SHIVAJIRAO KADAM INSTITUTE OF TECHNOLOGY & MANAGEMENT, INDORE

A LABORATORY MANUAL

FOR

BASIC CIVIL ENGINEERING

CIVIL ENGINEERING DEPARTMENT

SHIVAJIRAO KADAM INSTITUTE OF TECHNOLOGY & MANAGEMENT, INDORE

PREPARED BY: GIRISH PATIDAR

SHIVAJIRAO KADAM INSTITUTE OF TECHNOLOGY & MANAGEMENT, INDORE

CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

CERTIFICATE

This is to certify that Mr. / Ms. …….....

Roll No. ……., of ……Semester of B.E. …… year …… branch has completed the term work satisfactorily in Basic Civil Engineering for the academic year ……. as prescribed in the curriculum.

Enrollment No.: ……..….

Date : ……..….

Place : ……..….

Subject Teacher

Head of the Department

Director:

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BASIC CIVIL ENGINEERING

LIST OF EXPRIMENTS

1. Field tests on bricks
2. Amount of water absorbed by the bricks
3. Crushing strength of bricks
4. Particle size distribution and fineness modules of fine aggregates**.**
5. Field tests on cement.
6. Fineness of cement
7. Standard Consistency, Initial & Final setting time of the given cement sample by Vicat's apparatus.
8. Workability of concrete mix by slump test
9. Workability by compacting factor test.
10. Area of given polygon by chain & cross-staff survey
11. Surveying with prismatic compass
12. Elevation of various points with dumpy level/auto level by height of instrument method.
13. Elevation of various points with dumpy level/auto level by rise & fall method.
14. Height of the tie beam above the floor level.
15. Study different parts of transit theodolite and its temporary adjustments
16. Locating given points by plane table surveying (radiation method)
17. Locating given points by plane table surveying (intersection method)

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EVALUATION SHEET

Name of the student: Enrollment no.:

S.N.	Name of the Experiment	Date of experiment	Date of report submission	Grade	Signature
1					
2					
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CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

OBJECT: To conduct field tests on bricks.

MATERIAL: Bricks taken from the stack.

PROCEDURE:

Bricks are widely used material in construction work.

The following are the field tests to be conducted on bricks.

1) **Hardness**: A scratch is made on brick surface with a fingernail, no impression should be left on the surface. Now the brick is assumed to be hard.

2) **Shape and size**: The brick should be of standard size and its shape should be truly rectangular with sharp edges. Take 20 bricks of standard size (19 x 9 x 9 cm) at random from the stack, placed along length wise, along the width and along the height. For good quality of bricks, the results should be with in the following limits.

Length: 3680 mm to 3920 mm

Width: 1740 mm to 1860 mm

Height: 1740 mm to 1860 mm

3) **Soundness**: The bricks should not break and give a clear ringing sound when they struck with each other.

4) **Colour and appearance:** The well-burnt brick should have copper red colour and free from cracks. The colour should be uniform and bright. The bricks when broken should show a bright homogeneous and uniform structure, free from voids.

5) **Strength**: The brick should not break when dropped on a hard ground from a height of about 1 m.

S.No.	Type of field test	Observations	Remarks

RESULT: Based on filed tests the bricks are suitable / not suitable for the construction work.

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QUESTIONS:

1. What do you understand by the term brick? Explain different types of bricks.
2. What is the field tests carried out to determine the qualities of the brick?
3. What are the different uses of bricks?
4. How can good bricks be made from black cotton soil?
5. What are the substances which harm the qualities of good bricks, in their manufacture and as finished product?
6. Enumerate the chief characteristics of clay as material used for manufacture of bricks.
7. Describe how bricks are classified?
8. What are the constituents of good brick-earth?
9. What is efflorescence in bricks? What are its causes and remedies?

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BASIC CIVIL ENGINEERING

OBJECT: To find the amount of water absorbed by the bricks

APPARATUS: I) Electric oven ii) Weighing balance

PROCEDURE:

1. Select at least 4 to 5 brick samples randomly from the stack and marked them with numbers.
2. Dry these bricks in an electric oven at 105 c to 115 c. The bricks are taken out from oven and brought to room temperature.
3. Weigh the bricks accurately and immersed in water for 24 hours at a temperature of 27 c + 3 c.
4. After this period, each brick is taken out of water and cleaned with dry cloth. The bricks are again weighed accurately.
5. The Difference in weight gives the amount of water absorbed by the brick. The bricks should not absorb water more than 20% by weight for first class bricks and 22% by weight for second-class bricks.

S.No.	Weight of dry brick (W_1)	Weight of brick immersed in water, after 24 hours (W_2)	% Water absorption (W2-W1)X 100 W1	Remarks

RESULT: Based on the results of water absorption test, the bricks are suitable/not suitable for the construction work.

Questions:

1. What is the significance of water absorption in bricks?
2. What are the advantages of brick over stones?
3. Explain briefly tests conducted on bricks in the laboratories to ascertain their qualities.
4. Describe the common defects in bricks.
5. What is frog? What are its functions?

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CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

OBJECT: To find the crushing strength of bricks.

APPARATUS: compression testing machine, trowel, container, steel rule.

MATERIAL: Bricks, cement, fine sand.

THEORY: Bricks used in construction are generally subjected to compressive loads. Hence it is necessary to find the compressive strength of bricks. Compressive strength is the ratio of load at failure to surface area of brick. As per BIS: 1077-1957, the minimum crushing strength of bricks is 3.50 N/ mm^2. The bricks with crushing strength of 7to 14 N/mm^2 are graded as AA.

PROCEDURE: Select 5 bricks of standard size at random from the stack. Immerse the bricks in water for 24 hours at room temperature. Then the bricks are taken out from water and wipe off the surfaces with dry cloth. Apply cement mortar 1:1 on their faces and fill up the frogs also. Ensure that the loading faces are smooth and level. Now the bricks are kept under damp jute bags for 24 hours and there – after immersed in water for 3 days. Now the bricks are taken out and wipe off the surfaces with dry cloth. Measure the dimensions of the bricks. Place the bricks with flat faces horizontal and the mortar field frog face upwards between the two 3mm ply wood sheets in compression testing machine. The bricks should be kept in such a position that the loading should be axial. Now load is applied gradually at the rate of 14 N/mm2 per minute till failure occurs. The maximum load at failure is noted which is the crushing strength of the bricks. Repeat the procedure for remaining bricks. Calculate the average compressive strength.

OBSERVATIONS AND CALCULATIONS:

RESULT: Average compressive strength =

QUESTIONS:

1. What are the factors affecting the strength of bricks?
2. What are the different types of bonds? Explain them.

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CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

AIM: To determine the particle size distribution and fineness modules of fine aggregates.

APPARATUS REQUIRED:

Weighting balance and Sieves of sizes 4.75mm, 2.36mm, 1.18mm, 600micron, 300micron, 150micron

MATERIAL REQUIRED:

Sand 1 Kg.

THEORY:

The fineness modulus is a numerical index of fineness equal to the sum of cumulative percentages of material retained on set of ten sieves divided by 100. This will give some idea of the mean size of the particles present in the sample. The aggregate passing through 4.75mm sieve is called fine aggregate and retained on 4.75mm sieve is called coarse aggregate. It is necessary to find fineness modulus, to grade the given aggregate for the most economical mix and to get required strength and workability with minimum quantity of cement. The value of F.M. is higher for coarse aggregate.

For fine aggregate = 2 to 3.5

For coarse aggregate = 5.5 to8.0

For all in aggregate = 3.5 to 6.5

PROCEDURE:

The sieves mentioned in the table are taken and cleaned before use. The sieves are arranged with 80mm sieve at top and 150 microns sieve at bottom. Top sieve is covered with a lid and a receiver shall be placed below the last sieve. The sample of aggregate shall be brought to a dry condition before weighing and sieving. Weigh 1 kg of fine aggregate and place in the top most sieve of the set. The sieves are shaken either manually or mechanically. The shaking shall be done with a varied motion, backwards and forwards, left to right, circular clockwise and anti-clockwise so that the material is kept moving over the surface in frequently changing directions. This can be continued for a period of 2 minutes or more. In mechanical sieving, sieving shall be continued for not less than 10 minutes.

On completion of sieving, the material retained on each sieve shall be weighed. The readings are tabulated. Calculate sum of the cumulative percentages retained divided by 100. The value of fineness modulus is higher for coarse aggregate.

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OBSERVATIONS:
Weight of sample taken=

For Fine Aggregate:-

Sieve size	Wt. retained	Cumulative wt. retained	Cumulative% wt. retained
4.75mm.			
2.36mm			
1.18mm			
600 micron			
300 micron			
150 micron			

CALCULATIONS: Fineness modulus= sum of the cumulative percentages retained/100

RESULTS: Fineness modulus of fine aggregate =

PRECAUTIONS:

1) Each sieve shall be shaken for a period of at least 2 minutes if hand sieving is used.
2) Sieving should be in a circular clockwise and anti clockwise direction
3) If sieving is done in a shaken, at least 10 minutes sieving per test must be used.
4) The sample to be sieved should be in air dry condition.
5) The sieve should be in the proper sequence
6) There should be no wastage of aggregate during sieving
7) The weight of the aggregate retained on each sieve should measure

QUESTION:

1. What are fine and coarse aggregate?
2. Define fineness modulus.
3. Why the grading of aggregate is necessary?
4. What is the range of fineness modulus for fine and coarse aggregate?
5. How does the fineness of aggregates affect the workability of concrete?

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CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

OBJECT: To conduct field tests on cement.

MATERIAL: Cement samples.

PROCEDURE: The following field tests may be carried out to find roughly the quality of cement.

(i) **Colour:** The colour of cement should be greenish grey colour. The colour of cement should be uniform. This test gives a rough idea of excess lime or clay and the degree of burning.
(ii) **Physical properties:** The cement should be smooth when touched or rubbed in between fingers. It should give a cool feeling when hand is inserted in a cement bag. When a small quantity of cement is thrown in a bucket of water, the cement should float for a few minutes before it sinks. If it sinks immediately, it indicates some impurities present in cement.
(iii) **Presence of lumps:** Hard lumps should not be present in cement. Such lumps are formed by the absorption of moisture from the atmosphere.
(iv) **Strength:** Strength of cement is roughly determined by making briquettes with a lean mortar. The size may be 75mm x 25mm x 12mm, with a cement mortar (1:6). The briquettes are immersed in water for a period of 3 days. If the cement is of good quality, such briquettes will not be broken easily and it will be difficult to convert then into powder form.
1 m.

S.No.	Type of field test	Observations	Remarks

Result: Based on the observations, the cement is of good / bad quality.

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QUESTIONS:

1. State chemical and physical properties of portland cement.
2. What are the ingredients of Portland cement? State the function and limits of each of them.
3. List various uses of cement.
4. What tests would you specify to ensure if the cement supplied at the site is of good quality?
5. Describe with flow diagrams the dry and wet process of manufacture of cement.
6. When will you recommend high alumina cement in preference to low heat cement?
7. What precautions should be taken while storing cement?
8. What is the purpose of adding gypsum while manufacturing cement?
9. Differentiate between rapid hardening and slow setting cements.
10. What is the effect of mixing lime in cement?
11. Explain how cement gains strength.

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CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

OBJECT: To find the fineness of cement by sieve method

APPARATUS

1.Test Sieve: It comprises a firm, durable, non-corrodible, cylindrical frame of 150 mm to 200 mm nominal diameter and 40 mm to 100 mm depth, fitted with 90µm mesh sieve cloth of woven stainless steel, or other abrasion-resisting and non-corrodible metal wire. The sieve cloth shall comply with the requirements of IS 460 (Part 1) : 1985 and IS 460 (Part 3) : 1985 and shall be free of visible irregularities in mesh size when inspected optically by the methods of IS 460 (Part 3) : 1985. A tray fitting beneath the sieve frame and a lid fitting above it shall be provided to avoid loss of material during sieving.

2. Balance

Capable of weighing up to 10 g to the nearest 10 mg.

3. Brush

A nylon or pure bristle brush, preferably with 25 to 40 mm bristle, for cleaning the sieve.

Sampling and selection of test specimens: The samples of the cement shall be taken according to the requirements of IS 3535:1986 and the relevant standard specification for the type of cement being tested. The representative sample of the cement selected as above shall be thoroughly mixed before testing.

THEORY:

The finer cement will have fast chemical reaction with water and thus gives early strength. The fineness of cement is measured by sieving it on standard sieve. The proportion of cement of which the grain sizes are larger than the specified mesh size is thus determined.

PROCEDURE

Determination of the Cement Residue

1. Agitate the sample of cement to be tested by shaking for 2 min in a stoppered jar to disperse agglomerates.
2. Wait 2 min. Stir the resulting powder gently using **a** clean dry rod in order to distribute the fines throughout the cement.
3. Fit the tray under the sieve, weigh approximately 10 g of cement to the nearest 0.01 g and place it on the sieve, being careful to avoid loss. Disperse any agglomerates.
4. Fit the lid over the sieve. Agitate the sieve by swirling, planetary and linear movement until no more fine material passes through it.
5. Remove and weigh the residue. Express its mass as a percentage, R_1 of the quantity first placed in the sieve to the nearest 0.1 percent.
6. Gently brush all the fine material off the base of the sieve into the tray.
7. Repeat the whole procedure using a fresh 10 g sample to obtain R_2. Then calculate the residue of the cement R as the mean of R, and R, as a percentage, expressed to the nearest 0.1 percent.
8. When the results differ by more than 1 percent absolute, carry out a third sieving and calculate the mean of the three values.
9.The sieving process is carried out manually by a skilled and experienced operator.

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OBSERVATION AND CALCULATION:

S.No.	Weight of cement sample W_1	Weight of residue W_2	% residue by weight $R = (W_2/ W_1) \times 100$

Formula: the percentage residue as:

$$\% \text{ residue} = \frac{\text{Weight of residue}}{\text{Weight of cement}} \times 100$$

Result: The average % of residual weight of cement =

PRECAUTION:

1. Do not rub cement sample on sieve to breakdown the lumps.
   Any lump in the sample should be broken with fingers.
2. The sieve must be clean thoroughly before putting the sample.
3. Extra care should be taken to avoid loss.

QUESTIONS:

1. What does the fineness of cement indicate?
2. Why the finer cement give more early strength?
3. What is the effect of fineness of cement on ultimate strength?
4. How does the fineness affect shrinkage and cracking?
5. Define specific surface of cement.
6. What should be % residue by mass for ordinary Portland cement and rapid hardening cement?

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CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

OBJECT:

To determine **(a) Standard Consistency (b) Initial & Final setting time of the given cement sample by vicat apparatus.**

APPARATUS:

1. Vicat Apparatus with vicat plunger.
2. Vicat needles, Vicat plunger
3. Gauging trowel, Stop watch
4. Measuring jar
5. Weighing balance

THEORY:

Standard Consistency: The object of this test is to know the amount of water to be added to the cement to get a paste of normal consistency, i.e., the paste of a certain standard solidity, which is used to fix the quantity of water to be mixed in cement before performing tests for setting time, soundness & compressive strength. Standard consistency of cement is defined as that consistency which will permit plunger to penetrate at 33.34from the top of the mould. The consistency cement paste is expressed as a percentage by wt of dry cement. Usually this percentage varies from 26% to 33%.

Initial & Final Setting Time: When water is mixed to cement, a reaction start, this reaction is known as hydration. Due to this reaction the mixture of cement and water starts changing from one fluid state to a solid state

This is called setting of cement In the first few minute the setting action is more predominant and after some time hardening action becomes rapid. It is defined period elapsing between the time water added to the cement

and the time when the 1mm sq section needle fails to penetrate cement this block to depth of about 5mm form the
bottom of the mould.

Generally the initial setting time of cement is not less than 30min.

Final setting time of cement is defined as the period elapsed between the time when the water is added to the cement and the time at which the needle of is area 1mm² with 5mm diameter attachment, makes an impression on the test block, while the attachment fails to make an impression on the test block.

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PROCEDURE:

For standard Consistency:

1. For Preparing one mould take 400gm of cement passing through 850 micron sieve & prepare a paste of cement with a weighed quantity of water(100ml) taking care that the of gauging is between 3 to 5 min. The gauging time is counted from the time of adding of water to the dry cement until commencing to fill the mould.
2. Fill the vicat mould resting upon non-porous plate with this paste. After completely filling the mould, smooth off the surface of the paste by single movement of the palm making it level with the top of the mould. The mould may be shaken to expel air.
3. Place the test block in the mould with non-porous resting plate under the rod attached with the plunger. Lower the plunger gently to touch the surface of the test blocks & releases it quickly, allowing it to sink into the paste.
4. Prepare the trial pastes with varying % of water & test as described above until the amount of water necessary for the standard consistency as defined as obtained. Varying percentage of water firstly 4%, that is of 24%, 28% & 32% and then at an interval of 1% and 0.25% between the percentage range determined by the previous test.

For setting time of cement:

1. Prepare a neat cement paste by gauging with 0.85P water, where P=standard consistency as found before. The gauging time is again kept between 3 to 5 min. Start the stopwatch at the instant when the water is added to the cement.
2. Fill the vicat mould and smooth off the surface of the test paste making it level with the top of the mould. The cement block thus prepared is known as test block.
3. For the determination of initial setting, place test block confined in the mould and resting on non-porous plate under the rod attached with the square needle, lower the needle gently in contact with the surface of the test block and release quickly, allowing it to penetrate into the test block.
4. Repeat this procedure until the needled fails to pierce for the block about 5mm from the bottom of the mould. The period elapsed between the times when water is added to the cement at which the needle fails to pierce the test block by about 5mm is the initial setting time.
5. For the determination of final setting time replaced the square needle of the vicat apparatus by the square needle with annular collar. The cement is considered finally set when, upon applying square needle with annular collar gently to the surface of the test block, the needle makes an impression there on, while the attachment to do so.

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OBSERVATIONS:

For standard consistency

Type and brand of cement:……
Grade of cement:……

1.	Percentage of water				
2.	Initial Reading				
3.	Final Reading				
4.	Height not penetrate, mm (distance from base)				

For Setting time of cement

- Type and brand of cement:
- Grade of cement:
- Quantity of cement sample taken, W=
- Water for standard consistency P =
- Water to be added to cement = 0.85 xP xW =
- Time at the which water in first added to cement (T1)=
- Time when initial setting time needle fails topenetrate 33 to 35mm from top of mould (T2) =
- Time when final setting time needle makes an impression but the attachment fails to do so (T3) =
- Initial setting time = T2 -T1 =
- Final setting time = T3 - T1 =

RESULTS:

Standard consistency of cement = %
Initial setting time of the cement = Minuts.
Final setting of the cement = Minuts.

PRECAUTIONS:

1. The cement balls if any should be powdered before adding water to the cement.
2. While preparing the test block do not press cement in the mould.
3. Release the initial and final reading times needle gently.
4. The experiment should be free from vibrations and other disturbances.

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IS REQUIREMENTS:

The setting time of the cements, when tested by the Vicat apparatus method described in IS 4931 (Part 5) : 1988 shall conform to the following requirements:

a) Initial setting time in minutes, not less than 30; and

b) Final setting time in minutes, not more than 600.

All concreting operations viz. mixing, transportation, placing and compaction of concrete should be completed before initial setting time of cement .

CONCLUSION:

The setting times for the given cement sample are found……..(within/ not within) the limits specified by IS code.

QUESTIONS:

1. Which constituent of cement affects the early setting?
2. Which two factors mainly influence setting time of cement?
3. What is standard consistency of cement? How it is determined in the laboratory?
4. Explain the terms initial setting time and final setting time of cement. How they are determined?
5. What is the purpose of providing air vent in the final setting time needle?
6. State the significance of initial setting time and final setting time of cement?
7. What precautions will you take if initial setting time is less than BIS requirement?
8. What is the effect on setting time of cement if water added is less or more than 85% of normal consistency of cement?

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CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

AIM : To determine the workability of concrete mix by slump test

APPARATUS:
1- Weights and weighing device.
2- Tools and containers for mixing, or concrete mixer .
3- Tamper (16 mm in diameter and 600 mm length)
4- Ruler
5- Slump cone which has the shape of a frustum of a cone with the following dimensions:
Base diameter 20 cm
Top diameter 10 cm
Height 30 cm

THEORY: The ease with which the concrete is mixed, transported and placed is called workability of concrete . This test method is used to determine the slump of freshly mixed concrete, which is an approximate measure of consistency.

PROCEDURE:
1. Prepare concrete mix with known proportions
2. Place the mould on a smooth flat and non absorbent surface.
3. Fill the mould with concrete to about 1/4th the height
4. Compact the concrete with the help of steal rod 0.6m long and 16mm in diameter.
5. Fill the mould to about ½ of its height and compact it again
6. Repeat the procedure till the mould is filled completely and excess concrete is trimmed off
7. Remove the slump cone carefully in the vertical direction and on the removal of the mould the concrete subsides
8 Measure the height of concrete after subsidence

OBSERVATION:
1. Proportion of concrete mix
2. Water cement ratio=
3. Weight of cement =
4. Weight of sand=
5. Weight of aggregate =
6. Ht of concrete before slump subsidence =
7. Final height of concrete after subsiding =
8. Slump height =

RESULT: The slump value of given concrete mix is found to be ……..

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CONCLUSION: The concrete is suitable for ……..

PRECAUTIONS:

1. The material should be uniformly distributed in the mold.
2. Concrete should be filled in layers not exceeding 10 cm height.
3. While filling and Roding, be sure that the mold is firmly fixed by feet and can't move.
4. Distribute the strokes in a uniform manner over the cross section of the mold, each stroke just penetrating into the underlying layer.

QUESTIONS:

1. What is workability?
2. What is the effect of water cement ratio on workability?
3. On what factors do the workability of concrete depends?
4. What are the different types of concrete?
5. What are the uses of concrete?
6. What do you mean by R.C.C.
7. What are the slump values for concrete used for different works?
8. What is the curing of concrete necessary?

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OBJECT: To determine the workability by compacting factor test.

APPARATUS: Compaction factor testing machine.

THEORY:

Workability: This is defined as the ease with which concrete can be compacted fully without segregating and bleeding. It can also be defined as the amount of internal work required to fully compact the concrete to optimum density. The workability depends upon the quantity of water, grading, shape and the percentage of the aggregates present in the concrete.

To test the workably of freshly concrete, compaction factor test is carried out. This test works on the principal of determining the degree of compaction achieved by standard amount of work done by allowing the concrete to fall through a standard height. The degree of compaction factor is the ratio of weight partially compacted concrete to the weight of fully compacted concrete.

PROCEDURE:

1. Keep the compaction factor apparatus on a level ground.
2. Apply grease on the inner surface of hoppers and cylinder.
3. Fasten the flap doors.
4. Weigh the empty cylinder accurately and note down the mass as W1.
5. Fix the cylinder on the base with fly nuts and bolts in such a way that the central point of hopper and cylinder lie on one vertical line.
6. Cover the cylinder with a plate.
7. Prepare the dry concrete mix in the ratio 1:2:4 (take 2.25 kg cement,4.5 kg sand and 9 kg of coarse aggregate.)
8. Add water assuming the water cement ratio to be 0.50 .
9. Fill the sample of concrete to be tested gently in the upper hopper, using the hand scoop without compacting The hopper shall be filled level with its brim
10. After two minutes the trap-door shall be opened so that the Concrete falls into the lower hopper.(Certain mixes have a tendency to stick in one or both of the hoppers. If this occurs, the concrete may be helped through by pushing the rod gently into the concrete from the top.) During this process, the cylinder shall be covered by plate.
11. Immediately after the concrete has come to rest, the cylinder shall be uncovered, the trap-door of the lower hopper opened, and the concrete allowed to fall into the cylinder bringing the concrete into standard compaction.
12. Remove the excess of concrete above the level of the top of the cylinder by holding a trowel in each hand, with the plane of the blades horizontal, and moving them simultaneously one from each side across the top of the cylinder, at the same time keeping them pressed on the top edge of the cylinder.
13. Clean the outside of the cylinder.

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14. The 'weight of the concrete in the cylinder shall then be determined to the nearest 10 g. This weight shall be known as the weight of partially compacted concrete '.W2
15. The cylinder shall be refilled with concrete from the same sample in layers approximately 5 cm deep, the layers being heavily rammed or preferably vibrated so as to obtain full compaction.
16. The top surface of the fully compacted concrete shall be carefully struck off level with the top of the cylinder. The outside of the cylinder shall then be wiped clean.
17. Weigh the cylinder to the nearest 10gm. This weight is known as "weight of fully compacted concrete".W3
18. Calculate the compacting factor of concrete.
The Compacting factor = weight of partially compacted concrete /weight of fully compacted concrete

OBSERVATION AND CALCULATION:

Type and brand of cement =
Grade of cement =

1. Wt of cement=
2. Wt of sand=
3. Wt of aggregate. =
4. Water cement ratio =
5. Wt of empty cylinder W_1=
6. Wt of partial compacted concrete with cylinder W_2=
7. Wt of fully compacted concrete with cylinder W_3 =
8. Wt of partially compacted concrete (W2-W1) =
9. Wt of fully compacted concrete (W_3- W1) =

C.F. = (W2-W1)/ (W_3- W1) =

RESULT

The compaction for given concrete mix is found to be ……

PRECAUTIONS:

1. The test should be carried out on a level ground. All operation shall be carried out at a place free from vibration or shock.
2. The outside of mould must be wiped clean before weighing.
3. The mix should not be pressed or compacted in the upper hopper.
4. Certain mixes have a tendency to stick in one or both of the hoppers. If this occurs, the concrete may be helped through by pushing the rod gently into the concrete from the top.
5. The top hopper must be filled gently.
6. The hopper and cylinder must be washed, cleaned and wiped before use.

CONCLUSION

The degree of workability is …….and use for …….

QUESTIONS:

1. What is meant by workability?
2. How do you compare a slump tests with a compaction factor test?
3. What are the distance between cylinder top and bottom of lower hopper?
4. Will the workability increases with increase in compaction factor value and if so, why?
5. In what respect, compaction factor test is a better measure of workability than slump cone tests?
6. What are the limitations of this method?
7. What are the factors which affects the workability of concrete?
8. How does the size of aggregates influence the workability?

PREPARED BY: GIRISH PATIDAR

SHIVAJIRAO KADAM INSTITUTE OF TECHNOLOGY & MANAGEMENT, INDORE

CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

AIM : Measurement of distance by Ranging and Chaining & Determination of area of given polygon by chain & cross-staff survey

EQUIPMENT- : Chain, Arrows, Tapes, Ranging Rods, Offset Rods, Cross staff or optical square,Plumb bob, wooden mallet, pegs.

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) .
Chain The chain is composed of 100 or150 pieces of galvanized mild steel were 4mm
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 centre's 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. 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. Following are the various types of chain in common use:
1) Metric chains 2) Gunter` s chain or surveyors chain 3) Engineers chain 4) Revenue chain
5) Steel band or Band chain

Metric chain: Metric chains are made in lengths 20m and 30m. Tallies are fixed at
every five-meter length and brass rings are provided at every meter length except where

tallies are attached
b) Tapes:
The following are the various types of tapes
i) Cloth tape
ii) Metallic tape
iii) Steel tape
iv) Invar tape
Among the above, metallic tapes are widely used in surveying. A metallic tape
is made of varnished strip of waterproof line interwoven with small brass, copper or bronze wires. These are light in weight and flexible and are made 2m, 5m 10m, 20m, 30m, and 50m.

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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.
Cross-Staff is the simplest instrument used for setting out perpendicular i.e taking offsets from a chain line. it is easier and quicker method ,but not very accurate .if great accuracy is desired ,the work should be carried out by the theodolite.
Arrows: Arrows are made of good quality hardened steel wire of 4 mm diameter.
The arrows are made 400 mm in length, are pointed at one and the other end is
bent into a loop or circle
Open cross staff:- The simplest Type consists two parts 1) the head 2) the leg .the head is made of wooden block octagonal or round in shape about 15cm side or diameter an 4cm deep . on it are scribed two lines at right angles to another .At the end of these two lines are fixed two points of metallic strip having slits made in them .These slits two lines of sight which are at right angles to one another .The head is fixed on a wooden staff or pole about 3cm in diameter and 1.2 to 1.5m length .The pole is provided conical metal shoe so that it can be driven into the ground.

OFFSET ROD: The offset rod is used for measuring the off set of short lengths. It is
similar to a ranging rod and is usually of 3m lengths.

PEGS: These are rods made from hard timber and tapered at one end, generally 25mmor 30mm square and 150mm long wooden pegs are used to mark the position of the station on.
PLUMB BOB: While chaining along sloping ground, a plumb bob is required to transfer the points to the ground.
Determination of area of given polygon by chain & cross-staff survey
The object of cross staff survey is to located the boundaries of field or plot and
to find out its area .In this method a base line in the centre of the area is selected. Chaining along this line is done and the offsets of the points lying on the boundaries of the plot are taken at different chainages.by using a cross staff and tape on either side of the chain line and recorded against the chainages in the field note book as

already discussed .The offsets length are written on the left hand side or right hand side of the line as per position until whole of the area is surveyed. The plot is then divided into triangles and trapezoids because it it easy to find out the area of triangle and a trapezoids.
The area of the field is computed by the following formulae.
(1) The area of a right angle triangle is equal to the base multiplied by half the perpendicular
(2)The area of a trapezoid is equal to the base multiplied by half the sum of the Perpendicular.

PROCEDURE:
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.

Setting perpendicular offsets1) To find the foot of the perpendicular from the object the cross staff is held approximately in position and one pair of slits is directed in the direction of the ranging rod fixed at the forward and the chain line . The observer then looks through the other pair of slits and sees whether the particular object is bisected or not. if not the cross staff is moved to and from till the necessary bisection is obtained. Before noting down the chainage of the foot of the perpendicular care must be taken to see that one pair of slit is the direction of chain or not. While shifting the position of the cross-staff it may get twisted and hence precaution is necessary.
2) To set a perpendicular to the chain line at a given point one pair of slits is oriented in the direction of chain line by looking at the ranging rod fixed at the forward and by looking through the other pair of slits ranging rod is fixed in the direction of the line of sight provided by this pair.

To start the cross staff survey ,a chain line is run through the centre of the area to be surveyed .it is divided into right angled triangles and trapezoids .The perpendicular to the boundary are taken in order of their chainages. A cross staff or optical square is used to set out perpendicular offsets which are usually more than 15m .Care should be taken that no offset is overlooked before the chain is removed .The chainages of the points of intersection of the chain line and the boundaries should be recorded .The length of the boundary line may be measured by direct measurement to check the accuracy of field work.After the field work is over, the survey is plotted to some convenient scale. The figure thus formed by the boundary lines is divided in the tabular from as given below

Observation Table;- observations are taken in field book.

RESULT: Area of polygon by chain & staff method is found to be ----------square meter.

QUESTIONS:

1. Briefly explain features of metric chain.
2. Name the Instruments used in chain survey?
3. What is ranging?
4. What is chaining?
5. How many types of offsets?
6. How many types of chain?
7. How many types of tapes?
8. What is the use of field book?
9. How many types of cross-staff?
10. Mention obstacles in chaining & ranging?
11. How many links in 20m long metric chain?
12. How many links in 30m long metric chain?
13. How many numbers of tallies should be in 30m long metric chain?

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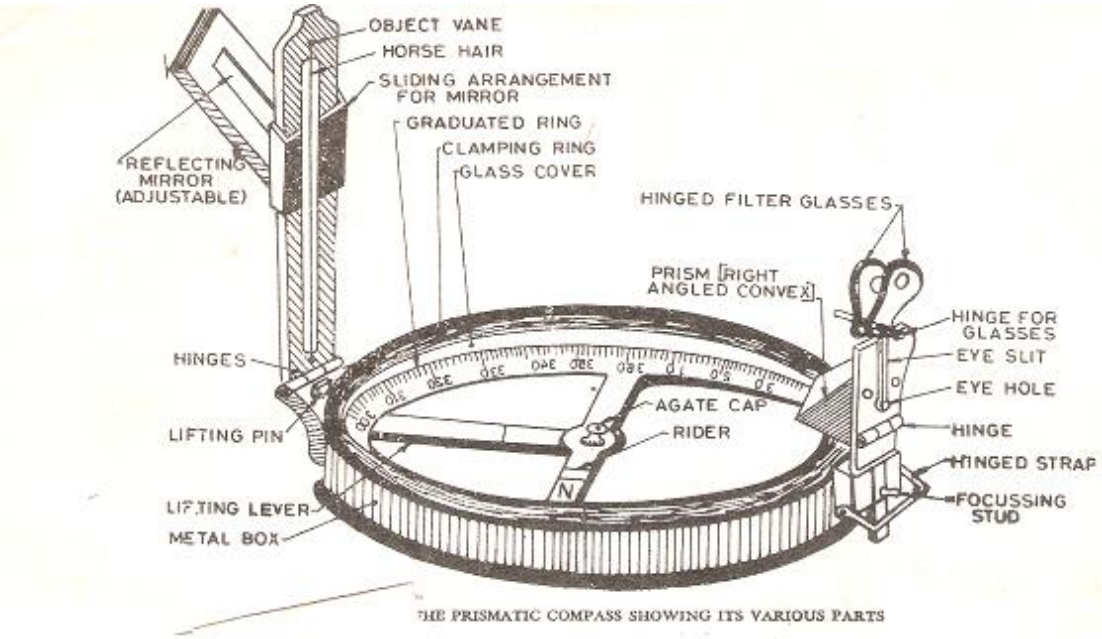
14. What is the use of cross-staff?
15. What is the Least count of 30m chain
16. What is base line, tie line, check line, main line, main surveying line, tie station?

SHIVAJIRAO KADAM INSTITUTE OF TECHNOLOGY & MANAGEMENT, INDORE
CIVIL ENGINEERING DEPARTMENT

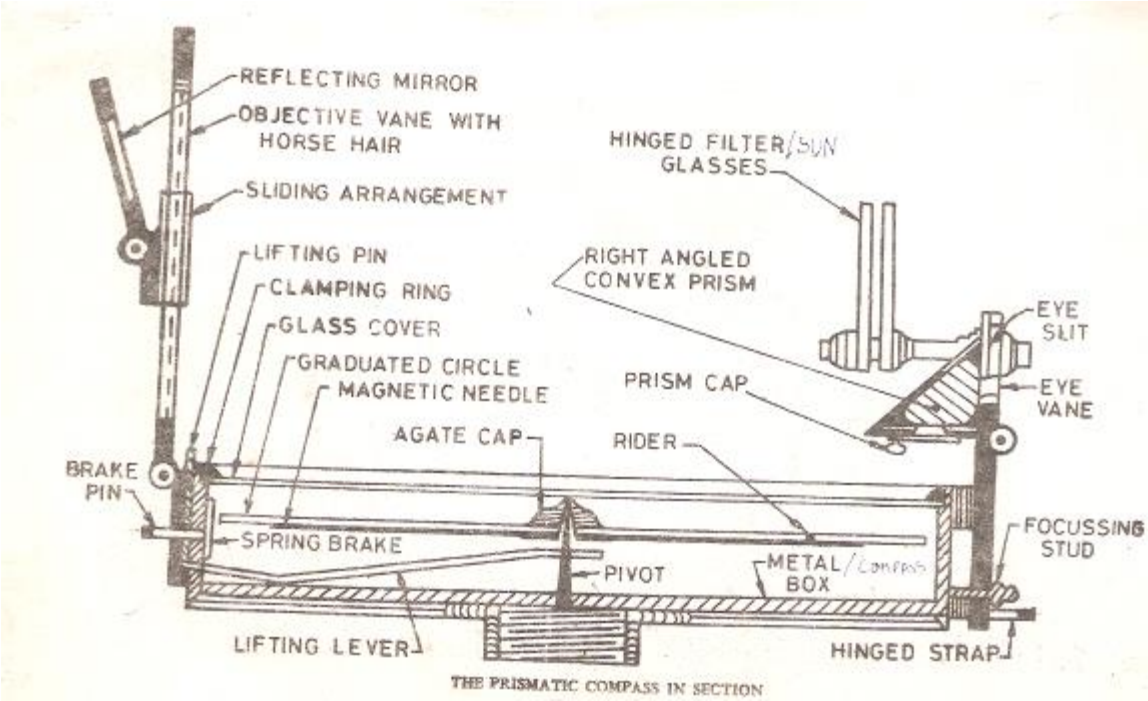
BASIC CIVIL ENGINEERING

AIM: To perform traverse surveying with prismatic compass, check for local attraction and determine corrected bearing and to balance the traverse by Bowditch's rule

APPARATUS: Prismatic compass, ranging rod, chain, tape, peg Tripod stand, small pieces of stones



THE PRISMATIC COMPASS SHOWING ITS VARIOUS PARTS



THE PRISMATIC COMPASS IN SECTION

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THEORY: The important parts of compass are:- 1)
A box with graduated circle. 2) A magnetic needle 3) A line of sight

When the line of sight is pointed to point, the magnetic needle of compass points towards north (Magnetic meridian). The angle which this line of sight makes with the magnetic meridian is read on graduated circle.it is known as magnetic bearing of the line.
There are two types of compasses:-
1) Prismatic compass 2) Surveyor's compass.

PRISMATIC COMPASS:-
Prismatic compass is very valuable instrument. It is usually used for rough survey for measuring bearing and survey lines. The least count of prismatic compass is 30 min. It consists of circular box of 10cm-12 cm dia. of non magnetic material. pivot is fixed at the centre of box and is made up of hard steel with a Sharp pivot. Graduated aluminum is attached to the needle. It is graduated in clockwise direction from 0^0 to 360^0.the figures are written in inverted. Zero is written at south end and 180 at north end and 270 at the east. Diametrically opposite are fixed to the box. The sighting vane consists of a hinged metal frame in the centre of which is stretched a vertical Horse hair fine silk thread of which is stretched a vertical hair. it presses against a lifting pin which lift the needle of the pivot and holds it against the glass lid. Thus preventing the wear of the pivot point to damp the oscillations of the needle when about to take reading and to bring to rest quickly, a light spring is brought lifted Inside the box. The face of the prism can be folded out the edge of the box when North end is used Sometime the sighting vanes is provided with a hinge mirror Which can be placed upward or downwards on the frame and can be also Slided along it is required. The mirror can be made inclined at any angle so that Objects which are too high or too low can be sighted directly by reflecting.

BEARING OF LINES: A bearing of a line is a horizontal angle made by the survey line with some reference direction or meridian. Meridian may be 1) A true meridian 2) A magnetic meridian 3) An arbitrary or assumed meridian
True meridian: The true geographical meridian passing through a point is a line of intersection of earth's surface by a plane containing north south pole and given point. They are not parallel to each other at different places.
Magnetic meridian:-the direction indicates by a free suspended and a properly balanced magnetic needle Free from all other attractive forces. The direction of magnetic meridian can be established with the help of magnetic compass.
Arbitrary meridian: Any direction is assumed to be the reference meridian to carry out small survey.
Traverse surveying is the main method used in compass surveying.

TRAVERSING: Surveying which involves a series of connected survey lines is known as traverse. The sides of traverse are known as traverse legs.
A traverse may be of two types: 1) Closed Traverse 2)Open Traverse

1)Closed Traverse : When the finishing point of the survey coincide with the starting point of the survey, it is called a closed traverse. Closed traverse is suitable for the survey of boundaries of ponds, forests, estates, etc.

2) Open Traverse: When the starting point of the survey does not coincide with last point of the survey, it is known as open traverse. Open traverse is suitable for the survey of roads, rivers, coastal lines, railways, etc.

Whole Circle Bearing:
In whole circle bearing system, the bearing of a line is always measured clockwise from the north point of the reference meridian towards the line right round the circle. The angle thus measured between the reference

meridian and the line is called Whole circle bearing of the line. Angles measured will have value between 0 to 360 degrees.

Conversion of W.C.B. in R.B

Case	W CB between	R . B .	QUADRANT
1	00 TO900	WCB	N-E
2	900 TO -1800	180-WCB	S-E
3	1800 TO -2700	WCB-1800	S-W
4	2700 TO 3600	3 60-WCB	N-W

Reduced bearing (R.B):

In this system of bearing of a line is measured clockwise or anticlockwise from north or south direction whichever is nearer to the line towards east or west. The concept of reduced bearing facilitates computations in traverse surveying.

Conversion of R.B in W.C.B.

Case	R .B in quadrant	Rule of W.C.B.	W .C.B between
1	N-E	WCB=R.B	0^0 TO90^0
2	S-E	WCB =180-R.B	90^0 TO -180^0
3	S-W	WCB =R.B+180	180^0 TO -270^0
4	N-W	WCB =360-R.B	270^0 TO 360^0

Adjustment of the Prismatic Compass

The compass may be held in hand but for better results it should be fitted at the top of tripod having ball and socket arrangement. The adjustment of a compass is done in the following three steps.

1) Centering: - The compass fitted over the tripod Is lifted bodily and placed approximately on the station peg by spreading the leg of a tripod equally, The centre of the compass is checked by dropping a small piece of stone from the centre of the bottom of the compass so that it falls on the top of the station peg. A plumb bob may be used to judge the centering either bt attaching it with a hook providing at the bottom or otherwise by holding it by hand.

2) Leveling:-After the compass is centered, it is leveled by means of ball and socket arrangement so that the graduated circle may swing freely. It can be checked roughly by placing a round pencil on the top of the compass, when the pencil does not move, that is roughly the horizontal position.

3) Focusing the prism: - The prism attached is moved up and down so that graduation on the graduated circle should become sharp and clear.

LOCAL ATTRACTION:

Sometimes .the magnetic needle does not point towards magnetic North or South. The reason being that the needle may be under the influence of external attractive forces which are produced due to magnetic substances Thus the deflection of the needle from its original position, due to the presence of some magnetic substances is known as local attraction. To detect local attraction at a particular place, fore and back bearing of each line are taken. Then difference comes out to be 180° there is no local attraction at either station. On the other hand of the difference is other than 180°,the bearing may be rechecked to find out the discrepancy may not be due to the presence of iron substance near to the compass. If the difference still remains the local attraction exists at on or both the stations.

Elimination of Local attraction:-

1st method: - In this method, the bearing of the other lines are corrected and calculated on the basis of the a line which has the difference between its fore bearing and back bearing equal to 180°.The magnetic of the error is formed due to local attraction by drawing a sketch of observed and correct bearing of the line at each station.

The error will be negative when the observed bearing is less than the corrected one and the correction will be positive and vice versa. If however, there is no such line in which the difference of fore bearing and back bearing is equal to 180°, the correction should be made from the mean value of the bearing of that line in which the difference between the fore and the back bearing is the least. If the bearings are observed in quadrantal system, the correction should be applied in proper direction by drawing a neat sketch roughly.

2nd Method: - This method is more general as the bearing at a station locally affected may be incorrect but include angles calculated from these bearing will be correct since the amount of the error will be the same for all the bearing observed from that station. Thus starting from the unaffected line and using these included angles the correct bearing of all other lines can be calculated.

check - The sum of the internal included angles must be equal to (2n-4) right angles
where n=number of sides of a closed traverse.

PROCEDURE:

1) Four ranging rods are fixed at different points i.e. A, B, C, D, E etc. such that it should be mutually visible and may be measured easily.
2) Measure the distance between them.
3) At point A the prismatic compass is set on the tripod Stand, centering and leveling is then properly done.
4) 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. 5) 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. 6) Repeat the same procedure at the stations C, D etc.

Observation Table

Sl.No	Line	Length	F.B.	B.B	correction	Corrected bearing		Remarks
						F.B	B.B	

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FORMULA: Included angle = B.B of previous line – F.B of next line.

CHECK: The sum of the included angles should be equals to (2n-4) x 90º where 'n' is number of sides of the traverse.

PRECAUTIONS: The following precautions are taken while conducting a compass traverse.

1) The centering is done perfectly
2) To stop the rotation of the graduated ring, the brake pin is pressed very gentl and not suddenly.

3) Readings is taken along the line of sight and not from any side.
4) When the compass has to be shifted from one station to other, the sight vane is folded over the glass cover. This is done to lift the ring out of the pivot avoid unnecessary wear of the pivot head.
5) The compass box is tapped gently before taking the reading. This is done to find out whether the needle rotates freely.
6) The stations is not selected near magnetic substances.
7) The observer should not carry magnetic substances.
8) The glass cover is not dusted with a handkerchief, because the glass gets charged with electricity and the needle may be deflected from its true direction. The glass cover should be cleaned with a moist finger.

QUESTIONS:

1. What is the purpose of prismatic compass in surveying?
2. For what a mirror is provided to the object vane?
3. Where is the 180º marked on the graduated ring?
4. What is the least reading that can be read from a compass?
5. States the reason for the graduations of prismatic compass are written inverted.
6. What is bearing? How many types of bearing?
7. What is traverse? How many types of traverse? Explain the check applied to a closed traverse
8. Difference between prismatic compass & surveyor compass?
9. Define local attraction. How do you detect it?
10. Define the whole circle bearing?
11. Define the reduced bearing?
12. Define fore bearing and back bearing?
13. What is the difference between fore bearing and Back bearing of a line?
14. The fore bearing of a line 60º 30', find its back bearing?
15. Convert 80º30', 130º40'into reduced bearing?
16. Convert S 52º30' into whole circle bearing?
17. If F.B. is 62º 0' & B.B. is 250º 30' calculate included angle?
18. If included angle is 45º 0 & B.B. is 270º 0' calculate F.B.?
19. If F.B. is N 10º 30' E calculate B.B
20. If B.B. is S 25º 0' W calculate F.B.?

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SHIVAJIRAO KADAM INSTITUTE OF TECHNOLOGY & MANAGEMENT, INDORE

CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

AIM: To perform leveling exercise and determination of elevation of various points with dumpy level/auto level by height of instrument method and rise & fall method.
APPARATUS: Dumpy level, leveling staff

THEORY:
Levelling: The art of determining and representing the relative height or elevation of different object/points on the surface of earth is called leveling. It deals with measurement in vertical plane. By leveling operation, the relative position of two points is known whether the points are near or far off. Similarly, the point at different elevation with respect to a given datum can be established by leveling.
Definitions
Differential leveling is the term applied to any method of measuring directly with a graduated staff the difference in elevation between two or more points.
Precise leveling is a particularly accurate method of differential levelling which uses highly accurate levels and with a more rigorous observing procedure than general engineering leveling. It aims to achieve high orders of accuracy such as 1 mm per 1 km traverse.
A level surface is a surface which is everywhere perpendicular to the direction of the force of gravity. An example is the surface of a completely still lake. For ordinary levelling, level surfaces at different elevations can be considered to be parallel.
A level datum is an arbitrary level surface to which elevations are referred. The most common surveying datum is mean sea-level (MSL), but as hydrological work is usually just concerned with levels in a local area, we often use:
An assumed datum, which is established by giving a benchmark an assumed value (e.g. 100.000 m) to which all levels in the local area will be reduced. It is not good practice to assume a level which is close to the actual MSL value, as it creates potential for confusion.
A reduced level is the vertical distance between a survey point and the adopted level datum.
A bench mark (BM) is the term given to a definite, permanent accessible point of known height above a datum to which the height of other points can be referred. It is usually a stainless steel pin embedded in a

substantial concrete block cast into the ground. At hydrological stations rock bolts driven into bedrock or concrete structures can be used, but structures should be used warily as they themselves are subject to settlement. The locations of benchmarks shall be marked with BM marker posts and/or paint, and recorded on the Station.
A set-up refers the position of a level or other instrument at the time in which a number of observations are made without mooring the instrument. The first observation is made to the known point and is termed a backsight; the last observation is to the final point or the next to be measured on the run, and all other points are intermediates.
Height of Collimation is the elevation of the optical axis of the telescope at the time of the setup.
The line of collimation is the imaginary line at the elevation.
Change points are points of measurement which are used to carry the measurements forward in a run. Each one will be read first as a foresight, the instrument position is changed, and then it will be read as a back sight.

LEVELLING INSTRUMENTS:-
The instrument which are directly used for leveling operation are:- Level, Leveling staff

Dumpy level:

The major components of a dumpy level

Telescope: It contains of two metal tubes, one of which slides within the other onetube carries the object glass and the second one carries eyepiece and diaphragm. **Focusing screw:** The telescope is focused by turning the focusing screw either forward or backward.

Bubble tubes: The telescope is attached with two bubble tubes. One is longitudinal and the other is cross bubble tube. These two are placed at right angles to each other. **Diaphragm:** It carries cross hairs.

Tribrach & Trivet: The telescope with vertical spindle is supported by two parallel triangular plates. The upper plate is called tribrach and the lower plate is called trivet

Foot screws: By turning the foot screws, the tribrach can be raised or lowered to bring the bubble to the center of its run.

Leveling staff:

The leveling staff: It is used for measuring the vertical distance of the points above or below the horizontal line of sight. The different staves in use are

1. Folding staff 3. Solid staff 4. Target staff

There are two systems of reduced levels

a) The plane of collimation system (H.I. method)

b) The Rise and fall system

a) The plane of collimation system (H.I. method)

In this system, the R.L. of plane of collimation (H.I) is found out for every set-up of the level and then the reduced levels of the points are worked out with the respective plane of collimation as described below.

1) Determine the R.L. of plane of collimation for the first set up of the level by adding B.S. to the R.L. of B.M.

R.L of plane of collimation= R.L. of B.M.+B.S.)

2) Obtained the R.L. of the intermediate points and first change point by subtracting the staff readings (I.S. and F.S). from the R.L. of plane of collimation (H.I).

R.L. of a point=R.L of plane of collimation H.I. - I.S or F.S

3) When the instrument is shifted and set up at new position a new plane of collimation is determined by addition of B.S. to the R.L of change point. Thus the levels from two set-ups of the instruments can be correlated by means of B.S. and F.S. taken on C.P.

4) Find out the R.L.s of the successive points and the second C.P. by subtracting their staff readings from this plane of collimation R.L.

5) Repeat the procedure until all the R.Ls are worked out.

b) The Rise and fall system

In this system, there is no need to determine R.L. of plane of collimation .The difference of level between consecutive points are obtained as described below.

1) Determine the difference in staff readings between the consecutive point comparing each point after the first with that immediately proceeding it.

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2) Obtained the rise or fall from the difference of their staff reading accordingly to the staff reading at the point is smaller or greater than that of proceeding point.
3) Find out the reduced level of each point by adding the rise to or subtracting fall from the R.L. of a proceeding point.

LEVELLING PROCEDURES

Adjustment of the level: The level needs two type of adjustment
1) Temporary adjustment and 2) Permanent adjustment

Temporary adjustments of dumpy level

These adjustments are performed at each set-up the level before taking any observation.

a) Setting up the level:- this includes
1) Fixing the instrument in the tripod:- the tripod legs are well spread on the ground with tripod head nearly level and at convenient height. Fix up the level on the tripod.
2) Leg adjustment:- Bring all the foot screws of the level in the centre of their run .Fix any two legs firmly into the ground by pressing them with hand and move the third leg to leg to right or left until the main bubble is roughly in the centre. Finally the legs is fixed after centering approximately both bubbles. This operation will save the time required for leveling.

b) Levelling: - Levelling is done with the help of foot screws and bubbles. The purpose of levelling is to make the vertical axis truly vertical. The method of leveling the instrument depends upon whether there are three foot screws or four foot screws. In all modern instruments three foot screws are provided and this method only is described.
1) Place the telescope parallel to pair of foot screws.
2) Hold these two foot screw between the thumb and first finger of each hand and turn them uniformly so that the thumbs move either toward each other until the bubble is in centre.3) Turn the telescope through 90°so that it lies over the third foot screw. 4) Turn this foot screw only until the bubble is centered.
5) Bring the telescope back to its original position without reversing the eye piece and object glass ends.
6) Again bring the bubble to the centre of its run and repeat these operation until the bubble remains in the centre of its run in both position which are at right angle to each other.
7) Now rotate the instrument through 180°,the bubble should remain in centre provided the instrument is in adjustment: if not ,it needs permanent adjustment.
c) **Focusing the eye piece:-** To focus the eye piece, hold a white paper in front of the object glass ,and move the eye piece in or out till the cross hairs are distinctly seen. Care should be taken that the eye piece is not wholly taken out ,some times graduation are provided at the eye piece and that one can always remember the particular graduation position to suit his eyes, This will save much time of focusing the eye piece.
(d) **Focusing the object glass**: - Direct the telescope to the leveling staff and on looking through the telescope, turn the focusing screw until the image appears clears and sharp. The image is thus formed inside the plane of cross hairs, Parallax, if any is removed by exact focusing. It may be noted that parallax is completely eliminated when there is no change in staff reading after moving the eye up and down.

Elimination of parallax:

i) Remove the lid from the object glass.
ii) Hold a sheet of white paper in front of the object glass.
iii) Move the eyepiece in or out until the cross hairs are distinctly visible.
iv) Direct the telescope towards the staff.
v) Turn the focusing screw until a clear and sharp image in formed in the plane of the cross hairs.

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Observation table:-
The plane of collimation system (H.I. method)

Station	Readings			R.L. of plane collimation (H.I)	Reduced Level	Remarks
	B.S	I.S	F.S			

H.I = R.L of B.M + B.S

R.L of other station points = H.I – I.S or F.S

Arithmetical check: The difference between the sum of the back sights and the sum of the

fore sights should be equal to the difference between the last and first reduced levels.

i.e ∑B.S - ∑ F.S.= LAST R.L –FIRST R.L

The Rise and Fall method

Station	Readings			Rise	Fall	Reduced Level	Remarks
	B.S	I.S	F.S				

Arithmetic check:- ∑B.S - ∑F.S = ∑RISE - ∑FALL = LAST RL- FIRST RL

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RESULT:The various reduced levels are calculated by rise and fall method and by using height or plane of collimation method are shown in observation table.

PRECAUTIONS:

1) Bench mark should be chosen properly
2) Staff should be held vertical.
3) At all the instrument stations the temporary adjustments are done before taking the reading.
4) Line of sight should be made horizontal.
5) After shifting the instrument, back sight reading at change point must always be taken.
6) Carefully enter the readings in the Back Sight and Fore Sight columns.

QUESTIONS:

1. What is leveling?
2. What is bench mark? How many types of bench mark
3. Name the types of level other than dumpy level
4. What are the different types of leveling staff?
   Which leveling staff in our practical lab.?
5. What is the least count of leveling staff?
6. What is elevation of mean sea level?
7. What is datum?

8. What is back sight, fore sight, intermediate sight, turning point, change point, reduced level, height of instrument, line of collimation, arithmetic check,
9. Compare the height of instrument with rise and fall method
10. What is parallax? How it is removed

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CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

AIM: Find the height of the tie beam above the floor level.

APPARATUS REQUIRED:

1) Dumpy Level/Auto Level
2) Tripod Stand
3) Ranging Rod
4) Pegs
5) Wooden Hammer
6) Measuring Tape
7) Field Book
8) Pencil

THEORY:

When the object is above the line of collimation (or line of sight) the staff is held inverted on the point and reading is taken .This reading being negative is entered in the level field book with minus sign, or to avoid confusion, 'Staff inverted' should be written in the remarks column against the entry of the reading.

When the reading on the inverted staff is a foresight or intermediate sight .it should also be recorded in field book with minus sign

PROCEDURE:

1. Select a suitable station from where the B.M. and the bottom of beam are clearly visible.
2. Do the necessary temporary adjustments of the level at selected station.
3. The first reading is taken as the Back Sight (B.S.) reading on the Bench Mark (B.M).
4. The Fore Sight(F.S.) reading at B is taken by rotating the telescope, but the staff is kept inverted to the tie beam that is station B and the reading should be treated as negative.

OBSERVATIONS TABLE:

S.No	Station	Back Sight (B.S)	Fore Sight (F.S)	Height of Instrument (H.I)	Reduced Level (R.L)	Remarks

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CALCULATIONS:

Height of Instrument(HI) = Reduced Level(RL) of Bench Mark(BM) + Back Sight(BS)

Reduced Level(RL) = Height of Instrument(HI) –(- Fore Sight(FS)) or Intermediate Sight(IS)

Height of tie beam above Floor Level = (R.L. of tie beam) - (R.L. of floor)

RESULTS:

R.L. of bottom of tie beam =

Height of tie beam above floor level =

PRECAUTIONS:

1. Bench mark should be chosen properly.
2. Staff should be held vertical and inverted.
3. At the instrument stations the temporary adjustments are done before taking the reading.
4. Line of sight should be made horizontal.
5. Only two reading should be taken from each instrument station.
6. Carefully enter the readings in the Back Sight and Fore Sight columns.

QUESTIONS:

1. Identify the situations where inverted staff readings are necessary.

2.what are the other methods of finding the height of beam at roof level.

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CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

OBJECTIVE : To study different parts of transit Theodolite and its Temporary adjustments.

EQUIPEMTNS: Transit theodolite.

THEORY :

The theodolite is the most intricate and accurate instrument used for measurement of horizontal and vertical angles. It consists of telescope by means of which distant objects can be sighted. The telescope has two distinct motions on in the horizontal plane and the Other in the vertical plane. The former being measured on a graduated Horizontal vertical circle of two verniear.

Theodolite are primarily classified as 1) Transit theodolite 2) Non-transit theodolite A theodolite is called transit theodolite when its telescope can be resolved through a complete revolution about its horizontal axis. In a vertical plane. The transit type is largely used.

Definition and terms

Vertical axis: It is the axis about which the telescope can be rotated in a horizontal plane.

Horizontal axis: It is the axis about which the telescope can be rotated in a vertical plane.

Line of collination: It is the imaginary line joining the intersection of the cross hairs of the diaphragm to the optical center of the object glass and its continuation.

Axis of the telescope: It is the line joining the optical center of the object glass to the center of the eye-piece.

Axis of the level tube: It is the straight line tangential to the longitudinal curve of the level tube at the center of the tube.

Centering: The process of setting the theodolite exactly over the station mark is known as centering.

Transiting: It is the process of turning the telescope in vertical plane through 180º about the trunnion axis.

Description cf Equipment:

Telescope: It consists of eye-piece , object glass and focusing screw and it is used to sight the object.

Vertical circle: It is used to measure vertical angles.

Levelling head: It consists of two parallel triangular plates called tribrach plates. Its uses are

1. To support the main part of the instrument.
2. To attach the theodolite to the tripod.

Lower plate: It consists of lower clamp screw and tangent screw.

Upper plate: The upper plate is attached to the inner axis and it carries two verniers. It consists an upper clamp screw and tangent screws. These screws are used to fix upper plate with lower plate accurately.

Foot screws: These are used to level the instrument

Plumb bob: It is used to center theodolite exactly over the ground station mark.

Swinging the telescope: It means turning the telescope about its vertical axis in the horizontal plane. A swing is called right or left according as the telescope is rotated clockwise or counter clockwise.

Face left: If face of the vertical circle is to the left side of the observer, then the observation of the angles taken is known as face left observation.

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Face right: If the face of the vertical circle is to the right side of the observation, then the observation of the angles taken is known as face right observation.
Changing face: It is an operation of bringing the face of the telescope from left to right and vice-versa.
Temporary adjustments: There are three temporary adjustments of a theodolite. These are
1. Setting up the theodolite over a station. 2. Leveling up. 3. Elimination of parallax.

Setting up: It includes two operations
1. Centering a theodolite over a station: Done by means of plumb bob.
2. Approximately leveling it by tripod legs only: Done by moving tripod legs radially or circumferentially.

Leveling up: Having centered and approximately leveled the instrument, accurate leveling is

done with the help of foot screws with reference to the plate levels, so that the vertical axis shall be truly vertical.
To level the instrument the following operations have to be done.
1. Turn the upper plate until the longitudinal axis of the plate level is roughly parallel to a line joining any two of the leveling screws (A & B). 2. Hold these two leveling screws between the thumb and first finger of each hand uniformly so that the thumb moves either towards each other or away from eachother until the bubble comes to the center. 3. Turn the upper plate through 90º i.e until the axes of the level passes over the position of the third leveling screw 'C'.
4. Turn this leveling screw until the bubble comes to the center.
5. Rotate the upper plate through 90º to its original position fig(a) and repeat step(2) till the bubble comes to the center.
6. Turn back again through 90º and repeat step 4 .
7. Repeat the steps 2 and 4 till the bubble is central in both the positions.
8. Now rotate the instrument through 180º. The bubble should be remaining in the center of its run, provided it is in correct adjustment. The vertical axis will then be truly vertical.

3. Elimination of parallax:
Parallax is a condition arising when the image formed by the objective is not in the plane of the cross hairs. Unless parallax is eliminated, accurate sighting is not possible. Parallax can be eliminated in two steps.
a. Focussing the eye-piece: Point the telescope to the sky or hold a piece of white paper in front of the telescope. Move the eyepiece in and out until a distant and sharp black image of the cross-hairs is seen.
b. Focussing the object: Telescope is now turned towards object to be sighted and the focusing screw is turned until image appears clear and sharp.

QUESTIONS:
1. State any four uses of a theodoite?

2. What is meant by face left and face right?

3. What does swinging of telescope means?

4. What is meant by transiting?

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CIVIL ENGINEERING DEPARTMENT

BASIC CIVIL ENGINEERING

AIM: Locating given points by **plane table surveying** (One full size drawing sheet)

APPARATUS: 1) The Plane table with tripod,2) Alidade,3) Trough compass 4) Sprit level ,
5) Plumbing fork or U-frame,6)Plumb bob,7) Tape ,chain, pegs, ranging rods, wooden mallet etc.

THEORY:

Plane table surveying: the system of surveying in which field observation and plotting work i.e. both are done simultaneously is called plane table surveying.

Method of Plane Table Survey There are four methods in Plane Table Survey:

1)Radiation Method 2)Intersection Method 3)Traversing Method

4)Resection Method: a)Two point problem) (b)Three point problem

The plane Table:- The drawing board made of well seasoned wood such as teak or pine which is used for the purpose of plotting is called plane table.It is available in sizes 500x400x15mm, 600x5000x15mm and 750x600x20mm.The top surface of board is perfectly plane and to the underneath it is fitted with a leveling head or ball and socket arrangement. The table is mounted on a tripod by means of a central screw with a wing nut or in such a manner so that the board can be revolved, leveled and clamped in any position.

Alidade: The tool or instrument which consist of metal (usually of brass) or wooden (well seasoned) rule 40cm to 60cm long, 3cmto5cm wide and fitted with two vanes at the ends is called an alidade. The beveled graduated edge is known as the fiducial edge. Such an alidade is known as plain alidade.

Trough Compass: The compass which is used to mark the direction of the magnetic meridian on the plane table is called trough compass. It consist of a long narrow rectangular non magnetic metallic box 8cm to 15cm long,3cm to 5cm wide and 2cm to 3cm high on the covered with a glass cover. it the centre of the box is provided a magnetic needle with a agate stone mounted on the sharp steel pivot. At the end the through compass graduated scales are with zero degree at the centre and up to 5° on either side of the zero line.A counter weight is also used for North end of the needle to represent North and is also used for balancing the dip of the needle.

Sprit Level:- A small sprit level circular or rectangular is required for seeing if the table is properly level. The level must have flat base so that it can be placed on the table.

Plumbing fork or U-frame: - The plumbing fork to which is attached a plumb bob ,used for centering the plane table over the station occupied by the plane table. it is also meant for transforming the ground point on to sheet so that both the points should be in the same vertical line

It consists of two light metal arms as shown in fig. approximately of equal lengths. A hook for suspending a plumb bob is provided at the lower arm immediately below the end point of the upper arm. The upper arm is placed on the plane table while the lower arm with a plumb bob is moved below the table for centering over the ground station mark,thus in the exact position the pointed end of the upper arm will give the corresponding position on the paper.

RADIATION METHOD:-

When from a single set of plane table on instrument station different details are located on the sheet, the method is known as radiation method In this method the rays are drawn from the instrument station to the point to be located, then the distances are measured from the instruments station to the point and the position of the

each point is plotted on the sheet using a suitable scale. The method is most suited for surveying small areas which can be controlled by
single setting. It can also be used in combination with other method. This method can be applied for locating distant points if the distances are obtained tacheometrically with the help of the telescope alidade.

Procedure for radiation method:-

1) Select the position of the table where it is be set so that all the points to be located are visible from it. Let 'O' be the position of such a point on the ground.

2) Set the plane table over this point and
level it. Draw the North line in the top corner of sheet by means of trough comp
ass at the table.

3) Now transfer the position of the point 'O' on the ground to the sheet by means of the a plumbing fork. The point 'O' will represent point 'o' will represent point 'O'on the ground.

4) With the alidade touching the point 'o'(may be represented by fixing a pin), sight
the point A in the field. Draw the ray along the fiducial edge. Measure the distance
of this point from the instrument station by means of tape and plot the point 'a' corresponding to point 'A' in the field to scale in the sheet.

5) Similarly sight other points such as B,C, etc. and measure their distances from the instrument station. Plot them to scale to get their position on the sheet such as b,c, etc. on the sheet.

INTERSECTION METHOD:-

When the location of an object is obtained on the sheet of paper by the intersection of the rays drawn after sighting at the object from two plane table stations (previously plotted), it is called intersection method. The method is suitable when the distance between the point and the instrument station is either too large or cannot be measured accurately due to some field conditions
as in case of mountainous country. It is also employed for filling up details, locating distant and inaccessible object, locating the broken boundaries as in the case of rivers etc. The method can also be used for checking of plotted points. The line joining the two instrument stations is known as the base line. No linear measurement other than the base line is made.

Procedure for intersection method :-

1) Select two points L and M in such a way so that all the points to be plotted are visible from them. Now set the table at station, point L in such a position so that the sheet should cover all the points. Level the table and clamp it.

2) Draw the north line in the top corner of sheet by means of trough compass

3) Now transfer the position of station point L on the sheet as 'l' with the help of plumbing fork so that it is vertically above the instrument station.

4) With the alidade pivoted about 'l' sight the ranging rod fixed at station point M and draw the line in the direction of M. Now measure the distance LM by means of the tape and cut off lm to some suitable scale along the ray drawn toward M; thus fixing the position of 'm' on the sheet corresponding to station point M on the ground. The line lm is called the base line.

5) With the alidade touching the point 'l' sight the objects in the field such as A,B,C,D,E etc. as shown in figure and draw the rays towards them. The direction of each line is marked with an arrow and a letter A,B,C,D.E etc. corresponding to above details.

6) Now shift the table to the station point M and approximately set it in the line with ML. Set it up so that the point 'm' is vertically above the station point 'M' and level it.

7) Orient the table roughly by compass, then finally by placing the alidade along ml and bisecting the ranging rod fixed at station point 'L' i .e by back sighting 'L'. Clamp the table in this position.

8) With the alidade centered at m sight the same object in the field such as A, B, C, D, E etc; and draw rays. The intersection of these rays with the respective rays from l locate the object A,B,C,D,E etc; as a ,b,c,d,e etc; on the sheet.

CALCULATIONS: formula: 1. Area of the Triangle = √ s (s-a) (s-b) (s-c) Where a, b, c are the sides of triangle S = (a + b + c) / 2

RESULT: The location of the given points is found on sheet.
Area of the field =

PRECAUTIONS:
1) Before starting the work, the equipment for survey work should be verified. Defective accessories should be replaced by perfect equipment.
2) The centering should be perfect.
3) The leveling should be proper.
4) The orientation should be accurate.
5) The alidade should be centered on the same side of the station-pin until the work is completed
6) While shifting the plane table from one station to another, the tripod stand should be kept vertical to avoid damage to the fixing arrangement.
7) Several accessories have to be carried. Therefore, care should be taken to ensure that nothing is missing.
8) The pencil should have a sharp point.
9) The distances of the object or lines should be written temporarily along the Respective rays until the plotting is completed.
10) Proper scale should be selected.

VIVA QUISTIONS
1. State the circumstance where plane table is suitable?
2. Name the accessories of plane table?
3. What is orientation; State the two methods of orientation?
4. State four demerits of plane table survey?
5. What is intersection method?

6. What is Radiation method?
7. What is the use of u-fork?
8. What is the use of alidade?
9. What is the use of spirit level?
10. What is the use of trough compass?
11. What instruments are used in plane table survey?
12. What is orientation?
13. State different methods of orientation.
14What is Centering?
15. How many methods are in plane table survey?

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