NEHRU COLLEGE OF ENGINEERING AND RESEARCH CENTRE
(NAAC Accredited)
(Approved by AICTE, Affiliated to APJ Abdul Kalam Technological University, Kerala)

DEPARTMENT OF MECHATRONICS ENGINEERING

COURSE MATERIALS

CE 100 BASICS OF CIVIL ENGINEEERING

VISION OF THE INSTITUTION

To mould true citizens who are millennium leaders and catalysts of change through excellence in education.

MISSION OF THE INSTITUTION

NCERC is committed to transform itself into a center of excellence in Learning and Research in Engineering and Frontier Technology and to impart quality education to mould technically competent citizens with moral integrity, social commitment and ethical values.

We intend to facilitate our students to assimilate the latest technological know-how and to imbibe discipline, culture and spiritually, and to mould them in to technological giants, dedicated research scientists and intellectual leaders of the country who can spread the beams of light and happiness among the poor and the underprivileged.

ABOUT DEPARTMENT

- Established in: 2013
- Course offered: B.Tech Mechatronics Engineering
- Approved by AICTE New Delhi and Accredited by NAAC
- Affiliated to the University of Dr. A P J Abdul Kalam Technological University.

DEPARTMENT VISION

To develop professionally ethical and socially responsible Mechatronics engineers to serve the humanity through quality professional education.

DEPARTMENT MISSION

1) The department is committed to impart the right blend of knowledge and quality education to create professionally ethical and socially responsible graduates.

2) The department is committed to impart the awareness to meet the current challenges in technology.

3) Establish state-of-the-art laboratories to promote practical knowledge of mechatronics to meet the needs of the society

PROGRAMME EDUCATIONAL OBJECTIVES

I. Graduates shall have the ability to work in multidisciplinary environment with good professional and commitment.

II. Graduates shall have the ability to solve the complex engineering problems by applying electrical, mechanical, electronics and computer knowledge and engage in lifelong learning in their profession.

III. Graduates shall have the ability to lead and contribute in a team with entrepreneur skills, professional, social and ethical responsibilities.

IV. Graduates shall have ability to acquire scientific and engineering fundamentals necessary for higher studies and research.

PROGRAM OUTCOME (PO'S)

Engineering Graduates will be able to:

PO 1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write

effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOME(PSO'S)

PSO 1: Design and develop Mechatronics systems to solve the complex engineering problem by integrating electronics, mechanical and control systems.

PSO 2: Apply the engineering knowledge to conduct investigations of complex engineering problem related to instrumentation, control, automation, robotics and provide solutions.

COURSE OUTCOME

After the completion of the course the student will be able to

COURSE OUTCOMES	
CO1	To understand the role of civil engineering in building the nation.
CO2	To able to understand the various building practices.
CO3	To familiarize the instruments and various methods of surveying.
CO4	To acquire knowledge about properties of various constructional materials.
CO5	To acquaint the students with techniques in building construction
CO6	To develop the knowledge in basic infra structural services.

CO VS PO'S MAPPING

CO Vs PO														
SUBJECT														
COURSE COUTCOME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C108.1	3	-	3	-	-	3	3	2	-	-	-	-	-	-
C108.2	3	3	3	-	-	3	2	3	-	-	-	-	-	-
C108.3	3	3	0	-	3	3	2	2	-	-	-	-	-	-
C108.4	3	-	0	-	2	3	2	2	-	-	-	-	-	-
C108.5	3	-	2	-	2	3	2	3	-	-	-	-	-	-
C108.6	3	-	2	-	-	3	2	2	-	-	-	-	-	-
C108	3	3	2.5	0	2.33	3	2.16	2.33	-	-	-	-	-	-
ATTAINMENT	3.00	3.00	2.50	0.00	2.33	3.00	2.16	2.33	0.00	0.00	0.00	0.00	0.00	0.00

Note: H-Highly correlated=3, M-Medium correlated=2, L-Less correlated=1

SYLLABUS

CE100	BASICS OF CIVIL ENGINEERING	2-1-0-3	2015

Course Objectives

1. To inculcate the essentials of Civil Engineering field to the students of all branches of Engineering.
2. To provide the students an illustration of the significance of the Civil Engineering Profession in satisfying societal needs.

Syllabus

General introduction to Civil Engineering - Introduction to types of buildings, Components of a residential building, Introduction to industrial buildings; Introduction to planning of residential buildings - Simple building plans; Introduction to the various building area terms; Setting out of a building; Surveying – Principles, Objectives, Horizontal measurements with tapes, Ranging; Levelling – Instruments, Reduction of levels; Modern surveying instruments; Building materials – Bricks, cement blocks, Cement, Cement mortar, Steel; Building construction – Foundations, Brick masonry, Roofs, Floors, Decorative finishes, Plastering, Paints and Painting; Basic infrastructure and services – Elevators, Escalators, Ramps, Air conditioning, Sound proofing, Towers, Chimneys, Water Tanks; Intelligent buildings.

Expected outcome

1. The students will be able to illustrate the fundamental aspects of Civil Engineering.
2. The students will be able to plan and set out a building.
3. Students will be able to explain the concepts of surveying for making horizontal and vertical measurements.
4. They will able to illustrate the uses of various building materials and explain the method of construction of different components of a building.
5. Students will be able to discuss about various services in a building.

References Books:

- Chudley, R., Construction Technology, Vol. I to IV, Longman Group, England
- Chudley, R. and Greeno, R., Building Construction Handbook, Addison Wesley, Longman Group, England
- Gopi, S., Basic Civil Engineering, Pearson Publishers
- Kandya, A. A., Elements of Civil Engineering, Charotar Publishing house

Course Plan			
Module	**Contents**	**Hours**	**Sem. Exam Marks**
I	General Introduction to Civil Engineering - Various disciplines of Civil engineering, Relevance of Civil engineering in the overall infrastructural development of the country.	2	15%
	Introduction to types of buildings as per NBC; Selection of site for buildings.	2	
	Components of a residential building and their functions. Introduction to industrial buildings – office / factory / software development office / power house /electronic equipment service centre (any one related to the branch of study)	2	
	Students have to visit one such building and submit an assignment about the features of any one of the listed building related to their branch (Not included for exam).	1	
II	Building planning - Introduction to planning of residential buildings- Site plan, Orientation of a building, Open space requirements, Position of doors and windows, Size of rooms; Preparation of a scaled sketch of the plan of a single storeyed residential building in a given site plan.	4	15%
	Introduction to the various building area terms - Computation of plinth area / built up area, Floor area / carpet area - for a simple single storeyed building; Setting out of a building.	3	
FIRST INTERNAL EXAM			
III	Surveying - Principles and objectives of surveying;	1	15%
	Horizontal measurements – instruments used – tape, types of tapes; Ranging (direct ranging only) – instruments used for ranging.	3	
	Levelling - Definitions, principles, Instruments (brief discussion only) - Level field book - Reduction of levels - problems on levelling (height of collimation only).	3	
	Modern surveying instruments – Electronic distance meter, digital level, total station, GPS (Brief discussion only).	1	
IV	Building materials - Bricks, cement blocks - Properties and specifications.	2	15%

	Cement – OPC, properties, grades; other types of cement and its uses (in brief).	1	
	Cement mortar – constituents, preparation.	1	
	Concrete – PCC and RCC – grades.	1	
	Steel - Use of steel in building construction, types and market forms.	1	
SECOND INTERNAL EXAM			
V	Building construction – Foundations; Bearing capacity of soil (definition only); Functions of foundations, Types - shallow and deep (sketches only).	2	
	Brick masonry – header and stretcher bond, English bonds – Elevation and plan (one brick thick walls only).	2	
	Roofs – functions, types, roofing materials (brief discussion only).	1	20%
	Floors – functions, types; flooring materials (brief discussion only).	1	
	Decorative finishes – Plastering – Purpose, procedure.	1	
	Paints and Painting – Purpose, types, preparation of surfaces for painting (brief discussion only).	2	
VI	Basic infrastructure and services - Elevators, escalators, ramps, air conditioning, sound proofing (Civil engineering aspects only)	2	20%
	Towers, Chimneys, Water tanks (brief discussion only).	1	
	Concept of intelligent buildings.	2	
END SEMESTER EXAM			

QUESTION BANK

AND

PREVIOUS YEAR SOLVED QUESTION PAPERS

PAPER 1

Reg. No:_____ Name:_____

FIRST SEMESTER B.TECH DEGREE EXAMINATION, MODEL QUESTION

Course Code: CE100

Course Name: BASICS OF CIVIL ENGINEERING

Max. Marks: 100 Duration: 3 Hours

Part A

Answer all questions. Each question carries 3 Marks.

1. Mention the factors to be considered in the selection of site for a residence.
2. Explain (i) floor area ratio (ii) Plinth area (iii) carpet area
3. What are the principles of surveying?
4. How tor steel is different from ordinary steel?
5. Define the bearing capacity of soil.
6. Distinguish between Shallow and deep foundations with sketches.
7. Explain the roofing materials generally used for buildings.
8. What is the necessity of understanding basic concepts of green buildings and intelligent buildings?
9. What are the advantages of an escalator?
10. What is a lift, how it differs from escalator?

Part B

Answer any 8 questions. Each question carries 6 Marks

11. Explain the types of buildings as per NBC.
12. Discuss the relevance of civil engineering in the infrastructure development of the country.
13. What is a site plan? Enlist the details that are to be included in it.
14. Explain the open space requirements necessary for lighting and ventilation as per Kerala Municipal Building Rules 1999.
15. Mention the procedure for setting out a building using tape and cross staff.

16. Give a brief note on; (i) Electronic distance meter (ii) digital level (iii) total station (iv) GPS
17. The following staff readings were taken successively with a level, the instrument being shifted after third, sixth and eighth readings:-

    1.235, 2.140, 0.785, 2.135, 2.845, 1.375, 0.625, 1.978, 2.312, 2.517

    Enter the above reading in a page of a level book and find the RL of points if the first reading was taken with a staff held on a bench mark of 415.374m. Apply necessary arithmetic checks.
18. (i) State the composition of brick earth to make good quality bricks?

    (ii) What are the qualities of good bricks?
19. Differentiate PCC and RCC.
20. (i) Explain the IS specification of ordinary Portland cement.

    (ii) Give a brief note on other types of cement and its uses.

Part C

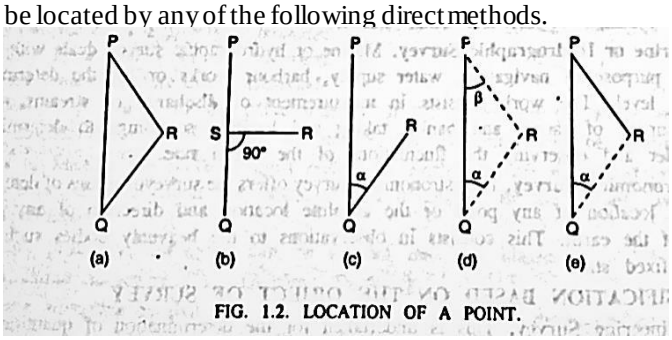
Answer any 2 questions. Each question carries 11 Marks

21. (a) (i) Distinguish between header and stretcher bond?

    (ii) Explain English bond in brick masonry (with elevation and plan of 1 brick thick wall)

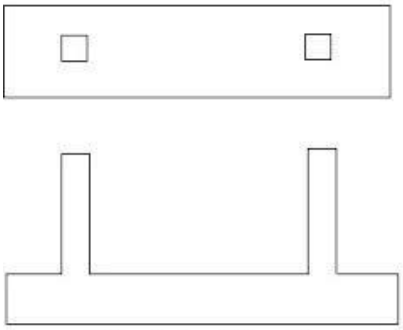
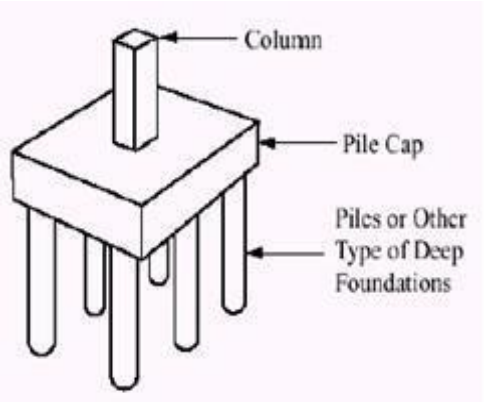
21. (b) List the functions of foundations. Draw diagrams of any four types of foundations.
22. (a) List the different types of sloping roof. Explain any two with neat sketches. Also state the advantages of flat roof over sloping roof
22. (b) Write short notes on the following :

    i. Towers
    ii. Chimneys
    iii. Water tanks
23. (a) Explain the working of Elevator and the speed specification of lift in different occupancies.
23. (b) Explain the functions and also list out the different methods and materials used for sound proofing.

Part	Qn. No	Mod. No	CE 100 BASICS OF CIVIL ENGINEERING-ANSWER KEY	Marks
A	**Answer ALL Questions**			
	1	1	• Natural resources –water table at the site should not be high • Safe bearing capacity of soil • Availability of amenities • Location of plot • Drainage facilities in the site • Shape of the plot	3
	2	2	Floor Area Ratio (FAR):- The total floor area means total built up area in all floors including parking area. The ratio of total floor area on all floors to plot area is FAR Plinth area is the built up covered of a building at floor level at any storey. Plinth area is calculated by taking the external dimensions of the building at the floor level excluding plinth offset, if any courtyards, open areas, balconies, cantilever projections are not included in plinth area. Supported porches (other than cantilevered) are included in the plinth area. Carpet area is the useable or liveable area of a building. This is the total floor area minus the circulation area. verandas, corridors, passages, staircase, lifts, entrance, etc. and minus other non-useable area as sanitary accommodations (Baths and W.Cs), air conditioning rooms, etc. For office building, carpet area is the useable area and for residential building carpet area is the liveable area and should exclude the kitchen, pantry, and similar other rooms which are not used for living purposes.	1 1 1
	3	3	The fundamental principles upon which the various methods of plane surveying are based are of very simple nature and can be stated under the following two aspects; (1) Location of a point by measurement from t w o points of reference. The relative positions of the points to be surveyed should be located by measurement from points of reference, the positions of which have already been fixed. Let P and Q Be the reference points on the ground. The distance PQ can be measured accurately and the relative positions of P and Q can be plotted on the sheet to some scale. The points P and Q will thus serve as reference points for fixing the relative positions of other points. Any other point, such as R, can be located by any of the following direct methods.  FIG. 1.2. LOCATION OF A POINT. (a) Distances PR and QR can be measured and point R can be plotted by swinging the two arcs to the same scale to which PQ has been plotted. The principle is very much used in chain surveying.	1.5

			(b) A perpendicular RS can be dropped on the reference line PQ and lengths PS and SR are measured. The point R can then be plotted using set square. This principle is used for defining details. (c) 11e distance QR and the angle PQR can be measured and point R is plotted either by means of a protractor or trigonometrically. This principleis used in traversing. (d) In this method, the distances PR and QR are not measured but angle RPQ and angle RQP are measured with an angle-measuring instrument. Knowing the distance PQ, point R is plotted either by means of a protractor or by solution of triangle PQR. Thisprinciple is very much used triangulation anti the method is used for very extensive work. (e) Angle RQP and distance PR are measured and point R is plotted either by protracting an angle and swinging an arc from P or plotted trigonometrically. This principle, used in traversing, is of minor utility. Fig (b), (c) and (d) can also be used to illustrate the principles of determining relative elevations of points, Considering these diagrams to be in vertical plane, with PQ Horizontal. Fig (b) represents the principle of ordinary spirit levelling. A horizontal line PQ is instrumentally established through P and the vertical height of R i6 measured taking staff reading. Similarly, Fig (c) arid (d) represent the principles of trigonometrical levelling. (2) Working from whole to part The second ruling principle of surveying, whether plane or geodetic, is to work from whole to part. It is very essential to establish first a system of control points and to fix them with higher precision. Minor control points can then be established by less precise methods and the details can then be located using these minor control points by running minor traverses etc. The idea of working in this way is to prevent the accumulation of errors and to control and localise minor errors which, otherwise, would expand to greater magnitudes if the reverse process is followed, thus making the work uncontrollable at the end.	1.5
	4	4	The most commonly used steel bar for concrete reinforcement is TOR steel. It has greater yield and bond strength. It can be possibly bent through 180 degrees without the formation of any cracks. It is hyper resistance and has got easy weld ability. It is suitable for tension as well as compression. It does not need end hooks and thus it is cost effective than other steel.	3
	5	5	The soil supporting a building must be strong enough to carry the super imposed load. After the preliminary and detailed investigation of the type of soil, depth of bed rock, elevation of ground water etc. The next step is to select a suitable foundation to be used for the building. The depth to which foundation is to be taken and its bottom dimension so that it can safely transmit the load from building to under lying soil without any failure or significant settlement. For the determination of this, knowledge of the safe allowable pressure on the soil is necessary. The ability of the soil to support the super imposed load without excessive settlement or failure is called	3

			Bearing capacity of soil. Dimension of foundation should be such that it can safely transmit the load from building to the soil without any failure or significant settlement. The gross pressure intensity at which the soil fails is called Ultimate bearing capacity. Safe bearing capacity: It is the maximum pressure which the soil can carry without the risk of shear failure. $$\text{Safe bearing capacity} = \frac{\text{Ultimate bearing capacity}}{\text{Factor of Safety}}$$ Usually adopted factor of safety is 2 to 3. Safe bearing capacity is used for the design of foundation and up to this load there is no settlement for the soil. Allowable bearing capacity is the maximum allowable net load intensity that can be applied to soil.	
	6	5	A foundation is that part of a structure which transmits the weight of the structure to the ground. A structure constructed on land is supported on foundations. A foundation is, therefore, a connecting link between the structure proper and the ground which supports it. A foundation is required for distributing the loads of the superstructure on a large area. The foundation should be designed such that (1) the soil below docs not tail in shear and (2) the settlement is within the safe limits. Foundations may be broadly classified into two categories: (1) Shallow foundations, (2) Deep Foundations.	1.5
			A shallow foundation transmits the loads to thee strata at a shallow depth. A deep foundation transmits the load at considerable depth below the ground surface. The distinction between a shallow foundation and a deep foundation is generally made according to Terzaghi's criterion. According to which a foundation is termed shallow if it is laid at a depth equal to or less than its width. Spread or shallow foundation In this type of foundation the load is spread over a large area and thus the intensity of load transmitted to the soil is less than its allowable bearing capacity. Raft or mat foundation and stepped foundation are common shallow foundation. When the soil at or near be ground surface is not capable of supporting a structure, deep foundations are required to transfer the loads to deeper strata. Deep foundations are therefore used when surface soil is unsuitable for shallow foundation. And a firm stratum is so deep that it cannot breached economically by shallow foundations. The most common types of deep foundations are piles, pies and caissons. The mechanism of transfer of the load to the soil is essentially the same in all types of deep foundations. A deep foundation is generally much more expensive than a shallow foundation. It should be adopted only when a shallow foundation is not feasible. In certain situation a fully compensated floating raft may be more economical than a deep foundation	1.5

			 Combined Footing 	
	7	5	Different materials used for covering the roof are thatch, country tiles, patented tiles and different types of sheets. Sheets made up of various materials are suitable for steel trusses. Types of sheets are : 1. Asbestos cement sheets (A. C sheets): Widely used sheets for industrial building, factories, cinema halls, auditoriums etc. A. C sheets are manufactured from asbestos, which is a silky fibrous material, found in veins of metamorphized volcanic rocks. These sheets are available in three forms namely corrugated sheets, semi corrugated sheets, plain sheets. They are 1. Light in weight and durable 2. Water tight, fire and termite resistant. 3. Less maintenance 4. Available in larger sizes. Galvanized iron corrugated (G. I) streets: Stronger than A. C sheets. These are iron sheets galvanized with zinc to prevent rusting. Trough they are costly, they are light in weight, water proof, with better impact and fire resistance. But these sheets are not suitable for flat roofs. Aluminium sheets : These are long lasting, economical than PVC, steel and cement sheets and make inside atmosphere cool. Its most important advantage is that it is corrosion free. It is eco-friendly and requires almost zero maintenance. Light in weight, with better appearance and has very good scrap value. These are used for sheds, industrial buildings and temporary construction.	3/4 3/4

			FRP sheets (Fibre glass sheets) :Fibre Reinforced Polymer (FRP) sheets are made with glass or any suitable fibre with a suitable resin. It is popularly known as fibre glass sheets. Available in different colour and shapes. Its advantages are : 1. Light weight 2. Durable 3. No warping or wilting 4. Non-corrosive 5. High thermal insulation 6. Highly flexible Powder coated sheets: To increase life and for improved appearance, conventional GI and aluminium sheets are enhanced by applying powder coating on the surface. i. Powder coated GI sheets: Coated with different coloured epoxy resins. They minimises rusting of GI sheets and has excellent mechanical properties along with excellent chemical resistance. ii. Powder coated aluminium sheets: Coated with epoxy resins. It improves life and appearance.	3/4 3/4
	8	6	A green building is one which uses less water, optimises energy efficiency, conserves natural resources, generates less water and provides healthier spaces for occupants, as compared to a conventional building. Green buildings have a new approach to save water, energy and material resources in the construction and maintenance of the buildings and can reduce or eliminate the adverse impact of buildings on the environment and occupants. Green buildings are eco-friendly structures. This helps the earth and people to retain nature to a maximum extent possible. An intelligent building is one in which the building fabric, space, services and information systems can respond in an efficient manner to the initial and changing demands of the owner, the occupier and be in harmony with the environment. An intelligent building system concept considers that the true cost of the building is not its cost of construction, it must include the operating and maintenance costs over its life span. Intelligent buildings yields cost reductions over all these areas by optimizing energy use through automated control, communication and management systems. So it is necessary to understand the basic concepts of green building and intelligent building.	1.5 1.5
	9	6	Escalators, or powered stairs, are used when it is necessary to move large numbers of people from floor to floor. They provide continuous movement of persons and can thus remedy traffic conditions that are not readily addressed by elevators. Escalators are preferred transportation systems whenever heavy traffic volumes are expected between relatively few floors. Escalators are used to connect airport terminals, parking garages, sports facilities, shopping malls, convention centres, hotels, public buildings and numerous mixed-use facilities. Although escalators generally are used in	3

			straight sections, spiral escalators also are available. The benefits of escalators are: they have the capacity to move large numbers of people, and they can be placed in the same physical space as one might install a staircase. They have no waiting interval; they can be used to guide people toward main exits or special exhibits.	
	10	6	Lift is an appliance designed to transport persons or materials between two or more levels in vertical or substantially vertical direction by means of guided car or platform, whereas escalators are moving stairs which provide continuous movement of persons from floor to floor. Elevators are used in buildings having more than three storeys. Elevators have passenger capacity according to the model whereas escalators have no such passenger capacity criteria.	3
B	**Answer any 8 Questions**			
	11	1	Group A : Residential Buildings These shall include any building in which sleeping accommodation is provided for normal residential purposes, with or without cooking or dining or both facilities, except any building classified under Group C. Residential types of building are further sub divided as per following 1. A-1 Lodging or rooming houses 2. A-2 One-or two-family private dwellings 3. A-3 Dormitories 4. A-4 Apartment houses (flats) 5. A-5 Hotels Group B : Educational Buildings These shall include any building used for school, college or day-care purposes involving assembly for instruction, education or recreation and which is not covered by Group D. Group C : Institutional Buildings These shall include any building or part thereof, which is used for purposes, such as medical or other treatment or care of persons suffering from physical or mental illness, disease or infirmity; care of infants, convalescents or aged persons and for penal or correctional detention in which the liberty of the inmates is restricted. Institutional buildings ordinarily provide sleeping accommodation for the occupants. Institutional types of building are further sub divided as per following 1. C-1 Hospitals and sanatoria 2. C-2 Custodial institutions 3. C-3 Penal and mental institutions Group D : Assembly Buildings These shall include any building or part of a building, where groups of people congregate or gather for amusement, recreation, social, religious, patriotic, civil, travel and similar purposes, for example, theatres, motion picture houses, assembly halls, auditoria, exhibition halls, museums, skating rinks, gymnasiums, restaurants, places of worship, dance halls, club	1.5

			rooms, passenger stations and terminals of air, surface and marine public transportation services, recreation piers and stadia, etc. Assembly types of building are further sub divided as per following 1. D-1 Buildings having a theatrical stage and fixed seats for over 1000 persons 2. D-2 Buildings having a theatrical stage and fixed seats for less than 1000 persons 3. D-3 Buildings without a stage having accommodation for 300 or more persons but no permanent seating arrangement 4. D-4 Buildings without a stage having accommodation for less than 300 persons 5. D-5 All other structures designed for assembly of people not covered by subdivisions D-1 -to D-4 Group E : Business Buildings These shall include any building or part of a building which is used for transaction of business (other than that covered by Group F and parts of buildings covered by 3.1.1); for keeping of accounts and records and similar purposes, professional establishments, service facilities, etc. city halls, town halls, court houses and libraries shall be classified in this group so far as the principal function of these is transaction of public business and keeping of books and records Business types of building are further sub divided as per following 1. E-1 Offices, banks, professional establishments, like offices of architects, engineers, doctors, lawyers, etc. 2. E-2 Laboratories, research establishments and test houses. 3. E-3 Computer installations. Group F : Mercantile Buildings These shall include any building or part of a building, which is used as shops, stores, market, for display and sale of merchandise, either wholesale or retail. Mercantile types of building are further sub divided as per following 1. F-1 Shops, stores, markets with area up to 500 m'. 2. F-2 Underground shopping centres, departmental stores with area more than 500 m2 Storage and service facilities incidental to the sale of merchandise and located in the same building shall be included under this group. Group G : Industrial Buildings These shall include any building or part of a building or structure, in which products or materials of all kinds and properties are fabricated, assembled, manufactured or processed, for example, assembly plants, laboratories, dry cleaning plants, power plants, pumping stations, smoke houses, laundries, gas plants, refineries: dairies and saw-mills.	1.5 1.5

			Industrial types of building are further sub divided as per following 1. G-1 Buildings used for low hazard industries 2. G-2 Buildings used for moderate hazard industries 3. G-3 Buildings used for high hazard industries. Group H : Storage Building These shall include any building or part of a building, used primarily for the storage or sheltering (including servicing, processing or repairs incidental to storage) of goods, wares or merchandise (except those that involve highly combustible or explosive products or materials), vehicles or animals, for example, warehouses,' cold storage, freight depots, transit sheds, storehouses, truck and marine terminals, garages, hangars (other than aircraft repair hangars), grain elevators, barns and stables. Storage properties are characterized by the presence of relatively small number of persons in proportion to the area, Any new use which increases the number of occupants to a figure comparable with other classes of occupancy shall change the classification of the building to that of the new use, for example, hangars used for assembly purposes, warehouses used for office purposes, garage buildings used for manufacturing. Group J : Hazardous Buildings These shall include any building or part of a building which is used for the storage, handling, manufacture or processing of highly combustible or explosive materials or products which are liable to burn with extreme rapidity and/or which may produce poisonous fumes or explosions; for storage, handling, manufacturing or processing which involve highly corrosive, toxic or noxious alkalis, acids or other liquids or chemicals producing flame, fumes and explosive, poisonous, irritant or corrosive gases; and for the storage, handling or processing of any material producing explosive mixtures of dust which result in the division of matter into tiny particles subject to spontaneous ignition.	1.5
	12	1	Infrastructure is the framework of supporting system consisting of transportation, communication, energy, lifeline facilities, irrigation facilities, etc., that help a community or a government to function, grow, and develop. Infrastructure development in any country contributes to the economic development of a particular nation. Higher the infrastructure facilities higher will be the growth prospects. A civil engineer has to conceive, plan, estimate, get approval, create and maintain all civil engineering infrastructure activities. Civil engineer has a very important role in the development of the following infrastructures, - Town and city planning - Build suitable structures for the rural and urban areas for various utilities. - Build tanks, dams to exploit water resources. - Purify the water and supply water to needy areas like houses, schools, offices and agriculture field - Provide good drainage system and purification plants	3 3

			- Provide and maintain communication systems like roads, railways, harbours and airports - Monitor land, water and air pollution and take measures to control them	
	13	2	The detailed sketch of the plot with the sketch of proposed building and necessary surrounding data is called a site plan. Site plan should be drawn to a scale not less than 1:1000 showing the following details 1. Boundaries of the plot with revenue survey particulars. 2. Position of site in relation the neighbouring streets with its main access. 3. Details of streets with name and width 4. All existing structures in the plot. 5. All existing streets and foot paths within the plot 6. Layout of streets adjoining, terminating at the site, existing, proposed to be widened or newly aligned 7. Proposed sub division of plot, if any 8. The access to each plot sub division 9. Details of undeveloped, not proposed to be developed and to be reclaimed area within the plot 10. Area and location of any paddy field and other agricultural land that are proposed to be converted. 11. North direction and predominant wind direction 12. Layout of proposed building 13. Topographic contours	2 2 2
	14	2	Exterior open spaces 1. Every building up to 10m in height shall have a minimum front yard of 3m depth. 2. Every building up to 10m in height shall have a minimum rear yard of 2m depth. 3. Every building up to 10m in height shall have an open air space of not less than 1.2m width on one side and not less than 1m on the other sides other than front and rear yards. 4. For buildings above 10m in height, 0.5m per increase of every 3m height is to be provided apart from minimum front, rear and side open spaces. Front open space – 3m + 0.5m per every additional height of 3m above 10m Rear open space – 2m + 0.5m per every additional height of 3m above 10m Side open space – 1.2m/1m + 0.5m per every additional height of 3m above 10m 5. For buildings above 4 storeys from ground level, a minimum open space of 5m is to be provided on any one side contiguous to front side. 6. For the building constructed on small plots, ie., plot area less than 125sq.m, the exterior open spaces as follows. Front yard depth – 1.8m	4

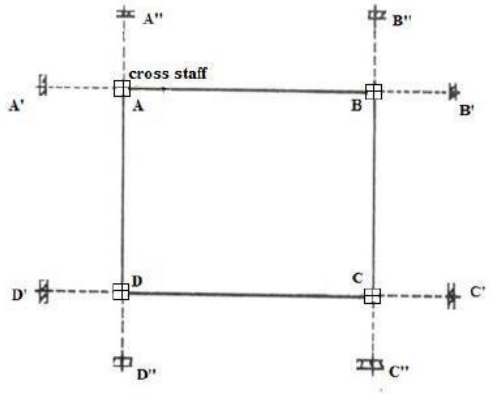
			Rear yard depth – 1.0m Side yard depth – 0.9m on one side and 0.6m on other side Interior open spaces 1. Any habitable room not abutting on front, rear or side open spaces, shall abut on an interior open space with a minimum width of 2.4m. 2. If the total height of the residential building is less than 7m, then the interior open space shall have 1.5m width.	2
	15	2	1. Calculate the center line lengths of the wall of the given single room building. 2. Establish a base line (length more than center line length) which is parallel to the boundary line by stretching a string between two wooden pegs driven at the ends A' and B'. 3. Drop a plumb bob to transfer the exact position of the first corner point A which is on the line A' B' and drive a peg at A. 4. From the point A measure the center line length along line A' B' and fix the exact position of the second corner point B. Drive a peg at point B. 5. To set the second line which is right angle to the first one, cross staff can be used. 6. Hold two ranging rods at A and B'. Fix a cross staff at point B. 7. Hold another two ranging rods in line so that one can see the ranging rods at A, B' and B", C" simultaneously. Mark the points and fix wooden pegs at these two new points. 8. From the point B measure the centre line length along line B" C" and fix the exact position of the third corner point C. Drive a peg at point C. 9. Repeat the steps to get the point D.  	4 2
	16	3	Electronic distance meter - Electronic distance meter is electronic equipment which is used to measure distances with the help of infrared rays. The distance is calculated from the time taken by the infrared beam to reach the target. For measuring the distances between two points, the instrument is set up at one point and a pole with a prism held at other point. EDM transmits an infrared beam and it reflects back to the instrument by reflector prism at the target. From the time taken by the infrared beam, the distance is calculated and displayed in EDM. Digital level - Digital level has the attributes of self-levelling instrumentation coupled with digital array photography and electronic	1.5

			image processing. The digital level is operated in conjunction with a special bar coded staff. This type of level has the same features as automatic levels, namely the eyepiece, the focussing knob, the compensator, the circular level bubble, tangent motion, the levelling screws and objective. This is in addition to the special features pertinent to it, ie., a built-in solid state "camera", a storage module, a microprocessor, a display register and a control panel. The procedure is to set up and level the instrument and focus it on the bar coded staff. When the appropriate button is pressed on the control panel, the image of the bar coded staff is captured and processed. It may take about 4 seconds. This processed image of the rod is compared with the image of the whole rod which is permanently stored in the machine, and the height values are determined. Total station - A total station is a combination of an electronic theodolite and an electronic distance meter. Using this combination it is possible to determine the coordinates of a reflector by aligning the instruments cross hair on the reflector and simultaneously measuring the vertical and horizontal angles and slope distances. Infrared radiations are used to measure the distances. The same telescope is used for observing angles and distance measurement. The infrared measuring beam coincides with line of sight of telescope. This is useful for applications where distances and angles are always required. Recording the readings and the necessary computations are done by a microprocessor inbuilt in total station. The data can be easily transferred to a computer where it can be used to generate a map showing the survey details. Global positioning system (GPS) – GPS is a US space based radio navigation system that provides reliable positioning, navigation and timing services to civilian users on a continuous worldwide basis. It is freely available to all. For anyone with a GPS receiver, the system will provide location and time. GPS provides accurate location and time information for an unlimited number of people in all weather, day and night, anywhere in the world. The GPS is made up of 3 parts: satellites orbiting the earth, control and monitoring stations on earth and the GPS receivers owned by users.	1.5 1.5 1.5

	17	3		6

Sl. No.	B.S. (m)	I.S. (m)	F.S. (m)	Height of the instrument H.I(m)	Reduced Level R.L (m)	Remarks
1	1.235			416.609	415.374	A (BM)
2		2.14		416.609	414.469	B
3	2.135		0.785	417.959	415.824	C (CP1)
4		2.845		417.959	415.114	D
5	0.625		1.375	417.209	416.584	E (CP2)
6	2.312		1.978	417.543	415.231	F (CP3)
7			2.517	-	415.026	G
∑ B.S =	6.307	∑ F.S =	6.655			

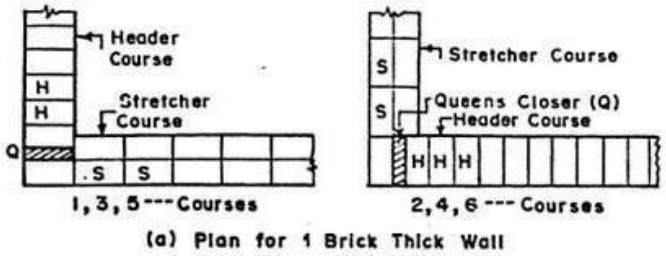
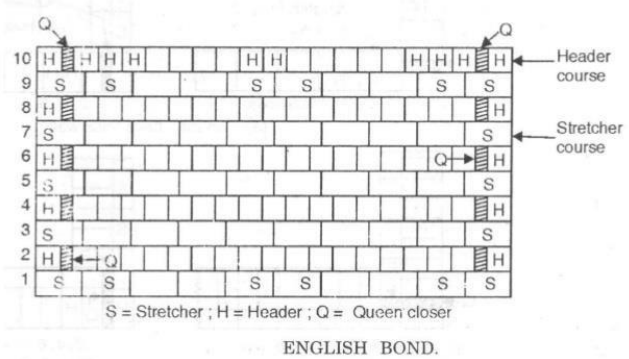
Arithmetic check:

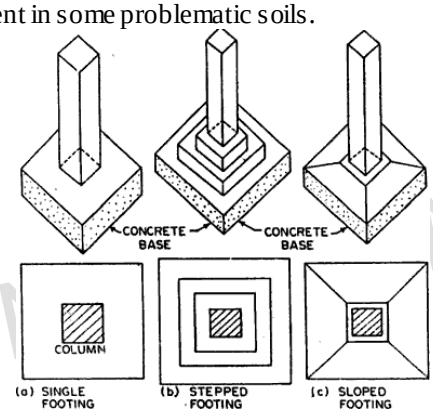
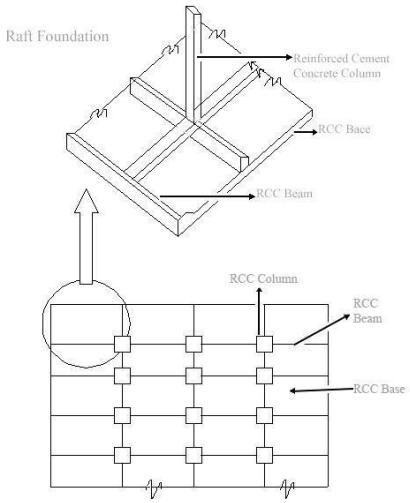
∑ B.S - ∑ F.S = 6.307 -6.655 = -0.348

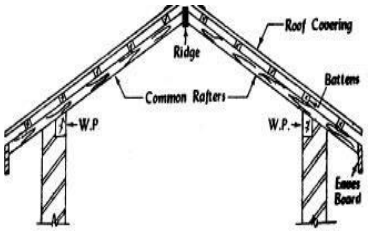
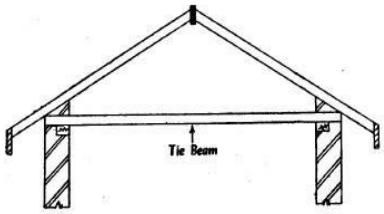
Last R.L. – First R.L. = 415.026-415.374 = -0.348
Hence verified

	18	4	(i) A good brick earth should contain clay and sand in such a way that when water is added, it can be easily moulded and dried without cracking or warping. The constituents of good brick earth are: 1. Alumina – A good brick earth should contain 20 to 30% of alumina. This constituent imparts plasticity to earth so that it can be moulded easily. If alumina is present in excess, raw bricks shrink and warp during drying and burning. 2. Silica - A good brick earth should contain 50 to 60% of silica. Presence of this constituent prevents cracking, shrinking and warping of raw bricks. It imparts uniform shape to bricks. If silica is in excess it makes the brick brittle. 3. Lime - A good brick earth should contain a small quantity of lime (<5%). Lime causes the grains of sand to melt and bind the	

			particles of clay together. It prevents shrinkage of raw bricks. If lime is excess, it will cause the brick to melt and hence its shape is lost. 4. Oxide of iron - A good brick earth should contain a small quantity of oxides of iron (about 5 to 6%). Iron oxides act as a flux to cause the grains of sand to melt and this helps to bind the particles together. It imparts red colour to brick on burning. Excess amount of iron oxide makes the brick dark blue. 5. Magnesia - A good brick earth should contain a very small quantity of magnesia (<2%). Magnesia imparts yellow colour to brick and it decreases shrinkage. Excess magnesia leads to decay of bricks. (ii) Good brick should have the following properties: 1. Bricks should have perfect edges, well burnt in kilns, copper coloured, and free from cracks with sharp and square edges. 2. It should be uniform in shape and of standard size. 3. Colour should be uniform and bright. 4. The brick when broken should show a bright homogeneous and uniform compact structure free from voids. 5. It should produce clear ringing sound when struck with each other. 6. Water absorption should not be greater than 20% for first class bricks and 22% for second class bricks when soaked in water for 24 hours. 7. Brick should be sufficiently hard, ie., no nail impression must be present when scratched. 8. It should not break when dropped from a height of one metre. 9. It should not have low thermal conductivity and should be sound proof. 10. Good bricks should not show any white or grey deposits of salts when immersed in water and dried. 11. Good bricks should not have crushing strength below 5.5N/mm2.	3 3
	19	4	Plain cement concrete (PCC) is a hard mixture of concrete, fine aggregate, coarse aggregate and water. It is very strong in compression but at the same time it is very weak in tension. Due to this property of concrete it cannot be used for structures which have to carry tensile load. Steel reinforcing bars are embedded in concrete to rectify this in various structural members. This concrete in which steel rods are embedded is called reinforced concrete (RCC). All the structural members like beams, columns, slabs and foundations are constructed with RCC. Concrete can be easily moulded into durable structural members of various sizes and shapes. It also has sufficient plasticity for working.	6
	20	4	(i) According to IS 269-1989 initial setting time of ordinary Portland cement should not be less than 30 minutes, the final setting time should not be less than 600 minutes and the consistency of cement paste should be between 26 to 33%. (ii) Quick setting cement – this type of cement is used for laying concrete under water. Low heat cement – it is used for concreting dams, abutment etc. High alumina cement – it is used for making refractory concrete and for insulation of furnaces. Expanding cement – it is used for repairing damaged concrete surfaces due to cracks and for constructing water retaining structures.	2

			Rapid hardening cement –it is used for the work which is to be completed speedily and economically. Sulphate resisting cement – it is used for structures which may be damaged due to severe alkaline conditions like canal lining, culverts etc. White cement – it is used for floor finish, plaster works, ornamental works, for moulding sculptures, for painting garden furniture etc. Coloured cement – it is widely used for finishing floors, external walls, stair treads etc. Waterproof cement – it is used for oil well construction.	4
C	**Answer any 2 questions**			
	21a	5	(i) A bond is an arrangement of layers of bricks by which no continuous vertical joints are formed. The types of bond in brick work are Stretcher bond – In stretcher bond all the bricks are arranged in stretcher courses. The stretcher bond is useful for one brick partition walls as there are no headers in such walls. As the internal bond is not proper, this is not used for walls of thickness greater than one brick. Header bond – In this type, all bricks are arranged in header courses. It is used for curved surfaces since the length will be less. If a stretcher bond is used in a curved surface, it will project beyond the face of the wall. (ii) English bond is the most commonly used bond, for all wall thicknesses. This bond is considered to be the strongest. The bond consists of alternate courses of header and stretcher. In this bond the vertical joints of the header courses come over each other, similarly the vertical joints of the stretcher courses also come over each other. In order to break the vertical joints in the successive courses, it is essential to place queen closer after the first header in each heading course.  (a) Plan for 1 Brick Thick Wall  ENGLISH BOND.	2 3

	21b	5	The functions of foundation are 1. Reduction of load intensity – Foundations distribute the loads of the superstructure to a larger area so that the intensity of load at its base does not exceed the safe bearing capacity of the sub soil. 2. Even distribution of load – Foundation distributes the non-uniform load of the superstructure evenly to the subsoil. 3. Provision of level surface – Foundations provide leveled and hard surface over which the super structure can be built. 4. Lateral stability – It anchors the super structure to the ground thus imparting lateral stability to the superstructure. The stability of the building against sliding s and overturning due to the horizontal forces is increased due to the foundations. 5. Safety against undermining – It provides the structural safety against undermining or scouring due to burrowing animals and flood water. 6. Protection against soil movement - Special foundation measures, prevents or minimizes the distress in the superstructure due to expansion or contraction of the subsoil because of moisture movement in some problematic soils.   	3 3
	22a	5	The different types of pitched roof are 1. Lean to roof 2. Couple roof 3. Couple close roof 4. Collar beam roof 5. Collar and tie roof	1.5

			Couple roof – It is formed by a pair of inclined rafters, centre ridge piece and wall plates for supporting the whole roof. Two battens are supported on common rafters and roofing material on battens. Span of couple roof is limited to 3.5m. Couple close roof – This type of roof is similar to couple. The only difference is that here the two rafters are connected by a wooden member which acts as a tie. Tie prevents the outward spreading of roof and can also be act as a support for ceiling. These roofs can be economically used for spans up to 4.2m.  Couple roof  Couple close roof Advantages of flat roof are 1. It does not require any false ceiling. 2. Its construction and repair are simple. 3. It is easier to make a flat roof fire resistance. 4. It provides architectural beauty to the building. 5. The construction work of the upper floor can be easily started. 6. A flat roof is more stable against high winds. 7. It can be used as floor in case of two storied building. 8. It possesses good insulating property.	2 1.5
	22b	6	Tower – A tower is a tall structure which is taller than its width. Most of the towers are not built to be habitable but to serve other functions. The principal function is the use of their height to enable various functions such as visibility of other features attached to the tower such as clock tower, light tower, etc. Towers can be stand alone structures such as TV, radio tower etc. Towers can also be supported by adjacent buildings or can be feature on top of a large structure or building. Chimney – Chimneys are tall slender structures which are used to discharge waste / flue gases at higher elevation with sufficient exit velocity such that the gases and suspended solids are dispersed into the atmosphere over a defined spread such that their concentration on reaching the ground is within acceptable limits specified by Pollution Control Regulatory Authorities. Water tanks – A water tank is a container for storing water. The need for a water tank is an old civilization. Water tanks are used for storing water for	2 2

			drinking, irrigation, fire suppression, industries etc. Various materials used for making water tank are plastics ie., polyethylene & polypropylene, fiberglass, concrete, steel, reinforced concrete and pre-stressed concrete etc.	2
	23a	6	In a typical elevator, the car is raised and lowered by six to eight motor driven wire ropes that are attached to the top of the car at one end. These wires travel around a pair of sheaves, and then attached to a counter weight at the other end. The counter weight adds accelerating force when the car is ascending and provides a retarding effort when the car is descending. A set of chains are looped from the bottom of the counterweight to the underside of the car to maintain balance by offsetting the weight of the suspension ropes. Guide rails keep the car and the counterweight from swaying or twisting during their travel. Rollers are attached to the car and the counterweight to provide smooth travel along the guide rails. Speed of lifts Passenger lift - Low and medium class flat – 0.5m/sec - Office buildings, hotels – 0.5 to 0.75m/sec - Large flats – 0.75 to 1.5m/sec - Hospitals – above 1.5m/sec - Departmental stores – 2 to 2.5m/sec Goods lifts - normal case – 0.25 to 0.5m/sec - Serving main floors – 1m/sec Hospital bed lift – short travel in small hospital – 0.25m/sec - Normal – 0.5m/sec - Long travel lift in large hospital – 1.0m/sec	2.5 2.5
	23b	6	Most of the common building materials absorb sound to a small extent. For absorbing sound some other materials to be incorporated on the surface of the wall, roof, floor, etc. such materials are known as sound absorbing materials. Qualities of good sound absorbing materials: 1. It should be economical in construction and maintenance. 2. It should be waterproof, fire proof and sufficiently strong. 3. It should be good in appearance. Sound absorption materials may be classified into four groups and they are: 1. Porous tiles of masonry and other products, which are installed on the walls, come under third group. Acoustical tiles can fix easily, but it is costly. This type of materials is suitable for rooms having small area, curtains comes under third group with coefficient of absorption 0.5. 2. Acoustical plasters come under fourth group. Acoustical plaster is also known as fibrous plaster and it includes granulated insulation material mixed with cement. For thickness of 20mm plaster and density 0.1gm/cm3 absorbent coefficient is 0.3. 3. Quilts and mats are prepared from mineral and glass wool and they are fixed in the form of acoustic blankets. For glass or mineral wool absorption coefficient is 0.9. 4. Cork tiles of 12mm thickness are made by blending phenolic or other thermosetting resin with cork granules and baking under high temperature and pressure to produce a strong tile of low porosity. It provides an attractive non skid and resilient surface.	2 4

PAPER 2

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2017

COURSE CODE: CE 100

COURSE NAME: BASICS OF CIVIL ENGINEERING

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions. Each question carries three marks)

1.Write short note on national building code.

2. What are the factors to be considered while fixing the position of doors and windows during .planning of a building.

3.Differentiate between plinth area and floor area of a

building. 4.What are the basic principles of surveying?

5.What is meant by grade of OPC?

6. Differentiate between cement mortar and cement concrete.

7. Define bearing capacity of soil.

8. Explain the purposes of painting buildings.

9. Explain the factors to be considered while designing a ramp.

10. Write a short note on chimneys.

PART B

(Answer any eight questions. Each question carries six marks)

11. What are the various disciplines in civil engineering?
12. Explain factors to be considered for selection of site for a building.
13. What are the basic principles for planning of a building?
14. List t he instruments used in chain surveying and explain any two of them in detail.
15. Explain the properties of concrete and its grades.
16. Explain how deep foundations are classified.
17. With the help of neat sketches differentiate between a header bond and a stretcher bond.
18. What are elevators? Explain its classification based on occupancy.
19. Discuss the various systems of air conditioning provided in buildings?
20. Explain the classification of towers.

PART C

(Answer any two questions)

21. a)What are the types of buildings based on their occupancy as per NBC? (6)

    b) Explain the step by step procedure for setting out a building. (5)

22. a) Discuss different types of cements available in the market and their uses. (6)

    b) What is total station? Explain how it is used in surveying. (5)

23. a) Explain different types of roofing used in buildings. (6)

    b) What are intelligent buildings? Explain. (5)

ANSWER KEY 2

1. The National Building Code of India (NBC), a comprehensive building Code, is a national instrument providing guidelines for regulating the building construction activities across the country. It serves as a Model Code for adoption by all agencies involved in building construction works be they Public Works Departments, other government construction departments, local bodies or private construction agencies. The Code mainly contains administrative regulations, development control rules and general building requirements; fire safety requirements; stipulations regarding materials, structural design and construction (including safety); building and plumbing services; approach to sustainability; and asset and facility management.

2. Maximum work space, min wastage of space,maximum cross ventilation,

Location to meet functional requirement, windows-height above 70-80 cm above floor level , doors number should be minimum(6x 0.5)

3. **Plinth area** is the built up covered **area of a building** measured at floor level of any storey. **Plinth area** is calculated by taking external dimensions of the **building** at floor level.

Floor area- built up area of building at any level (1.5 each)

4)i) Working from whole to part ii) Location of a point by measurement from two points of reference. (1.5 each)

5. The Bureau of Indian Standards has classified OPC into three grades for producing different grades of concrete to meet the demands of the construction industry. The classification is made on the basis of compressive strength at 28 days as: 33 grade - ordinary portland cement, IS 269:1989 43 grade - ordinary portland cement, IS 8112:1989 53 grade - ordinary portland cement, IS 12269 : 1987. The grade indicates compressive strength of the cement in N/mm2 at 28 days -(Defn- 2marks, types.1 mark

6. **Mortar** is used to hold building materials such as brick or stone together. It is composed of a thick mixture of water, sand, and **cement**. The water is used to hydrate the **cement** and hold the mix together. The water to **cement** ratio is higher in **mortar** than in concrete in order to form its bonding element. Esed for plastering

Cement **concrete** is an artificial building material that is obtained by mixing together cement, water and some other inert materials. The mixture in a plastic condition when allowed to set becomes as hard as stone. Used for construction, foundation, slabs, roads, damscolumns beams etc (1.5 each)

7. **bearing capacity** is the**capacity of soil** to support the loads applied to the ground. The **bearing capacity of soil** is the maximum average contact **pressure** between the foundation and the **soil** which should not produce shear failure in the **soil**.

8.(i) It protects wood from decaying.
(ii) It prevents corrosion of metals.
(iii) It renders surface hygienically safe and clean.
(iv) It gives decorative and attractive appearance to the surface.
(v) It also protects the surface from harmful effects of
atmospheric agencies.

9. a)Transmission towers, - suspension, angle types

b)telecommunication towers- selfsupporting, guyed, monopole(1.5 each)

.9. slope- 15 per cent, width -2m, landing to be of equal width, normmlly ae rcc slabs with supporting columns.

10. Chimneys-A **chimney** is a structure that provides ventilation for hot flue gases or smoke from a boiler, stove, furnace or **fireplace** to the outside atmosphere. The space inside a**chimney** is called a flue.-
1.5marks

Types-self supporting, guyed, stayed 1.5 marks

11. 11.

- Construction Engineering,
- Structural engineering
- Geotechnical engineering
- Transportation engineering
- Environmenal engineering
- Water resources

engineering Any 4 - 2 marks

each

12)

- The site should be in fully developed area or in the area which has potential of development.
- The site should command a good view of landscape such a hill, river, lake, etc.
- There should be good transport facilities such as railway, bus service, for going to office, college, market, etc.

- Civic services such as water supply, drainage sewers, electric lines, telephone lines, etc. should be very near to the selected site so as to obtain their services with no extra cost.
- Soil at site should not be of made up type as far as possible. The buildings constructed over such soils normally undergo differential settlement and sometimes become the cause of collapse. Cracks in buildings in such conditions, are quite common
- The selected site should be large enough; both to ensure the building abundant light and air to prevent any over dominance by the neighbouring buildings.
- The ground water table at the site should not be very high.
- Nearness of schools, hospitals, market, etc. are considered good for residential site but these facilities do not carry any significance in the selection site for other public buildings.
- Good foundation soil should be available at responsible depth. This aspect saves quite a bit in the cost of the building.
- Residential house site should be located away from the busy commercial roads.
- Residential site should not be located near workshops, factories, because such locations are subjected to continuous noise.
- Orientation of the site also has some bearing on its selection. Site should be such in our country that early morning sun and late evening sun is accepted in the building in summer and maximum sun light is available in most of winter. Any 8- (1 mark each.)

13. Aspect, prospect, privacy, grouping,roominess, sanitation, flexibility,communication, practical consideration

14. Chain, tape, ranging rod, offset rod, cross staff, pegs, arrows

etc- Listing 2 marks, explanation- 3 each

15 Fresh concrete- workability, segregation, bleeding - (3 marks)

Hardened concrete-Strength, durability, impermeability, shrinkage, creep etc- (3 marks)

Grades- (2 marks)

16. pile foundation,-

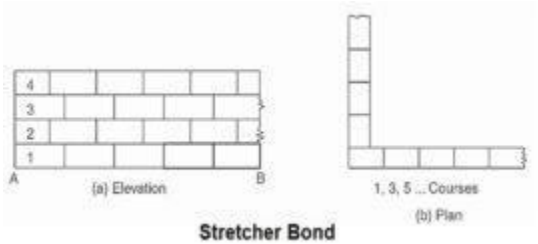
a) based on function- -

Load bearing -end bearing and friction

Non load bearing- compaction, sheet, anchor, batter, fender, compaction piles

b) based on materials- concrete, steel, cast iron, timber, composite, sand piles Listing 2 marks, Explanation - 1 each for each type

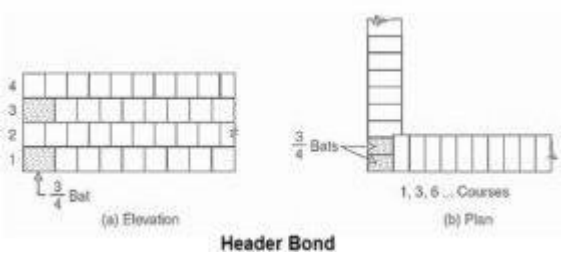
17. STRETCHER BOND:



Stretcher Bond

Stretcher bond is the simplest form of brick bond utilized for construction works. Sometimes it is also known as running bond. In the arrangement of stretcher bond, all the bricks are laid as stretchers (as shown in fig). No header is present in this bond, hence suitable reinforcement should always be provided for construction of structural bond.

HEADER BOND:



Header Bond

18. In this pattern of bonding all the bricks are placed as header on the faces (as shown in fig). This bond is also known as heading bond.The overlap is half the width of the brick and can be achieved by providing a three-quarter bat in each alternate course at quoins. Header bond can be used in the construction of curved structure, brick foundation etc. (4 each)

19. Elevator-is a type of vertical transportation that moves people or goods between floors (levels, decks) of a building, vessel, or other structure. Elevators/lifts are generally powered by electric motors that either drive traction cables and counterweight systems like a hoist, or pump hydraulic fluid to raise a cylindrical piston like a jack.- 2 marks

Passenger, goods, hospital -

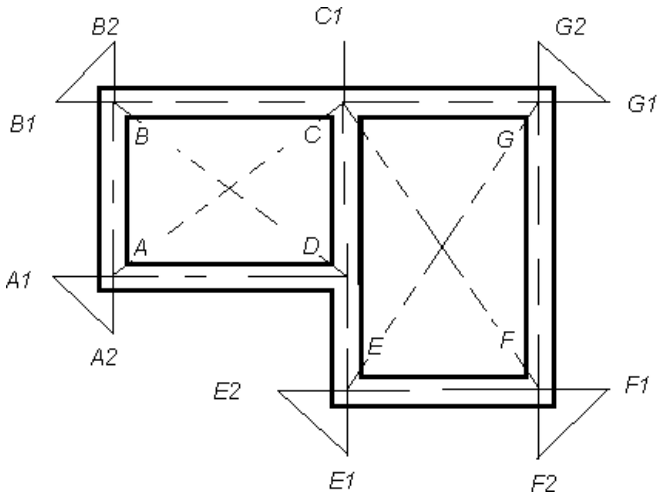
(2 marks each)

20. Central, Self contained, Semi contained, Combined- (2 marks Each)

21. a)Occupancy based classification

- A Residential Occupancy
- B Educational Occupancy
- C Institution for care Occupancy
- D Health Care Occupancy
- E Business Occupancy
- F Mercantile Occupancy
- G Industrial Occupancy
- H Storage Occupancy
- I Assembly Occupancy
- J Hazardous Occupancy
- K Garages Occupancy
- L Utilities Occupancy
- M Miscellaneous (1mark each)

21 b).



1.From the plan (fig 1), the centre line of the walls are calculated. Then the centre lines of the rooms are set out by setting perpendiculars in the ratio 3:4:5. Suppose the corner points are a, b, c, d, e, f and g which are marked by pegs with nails on top.

2. The setting of the corner point is checked according to diagonals ac, bd, cf and eg.

3. During excavation, the centre points a, b, c, d, e, f, g may be removed. Therefore the centre lines are extended and the centre points are marked about 2m away from the outer edge of excavation. Thus the points A1, A2, B1, B2 and like wise, are marked outside the trench. Centre line are shown clearly by stretching thread or rope. The centre points fixed 2m away from the excavation are marked with sit out pegs.

4. From the plan details, the width of excavation to be done is also marked by thread with pegs at appropriate positions.

5. The excavation width is then marked by lime or by with furrow with spade.

6. If the plan is much to complicated and follows a zigzag pattern, then the centre pegs are kept at suitable positions according to site conditions. (5 marks)

22.a)

Types of Cement	Composition	Purpose
Rapid Hardening Cement	Increased Lime content	Attains high strength in early days it is used in concrete where formworks are removed at an early stage.
Quick setting cement	Small percentage of aluminum sulphate as an accelerator and reducing percentage of Gypsum with fine grinding	Used in works is to be completed in very short period and concreting in static and running water
Low Heat Cement	Manufactured by reducing tricalcium aluminate	It is used in massive concrete construction like gravity dams
Sulphates resisting Cement	It is prepared by maintaining the percentage of tricalcium	It is used in construction exposed to severe sulphate

	aluminate below 6% which increases power against sulphates	action by water and soil in places like canals linings, culverts, retaining walls, siphons etc.,
Blast Furnace Slag Cement	It is obtained by grinding the clinkers with about 60% slag and resembles more or less in properties of Portland cement	It can be used for works economic considerations is predominant.
High Alumina Cement	It is obtained by melting mixture of bauxite and lime and grinding with the clinker it is rapid hardening cement with initial and final setting time of about 3.5 and 5 hours respectively	It is used in works where concrete is subjected to high temperatures, frost, and acidic action.
White Cement	It is prepared from raw materials free from Iron oxide.	It is costlier and is used for architectural purposes such as precast curtain wall and facing panels, terrazzo surface etc.,
Colored cement	It is produced by mixing mineral pigments with ordinary cement.	They are widely used for decorative works in floors
Pozzolanic Cement	It is prepared by grinding pozzolanic clinker with Portland cement	It is used in marine structures, sewage works, sewage works and for laying concrete under water such as bridges, piers, dams etc.,
Air Entraining Cement	It is produced by adding indigenous air entraining agents such as resins, glues, sodium salts of Sulphates etc. during the grinding of clinker.	This type of cement is especially suited to improve the workability with smaller water cement ratio and to improve frost resistance of concrete.
Hydrographic cement	It is prepared by mixing water repelling chemicals	This cement has high workability and strength

Any 6- (1 mark each.)

22b)Total station is a surveying equipment combination of **Electromagnetic Distance Measuring Instrument** and electronic theodolite. It is also integrated with microprocessor, electronic data collector and storage system. The instrument can be used to measure horizontal and vertical angles as well as sloping distance of object to the instrument.

- Microprocessor unit in total station processes the data collected to compute:
- Average of multiple angles measured.
- Average of multiple distance measured.
- Horizontal distance.
- Distance between any two points.
- Elevation of objects and
- All the three coordinates of the observed points.

Data collected and processed in a Total Station can be 聽 downloaded to computers for further processing.

Total station is a compact instrument and weighs 50 to 55 N. A person can easily carry it to the field. Total stations with different accuracy, in angle measurement and different range of measurements are available in the market

Use of Total Station

The total station instrument is mounted on a tripod and is levelled by operating levelling screws. Within a small range instrument is capable of adjusting itself to the level position. Then vertical and horizontal reference directions are indexed using onboard keys. It is possible to set required units for distance, temperature and pressure (FPS or SI). Surveyor can select measurement mode like fine, coarse, single or repeated.

When target is sighted, horizontal and vertical angles as well as sloping distances are measured and by pressing appropriate keys they are recorded along with point number. Heights of instrument and targets can be keyed in after measuring them with tapes. Then processor computes various information about the point and displays on screen.

This information is also stored in the electronic notebook. At the end of the day or whenever electronic note book is full, the information stored is downloaded to computers.

The point data downloaded to the computer can be used for further processing. There are software like auto civil and auto plotter clubbed with AutoCad which can be used for plotting contours at any specified interval and for plotting cross-section along any specified line. (5marks)

23.

23a)Roof is the upper most portion of the building which protects the building from rain, wind and sun. Various types of roofs used may be divided broadly into three types:

1. Flat roofs 2. Pitched roofs
3. Shells and folded plates.

Pitched Roofs: In the areas of heavy rain falls and snow fall sloping roof are used. The slope of roof shall be more than 10°. They may have slopes as much as 45° to 60° also. The sloped roofs are known as pitched roofs. The sloping roofs are preferred in large spanned structures like workshops, factory buildings and ware houses. In all these roofs covering sheets like A.C. sheet, G.I. sheets, tiles, slates etc. are supported on suitable structures. The pitched roofs are classified into

(a) Single roofs (b) Double or purlin roofs
(c) Trussed roofs.

(a) Single Roof: If the span of roof is less than 5 m the following types of single roofs are used.

(i) Lean to roofs (ii) Coupled roofs
(iii) Coupled-close roof (iv) Collar beam roof
In all these roofs rafters placed at 600 mm to 800 mm spacing are main members taking load of the roof. Battens run over the rafters to support tiles. Figure 8.13 shows various types of single roofs.

(b) Double or Purlin Roofs: If span exceeds, the cost of rafters increase and single roof becomes uneconomical. For spans more than 5 m double purlin roofs are preferred. The intermediate support is given to rafters by purlins supported over collar beams. Figure 8.14 shows a typical double or purlin roof.

Trussed Roof: If span is more, a frame work of slender members are used to support sloping roofs.

Shells and Folded Plate Roofs: Shell roof may be defined as a curved surface, the thickness of which is small compared to the other dimensions. In these roofs lot of load is transferred by membrane compression instead of by bending as in the case of conventional slab and beam constructions. Caves are having natural shell roofs. An examination of places of worships built in India, Europe and Islamic nations show that shell structures were in usage for the last 800 to 1000 years. However the shells of middle ages were massive masonry structures but nowadays thin R.C.C. shell roofs are built to cover large column free areas. Figure 8.18 shows commonly used shell roofs. (3 x 2 marks)

23b)An intelligent building uses the latest technology and processes to operate as safely and efficiently as possible. Intelligent buildings are designed to be energy-efficient, environmentally friendly, and provide the optimal environment for their occupants. As a result, these buildings have lower operational costs and offer considerable benefits for owners and occupants.

Intelligent building design ideally begins at the planning stage but existing structures can be retrofit to bring them in line with intelligent design principles. To achieve the desired energy efficiency and level of environmental control, intelligent buildings must be responsive and adjust to changing conditions and occupant actions. Hardware such as occupancy sensors, motion detectors, CCTV cameras, and RFID scanners are placed throughout the building and surrounding area to provide information on changing conditions. All of the building 織 s environmental and electrical systems are linked into a single network so they can exchange information and work together to achieve optimum efficiency.

The various occupancy sensors in an intelligent building register changing conditions, such as occupants leaving or entering an area. Sensors also monitor environmental conditions including temperature, indoor air quality, energy usage, etc. **Building automation** systems then take appropriate action as needed, such as turning off the HVAC and lighting in unoccupied areas, adjusting airflow to vent excess CO2, or alerting appropriate authorities of security breaches. Intelligent buildings are able to operate at peak efficiency this way, without wasting energy in unoccupied areas. (5mark s)

MODULE I

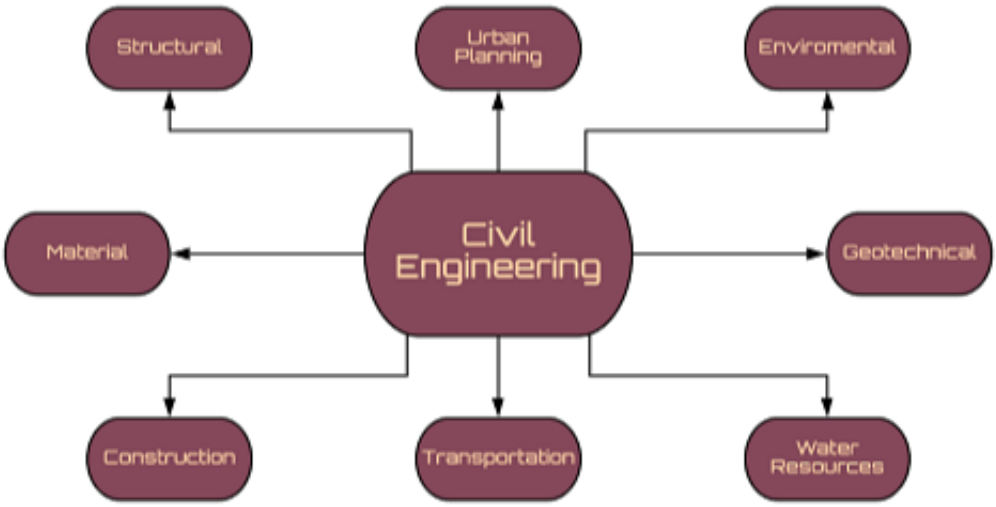
INTRODUCTION TO CIVIL ENGINEERING

Civil Engineering deals with **construction activities** of buildings, roads, bridges, tunnels, etc. and also with engineered constructions, their planning, design, construction and management. Enjoying spacious and comfortable living in a building, or an underground enclave; driving from a given location to virtually any region in the continent; and having plenty of clean water available for any domestic use are some of the examples that the civil engineering profession offer today.

The main scope of Civil Engineering is **planning, designing, estimating, supervising and management** of different construction activities.

❖ Various Disciplines of Civil Engineering

According to scope, type of structures and activities carried out, following are themain branches of civil engineering:



i. Building Construction

ii. Advanced Building Construction

iii. Building Planning and Management

iv. Environmental Engineering or Water Supply and Sanitary Engineering

v. Geotechnical Engineering (Soil Mechanics)

vi. Surveying and Levelling

vii. Structural Engineering

viii. Transportation Engineering

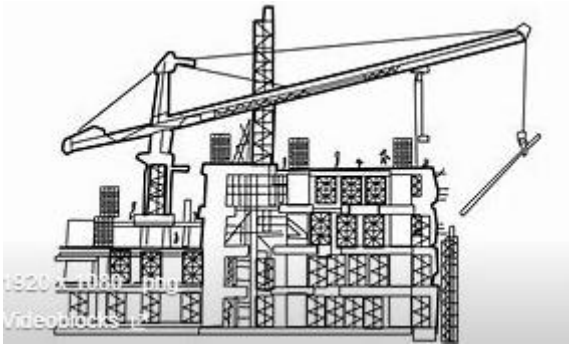
ix. Town Planning

x. Water Resource Engineering

- **Building Construction**

o Construction of various structures and different types of buildings

- Construction of **building components** like brick work, Reinforced CementConcrete (RCC) works, foundations, doors and windows, floor, roof, etc.
- Study of **engineering materials** like cement, steel, timber, glass, etc.



- **Advanced Building Construction**

- Study of construction of **deep foundations**
- Underwater construction
- Construction of **dams, bridges, tunnels**, off-shore oil rig, etc.
- Study of equipment like power shovel, rollers, cranes etc. for large scaleprojects

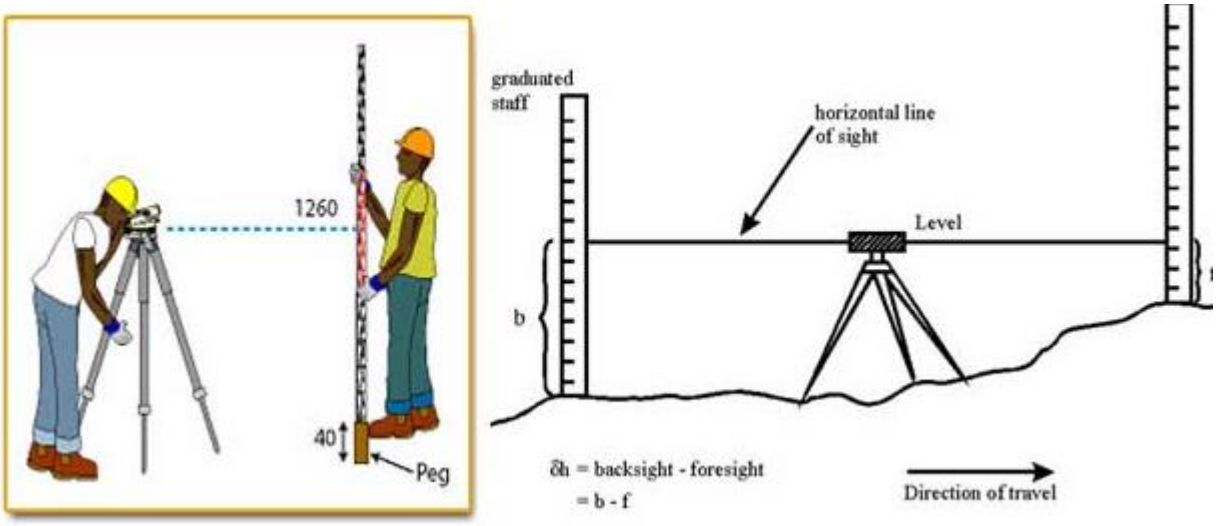
- **Building Planning and Management**
  - Fundamental principles of planning

  - **Building bye-laws**
  - Planning of public, residential and industrial buildings
  - **Construction management** of whole project
  - Management of construction materials, labour and equipment

- **Environmental Engineering**
  - Design, construction and maintenance of **water treatment** plant, water **distribution** system and sewage system
  - Waste water treatment and **solid waste management**
  - Air, water and land pollution

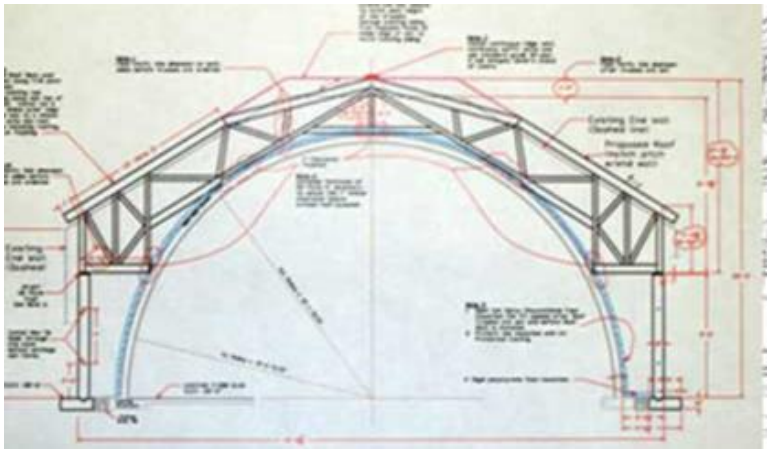
- **Geotechnical Engineering**
  - Soil investigation
  - Design of foundations
  - Measurement of soil parameters and safe bearing capacity of soil
  - Study of geology

- **Surveying and Levelling**
  - For setting out of works
  - For preparing maps of land
  - Measurement of levels of land and prepare contour maps
  - Carried out using chains, compass, plane table, levels, theodolites, EDMinstruments, etc.



- **Structural Engineering**

- Design of RCC structures (Retaining walls, water tanks, bridges, residential buildings, etc.)
- Design of steel structures (railway platform, factory sheds, steel bridges, etc.)
- Design of earth quake resistant structures
- Concrete technology



- **Transportation Engineering**

- Airport engineering
- Bridge engineering
- Harbour and Docks engineering
- Highway engineering
- Railway engineering

- Tunnel engineering
- Traffic engineering

- **Town Planning**

- Arrangement of various components of a town in such a way that the townattains significance of a living organism
- Towns are divided into different zones like residential zone, commercialzone, industrial zone, etc.

- **Water Resources Engineering**

- Fluid Mechanics – deals with behaviour of all, more or less incompressible, liquids and gases
- Hydrology – deals with study of sources of water, measurement and study ofrainfall, flood, etc.
- Irrigation Engineering – deals with designing of hydraulic structures like dams, canals, etc.

❖ **Relevance of Civil Engineering in Overall Infrastructural Development**

The importance of infrastructure for sustained economic development is well recognized. The visible signs of current shortfalls include increasingly congested roads, power failures, shortage of drinking water, etc. These illustrate the widening gap between demand and supply of infrastructure.

There is a potential for public-private partnerships to contribute more and help to bridge the infrastructure gap in India. There is a need of holistic approach to look into infrastructure from the industrial perspective to enhance the quality of inputs to the operations of the company.

Buildings are designed by civil engineers by conveying an array of structural elements that support the architectural spatial distribution. Highway is designed by creating a plane that adequately supports weight and stresses of vehicles in motion. The water resource system is designed by a civil engineer that arranges for water intake at an appropriate source, a water conveyance set and a water distribution network. The civil engineer designs waste water disposal and waste water treatment plants.

Operations management for infrastructural development has three major aspects:

i. Quality

ii. Cost and

iii. Time

Infrastructure Development involves fundamental structures that are required for the functioning of a community & society. This is usually referred to structures like roads, water supply, sewers, electrical grids, telecommunications, renewable energy, water sources identification & boring (wells), purification systems for clean water, hazard waste management and so on. Governments cannot manage to do it without skilled/trained manpower (which includes engineers from all the departments).

Civil engineers can manage to do these projects related to infrastructural development as the fundamental idea of **less space and more efficiency** is embedded in all civil engineers which is a crucial factor in development of infrastructure.

So civil engineers have a very crucial role to play in the development of infrastructure. The role of Civil Engineering activities in the infrastructural development can be summarised as follows:

- A proper **planning of towns** and extension areas in the cities.
- Fast rate of urbanisation and increase in the cost of land has forced civil engineers to go for **vertical growth in cities**. This has resulted in new building technologies and sophisticated analysis methods. Civil engineers have to solve problems of rural areas as well. **Low cost housing** is the need of the hour to make poor people afford their own houses.
- Water is an important need for all living beings. Civil engineers have to explore into various water resources and **ensure water supply** to urban areas throughout the year. Water is required for agriculture also.
- Good **roadways and transportation facilities** include another important amenity of the public which civil engineers deliver.
- Other important infrastructural activities of civil engineers are controlling pollution of air, water and land.

- The impact of infrastructural development of a country

- Provide protection from drought, famine, flood, etc.
- Improved irrigation facilities
- Better sewage system
- Improved education facilities
- Improvement in transportation and communication
- Generation of electricity from natural resources

❖ Types of Buildings as per NBC

As per the National Building Code (NBC), buildings are classified into **nine groups** based on their occupancy as follows:

- Group A - Residential buildings
- Group B - Educational buildings
- Group C - Institutional buildings
- Group D - Assembly buildings
- Group E - Business buildings
- Group F - Mercantile buildings
- Group G - Industrial buildings
- Group H - Storage buildings
- Group I - Hazardous buildings

• Group A – Residential buildings

The buildings which are provided with sleeping accommodation for **normal residential purposes**, with or without cooking/dining or both the facilities, except those under Group C. Sub-divisions of Group A are:

o Sub-group A-1 - Lodging or rooming houses

- Sub-group A-2 - One or two family private dwellings
  - Detached houses
  - Semi-detached houses
  - Row of houses
  - Apartments or flats
  - Duplex type apartments
  - Skyscrapers

- Sub-group A-3 - Dormitories
- Sub-group A-4 - Apartment houses (Flats)
- Sub-group A-5 - Hotels

Sub-group A-1: Lodging or rooming houses

Any building or a group of buildings under the same management in which separate sleeping accommodation for a total of **not more than 15 persons** on either transient or permanent basis with or without dining facilities.

Sub-group A-2: One or two family private dwellings

Any private dwelling which is occupied by members of a single family and has a total sleeping accommodation for **not more than 20 persons**. If rented to outsiders, it should be for accommodating not more than 3 persons.

Different types of dwellings:

- *Detached house* – All walls and roofs are **independent** of any other building with proper set-back distances on all sides. Plot size: minimum 250 m^2;Frontage: 12 m.

- *Semi-detached house* – **Three sides are detached** with proper set back distances. Plot size: 125 to 250 m^2; Frontage: 8 to 12 m.

- *Row of houses* – **Two sides are detached** with proper set-back distances. Plot size: 50 to 125 m^2; Frontage: 4.5 to 8 m. Very common in cities like Mumbai, Kolkata, Chennai, etc.

- *Duplex house* – It is a type of detached or semi-detached house provided with an accommodation of **single dwelling at two or more floors**. Interesting spaces due to differences in level.

- *Flat/Terrace house* – A **group of dwelling units** separated by horizontal divisions. A single flat generally has 3 to 4 rooms with usual amenities provided for one family.

Sub-group A-3: Dormitories

Any building in which **group sleeping accommodation** is provided with or without dining facilities for persons who are not the members of same family in a single room or a series of rooms, under single management.

Sub-group A-4: Apartment houses / Flats

Any building or structure in which living quarters are provided for 3 or more families living independently with separate cooking facilities.

Sub-group A-5: Hotels

Any building or group of buildings under single management in which sleeping accommodation with or without dining facilities is provided for more than 15 persons.

- **Group B – Educational buildings**

Any school, building or day-care centre used for educational purpose for **more than 8 hours a week** involving assembly for instruction, education or recreation and which is not covered by Group D comes under this group.

- **Group C – Institutional buildings**

These include any building or part thereof, which is used for purposes like medical or other treatment/care of persons suffering from physical or mental illness, diseases or infirmity, care of infants, aged persons, etc. Sub-divisions of Group C are:

- **Sub-group C-1- Hospitals and Sanitaria**

Hospitals, clinics, sanitaria, etc. under single management

- **Sub-group C-2- Custodial Institutions**

  Orphanages, old age homes, etc.

- **Sub-group C-3 - Penal Institutions**

  Jails, prisons, mental sanitaria, etc.

- **Group D – Assembly buildings**

Any building or part of a building like theatres, assembly halls, restaurants, places of worship, dance halls, club house, air terminals, surface and marine public transportation service, recreation piers, sports stadium, gymnasiums, skating rings, etc. **where group of people gather** for amusement, recreation, social, religious or other similar purposes are included in Group D. Subdivisions of this group are:

- **Sub-group D-1**
  - Fixed seats **over 1000** persons
  - Primarily meant for theatrical or operatic performances
- **Sub-group D-2**
  - Seating capacity of **less than 1000** persons
- **Sub-group D-3**
  - Primarily meant for assembly of **more than 300 persons without permanent seating** arrangement
- **Sub-group D-4**
  - Primarily meant for assembly of **less than 300 persons without permanent seating** arrangement
- **Sub-group D-5**
  - Any building meant for **outdoor assembly** of people not covered by sub-groups D-1 to D-4

- **Group E – Business buildings**

Any building or part of a building which is used for the **transaction of business** (other than Group F), for keeping of accounts and records, **barber shops, lunch counters** serving less than 100 people, is included in Group E.

- **Group F – Mercantile buildings**

This group includes any building or part of a building which is used as **shops, offices, stores, markets, showrooms** for display and sale of merchandise either whole sale or retail.

- **Group G – Industrial buildings**

This group includes any building or part of a building in which products or materials of all kinds and properties are **fabricated, assembled or processed**. These include assembly plants, smoke houses, gas plants, refineries, diaries, textile mills and saw mills.

- **Group H – Storage buildings**

This group includes any building or part of a building which is primarily used for **storage** or sheltering of **goods, wares or merchandise** except those which are highly combustible/explosive products, vehicles or animals. These include warehouses, cold storages, freight depots, transit sheds, store houses, truck and marine terminals, garages, etc.

- **Group I – Hazardous buildings**

This group includes any building or part of a building which is used as storage, handling, manufacture or processing of **highly combustible or explosive materials** or products which may produce poisonous fumes or which are highly corrosive or toxic, or acids and other chemicals producing flames/fumes, irritant gases, or which require any material producing explosive mixtures. This group includes:

i. Storage under pressure of 0.1 N/mm^2 and in quantities exceeding 70 m^3 ofacetylene, hydrogen, illuminating and natural gases, ammonia, chlorine, SO_2, CO_2, methyl oxide and all gases subject to explosion, fume or toxic hazard

ii. Storage and handling of hazardous and highly inflammable liquids and othermaterials

iii. Manufacture of artificial flowers, synthetic leather, explosives and fireworks

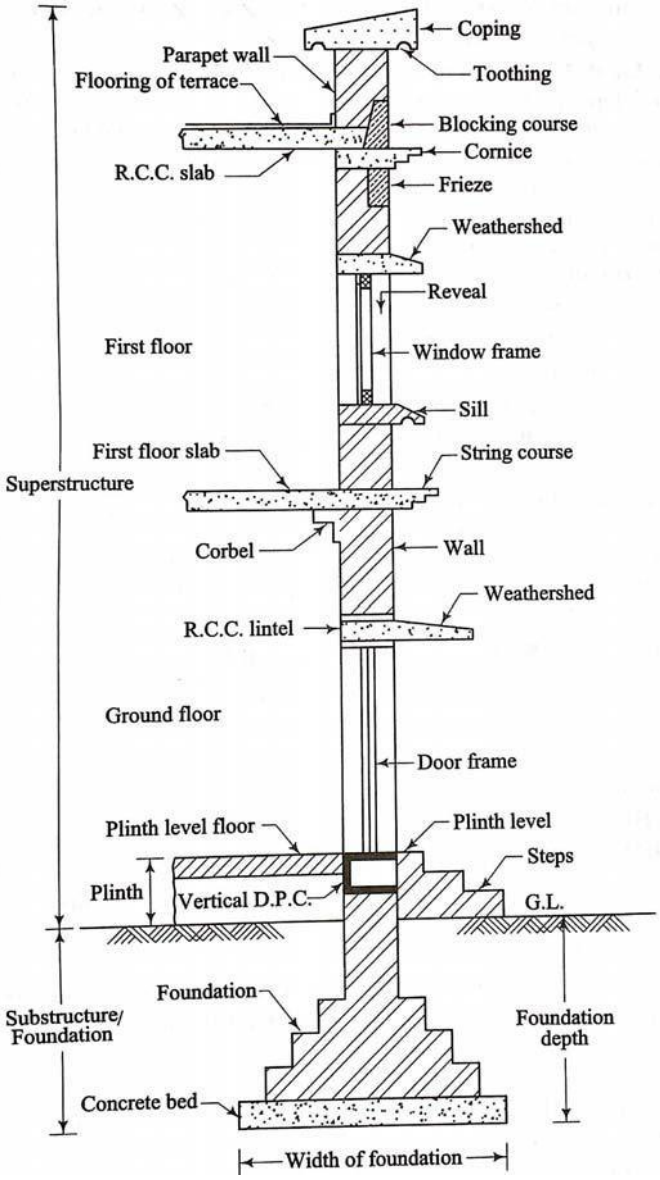
❖ **Selection of Site for Buildings**

For good planning and designing of buildings, the site selection is the one of the most important factor. The following general principles should be kept in mind while selecting a site for a building:

- The purpose of building and extend of privacy is desired
- The site should be located in fully developed or fast developing locality
- The site should be located in such a way that community services like police and fire protection, clearing of waste and street cleaning, utility services like water-supply, electricity, etc., amenities like school, hospital, market, etc. and means of transport are also available
- Before selecting a site, one should study the **bye-laws of the local authority**, which put before restrictions regarding proportions of plots to be built up, open spaces and margins to be left around, heights, etc.
- Area of plot should be such that the building constructed on it meets the **requirement of the owner**, after following certain restrictions of local authority
- **Shape of the plot** should not be irregular, and should not be having any sharp corners
- The site should be situated on an elevated place and also levelled with uniform slopes from one end to the other to provide **good drainage of rain water**

- The soil of the site should be good enough with **high Safe Bearing Capacity** to provide economical foundations
- The site should be situated in a naturally **beautiful environment** which creates healthy living and working conditions
- The site should be **away from quarries**, kilns, factories, industries, rivers with heavy flood, etc., if possible
- The **legal and financial aspects** should also be given due consideration

Components of a Residential Building



Usually a building is divided into three parts:

i. Foundation

ii. Plinth

iii. Superstructure

Foundation is the part of a building constructed below ground level and which is in direct contact with sub-strata and transmits all the loads to the sub-soil.

Plinth is the building above the ground level and up to the floor level immediately above the ground.

Superstructure is the part of the building constructed above the plinth level.

The Table 1.1 gives the functions of different structural components of a building.

Table 1. Important building components and their functions

Foundation	**Transmits the loads**; supports the superstructure; provides stability. Provides safety against scouring
Plinth	Helps in transmitting loads from superstructure to substructure; **Protects** the building from moisture rainwater, dust, insects, termite, etc.
Wall	Supports beam and slab; transmits the loads. Provides **partition**, privacy and safety; Protects building against heat, cold, rain, noise, fire, etc.
Column	**Supports** beam and slab Transmit the loads
Floor	Gives a plane and **levelled surface** for the occupants, furniture, the equipment, etc.

Roof	Covers the top of the building Gives **protection** against rain, heat, snow. Sound, wind, etc.
Door	**Permits entry, exit**, light and ventilation to the building Imparts safety and privacy to the building
Window	Gives nice scenic view to the building Permits **light and ventilation**
Step	For access in building from GL to upper floors
Stair	For **vertical circulation** among the floors in the building
Lintel, Arch	Gives support to the wall above the openings in wall
Sill	It gives support to the bottom of window openings
Beam	Supports the slab Transmits loads coming from slab to column or wall
Weather shed (Sun shade)	Protects the walls of the buildings from sun, heat and rain
Parapet	Provides boundary to the terrace and encloses it

Industrial buildings

Any building structure used by the industry to store raw materials or for manufacturing products of the industry is known as an industrial building. It provides facility in such a way that the space is used primarily for **research, development, service, production, storage or distribution of goods** which may also include someoffice space.

Industrial buildings may be classified as:

- Normal Type Industrial buildings
- Special Type Industrial buildings

Normally industrial buildings are **shed type** buildings, with simple roof structures on open frames. These buildings are used for workshops, warehouses, etc. These buildings require large and **clear areas unobstructed by the columns**. The large floor area provides sufficient flexibility and facility for a later change in the production layout without major alterations to the building.

Industrial **floors shall have sufficient resistance to abrasion**, impact, acid action and temperature

MODULE 3 – SURVEYING

Surveying is the art of and science of determining the relative positions of various points or stations on the surface of the earth by measuring the horizontal and vertical distances, angles, and taking the details of these points and by preparing a map or plan to any suitable scale."

Leveling is a branch of surveying which deals with the measurement of relative heights of different points on, above or below the surface of the earth. Thus in leveling, the measurements (elevations) are taken in the vertical plane

Objective of Surveying-

- to prepare a map or plan of areas to show positions of objects on surface of earth
- To layout alignments of different engineering features such as buildings, roads, railways, dams, reservoir, canals, tunnel, airports, bridges etc.

Purpose /uses of surveying

- Preparation military map, geological map, archaeological map etc.
- Layout of alignment of engineering structures
- Measurement of quantities in cutting & filling
- for finding capacity of reservoir
- For setting out work and transferring details from the map on the ground

Purpose of Leveling- i) To determine difference in levels/ objects

ii) To establish pints or erect machinery or construct building components at a prefixed level

Primary Classifications/ Divisions of Surveying

- Plain Surveying- The plain surveying is that type of surveying in which earth surface is considered as a plane. In such surveying a line joining any two stations is considered to be straight. The triangle formed by any three points is considered as a plane triangle, and the angles of the triangle are considered as plain angles. Surveying is carried out for a small area of less than 250 km^2. It is carried out by local or state agencies like, Irrigation department, Railway department
- **Geodetic Surveying**- The geodetic Surveying is that type of surveying in which the curvature of the earth is taken into account. It is generally extended over larger areas. The line joining any two stations is considered as curved line. The triangle formed by any three points is considered to be spherical and the angles of the triangle are considered to be spherical angles. Geodetic surveying is carried out for a larger area exceeding 250 km^2

Classification based on Purpose

- **Geological Survey:**

  In this both surface and subsurface surveying are conducted to locate different minerals and rocks. In addition, geological features of the terrain such as folds and faults are located.

- **Mine Survey** - includes include both surface and underground surveys. It is conducted for the exploration of mineral deposits and to guide tunneling and other operations associated with mining

- **Archaeological Survey**- It is conducted to trace relics of past civilization, kingdoms, forts, temples, etc.

- **Military Survey**- It has a very important and critical applications in the military. It is conducted to locate strategic positions for the purpose of army operations

Classification of Surveying based on instruments used- *refer ppt for explanation*

Chain Survey, Compass Survey, Plane Table Surveying, Theodolite Survey, Tachometry Survey, Leveling Survey, Photogrammetric Survey, EDM Survey

Principles of Surveying – refer answer key & ppt

Direct ranging- refer answer key & ppt

Ranging- When a survey line is longer than a chain length, it is necessary to align intermediate points on chain line so that the measurements are along the line. The process of locating intermediate points on survey line is known as ranging. There are two methods of ranging - direct ranging and reciprocal ranging

Instruments are used for horizontal measurement / chaining

Chains, Tapes, Arrows, Ranging rods and offset rods, Laths & Whites, Pegs, Plumb bob, Cross staff

Ranging rods are used for ranging some intermediate points on the survey line. Ranging rods are circular rods 2 to 3 m in length and are painted with characteristic red & white bands

Cross staff - Used for setting out right angles to a chain line is called cross staff. Main parts are a frame or box with two pairs of vertical slits & a pole to mount it. Different type's are- open cross staff, French cross staff, adjustable cross staff

Tapes are used where greater accuracy of measurements are required, such as setting out of buildings and roads they are 15m or 30m long C*lassified based on the materials such as* Fiber Tape-

- Cloth or linen tape- made up of linen cloth with brass handle Cloth tapes are not used for accurate measurements because: 1) Length of cloth tape is gets altered by stretching. 2) Cloth tape is easy to twist and tangle. easily affected by dampness
- Metallic Tape- it is linen tape reinforced with brass to prevent stretching or twisting of fibers Metallic tapes are particularly useful in cross-sectioning
- Steel tape- wound on a corrosion resisting metal case
- Invar Tape it is made of alloy of steel 64% & nickel 36% errors due to temperature are minimum used for high precision work

Levelling terms

- **line of collimation-** it is a line joining intersection of cross hairs of diaphragm to the optical Centre of object glass & its continuation it is as known as line of sight
- **Datum surface**-. Imaginary level surface with reference to which vertical distance of points are measured .In India mean sea level is considered as datum of zero elevation

- **Elevation.** The distance measured along a vertical line from a vertical datum to a point or object
- **Benchmark (BM)** - A relatively permanent object, natural or artificial, having a marked point whose elevation above or below a reference datum is known or assumed. Types are - GTS benchmark, Permanent bench mark, Arbitrary benchmark, Temporary benchmark
- **Height of instrument**: It is the elevation of the plane of sight with respect to assumed datum. It is also known as plane of collimation.
- **Back sight (BS)**: It is the first sight taken on the level staff, of a known elevation with the intention to obtain the elevation of plane of collimation. It is called PLUS sight because it is added to elevation of that point to get height of instrument or plane of collimation.

- **Intermediate sights (IS):** These are the sight taken after back sight and before sighting the final point. These are called MINUS sights. These are subtracted from plane of collimation to find the reduced level of different points.
- **Fore sight (FS):** The last reading taken from the instrument before shifting instrument. This is also a MINUS sight.
- **Change point (CP)** or turning point (TP): The point at which both BS and FS are taken.
- **Reduced level(RL):** The elevations of the points with respect to assumed datum

Following Instruments essentially required in levelling

(i) Leveling instrument (ii) Levelling staff

***Levelling Instrument*:**

Instrument used to furnish horizontal Line of sight for observing staff readings & determining RL Simplest form of levelling instrument is dumpy level. The different parts of levelling instrument are,

(a) Telescope (b) Eye-piece (c) focusing knob (d) level tube (e) cross bubble (f) foot screws (g) levelling head (h) diaphragm (i) ray shade Types of level- dumpy level, tilting level, automatic level

Dumpy level- it is a simple, compact & stable instrument. Telescope is rigidly fixed to its support .henceit cannot be rotated abut its horizontal axis

***Levelling staff*:** It is an important accessory used with levelling instrument at the time of conducting levelling survey. Reading is taken on the levelling staff held properly at the point concerned by viewing through the telescope of the levelling instrument.

- Usually 4 m levelling staff may be used of folding type or telescopic type
- Types are – self reading staff & target staff

Basic Principle of Leveling-

- Measures height differences between points
  - Along a line
  - Several points from one occupation

Also explain simple levelling

Types of levelling- Simple levelling, Differential levelling, Fly levelling, Profile levelling, Cross sectional levelling, Reciprocal levelling

There are two methods for obtaining the elevations at different points:

Height of instrument (or plane of collimation) method , Rise and fall method

Temporary adjustments of levelling

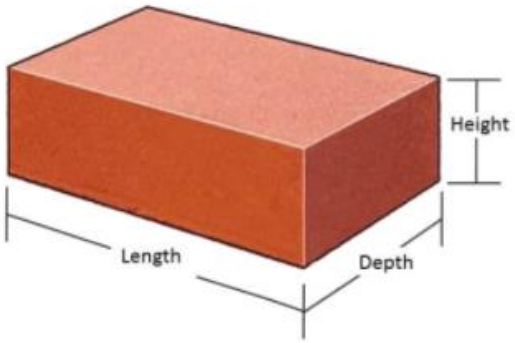
These adjustments can be performed at every setup of instrument setting up of level

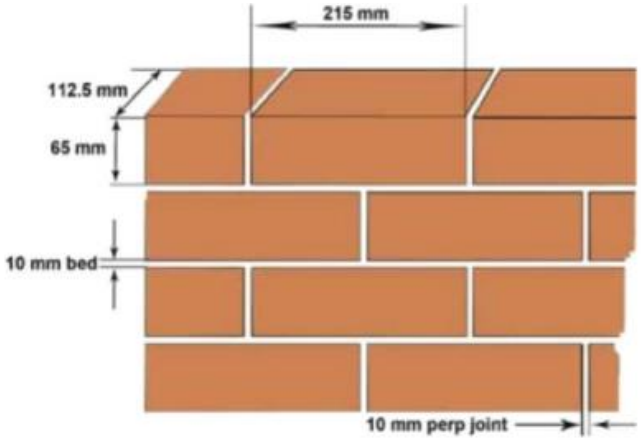
- Setting up of the level
- Levelling of telescope
- Elimination of parallax- i) Focusing of the object glass
  - ii) focusing of the eyepiece

MODULE 4 - BUILDING MATERIALS

BRICKS

Bricks are prepared by moulding clay in rectangular blocks of uniform size and then drying and burning these blocks. In order to get a good quality brick, the brick earth should contain following constituents.





Constituents of Good brick earth

Silica

- Brick earth should contain about 50 to 60 % of silica.
- It prevents cracking, shrinking and warping of bricks.

Alumina

- Good brick earth should contain about 20% to 30% of alumina.
- It imparts plasticity to earth, for moulding operation.
- If present in excess, then the raw brick shrink and warp during drying.

Lime

- The percentage of lime should be in the range of 5% to 10% in a good brick earth.
- It causes silica in clay to melt on burning and thus helps to bind it.

Iron oxide

- A good brick earth should contain about 5% to 7% of iron oxide.
- It imparts red color to the bricks.
- It improves impermeability & gives hardness.

Size of brick

Conventional / Traditional bricks: Size 23 cm x 11.4 cm x 7.6 cm...Standard / Modular: Size: 19 cm x 9 cm x 9 cm. With mortar joints the size of these bricks will be 20cmx 10cmx 10cm...

Qualities/characteristics of bricks- refer *answer key*

1. Hardness 2 Soundness 3) Fire resistance 4) Strength.5) Water absorption. 6) Efflorescence. 7)Texture 8)Thermal Conductivity-

Classification of Bricks as per common practice:

Bricks, which are used in construction works, are burnt bricks. Unburnt bricks (dried in sunlight) used for filling works. Classified into four categories on the basis of its manufacturing and preparation,

First Class Bricks:

These bricks are table moulded and of standard shape and they are burnt in kilns. The surface and edges of the bricks are sharp, square, smooth and straight.

Second Class Bricks:

These bricks are ground moulded & they are burnt in kilns. The surface of these bricks is rough and shape is slightly irregular. May have hair cracks and their edges may not be sharp & uniform.

Third Class Bricks:

These bricks are ground moulded & they are burnt in clamps. They have rough surfaces with irregular & distorted edges. They are used for temporary structures & at places where rainfall is not heavy.

Fourth Class Bricks:

These are over burnt bricks with irregular shape and dark color. These bricks are used as aggregate for concrete in foundations, floors, roads due to the fact that the over burnt bricks have compact structure

Uses of bricks:

- A fire brick is used for lining the interiors of ovens, chimneys and furnaces.
- Broken brick are used as ballast material for railway tracks, and also as a road metal.
- Extensively used for construction of load-bearing walls and partition walls.
- Used for face-work when artistic effect is required.

CEMENT

Cement is a binder, a substance that sets and hardens and can bind other materials together. The cement is obtained by burning a mixture of calcareous (calcium) & argillaceous (clay) material at a very high temperature and then grinding the clinker so produced to a fine powder

Ordinary Portland cement- It consists of dry powder of very fine particles & forms a paste when mixed with water. This paste coats all the aggregates together as well as hardens & forms a solid mass. It holds Adhesion & cohesion properties. Chemical reaction like heat of Hydration occurs when mixed with water

Physical & chemical Properties, Grades of cement- refer answer key & ppt

Uses of Cement- Cement is used widely for the construction of various structures. Some of them are

(i) Cement slurry is used for filling cracks, in concrete structures.

(ii) Cement mortar is used for masonry work, plastering and pointing.

(iii) Cement concrete is used for the construction of various structures like buildings, bridges. Water tanks, tunnels, docks, harbors, Preparation of foundation, etc.

(*v*) For manufacturing cement pipes, railway sleepers, and precast structures

Boques compounds – *refer notes*

Ingredients /constituents of cement

	percentage	Constituents	Function
Sio2	17% - 25%	Silica(C2S& C3S)	Imparts strength. Excess increases setting time too
Al2O3	**3 to 8%**	Alumina	imparts to set quickly
Cao	62 - 67%	Lime	It provides strength. Excess lime causes to expand & disintegrate
Fe203	0.50 to 6%	Iron oxide	Provide color, hardness & strength
MgO	0.10 to 4 %	Magnesia	Provides, hardness &color. excess makes unsound
CaSo4	4 %	(gypsum)	Increase the initial setting time of concrete
So3	1-2.75%	Sulphur trioxide	Making sound cement.

Different Types of cement & their uses

Rapid hardening Portland cement

- It contains more C_3S are less C_2S than the O.PC
- Its 3 days strength is same as 7 days strength of O.P.C. Used in concrete where form work areremoved at an early stage.

Low heat Portland cement

- Heat generated in O.PC at 3days 80cal/gm. While in low heat cement it is 50cal/gm of cement.
- Reduce and delay the heat of hydration. Used in massive concrete construction like gravity dams

Sulphate resisting Portland cement

- It is used in construction exposed to severe sulphate action by water and soil in places like canals linings, culverts, retaining walls,
- Maximum % of C3A below 6% which increases power against sulphates

Blast Furnace Slag cement

- For this cement, the slag as obtained from blast furnace is used
- The clinkers of cement are ground with about 60 to 65 percent of slag.
- It proves to be economical, as slag is a Waste product, is used in its manufactures.

Pozzolanic cement

- As per Indian standard, the proportions of Pozzolana may be 10 to 25 % by weight.
- It imparts higher degree of water tightness
- used in marine structures, sewage works, & for laying concrete under water

White Portland cement

- Grey color is due to presence of Iron Oxide. Hence in White Cement FeO_2 is limited to 1%. •:
- It is quick drying, possesses high strength and has superior aesthetic values
- White Cement are used in Swimming pools, painting furniture, moulding sculptures & statues

---

CONCRETE

Concrete is a composite material composed mainly of binding material, water, aggregate, and cement. This can be easily moulded to desired shape and size before it loses plasticity and hardens. Often, additives and reinforcements are included in the mixture to achieve the desired physical properties of the finished material.

Constituents of Concrete and their Requirements

The materials that go to form concrete are:

1. *Binding material*, which is cement or lime. - Cement or lime binds aggregate by virtue of its inherent properties of setting or hardening in combination with water. It helps to fill the voids and gives density to the concrete. stone dust, als added in mortar

2. *Fine aggregate*, which is sand or stone dust.- dust serves to fill the voids in coarse aggregate and reduce the quantity of cement. It prevents shrinkage & cracks when mortar sets.

3. *Coarse aggregate* which are broken stone or broken brick. - Forms the main hulk of concrete around the surfaces of which the binding materials adhere in the form of a film.

4. *Water*- suitable for drinking. Free from harmful ingredients such as oil, alkali, acid. It activates the hydration of cement.

A small quantity of admixtures like air entraining agents, water proofing agents, workability agents etc. may also be added to impart special properties to the plain concrete mixture.

Preparation of concrete - refer second semester

answer keyCement bocks & its types – refer ppt

Grades of concrete & their uses

grades	Proportion of concrete	**Uses**
M5	1:5:10	Strong walls &foundations
M7.5	1:4:8	Mass concretes like dam, foundation course for walls, for making concrete blocks.
M10	1:3:6	Culverts, retaining walls, Flooring, Piers, abutments
M15	1:2:4	PCC
M20	1:1.5:3	RCC works- machine foundation,stairs,beams
M25	1:1:2	Water retaining structures, pile, footings for steel columns
M30	Design mixes	Heavy loaded RC columns, RCC arches
M35	Design mix	Pressed concrete

Properties of Concrete

Concrete has completely different properties when it is the plastic stage and when hardened. The properties of green concrete include: Workability, Segregation,

Bleeding, and Harshness.

The properties of hardened concrete are: Strength, Resistance to wear, Durability, and Impermeability.

Plain Cement Concrete

Plain concrete is a hard mixture of cement, fine, coarse aggregate & water. It is strong in compression butvery weak in tension

Reinforced Cement Concrete

Concrete is good in resisting compressive stress but very weak in resisting tensile stresses. Hence reinforcement is provided in the concrete wherever tensile stress is expected. Since elastic modulus & tensile strength of steel is quite high compared to concrete, the force & bond developed in steel is high. A cage of reinforcements is prepared as per the design requirements, kept in the form work and then green concrete is poured. After the concrete hardens, the form work is removed. The composite material of steeland concrete, now called R.C.C. acts as a structural member

PCC	RCC
Suitable for compression only Bears Less loads Doesn't withstand fire & weather Low tensile strength & ductility Volume instability Internal stress developed due to linear expansion	Can resist tensile as well as compressive forces efficiently. Bear heavier loads Resistant to erosion & abrasion Stress can be transmitted to steel Good ductile property Impermeable to moisture so used for water retaining structures

Uses of R.C.C.

R.C.C. is used as a structural member wherever bending of the member is expected. The Common structural elements in a building where R.C.C. is used are: Footing & Columns

R.C.C. is used for the construction of storage structures like: Water tanks & Dams

R.C.C. is used for building tall structures like Multistorey buildings, Chimneys, towers

R.C.C. is used for paving High ways, City roads, Airports

CEMENT

MORTAR

Mortar is an intimate mixture of binding material, fine aggregate and water. When water is added to the dry mixture of binding material (cement) and the inert material, binding material develops the property that binds not only the inert material (sand) but also the surrounding stones and bricks. Other mortars commonly used are lime mortar and mud mortar

Properties of Cement Mortar

Good building mortar should have following properties:

1. It should be easily workable, 2) gain sufficient strength for the work.

3. It should join the bricks or stones to give a tight joint.

4. A mix richer than 1:3 is prone to shrinkage.

5. Well-proportioned mortar provides impervious surface.

Preparation of mortar

For preparing mortar, first a mixture of cement and sand is made thoroughly mixing them in dry condition. Water is gradually added and mixed with shovels.

The cement to sand proportion recommended for plastering concrete 1:3 & Masonry works 1:6 to 1:8 **Curing-** Cement gains the strength gradually with hydration. Hence it is necessary to see that mortar iswet till hydration has taken place. The process to ensure sufficient moisture for hydration after laying mortar/concrete is called curing. Curing is ensured by spraying water. Curing normally starts 6–24 hoursafter mortar is used. It may be noted that in the initial period water requirement is more for hydration andgradually it reduces. Curing is recommended for 28 days.

STEEL

Steel is an alloy of ferrous metal with 0.25 to 1.5 per cent of carbon. Higher the carbon content, harder is the steel. Steel bars of circular cross sections are used as reinforcement to strengthen concrete structures.

Types of reinforcement bars

Plain steel bars- Round sections. Composed of Mild steel and medium tensile steel. Plain steel bars – 5mm to 32mm.Designated as Fe250. Used as window bars, for grills and for making steel gates

High yield strength bars /TOR Steel- provided with ribs deformation on surface so that bond betweenconcrete and steel improves. These bars are available in diameters 8 to 40 mm...

High tensile bars are used as reinforcement in prestressed concrete

Uses of Mild Steel:

(i) Round bars are extensively used as reinforcement in R.C.C. works.

(ii) Rolled sections like I, T, L, C, plates etc. are used to build steel columns, beams, trusses etc.

(iii) Tubular sections are used as poles and members of trusses.

(iv) Plain and corrugated mild steel are used as roofing materials.

(v) Mild steel sections are used in making parts of many machineries.

Structural Steel Sections / Market Forms of Steel

- **Rolled steel bar section:**
  - Indian Standard Round Bars (ISRO):

- Designated as ISRO 10 (round bars having diameter 10mm)
- Available in diameter varying from 6mm to 25mm

- *Indian Standard square bars (ISSQ):*
  - Designated as ISSQ 10 (square bars of size 10mm)
  - Used for grillwork, handrails for staircases etc.

- **Rolled Steel Plate Section (ISPL):**
  - Designated as ISPL 500 x 5 (500mm width and 5mm thickness)
  - Used for construction of water tanks & other storage structures, base plate for foundations
- **Rolled Steel Angle Sections (ISA)**- Designated as ISA and width and length of legs
  - Equal angle sections- i) Two legs will be equal in length

    ii) Available in sizes varying from 20mm x 20mm x 3mm to 200mm x 200mm x 25mm
  - **Unequal angle sections- i)** Two legs will be unequal in length.

    ii) Available in sizes varying from 30mm x 20mm x3mm x 3mm to 200mm x 150 mm x 18mm
- **Rolled steel Tee sections:**
  - Available in sizes varying from 20mm x 20mm x 3mm to 150mm x 150mm x 10mm.
  - Widely used as members of the steel roof truss and form built – up sections
  - Different types available are: Indian Standard Normal Tee (ISNT), Indian Standard HeavyTee (ISHT)
- **Rolled Steel Channel Sections:**
  - Consists of a web and two equal flanges.Designated by height of web and width of flange
  - Available in sizes varying from 100mm x 45mm to 400mm x 100mm.
  - Widely used for beams and columns
- **Rolled Steel I – Sections**
  - Consists of 2 flanges connected by a web.Designated of overall depth & width of flange.
  - Available in sizes varying from 75mm x 50mm to 600mm x210mm
  - Different types are: Indian Standard junior beam (ISJB), Indian Standard Light Beam(ISLB), Indian Standard Medium Beam (ISMB)

DIFFERENCE B/W MILD STEEL & HYSD BARS

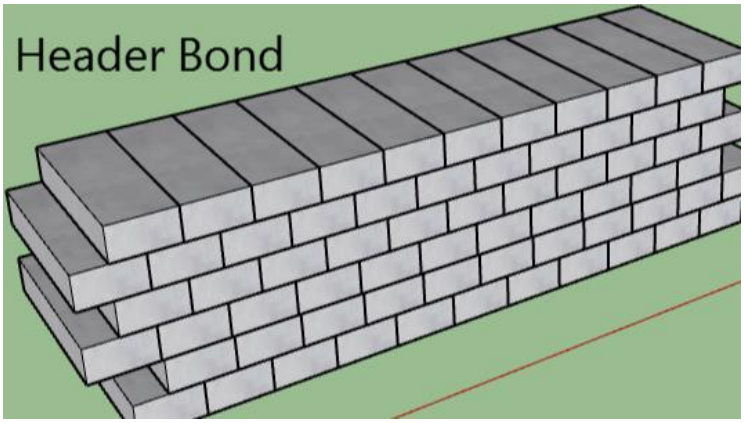
MILD STEEL BARS	(HYSD)/ TOR STEEL
• malleable and ductile, elastic • Plain steel bars – 5mm to 32mm • Yield strength – 250 N/mm^2 & Young's modulus is 2×10^5 • Equally strong in tension & in compression. • Specific gravity-7.8	• Cold twisted deformed bars • Tor steel bars – longitudinal ribs in the form of continuous helix • High yield strength • Mean diameters – 8mm to 40mm • Can be bent 180' without cracks • Designated as Fe415,Fe500, Fe550 • Note- (No. indicates the tensile strength)

MODULE 5

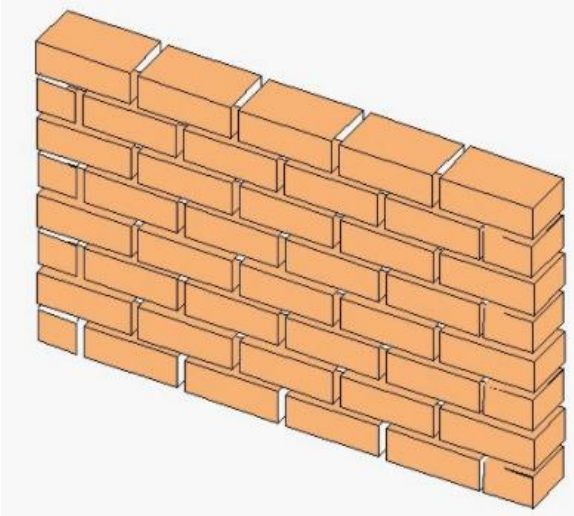
Module 5- BRICK MASONRY

The art of laying bricks in mortar in a proper systematic manner gives homogeneous mass which can withstand forces without disintegration, called brick masonry.

Header: A brick laid with its length perpendicular to the direction of wall. The course of brick work in which all the bricks are laid as headers is known as header course.



Stretcher: A brick laid with its length parallel to the direction of wall. The course of brick work in which all the bricks are laid as stretchers is known as stretcher course.



Quoins: it is a corner angle on face side of a wall. These are stones used for corners of walls of a structure.

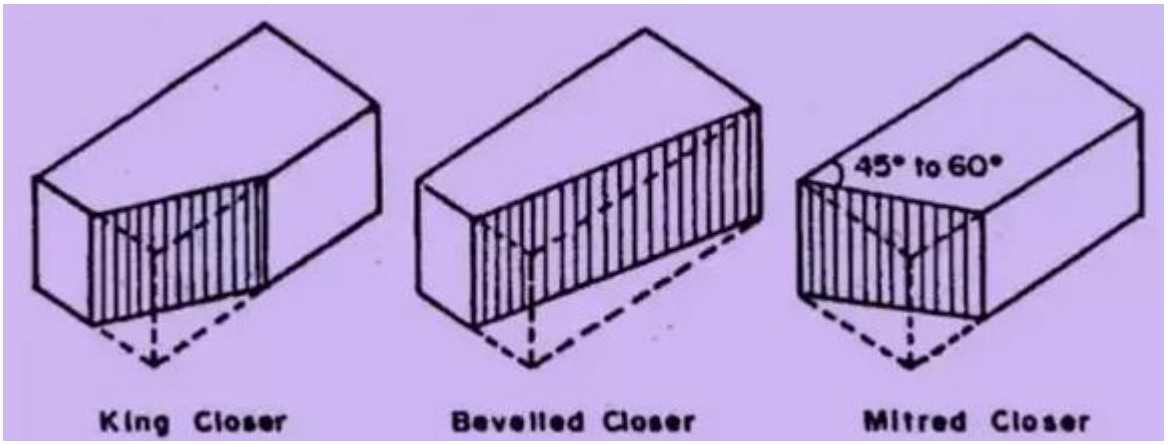
Bat: it is the portion of brick cut across the width.

Closer: it is the portion of the brick cut length wise in such a manner that its one long face remains uncut.

Queen closer: It is the portion of brick obtained by cutting a brick length wise into two portions.

King Closer: these are the portions of a brick obtained by cutting off the triangular piece between the center of one end and the center of one side.

Bevelled Closer: it is that portion of a brick in which the whole length of the brick is beveled for maintaining half width at one end and full width art the other.



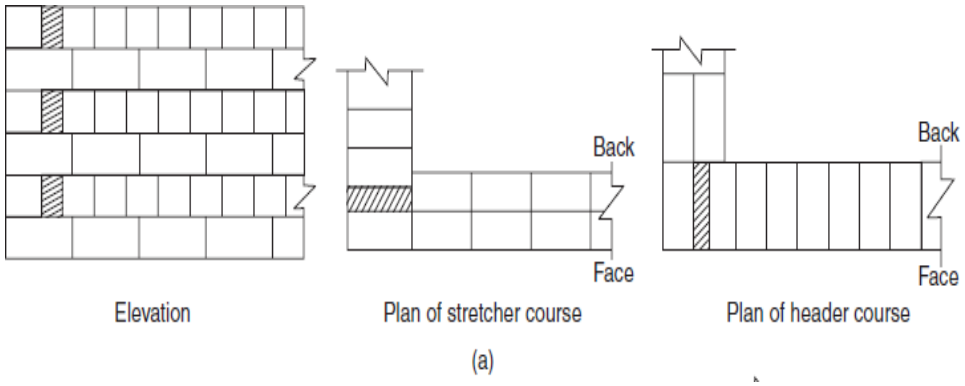
Types of bond- Stretcher bond, header bond, English bond, Flemish bond,

Flemish bond- In this type of bond each course comprises of alternate header and stretcher [Fig-4]. Alternate courses start with stretcher and header. To break the vertical joints queen closers are required, if a course starts with header. Every header is centrally supported on the stretcher below it.

English bond

- In this, alternate courses consist of either headers or stretchers in elevation.

- This is considered to be the strongest bond. Hence it is commonly used bond for the walls of all thicknesses
- To avoid continuity of the vertical joints, queen closers are provided



Comparison between English bond & Flemish bond- *refer supply.answer key pg 7*

Importance of determining Bearing capacity of soil

The selection of a suitable foundation is an important task for any structure. The type, depth, shape &size of foundation are to be determined so that it can safely transmit the load to the soil. The loads from a structure are finally transmitted to the soil & hence, it is important to study strength and behavior of the soil. The supporting power of soil without any failure is called bearing capacity

Purpose/Functions of Foundation *– refer second sem. answer key page 9*

• When depth of foundation is less than orequal to the width ,then shallow foundation • type of foundation Used when earth directly beneath structure has sufficient bearing capacity • cheaper than deep foundation & Easier	Deep foundations have depth more than width Used when the soil near the ground surface is weak Costly **&** Construction is difficult

Differentiate between shallow and deep foundation

Types of foundation *- refer supply. Answer key*

Strap Footing/ Cantilever Footing

- These are Isolated footings connected by a strap beam

- This type of foundation is provided when the distance between the columns is large.

Combined Footing

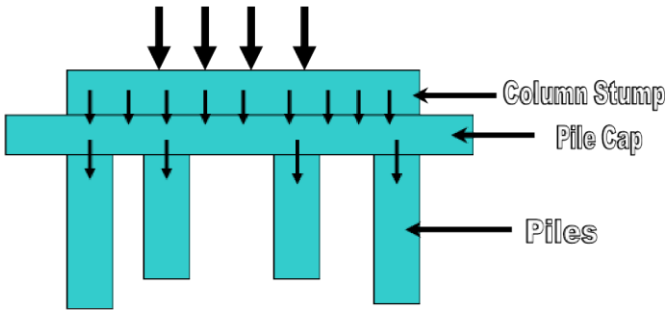
- When a footing is constructed for two or more columns is known as combined footing. The aim is to get uniform pressure distribution under the footing.
- Adopted when end column is near a property line so that its footing cannot spread in that direction.

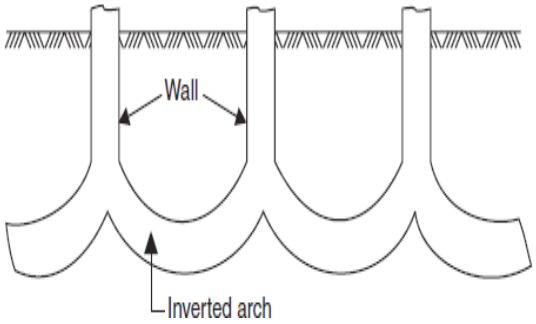
Inverted arch footing

- These are constructed between two walls at the base. In this, end columns are to be designed to resist outward pressure caused by arch action.
- It is commonly used for bridge piers, tanks& support for drainage works

Well Foundation

- Well foundation is a box like structure mainly used for the bridge construction
- They are hollow from inside which should be filled with sand and plugged at the bottom with concrete.





ROOFS

- Uppermost part of building as a structural covering & Protect building from weathering agencies

Requirements

- Should be durable, waterproof, fire resistant
- Should have adequate strength and stability, thermal and sound insulation properties

TYPES OF ROOF

1. Flat Roof- Used in plains where rainfall is less and climate is moderate. Over-head water tanks and other services can be located easily. Leakage problem may occur at latter date also due to development of cracks. Once leakage problem starts, it needs costly treatments

2. Pitched Roof- The slope of roof shall be more than 10°.The sloping roofs are preferred in large spanned structure like workshops, factory etc They are used in places where rainfall is more. Drainage is excellent

3. Curved Roof- They have top surface curved. Such roofs are provided to get architectural effects. It includes shells, domes, folded slab etc. Such roofs are more suitable for public buildings like libraries, theatre etc

Trussed Roof

- A roof truss is a frame work of members arranged in triangles to form a roof system made either of steel or timber

Purlins- these are horizontal steel members to support roofing material of a roof.

Rise- it is vertical distance between top of ridge & wall plate.

Principal rafter- this is the inclined member running from ridge to the eaves

Roof Coverings

Materials which gives a protective surface to the roofing structure. The **function** is only to prevent ingress or egress of heat & moisture into the building. Various types of coverings depending on :-The character of the building, type of the roofing structure, Local conditions, cost, etc.

TYPES OF ROOF COVERINGS

1.**Thatch Roofing-** This is the cheapest roof covering ,commonly used in villages. It is light in weight, but is highly combustible. It absorbs moisture and will decay easily

2. **Wood-** thin, tapered pieces of wood primarily used to cover roofs and walls of buildings to protect them from the weather

3.**Tile Roofing** - Made of a ceramic material and is hard and brittle, poorly suited for places where tree limbs can fall on a house's roof.

4.**Asbestos Cement Sheet(AC Sheet)** - These are widely used sheets for industrial buildings, factories, theatre etc. They are manufactured from asbestos mixed with O.PC. They are cheap, light weight & durable

5. **Galvanized Iron Sheets(G I Sheets)** – These are iron sheets galvanized with zinc to prevent corrosion. They are stronger than AC Sheets but are costly

6.**Aluminium Sheets** – They are long lasting, economical and corrosion free sheets It is light in weight with better appearance. They are mainly used for industrial buildings and for temporary construction

7.**Fibre Glass Sheets(FRP Sheets) -** Fibre reinforces polymer sheets are made with glass or any suitable fibre with a suitable resin. They are UV protected, non combustible, light weight and durable sheets

FLOORS

Selection criteria/requirements

- Should have Adequate strength and stability, fire resistance, Sound insulation, Damp resistance, Thermal insulation,Less Initial Cost , good Appearance, Cleanliness, Durability

TYPES OF FLOORS

- Depending upon the position of floors, it can be classified as-

1. Ground Floor, 2. Basement Floor , 3.Upper Floors

- Upper floors can be classified based on the material of construction as-

Jack Arch Floor

- Floors used in older days
- It consist of I Section of steel supported on walls and the gap b/w I section is filled with concrete arch

RCC Floor

- They are most commonly used in the construction
- The thickness of slab depends on the super imposed load
- For larger span(>4m) and for greater loads, RCC beam and slab construction is adopted

Flat Slab Floor

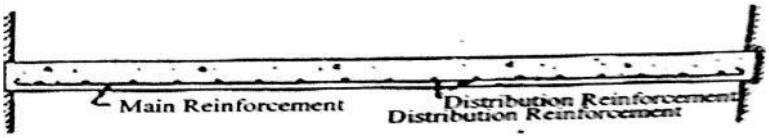


fig. 8.2 Flat slab floor

- In this, the load of reinforced slab is transferred directly to the supporting wall without beam

Precast concrete floor-

- With advancement in technology, it is possible to Cast suitable elements of floors with concrete and place it over walls or beams. Precast units are jointed & grouted with mortar at site. No formwork required

TYPES OF FLOORING

1. Mud Flooring

- Used for unimportant buildings, particularly in villages.
- Merits - Cheap, hard and fairly impervious. Good thermal insulation.
- demerits - For proper maintenance, the floors are required to be given a wash of cow dung plaster once a week

2. Brick Flooring

- Used in places where heavy articles are to be stored e.g. warehouses, stores and godowns
- Used in alluvial places like U.P. where stone is scarce and well burnt bricks are readily available.
- Merits- Durable and hard, Non-slippery and fire resistant. Initial cost is less.
- demerits -It is absorbent

3. Mosaic Flooring:

- Made of small pieces of broken tiles of glazed/cement/marble arranged in different pattern

- Tiles used are available in a variety of patterns and colours.
- Commonly used in operation theatres, temples, bathrooms and superior type of building floors

4. Tiled Flooring:

- Constructed from square or any other shape made of clay, cement or terrazzo.
- Available in sizes from 20cmx20cm to 120cmx 120cm.
- Merits- Quick laying of floors. Easily repaired.
- Demerits- Initial cost is high. On becoming wet, provides a slippery surface.

5. Timber Flooring

- Not used much for residential buildings in India because it is costly.
- Used for carpentry halls, dancing halls, auditoriums etc.
- Demerits- Entire area below the floor is covered with an impervious material ***to prevent dampness***.

PLASTERING

Applying mortar coats on surfaces of walls, columns, ceiling to get smooth finish is termed as plastering

Purpose / objective of Plastering

1. To conceal defective workmanship in masonry or concrete

2. To give even, smooth surface to avoid catching of dust.

3.To preserve & protect the wall from rain water and other atmospheric agencies.

Types of Plastering- Depending upon the binding material

- **Cement Plastering**, **Mud Plastering**, **Lime Plastering**, **Lime cement plaster**

Lime plastering

- Lime plaster is a mixture of calcium hydroxide and sand (or other inert fillers) in 1: 1 ratio.

Carbon dioxide in the atmosphere causes the plaster to set by transforming the calcium hydroxide into calcium carbonate (limestone).

Cement plastering

- Cement and sand in required proportions (1:3 or 4) are first thoroughly mixed in dry conditions and then water is added to form a paste of required consistency.
- This prepared mortar should be consumed within 30 minutes after the addition of water.

Procedure /method for cement plastering- *refer supply.answer key , page 14*

PAINT

Characteristics of good paint

- Good **spreading power**, Dry quickly, **Not crack on drying**
- **Durable, tough, resistant to wear on** drying,
- Color should not fade or change, Smooth and pleasing appearance.

Type of paints-Enamel paint, Emulsion paint, Distempering, Cement Paint, Bituminous Paints, Anti corrosive Paint, oil paint

Enamel Paint:

- It contains white lead, oil, petroleum spirit and resinous material.
- The surface provided by it resists acids, alkalies and water very well.
- It is desirable to apply a coat of titanium white before the coat of enamel is applied. It can be used both for external and internal walls.

Oil paint

- These paints are applied in three coats-primer, undercoat and finishing coat. Presence of dampness while applying the primer adversely affect the life of oil paint. This paint is cheap & easy to apply.
- Used in general purposes- Wood work, walls, ceiling , metal work etc

Anti-corrossive Paint:

- It consists essentially of oil, a strong drier, lead or zinc chrome and finely ground sand.
- It is cheap and resists corrosion well. It is black in colour.

Other two types of paint - study from supply. Answer key, page 12

Preparation of different surfaces for painting

Painting on new wood work

Four coats of paints are required.Before applying Prime coat

- ✓ Wood work to be cleaned thoroughly
- ✓ Nail holes and cracks to be filled with putty
- ✓ Rub the surface with water proof abrasive paper.
- ✓ Apply priming coat over the finished surface so that pores get filled
- ✓ After drying the first coat surface is rubbed with pumic stone
- ✓ Under coats and surface coat are then applied on the surface one after other

MODULE 6

BASIC INFRASTRUCTURE & BUILDING SERVICES

Vertical transportation is an important service to be designed with due care especially in multi storied buildings for the circulation of traffic both in normal use & in emergencies. The various measures of vertical transport are staircases, ramps, elevators or lifts and escalators.

Elevators or lifts

Elevator or lift is an appliance designed to transport persons or materials between two or more levels in a vertical or substantially vertical direction by means of a guided car or platform. Elevators are used in buildings having more than three storeys. They are either electric traction elevators or hydraulic elevators. Electrical traction elevators are used exclusively in tall buildings. Hydraulic elevators are generally used for low-rise freight service which rises upto about six storeys.

Various types of lifts are passenger lift, hospital lift, goods lift, service lift, fireman's lift. The important considerations of design of lift system are number of floors to be served, Floor to floor distance, Population of each floor, maximum peak demand. Various design parameters are population (The total building population & its future projections are required), quantity of service (Handling capacity- It is the measure passenger handling capacity), & Quality of service (or interval – time interval a passenger has to wait). The location of elevators should be such that it can be easily accessed by people.

Escalators

Escalators are power driven, inclined and continuous stairway used for raising or lowering passengers. These are used to move large number of people from floor to floor of buildings. Escalators are installed at commercial centres, shopping malls, airports, railway stations and in other public buildings where heavy people movement is expected. These stairs have continuous operation without the need of operators. Escalators with electronic sensors are also available which operate automatically only when people approach to use it so as to save energy. Escalators

have large capacity with low power consumption. Escalators are in the form of an inclined bridge spanning between the floors.

They are generally operated at a speed of 0.5 to 0.75 m/s. Slope of stairs is standardized at 30^0. For a given speed, the width of steps decides the capacity of the powered stairs. Normally a design capacity of 3200 to 6400 person per hour is adopted depending upon the width of the escalator. Escalators are installed at where traffic is heaviest & convenient for passengers in a building. Escalators are generally installed as pair. Up going traffic & down moving traffic are carried by this pair of escalators. The arrangement of escalators in each storey can be either parallel or criss-cross. Criss-cross is more compact & reduces walking distance.

Ramps

Ramps are sloping surfaces used to provide an easy connection between the floors or access from ground to the floors. They are especially useful when large number of people or vehicles have to be moved from floor to floor. They are usually provided at places such as garages, railway stations, stadiums, town halls, offices etc. As per the prevailing building bye laws, ramps are to be provided in all public buildings and residential apartments for the use of physically challenged persons in lieu of steps/stairs. It is also provided in hospitals to facilitate movement of stretchers & wheel chairs from one floor to other floor.

Ramps should be constructed with a non-slippery surface. Ramps are generally given a slope of 15 percent. But a slope of 8 to 10 percent is usually preferred. A level landing of minimum length 1.1m is provided at places where direction of ramp changes or at door steps. Minimum width of pedestrian ramp is 1.2m.

Air Conditioning

Air conditioning is the process of treating air so as to control simultaneously its temperature, humidity, purity, distribution, air movement and pressure to meet the requirements of the conditioned space.

Purposes:

- It is required to preserve & maintain the health, comfort & convenience of occupants
- It preserves quality of products & working of industrial process such as artificial silk, cotton etc.

Air conditioning is classified into:

- Comfort air conditioning: conditions of air inside the room are created to give max. human comfort.
- Industrial air conditioning: conditions are created, controlled and maintained which is suitable for the material processing, manufacturing and storage etc. rather than comfort.

Systems of air conditioning:

- Central system: In this system, all the equipments pertaining to air conditioning are installed at one central point & then the conditioned air is distributed to all rooms or enclosures by ducts. This type system is adopted usually in commercial, office, public & industrial buildings.
- Self-contained or unit system: In this system, special portable attractive cabinets which fit in with the decoration of modern rooms are placed inside the room near the ceiling or window.
- Semi-contained or unitary central system: In this system, every room is provided with an air- conditioning unit and the room unit obtains its supply from the central system.
- Combined system: A combined system may consist of one of the following combinations.
    a) Central and self-contained system
    b) Central and semi-contained system
    c) Self-contained and semi-contained system

Sound Proofing

Sound insulation is the process of soundproofing an enclosed space such as room. Sound

proofing is any means of reducing the sound pressure with respect to a specified sound source and receptor. This type of insulating activity is usually employed when there is a need to keep sound from filtering into or out of the space. Sound insulation techniques are often used in business settings, as well as in recording studios, radio, or television stations and other type of buildings.

The levels of air- borne and impact sound insulation for different frequencies have been laid by Indian Standard (IS: 1950-1962) for various types of buildings. Practical measures to reduce noise and for sound insulation are as follows:

- Lining of walls and ceilings can be done with air filled materials like straw boards, felts, glass wool, rock wool, perforated gypsum etc.
- Use of heavy and rigid partition walls & floors improves the sound insulation.
- Insulation of impact noise may be reduced with resilient materials like carpet, linoleum, cork under layers etc.
- Cavity walls or double wall construction with air space or filled with resilient materials is one of the best methods.
- Partition walls with porous materials like porous concrete, cinder concrete etc. reduces the noise transmission.
- Using of suspended ceilings
- In case of windows, sound insulation may be improved by making them air tight by using filling materials or rubber beadings.

SPECIAL STRUCTURES

Towers:

A tower is a tall structure, taller than it is wide, often by a significant margin. Towers are specifically distinguished from 'buildings' in that they are not built to be habitable but to serve other functions. The principal function is the use of their height to enable various functions to be achieved including: visibility of other features attached to the tower such clock towers; as part of

a larger structure or device to increase the visibility of the surroundings as in a fortified building such as a castle; or as a structural feature as an integral part of a bridge.

Towers can be stand alone structures or be supported by adjacent buildings or can be a feature ontop of a large structure or building.

Functions:

- To access tall or high objects
- To access atmospheric conditions: eg:wind turbine, meteorological measurementtower, tower telescope, solar power station
- To lift high tension cables for electrical power distribution transmission tower
- To expel and disperse potentially harmful gases and particulates into theatmosphere: chimney
- For industrial production: shot tower
- For surveying: Survey tower
- To drop objects: Drop tube (drop tower), bomb tower, diving platform
- To test height-intensive applications: elevator test tower
- To mimic towers or provide height for training purposes: fire tower, parachute tower
- As art: Shukhov Tower
- For recreation: rock climbing tower
- As a symbol: Tower of Babel, The Tower (Tarot card), church tower

Chimneys:

Chimney is a structure which provides ventilation for hot flue gases or smoke from a boiler, stove, furnace or fireplace to the outside atmosphere. Chimneys are typically vertical, or as near as possible to vertical, to ensure that the gases flow smoothly, drawing air into the combustion in what is known as the stack, or chimney, effect. The space inside a chimney is called a *flue*. Chimneys may be found in buildings, steam locomotives and ships.

The height of a chimney influences its ability to transfer flue gases to the external environment via stack effect. Additionally, the dispersion of pollutants at higher altitudes can reduce their impact on the immediate surroundings. In the case of chemically aggressive output, a

sufficiently tall chimney can allow for partial or complete self-neutralization of airborne chemicals before they reach ground level. The dispersion of pollutants over a greater area can reduce their concentrations and facilitate compliance with regulatory limits.

Classification of chimneys:

1. Self-supporting chimneys
2. Guyed chimneys: with support of guys
3. Stayed chimneys: with support of stays

Water tanks:

A water tank is a container for storing liquid. The need for a water tank is as old as civilization, to provide storage of water for use in many applications, drinking water, irrigation agriculture, fire suppression, agricultural farming, both for plants and livestock, chemical manufacturing, food preparation as well as many other. Water tank parameters include the general design of the tank, and choice of construction materials, linings. Various materials are used for making a water tank: plastics (polyethylene, polypropylene), fiberglass, concrete, stone, steel (welded or bolted, carbon, or stainless), Earthen ponds function as water storage. Water tanks are an efficient way to help developing countries, LEDCs, to store clean water.

In general water tanks can be classified under three heads:

1. Tanks resting on ground
2. Elevated tanks supported on staging
3. Underground tanks

INTELLIGENT BUILDINGS

An intelligent building is one equipped with the telecommunications infrastructure that enables it to continuously respond and adapt to changing condition, allowing for a more efficient use of resources, Increasing the comfort and security of its occupants .An intelligent building provides these benefits through automated control systemssuch as: Heating, Ventilation, Air conditioning, fire safety security , Energy /lighting , management

The intelligent building concept takes into consideration the fact that the true cost of a building is not only the cost of construction, but also the costs of operating, maintenance and repairs that come later.

An intelligent building can help reduce the operating and maintenance costs to a great extent by controlling and regulating the systems within the building. It is also possible to convertan existing building into an intelligent building by installing integrated systems.

In a new intelligent building installation we should expect the following features:

• High- speed fibre optic communication network trunk for data, video and BAS(building administrative system);

• Flexible HVAC system with modular distribution and 100% outdoor air capability to take advantage of free cooling as well as to allow flushing of the building to dilute volatile off-gassing contaminants;

• Advanced integrated Energy Management & Control System (EMCS) utilizing direct digital control technology for HVAC, Lighting, Fire Alarm and other building support systems;

• Dedicated circuit power distribution network complete with Uninterruptable Power Supply units;

• Generous standby power generation;

• High efficiency filtration, energy recuperation and/or thermal storage features to improve indoor air quality and energy consumption performance;

• Networked multi-user access incorporating structured password protection;

• Maximum transparency and communication capabilities between subsystems;

• Electrical design features tailored to Intelligent Building;

• Individually controlled HVAC terminal units allowing occupant control flexibility through Intelligent Terminals Controllers at each workstation.

Intelligent building model has been broadly subdivided into 7 systems:

- Heating, ventilating and air conditioning (HVAC) system
- Electrical power distribution system
- Communication systems

- Lighting systems
- Vertical transport systems
- Security system
- Life safety system