UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR

Lecture-wise Plan

Subject Name: Organizational Behavior **Subject Code-HU501**
Year: 3rd Year **Semester: Fifth**

Module Number	Topics	Number of Lectures
1	**Introduction:**	**23L**
	1. Organizational Behaviour: Definition, Importance, Historical Background, Fundamental Concepts of OB, Challenges and Opportunities for OB.	2
	2. Personality and Attitudes: Meaning of personality, Personality Determinants and Traits, Development of Personality, Types of Attitudes, Job Satisfaction.	3
	3. Perception: Definition, Nature and Importance, Factors influencing Perception, Perceptual Selectivity, Link between Perception and Decision Making.	3
	4. Motivation: Definition, Theories of Motivation - Maslow's Hierarchy of Needs Theory, McGregor's Theory X & Y, Herzberg's Motivation-Hygiene Theory, Alderfer's ERG Theory, McClelland's Theory of Needs, Vroom's Expectancy Theory.	5
2	5. Group Behaviour: Characteristics of Group, Types of Groups, Stages of Group Development, Group Decision Making.	3
	6. Communication: Communication Process, Direction of Communication, Barriers to Effective Communication.	3
	7. Leadership: Definition, Importance, Theories of Leadership Styles.	4
	Organizational Politics	
3.		**10L**
	8. Organizational Politics: Definition, Factors contributing to Political Behaviour.	2
	9. Conflict Management: Traditional vis-a-vis Modern View of Conflict, Functional and Dysfunctional Conflict, Conflict Process, Negotiation – Bargaining Strategies, Negotiation Process.	4
4	10. Organizational Design: Various Organizational Structures and their Effects on Human Behaviour, Concepts of Organizational Climate and Organizational Culture.	4
	TOTAL	**33L**

Faculty In-Charge HOD, Humamities Dept.

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR

Lecture-wise Plan

Subject Name: Foundation Engineering   Subject Code: **CE-501**

Year: **3rd Year**   Semester: **Fifth**

Module Number	Topics	Number of Lectures
1	**Earth Pressure Theories**	**5L**
	1. Plastic equilibrium of soil, Earth pressure at rest, Active & passive earth pressure	1L
	2. Rankine's earth pressure theories	2L
	3. Coulomb's earth pressure theories	2L
2	**Retaining wall & sheet pile structures**	**3L**
	1. Proportions of retaining walls, Design	2L
	2. stability checks, Gravity and cantilever retaining wall	1L
3	**Stability of Slopes**	**6L**
	1. Analysis of finite and infinite slopes,	3L
	2. Swedish And friction circle, method, Taylor's stability number, Bishop's method of stability analysis	3L
4	**Site investigation & soil exploration**	**6L**
	1. Planning of sub-surface exploration, methods ,sampling, samples,	3L
	2. Insitu tests: SPT, SCPT, DCPT, Field vane shear, Plate load test	3L
5	**Shallow foundations**	**6L**
	1. Safe bearing capacity, Terzaghi's bearing capacity theory,	2L
	2. Effect of depth of embedment, water table	2L
	3. Eccentricity of load, foundation shape on bearing capacity	2L
6	**Settlement analysis of shallow foundation**	**4L**
	1. Immediate and consolidation settlement	1L
	2. settlement in various types of soil	2L
	3. Allowable bearing capacity	1L
7	**Deep foundations**	**6L**
	1. Types, load transfer mechanism of piles	1L
	2. Determination of load carrying capacities of piles by static and Dynamic formulae	2L
	3. Pile group: Group efficiency	2L

	4. Negative skin friction, pile load test	1L
Total Number Of Hours = 36L		

Faculty In-Charge HOD, CE Dept.

Module-1(Earth Pressure Theories):

1. If a retaining wall 5 m high is restrained from yielding, what will be the at-rest earth pressure per meter length of the wall? Given: the backfill is cohesionless soil having ϕ= 30° and γ = 18 kN/m^3. Also determine the resultant force for the at-rest condition
2. A retaining wall with a vertical back of height 7.32 m supports a cohesionless soil of unit weight 17.3 kN/m^3 and an angle of shearing resistance ϕ= 30°. The surface of the soil is horizontal. Determine the magnitude and direction of the active thrust per meter of wall using Rankine theory.
3. A wall of 8 m height retains sand having a density of 1.936 Mg/m^3 and an angle of internal friction of 34°. If the surface of the backfill slopes upwards at 15° to the horizontal, find the active thrust per unit length of the wall. Use Rankine's conditions.
4. A retaining wall has a vertical back and is 7.32 m high. The soil is sandy loam of unit weight 17.3 kN/m^3. It has a cohesion of 12 kN/m^2 and ϕ= 20°. Neglecting wall friction, determine the active thrust on the wall. The upper surface of the fill is horizontal.
5. A rigid retaining wall 19.69 ft high has a saturated backfill of soft clay soil. The properties of the clay soil are γ_{sat} = 111.76 lb/ft^3, and unit cohesion c_u = 376 lb/ft^2. Determine (a) the expected depth of the tensile crack in the soil (b) the active earth pressure before the occurrence of the tensile crack, and (c) the active pressure after the occurrence of the tensile crack. Neglect the effect of water that may collect in the crack.

Module-2 (Retaining wall & sheet pile structures):

1. For the cantilever retaining wall below, determine the maximum and minimum pressure under the base of the cantilever. The relevant shear strength parameters of the backfill, and backfill are c=0,ϕ=35^0, unit weight of soil γ=17.5 kN/m^3, the unit weight of the wall material= 23.5 kN/m^3. Find also the factor of safety against sliding overturning considering reduced value of base friction (2/3ϕ)

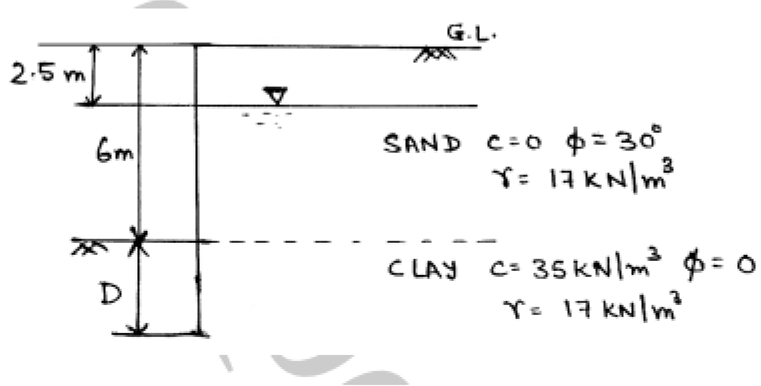
2. What are the assumptions made to analysis an anchored sheet pile structure inder free earth method of analysis? Derive the expression of depth of embedment of an anchored sheet pile structure when driven into cohesive soil. Find the embedded depth of the anchored sheet pile as shown in the fig.

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR

Lecture-wise Plan

Subject Name: Foundation Engineering | Subject Code: **CE-501**

Year: **3rd Year** | Semester: **Fifth**



Module-3 (Stability of Slope):

1. An infinite slope is underlain with an over consolidated clay having c' - 210 lb/ft^2, ϕ' = 8° and γ_{sat} = 120 lb/ft^3. The slope is inclined at an angle of 10° to the horizontal. Seepage is parallel to the surface and the ground water coincides with the surface. If the slope fails parallel to the surface along a plane at a depth of 12 ft below the slope, determine the factor of safety.
2. A 40° slope is excavated to a depth of 8 m in a deep layer of saturated clay having strength parameters c = 60 kN/m^2, 0 = 0, and y= 19 kN/m^3. Determine the factor of safety for the trial failure surface shown in Fig.

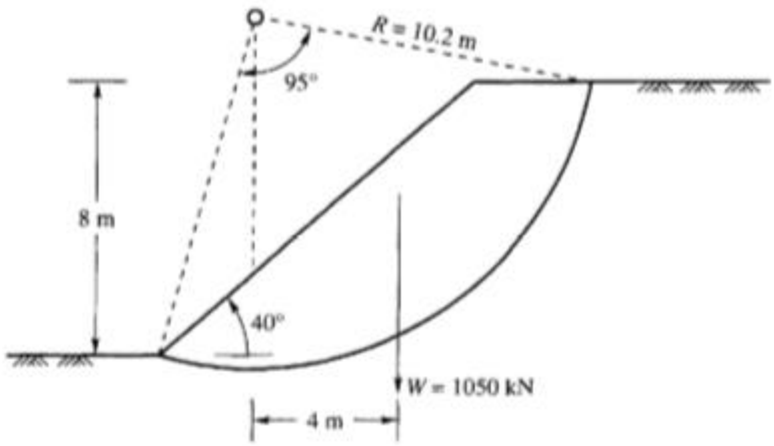


Figure Prob. 10.5

3. An embankment has a slope of 2 (horizontal) to 1 (vertical) with a height of 10 m. It is made of a soil having a cohesion of 30 kN/m^2, an angle of internal friction of 5° and a unit weight of 20 kN/m^3. Consider any slip circle passing through the toe. Use the friction circle method to find the factor of safety with respect to cohesion.
4. The following particulars are given for an earth dam of height 39 ft. The slope is submerged and the slope angle i = 45°. γ_b = 69 lb/ft^3 c' = 550 lb/ft^2 ϕ' = 20°. Determine the factor of safety FS.

Module-4 (Site investigation & soil exploration):

1. Describe various methods of drilling holes for subsurface investigation.
2. Describe split spoon sampler. What is its use?
3. Discuss various types of soil samplers for obtaining undisturbed sample
4. Discuss standard penetration test. What are the various corrections?
5. Describe static and dynamic cone penetration tests.

Module-5 (Shallow foundations):

1. A strip footing of width 3 m is founded at a depth of 2 m below the ground surface in a (c -ϕ) soil having a cohesion c = 30 kN/m^2 and angle of shearing resistance ϕ= 35°. The water table is at a depth of 5 m below ground level. The moist weight of soil above the water table is 17.25 kN/m^3. Determine (a) the ultimate bearing capacity of the soil, (b) the net bearing capacity, and (c) the net allowable bearing pressure and the load/m for a factor of safety of 3. Use the general shear failure theory of Terzaghi.
2. A square footing fails by general shear in a cohesionless soil under an ultimate load of Q_{ult}= 1687.5 kips. The footing is placed at a depth of 6.5 ft below ground level. Given ϕ= 35°, and 7=110 lb/ft^3, determine the size of the footing if the water table is at a great depth .
3. Calculate the net ultimate bearing capacity of a rectangular footing 1.8 m x 3.6 m in plan, founded at a depth 1.6 m below the ground surface. The load on the footing acts an angle of 16^0, to the vertical and eccentric to the width by 15 cm. The unit weight of the soil is 18 kN/m^3. Natural water table is at 2m below the ground surface, c= 15 kN/m^2, ϕ=30^0, N_c=30.10, N_q= 18.38 and N_γ=22.4.
4. A footing 2m^2 is laid at a depth 1.3 m below the ground surface. Determine the net ultimate bearing capacity using IS code method. Given γ=20 kN/m^3, ϕ=20^0, c= 0, N_c=30.14, N_q= 18.38 and N_γ=22.4, S_c=1.3, S_q= 1.2 and S_γ=0.80

Module-6 (Settlement analysis of shallow foundation):

1. Estimate the immediate settlement of a concrete footing 1.5 x 1.5 m in size founded at a depth of 1 m in silty soil whose modulus of elasticity is 90 kg/cm^2. The footing is expected to transmit a unit pressure of 200 kN/m^2
2. Describe Plate Load test.
3. A plate load test using a plate of size 30 x 30 cm was carried out at the level of a prototype foundation. The soil at the site was cohesionless with the water table at great depth. The plate settled by 10 mm at a load intensity of 160 kN/m^2. Determine the settlement of a square footing of size 2 x 2 m under the same load intensity. Estimate the load intensity if the permissible settlement of the prototype foundation is limited to 40 mm.

Module-7 (Deep foundations):

1. Describe pile load test.

2. A concrete pile 30 cm diameter is driven into a medium dense sand ($\phi=35^0$, N_q= 60, D_c/B=12, γ=21 kN/m^3, k=1, tanδ=0.7) for a depth of 8m. Estimate the safe load taking FS 2.5
3. In a 16 pile group pile diameter is 60 cm and centre to centre spacing of the square pile group is1.8m. If c=50 kN/m^2, determine the failure would occur with the pile acting, individually or group. Neglect bearing at the tip of the pile. All are 15m long. Take the degree of mobilization of shear=0.7
4. Using Hiley's formula determine the safe pile load. With the following data, width of the hammer= 30 kN, weight of the pile=18 kN, average set under last 6 blows= 12.5 mm, Hammer stroke-= 0.91mm, Hammer efficiency = 70%, k1=6 mm, k3=2.5 mm, Pile length 10m and pile diameter 300 mm.

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR

Lecture-wise Plan

Subject Name: Design of RC Structures **Subject Code-CE502**

Year: 3rd Year **Semester: Fifth**

Module Number	Topics	Number of Lectures
1	**Introduction:**	**2L**
	1. Principles of design of reinforced concrete structures: Working stress method .	1
	2. Principles of design of reinforced concrete structures: Limit State Method	1
2	**Working stress method of design:**	**2L**
	1. Basic concepts and IS code provisions (IS: 456 2000)for design against bending moment and shear force	1
	1. Basic concepts and IS code provisions (IS: 456 2000) for Balanced, under-reinforced and over-reinforced beam/ slab sections	1
3	**Limit state method of design:**	**6L**
	1. Basic concepts and IS code provisions (IS: 456 2000)for design against bending moment	2
	2. Basic concepts and IS code provisions (IS: 456 2000) for design against shear	2
	3. Basic concepts and IS code provisions (IS: 456 2000) for design of bond stress and development length.	2
4	**Analysis, design and detailing of beam:**	**6L**
	1. Singly reinforced	2
	2. Doubly reinforced	2
5	3. Flanged (T-beam, L-beam)	2
	Analysis, design and detailing of slab:	**4L**
	1. One-way slab	2
	2. Two-way slab	2
6	**Analysis, design and detailing of continuous member**	**4L**
	1. Beam	2
	2. One- way slab	2
7	**Analysis, design and detailing of Staircase:**	**2L**
	1. Dog-legged staircase (waist-type)	1
	2. Dog-legged staircase (tread-type)	1
8	**Design and detailing of reinforced concrete short columns:**	**6L**
	1. Column with axial loading	2
	2. Column with uniaxial loading	2

	3. Column with biaxial loading	2
9	**Shallow foundation:**	**4L**
	1. Types; Design and detailing of reinforced concrete isolated square	2
	2. Design and detailing of reinforced concrete isolated rectangular footing for columns as per IS code provisions	2
Total Number Of Hours = 38		

Faculty In-Charge HOD, CE Dept.

Assignment:

Module-1(Introduction):

1. Discuss the various design philosophies of design. How working stress method is different from limit state method of design?
2. Discuss shrinkage and creep of concrete.
3. Define characteristic strength of concrete.

Module-2 (Working stress method of design):

1. Describe under-reinforced, over-reinforced and balanced section.
2. Define modulus of rupture, cracking moment.
3. The cross-section of a singly-reinforced concrete beam is 300 mm wide and 400 mm deep to the centre of the reinforcement which consists of four bars of 16 mm diameter. If the stresses in concrete and steel are not exceed 7 N/mm^2 respectively, determine the moment of resistance of the section. Take m = 13.33

Module-3(Limit state method of design):

1. Draw the stress strain block diagram for singly reinforced steel section.
2. Find the moment of resistance of a rectangular beam section of width 250 mm and depth 400 mm, reinforced with 3-16ϕ bars. Take M20 grade of concrete and Fe250 steel.
3. Design shear reinforcement of as simply supported beam, 300 mm wide and 600 mm effective depth carrying a UDL of 74 kN/m including its own self weight over an effective span of 6 m. The reinforcement consists of 5 bars of 25 mm dia. Out of these two bars can be safely bent up at a distance of 1 m from the support. Assume M20 grade of concrete and Fe 415 steel. Width of support = 400 mm

Module-4(Analysis, design and detailing of beam):

1. A rectangular reinforced concrete beam located in moderate exposure condition is simply supported on two walls having an effective span of 6m. The beam is carrying an applied moment of 126 kNm. Design the beam section for the applied moment. Check for deflection control only. Assume Fe415 steel.
2. Find the moment of resistance of doubly reinforced beam of width 300 mm and effective depth 500 mm having a clear cover of 25mm. The beam is reinforced with 3-

20ϕ in compression zone and 5-25ϕ in tension zone. Assume d′=35mm M20 grade of concrete and Fe415 steel

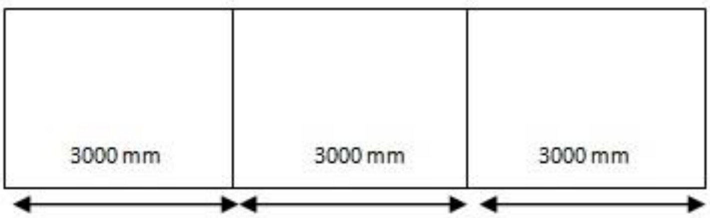
3. Design a doubly reinforced section of width 300 mm and overall depth 600 mm which has a clear cover of 25mm and an applied moment of 350 kNm. Assume M20 grade of concrete and Fe415 steel
4. Design a doubly reinforced rectangular beam whose size is limited to 250 mm x 400 mm. It has to carry a LL of 10 kN/m, DL of 5 kN/m and a conc. load DL of 30 kN placed at the midspan. The beam is simply supported on two 230 mm thick and 6 m apart masonry wall (centre – centre). Assume M25 grade and Fe415 grade of steel. Unit wt. of concrete= 25 kN/m^3.
5. Find the moment of resistance of an existing T-beam having the following data:
   Width of flange, b_f = 740 mm
   Width of web, b_w =240 mm
   Thickness of flange, D_f = 100 mm
   Effective depth, d= 400 mm
   Area of steel, A_{st}= 5-20 ϕ
   Assume M15 grade of concrete and Fe 250 steel.

Module-5(Analysis, design and detailing of slab):

1. What is one-way and two way slab? Explain with the help of suitable diagram.
2. Design a simply supported RCC slab for a roof of a hall 3.5m x 8m (inside dimension) with 250 mm walls all around. Assume a LL of 4 kN/m^2 and finish 1 kN/m^2. Use M20 grade of concrete and Fe415 Steel.
3. Design a two way slab of size 5.5mm x 4 mm simply supported on all the four sides. It has to carry a characteristics live load of 8 kN/m^2. Assume M25 grade of concrete and Fe415 steel. Consider mild exposure conditions.

Module-6(Analysis, design and detailing of continuous member):

1. Design the one-way continuous slab subjected to UDL imposed (fixed) of 5 kN/m^2 using M20 and Fe415 steel. The loas of floor finish is 1 kN/m^2. The span dimensions shown in fig are effective spans. The width of the beam at support is 300 mm.



Module-7(Analysis, design and detailing of Staircase):

1. Design a waist slab type dog legged staircase fo an office building, given the following data:
   Height between floor= 3.2m
   Riser=160mm, tread= 270 mm
   Width of flight= landing width= 1.25 m
   Live load= 5 kN/m^2
   Finishes load = 0.6 kN/m^2
   Assume the stairs to be supported on 230 mm thick masonry walls at the outer edges of the landing, parallel to the risers. Use M20 concrete and Fe415 steel. Assume mild exposure conditions

Module-8(Design and detailing of reinforced concrete short columns):

1. A concrete column is reinforced with 4-20 ϕ whose size is 450mm x 450mm. Determine the ultimate load carrying capacity of the column, using M20 grade of concrete and Fe415 steel.
2. Design the reinforcement in a column of size 400 mm x 600 mm subjected to an axial load of 2000 kN under service dead load and live load. The column has an unsupported length of 4.0 m and effectively held in position and restrained against rotation in both ends. Use M 25 concrete and Fe 415 steel.
3. A corner column (400 mm x 400 mm) located in the lowermost storey of a system of braced frames, is subjected to factored loads : P_u = 1300 kN and M_{ux}=190 kNm and M_{uy}= 110 kN/m. The unsupported length of the column is 3.5 m. Design the reinforcement in the column assuming M25 concrete and Fe415 steel.

Module-9(Shallow foundation):

1. Design an isolated footing for a square column, 450 mm x 450 mm, reinforced with 8-25ϕ bars, and carrying a service load of 2300 kN. The safe soil bearing capacity may be taken as 300 kN/m^2 at a depth of 1.5 m below ground. Assume M20 concrete and Fe 415 steel for the footing, and M25 concrete and Fe415 steel for the column.

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR

Lecture-wise Plan

Subject Name: Concrete Technology | **Subject Code-CE503**

Year: 3rd Year | **Semester: Fifth**

Module Number	Topics	Number of Lectures
1	**Cement:**	**6L**
	1. Properties of cement, Chemical composition of cement, Hydration of cement	1
	2. Tests on Cement and Cement Paste – Fineness, consistency	1
	3. Tests on Cement and Cement Paste- Setting time, soundness, strength	1
	4. Quality of Water – Mixing Water, Curing Water, Harmful Contents	1
	5. Types of portland cement-Ordinary, Rapid hardening, low*heat, sulphate resisting	1
	6. Types of portland cement-Portland slag, Portland pozzolana, super sulphated cement, white cement	1
2	**Aggregate:**	**5L**
	1. Aggregates – Classification, Mechanical and Physical Properties	1
	2. Deleterious Substances, Alkali-Aggregate Reaction	1
	3. Sieve Analysis, Grading Curves, Fineness modules, Grading Requirements	1
	4. Testing of Aggregates – Flakiness, Elongation Tests, Aggregate Crushing Value, Ten Percent Fines Value, Impact Value, Abrasion Value	2
3	**Admixtures:**	**5L**
	1. Definination and Classification, Plasticiser, Super Plasticiser	1
	2. Accelerating admixture, Retarding admixture	1
	3. Basic concepts and IS code provisions (IS: 456 2000) for design of bond stress and development length.	1
	4. Alkali aggregate expansion inhibitor, coloring admixture	1
	5. Mineral Admixture	1
4	**Fresh Concrete:**	**10L**
	1. Workability, Factors Affecting Workability	1
	2. Test for workability- Slump Test, Compacting Factor Test, Flow Table Test	1
	3. Segregation, Bleeding, Setting Time	1
	4. Process of manufacture of concrete- Batching, classification	1
	5. Process of manufacture of concrete-Mixing, Types of drum mixers	1
	6. Process of manufacture of concrete- Transporting	1
	7. Process of manufacture of concrete- Placing, Pumpable concrete	1
	8. Process of manufacture of concrete- Compacting, Hand compaction, vibrator	1
	9. Process of manufacture of concrete- Curing	1
	10. Process of manufacture of concrete- finishing	1
	Strength of concrete:	**6L**

5	1. Factors on which strength of concrete depends: Water cement ratio, gel space ratio	1
	2. Factors on which strength of concrete depends: Aggregate cement ratio, maximum size of aggregate	1
	3. Age and maturity of concrete, relationship between compressive strength and flexural strength	1
	4. Shrinkage, types of shrinkage	1
	5. Modulus of elasticity for concrete, creep	1
	6. Introduction to Non Destructive Tests (Rebound hammer & Ultrasonic pulse velocity)	1
6	**Mix Design:**	**2L**
	1. Mix Design as per IS 10262	1
	2. Light-weight, Polymer and Fibre-reinforced concrete	1
Total Number Of Hours = 34		

Faculty In-Charge HOD, CE Dept.

Assignment:

Module-1(Cement):

1. Explain initial setting time and final setting time of cement. Mention the test used to determine the same.
2. What is hydration of cement? What is heat of hydration? Write a short note on extra rapid hardening cement.
3. What are the basic constituents of cement? Describe the functions of each constituents of cement.
4. Explain Role of 'Gypsum" in cement and role of 'C 3A' in cement.
5. What are the chemical compositions of cement.
6. Write a short note on: Ordinary Portland cement, rapid hardening cement, extra rapid hardening cement, sulphate resistant cement, quick setting cement, low heat cement, Portland pozzolana cement.
7. Define characteristic strength of concrete.

Module-2 (Aggregate):

1. Classify aggregate based upon source and size. Give example of each.
2. Explain of bulking of aggregate.
3. What is alkali aggregate reaction?
4. Which type of aggregate based on shape forms higher bonds with cement? Why?
5. Define: i) Soundness of aggregate ii) Flakiness index iii) Aggregate crushing value. iv) Aggregate impact value v) Elongation Index.
6. Which type of aggregate based upon surface texture forms higher bonds with cement? Why?
7. Explain bulk density and absorption and moisture content of aggregate.

Module-3(Admixtures):

1. What is admixture? What are the different types of admixture used?
2. Explain corrosion inhibitor.
3. What are plasticizers? Explain the actions involved in plasticizers?
4. What is accelerating admixture? Explain the two groups of it which is classified based on performance and application.
5. How alkali aggregate expansion inhibiting admixtures prevent this reaction?

6. Write a short note pozzolans
7. Explain
   i) Damp proofing and water proofing admixture
   ii) Retarding admixture
8. Explain the test for determination of i) Aggregate crushing value ii) Ten percent fines value.

Module-4(Fresh Concrete):

1. What is workability of concrete? What are the different factors on which workability depends?
2. Explain how the workability of concrete depends upon water-cement ratio and size of aggregate.
3. What is segregation? What are the three types of segregation? Write 3 conditions favourable for segregation? Write three preventions for segregation.
4. Explain the procedure of slump test for workability.
5. What is bleeding and laitance?
6. Define compaction. What are the different types of concrete compaction? Explain various types of hand compaction.
7. What are the two methods adopted for mixing of concrete? Explain.
8. Classify different types of drum mixers. Explain.
9. Explain various types of vibrators used for compaction.
10. What is curing of concrete? State and explain various methods of curing of concrete.
11. What is finishing of concrete? What are the different types of finishes? Explain any two of them.
9. Explain with suitable diagram
   i) Direct acting Concrete pump. ii) Squeeze type concrete pump

Module-5 (Strength of Concrete):

1. Write short note on: Maturity of concrete, Rebound hammer test on concrete, Ultrasonic Pulse Velocity test on concrete,
2. What is shrinkage of concrete? State and explain the different types of shrinkage.
3. What is the phenomenon of creep of concrete?
4. What are the effects of maximum size of aggregate on concrete strength?
5. State the various modulus of elasticity of concrete.
6. How the strength of concrete get influenced by:
   i) Aggregate cement ratio
   ii) Gel-Space ratio

Module-6(Mix Design):

1. Client Requirements
   a) Grade designation : M40
   b) Type of cement : OPC 43 grade
   c) Maximum nominal size of aggregate : 20 mm
   d) Workability : 100 mm (slump)
   e) Exposure condition : Severe
   f) Degree of supervision : Good
   g) Chemical admixture type : Super plasticizer
   h) Method of concrete placing : Pumping
   i) Maximum cement content : 450 kg/m^3
   j) Minimum cement content : 320 kg/m^3
   k) Maximum W/C ratio : 0.45

   Test data for materials:

   a) Cement used : OPC 43 grade conforming to IS 8112
   b) Specific gravity of cement : 3.15
   c) Chemical admixture : Super plasticizer conforming to IS 9103

d)	Specific gravity of CA & FA	: 2.74 for both
e)	Water absorption	: 0.5 % for CA , 1.0% for FA
f)	Free surface moisture of CA & FA	: NIL for both

2. Write a short note on: light weight concrete, polymer concrete.

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR

Lecture-wise Plan

Subject Name: **Engineering Geology** Subject Code: **CE-504**

Year: **3rd Year** Semester: **Fifth**

Module Number	Topics	Number of Lectures
1	**Geology and its importance in Civil Engineering.**	**2L**
	1. Importance of geology in Engineering.	1L
	2. Branches of Geology and their importance.	1L
2	**Mineralogy**	**3L**
	1. Definition, Physical properties of minerals.	
	2. Study of internal and external structure of minerals, study of crystals.	1L
	3. Study of various minerals and their use.	1L
3	**Classification of rocks**	**4L**
	1. Igneous rocks: Origin, mode of occurrence, texture, classification and engineering importance.	1L
	2. Sedimentary rocks: Process of sedimentation, texture, classification and engineering importance.	2L
	3. Metamorphic rocks: Agents and types of metamorphism, classification and engineering importance.	1L
4	**Weathering of rocks**	**2L**
	1. Agents and kinds of weathering, soil formation & classification based on origin.	2L
5	**Geological work of rivers**	**1L**
	1. Origin and stages in the system, erosion, transportation and deposition.	1L
6	**Structural geology**	**4L**
	1. Introduction to structural elements of rocks, dip & strike, definition and description.	2L
	2. Classification of folds, faults and joints, importance of geological structures in Civil Engineering.	2L
7	**Earthquakes and seismic hazards**	**4L**
	1. Definition, Causes and effects of earthquake, Focus and epicentre of earthquake.	1L
	2. Types of earthquake, seismic waves and seismographs.	2L
	3. Magnitude & Intensity Of Earthquake, Mercelli's Intensity Scale and Richter's Scale of magnitude.	1L

8	**Engineering properties of rocks**	**2L**
	1. Porosity, permeability, compressive strength, tensile strength and abrasive resistance.	2L
9	**Rocks as construction materials**	**3L**
	1. Qualities required for building and ornamental stones, foundations, concrete aggregate, railway ballast, road metal, pavement, flooring and roofing.	3L
10	**Geophysical exploration**	**4L**
	1. Methods of Geophysical Exploration.	1L
	2. Methods of Geophysical explorations- Electrical resistivity method, field procedure-resistivity profiling, electrode configuration	2L
	3. Geophysical surveys in ground water and other Civil Engg. Projects.	1L
11	**Applied Geology**	**4L**
	1. Surface and subsurface geological and geophysical investigations in major Civil Engg. Projects	2L
	2. Geological studies of Dams and reservoir sites.	1L
	3. Geological studies for selection of tunnels and underground excavations.	1L
12	**Landslides**	**3L**
	1. Types of landslides, causes, effects and prevention of landslides,	3L
Total Number Of Hours = 36L		

Faculty In-Charge HOD, CE Dept.

Assignments:

Unit 1:

1. What do you mean by Geology?
2. Define the different branches of geology.
3. Elaborate the importance of geology with respect to Civil Engineering.

Unit 2:

1. What is cleavage? Draw a neat sketch and give an example of cleavage.
2. What is fracture? Draw a neat sketch and give an example.
3. Define 'Crystal' & 'Mineral'. How would you systematically describe & identify minerals in hand specimen? Cite common examples.

Unit 3:

1. What do you mean by metamorphic rock? What are the types of metamorphic rock? Explain the use of metamorphic rock in civil engineering projects.
2. What do you mean by igneous rock? What are the types of igneous rock? Explain the use of igneous rock in civil engineering projects.
3. What do you mean by sedimentary rock? What are the types of sedimentary rock? Explain the use of sedimentary rock in civil engineering projects.
4. Write the properties of:
   i) Igneous Rock
   ii) Sedimentary Rock
   iii) Metamorphic Rock

Unit 4:

1. Explain how climate, rock types topography and time influence the types of soil produced by weathering.
2. What do you mean by weathering? What are the different types of weathering? Describe all of them in brief.
3. How are soils formed? How are they classified on the basis of formation and origin?

Unit 5:

1. Describe the stages of the river.

2. Write briefly on geological work of rivers.

Unit 6:

1. Write a note on internal constitution of the earth.
2. Define fault of a structure and also give a comprehensive classification of fault.
3. Define fold and discuss different parts of a folded layer. Write a note on engineering consideration of fold structures in rock.
4. Give the schematic diagrams of symmetrical, asymmetrical, overturned and recumbent anticlines and synclines.
5. What is unconformity? What are the different types of unconformities?
6. Distinguish between joint and fault?

Unit 7:

1. What do you mean by focus and epicentre of earthquake?
2. Describe the causes and effects of Earthquake.
3. What do you mean by seismic waves? Explain the different types of seismic waves.
4. Write Short note on the following:
   i) Richter Magnitude Scale
   ii) Mercalli Intensity Scale
5. Give an account of important factors to be considered for evolving seismic designs in a seismic region.
6. What are the parameters of an earthquake? What do you mean by the term intensity and magnitude of an earthquake? Explain the terms in the formula for magnitude of an earthquake. Describe a method of determining earthquake epicentre.
7. Write briefly on the nature of precautions required in major constructions in earthquake-prone regions.
8. How are earthquake waves useful in deciphering the interior of the earth?

Unit 8:

1. Define the following term:
   i) Porosity
   ii) Permeability
   iii) Compressive Strength
   iv) Tensile Strength

v) Abrasive resistance.

Unit 9:

1. Explain various properties that need thorough investigation for selection of stones for use in building construction.
2. Mention the criteria for selection of railway ballast.

Unit 10:

1. Explain the necessity and importance of Geophysical investigations in Civil Engineering Project.
2. In general how many kinds of Geophysical methods of investigation are carried out for the physical property of subsurface formations for Civil Engineering Project?
3. Write the name of the Geophysical methods which is carried out for measuring the following physical properties.
4. Write the Geophysical Unit of these physical properties :
   Density, Magnetic Susceptibility, Natural Remanent Magnetism, Electrical Resistivity, Electrical Conductivity, Electrochemical Activity, Elastic Property.
5. Describe the general importance of the following geological investigation for any large Civil Engineering Project :
   Topography, Lithology, Structure, Groundwater conditions and Seismicity of the area.
6. What are the different zones of groundwater? What is cone of depression in groundwater? How is this property of groundwater useful in civil engineering construction in an area that lies below the ground water table? Illustrate with neat sketches.

Unit 11:

1. Write briefly on the principle of electrical receptivity method in geophysical investigation. Comment an interpretation on receptivity data.
2. Write briefly on geological studies for selection of tunnel sites.
3. How structural, geological and engineering properties of rock influence the selection of dam sites?
4. What is a reservoir? What are the geological factors that are consider for selection of sites for construction of reservoir?

Unit 12:

1. What are the Causes and effects of landslide?
2. What do you mean by landslide? Describe the different types of landslide.
3. What are the preventive measures that can be taken to prevent landslides?

Title of Course: Soil Mechanics Lab-II
Course Code: CE 591
L-T-P scheme: 0-0-3 **Course Credit: 2**

Objectives:
1. The students will be able to differentiate between different types of soils and characteristics of each type of soil.
2. The students will be involved in the collection of the field samples and identification of the types of soils without natural testing.
3. The students will be able to determine the natural moisture content of the soil.
4. The students will be able to determine the compressibility characteristics of the soil by Oedometer test which involves the co-efficient of consolidation and compression index.

Learning Outcomes: The students will develop a clear understanding of the different types of soils and will be able to identify the types of soils as per the Indian Standards. The students will be able to determine the moisture contents and specific gravity of cohesive soils and cohesion less soils. The students will also develop a clear understanding of the compaction characteristics of the soil. The students will develop a understanding of the Triaxial Test that is to determine the shear parameters of the soil. They will also develop the basic concepts of Direct Shear Test and to find out the compressive strength of the soil. The students will be exposed to the concepts of Standard Penetration Test which involves the collection of field samples and performing tests for the determination of various soil parameters like bearing capacity, compressive strength.

Course Contents:
Practicals that must be done in this course are listed below:

- Determination of compressibility characteristics of soil by Oedometer test (co-efficient of consolidation & compression Index).
- Determination of unconfined compressive strength of soil.
- Determination of Shear parameter of soil by Direct shear test.
- Determination of undrained shear strength of soil by Vane shear test.
- Determination of shear parameter of soil by Triaxial test (UU).
- Standard Penetration Test.
- Expt No. 6 by large groups in the field.

Text Book:
1. Soil testing by T.W. Lamb (John Willey).
2. SP-36 (Part-I & Part –II).
3. Soil Mechanics Laboratory Manual by B. M. Das, OXFORD UNIVERSITY PRESS.
4. Measurement of engineering properties of soil by E.Jaibaba Reddy & K. Ramasastri.

EXPERIMENT NO 1: DIRECT SHEAR TEST

Objective

To determine the shearing strength of the soil using the direct shear apparatus.

NEED AND SCOPE

In many engineering problems such as design of foundation, retaining walls, slab bridges, pipes, sheet piling, the value of the angle of internal friction and cohesion of the soil involved are required for the design. Direct shear test is used to predict these parameters quickly. The laboratory report cover the laboratory procedures for determining these values for cohesionless soils.

PLANNING AND ORGANIZATION

Apparatus

1. Direct shear box apparatus

2. Loading frame (motor attached).

3. Dial gauge.

4. Proving ring.

5. Tamper.

6. Straight edge.

7. Balance to weigh upto 200 mg.

8. Aluminum container.

9. Spatula.

KNOWLEDGE OF EQUIPMENT:

Strain controlled direct shear machine consists of shear box, soil container, loading unit, proving ring, dial gauge to measure shear deformation and volume changes. A two piece square shear box is one type of soil container used.

A proving ring is used to indicate the shear load taken by the soil initiated in the shearing plane.

PROCEDURE

1. Check the inner dimension of the soil container.

2. Put the parts of the soil container together.

3. Calculate the volume of the container. Weigh the container.

4. Place the soil in smooth layers (approximately 10 mm thick). If a dense sample is desired tamp the soil.

5. Weigh the soil container, the difference of these two is the weight of the soil. Calculate the density of the soil.

6. Make the surface of the soil plane.

7. Put the upper grating on stone and loading block on top of soil.

8. Measure the thickness of soil specimen.

9. Apply the desired normal load.

10.Remove the shear pin.

11. Attach the dial gauge which measures the change of volume.

12. Record the initial reading of the dial gauge and calibration values.

13. Before proceeding to test check all adjustments to see that there is no connection between two parts except sand/soil.

14. Start the motor. Take the reading of the shear force and record the reading.

15.Take volume change readings till failure.

16. Add 5 kg normal stress 0.5 kg/cm2 and continue the experiment till failure

17. Record carefully all the readings. Set the dial gauges zero, before starting the experiment

GENERAL REMARKS

1. In the shear box test, the specimen is not failing along its weakest plane but along a predetermined or induced failure plane i.e. horizontal plane separating the two halves of the shear box. This is the main draw back of this test. Moreover, during loading, the state of stress cannot be evaluated. It can be evaluated only at failure condition i.e Mohr□s circle can be drawn at the failure condition only. Also failure is progressive.

2. Direct shear test is simple and faster to operate. As thinner specimens are used in shear box, they facilitate drainage of pore water from a saturated sample in less time. This test is also useful to study friction between two materials □ one material in lower half of box and another material in the upper half of box.

3. The angle of shearing resistance of sands depends on state of compaction, coarseness of grains, particle shape and roughness of grain surface and grading. It varies between 28o(uniformly graded sands with round grains in very loose state) to 46o(well graded sand with angular grains in dense state).

4. The volume change in sandy soil is a complex phenomenon depending on gradation, particle shape, state and type of packing, orientation of principal planes, principal stress ratio, stress history, magnitude of minor principal stress, type of apparatus, test procedure, method of preparing specimen etc. In general loose sands expand and dense sands contract in volume on shearing. There is a void ratio at which either expansion contraction in volume takes place. This void ratio is called critical void ratio. Expansion or contraction can be inferred from the movement of vertical dial gauge during shearing.

5. The friction between sand particle is due to sliding and rolling friction and interlocking action.

The ultimate values of shear parameter for both loose sand and dense sand approximately attain the same value so, if angle of friction value is calculated at ultimate stage, slight disturbance in density during sampling and preparation of test specimens will not have much effect.

EXPERIMENT NO 2: CONSOLIDATION TEST

OBJECTIVE

To determine the settlements due to primary consolidation of soil by conducting one dimensional test.

NEED AND SCOPE

The test is conducted to determine the settlement due to primary consolidation. To determine :

i. Rate of consolidation under normal load.

ii. Degree of consolidation at any time.

iii. Pressure-void ratio relationship.

iv. Coefficient of consolidation at various pressures.

v. Compression index.

From the above information it will be possible for us to predict the time rate and extent of settlement of structures founded on fine-grained soils. It is also helpful in analyzing the stress history of soil. Since the settlement analysis of the foundation depends mainly on the values determined by the test, this test is very important for foundation design.

PLANNING AND ORGANIZATION

1. Consolidometer consisting essentially

a) A ring of diameter = 60mm and height = 20mm

b) Two porous plates or stones of silicon carbide, aluminum oxide or porous metal.

c) Guide ring.

d) Outer ring.

e) Water jacket with base.

f) Pressure pad.

g) Rubber basket.

2. Loading device consisting of frame, lever system, loading yoke dial gauge fixing device and weights.

3. Dial gauge to read to an accuracy of 0.002mm.

4. Thermostatically controlled oven.

5. Stopwatch to read seconds.

6. Sample extractor.

7. Miscellaneous items like balance, soil trimming tools, spatula, filter papers, sample containers.

PRINCIPAL INVOLVED

When a compressive load is applied to soil mass, a decrease in its volume takes place, the decease in volume of soil mass under stress is known as compression and the property of soil mass pertaining to its tendency to decrease in volume under pressure is known as compressibility. In a saturated soil mass having its void filled with incompressible water, decrease in volume or compression can take place when water is expelled out of the voids. Such a compression resulting from a long time static load and the consequent escape of pore water is termed as consolidation.

Then the load is applied on the saturated soil mass, the entire load is carried by pore water in the beginning. As the water starts escaping from the voids, the hydrostatic pressure in water gets gradually dissipated and the load is shifted to the soil solids which increases effective on them, as a result the soil mass decrease in volume. The rate of escape of water depends on the permeability of the soil.

1) From the sample tube, eject the sample into the consolidation ring. The sample should project about one cm from outer ring. Trim the sample smooth and flush with top and bottom of the ring by using a knife. Clean the ring from outside and keep it ready from weighing.

2) Remoulded sample :

a) Choose the density and water content at which samples has to be compacted from the moisture density relationship.

b) Calculate the quantity of soil and water required to mix and compact.

c) Compact the specimen in compaction mould in three layers using the standard rammers.

d) Eject the specimen from the mould using the sample extractor.

PROCEDURE

1. Saturate two porous stones either by boiling in distilled water about 15 minute or by keeping them submerged in the distilled water for 4 to 8 hrs. Wipe away excess water. Fittings of the consolidometer which is to be enclosed shall be moistened.

2. Assemble the consolidometer, with the soil specimen and porous stones at top and bottom of specimen, providing a filter paper between the soil specimen and porous stone. Position the pressure pad centrally on the top porous stone.

3. Mount the mould assembly on the loading frame, and center it such that the load applied is axial.

4. Position the dial gauge to measure the vertical compression of the specimen. The dial gauge holder should be set so that the dial gauge is in the begging of its releases run, allowing sufficient margin for the swelling of the soil, if any.

5. Connect the mould assembly to the water reservoir and the sample is allowed to saturate. The level of the water in the reservoir should be at about the same level as the soil specimen.

6. Apply an initial load to the assembly. The magnitude of this load should be chosen by trial, such that there is no swelling. It should be not less than 50 g/cm3 for ordinary soils & 25 g/cm2 for very soft soils. The load should be allowed to stand until there is no change in dial gauge readings for two consecutive hours or for a maximum of 24 hours.

7. Note the final dial reading under the initial load. Apply first load of intensity 0.1 kg/cm2 start the stop watch simultaneously. Record the dial gauge readings at various time intervals. The dial gauge readings are taken until 90% consolidation is reached. Primary consolidation is gradually reached within 24 hrs.

8. At the end of the period, specified above take the dial reading and time reading. Double the load intensity and take the dial readings at various time intervals. Repeat this procedure fir successive load increments. The usual loading intensity are as follows :

a. 0.1, 0.2, 0.5, 1, 2, 4 and 8 kg/cm2.

9. After the last loading is completed, reduce the load to 60 % of the value of the last load and allow it to stand for 24 hrs. Reduce the load further in steps of the previous intensity till an intensity of 0.1 kg/cm2 is reached. Take the final reading of the dial gauge.

10. Reduce the load to the initial load, keep it for 24 hrs and note the final readings of the dial gauge.

11. Quickly dismantle the specimen assembly and remove the excess water on the soil specimen in oven, note the dry weight of it.

In the log fitting method, a plot is made between dial reading and logarithmic of time, the time corresponding to 50% consolidation is determined.

In the square root fitting method, a plot is made between dial readings and square root of time and the time corresponding to 90% consolidation is determined. The values of Cv are recorded in table

EXPERIMENT NO 3: UNCONFINED COMPRESSION TEST

OBJECTIVE determine shear parameters of cohesive soil

NEED AND SCOPE OF THE EXPERIMENT

It is not always possible to conduct the bearing capacity test in the field. Some times it is cheaper to take the undisturbed soil sample and test its strength in the laboratory. Also to choose the best material for the embankment, one has to conduct strength tests on the samples selected. Under these conditions it is easy to perform the unconfined compression test on undisturbed and remoulded soil sample. Now we will investigate experimentally the strength of a given soil sample.

PLANNING AND ORGANIZATION

We have to find out the diameter and length of the specimen.

EQUIPMENT

1. Loading frame of capacity of 2 t, with constant rate of movement. What is the least count of the dial gauge attached to the proving ring!

2. Proving ring of 0.01 kg sensitivity for soft soils; 0.05 kg for stiff soils.

3. Soil trimmer.

4. Frictionless end plates of 75 mm diameter (Perspex plate with silicon grease coating).

5. Evaporating dish (Aluminum container).

6. Soil sample of 75 mm length.

7. Dial gauge (0.01 mm accuracy).

8. Balance of capacity 200 g and sensitivity to weigh 0.01 g.

9. Oven, thermostatically controlled with interior of non-corroding material to maintain the temperature at the desired level. What is the range of the temperature used for drying the soil

10. Sample extractor and split sampler.

11. Dial gauge (sensitivity 0.01mm).

12. Verniercalipers

EXPERIMENTAL PROCEDURE (SPECIMEN)

1. In this test, a cylinder of soil without lateral support is tested to failure in simple compression, at a constant rate of strain. The compressive load per unit area required to fail the specimen as called Unconfined compressive strength of the soil.

Preparation of specimen for testing

A. Undisturbed specimen

1. Note down the sample number, bore hole number and the depth at which the sample was taken.

2. Remove the protective cover (paraffin wax) from the sampling tube.

3. Place the sampling tube extractor and push the plunger till a small length of sample moves out.

4. Trim the projected sample using a wire saw.

5. Again push the plunger of the extractor till a 75 mm long sample comes out.

6. Cutout this sample carefully and hold it on the split sampler so that it does not fall.

7. Take about 10 to 15 g of soil from the tube for water content determination.

8. Note the container number and take the net weight of the sample and the container.

9. Measure the diameter at the top, middle, and the bottom of the sample and find the average and record the same.

10. Measure the length of the sample and record.

11. Find the weight of the sample and record.

B. Moulded sample

1. For the desired water content and the dry density, calculate the weight of the dry soil Ws required for preparing a specimen of 3.8 cm diameter and 7.5 cm long.

2. Add required quantity of water Ww to this soil.

Ww = WS *W/100 gm

3. Mix the soil thoroughly with water.

4. Place the wet soil in a tight thick polythene bag in a humidity chamber and place the soil in a constant volume mould, having an internal height of 7.5 cm and internal diameter of 3.8 cm.

5. After 24 hours take the soil from the humidity chamber and place the soil in a constant volume mould, having an internal height of 7.5 cm and internal diameter of 3.8 cm.

6. Place the lubricated moulded with plungers in position in the load frame.

7. Apply the compressive load till the specimen is compacted to a height of 7.5 cm.

8. Eject the specimen from the constant volume mould.

9. Record the correct height, weight and diameter of the specimen.

Test procedure

1. Take two frictionless bearing plates of 75 mm diameter.

2. Place the specimen on the base plate of the load frame (sandwiched between the end plates).

3. Place a hardened steel ball on the bearing plate.

4. Adjust the center line of the specimen such that the proving ring and the steel ball are in the same line.

5. Fix a dial gauge to measure the vertical compression of the specimen.

6. Adjust the gear position on the load frame to give suitable vertical displacement.

7. Start applying the load and record the readings of the proving ring dial and compression dial for every 5 mm compression.

8. Continue loading till failure is complete.

9. Draw the sketch of the failure pattern in the specimen.

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR
Lab Manual

Title of Course: Concrete Lab
Course Code: CE 592
L-T-P scheme: 0-0-3 **Course Credit: 2**

Objectives:
1. The students will develop a clear understanding of the various tests conducted on concrete in both fresh and hardened states.
2. They will develop the concepts of workability, slump test, Vee-bee compacting test and compaction factor tests which are conducted on fresh concrete to determine the fresh concrete properties.
3. The students will be able to perform mix design of concrete and as per the proportion develop concrete mixes of different compressive strengths.
4. The students will be able to perform and analyze the various properties of concrete in hardened state like compressive strength, Split Tensile Strength, Flexure Tests.
5. The students will be exposed to non-destructive testing like Rebound Hammer and Ultrasonic Pulse Velocity test.

Learning Outcomes: The students will be able to understand the various tests which are performed on cement like specific gravity, normal consistency, setting time. The students will also develop a clear understanding of the compressive strength on cement mortar cubes. The students will also develop a clear understanding of the various tests on fine aggregates like sieve analysis, fineness modulus, moisture content, bulk density. The students will also develop concepts on various tests conducted on coarse aggregate like fineness modulus, bulk density.

Course Contents:
Practicals that must be done in this course are listed below:

1. Tests on cement – specific gravity, fineness, soundness, normal consistency, setting time, compressive strength on cement mortar cubes.
2. Tests on fine aggregate – specific gravity, bulking, sieve analysis, fineness modules, moisture content, bulk density and deleterious materials.
3. Tests on coarse aggregate - specific gravity, sieve analysis, fineness modulus, bulk density.
4. Tests on Fresh Concrete: Workability: Slump, Vee-Bee, Compaction factor tests.
5. Hardened Concrete: Compressive strength on Cubes, Split tensile strength, Static modulus of elasticity, Flexure tests ,Non destructive testing (Rebound hammer & Ultrasonic pulse velocity).
6. Mix Design of Concrete.

Text Book:
1. Relevant latest IS codes on Aggregates, Cement & Concrete [269, 383, 2386, 10262(2009), SP23].
2. Laboratory manual of concrete testing by V.V. Sastry and M. L. Gambhir.

Experiment No. 1

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

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

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.

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 immediately after filling the mould.

6. 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.

Experiment No 2

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

Apparatus: Vicat apparatus conforming to IS : 5513-1976, Balance, Gauging Trowel, Stop Watch, etc

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

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 with a cement paste gauged as above, the mould resting on a nonporous plate. Fill the mould completely and smooth off the surface of the paste making it level with the top of the mould.

3. Immediately after moulding, place the test block in the moist closet or moist room and allow it to remain there except when determinations of time of setting are being made.

4. 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

5. 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.

6. Determination of Final Setting Time - Replace the needle (C) of the Vicat apparatus by the needle with an annular attachment (F).

7. 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.

8. The period elapsing between the time when water is added to the cement and the time at which the needle makes an impression on the surface of test block while the attachment fails to do so shall be the final setting time

Experiment No: 3

Objective: To determine the compressive strength sample of cement.

Apparatus : The standard sand to be used in the test shall conform to IS : 650-1966, Vibration Machine, Poking Rod, Cube Mould of 70.6 mm size conforming to IS : 10080-1982, Balance, Gauging Trowel, Stop Watch, Graduated Glass Cylinders, etc.

Theory : The compressive strength of hardened cement is the most important of all the properties. Therefore, it is not surprising that the cement is always tested for its strength at the laboratory before the cement is used in important works. Strength tests are not made on neat cement paste because of difficulties of excessive shrinkage and subsequent cracking of neat cement.

Procedure:

1. Preparation of test specimens - Clean appliances shall be used for mixing and the temperature of water and that of the test room at the time when the above operations are being performed shall be 27 ± 2°C. Potable/distilled water shall be used in preparing the cubes.

2. The material for each cube shall be mixed separately and the quantity of cement, standard sand and water shall be as follows:

Cement 200 g and Standard Sand 600 g

Water per cent of combined mass of cement and sand, where P is the percentage of water required to produce a paste of standard consistency determined as described in IS : 4031 (Part 4)-1988 or Experiment 1

3 .Place on a nonporous plate, a mixture of cement and standard sand. Mix it dry with a trowel for one minute and then with water until the mixture is of uniform colour. The quantity of water to be used shall be as specified in step 2. The time of mixing shall in any event be not less than 3 min and should the time taken to obtain a uniform colour exceed 4 min, the mixture shall be rejected and the operation repeated with a fresh quantity of cement, sand and water.

4. Place the assembled mould on the table of the vibration machine and hold it firmly in position by means of a suitable clamp.

6. Immediately after mixing the mortar in accordance with step 1 & 2, place the mortar in the cube mould and prod with the rod. Place the mortar in the hopper of the cube mould and prod again as specified for the first layer and then compact the mortar by vibration.

7. The period of vibration shall be two minutes at the specified speed of 12 000 ± 400 vibration per minute.

8. Curing Specimens - keep the filled moulds in moist closet or moist room for 24 ± 1 hour after completion of vibration. At the end of that period, remove them from the moulds and immediately submerge in clean fresh water and keep there until taken out just prior to breaking and shall be maintained at a temperature of 27 ± 2°C

9. Test three cubes for compressive strength for each period of curing mentioned under the relevant specifications (i.e. 3 days, 7 days, 28 days)

10. The cubes shall be tested on their sides without any packing between the cube and the steel plattens of the testing machine. One of the plattens shall be carried on a base and shall be self-adjusting, and the load shall be steadily and uniformly applied, starting from zero at a rate of 40N/mm2/min

Experiment No.4

Objective: To determine specific gravity of a given sample of fine aggregate.

Apparatus: Pycnometer, A 1 000-ml measuring cylinder, well-ventilated oven, Taping rod, Filter papers and funnel, etc.

Theory:

Procedure: 1. Sample of about 500 g shall be placed in the tray and covered with distilled water at a temperature of 22 to 32°C.. The sample shall remain immersed for 24 ± l/2 hours.

2. The water shall then be carefully drained from the sample. The saturated and surface-dry sample shall be weighed (weight A).

3. The aggregate shall then be placed in the pycnometer which shall be filled with distilled water. Any trapped air shall be eliminated by rotating the pycnometer on its side, the hole in the apex of the cone being covered with a finger. The pycnometer shall be dried on the outside and weighed (weight B).

4. The contents of the pycnometer shall be emptied into the tray, Thepycnometer shall be refilled with distilled water to the same level as 21 before, dried on the outside and weighed (weight C).

5. The water shall then be carefully drained from the sample. The sample shall be placed in the oven in the tray at a temperature of 100 to 110°C for 24 f l/2 hoursIt shall be cooled in the air-tight container and weighed (weight D).

Experiment No.5

Objective: To determine fineness modulus of fine aggregate and classifications based on IS: 383-1970

Apparatus : Test Sieves conforming to IS : 460-1962 Specification of 4.75 mm, 2.36 mm, 1.18 mm, 600 micron, 300micron, 150 micron, Balance, Gauging Trowel, Stop Watch, etc.

Theory: The sieve analysis is conducted to determine the particle size distribution in a sample of aggregate, which is known as gradation . The following limits used to classifie

Procedure:

1. The sample shall be brought to an air-dry condition before weighing and sieving. The air-dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest.

2. Material shall not be forced through the sieve by hand pressure. Lumps of fine material, if present, may be broken by gentle pressure with fingers against the side of the sieve.

3. Light brushing with a fine camel hair brush may be used on the 150-micron and 75-micron IS Sieves to prevent aggregation of powder and blinding of apertures.

4. On completion of sieving, the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

Experiment No. 6

Objective: To determination of particle size distribution of coarse aggregates by sieving
Apparatus : Test. Sieves conforming to IS : 460-1962 Specification of 80 mm, 40 mm20 mm, 10 mm, 4.75 mm, Balance, Gauging Trowel, Stop Watch, etc.

Theory: Grading refers to the determination of the particle-size distribution for aggregate. Grading limits and maximum aggregate size are specified because grading and size affect the amount of aggregate used as well as cement and water requirements, workability, pumpability, and durability of concrete. In general, if the water-cement ratio is chosen correctly, a wide range in grading can be used without a major effect on strength. When gap-graded aggregate are specified, certain particle sizes of aggregate are omitted from the size continuum. Gap-graded aggregate are used to obtain uniform textures in exposed aggregate concrete.

Procedure:

1. The sample shall be brought to an air-dry condition before weighing and sieving. This may be achieved either by drying at room temperature or by heating at a temperature of 100‖ to 110°C. The air-dry sample shall be weighed and sieved successively on the appropriate sieves starting with the largest.

2. Material shall not be forced through the sieve by hand pressure.

3. On completion of sieving, the material retained on each sieve, together with any material cleaned from the mesh, shall be weighed.

Experiment No. 7

Objective: To determine crushing value of course aggregate .

Apparatus: A 15-cm diameter open-ended steel cylinder, with plunger and base-plate, of the general form and dimensions shown in Fig. ,A straight metal tamping rod, A balance of capacity 3 kg, readable and accurate to one gram, IS Sieves of sizes 12.5, 10 and 2.36 mm, For measuring the sample, cylindrical metal measure of sufficient rigidity to retain its form under rough usage and of the following internal dimensions: Diameter 11.5 cm and Height 18.0 cm .

Theory: The _aggregate crushing value' gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. With aggregate of aggregate crushing value' 30 or higher, the result may be anomalous, and in such cases the_ten percent fines value' should be determined instead.

Procedure :

1. The material for the standard test shall consist of aggregate passing a 12.5 mm IS Sieve and retained on a 10 mm IS Sieve, and shall be thoroughly separated on these sieves before testing.

2. The aggregate shall be tested in a surface-dry condition. If dried by heating, the period of drying shall not exceed four hours, the temperature shall be 100 to 110°C and th aggregate shall be cooled to room temperature before testing.

3. The appropriate quantity may be found conveniently by filling the cylindrical measure in three layers of approximately equal depth, each layer being tamped 25 times with the rounded end of the tamping rod and finally leveled off, using the tamping rod as a straight-edge.

4. The weight of material comprising the test sample shall be determined (Weight A) and the same weight of sample shall be taken for the repeat test.

5. The apparatus, with the test sample and plunger in position, shall then be placed between the platens of the testing machine and loaded at as uniform a rate as possible so that the total load is reached in 10 minutes. The total load shall be 400 kN.

6. The load shall be released and the whole of the material removed from the cylinder and sieved on a 2.36 mm IS Sieve for the standard test. The fraction passing the sieve shall be weighed (Weight B).

The aggregate crushing value should not be more than 45 per cent for aggregate used for concrete other than wearing surfaces, and 30 per cent for concrete used for wearing surfaces such a runways, roads and air pavements.

Experiment No. 8

Objective: To determine the impact value of course aggregate

Apparatus: An impact testing machine of the general form shown in Fig. 2 and complying with the following:

1. A cylindrical steel cup of internal dimensions: Diameter 102 mm, Depth 50 mm and not less than 6.3 mm thick

2. A metal hammer weighing 13.5 to 14.0 kg, the lower end of which shall be cylindrical in shape, 100.0 mm in diameter and 5 cm long, with a 2 mm chamfer at the lower edge, and case-hardened. The hammer shall slide freely between vertical guides so arranged that the lower (cylindrical) part of the hammer is above and concentric with the cup.

3. Means for raising the hammer and allowing it to fall freely between the vertical guides from a height of 380.0 mm on to the test sample in the cup, and means for adjusting the height of fall within 5 mm.

Sieves-The IS Sieves of sizes 12.5, 10 and 2.36 mm, Tamping Rod, balance of capacity not less than 500 g, Oven etc.

Theory: The aggregate impact value' gives a relative measure of the resistance of an aggregate to sudden shock or impact, which in some aggregates differs from its resistance to a slow compressive load.

Procedure :

1. The test sample shall consist of aggregate the whole of which passes a 12.5 mm IS Sieve and is retained on a 10 mm IS Sieve. The aggregate comprising the test sample shall be dried in an oven for a period of four hours at a temperature of 100 to 110°C and cooled.

2. The measure shall be filled about one-third full with the aggregate and tamped with 25 strokes of the rounded end of the tamping rod. The net weight of aggregate in the measure shall be determined to the nearest gram (Weight A)

3. The impact machine shall rest without wedging or packing upon the level plate, block or floor, so that it is rigid and the hammer guide columns are vertical.

4. The cup shall be fixed firmly in position on the base of the machine and the whole of the test sample placed in it and compacted by a single tamping of 25 strokes of the tamping rod.

5. The hammer shall be raised until its lower face is 380 mm above the upper surface of the aggregate in the cup, and allowed to fall freely on to the aggregate. The test sample shall be subjected to a total of 15 such blows each being delivered at an interval of not less than one second.

6. The crushed aggregate shall then be removed from the cup and the whole of it sieved on the 2.36 mm IS Sieve until no further significant amount passes in one minute. The fraction passing the sieve shall be weighed to an accuracy of 0.1 g (Weight. B).

7. The fraction retained on the sieve shall also be weighed (Weight C) and, if the total weight (C+B) is less than the initial weight (Weight A) by more than one gram, the result shall be discarded and a fresh test made. Two tests shall be made.

The aggregate impact value should not be more than 45 per cent for aggregate used for concrete other than for wearing surfaces, and 30 per cent for concrete used for wearing surfaces such a runways, roads and air field pavements

Experiment No. 9

Objective: To determine compressive strength of concrete cube specimen.

Apparatus:

Testing Machine - The testing machine may be of any reliable type, of sufficient capacity for the tests and capable of applying the load at the rate specified in 5.5

Cube Moulds - The mould shall be of 150 mm size conforming to IS: 10086-1982.

Cylinders -The cylindrical mould shall be of 150 mm diameter and 300 mm height conforming to IS: 10086-1982.

Weights and weighing device, Tools and containers for mixing, Tamper (square in cross section) etc.

Theory : Age at Test - Tests shall be made at recognized ages of the test specimens, the most usual being 7 and 28 days. Where it may be necessary to obtain the early strengths, tests may be made at the ages of 24 hours ± ½ hour and 72 hours ± 2 hours. The ages shall be calculated from the time of the addition of water to the 63 dry ingredients.

Number of Specimens - At least three specimens, preferably from different batches, shall be made for testing at each selected age.

Procedure :

1. Sampling of Materials - Samples of aggregates for each batch of concrete shall be of the desired grading and shall be in an air-dried condition. The cement samples, on arrival at the laboratory, shall be thoroughly mixed dry either by hand or in a suitable mixer in such a manner as to ensure the greatest possible blending and uniformity in the material.

2. Proportioning - The proportions of the materials, including water, in concrete mixes used for determining the suitability of the materials available, shall be similar in all respects to those to be employed in the work.

3. Weighing - The quantities of cement, each size of aggregate, and water for each batch shall be determined by weight, to an accuracy of 0.1 percent of the total weight of the batch.

4. Mixing Concrete - The concrete shall be mixed by hand, or preferably, in a laboratory batch mixer, in such a manner as to avoid loss of water or other materials. Each batch of concrete shall be of such a size as to leave about 10 percent excess after moulding the desired number of test specimens.

5. Mould - Test specimens cubical in shape shall be 15 × 15 × 15 cm. If the largest nominal size of the aggregate does not exceed 2 cm, 10 cm cubes may be used as an alternative. Cylindrical test specimens shall have a length equal to twice the diameter.

6. Compacting - The test specimens shall be made as soon as practicable after mixing, and in such a way as to produce full compaction of the concrete with neither segregation nor excessive laitance.

7. Curing - The test specimens shall be stored in a place, free from vibration, in moist air of at least 90 percent relative humidity and at a temperature of 27° ± 2°C for 24 hours ± ½ hour from the time of addition of water to the dry ingredients.

Placing the Specimen in the Testing Machine - The bearing surfaces of the testing machine shall be wiped clean and any loose sand or other material removed from the surfaces of the specimen

which are to be in contact with the compression platens

Conclusion / R :

i) The average 7 Days Compressive Strength of concrete sample is found to be …..…..

ii) The average 28 Days Compressive Strength of concrete sample is found to be …..…..

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR
Lab Manual

Title of Course: Quantity Surveying, Specifications & Valuation Lab
Course Code: CE 593
L-T-P scheme: 0-0-3 **Course Credit: 2**

Objectives:
1. The students will develop the basic concepts of the types of estimates, approximate estimates, items of work, unit of measurement and unit rate of measurement.
2. The student will be able to calculate the details of measurements and calculation of quantities with cost, bill of quantities and abstract of quantities.
3. The students will develop the concept of analysis and schedule of rates for Earthwork, Brick Flat Soling, DPC, PCC and RCC work.
4. The students will have a clear understanding of the specifications of the materials like bricks, cement, fine and coarse aggregates.

Learning Outcomes: The students will develop a clear concept of the type of estimates and will be able to affectively determine the project cost of the any tender being undertaken. The students will be exposed to the concept of Bar Bending Schedule and quantity estimate of single storied building. The students will also develop the understanding of the specification of works like plain cement concrete, reinforced cement concrete, first class brickwork, cement plastering. The students will develop the basic concepts of valuation of work like Gross Income, Net Income, Depreciation, Mortgage and Valuation Table.

Course Contents:
Practicals that must be done in this course are listed below:

1. **Quantity Surveying**: Types of estimates, approximate estimates, items of work, unit of measurement, unit rate of payment.
2. **Quantity estimate** of a single storied building,Bar bending schedule.
3. **Details of measurement** and calculation of quantities with cost, bill of quantities, abstract of quantities. Estimate of quantities of road, Underground reservoir, Surface drain, Septic tank. Analysis and schedule of rates: Earthwork, brick flat soling, DPC, PCC and RCC, brick work, plastering, flooring and finishing, Specification of materials: Brick, cement, fine and coarse aggregates ,Specification of works: Plain cement concrete, reinforced cement concrete, first class brickwork, cement plastering, pointing, white washing, colour washing, distempering, lime punning, painting and varnishing.
4. **Valuation:** Values and cost, gross income, outgoing, net income, scrap value, salvage value, market value, Book Value, sinking fund, capitalised value, Y. P., depreciation, obsolescence, deferred income, freehold and leasehold property, mortgage, rent fixation, valuation table .

Text Book:

1. Estimating, costing, Specification and Valuation in Civil Engineering by M..Chakroborty.
2. Estimating and Costing in Civil Engineering" by B.N.Dutta, USB Publishers & Distributers.
3. Civil Estimating, Costing and Valuation by Agarwal / Upadhay.

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR
Lab Manual

Title of Course: Engineering Geology Lab
Course Code: CE594
L-T-P scheme: 0-0-3 **Course Credit: 3**

Objectives:

1. To understand the role of geology in the design and construction process of underground openings in rock.
2. To apply geologic concepts and approaches on rock engineering projects.
3. To identify and classify rock using basic geologic classification systems.
4. To use the geologic literature to establish the geotechnical framework needed to properly design and construct heavy civil works rock projects.
5. To identify and characterize intact rock/rock mass properties.

Learning Outcomes:

1. Have knowledge of the field and laboratory test procedures and be able to interpret test results to estimate intact and rock mass properties.
2. Study photographs and use observational approach to identify different categories of rock behavior in actual underground openings.

Course Contents:
Exercises that must be done in this course are listed below:
Exercise No.1: To study of Physical properties of minerals
Exercise No.2: To Study various rock forming minerals.
Exercise No.3: Study of crystals with the help of crystal models
Exercise No.4: Identification of Rocks and Minerals [Hand Specimens]
Exercise No.5: Microscopic study of Rocks and minerals
Exercise No.6: Study of Geological maps, interpretation of geological structures.

Text Book:
Engineering Geology Practicals (Lab. Practice) by M.T.M. Reddy,

UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR
Lab Manual

Experiment: - 1

Objective: - **Study of Physical properties of minerals**

Theory :- Earth is made up of minerals that are the constituents of rocks. Mineral specimens are usually identified by determining their physical properties.

Colour : Although the colour of some minerals, such as azurite, is quite distinctive, other minerals, such as quartz, occur in a variety of colours. Also there are many white minerals. Hence colour is frequently NOT a useful diagnostic property.

Streak: Streak is the colour of the powdered mineral. It is a useful diagnostic property for many coloured minerals — especially those with a metallic lustre. It is found by rubbing the specimen on a piece of unglazed tile, or streak plate.

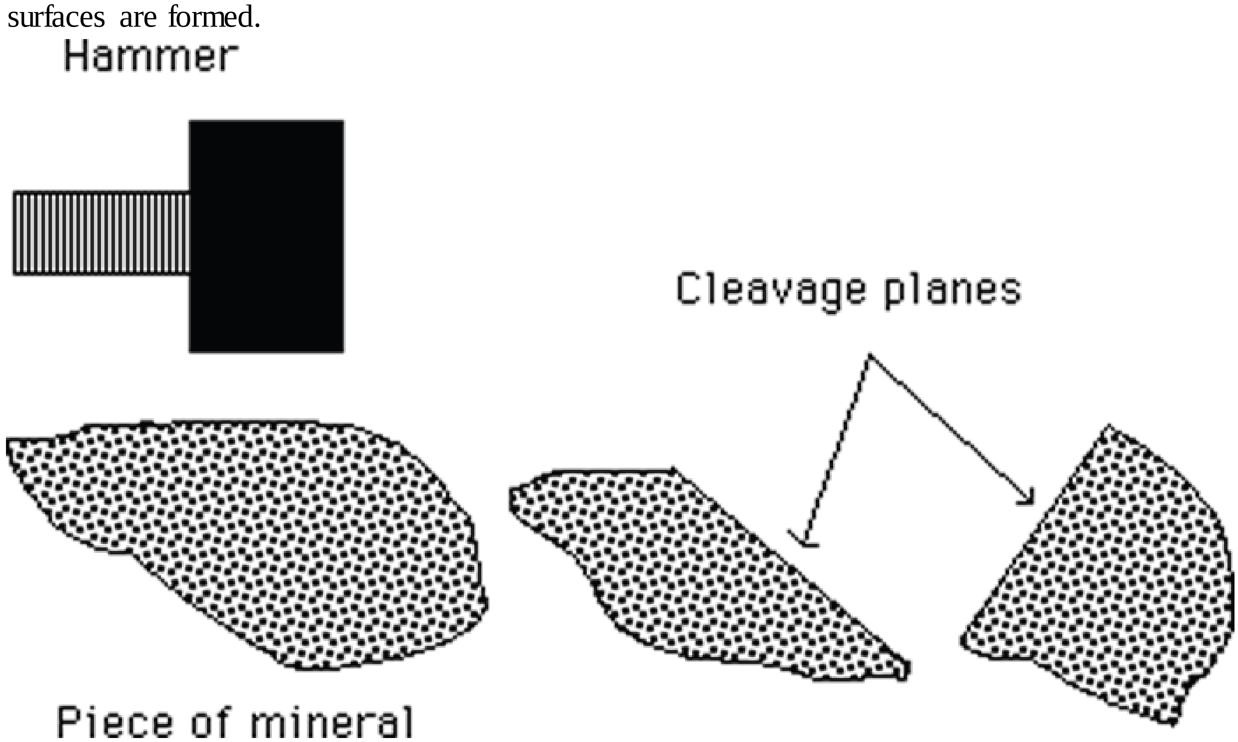
Lustre: The lustre of a mineral is the way its surface shines when held up to the light. Lustre is a property distinct from colour. There are many ways of classifying and describing lustre, but the following system is adequate:

Vitreous — the mineral shines like glass — e.g. quartz, diamond
Metallic — the mineral shines like the surface of a metal — e.g. pyrite, galena
Earthy (dull) – the mineral does not shine at all — e.g. kaolinite

Hardness: The hardness of any mineral can be assigned a number between 1 and 10, on Moh's Scale of Hardness. The instruments used to determine the hardness of a mineral specimen are (in order of increasing hardness) a finger-nail, copper coin, knife blade and a quartz crystal.

Density: It is not usual to measure the actual densities (relative to water = 1) of specimens; however, minerals should be classified according to whether they are light, medium or heavy. This can be done by holding similar-sized specimens of two different minerals in your hands, and comparing their weights.

Cleavage: When a piece of a mineral is dropped or struck, it may tend to break so that flat, shiny surfaces are formed.



Minerals, or individual surfaces, that do not cleave to form flat faces are said to show fracture. Cleavage is a diagnostic property for identification of minerals, but the cleavage of an actual specimen is not always easy to determine. Many specimens do not show the expected cleavage characteristics.

Magnetism: Some minerals that contain iron are magnetic. Magnetite is strongly magnetic, and will be attracted by a magnet. Other iron-bearing minerals such as ilmenite sand size particles.

Reaction to dilute Hydrochloric Acid: Some minerals especially carbonates, effervesce when a drop of dilute hydrochloric acid is placed on them. This is useful diagnostic test for calcite and a white mineral which is not easily distinguished.

Mineral Physical Property chart		
Physical Property	**Definition**	**Testing Method**
Cleavage	Breakage of a mineral along planes of weakness in the crystal structure	Examine the mineral for area where the mineral is broken. Look for area where the light reflects from planar surfaces. This can be easily confused with a crystal face and is the most difficult properties for student to master
Color	Visible light spectrum radiation reflected from a mineral.	look at the sample and determine its color white, green, black, clear etc.
crystal forms	Geometric shape of a crystal or mineral	examine and describe the geometric shape of the mineral, cubic, hexagonal, etc. Not commonly seen in most lab samples
Fractures	Breakage of a mineral, not along planes of weakness in the crystal structure	Examine the mineral for area where the mineral is broken. Describe the breakage as either irregular or conchoidal (has the appearance of broken glass)
Hardness	Resistance to scratching or abrasion	Use mineral of know hardness from the Mohs hardness Kits. Scratch the unknown mineral with a know hardness to determine which is harder. Continue doing this with harder or softer minerals from the kit until the hardness is determined.
luster	Character of the light reflected by a mineral	Look at the samples to determine if the mineral is metallic in appearance or non metallic. Vitreous, like glass and earthy (like dirt, or other Powderly material)
Magnetism	Electromagnetic force generated by an object or electric field.	Use of magnet to determined in an introductory lab.
Specific gravity	Ratio of the mass of a mineral to the mass of an equal volume of water	Generally not determined in an introductory lab.

Streak	Color of the mineral when it is powdered	Grind a small amount of a mineral into a powder on a porcelain streak plate and determine the color of the powder.
Transparent	Stages of transparency of mineral	A mineral is Transparent when the outline of an

The table below lists the minerals that define **Moh's Scale of Hardness**, and gives the relative harnesses of the test items named above.

Table -2 Moh's scale of Hardness	
Hardness	**Mineral**
1	Talc
2	Gypsum
3	Calcite
4	Fluorite
5	Apatite
6	Orthoclase
7	Quartz
8	Topaz
9	Corundum
10	Diamond

(Table - 3) Specific Gravity of the Important Minerals	
Mineral	**Specific Gravity**
Graphite	2.23
Quartz	2.65
Feldspars	2.6- 2.75
Fluorite	3.18
Topaz	3.53
Corundum	4.02
Barite	4.45
Pyrite	5.02
Galena	7.5
Cinnabar	8.1
Copper	8.9
Silver	10.5

Viva Questions

1. Differentiate between Rock and Mineral
2. What is streak?
3. What instrument is used to find the streak?
4. Explain Clevage and Magetism.
5. Why study of minerals is important in Geology?

EXPERIMENT:-2

Objective: - To Study various rock forming minerals

Theory:- Although about 4000 minerals are known to exist, only about 8 of them are common. These common rock forming minerals are the major constituents of igneous, sedimentary and metamorphic rocks. They constitute more that 99% of Earth's crust. You must be able to identify these 8 minerals, and you must know the mineral group to which each one belongs.
The following table lists the common rock-forming minerals…

Mineral	Group	SIGNIFICANT DIAGNOSTIC PROPERTIES				
		H	Colour	Lustre	Cleavage	Other properties
Quartz	Silicate	7	Clear when pure. Impurities cause many colour variations.	Vitreous	None	Hexagonal crystals
Feldspar group: Orthoclase Plagioclase	Silicate	6	Orthoclase: pink, cream Plagioclase: white, grey	Vitreous	2 at ~90°	
Biotite	Silicate	2.5	Black	Vitreous: sometimes appears metallic	1	Thin sheets are flexible and elastic
Muscovite	Silicate	2.5	White or clear		1	
Amphibole (*e.g.* Hornblende)	Silicate	5.5	Black	Vitreous	2 at 120°	Often confused with Pyroxene
Olivine	Silicate	6.5	Green	Vitreous	none	Small green crystals. Often enclosed in a basalt volcanic 'bomb'.
Pyroxene (*e.g.* Augite)	Silicate	5.5	Black	Vitreous	2 at 87° & 93°	Often confused with Amphibole
Calcite	Carbonate	3	White or clear	Vitreous	3 **not** at 90°	Effervesces with acid
Clays (*e.g.* Kaolinite)	Silicate	2.5	White	Dull	None	Very powdery

Properties:- Properties Such as Hardness, Density and cleavage are often impossible to determine in these specimens. However, colour, lustre and streak are usually sufficient for identification of common ore minerals

Mineral	Composition	SIGNIFICANT DIAGNOSTIC PROPERTIES				
		H	Colour	Lustre	Streak	Other properties
Galena	Lead sulphide (PbS)	2.5	Grey	Metallic	Lead-grey	Very high density, 3 cleavage planes at 90°
Chalcopyrite	Copper iron sulphide ($CuFeS_2$)	3.5	Greenish-gold or many colours (iridescent)	Metallic	Greenish black	Iridescent specimens are known as 'peacock ore'.
Malachite	Copper carbonate [$Cu_2CO_3(OH)_2$]	3.5	Green	Vitreous or dull	Green	Green colour is diagnostic.
Sphalerite	Zinc sulphide (ZnS)	3.5	Brown/black	Metallic	Brown	Dodecahedral cleavage (6 planes of cleavage)
Bauxite	Mixture of aluminium hydroxides	2	Brown	Dull	Brown	Consists of round nodules (*i.e.* pisolitic). Easily recognised.
Haematite	Iron oxide (Fe_2O_3)	6	Reddish brown to black	Usually dull	Reddish brown	Appearance of mineral varies. Streak is diagnostic.
Magnetite	Iron oxide (Fe_3O_4)	6	Black	Metallic	Black	Strongly magnetic.

Rock-forming minerals:-

Minerals are the building blocks of rocks. Geologists define a mineral as:

A naturally occurring, inorganic, solid, crystalline substance which has a fixed structure and a chemical composition which is either fixed or which may vary within certain defined limits.

Some minerals have a definite fixed composition, e.g. quartz is always SiO_2, and calcite is always $CaCO_3$. However, other minerals exhibit a range of compositions between two or more compounds called end-members. For example, plagioclase feldspar has a composition that ranges between end-members anorthite ($CaAl_2Si_2O_8$) and albite ($NaAlSi_3O_8$), so its chemical formula is written as (Ca, Na)(Al, Si)$AlSi_2O_8$.

There are also minerals which form both by inorganic and organic processes. For example, calcite ($CaCO_3$) is a common vein mineral in rocks, and also a shell-forming material in many life forms. Calcite of organic origin conforms to the above definition except for the requirement that it be inorganic. This is an inconsistency in the definition of a mineral that is generally overlooked.

How can a mineral be identified?

A particular mineral can be identified by its unique crystal structure and chemistry. Geologists working in the field, however, don't usually have access to the sophisticated laboratory techniques needed to determine these properties. More commonly, they use Properties which can be observed with the naked eye (or with a hand lens) or determined with simple tools (e.g. a pocket knife).

Useful physical properties for identifying a mineral include its cleavage / fracture, colour, crystal habit / mode of occurrence, hardness, lustre, specific gravity, streak and transparency.

EXPERIMENT:-3

OBJECTIVES: - Study of Crystals

VOCABULARY:

i. Conglomerate
ii. Gneiss
iii. Granite
iv. Marble
v. Obsidian
vi. Sandstone
vii. Schist
viii. Scoria
ix. Shale

MATERIALS:

i. Identification sheets made in pre lab
ii. Rocks
iii. 10% HCL Solution (Optional)

Theory:-

Rocks record the earth's history when those rocks where formed. When students get a piece of rock in lab they need to associate different environments of sedimentary, igneous, and metamorphic. Although sedimentary is the most common rock found on the surface of earth, students can most of the groups very easily. It is very common for building and see the different types of rocks, even if they did not form in that city.

Discuss with the students that rocks have key characteristics, just like minerals, but that identifying rocks is much more difficult, in this lab they will become familiar with the key characteristics of small group of sedimentary, igneous and metamorphic,

PROCEDURE:-

1. Review the rocks on the pre lab identification sheets. You may want to go over some of the characteristics described below.

BLACK, GLASSY - black-the color; glassy - have students imagine broken glass
RED, HOLES - red-the color; holes, - like Swiss cheese
LARGE MINERALS - visible, obvious minerals
WHITE, FLAT, LIGHT - white-the color; flat - as a pancake; _ like a balloon
PEBBLES, GLUED - sand size; sand grains look like they are pasted together
FLAT, LAYERS - pancakes stacked on top of each other
SHINY - like a new car
WHITE AND GRAY MINERALS - the minerals are large enough to see and are white and gray; fizz - if you have dilute HCl(can be bought in a hardware store as Muriatic Acid -

Cement Cleaner) pour just a drop on a specimen so students can see it fizz (DO NOT LET CHILDREN PLAY WITH HCl).

2. See if the students can match the rocks in their packets with the characteristics on the identification sheet. Frequently check on their process. as they decide which rock belongs where.

3. Discuss with students which rocks belong to which group as grouped below:
   IGNEOUS - granite, scoria, obsidian

   SEDIMENTARY - sandstone, conglomerate, shale

   METAMORPHIC - marble, schist, gneiss

Physical Properties of rocks:-

i) **Hardness** :- A scratch test developed by a German mineralogist Fredriech Mohs in 1822 is used to determine mineral hardness. He developed a hardness scale that helps to identify mineral properties.

ii) **Color** :- Color can sometimes be helpful when identifying minerals. However, some minerals have more than one color, like quartz. Quartz can be blue, brown, pink, red, purple, and almost any other color, or it can be totally colorless. Therefore, geologists have developed a better way of using color as an identifying property. This property is called a streak.

iii) **Streak** :- Streak is the name given to the colored residue left by scratching a mineral across an abrasive surface, such as a tile of unglazed porcelain. The streak may not always be the same color you see in the hand specimen. A mineral with more than one color will always leave a certain color of streak. Hematite is a mineral that can be red, brown, or black, but it will always leave a characteristic reddish brown streak.

iv) **Luster: -** Another mineral property that geologists use to identify minerals is luster. Luster is the way in which the surface of a mineral reflects light. There are two main types of luster: metallic and nonmetallic. A metallic luster is shiny and similar to the reflection from a metal object, such as a faucet. A mineral that does not shine like metal has a nonmetallic luster. For example, the wall has a nonmetallic luster.

v) **Cleavage: -** Cleavage is another property used to distinguish minerals. Cleavage is the tendency for minerals to break along flat planar surfaces. Cleavage is rated as good, fair and poor depending on the quality of the flat surface produced. Mica, for example, is a mineral that has good cleavage.

vi) **Chemical Reaction** :- A weak acid is used to tell if rocks or minerals contain calcium carbonate ($CaCO_3$). If the specimen fizzes (giving off CO_2) when it comes in contact with acid, it is considered carbonate rich. If it does not contain calcium carbonate, it will not fizz. Calcite and aragonite are two minerals that will always fizz.

EXPERIMENT: - 4

Objective: - Study of Rock and Minerals

MINERALS

QUARTZ (Sio$_2$)

Habit and crystal system : Crystalline and hexagonal system

Colour : Variety colourless, transparent, snow white

Scratch ability and hardness: Cannot be scratched by knife, H=2.5 to 2.7

Streak : White

Cleavage : Nil

Fracture : Uneven at place conchoidal

Specific gravity : Crystalline, habit, horizontal, faces, piezo electric, absence of cleavage through crystalline breaks with sharp cutting edges, conchoidal faces.

Uses / Importance : Important rare forming mineral 7th standard mineral in Mohr's scale, glass making electronic lenses, wireless apparatus, radar watches and clocks, industrial and agro granules and powder glass cutting.

OPAL
(Sio2.H2O)

Habit and crystal system : Massive

Colour and luster : Milk white, dirty white resinous

Scratch ability and hardness : Cannot be scratched by knife, H=4.5 to 5.5

Streak : White

Cleavage : Nil

Fracture : Uneven at Many places, conchoidal

Specific gravity : Low 1.9 to 2.3

Special properties : Resembles Magnetic, alkali gravity, some varieties

Uses / Importance : Filler, translucent, variety cats eye, used in jewellery.

MAGNETITE
(Fe304)

Habit and crystal system	:	Crystalline, isometric system, octahedron and also massive
Colour and luster	:	Iron, Block, Metallic
Scratch ability and hardness	:	It cannot be scratched by knife hardness H=5.5
Streak	:	Block
Cleavage	:	Four sets of oblique cleavage, massive
Fracture	:	Uneven
Specific gravity	:	High 5.5
Special properties	:	Strongly Magnetic
Uses / Importance	:	Ore of Iron, Ferrite rod, radio Antenna

HEMATITE
(Fe203)

Habit and crystal system	:	Crystalline, hexagonal, and massive
Colour and luster	:	When fresh bright steel gray when altered reddish brown, metallic
Scratch ability and hardness	:	It cannot be scratched and hardness H = 5.5
Streak	:	Reddish brown, cherry brown
Cleavage	:	Oblique cleavage
Fracture	:	Uneven
Specific gravity	:	High 5.5
Special properties	:	Heavy, cherry red colour, some varieties are magnetic due to branches of magnetic
Uses / Importance	:	Ore of Iron dyes.

BAUXITE
(Al203.2H20)

Habit and crystal system	:	Massive commonly pisolitic
Colour and luster	:	Dry white, stained, reddish brown, yellowish by wides, dull sometimes resinous
Scratch ability and hardness	:	Can be scratch easily by knife
Streak	:	White

Cleavage	:	Nil
Fracture	:	Uneven earthy
Specific gravity	:	Low 2.3 to 2.5
Special properties	:	Pisolitic habit, some varieties, low specific gravity
Uses / Importance	:	Chief ore of alumina, oil refining, bauxite cement, refractory bricks, water purification, paper making, ceramics, chemicals, mineral salts.

MUSCOVITE MICA [H2KAL3 (sio4)3]

Habit and crystal system	:	Flaky, monoclinic system, pseudo hexagonal
Colour and luster	:	Colourless, transparent, silver white, in bulk with dark brown pearly
Scratch ability and hardness	:	Scratched by fingernail and hardness H = 2 – 2.5
Streak	:	White shining
Cleavage	:	One set of perfect basal cleavage
Fracture	:	Uneven
Specific gravity	:	Medium 2.7 to 3
Special properties	:	Extremely thin, elastic, transparent. Colourless flakes, bad conductor of elasticity
Uses / Importance	:	Electric and electrical isolator, gas light. Chimes, fancy points, ornaments.

BLOTITE MICA

Habit and crystal system	:	Flaky, Monoclinic system, pseudo hexagonal
Colour and huster	:	Brownish block, transparent
Scratch ability and hardness	:	Scratched by nail and hardness H = 2 to 2.5
Streak	:	Pale yellow
Cleavage	:	One set of perfect basal cleavage
Fracture	:	Uneven
Specific gravity	:	Medium 2.9 to 3.1
Special properties	:	Brownish block to black colour
Uses / Importance	:	Important rock forming, minerals boiler

ORTHOCLASE [FELDSPAR [KAL.(Si308)]

Habit and crystal system	:	Massive, commonly monoclinic system
Colour and luster	:	White, Pink, Vitreous
Scratch ability and hardness	:	Cannot be scratched by knife and hardness [H = 6]
Streak	:	White
Cleavage	:	Two sets perpendicular
Fracture	:	Uneven
Specific gravity	:	Medium 2.6
Special properties	:	Alkaline 2 sets perpendicular
Uses / Importance	:	6 standard mineral in Mohr's scale, glass making

AUGITE [Complex silicate of Ca, Al, Mg, F3]

Habit and crystal system	:	Crystalline, monoclinic system, crystals are short and shout eight sided cubical cleavage fracture
Colour and luster	:	Dark gray, greyish block, block, vitreous
Scratch ability and hardness	:	Can be scratched by knife and harness H = 5.5
Streak	:	greenish white
Cleavage	:	2 sets almost perpendicular
Fracture	:	Uneven
Specific gravity	:	Medium 3.2 to 3.5
Special properties	:	Nearly perpendicular cleavage
Uses / Importance	:	Important rock forming mineral

CALCITE
(CaC03)

Habit and crystal system	:	Crystalline, hexagonal system
Colour and luster	:	White, grey, pink, transulent, colourless transparent
Scratch ability and hardness	:	Scratched easily by knife and hardness H = 3
Streak	:	White
Cleavage	:	3 sets of oblique perfect Rhombo hedral
Fracture	:	Uneven
Specific gravity	:	Medium 2.7
Special properties	:	Perfect Rhombo hedral cleavags, reacts readily with dilute - HCL
Uses / Importants	:	Third standard mineral on Mohr's scale of hardness, polarizing mica microscopes Co_2, calcium carbide, nitro line cost lime nitrogen, bleaching powder, soil tooth paste, glass, flux in smelting

GARNET (Complex silicate of Ca mg & fe)

Habit and crystal system	:	Crystalline, Isometric system, Decahydral system
Colour and luster	:	Brownish block, Reddish brown, honey brown, when fresh vitreous to metallic.
Scratch ability and hardness	:	Can't be scratched by knife and hardness H = 6.5 to 7.5
Streak	:	Reddish brown when altered
Cleavage	:	Inter obtained, very distinct, parallel to deca hydral faces
Fracture	:	Uneven
Specific gravity	:	Medium to high 3.2 to 4.5
Special properties	:	Crystal frequently distributed
Uses / Importance	:	ceramic stones

TALC

Habit and crystal system	: Massive, Foliated
Colour and luster	: Pale green, Apple green, pearly
Scratch ability and hardness	: It can be scratched by knife and hardness H = 1 – 1.5
Streak	: Pale white
Cleavage	: Nil
Fracture	: Uneven
Specific gravity	: Medium 2.7 to 2.8
Special properties	: Very soft and smooth
Uses / Importance	: 1^{st} standard mineral in Mohr's scale of hardness, filer material

DOLOMITE

Habit and crystal system	: Crystalline, hexagonal system
Colour and luster	: White, grey pink, colourless, transparent, pearly
Scratch ability and hardness	: Can be scratched by knife and hardness H = 3
Streak	: White
Cleavage	: 3 sets of oblique perfect Rhombo - hydral
Fracture	: Uneven
Specific gravity	: Medium 2.7
Special properties	: Rhombo hydral cleavage, colourless varieties
Uses / Importance	: 3^{rd} standard mineral in Mohr's scale of hardness,

MAGNESITE
(MgCo3)

Habit and crystal system	: Crystalline
Colour and luster	: White, grey, pink and pearly
Scratch ability and hardness	: Scratched with knife and hardness H = 3.5 to 4
Streak	: White
Cleavage	: 3 sets of oblique cleavage, Rhombo hedron
Fracture	: Uneven
Specific gravity	: Medium 1.7 to 1.8
Special properties	: Pearly Luster, Reacts with concentrated - HCL
Uses / Importance	: Refractory at 1700^0c, special cements,

GALENA
(pbs)

Habit and crystal system	:	Crystalline, Isometric system, cubes,
Colour and luster	:	Lead grey, silver grey, bright and metallic
Scratch ability and hardness	:	Can be scratched easily by knife and hardness H = 2 to 2.5
Streak	:	Lead grey
Specific gravity	:	Medium 2.8
Special properties	:	Soft heavy and diamagnetic
Uses / Importance	:	Ore of heal Alloys, crystals used in Radio sets, heavy aggregate concrete for protective walls in atomic and Nuclear Reactors.

OLIVINE

Habit & Coastal system	:	Massive
Colour & Iusture	:	Olive green, Lusture (dull)
Scratch ability & Hardness	:	Hardness (6-7) cannot be scratched y knife
Streak	:	Light green, pale colour
Cleavage	:	Absent
Fracture	:	Uneven
Specific gravity	:	Medium (3.2 – 3.5)
Special properties	:	Commonly unsaturated mineral
Uses (or) Importance	:	- - -

ASBESTOS

Habit & Coastal system	:	Fibrous
Colour & Iusture	:	Pale, green, silky
Scratch ability & Hardness	:	Can be scratched by knife & hardness (2-2.5)
Streak	:	Nil
Cleavage	:	Nil
Fracture	:	Nil
Specific gravity	:	2-2.2
Special properties	:	Fibre, Fine, Strong, Easily separated, Fire proof, Heat proof
Uses (or) Importance	:	Asbestos break & clutch, theatres, curtains, damp proof structures, paper, air & as it filtration

EXPERIMENT: - 5

Objective: - To Study various rock forming minerals

Procedure

To identify a rock three things must be considered: (1) Origin, (2) Composition (3) Texture

Rock Origin: The first step to identify a rock is to try categorizing the rock into of the three main types or group of rocks. These include igneous, sedimentary and metamorphic types. The only rocks which do not fall into one of these categories are meteorites. Igneous, sedimentary and metamorphic rock tupes are distinguished by the processes of their formation.

Rock Composition: The rock composition is determined by the identification of mineral make up the rock. By the identification, a rock is a solid mass or compound consisting of at least two minerals (although there are some exceptions when a rock may consist entirely of one mineral). The minerals comprising the rock cab be identified using common field testing method for individual minerals, particularly where the texture is sufficiently coarse grained enough to distinguish the individual minerals with the naked eye or a hand lens. Where the grain sizes of the minerals comprising the rock are too fine grained to recognize identification in many cases.

Rock Texture: The texture of a rock is defined by observing two criteria: 1) grain size, 2) grain shapes.

Grain Size: it is the average size of the mineral grains. The size scales used for sedimentary, igneous and metamorphic rock are different.

Grain Shape: It is the general shape of the mineral grain (crystal faces evident, or crystals are rounded)

Rock Type	Very Fine grained	Fine Grained	Medium Grained	Coarse Grained	Very Coarse Grained
Clastic Sedimentary	.06 - .125mm	.125 - .25 mm	.25 - .5 mm	.5 - 1 mm	1 - 2 mm
Metamorphic		<.25 mm	.25 - 1mm	1 - 2 mm	> 2 mm
Igneous		< 1 mm	1 - 5 mm	5 - 20 mm	> 20 mm

Recognition of Sedimentary Rocks				
Hardness	**Grain Size**	**Other**	**Composition**	**Rock type**
Hard	Coarse	White to brown, Foliated	Clean Quartz	Sand stone
Hard	coarse	Quartz and Feldspar	Usually very coarse	Arkose
Hard to Soft	Mixed	Mixed rocks and sediments	Round rocks in finer sediment matrix	Conglomerate
Hard to soft	Mixed	Mixed rocks and sediments	Sharp and angular pieces of rocks in finer sediments matrix	Breccia

Soft	Fine	Fizzes with acid	Calcite	Limestone
Soft	Fine	Foliated	Clay minerals	Shale
Hard	Fine	Chalcedony	No fizzing with acid	Chert
Hard	Fine	Feel gritty on teeth	Very fine sand no clay	Silts tone

Recognition of Igneous Rocks				
Grain size	**Usual color**	**Other**	**Composition**	**Rock type**
Coarse	Green	Dense	Approximately 90 to 95% Olivine	Dunite
Fine	Dark	Contain Quartz	Low - silica lava	Basalt
Coarse	Light	Wide range of color and grain size	Large grains of quartz, feldspar, Olivine and pyroxene	Granite
Coarse	Medium to dark	Little or no Quartz	Plagioclase and dark mineral	Diorite
Coarse	light	Wide range of color and grain size but no Quartz	Feldspar with Pyroxene, amphibole and mica	Syenite
Coarse	Medium to dark	Quartz may have Olivine	Calcium Plagioclase and dark minerals	Gabbro
Fine	Medium	Between felsites and basalt	Medium Silica Lava	Andesite
Fine	Light	Contain Quartz	High Silica Lava	Felsites

Recognition of Metamorphic Rocks					
Grain Size	**Hardness**	**Foliation**	**Usual Color**	**Other**	**Rock Type**
Coarse	Hard	Foliated	Mixed dark and light	wrinkled foliation; often has large crystal	Schist
Coarse	Hard	Foliated	Mixed	Banded	Gneiss
Fine	Soft	Foliated	Dark	"tink" when struck	Slate
Coarse	Soft	Nonfoliated	light	Calcite or dolomite by the acid test	Marble
Coarse	Hard	Nonfoliated	light	Quartz (no fizzing with acid)	Ouartzite

Fine	Soft	Foliated	Dark	Shiny, Crinkly foliation	Phyllite
Coarse	Hard	Foliated	Dark	Mostly hornblende	Amphibolite
Coarse	Hard	Foliated	Mixed	Distored "metled" layer	Migmatite

Viva Quations :-

1. What is Rock?
2. Properties of Rocks.
3. What is the Classification of Rocks?

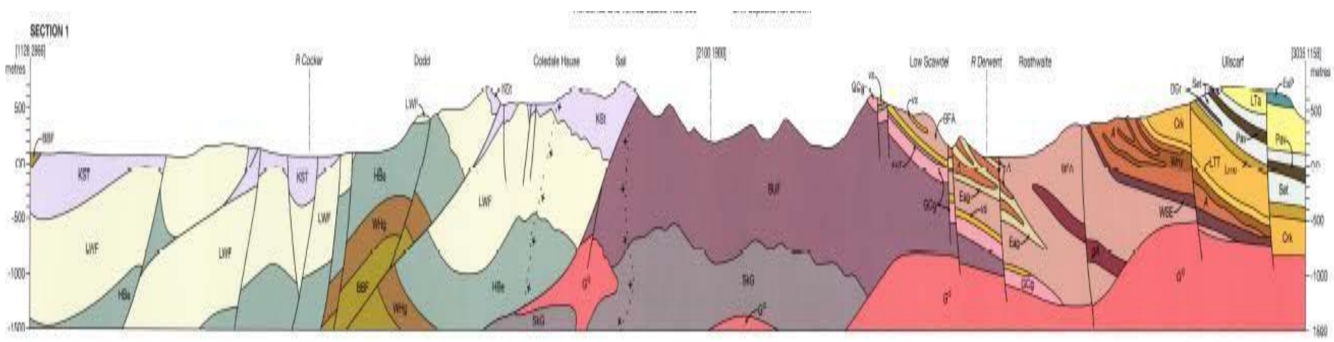
UNIVERSITY OF ENGINEERING AND MANAGEMENT, JAIPUR

Lab Manual

EXPERIMENT:-6

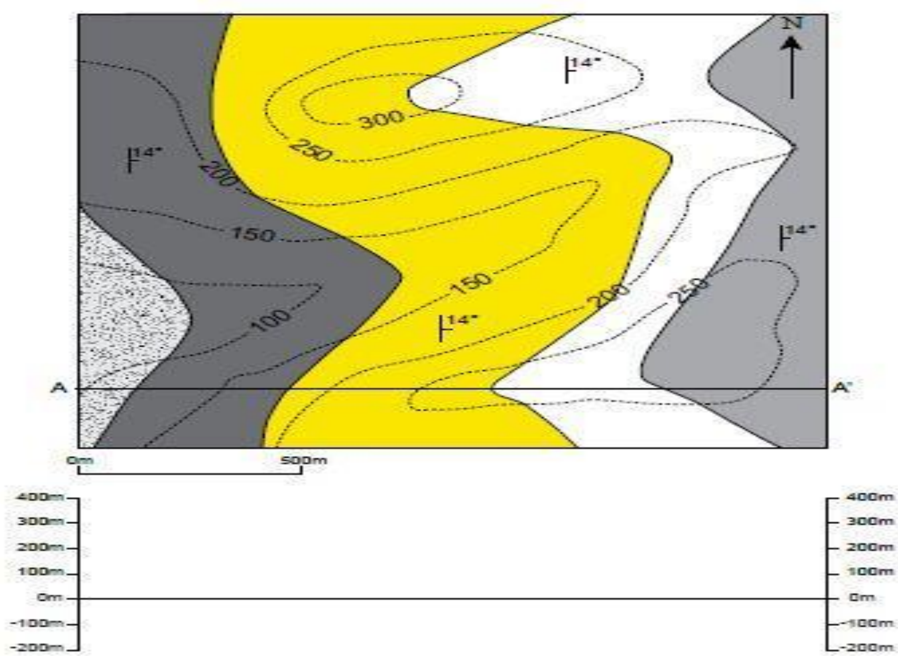
Objective:-Study of Geological map, interpretation of geological structures.

Theory:-A cross section should be consistent with all the available data, although there are often several viable interpretations of the same data. Most cross sections are drawn to true scale, that is, where the horizontal scale is the same as the vertical scale. This means the true dip of the rock units are shown. Vertical exaggeration, where the vertical scale is increased relative to the horizontal, is sometimes used to make a cross section clearer. However, it also increases the dips of the rock units exaggerating the geological structures.



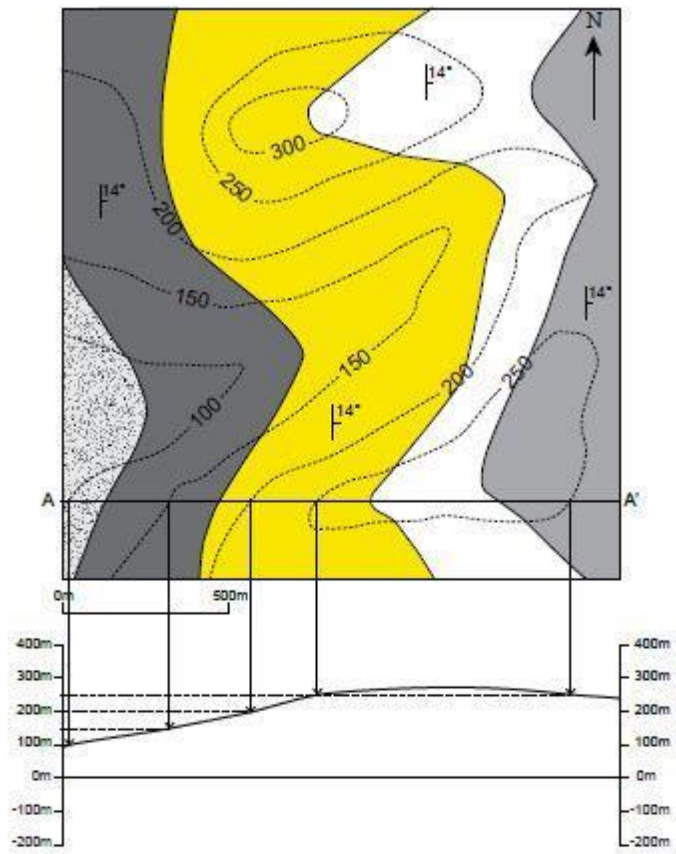
Procedure:-

Step 1: Determine the line along which to draw the section. The line of section should be representative of the study area, be perpendicular to the major structural feature of the area (e.g. large scale folds or faults), cross as many structural features as possible and run through areas with the most data readings.



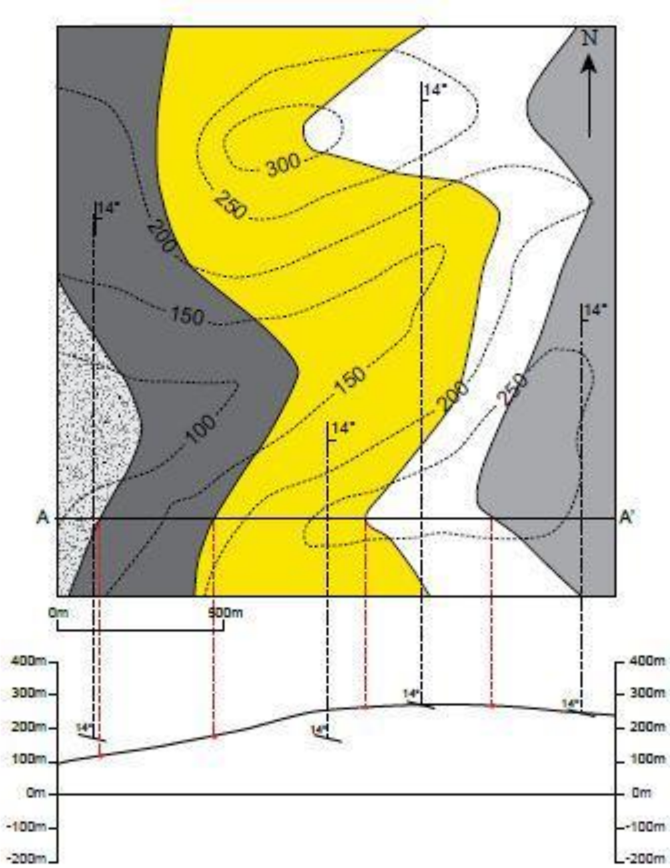
Step 2:
Draw axes of an appropriate scale with theopographic values. Unless there is a reason todo otherwise, draw a true-scale section.

Step 3:
Transfer the topographic information from the map to the section. Project the height of each topographic contour, where it crosses the line of section, on to the section and draw in
The topography.



Step 4:
Transfer the lithological boundaries, faults etc onto the cross section in the same way.

Step 5:
Transfer bedding readings on to the section, correcting for apparent dip if necessary (see figure). Plot the readings at the height at which they occur, so where a reading is extrapolated from a greater or lesser height than the topography of the cross section plot it above or below the topography as appropriate.



Step 6:

Using the bedding readings as a guide, draw in the lithological boundaries both above and below the surface. Geology extended above the topography is shown by dashed lines.
When drawing the section always consider what is geologically reasonable behavior for the Layers e.g. sudden changes in a unit's thickness or dip should be justifiable.

Theory:-If the Earth's surface was flat, if there was no topography, then geological maps would be simple. They would be a direct reflection of the underlying geology. However, topography interacts with the geology to produce more complex but predictable patterns.

Horizontal and vertical strata:

Horizontal and vertical strata are the most straight forward to interpret on a map. Horizontal outcrops will always follow the topographic contours (figure 2a), whilst vertical layers will always form straight lines (figure2b).

Dipping strata

Dipping layers interact with the topography in predictable ways. In valleys, beds will appear to 'vee' either up or down the valley in the direction of dip (figure 2c and 2d). This is because the valley side acts as an approximate cross section–not always helpful on small scale maps but on large scale maps and in the field this is a useful aid in interpretation.

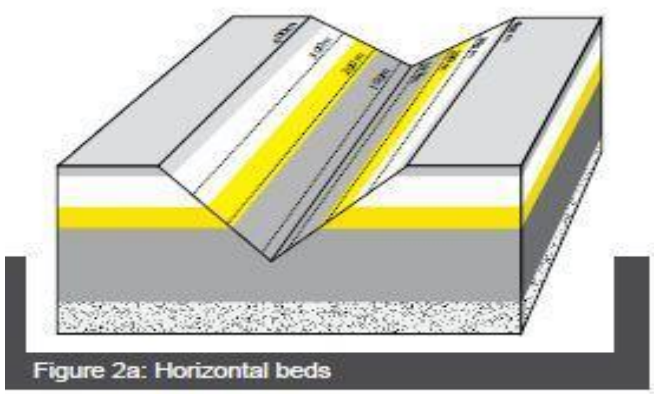


Figure 2a: Horizontal beds

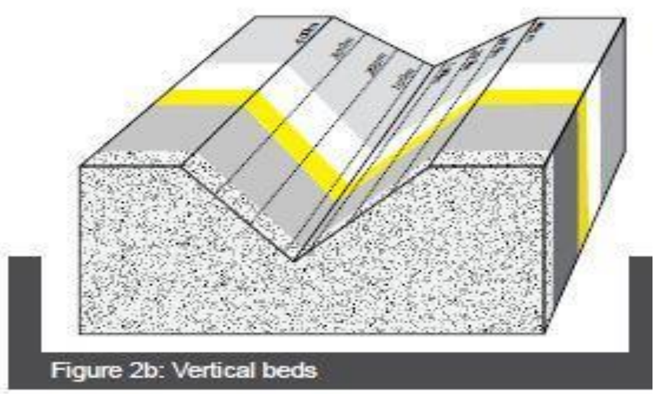


Figure 2b: Vertical beds

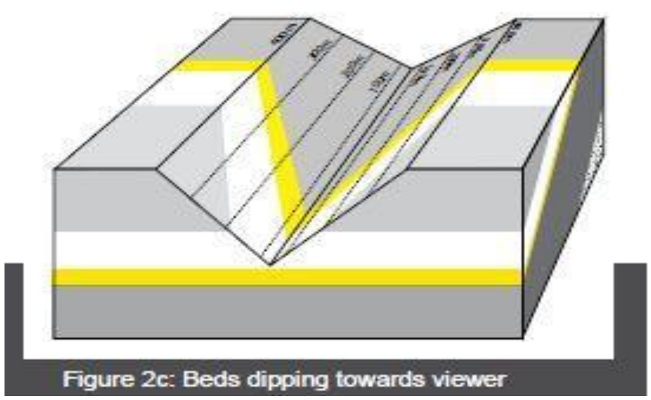


Figure 2c: Beds dipping towards viewer

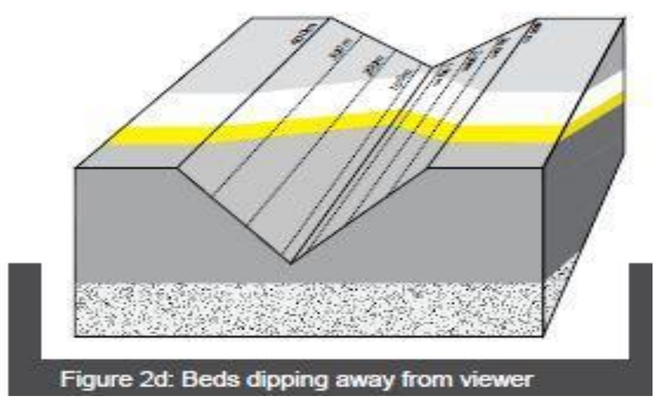


Figure 2d: Beds dipping away from viewer

A. Folding of rocks

a. Layer cake relations

(1) Oldest on bottom, youngest on top

b. Fold Types

(1) Anticlines-upfolded forms, results in older rocks becoming enclosed within younger strata

(2) synclines-downfolded forms, results in younger rocks becoming enclosed within older strata.

(3) Symmetrical folds- both limbs of the fold dipping at same angle away from fold axis

(4) Asymmetrical folds- both limbs of the fold not dipping at same angle away from fold axis

(5) Overturned folds- condition in which one limb of fold has been tilted beyond vertical

(6) Plunging folds- axis of fold is tilted

(7) Domes- more or less circular equivalent of anticline, oldest rocks exposed in center of dome

(8) Structural Basin- more or less circular equivalent of syncline, youngest rocks exposed in center of dome (not to be confused with depositional basin)

c. Outcrops Patterns Associated with Folded Rocks

(1) As rocks are folded, and subsequently subjected to erosion, regular patterns become evident in relation to type of rock that outcrops and age of the rock that outcrops in an area of folded strata. In essence, erosion exposes the interiors of the folds

(2) Non-plunging Folds- axis of fold is horizontal, results in parallel bands of dipping strata about the fold axis

(a) anticlines- oldest strata exposed along fold axis

(b) synclines- youngest strata exposed along fold axis

(3)Plunging Folds-axis of fold is tilted, results in alternating V-shaped bands of dipping strata oriented about the fold axis.

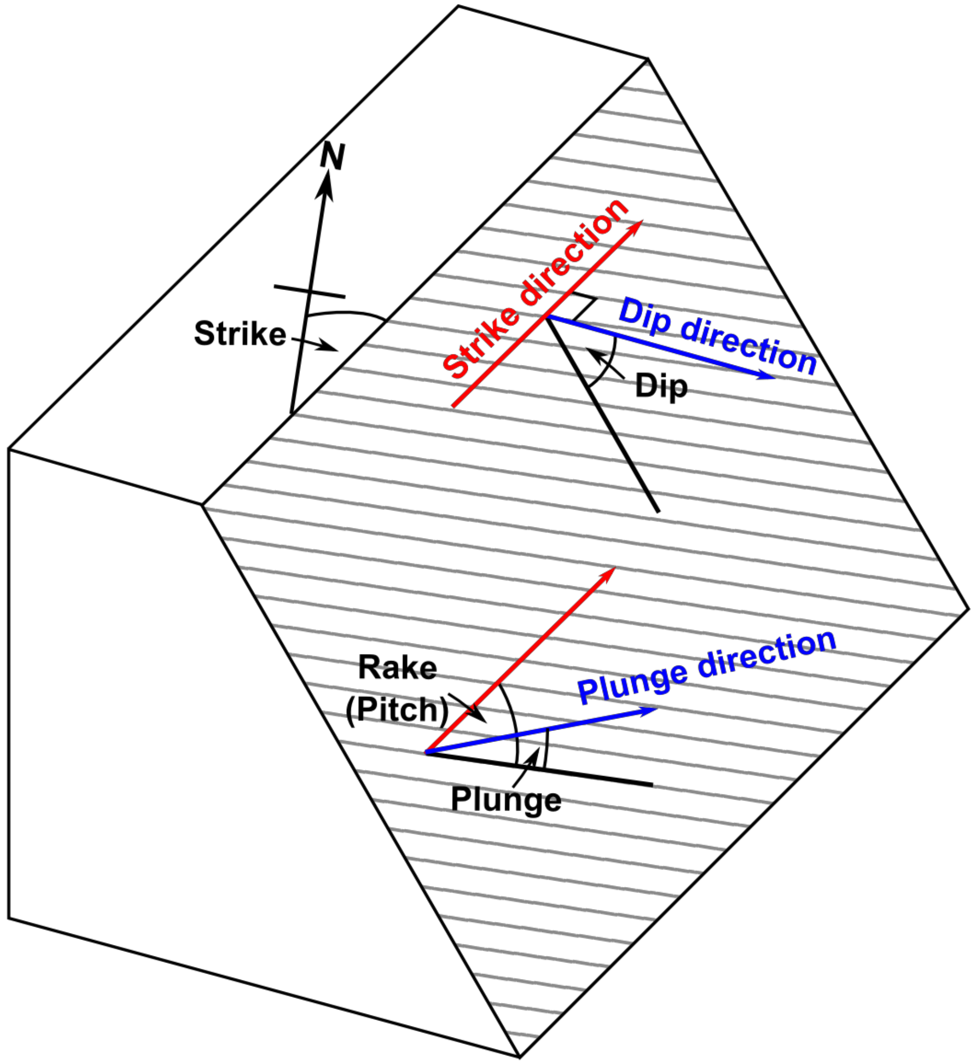
(a) anticlines- oldest strata exposed in the center of the V, V points in direction of plunge of fold axis

(b) syncline- youngest strata exposed in the center of the V, V points in opposite direction of plunge of fold axis.

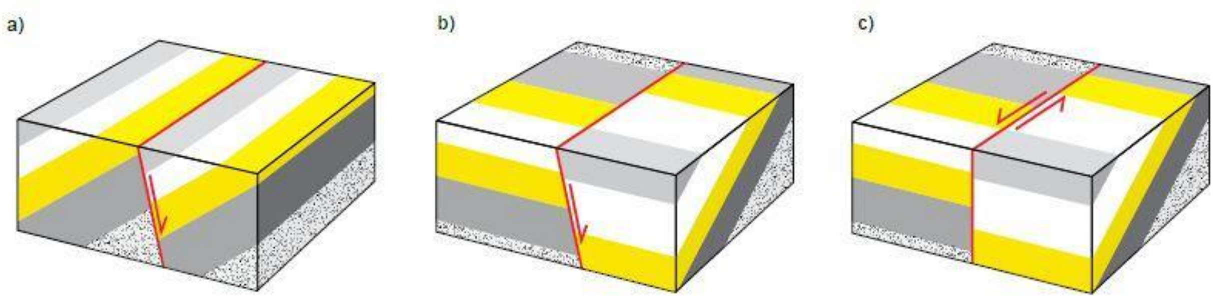
(4) Doubly Plunging Folds- fold axis is plunging in two opposite directions, results in a flattened oval pattern, or a double V-shaped pattern <<<>>>>.

(a) anticlines- oldest strata exposed in center of flattened oval

(b) synclines-youngest strata exposed in center of flattened oval.



Faults on maps:-Faults can occur at any angle with respect to bedding and so the outcrop patterns produced are not unique to any one fault type. Figure **a** and **b** show two potential outcrop patterns for a normal fault.



Fold on maps: - Figure shows the different outcrop patterns for folds. The limbs of the folds form a repeating pattern on either side of the axial plane. For anticlines, the oldest rocks are in core of the fold and the rocks get younger away from the axial trace (figure a). For synclines, the youngest rocks are in the core and the rocks get older away from the axial trace (figure b).

Plunging folds form the same repeating pattern as non-plunging folds, except their limbs converge around the axial traces. The limbs of synclines open in the direction they plunge (figure c); whilst the limbs of anticlines close in the direction they plunge (figure d).

Viva Questions:-

1. What do you mean by Geological Map?
2. What are lithological boundaries?
3. What do you mean by Scale?
4. What is Fault?
5. What is Fold?
6. What do you mean by Syncline and anticyline?