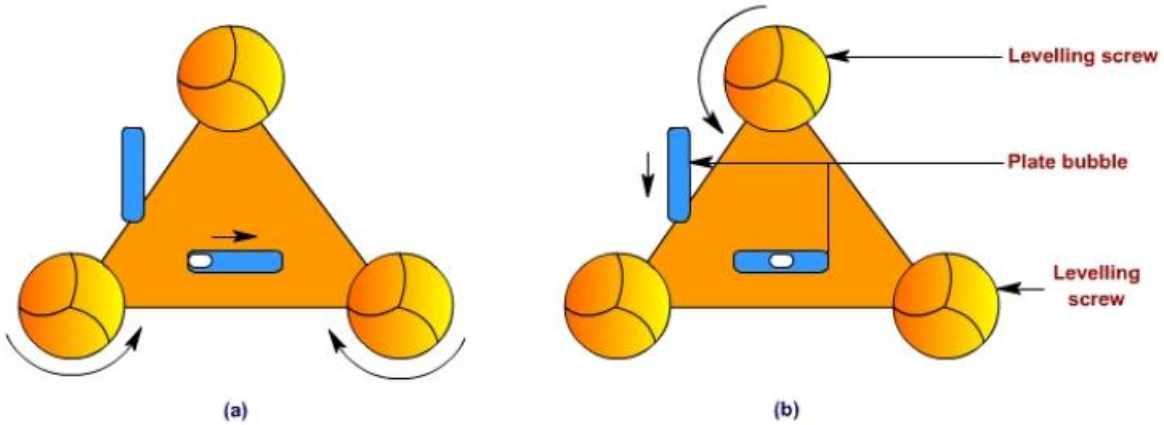
It is the operation by which the vertical axis of the theodolite represented by a plumb line is made to pass through the mark of instrument station on the ground.

Approximate levelling

The approximate leveling may be done with the reference to a small circular bubble provided on the tribrach or by eye judgements.

b) Levelling up

The operation of making the vertical axis truly vertical is known as leveling of the Theodolite. After the centering and approximate leveling an accurate leveling is to be done with the help of foot screws.



i) First the telescope is to be kept parallel to any of the two foot screws as in the figure.
ii) The bubble of plate level is to be brought to the centre of its run by turning the foot screws either inwards or outwards simultaneously.
iii) Then the telescope is to be turned through 90°, so that it lies over the third foot screw (i.e perpendicular to the first position)
iv) The bubble is to be brought to the centre of its run by turning the third foot screw either clockwise or anticlockwise.
v) Then the telescope is brought back to its original position (position at (i)) and the position of bubble is checked whether it remains in the center or not.
vi) If the bubble is not in centre the above operations are repeated till the bubble retain at centre in both the positions.

c) Elimination of parallax.

An apparent change in the position of an object caused by the change in position of the observer's eye is known as **parallax.** This can be eliminated in two steps.
i) Focusing the eye piece for distinct vision of the cross hairs.
ii) Focusing the objective to bring the image of the object in the plane of cross hairs.
i) Focusing the eye piece

The telescope is to be pointed towards the sky or a sheet of white paper is to be hold in front of the objective.

The eye piece is to be moved in or out by rotating it gradually until the appearance of cross hairs becomes sharp and distinct.

ii) Focusing the objective

Telescope is to be directed towards the object. Focusing screw is to be turned until the appearance of the object becomes sharp and clear.