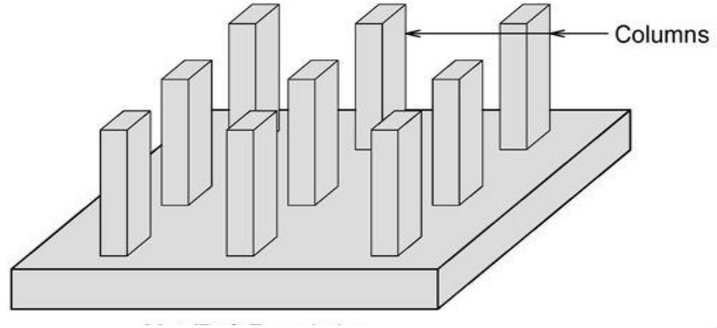
10

Building Construction and Drawing



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Technical and Vocational Stream
Learning Resource Material

Building Construction and Drawing

(Grade 10)

Civil Engineering

Government of Nepal
Ministry of Education, Science and Technology
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Preface

The curriculum and curricular materials have been developed and revised on a regular basis with the aim of making education objective-oriented, practical, relevant and job oriented. It is necessary to instill the feelings of nationalism, national integrity and democratic spirit in students and equip them with morality, discipline, self-reliance, creativity and thoughtfulness. It is essential to develop linguistic and mathematical skills, knowledge of science, information and communication technology, environment, health and population and life skills in students. It is also necessary to bring the feeling of preserving and promoting arts and aesthetics, humanistic norms, values and ideals. It has become the need of the present time to make them aware of respect for ethnicity, gender, disabilities, languages, religions, cultures, regional diversity, human rights and social values to make them capable of playing the role of responsible citizens with applied technical and vocational knowledge and skills. This learning resource material for civil engineering has been developed in line with the Secondary Level civil engineering Curriculum with an aim to facilitate the students in their study and learning on the subject by incorporating the recommendations and feedback obtained from various schools, workshops, seminars and interaction programs attended by teachers, students, parents and concerned stakeholders.

In bringing out the learning resource material in this form, the contribution of the Director General of CDC Mr. Yubaraj Paudel and members of the subject committee Dr. Jagat Kumar Shrestha, Dr. Bhim Kumar Dahal, Er. Anisha Lamsal, Er. Gita Lamichhane, Mr. Durga Bahadur Pun is highly acknowledged. This learning resource material is compiled and prepared by Er. Jagadishchandra Karki, Er. Kedarnath Dahal, Er. Hemantaraj Joshi and Er. Sabin Silwal. The subject matter of this material is edited by Mr. Badrinath Timsina and Mr. Khilanath Dhamala. Similarly, the language is edited by Mr. Nabin Kumar Khadka. CDC extends sincere thanks to all those who have contributed to developing this material in this form.

This learning resource material contains a wide coverage of subject matters and sample exercises which will help the learners to achieve the competencies and learning outcomes set in the curriculum. Each chapter in the material clearly and concisely deals with the subject matters required for the accomplishment of the learning outcomes. The Curriculum Development Centre always welcomes creative and constructive feedback for the further improvement of the material.

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Table of Content

Guidelines to Teachers

A. Facilitation Methods

The goal of this course is to combine the theoretical and practical aspects of the contents needed for the subject. The nature of contents included in this course demands the use of practical or learner focused facilitation processes. Therefore, the practical side of the facilitation process has been focused much. The instructor is expected to design and conduct a variety of practical methods, strategies or techniques which encourage students engage in the process of reflection, sharing, collaboration, exploration and innovation new ideas or learning. For this, the following teaching methods, strategies or techniques are suggested to adopt as per the course content nature and context.

Brainstorming

Brainstorming is a technique of teaching which is creative thinking process. In this technique, students freely speak or share their ideas on a given topic. The instructor does not judge students' ideas as being right or wrong, but rather encourages them to think and speak creatively and innovatively. In brainstorming time, the instructor expects students to generate their tentative and rough ideas on a given topic which are not judgmental. It is, therefore, brainstorming is free-wheeling, non-judgmental and unstructured in nature. Students or participants are encouraged to freely express their ideas throughout the brainstorming time. Whiteboard and other visual aids can be used to help organize the ideas as they are developed. Following the brainstorming session, concepts are examined and ranked in order of importance, opening the door for more development and execution. Brainstorming is an effective technique for problem-solving, invention, and decision-making because it taps into the group's combined knowledge and creative ideas.

Demonstration

Demonstration is a practical method of teaching in which the instructor shows or demonstrates the actions, materials, or processes. While demonstrating something the students in the class see, observe, discuss and share ideas on a given topic. Most importantly, abstract and complicated concepts can be presented into visible form through demonstration. Visualization bridges the gap between abstract ideas and concrete manifestations by utilizing the innate human ability to think visually. This enables students to make better decisions, develop their creative potential, and obtain deeper insights across a variety of subject areas.

Peer Discussion

Peer conversation is a cooperative process where students converse with their peers to exchange viewpoints, share ideas, and jointly investigate subjects that are relevant or of mutual interest. Peer discussion is an effective teaching strategy used in the classroom to encourage critical thinking, active learning, and knowledge development. Peer discussions encourage students to express their ideas clearly, listen to opposing points of view, and participate in debate or dialogue, all of which contribute to a deeper comprehension and memory of the course material. Peer discussions also help participants develop critical communication and teamwork skills by teaching them how to effectively articulate their views, persuasively defend their positions, and constructively respond to criticism.

Peer conversation is essential for professional growth and community building outside of the classroom because it allows practitioners to share best practices, work together, and solve problems as a group. In addition to expanding their knowledge horizon and deepening their understanding, peer discussions help students build lasting relationships and a feeling of community within their peer networks.

Group Work

Group work is a technique of teaching where more than two students or participants work together to complete a task, solve a problem or discuss on a given topic collaboratively. Group work is also a cooperative working process where students join and share their perspectives, abilities, and knowledge to take on challenging job or project. Group work in academic contexts promotes active learning, peer teaching, and the development of collaboration and communication skills. Group work helps individuals to do more together than they might individually do or achieve.

Gallery Walk

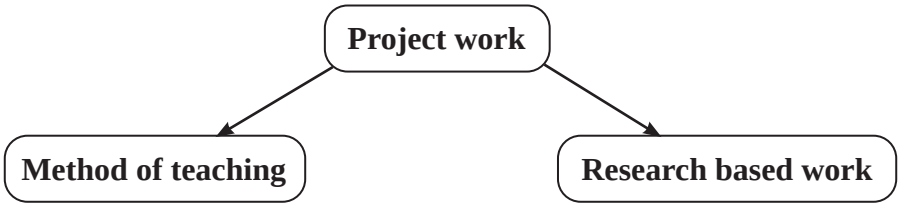
Gallery walk is a critical thinking strategy. It creates interactive learning environment in the classroom. It offers participants or students a structured way to observe exhibition or presentation and also provides opportunity to share ideas. It promotes peer-to-peer or group-to-group engagement by encouraging participants to observe, evaluate and comment on each other's work or ideas. Students who engage in this process improve their communication and critical thinking abilities in addition to their comprehension of the subject matter, which leads to a deeper and more sophisticated investigation of the subjects at hand.

Interaction

The dynamic sharing of ideas, knowledge, and experiences between people or things is referred to as interaction, and it frequently takes place in social, academic, or professional settings. It includes a broad range of activities such as dialogue, collaboration or team work, negotiation, problem solving, etc. Mutual understanding, knowledge sharing, and interpersonal relationships are all facilitated by effective interaction. Interaction is essential for building relationships, encouraging learning, and stimulating creativity in both in-person and virtual contexts. Students can broaden their viewpoints, hone their abilities, and jointly achieve solutions to difficult problems by actively interacting with others.

Project Work

Project work is a special kind of work that consists of a problematic situation which requires systematic investigation to explore innovative ideas and solutions. Project work can be used in two senses. First, it is a method of teaching in regular class. The next is: it is a research work that requires planned investigation to explore something new. This concept can be presented in the following figure.



Project work entails individuals or teams working together to achieve particular educational objectives. It consists of a number of organized tasks, activities, and deliverables. The end product is important for project work. Generally, project work will be carried out in three stages. They are:

- Planning
- Investigation
- Reporting

B. Instructional Materials

Instructional materials are the tools and resources that teachers use to help students. These resources/materials engage students, strengthen learning, and improve conceptual comprehension while supporting the educational goals of a course or program. Different learning styles and preferences can be accommodated by the variety of instructional

resources available. Here are a few examples of typical educational resource types:

- Daily used materials
- Related Pictures
- Reference books
- **Slides and Presentation:** PowerPoint slides, keynote presentations, or other visual aids that help convey information in a visually appealing and organized manner.
- **Audiovisual Materials:** Videos, animations, podcasts, and other multimedia resources that bring concepts to life and cater to auditory and visual learners.
- **Online Resources:** Websites, online articles, e-books, and other web-based materials that can be accessed for further reading and research.

Maps, Charts, and Graphs: Visual representations that help learners understand relationships, patterns, and trends in different subjects.

Real-life Examples and Case Studies: Stories, examples, or case studies that illustrate the practical application of theoretical concepts and principles.

C. Assessment

Formative Test

Classroom discussions: Engage students in discussions to assess their understanding of concepts.
Quizzes and polls: Use short quizzes or polls to check comprehension during or after a lesson.
Homework exercises: Assign tasks that provide ongoing feedback on individual progress.
Peer review: Have students review and provide feedback on each other's work.

Summative Test

Exams: Conduct comprehensive exams at the end of a unit or semester.
Final projects: Assign projects that demonstrate overall understanding of the subject.

Peer Assessment

Group projects: Evaluate individual contributions within a group project.
Peer feedback forms: Provide structured forms for students to assess their peers.
Classroom presentations: Have students assess each other's presentations.

Objective Test

Multiple-choice tests: Use multiple-choice questions to assess knowledge.
True/False questions: Assess factual understanding with true/false questions.
Matching exercises: Evaluate associations between concepts or terms.

Portfolio Assessment

Compilation of work: Collect and assess a variety of student work samples.
Reflection statements: Ask students to write reflective statements about their work.
Showcase events: Organize events where students present their portfolios to peers or instructors.

Observational Assessment

Classroom observations: Observe students' behavior and engagement during class.
Performance observations: Assess practical skills through direct observation.
Field trips: Evaluate students' ability to apply knowledge in real-world settings.

Unit 1: Definition of estimating

1.1 Introduction to Building

1.1.1 Introduction to Building and their Types

Types of Building

Residential Building

Residential buildings are used for residence purpose. They are small scale in shape and size. These building are used for human beings and have small scale of different rooms like living room, bathroom, bedroom, kitchen, etc.

Institutional and Educational Building

These buildings are type of building in which school, college, university, are open. It's main purpose is to give public platform for the different education like commerce, arts, science, etc.

Business Building

In these types of building, the commercial thing like market, shop will be open and give service to public. Business buildings are used in large scale so that large number of businesses and people get more service from it.

Storage Building

The buildings in which different types of material or things can be stored for a long time are storage building.

Industrial Building

These types of building are built for the production purpose in large scale so that it can manufacture different types of daily usable things and other useful things required for future.

1.1.2 Loads on Building

1. **Live loads:** These are the loads that can move or change, like the weight of people standing on the floor, furniture, materials temporarily stored, or even snow on the roof. This load is measured in kilonewtons per square meter (kN/m^2).

2. **Dead loads:** These are the permanent loads of a building, like walls, floors, roofs, and pillars. Other fixed things, like partition walls or terrace gardens, are also part of the dead load. This load is measured in kilonewtons per square meter (kN/m^2).

3. **Wind load:** In tall buildings, wind pressure must be considered because it acts on the exposed walls and roof. This pressure can affect the stability and safety of the building, so engineers carefully design structures to withstand it.

1.1.3 Components of Building

Sub-structure

It is the lower portion of the building usually located below the ground level which transmit the load of the super structure to the supporting soil. Its basic function is to transmit the dead load, live load and other load to the sub-soil or sub grade soil. In the sub-structure, it consists of mainly footing. This is the lowest part of the building or any construction work in which different part like wall, PCC, RCC, soling and natural ground sub soil or sub grade soil. This all components are design or constructions per specification and required.

Super Structure

It is part of a building which is above the ground level and it serves the purpose of use. The super structure has masonry work, beam, pillar, roof structure, floor structure, door, window, staircase or finished work.

Masonry Work

It is defined as the construction of the building. It is the boundary of the building. It makes the partition of the building or divide the room in the different part of the area. Its main purpose is to separate the area for different purposes inside the building. It is the essential part or component of the building and its primary function is to enclose and to make functionable useful.

Column/Pillar

It is an essential part of the building. It is on isolated vertical load bearing member and having length, breadth and height as per design or required. It is the vertical component so that it takes all the load of the sub-structure. So, generally column or pillars are stronger than other structure.

Beam

It is an also calculated horizontal tensile load bearing member having length, breadth and span as per required or as per design. It is horizontal component so that its main purpose is to support the wall, slab or other any component of building on slab and it transfers its own weight or load and other all load above it to the pillar.

Floor Structure

Floors are the horizontal element which divides the building into different level. Its main purpose is to create the open surface or accumulation for the different use on it. It has length, breadth and thickness as per required or design. In the building, floor work is of any material or any types.

Roof Structure

A roof is the uppermost part of the building. It is covering provided on the top of building with a view to keep out rain, snow, sunlight, wind, etc., and to protect the building from their adverse effect. The roof is of different design such as slope, flat; and of different materials.

Door

A door is a framework of wood, steel, aluminum, etc. fixed in the wall opening for the purpose of providing access to user of the building.

Window

It is also an opening made in the wall; and fixed on it for the purpose of providing day light, wind or ventilation and for vision purpose.

Staircase

It is defined as a series of steps which are suitably arranged for the purpose to connect different floor of the building. It provides an easy, safe, and quick access to the user in the different floor to floor.

Building Finish

They are used to give protective coveting to various building component at a same time. They provide decorative effect.

1.1.4 Consideration of Building Design

- Types of building

- Geographical location
- Decorative purpose
- Fine performance
- Impact resistance
- Environmental performance
- Detailing and interface
- Cost

1.2 Foundation

1.2.1 Definition of Foundation

Every building has two basic components; one is super structure and the other is sub-structure.

A foundation is, therefore, that part of structure which is in direct contact with ground to which the load is transmitted. It is the lowest land in which all the buildings load is rested on it; and it is totally below the ground level and in some cases the lowest part of building wall or masonry partially or wholly below the surface of ground. The foundation will resist all load i.e. dead load, live load, wind load will transmit the sub grade soil and it won't provide any settlement on the foundation. A foundation should be sufficiently strong to prevent excessive settlement as well as unequal settlement. Foundation also preserves the building from ground movement, shrinkage of land, uplift pressure and other unexpected impact.

1.2.2 Function of Foundation

a. Reduction of Load Intensity

Foundation distributes the load of the super structure to the large area so that the intensity of load at its base doesn't exceed safe soil bearing capacity of the sub-soil.

b. Even Distribution of Load

Foundation distributes the non-uniform load of super structure evenly to a large are of sub-soil for example. Two columns carrying unequal load can have a combine footing which may transmit the load to sub-soil evenly with uniform soil pressure. Due to this, unequal or differential settlement are minimized.

c. Provision of Level Surface

Foundation provides level and hard surface over which the super structure can be

built.

d. Lateral Stability

Due to the different load like wind load impact load and the load created by soil mass movement inside the ground. The foundation will give to the stability for the super structure of the building. It gives stability on sliding and over turning.

e. Safe Against Under Mining

In some cases, under the beneath of the foundation, the soil can be scoring. As a result, the foundation may get unequal settlement, foundation gives safety against it.

f. Protection Against Soil Movement

Foundation will measure preventive method to minimize the crack on the super structure or other structure due to the movement of soil or expansion or construction and due to the moisture movement.

1.2.3 Essential Requirement of Good Foundation

Foundation should be constructed safely with the following requirement:

- Foundation should be constructed to resist/bear on the imposed load and to transmit to the sub grade soil in such a way that all pressure.
- Won't give any settlement on the foundation.
- The foundation base should be rigid so that all the differential settlement can be minimized when the super structure load or other are distributed unevenly.
- Foundation should be taken sufficiently deep to resist the building laterally when the soil-mass get movement under foundation.
- Foundation should be performed stable when it is affected by unexpected load or impact.

1.2.4 Types of Foundation

a) Shallow foundation

b) Deep foundation

Shallow Foundation

The features of shallow foundation are as follows:

- The depth of foundation is less than or equal to its width.
- It is placed immediately beneath the lowest part of super structure.

- It is spread more horizontal than vertical.
- It transfers the load to sub soil at a shallow depth close.

Types of Shallow Foundation

- Spread footing
- Strip footing
- Mat footing
- Grillage footing

Spread Footing

In this type of foundation, the base is made wider than the top so as to distribute the load from the superstructure over a large area. This type of foundation is commonly used for wall and masonry column. These foundations are built after opening the trench to required depth. These foundations are in suitable depth and they are grouped under shallow depth. Before starting the masonry, PCC is provided.

Types of Spread Footing

Isolated Footing

If separate footings are provided for each column, it is called isolated footing. The size of footing is based on the distribution of load and soil type and the thickness may be uniform or varying.

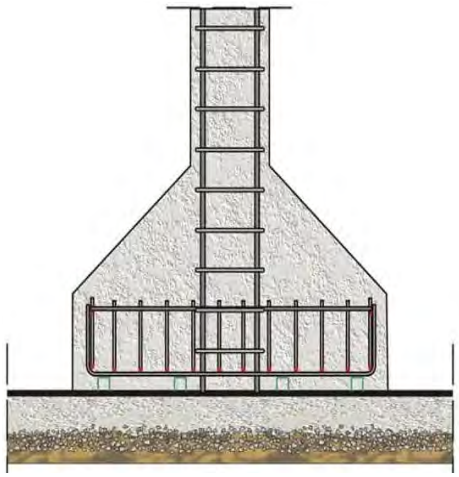


Fig: Isolated Footing

Combine Footing

In combine footing, two or more column are supported by a single base. This type

of footing is necessary when a column is much closed to each other and near to the boundary hence, there is no scope to project footing. The two columns may or may not be connected by a strap beam.

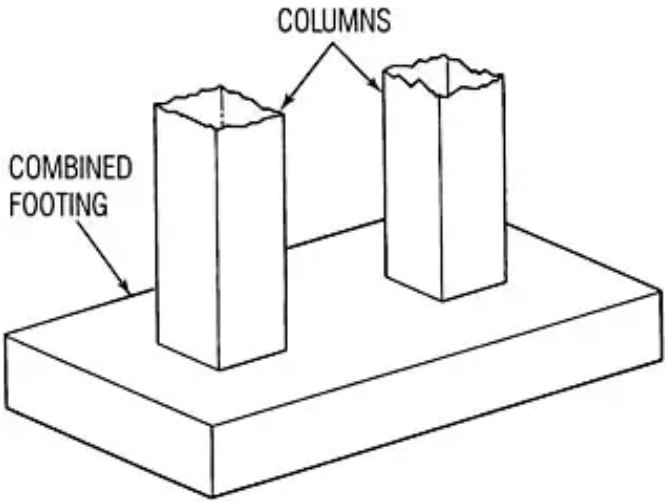


Fig: Combine Footing

Continuous Footing

If a footing is common to more than two columns in a row is called continuous footing. This type of footing is necessary if the columns in a row are closed, and, if bearing capacity of soil is low.

Strip Footing

Strip footing is an independent footing used for two columns; that columns are connected by a beam, especially in areas where the soil has low bearing capacity. These types of footing is also provided when the load from structure is transferred through walls, in boundary construction, where columns are eccentrically loaded, strip footings are used alone with a connecting beam to distribute the load properly.

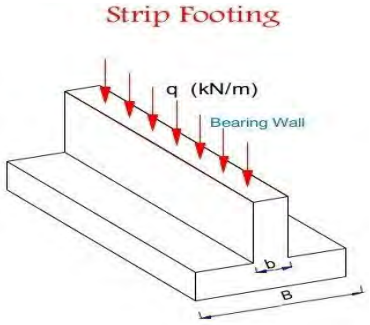


Fig:1.1 Strip Footing

Mat Footing

If the load on the column is quite high or when the bearing capacity of soil is very low and the size of isolated column may work out to be to such extent that they overlapped each other and the load of such building can't resist by isolated footing, in such case mat and raft foundation is provided. In this footing, the whole footing area is made one isolated footing of mat in its desired thickness. The advantage of such footing is that settlement in uniform and hence, unnecessary stresses are not produced.

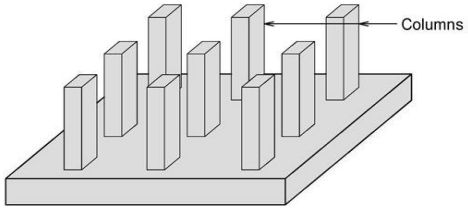


Fig: Mat/Raft Footing

Grillage Foundation

High rise buildings are built with steel column in case of concrete. Such columns carry very heavy load and hence they need very special foundation to spread out load to the large area of soil. Sp, Grillage foundation is one such special foundation which is used where, the load of the structure is excessive and the bearing capacity of soil is very poor and the deep foundation is not possible. It consist of I section steel beam and chanel section or I section are used for beam. All the floor load, and beam load are transferred to the base plate which is constructed at the base of the foundation. To rest all the base plate, column is constructed of an isolated footing inside the foundation and all other beam chanel section est on it.

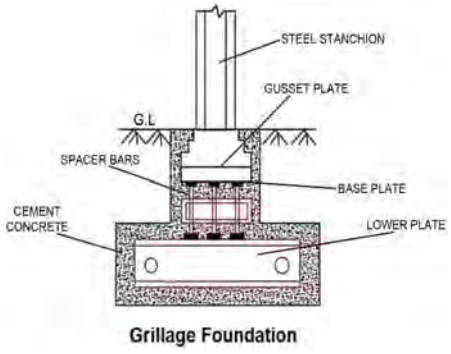


Fig: Grillage Footing

Deep Foundation

Deep foundation is those for which depth of the foundation is more than the width of

foundation. The foundation is driven deep into the ground till it reaches hard strata or compacted soil. This is preferred where the soil strata at the surface are not good for the bearing capacity of heavy structure of building and the bearing capacity of soil is very low and the soil contained more sand.

Necessity of Deep Foundation

Deep foundation when strata having more sandy and the bearing capacity of soil is unsuitable so the foundation of structure has to take deep with the purpose of attending or suitable bearing capacity of strata.

To ensure stability of structure e.g. The foundation a bridge must be placed very deep. Although suitable bearing strata may exist at a higher level.

Type of Deep Foundation

Pile Foundation

Pile is the pile like structure driven deep into the ground to increase the strength of soil. When the pile is driven, it makes soil compacted inside the ground and makes soil strata well compacted and strong. It acts as support to the spread footing. Piles are driven along the ground throughout the area of foundation or individually a one foundation. Piles are made precast or formed insitu by excavating a hole and then filling it with concrete. A group of pile is driven to the required depth and isolated foundation, mat or raft foundation is constructed over it and superstructure is constructed. In this way, pile foundation transfers the heavy load to the very depth of the foundation and also this foundation is used where the water-logged soil is presence.

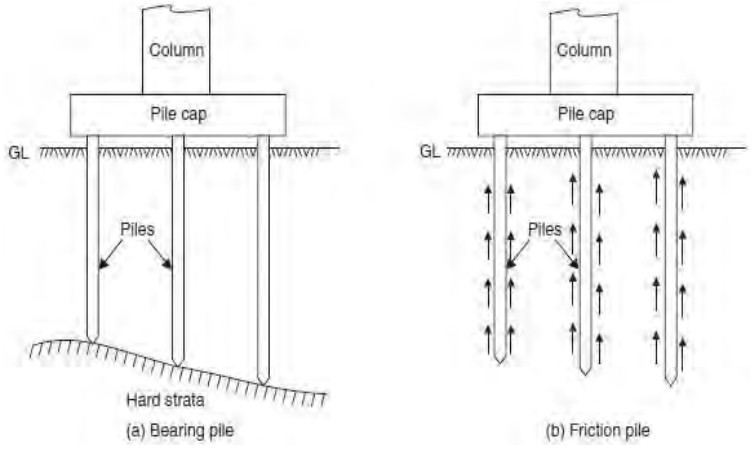


Fig: Pile Foundation

Caissons or Well Foundation

It is the water tight box structure of concrete. This foundation is mostly used in the bridge. It is constructed below the ground level. Caissons are inserted into the ground in the shape of box with a open buttom. It is made of concrete which is used for the water-logged area which provides resist to flow of water inside the foundation. If there is water movement inside the foundation, water may flow clay particle of the soil which makes soil strata weak in the deep foundation. Therefore, a well foundation should be constructed throughout the area of the foundation so that it makes the soil more compacted and increases bearing capacity. Above the well foundation; other structure such as isolated footing and super structures are built.

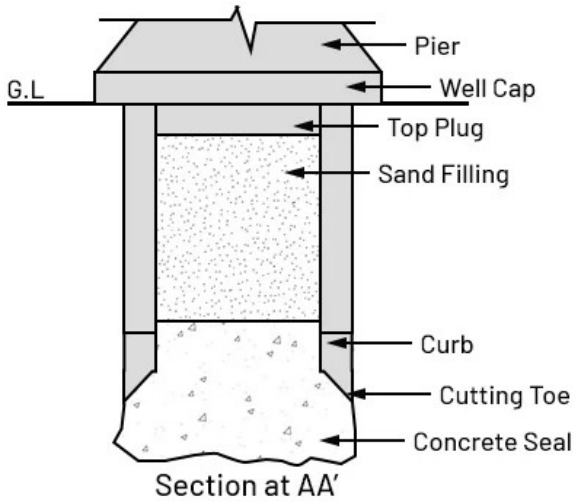


Fig: Caissons Foundation

Cause of Foundation Failure

The foundation fails or collapses due to the following reasons:

- Unequal settlement of soil beneath the area of building
- Unequal settlement of masonry work inside the building
- Due to the unequal load distribution to the footing level
- Shrinkage and cracks are formed in the soil particle which causes due to the movement of water in different weather
- Lateral escape of soil below the foundation due to the lateral movement of water
- The foundation may also fail due to the natural disasters like landslide earthquake
- It also fails due to the collapse of retaining wall and causes soil erosion on the

foundation level

Precaution Against Failure (Remedial measures)

- To prevent the unequal settlement; select the appropriate site and conduct soil testing before constructing the structure
- The foundation should be selected as per its soil type; and proper material should be used to prevent the unequal settlement of the foundation
- The unequal settlement of masonry can be prevented by using stiff mortar and avoiding construction the wall greater than 1.5m in height per day
- In some soil condition, the sub soil moisture may dry up during hot weather and cause shrinkage. In such case, piles should be driven down to the hard strata
- The lateral pressure on the sub structure can cause tilting overturning of foundation. This can be prevented by providing sufficient area below the wall and column
- The lateral scope of support in material like soil, retaining wall can be prevented by confining the soil by driving sheet pile around the foundation.

1.3 Staircase

1.3.1 Definition of Stair and Classification of Staircase

A staircase is defined as a series of steps provided to allow ascent and descent between two floors, often including landing. Staircase is generally located at the middle of the building though it can be at any corner. The opening or space occupied by the stair is called stairway. The other means of transportation between the floors are lifts, ramps, moving stairs, etc.

Classification of Staircase

1. Straight
2. Turning quarter

   Half dog legged

   Three quarter turn

   Open well
3. Circular or helical or spiral

1. Straight

In the straight staircase, all the steps are laid in one direction. This type of staircase

used when space is enough and width is narrow.

2. Quarter Turning

A stair turning through one right angle is called quarter turning stair. If the quarter turn stair is branched into two flights, then the landing must be provided and it is as middle.

Half Turning

Dog Legged

In the case of Dog legged stair, the flight runs in opposite direction and there are some inches of space between them. This is good for less space available in the building.

Open Well

In the case of open well, there is a well or hole or space between two flights and the steps are added in between that open space.

Three Quarter Turn

A stair turning through three right angles is called three quarter turn.

3. Circular or Helical or Spiral

In this type of stair, the steps are made from the center of the main post, and they behave like circular or helical or spiral.

1.3.2 Technical Terminology

1. Baluster	2. flight
3. going	4. handrail
5. Headroom	6. landing
7. Newel post	8. Nosing
9. Riser	10. Tread
11. Pitch/slope	12. waist
13. Scotia	14. Soffit

Baluster

This is the vertical member which is fixed between the handrail and on steps to give support the hand rail.

High

This is defined as the unbroken series of steps between the landing.

Going

This is the horizontal distance between the face of two consecutive riser.

Handrail

It is the inclined rail over the Balster. It is provided at convenient height of different material so as to give graps to the hands during ascent and descent.

Headroom

This is the vertical distance between the nosing of one flight and the bottom of flight immediately above.

Landing (a raised level area in which people or things stand)

It is the horizontal platform between two flight of stair. It changes the direction and provides the opportunity of taking rest during the use of stair.

Newel Post

This is the vertical member which is placed at the end of the flight to connect the end of string and handrail.

Nosing (at or to the further side of)

The projection part of the trade beyond the face of riser.

1.3.3 Requirement of Good Stair

1. Location
2. Width of stair
3. Length of light
4. Pitch of stair
5. Material
6. Landing
7. Different components (handrail, newel post headroom, riser, tread)

A well plan and design of staircase should provide an easy, quick and safe mode of communication between the floor. The requirement of good stair are:

Location

It should be located at the middle point of building or sufficient light and ventilation.

Width of Stair

It is the width (breadth) part of staircase so that the breadth of staircase varies with the purpose and uses. The public and residential buildings have different width of stair. A good staircase should be sufficient for the two way movement in each case.

Length of Flight

The length of the flight varies for the comfortable ascent and descent in the stair. The number of steps in the flight should be more for the movement. The number depends on length fo the flight.

Pitch of Staircase (compliment insincerely)

The pitch of stair should be flatter as far as possible to make the easy movement on it. Its inclination slopes depends on the types of stair and height of building. The slope should not exceed 45^{o} and flatter less than 25^{o}.

Material

The material used in the staircase should be of good quality, so as to resist all type of damage and certain impact load while using it. It also should possess fire resistance quality.

Landing

The width of landing should be greater than or equal to the width.

Different Component

Handrail, Newel post, Tread and Riser must be of good material and should be provided with great finishing work so that while using it, it doesn't harm the user. The height of the handrails should rise above more than 0.8m and Trader and riser should be provided with as per design and tread should be horizontal and riser must be vertical.

1.3.4 Design Criteria (except structural design)

1. Width of flight=width of landing
2. Riser=(6-8)"

   6"=6x2.54 =15.24cm

   =150mm

   8"=210mm

3. Tread =(9-13)"

   9"=9x2.54x10 13"=13x2.54x10

   = 220mm =330mm

4. 2R+T=600
5. T=R-1
6. Slope

Q.1. For two storied building is to have an RCC stair from ground to first floor. The size of staircase is (5mx3m)

Height of floor = 3.3m (in residential Building, masonry thickness= 9" gap =6")

solution

Let

width of flight = 1190

we have,

width of flight= width of landing

Now, Height of half floor = $\frac{3.3}{2}$ =1.65cm

Let us assum height of Riser =160mm

in m = $\frac{160}{100}$ = 0.16

Now, No of Riser = $\frac{165}{0.16}$ = 10nos

No of Tread = R-1

= 10-1

= 9 nos

Let us, assume = 260mm

length of tread = 9x260mm

= 2340mm

Then, length covered by tread and landing = 3530mm and remaining 5000-3530mm

= 1470mm which is greater than 1000

1.4 Doors and Windows

1.4.1 Door

Door is a movable barrier seared in a wall opening which is used for the movement from the outside to inside and to ventilate the light and other physical atmospheric

control. Door is also is taken as noise barrier and it gives the complete form of room.

Door should be at the corner of the room as far as possible. If the double door is to be provided, in the room, the door should be in opposite wall if possible. The door should be kept minimum.

1.4.2 Window

A window is a ventilated open part of the room to admit the light and other atmospheric control inside room. It also provides view to outside the room. It is also a noise barrier.

1.4.3 Parts of Door/Window

Panel: It is the area of the shutter enclosed between adjacent near or next to rail.

Mullion: It is the vertical member of a frame which sub divides the door vertically.

Transon: It is the horizontal member of the door which subdivides the door horizontally.

Hold fast: This is the steel bent in Z shaped to fix or hold frame on the wall vertically.

Size of the Door

Main: Door for residential building, main door (1m to 1.5m) (width) and height (2m to 2.5m)

Main: (0.85-0.95m) width and height (2 to 2.5m)

(kitchen bathroom, store room, Baranda door): (0.6-0.85) width and height (2 to 2.5m)

Ventilator and Sky Lights

Ventilators are the small window fixed at the great height which is generally at the lintel a horizontal support across the top of a door level of the window. Its main function is to ventilate air outside to inside which is made up of frame and shutter with one panel and upwards openable. (a section of a door, vehicle, garment, etc)
Sky light is provided on the slope of the room to admit the light and it is water proof.

1.4.4 Location of Door/Window

Location of Window

The window must be on the middle part of the wall as far as possible; and in the case of more than one windows need, the gap between the two windows must be greater than 1m.

Windows are used for ventilation, view outside the room and for atmospheric control. So room requires atleast one window and one door. Windows should be kept at the height of greater than 0.6m from the floor level and must not be greater than 2.5m.

Location of Door

- The door should be kept in the corner of room as far as possible.
- It should be about 20-25cm far from the corner of the room.
- If two doors should be kept in one room, it must be in opposite direction if possible.
- The location of the door must be in the room such that it gives the easily movements of the user form one room to another room without any conflict.

1.4.5 Related Terminologies

For Door

1. **Lintel:** A horizontal structural element placed above the door opening to support the load above.
2. **Threshold:** The bottom part of a door frame provides a transition between two spaces.
3. **Architrave:** A decorative molding that surrounds the door frame.
4. **Hinges:** Mechanical devices that allow the door to swing open and close.
5. **Sill:** The bottom horizontal part of the door frame, similar to a threshold but typically found in exterior doors.

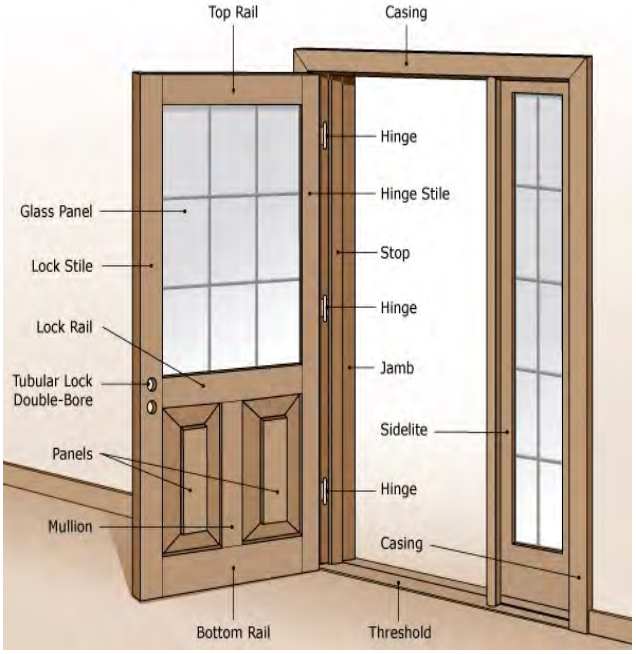


Fig: Door Parts

For Windows

1. **Mullion:** A vertical or horizontal structural element that divides window panes.
2. **Sash:** The frame that holds the glass in a window, which may be movable or fixed.
3. **Transom:** A horizontal bar or window above a door or another window.
4. **Glazing:** The process of installing glass panes in a window frame.
5. **Jamb:** The side post or frame of a window that supports the sash.

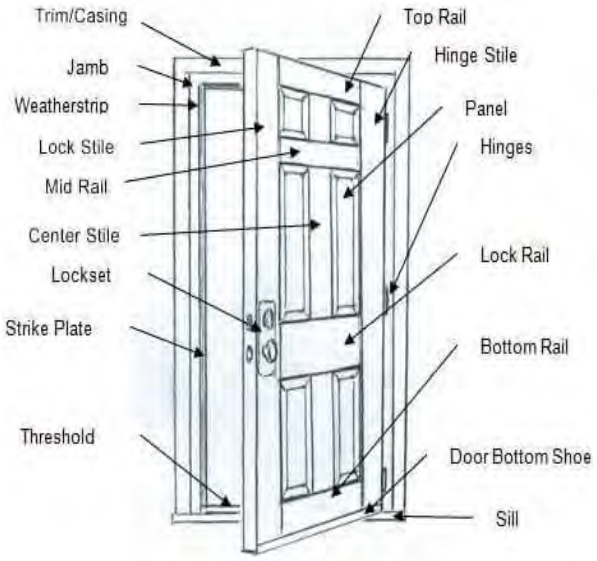


Fig: Window

1.4.6 Size and Types of Doors/Windows

Types of Windows

- Fixed window
- Pivoted window
- Sliding window
- Gazed window

Fixed window: These windows are provided for the purpose to admit the light and providing vision in the room. It cannot be opened.

Pivoted window: These windows are allowed to swing round pivoted fixed to the window frame. The frame of the window is similar to fixed window. The shutter of the pivoted window rotates either horizontally or vertically.

Sliding window: The shutter moves either horizontally a structure of a piece of glass on

which object is placed or vertically on the frame to make opening when it is slide. It is mostly used in buses, shops, bank, party palace and where the space is not sufficiently available for the opening.

Glazed window: They are provided if the additional light is required to the room. Glazed are usually used in all window in place of panel but in the case, glazed window is covered by glazed which is fixed at the frame and shutter.

1.5. Roof/Roof Covering Works

1.5.1. Roof

A roof is the top covering of a building that protects the structure and its occupants from external elements such as rain, wind, snow, and sunlight. Roof covering refers to the material used to cover the roof and provides weather resistance.

1.5.2. Requirements of a Roof

A good roof should:

- Be weather-resistant to withstand rain, wind, and extreme temperatures
- Provide thermal insulation for energy efficiency
- Offer sound insulation to reduce noise
- Have sufficient drainage to prevent water accumulation
- Be structurally stable and durable
- Be aesthetically pleasing, and complements the building design

1.5.3. Types of Roof (pitched or sloping roof)

1. **Gable Roof:** A triangular-shaped roof with two sloping sides
2. **Hip Roof:** A roof with slopes on all four sides, offering better stability
3. **Mansard Roof:** A four-sided roof with two different slopes on each side
4. **Shed Roof:** A single sloping roof, often used for small structures
5. **Gambrel Roof:** A two-sided roof with two different slopes, common in barns

1.6. Ceiling Works

1.6.1. Purpose of Ceiling

- Conceals structural elements (wiring, pipes, ducts)
- Provides sound proofing and thermal insulation
- Enhances aesthetics and lighting

- Improves fire resistance in buildings

1.6.2. Materials Used

- **Gypsum board:** Lightweight, fire-resistant, and commonly used
- **Plaster board:** Durable and provides a smooth finish
- **Wooden panels:** Aesthetic and provides warmth
- **Metal ceilings:** Durable and commonly used in commercial buildings
- **PVC ceilings:** Water-resistant and cost-effective

1.6.3. Advantages and Disadvantages

Advantages

- Enhances aesthetics and interior design
- Provides insulation and soundproofing
- Conceals electrical wiring and structural elements
- Improves energy efficiency

Disadvantages

- Can reduce ceiling height, making the room feel smaller
- Some materials require maintenance and repair over time
- Installation can be expensive depending on material selection

1.7. Flooring Works

1.7.1. Introduction to Flooring Works

Flooring refers to the permanent covering of a floor surface. It is an essential part of a building that provides durability, aesthetics, and comfort for users. Different types of flooring materials are selected based on function, aesthetics, and durability requirements.

1.7.2. Types of Flooring and Terminologies Used

Types of Flooring

1. **Concrete flooring:** Concrete Flooring is highly durable and can withstand heavy loads, making it ideal for industrial and commercial spaces. It is commonly used in warehouses, factories, and outdoor areas due to its strength and low maintenance. Additionally, it can be polished, stained, or textured to enhance its aesthetic appeal.

2. **Wooden flooring:** Wooden flooring offers a warm, natural, and elegant look, making it popular in residential interiors. It is available in various types, including hardwood, engineered wood, and laminate, each providing different durability and cost options. However, it requires regular maintenance to prevent moisture damage and scratches.
3. **Tile flooring:** Tile flooring includes ceramic, porcelain, and vitrified tiles, which come in various colors and patterns to suit different aesthetics. These tiles are water-resistant and easy to clean, making them ideal for kitchens and bathrooms. While highly durable, they can be slippery when wet, requiring anti-slip treatments in certain areas.
4. **Marble and granite flooring:** Marble and granite flooring is a luxurious natural stone option used in high-end buildings and homes. It is highly durable, resistant to scratches, and can be polished for a premium look. However, it is expensive and requires proper sealing to prevent stains and moisture absorption over time.
5. **Vinyl flooring:** Vinyl flooring is an affordable and water-resistant option, making it suitable for residential and commercial use. It is soft underfoot, providing comfort while being available in various colors and patterns that mimic wood or stone. Despite its advantages, it can wear out over time, especially in high-traffic areas.
6. **Carpet flooring:** Carpet flooring provides warmth, comfort, and sound insulation, making it ideal for homes, offices, and hotels. Available in different colors, textures, and materials like wool or synthetic fibers, it enhances the aesthetic appeal of interiors. However, it requires regular vacuuming and cleaning to prevent dust accumulation and allergens.

Terminologies Used

- **Subfloor:** The base layer beneath the flooring
- **Underlayment:** A layer placed between the subfloor and flooring for insulation and cushioning
- **Grouting:** The process of filling gaps between tiles or stones.
- **Laminate Flooring:** A multi-layered synthetic flooring imitating wood or stone.
- **Expansion Joint:** A gap left between flooring sections to accommodate expansion and contraction.

Exercises

Choose the correct answer from the given alternatives.

1. Which type of building is primarily used for educational purposes?

   a. Residential building

   b. Institutional and Educational Building

   c. Industrial Building

   d. Storage Building

2. What is the main purpose of a roof structure?

   a. To divide the building into different levels

   b. To cover the top of the building and protect it from weather elements

   c. To support the wall structure

   d. To connect different floors of a building

3. Which type of load includes the weight of furniture and people in a building?

   a. Dead Load b. Wind Load

   c. Live Load d. Foundation Load

4. What is the horizontal distance between two consecutive risers in a staircase called?

   a. Nosing b. Going c. Landing d. Riser

5. What is the vertical member that supports a handrail in a staircase called?

   a. Baluster b. Newel Post c. Soffit d. Scotia

6. Which type of foundation is used for deep structures like bridges or high-rise buildings?

   a. Shallow Foundation b. Spread Footing

   c. Deep Foundation d. Combined Footing

7. What is the purpose of a ventilator in a building?

   a. To provide access b. To allow light and air circulation

   c. To separate rooms d. To provide structural support

8. What is the role of a column or pillar in a building?

   a. To divide rooms

   b. To support vertical loads and transmit them to the foundation

   c. To cover the building

   d. To provide access between floors

9. Which type of staircase involves steps arranged around a central post?

   a. Straight Staircase b. Quarter Turn Staircase

   c. Spiral Staircase d. Dog-legged Staircase

Write short answer to the following questions.

1. Define a dead load in building construction.
2. What is the primary function of a foundation in a building?
3. Name three types of shallow foundations.
4. What is the function of a landing in a staircase?
5. Mention two essential requirements of a good door.

Write long answer to the following questions.

1. Explain the differences between live loads, dead loads, and wind loads, including examples for each type.
2. Describe the components of a staircase and their individual functions. Include technical terminology such as tread, riser, and baluster in your explanation.
3. Discuss the key considerations for designing a foundation, including its functions and the requirements of a good foundation.

Project Work

1. Draw the various shallow foundation, column, dog legged stair, frame of door and window, roof.

Unit 2: Substructure and Superstructure

2.1 Types of Wall and Their Function

a) Load bearing wall

b) Non load bearing wall

c) Partition wall

a) Load Bearing Wall

In general building a load bearing wall takes all the load of the building of super structure, (wall, door, window, slab, roof and finishes) etc. on it. Load bearing wall consists of brick with mortar or block combined of these three or other materials. In the building if there is no any frame structure, then all the load of the building is taken by the wall. So it is called load bearing wall.

Function

- Its main function is to resist the entire load which comes over the building and give the bounded structure for the building
- It takes the load of the roof and other load of floor, slab on it; and it transfer to the foundation
- It's another function is to install doors and windows on it
- Due to the load bearing wall, its thickness becomes larger than other wall. So, it has more load to the foundation
- It is also used as partition wall on the building

b) Non-load Bearing Wall

A non-load bearing wall is a type of wall which doesn't support the weight of structure other than the waqll itself. Examples of such walls include infill wall, interior wall,curtain wall, partition walls, etc.

Functions of Non-load Bearing Wall:

- Its main function is only to bound the boundary of building doesn't take any load except own load.
- Its function is less in compared to load bearing due to frame structure.

- In the non-load bearing wall its wall thickness is thinner than load bearing wall so, it has less load on the building.

Partition wall

A partition wall is a wall made by brick stone or other material which has the main purpose to divide or separate the room. It is also taken as a non-load bearing wall because all the load of the building is taken by main building wall and the partition wall is only constructed inside the building.

Function of Partition Wall

- Its main function is to divide or separate the room inside building. It is also used as to install the door for the room.
- Partition wall is used for the insulation purpose.
- Due to the thin wall thickness its load is also less than the main building wall.

Types of Brick Masonry

1. **Stretcher:** A stretcher is the longer face of brick. It is laid on an stretcher on facing is known as stretcher.
2. **Header:** A header is the shorter face of the brick.

Types of Stone Masonry Rubble, Coursed Hammer Dressed

a) Rubble Masonry

In the rubble masonry, the block of stones are used either undressed or comparatively roughly dressed. The masonry has wide joints, since stone of irregular size are used.

Its' main types are:

- Random rubble
- Square rubble
- Miscellaneous types
- Dry rubble

Ashlar Masonry

Ashlar is finally dressed masonry either an individual stone that has been worked until square or the masonry built of such stone. It is the finest stone masonry unit, generally cuboid or less frequently trapezoidal. It consists of block of an accurately dressed stone with extremely fine bed and end point. The blocks may be either square or rectangular

shape. The height of block in each course is kept equal or rectangular shape. The height of block in each course is kept equal but it is not necessary to keep all the course of same height. It is sub divided into:

- Ashlar fine tooled
- Ashlar rough tooled
- Ashlar rock, rustic or quarry faced
- Ashlar chamfered
- Ashlar block in course
- Ashlar facing

2.2 General Principle to be Observed in Stone Masonry Construction

- The stone used should be strong, tough, hard and should conform with specification of the work
- The stone used should be free form defect like cracks, flaws (flake) cavities veins, etc.
- Proper Bond should be maintained. Formation of vertical joint should be avoided
- Tough stone should be used for facing and backing of wall to well bond
- Double scaffolding should be adopted to carry out the stone masonry construction at higher level (at least at 1.5)
- After the construction is over, the whole work should be cured at least for 2-3 weeks

2.3. Choosing Wall Thickness, Height-to-Length Ratio for the Substructure

Selecting the appropriate wall thickness and height-to-length ratio in a substructure (foundation and basement walls) is crucial for ensuring stability, load-bearing capacity, and durability of a building.

1. Wall Thickness Selection

The thickness of a wall in the substructure depends on various factors such as the type of soil, load-bearing requirements, and materials used.

- **Brick Masonry Walls:** Typically range from 230 mm (9 inches) to 450 mm (18 inches) depending on load and soil conditions
- **Concrete Walls:** Usually 150 mm (6 inches) to 300 mm (12 inches) thick, with

reinforcement for added strength

- **Stone Masonry Walls:** Can be 350 mm (14 inches) or more, depending on stone size and foundation load
- **Rammed Earth or Stabilized Soil Blocks:** Typically, 250 mm to 450 mm, depending on compaction and soil strength

2. Height-to-Length Ratio of Walls

The height-to-length (H/L) ratio is crucial in preventing excessive slenderness, which may cause instability.

- The recommended H/L ratio for masonry walls is usually 1:4 or lower to prevent buckling
- For reinforced concrete walls, a ratio of up to 1:6 can be used due to higher structural strength
- Basement retaining walls should follow 1:3 or lower for better lateral resistance against soil pressure
- If the height is too large compared to length, lateral bracing or additional reinforcement is required

Proper selection of wall thickness and H/L ratio ensures the structural integrity, load resistance, and durability of the substructure, reducing risks of failure due to lateral forces, soil pressure, and load distribution.

2.4 Damp Proofing

Dampness is the presence of moisture due to hydroscopic or gravitational moisture on the building or any structure. The term damp proofing is treatment given to keep the wall, floor, roof and basement dry and free from any kind of moisture. Dampness gives rise to unhygienic condition and may effect of the different finishes.

Source of Dampness

- Ground water (Rising up)
- Air water or Condensation
- Rain water travel from wall top
- Defective junction from wall top
- Defective roof covering
- Faulty design of roof and valley gutter

- Improper rain water collection
- Inadequate roof slope
- Splashing rain water

Causes of Dampness

- Moisture rising up on the wall from the ground
- Every structure are founded on soil and soil get moisture from the ground water gradually due to capillary action in building or wall get moisture which cause dampness.
- Rain travel; from wall top
- Rain travel from wall top if wall top are not properly made and protected then the rain water get penetrate inside the wall
- Rain biting against external wall
- Due to splashing rain the wall get direct hit by the rain water and may get moisture which may enter inside the wall
- Condensation
- Condensation may also get wall dampness due to the condensation water deposited on wall, floor and ceiling cause dampness
- Miscellaneous poor drainage
- Imperfect roof slope
- Poor drainage
- Imperfect orientation
- Defective construction

Defect of Dampness

- Dampness creates unhealthy living condition
- Wall and ceiling may cause unsightly patches
- Softening and crumbling of plaster (especially lime, plaster)
- The wall decoration may damage
- Moisture in the wall may causes efflorescence of brick, stone tiles and may also reduction in strength
- Flooring material may get damaged

- Timber fitting such as door, window, etc. coming in contact with moisture and get deteriorated
- Electrical fitting may get damaged and get short circuit
- Growth of termites
- Spread the germs and cause dangerous diseases such as TB, and also cause asthma problem
- Moisture caused rusting, corrosion at metal fitting

2.5 Remedial Measures to Prevent Dampness

1. **Use of DPC (DAMP Proof COURSE)**

   This is the membrane damp roofing consists of course between the source of dampness and the part of building adjacent to it. DPC may consists of flexible material such as bitumen, bituminous felts, plastic or polythene sheet, metal sheet, cement, concrete, etc. It is done throughout the wall and both way of building on the ground level.

2. **Integral Damp Proofing**

   This consists of adding certain water proofing component compound of material to the concrete mixed so that it became impermeable.

3. **Surface Treatment**

   It consists of application of layer of water in trapping agent or compound on these surface through which moisture enter. Pointing and plastering of exposed surface must be done carefully.

4. **Cavity wall Construction**

   This is an effective method of damp prevention, in which the main wall is shielded by outer skin wall, leaving cavity between them.

5. **Gunting**

   This consists of depositing under pressure and impervious layer of rich cement mortar over the exposed surface. Cement mortar consist of 1:3 cement and sand mixed which is shot on the clean surface with the help of cement gun under a pressure.

6. **Pressure Grouting**

   This consists of facing cement grout under pressure into crack, voids, etc. This method is quite effective in checking the seepage of raise ground water through

the foundation and also in super structure.

2.6 Materials Used for Damp Proofing

Plastic Sheet

Plastic Sheet is used below the ground level to prevent from moisture inside the foundation. Plastic sheet is an impervious material from which moisture cannot transfer from it.

Hot Bitumen (Bituminous felt)

Bitumen are the solid material which character is hard in day, soft in hot and no soluble with water so, hot bitumen is spread out through the exposed wall or in between the wall masonry which is not more than 3-5mm thickness.

Metal Sheet

Metal sheet are the iron sheet which is also used for preventing seepage of water from ground to the structure wall.

Stone Slab

Stone slab is also laid on the masonry at exposed area where it can easily raise or penetrate to the wall.

Cement Concrete (Mortar)

Cement concrete is widely used for the damp proofing in which cement and sand is used.

Other Materials

Combination of sheet and fest.

Bituminous felt.

Brick

Exercises

Choose the correct answer from the given alternatives.

1. What is the primary function of a load-bearing wall?

   a. To decorate the building

   b. To resist the load of the superstructure

   c. To prevent dampness

   d. To divide rooms

2. Which type of wall is constructed only to separate rooms within a building?

   a. Load-bearing wall
   b. Non-load bearing wall
   c. Partition wall
   d. Cavity wall

3. In a frame structure, which wall primarily carries its self-weight?

   a. Load-bearing wall
   b. Non-load bearing wall
   c. Partition wall
   d. Damp-proof wall

4. What is the main purpose of a damp-proof course (DPC)?

   a. To increase the thickness of walls
   b. To prevent moisture from rising
   c. To enhance insulation
   d. To separate rooms

5. What material is commonly used as a flexible damp-proofing membrane?

   a. Bitumen b. Wood c. Steel d. Glass

6. Which masonry is made of finely dressed stones?

   a. Rubble masonry
   b. Ashlar masonry
   c. Random rubble masonry
   d. Dry rubble masonry

7. What is one defect caused by dampness in buildings?

   a. Reduction of wall height
   b. Unhealthy living conditions
   c. Hardening of plaster
   d. Strengthening of bricks

8. Which type of masonry uses undressed or roughly dressed stones?

   a. Ashlar masonry
   b. Rubble masonry
   c. Header masonry
   d. Facing masonry

9. What is the function of a cavity wall in damp-proofing?

   a. To resist external loads

   b. To provide insulation

   c. To shield the main wall by leaving a cavity

   d. To support heavy structures

10. Which damp-proofing method uses cement mortar shot under pressure?

    a. Surface treatment

    b. Pressure grouting

    c. Integral damp-proofing

    d. Grunting

Write short answer to the following questions.

1. What is the primary difference between load-bearing and non-load bearing walls?
2. Define partition wall and mention one of its functions.
3. What is rubble masonry, and where is it commonly used?
4. What are the main causes of dampness in buildings?
5. Explain the purpose of surface treatment in damp-proofing.
6. What is Ashlar masonry, and how does it differ from rubble masonry?
7. List any two materials used for damp-proofing and their applications.

Write long answer to the following questions.

1. Explain the functions and characteristics of a load-bearing wall. How does it differ from a non-load bearing wall?
2. Discuss the causes and effects of dampness in buildings. Suggest preventive measures for controlling dampness.
3. Describe the types of rubble masonry and Ashlar masonry. Highlight the differences between the two.
4. Explain the methods and materials used in damp-proofing. Include examples of their practical applications.
5. Write a detailed note on the construction and functions of a cavity wall for damp prevention.

Project Work

1. To prepare a different bond on brick masonry.

Unit 3 : Temporary Construction

3.1 Shoring

Shoring is the construction of a temporary structure to support temporarily an unsafe structure. Shoring is used to address a variety of situation where a structure is at risk of collapsing or needs temporary support.

Types

Racking Shoring (inclined shoring)

A racking shoring is defined as the inclined support give to the external wall from the ground. It consists of rocker wall, plate, needle, cleat, sole plate, bracing.

The following point should be considered during shoring:

- It should be inclined to the ground by 45^0 Top rocker should not inclined steeper by 75^0
- Rocker should be properly braced at interval
- Factor of safety should be adopted while designing shoring

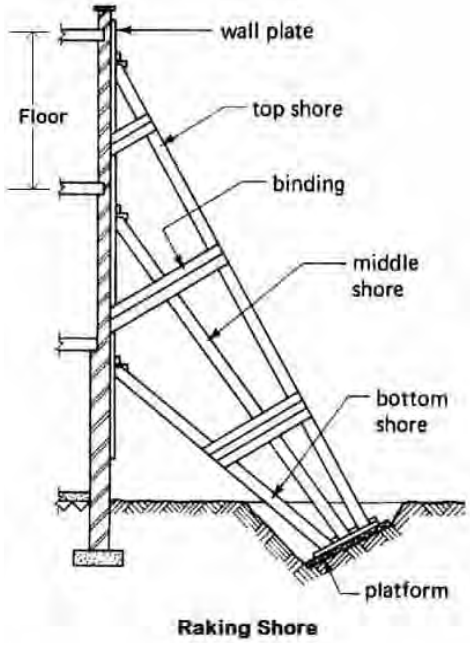


Fig: Racking Shoring

Horizontal Shoring (flying shoring)

In this arrangement, the horizontal support are given to two parallel wall which have became unsafe due to removal or collapse or intermediate building. In this shoring, the bracing are fixed from one wall to another wall in cross shaped which looks like flying and the horizontal snore are kept at the middle of the cross to support all parts of shoring cleat, plate needle, sole plate.

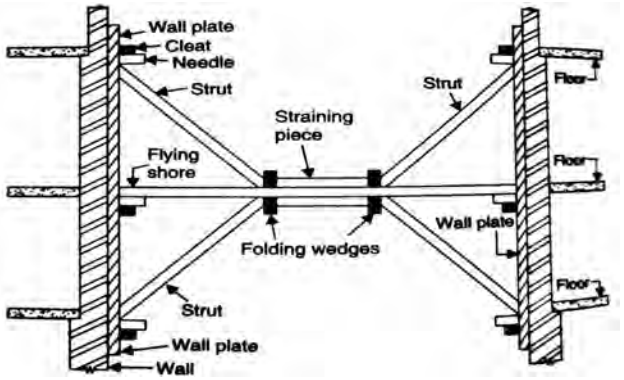


Fig: Single Fly Shoring

Dead or Vertical Shoring

In this arrangement, the horizontal member known as needle is support by vertical member known as dead shore. Dead shore is done for following cases:

- When the lower part of the foundation wall becomes defective
- When the foundations are to be extended deeper
- When the large opening are to be made in the existing wall

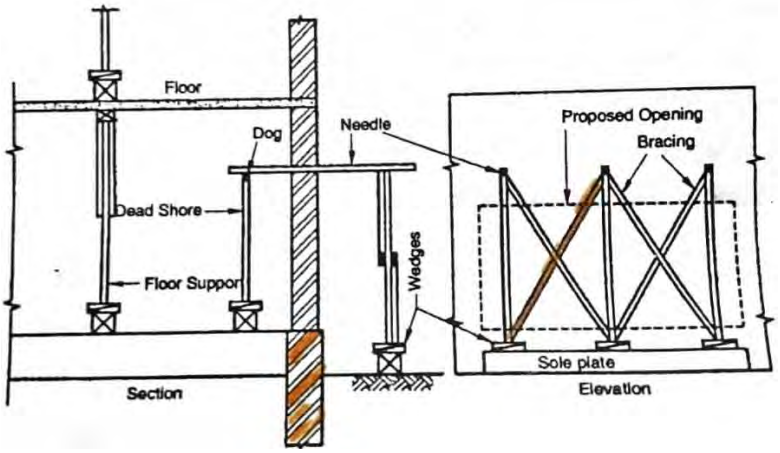


Fig: Vertical Shoring

3.2 Underpinning

The placing of new foundation below an existing foundation or the process of strengthening the existing foundation is known as underpinning. The following point should be considered for underpinning.

a) A building with deep foundation is to be constructed adjoining to an existing building

b) When the basement is to be provided to improve to an existing building

c) When the settlement of the existing building has taken place, then the underpinning is required

Shoring and shuttering should be provided; and the examination of the building should be conducted so that it can find out the present condition of the building; and it can provide under pinning when repair is required.

Types of Underpinning (Method)

a) Pit Method

In this method, the existing wall is divided into suitable section of width about 1.2m-1.5m. Jack is provided both side of the shutter to take the load on it and distribute both side with the help of Jack shore.

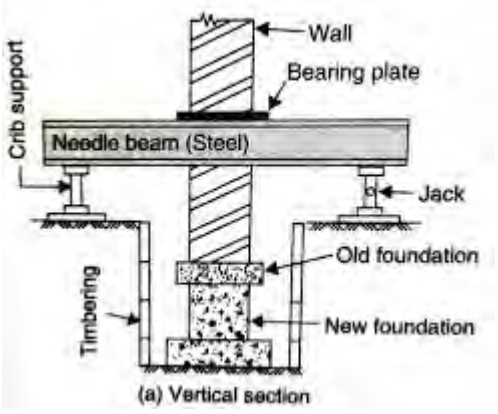


Fig: Pit Method

b) Pile Method

In this method, the pile is driven along with the both side of the existing foundation wall and then, pile caps are provided to take the load on it and distribute on the both side the pile. This method is useful in the clay soil, water logged area. While driving the pile it must be in the equal interval and along the both side of the wall. The piles are connected by a steel leader or concrete slab penetrating wall.

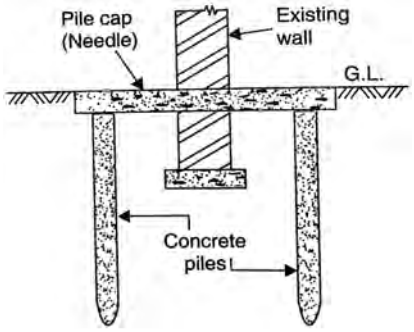


Fig: Pile Method

3.3 Scaffolding

Scaffolding refers to a temporary, when the height above floor level exceeds about 1.5m at the construction of masonry or other work a temporary structure is needed for the placement of the material and workmanship. For this a temporary structure of timber or steel is erected close to the work or parallel to wall. It gives or provides safe platform for all these workers and materials.

Types

Single Scaffolding: This consist of single framework of standard, ledger put log, boarding, etc. constructed parallel to the wall at a distance of about 1.2m. The standards are placed at distance of (2-2.5) metre and material ledgers are connected to the standards and provided at a vertical. Putlogs are placed at one end on ledger and continuously putlog are provided at interval as standard are paced and the boarding are rest on the putlog which will provide as a required platform for workers and materials. It also called putlog scaffolding.

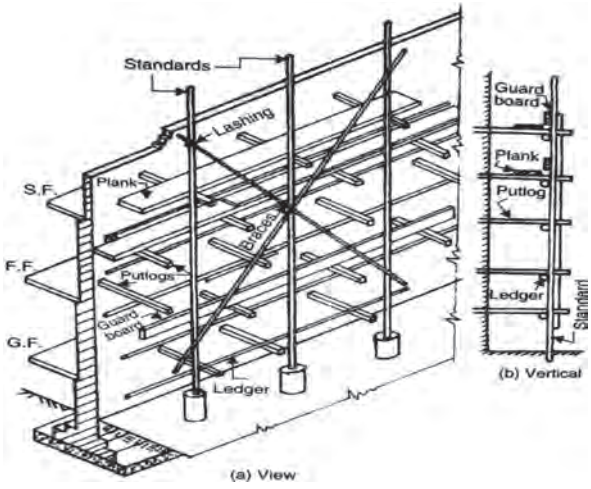


Fig: Single Scaffolding

Double Scaffolding: This consists of the double framework of standards and ledgers and other all as single scaffolding. This method is adopted when the stone masonry should be constructed and in other case the platform need more space, more strength which is generally done on the high rise building and it also makes the wall without any holes which is needed on the single scaffolding. Rockers and Braces are to be provided in the cross shape to make the double scaffolding strong and stable.

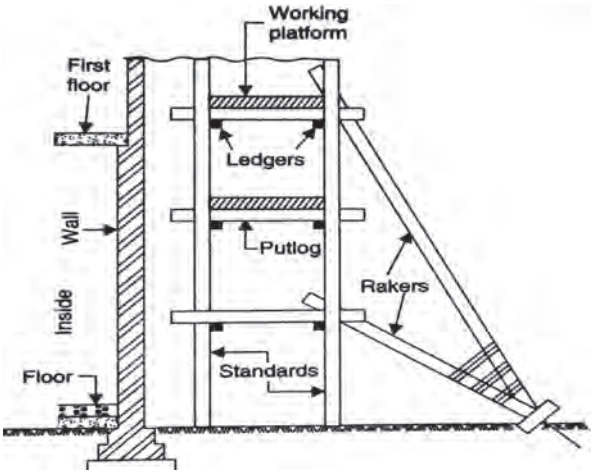


Fig: Double Scaffolding

Component Parts

a) **Standards:** These are the vertical member running parallel to the wall.

b) **Ledger:** These are the horizontal member running parallel to the wall and perpendicular to the standards.

c) **Braces :** These are the diagonal member fixed at the standard.

Putlogs: These are the transverse members' right angle to the wall with one end support on ledger and other end on the wall in the case of single scaffolding.

Boarding: These are horizontal platform to support workman and material. These boars are provided on the putlog.

Guard Rail: These rails are provided like a ledger to give protection at the level of working height.

Uses

Uses of scaffolding are :

- It is used to provide a platform for the material and workmanship safely

- It is also used for plastering, painting at the high level

3.4 Formwork for Slab/Beam/Column

Formwork is a temporary construction provided for laying reinforcement and support wet concrete to required shape and size. It also provides platform for the workmanship and equipment. Formwork can be made from different material like plywood, steel, plastic, etc.

Requirement of Good Formwork

a) Strength

b) Low cost

c) Formwork true to design

d) Proper material

e) Finish

3.5 Formwork for Slab/Beam/Column

Column: Formwork for column is probably the simplest formwork. It consists of sheet or plank all around the column. Site plank and ends plank are consisting of two members each side along the height of column.

Beam: Formwork for beam is continuously horizontal member or horizontal part throughout the entire beam which is rest on the pillar and support by apps. The horizontal members of beam are of plants on three sides of rectangle.

Slab: Formwork for slab is continuous over a member of beams which is plywood, timber, plank, shuttered tightly throughout the area over the beam at its required thickness.

3.6 Types of Walls and Their Functions

Walls are essential structural components in buildings, providing support, enclosure, security, and insulation. They can be classified based on their function, material, and construction method. Below are the primary types of walls and their respective functions:

1. Load Bearing Walls

Function: Carry and transfer structural loads from the roof and upper floors to the foundation.

Examples: Brick masonry walls, reinforced concrete walls, stone walls.

2. **Non-Load-Bearing Walls**

   Function: Serve as partitions without carrying structural loads. Their primary purpose is to enclose spaces and provide privacy.

   Examples: Interior partition walls, drywall, and glass partitions.

3. **Shear Walls**

   Function: Resist lateral forces such as wind and seismic loads, preventing building deformation.

   Examples: Reinforced concrete shear walls, plywood shear walls.

4. **Retaining Walls**

   Function: Hold back soil or water in areas with elevation differences, preventing erosion and landslides.

   Examples: Gravity walls, cantilever walls, anchored walls.

5. **Cavity Walls**

   Function: Provide insulation by creating an air gap between inner and outer wall layers, reducing heat transfer and moisture penetration.

   Examples: Brick cavity walls, concrete cavity walls.

6. **Parapet Walls**

   Function: Act as safety barriers on roofs, terraces, and balconies while providing protection against wind and water intrusion.

   Examples: Solid parapet walls, perforated parapet walls.

7. **Curtain Walls**

   Function: Serve as exterior non-load-bearing walls made of lightweight materials like glass or aluminum, enhancing aesthetics and energy efficiency.

   Examples: Glass curtain walls, metal curtain walls.

8. **Partition Walls**

   Function: Divide internal spaces within a building for functional and privacy purposes.

   Examples: Brick partition walls, gypsum board walls, glass partitions.

Exercises

Choose the correct answer from the given alternatives.

1. What is the purpose of shoring in construction?

   a. To strengthen foundations

   b. To provide temporary support to walls or structures

   c. To decorate a building

   d. To repair roofs

2. What angle is recommended for inclined shoring?

   a. 90° b. 60° c. 45° d. 30°

3. Which type of shoring is used for supporting parallel walls?

   a. Racking shoring b. Horizontal shoring

   c. Dead shoring d. None of the above

4. What is underpinning primarily used for?

   a. Creating openings in walls

   b. Strengthening or deepening foundations

   c. Demolishing walls

   d. Installing beams

5. Which method of underpinning is suitable for clay soil or waterlogged areas?

   a. Pit method b. Pile method

   c. Jack method d. Sole plate method

6. What is scaffolding primarily used for?

   a. Supporting beams

   b. Providing a platform for workers and materials

   c. Strengthening walls

   d. Enhancing insulation

7. Which of the following is a vertical member in scaffolding?

   a. Ledger b. Putlog

c. Standard d. Braces

8. What material is commonly used for formwork?

a. Cement b. Plastic

c. Timber or plywood d. Bricks

9. What is the main requirement of good formwork?

a. High cost b. Low durability

c. Strength and low cost d. Lightweight materials only

10. What is the minimum height above which scaffolding is required?

a. 0.5 m b. 1.0 m c. 1.5 m d. 2.0 m

Write short answer to the following questions.

1. Define shoring.
2. What is the purpose of racking shoring?
3. When is dead shoring required?
4. What is underpinning?
5. List the components of scaffolding.
6. Mention the materials used for formwork.
7. What are the requirements of good formwork?

Write long answer to the following questions.

1. Explain the types of shoring with neat sketches.
2. Describe the methods of underpinning and their applications.
3. What are the types of scaffolding, and where is each type used?
4. Discuss the components and requirements of formwork for slabs, beams, and columns.
5. Write a detailed note on the precautions and materials used for scaffolding in high-rise buildings.

Project Work

1. Arrange the field trip on different temporary construction structure.

Unit 4 : Cement and Concrete Construction

4.1 Lime Concrete

Lime concrete is a traditional building material made from lime, sand, gravel, and water. It offers good workability, flexibility, and moisture resistance. Used historically in foundations, flooring, and masonry, it remains popular for heritage restoration. Lime concrete allows structures to breathe, reducing dampness issues. It is eco-friendly and durable, making it suitable for sustainable construction. Though replaced by cement concrete, it is still used in specialized applications.

Constituents

- Lime: Used as a binding material (fat lime or hydraulic lime)
- Aggregate: Coarse and fine aggregates such as gravel, sand, or crushed stone
- Water: Required for hydration and chemical reactions
- Pozzolanic Materials (Optional): Such as brick dust or surkhi to improve strength and durability

Mix Proportion

- Typical mix ratio: 1:2:5 (Lime: Sand: Coarse Aggregate)
- Water is added gradually to achieve the desired workability

Uses

- Foundations and base courses in historical structures
- Underlayment for flooring
- Masonry work in old buildings
- Construction in areas with low-strength requirements

4.2 Cement Concrete

Cement concrete is a strong and durable construction material made from cement, sand, aggregate, and water. It hardens over time through hydration, providing excellent compressive strength. Used in buildings, bridges, roads, and foundations, it is the most widely used construction material. Admixtures can be added to improve workability, strength, and setting time. It resists fire, water, and weathering, making structures long-lasting. Cement concrete is essential for modern infrastructure development.

Constituents

- **Cement:** Acts as the binding material (Ordinary Portland Cement, PPC, or rapid hardening cement)
- **Fine Aggregate:** Sand (natural or manufactured) for filling voids
- **Coarse Aggregate:** Gravel or crushed stone for strength and stability
- **Water:** Required for hydration and setting
- **Admixtures (Optional):** Plasticizers, retarders, or accelerators for specific properties

Uses

- **Structural Applications:** Beams, columns, slabs, foundations
- **Road Construction:** Rigid pavements and bridges
- **Precast Elements:** Blocks, pipes, and railway sleepers
- **Dams and Water Retaining Structures:** Due to high strength and durability

4.3 Grading of Fine and Coarse Aggregate

Grading of Fine Aggregate (Sand)

Fine aggregates are classified based on particle size distribution using sieves:

- **Zone I:** Coarse sand (better for high-strength concrete)
- **Zone II:** Medium sand (commonly used in concrete)
- **Zone III:** Fine sand (used for plastering and finishing)
- **Zone IV:** Very fine sand (not suitable for concrete)

Grading of Coarse Aggregate

Coarse aggregates are graded based on sieve size

- **Single-sized Aggregates:** 10mm, 20mm, or 40mm aggregates
- **Graded Aggregates:** Combination of different sizes to enhance compaction and reduce voids

Importance of Proper Grading

- Ensures better workability and strength.
- Reduces water demand and shrinkage.
- Improves durability and compaction.

4.4 Nominal Mix and Controlled Mix

Nominal Mix

- Prescribed in IS 456:2000 without laboratory testing
- Used for small-scale or general construction work
- Common ratios:
    - o $\mathbf{M_{10}}$ – 1:3:6 (Cement: Sand: Aggregate)
    - o $\mathbf{M_{15}}$ – 1:2:4
    - o $\mathbf{M_{20}}$ – 1:1.5:3
        - Easy to prepare but lacks precise strength control.

Controlled Mix (Design Mix)

- Proportions are determined by mix design based on material properties
- Ensures targeted strength and durability
- Used in large-scale or important structures (e.g., bridges, high-rise buildings)
- Requires testing and quality control

Difference

Feature	Nominal Mix	Controlled Mix (Design Mix)
Strength Control	Low	High
Flexibility	Fixed ratios	Custom proportions
Suitability	Small-scale works	Large, critical structures
IS Code	IS 456:2000 (Table-based)	IS 10262:2019 (Mix Design)

4.5 Workability of Concrete and Water Cement Ratio

The strength of concrete at given edge and cured at a prescribe temperature is assumed to depend primary on two factor water cement Ratio and degree of compaction.

Water Cement Ratio

Water cement ratio is the ratio of cement and is expressed as the ratio of the weight or volume of water in the concrete mixer. The curve plotted between water cement ratio and compressive strength indicates that strength of concrete decreases as the water cement ratio increases.

Note:

E.g.: Water Cement Ratio

SN	Grade of concrete	Ratio	water cement Ratio
1	M10	1:3:6	0.6-0.65
2	M15	1:2:4	0.55-0.6
3	M20	1:1.5:3	0.5-0.55
4	M25	1:1:2	0.25-0.5

Workability of Concrete

The strength of concrete of given mix proportion is very seriously affected by degree of its compaction. Therefore, the consistence of mixed be such that concrete can be transported, placed and finished sufficiently, easily and without segregation. It can also be defined as amount of internal work required to fully compacted that the concrete to be optimum density.

Factor Affecting Workability

W/C

Water cement Ratio is directly proportional to the:

- Size of aggregate
- Bigger the size lowers the workability

Shape of aggregate:

- More rounder more workability

Surface texture of aggregate:

- Smoother more workability

Grading of aggregate:

- Well grading improves workability

Time

Faster the placement or quicker the time using mixer more the strength of work ability.

Measurement of Workability

Slump Test

The test is conducted to determine the workability of concrete. It needs simple cone for

test. Slump cone is a vessel in the shape of frustum of a cone with diameter at bottom 200mm and 100mm at top and 300mm height. And this test must be done on the impervious platform.

Process

- It is placed in smooth surface with smaller opening at the top and fills with the concrete in four layers.
- Each layer is tamped 25 times with the standard bull nose diameter steel rod and top surface is struck with trowel.
- Immediately after feeling, the cone is slowly lifted and the unsupported concrete will now stump the decrease in the height of the highest.

Then, keep the mould just side of the sample and measure the height with tape.

4.6 Methods of Mixing of Concrete

a) Hand mixing

b) Machine mixing

a) Hand Mixing

Hand mixing is the process of mixing the ingredient of concrete by manual, labor. The concrete thus produced is known as hand mixed concrete. The ingredient of mortar are batch by volume or weight and spread on an impervious platform. Then, the dry mix is done properly to make homogenous mixture. Then, necessary water is sprinkled over the dry mix. The mixture is again turned over two or three times for throughout and even mixing of material prepared mixed should be consumed in 30 minutes after adding water. This method is allowed in case of small work and 10% more cement must be added as specified.

b) Machine Mixing

It is the process of mixing the ingredient of concrete by a machine The concrete thus produced is known as machine mixed concrete. Firstly, the batching is done by the volume or weight and out it inside the mixing drum of mixer. Then, the drum is rotated for 1-2 minutes for each batch for the homogenous mix, and the water is poured inside it and the same process is done for homogenous mix.

- Add the water and pour inside it and the same process is done.
- Generally, 4.5 liter of fresh water is required for $0.03m^3$ of concrete.

- Then, the concrete mix is poured on the impervious surface and it is transferred to the required side within the 30min of water added to the mixer.
- Then, the mixer should be washed and cleaned after uses.
- This method is superior than hand mix because it doesn't need any additional cement and makes the concrete mix homogenous and also helps to increase the strength of concrete.
- It is used where continuous supply of concrete is required for big or important engineering project.

4.7 Bulking of Sand

The increase of volume of sand due to presence of surface moisture up to some extent is called bulking of sand while bulking doesn't affect the proportioning of material by weight. The extent of bulking depends on the percentage of moisture present in sand and on its fineness.

- Take a measuring cylinder of about 250 cubic centimeters (C.C) of cup.
- Take sand sample, then make the sand damp with water and for both cases, pour it into the cylinder and note a level as $h_1 h_1$ respectively.
- Then, add sufficient quantity of water into the cylinder to saturate the sand completely and stir the sample and note level h_2 which is equal to h.
- Then, calculate the bulking of sand by (%) bulking sand = $\frac{h_1 - h_1}{h_2} \times 100$

Preparation of Concrete

- Storing of concrete material

4.8 Batching or Concrete

- Mixing
- Transporting and placing
- Compaction
- Curing

Storing of Concrete Material

The coarse aggregate and fine aggregate should be stored in a bin water tight store. The bin may be open or closed but it should be constructed in such a way that loading and unloading take minimum amount of time and work.

Now, in the case of cement, it should be stored inside a room where there is no possibility of any moisture and direct sunlight.

Batching

The measurement of material for making concrete is known as batching. The following two method of batching is practised :

1. Volume Batching
2. Weight Batching

1. Volume Batching

In this method, cement, sand and Aggregate are batched by volume. A gauge box is made with wooden plate. Its volume is equal to that of 1 bag cement which is 35l or $\frac{35}{1000} m^3$. The required amount of an aggregate is added by measuring on the boxed as it requires.

2. Weight Batching

This is the recommended method of batching. A weighting platform is used in the field to pick up proportion of sand. Weight batching is more accurate than volume batching due to its accurate weight.

4.9 Mix Design

It is the method of selection the amount of suitable ingredient of concrete with the objective of getting economical concrete of certain minimum strength, durability, and workability. The main purpose of its design is to economize the cost of concrete and gain the desired strength. There are two types of mix:

a. Control mix

b. Nominal mix

a. Control Mix

When the proportion of cement, sand, aggregate and water establish standard relationship, then the mix is called control mix and the concrete is called control mix concrete. The basic assumption in the control mix concrete is that compressive strength of concrete depends almost entirely on the water cement ratio.

b. Nominal Mix

When the proportion of cement (sand, aggregate and the water are adopted by using arbitrary standards, then the mix is known as nominal mix. This method is applied

in such work where the quality control is required and control mix is difficult to implement.

4.10 Introduction to Reinforced Cement Concrete

Concrete is good in resisting compression but very weak in the concrete wherever tensile stress is expected. The best reinforcement is steal since tensile strength of steal is quite high and bonded between steel and concrete is good. As the force resistance by steal is high for the same extent the force resistance by steal is high compared to concrete. However, in the tensile zone, hair crack in concrete are unavoidable. Reinforcement are usually in the form of mild steal, Tor steal and TMT steel and steel bars are of 6mm to 32 mm diameter. Now, the concrete reinforcement is prepared as per design requirement and is kept in a formwork, and then wet concrete is removed. The composite material hardens, the formwork is removed. The composite materials of steel and concrete now called RCC act as a structural member and can resist tensile as well as compressive stresses very well.

Properties of RCC

- It should be capable of resisting expected tensile compressive bending and shear forces.
- It should not show excessive deflection and spoil serviceability requirement.
- When it is fresh, it can be molded to any desired shape and size.
- The hair cracks developed should be within the permission limit.
- It should be fire resistance.
- RCC structure can be designed to take any load.

Advantage/use of RCC

It is widely used in building material some of the advantage is listed below:

1. Its main advantage is to contract structural element in a building where RCC is used. For example:
   a) Footing
   b) Column
   c) Beam
   d) Lintel and sill band
   e) Roof and slab
   f) Staircase, etc.

2. RCC is used for constructing storage structure like:
    a) Water tank
    b) Dams
    c) Weir and barrage
    d) Hydropower reservoir
    e) Bunker
3. RCC are used for the construction of big structure like
    a) Bridge
    b) Retaining wall (shear wall)
    c) Under water structure
4. It's another advantage which is widely used for pre-casting are electric pole, concrete pipe (hump pipe) etc.
5. RCC is used in cost of tall structure
    a) Multi storied building
    b) Chimney
    c) Tower/light house
6. It is also used as paving
    a) Road
    b) Airport

Properties of Concrete

Concrete has completely different properties when it is in plastic stage and when in hardened stage. Concrete in plastic stage is known as green concrete. Properties of wet concrete are:

- Workability
- Segregation
- Bleeding
- Hardness

Workability

This is defined as the case with which concrete can be compacted completely without any

segregation and bleeding. It can also be defined as the amount of internal work required to fully compacted to obtain optimum density. It depends the quantity of water, grading of aggregate. Workability is measured by:

Segregation

It refers to the separation of course particle from the concrete due to improper placement and proportion of aggregate and vibration. Because of the segregation, the cohesiveness of concrete is lost and honeycombing results. Ultimately, it results in the loss of strength of hardened concrete. Hence, most care is to be taken to avoid segregation.

Bleeding

This refers to the appearance of water along with cement particle on the surface of freshly lay concrete. This happens when there is excessive quantity of water in mix compaction. Bleeding causes the formation of porous and also makes the insufficient cement paste which makes concrete weak. Bleeding can be avoided by controlling the quantity of water and in compaction.

Hardness

Hardness is the resistance offered by concrete to its surface fineness. Hardness is due to the presence of less quantity of fine aggregate in sufficient cement and due to use of poor grading of sand and aggregate and also due to the insufficient smooth surface finish. So, while concreting, we should be careful about the proportion of cement, aggregate sand and water.

Properties of Dry Concrete

- Strength
- Resistance to wear
- Dimensional change
- Durability
- Durability
- Impermeability

Strength

The characteristics of strength of concrete is defined as compressive strength of 150mm size cube after 28 days of curing, below which not more than 5% of the test result are expected to fail. The unit of stress is N/mm^2. IS 456 code has grades the concrete based on

its characteristics. The strength is shown it table.

Grade	M10	M15	M20	M25	M30	M35	M45
Characteristics	10	15	20	25	30	35	45

Resistance to Wear

The characteristics of concrete is to resist any kind of physical wear and chemical wear on the surface of it. However, concrete gains strength after 28 days, then only it shows the resistance to wear. After mixing, placing and compaction, its surface becomes smooth and plane as per desire and the curing is conducted for 7 days. Up to this, it gains, strength 60-65% which may not be capable to resistance to wear by physical or chemical.

Dimensional Change

Concrete shrinks with age. The total shrinkage depends upon the component of concrete, size of member and the environmental condition. The total shrinkage is approximately 0.003 of original dimension. The permanent dimension change due to loading over a long period. Its value depends on the stress in the concrete, age of concrete and duration of loading. The size of concrete may also change due to thermal expansion. The coefficient of thermal expansion depends upon the nature of cement, types of aggregate water contain and its humidity and the size of section of structure.

Durability

Environmental force such as weathering environment condition, freezing, excessive heat may destroy the concrete. The period of exiting of concrete without getting adversely affects by these force is known as durability. Generally crossing strength of the concrete guide says that its durability should have adequate cement contain and should have perfect w/c.

Impermeability

This is the resistance of concrete to the flow of water through it. Excessive water during concreting leaves a large number of continuous pores leading to the permeability. Since the permeability reduces the durability of concrete, it should be kept very low by using perfect w/c, dense and well- graded aggregate, good compaction and continuous curing at low temperature.

Compaction

In the process of placing of concrete, air is entrapped. This entrapped air reduces the strength

of concrete up to 30%. Hence, it's necessary to remove this entrapped air. Compaction can be carried out either by hand or with the help vibrator.

Hand Compaction

In this method, concrete is compacted by ramming, tamping and spading with tools. A pointed wooden rod, steel rod, iron rod of 16 mm diameter which is long in length for compaction concrete in column/pillar are used.

Compaction by Vibrator

Concrete can be compacted by using high frequency. Vibrator vibration reduces the friction between particles and seethe motion of particle. As a result, entrapped air is removed and the concrete is compacted. The use of vibrator reduces the compaction time and also helps to improve strength of concrete. Homogenous vibration should be stopped as soon as cement paste is on the surface of concrete.

Curing

Curing may be defined as the process of maintaining enough moisture and temperature condition for freshly placed concrete for some specified time to proper hardening of concrete. Curing must be done for 2 weeks for gaining proper strength of concrete. If curing isn't done properly, the strength of concrete decreases, crack developed due to shrinkage.

The methods of curing are:

- Sprinkling (of water)
- Wet covering the surface
- Ponding

Application of Curing Component

The component like calcium chloride may be applied on curing surface. It shows the affinity to the moisture and retain on the surface. It keep the concrete surface wet for a long time.

- Sprinkling (of water)
- Wall, column, plaster surface are cured by sprinkling of water with the help of any process as possible
- Wet covering the surface
- Column and other vertical surface may be cured by covering the surface with wet bags or sacks or straw

Ponding

The horizontal surface like slab, floor are cured by ponding the water to a height of 25-50 mm by providing temporary small hands at the boundary surface so that it can pond the water on it.

Exercises

Choose the correct answer from the given alternatives.

1. What does the water-cement ratio primarily affect in concrete?

   a. Durability b. Strength c. Appearance d. Weight

2. Which test is used to measure the workability of concrete?

   a.Tensile test b. Slump test

   c. Compression test d. Flexural test

3. Which factor improves the workability of concrete?

   a. Bigger aggregate size b. Rough surface texture

   c. Well-graded aggregate d. Low water-cement ratio

4. What happens to the strength of concrete as the water-cement ratio increases?

   a. Increases b. Decreases

   c. Remains constant d. No effect

5. What is the purpose of curing concrete?

   a. Enhance appearance b. Maintain moisture for strength gain

   c. Reduce cement content d. Prevent segregation

6. Which method of concrete mixing is more suitable for large-scale construction?

   a. Hand mixing b. Machine mixing

   c. Volume batching d. None of the above

7. What is the effect of bleeding in concrete?

   a. Improves strength b. Causes porous concrete

   c. Increases workability d. Reduces water requirement

8. Which property of RCC makes it suitable for tall structures?

   a. Fire resistance b. Moldability

   c. High tensile strength d. Impermeability

9. What type of sand bulks more significantly?

a. Dry sand
b. Sand with surface moisture
c. Saturated sand
d. Sand without fineness

Write short answer to the following questions.

1. Define the water-cement ratio.
2. What is workability in concrete?
3. List any three factors affecting the workability of concrete.
4. Explain the slump test briefly.
5. What is the difference between hand mixing and machine mixing of concrete?
6. What is the purpose of curing in concrete?
7. Define segregation and its effect on concrete.

Write long answer to the following questions.

1. Explain in detail the factors affecting the workability of concrete.
2. Discuss the step-by-step procedure for the slump test, including its significance.
3. Compare hand mixing and machine mixing of concrete, highlighting their advantages and disadvantages.
4. Describe the various methods of curing concrete and their respective applications.
5. Explain the properties of reinforced concrete (RCC) and its advantages in construction.

Project Work

1. To prepare slump test.

Unit 5: Earthquake Resistant Features

5.1 Earthquake

An earthquake is a sudden rapid shaking of the earth surface caused by breaking and shifting of rock plate beneath the earth surface. During earthquake, ground motion occurs in a random manner in all direction radiating from a point within an earth crust called epicenters. It causes vibration of structure and induces inertia force on them. As a result, structure may collapse resulting in a loss of property and lives. Earthquake do not kill people, structure do so. Hence, it is necessary to design earthquake resistance building structures in a highly seismic zone.

Types of Earthquakes

- Natural earthquake
- Earthquake due to induce activities
- National earthquake
- Natural earthquake may be due to active fault
- Movement of tectonic plate.
- Due to volcanic eruption.

Active Fault

The displacement of rock fault causes earthquake when the earth mass moves due to the earth pressure or any natural pressure. Then, it creates displacement of rock; and whole plate starts to move and causes motion on the surface.

Movement of Tectonic Plate

Moving plate of earth surface provides an expansion for a new settlement. A relatively simple theory is that the tectonic plate moves towards or upward to each tectonic plate which creates seismic activities on the earth. The basic idea is that the earth curst consists of several large and fairly stable slab called plates. These plates are further compared as smaller sub-plate which moves throughout the area of such tectonic plate. The plate moves against each other with average speed ranging from 1 to 6 cm/years.

Volcanic Eruption

Volcano is a mountain or hill having lava, rock-fragmented, hot vapors and gas. It erupts

from the earth crust occasionally and becomes active and creates earthquake near the mountain.

Seismograph

Seismograph is an instrument for measuring oscillation of earth during earthquake.
It has three major components:

- The sensor
- The recorder
- Time

The pendulum mass, string, magnet together constitute the sensor. The drum pen and chart paper consist the recorder. The motor that rotate the forms at a constant speed forms the timer.

The magnet around the string provide the require damping to control the amplitude of the oscillation.

Earthquake Magnitude

It is the quantity to measure the size of an earthquake and is independent of the place of the observation. It is a quantitative measure of strength of earthquake which would be the same from any seismographic station recording that earthquake. The magnitude of most earthquake is measured on Richter scale. The pitcher magnitude is calculated from the completed largest seismic waves recorded for the earthquake, on matter what types of wave was the strongest. The magnitude are based on logarithm, scale which means that for each whole number goes up on the rector scale with logarithm scale base 10 ($\log_{10}$)

Magnitude and Effect

Richter	Description	Earthquake effect
<2 (less than 2)	Micro	Micro earthquake, not felt
2-2.9	Minor	General not felt but recorded often felt, but rarely cause damages
3.3.9	Minor	General, not felt, but recorded often felt, but rarely cause damages
4- 4.9	Light	Noticeable shaking of indoor items, rattling noises, significant

5-5.9	Moderate	Can cause major damages to poorly constructed building slight damages to well design building at most
6-6.9	Strong	Cause destructive in area up to 160 km.
7-7.9	Major	Can cause seriously damage over large area greater than 160 km.
8-8.9	Great	Can cause serious damage in area 100 mile across. Several damage in mile across
9-9.9	Epic	Never recorded

Earthquake Intensity

It is a measure of the effect of an earthquake at a particular place on human and or structure on the earth surface. It is a qualitative assessment of the kind of damage. Intensity is a qualitative measure of the actual shaking at a location during an earthquake. Hence, for the same earthquake; it has different value at different places; highest value being at the intensity at a point depends not only upon the strength of earthquake to the epicenter and the local geology at that point. The damage reduces with increased distance from the epicenter for the same earthquake. Earthquake intensity is the violence of an earthquake felt in a particular locality. Intensity is assessed in the term of associated effect. It depends on:

- Distance from the epicenter
- Local geological condition
- Type and quality of building
- Human observation influence by panic and state of after major shock (earthquake)

Effect of Earthquake

The effect of earthquake are as follows:

- Ground shaking
- Liquefaction
- Landslide
- Retaining structure fail
- Life line hazard
- Tsunami
- Fire

- Ground subsidence
- Sand blow
- Surface faulting
- Ground Shaking

Earthquake shakes ground as well as structure above it; and causes them to collapse. Most earthquake related death are caused by the collapse of structure and construction like temples, towers, compound walls and other heavy structures (water tank). The following occurrence happens during earthquake on ground.

- The whole building including all component and life can be in hazard after ground shaking.
- The earthquake motion results into vibration of building along its all three axis.
- The movement is reversible in direction and the numbers of cycle per second depends on the characteristics of earthquake.
- Inertia forces are created on the masses due to the ground acceleration.

Liquefaction

Liquefaction is more likely to occur in loose or moderate or saturated soil with poor drainage such as silt sand or sand and gravel containing impermeable sediment.

During Loading Usually Cyclic on Drain Loading

Loose sand tends to decrease in volume which produces an increase in their pore water pressure. It deposits most susceptible to liquefaction on young sands silt. Such deposits are often found along river bed, ocean and area where sand has deposited. It causes damage to structure in several ways.

- Building whose foundation on sand liquefies, will experience a sudden loss of support and irregular settlement of building
- Pipe line and other underground structure may float up

Landslide

It is a geological phenomenon which includes a wide range of ground mass movement. The primary force for a landslide occurance is falling of rocks. Another contributing factor earthquake magnitude: often on stable range of hill side and mountain allure. It also causes non-lethal slides on highway and blocks transportation and causes emergency rescue operation.

Retaining structure Failure

Earthquake causes significant damage to masonry in-fill types retaining wall. It is observed that some walls, which is not in proportion, has major crack, and wall also sink into the earth due to insufficient pressure support at its toe (lowermost part of retaining wall)

Life Line Hazard

The earthquake has a great effects on life line supply. It may block the mode of transportation, rail, road. Pipe line of gas, water, communication can be disconnected. It lowers the economic status of a country. Residential building can be damaged, and all, daily supply and life style change.

Tsunami

Dramatic bi-product of certain type of earthquake is Tsunami. The term means harbor wave. Tsunamis are frequently confused with tidal wave but they have nothing to do with tides. They are the result of sudden vertical effect in the ocean floor caused by earthquake.

Fire

Fire is the indirect result of earthquake caused by broken gas and power line. This induces fire in addition to the damage of building due to earthquake.

Ground Subsidence

Due to ground shaking during earthquake compaction of soil is rearranged and takes less space. When the volume of soil is reduced in this manner, the land is settle down forming a depression. This results falling of land, crack formation, damage to building, road, bridge, pipe line, etc.

Sand Blow

In the same case, when the surface is on drain by a saturated san riches, layer of soil shaking can cause the expulsion of fluid from the sand layer resulting in large sand blows.

Surface Faulting

During earthquake there is sometime a discontinuity of movement on the two sides of boundary line consisting of a narrow belt of land. This belt is called fault. Normal fault occurs due to tension of over lying block moving.

5.2 Improving Earthquake Resistance of Building

- Building configuration
- Height and no of storey
- Distribution of load bearing element
- Location and size of door and window openings
- Building materials

5.2.1 Building Configuration

The main consideration to make the building earthquake resistant is to consider on building configuration (setting). It explains about its shape, uniformity, simplicity and several blocks. It include:

- symmetry
- Regularity
- separation of block
- Simplicity
- Enclosed area

The building as a whole or its variation block should be kept symmetrical about its axis. For this, a square shaped building is most suitable whereas rectangular shape building is also good as long as its length doesn't exceed three time the width. Likewise regularity is also considered in building construction.

The irregular shape and many projections occur tensional effect on ground motion and the large building must be separated in several block which may be required so as to obtain symmetric and regularity of each block. Ornamentation involving large cornice vertical or horizontal cantilever, face stone like are dangerous; and a desirable from a seismic view point. a small building in closer with properly interconnected wall act like rigid box and wall thickness cross wall determine strong and durable and collar beam, column and foundation in a rigid state make building seismically strong.

5.2.2 Height and Number of Stories

The height of building in an earthquake is directly considerable to its horizontal force on ground motion. The height of building should not exceed three times its width. It is self-evident that increasing height increases the earthquake resisting problem. While earthquake occurs, it vibrates the building, and higher the building, longer its period limiting the height

width ratio to 3 or 4 keeps the overturning problems.

5.2.3 Distribution of Load Bearing Elements

Distribution of load in a building plays the vital role to resist the building from earthquake. The load from roof, slab, and wall to the foundation should maintain symmetric and transferred of load must be vertically down wards to beneath of the foundation. The thickness of wall floor/roof slab or truss should have a sufficient bearing to wall and tied properly to prevent from tall and transferred land vertically. In load bearing, masonry wall are the main lateral load resistance cement in brick masonry in cement mortar, the minimum thickness of wall in ground, first and second are 350 mm, 230 mm and 230mm respectively.

The foundation should be designed in such a way that the all load coming from the superstructure must resist on it; and its width should not be less than 900mm. The load of wall and after cement must be transferred symmetrically to the foundation.

5.2.4 Opening and Size of Door and Window Opening

Openings are functional necessities in building. However, location and size of opening in wall assume significances in deciding the performance of masonry building. During earthquake shaking, inertia force acts in the strong direction and in the weak direction it act perpendicular to wall where the opening gets most probability to damage. So opening of window, and door from the corner of wall must be of at least 600mm from corner of the gap between the window and door must be of greater than the 0.25 height of door.

Door and Window Size and Opening

Walls are the main lateral load resistance element in load bearing wall. Doors and windows are the voids in wall that makes walls weaker. Therefore, their size and location need to be carefully decided and constructed. Opening from close to wall corner hampers the flow of forces from one wall to another furthermore, large opening weakens walls from carrying the inertia force in their own plane. Thus, it is best to keep all openings as small as possible.

5.3 Requirement for Openings in Wall as Provisioned Under NBC

Any opening in the wall should be small in size and centrally located and away from inside corner by a clear distance equal to atleast $\frac{1}{4}$ of the height of the opening but not less than 600mm.

The total length of opening in a wall is not to exceed 50% of the length of the wall between consecutive cress wall in single storey 42% in two storey and 33% in three storeys.

The horizontal distant between two openings is to be not less than one half of the height of the shorter openings but not less than 600m.

The vertical distance from one opening to another opening directly above it shall not be less than 600mm.

It the vertical opening of the wall is more than 50% of the wall height vertical bars shall be provided in the jams

Door window opening attached to wall junction also increase weakness of the building.

Band

It is the RCC band which is constructing throughout the wall length and width of minimum thickness is 75mm and at least two bars of 8mm diameter and they should be tied with steel limbs of 6mm diameter at 150mm center to center spacing if the wall size is large and vertical band also may be provided.

5.3.1 Types of Band

There are four types of bands in a typical masonry building which are named after location in the building. They are:

Gable Band

The gable band is employed only in buildings with pitched or sloped roofs.

Roof band

In building with flat reinforced concrete or reinforced brick roofs, the roofs band is not required because the roof slab also plays the role of a band, however, in building with flat timber or CGI sheet, roof band needs to be provided.

Lintel Band and Sill Band

The lintel band and sill band is the horizontal band constructed throughout the wall just above and below the level of window. It is the important of all and needs to be provided in almost all building. The lintel and sill band ties the wall together and creates a support for walls loaded along weak direction from walls loaded in strong direction. These bands also reduce the unsupported height of the walls and hereby improve their stability in the weak direction.

Plinth Band

Plinth band are primarily used there is concern about uneven settlement of foundation soil. It is also constructed throughout the area of the wall both length and width. It is connected

to the column also so that it can transfer the load equally throughout all the foundation equally.

Bar Bending

When the length of the bar is insufficient as per design in the beam and slabs, the bar bended is provided. It is also called anchored bar which is kept in bent of angle $90^0, 270^0$ and 30^0 *to* 60^0 as per required. There are several reasons for bending bars:

- Where anchorage cannot be provided to straight length with on the available concrete shape.
- When continuity of strength is required between two intersections on concrete, the member bar will be bended.
- When tie like stirrups enclose longitudinal bar in a beam or column, the bend is provided at angle 30^0 or not more than 45^0.

Exercises

Choose the correct answer from the given alternatives.

1. What is the primary cause of an earthquake?

   a. Volcanic eruptions

   b. Breaking and shifting of rock plates beneath the Earth's surface

   c. Movement of the moon

   d. Human-induced activities

2. What is the term used to describe the point within the Earth's crust where an earthquake originates?

   a. Focus b. Epicenter c. Fault d. Tectonic plate

3. Which type of soil is most susceptible to liquefaction?

   a. Rocky soil b. Loose, saturated soil

   c. Clayey soil d. Dry sandy soil

4. What does a seismograph measure?

   a. Earthquake intensity

   b. Ground acceleration

   c. Oscillation of the Earth's surface during an earthquake

   d. Magnitude of tectonic plate movement

5. What is the Richter scale based on?

   a. A linear scale b. A logarithmic scale

   c. A proportional scale d. A geometric scale

6. Which band is specifically used in buildings with sloped roofs?

   a. Plinth band b. Gable band c. Lintel band d. Roof band

7. What is the primary purpose of a lintel band in masonry buildings?

   a. To provide thermal insulation

   b. To resist vertical loads only

   c. To tie walls together and reduce unsupported wall height

d. To act as a decorative feature

8. What is the appropriate distance of openings like doors and windows from wall corners?

   a. 300 mm b. 400 mm c. 600 mm d. 800 mm

9. What is the movement speed of tectonic plates on average?

   a. 0.1-1 cm/year b. 1-6 cm/year c. 10-20 cm/year d. 50-100 cm/year

10. Which seismic zone does Nepal lie in?

    a. Zone I b. Zone II c. Zone IV d. Zone V

Write short answer to the following questions.

1. Define an earthquake and its primary cause.
2. What is a seismograph, and what are its components?
3. What is the difference between earthquake magnitude and intensity?
4. List the types of bands used in earthquake-resistant masonry buildings.
5. Explain the concept of liquefaction and how it affects structures.
6. Why is it important to consider the height-to-width ratio in building design for seismic resistance?
7. What is the role of plinth bands in earthquake-resistant construction?

Write long answer to the following questions.

1. Explain the effects of earthquakes on structures and the ground. Discuss at least five effects in detail.
2. Describe the measures to improve earthquake resistance in buildings, including building configuration and bands.
3. Explain the different types of earthquakes and their causes, including natural and induced activities.
4. Discuss the role of seismic zones in earthquake-resistant design and specify Nepal's seismic considerations.

Project Work

1. Write a report on B.S. 2072 earthquake in Nepal.

Unit 6: Introduction to Engineering Drawing/Basic Drafting Concept

6.1 Introduction to Types of Drawings

An engineering drawing, a type of technical drawing, is used to fully and clearly defined requirements for engineered items.

Engineering drawing (the activity) produces engineering drawings (the documents). More than merely the drawing of pictures, it is also a language, a graphical language that communicates ideas and information from one mind to another.

Following are the types of drawing:

- Architectural drawing
- Structural drawing
- Service drawing
- Electrical drawing
- Sanitary drawing
- Detailed drawing, etc.

Architectural drawings are technical plans of a building, created to communicate design ideas, help in construction, and document completed work. They follow specific conventions, such as views, scales, and annotations, and were historically drawn by hand, with modern designs using CAD software. Structural drawings, on the other hand, are created by engineers to show the building's load-carrying elements, including materials and connections, and are used to guide contractors in construction.

Detail drawings focus on the specific parts of an object or structure, providing large-scale views with precise dimensions and specifications. These are used to clarify construction details that might not be visible in general plans. Increasingly, these drawings are made using BIM software for 3D representations. They are distinct from working or detailed design drawings, which serve different purposes in the design and construction process.

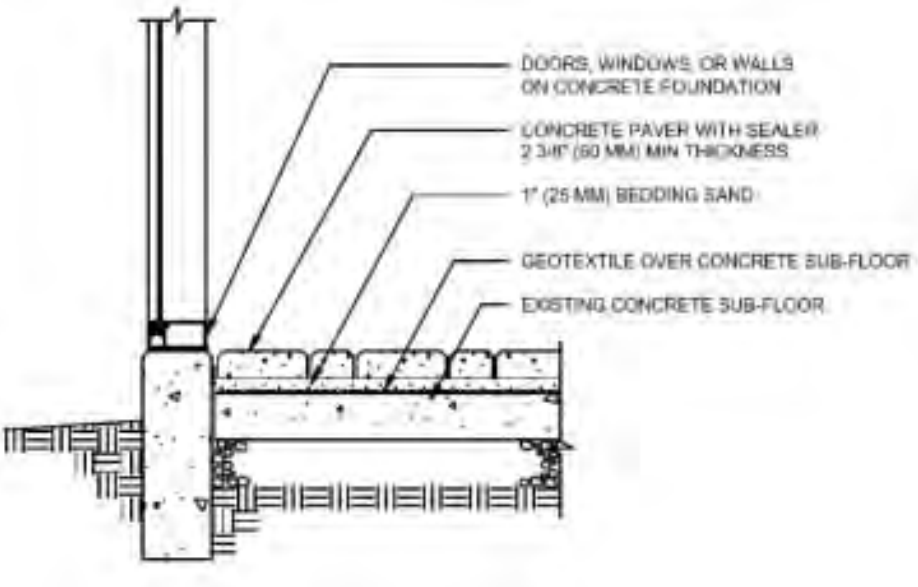


Fig: Typical Detail of Drawing

6.2. Engineering Symbols and Conventional Signs

Engineering symbols and conventional signs are standardized graphical representations used in technical drawings, blueprints, and schematics to convey information efficiently. These symbols represent various elements such as materials, components, structural elements, and utilities in engineering fields like civil, mechanical, electrical, and architectural engineering. They help in maintaining uniformity, reducing text, and ensuring clear communication among engineers, designers, and construction professionals. Examples include symbols for different types of lines, structural components (such as beams and columns), electrical circuits, plumbing fixtures, and surveying notations. Standardization of these symbols follows guidelines set by organizations like ISO, ANSI, and BIS, ensuring consistency across projects.

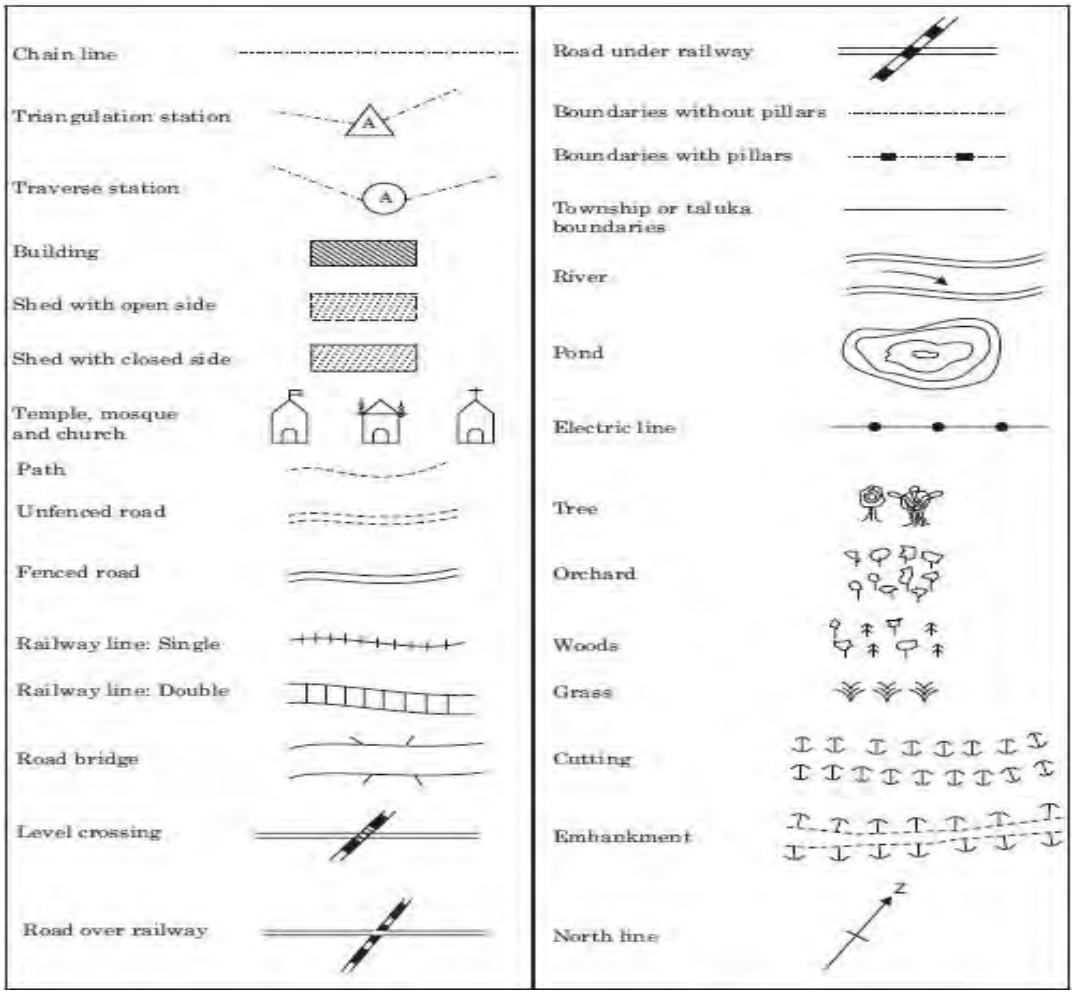


Fig: Symbol used in Drawing

6.3 Introduction to By-laws and Codes

A by-law and code is a rule or law established by an organization or community to regulate itself, as allowed or provided by some higher authority. The higher authority, generally a legislature or some other governmental body, establishes the degree of control that the by-laws may exercise. By-laws may be established by entities such as a business corporation, a neighborhood association, or depending on the jurisdiction, a municipality.

By laws and codes is the strict rule which must be obeyed by everyone. If everyone makes building without obeying any rules, then there will be the following problems:

- Irregular and narrow roads
- Problem of parking
- Health problems due to pollution
- Poor light and ventilation
- No proper planning of gardens, plat ground, etc.
- Problems regarding services like water supply, drainage, telephone, gas, electricity, etc.
- Noise insulation in education, hospitals, court, etc.

6.4 Drafting and Preparing Foundation Plans

6.4.1 Architectural Drafting Lettering, Dimension Lines, Title Blocks, Office Standard

Architectural Drafting Lettering

Architectural drafting lettering is expected as a designer or architect that all blueprints, drawings and designs have architectural lettering.

Dimension Lines

The dimension line is a thin line, broken in the middle to allow the placement of the dimension value, with arrowheads at each end (see diagram below). An arrowhead is approximately 3 mm long and 1mm wide. That is, the length is roughly three times the width.

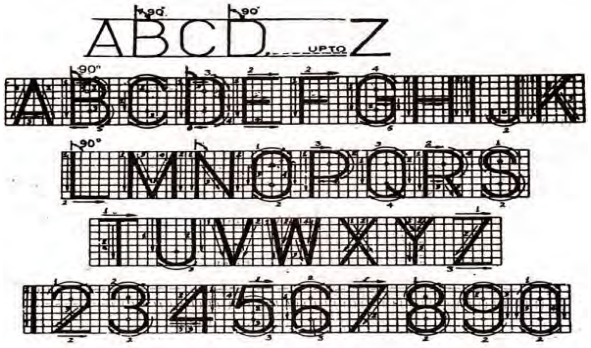
The purpose of dimension is to provide a clear and complete description of an object. A complete set of dimensions will permit only one interpretation needed to construct the part. Dimensioning should follow these guidelines:

Accuracy: Correct values must be given

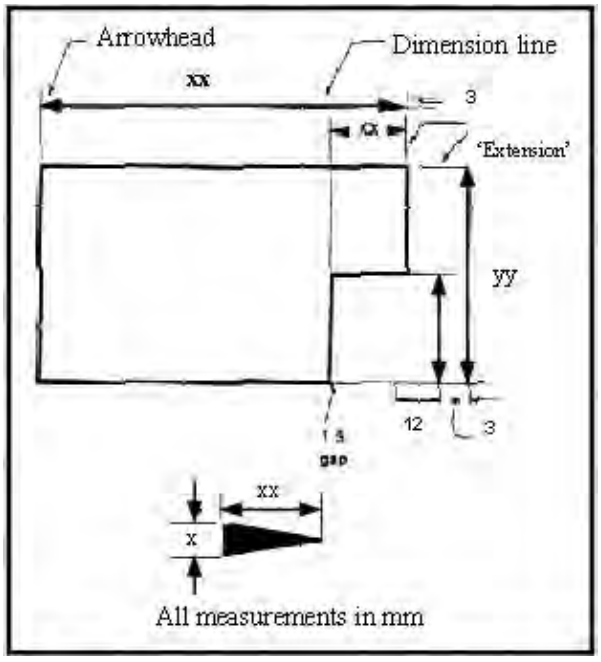
Clearness: Dimensions must be placed in appropriate positions

Completeness: Nothing must be left out, and nothing duplicated

Readability: The appropriate line quality must be used for legibility

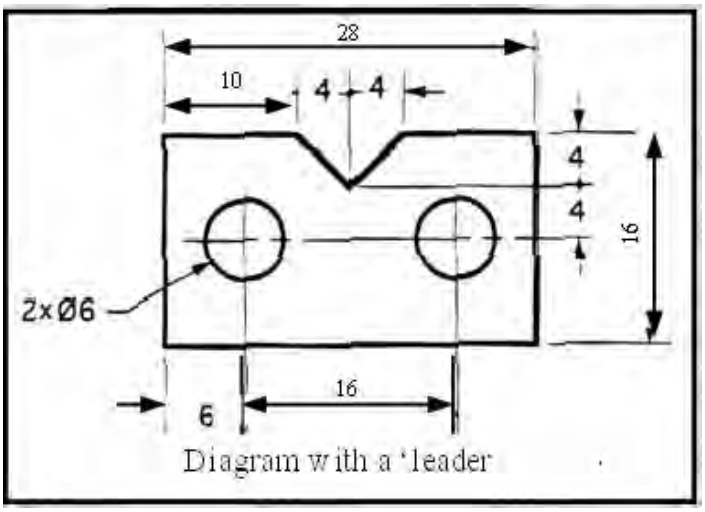


An extension line extends a line on the object to the dimension line. The first dimension line should be approximately 12 mm (0.6 in) from the object. Extension lines begin 1.5 mm from the object and extend 3 mm from the last dimension line. A leader is a thin line used to connect a dimension with a particular area (see the hole diameter arrow shown) A leader may also be used to indicate a note or comment about a specific area.



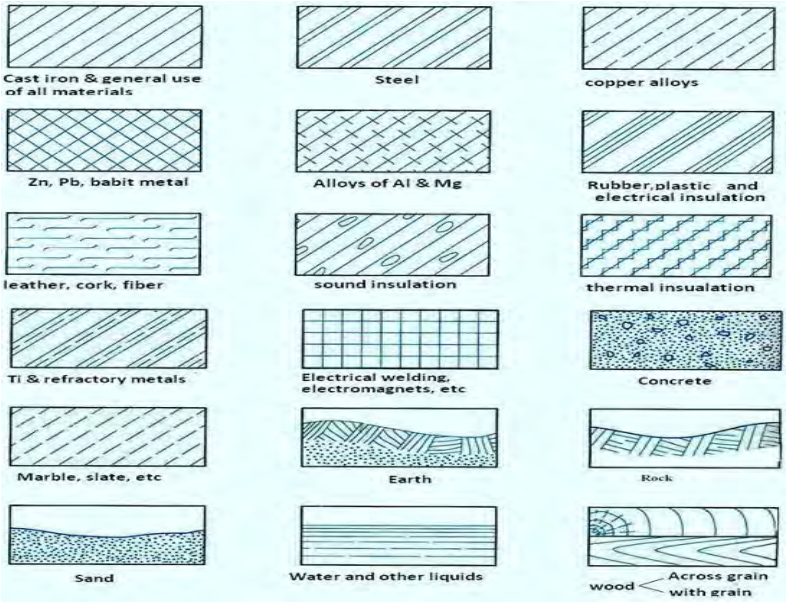
When there is limited space, a heavy black dot may be substituted for the arrows, again clarity is the rule - it should be a clear point into which the dimension lines ends.

Also in this drawing, shown, two holes on the main surface of the flat panel are identical, allowing the "2x" notation to be used and the dimension to point to only one of the circles. This is more preferable than cluttering the space with duplicate information.



Title Blocks

A title block is comprised of the information boxes found on the bottom right- hand corner of a drawing, which indicate drawing details such as the title, author name, scale, and date the drawing was created. This is an introductory activity designed to be completed prior to any other board drawing activities.



Office Standards (Official used)

In engineering drawing there is a portion in the drawing which is used for the official used or concerned authority uses where they gives authorized approval to the drawings.

6.4.2 Drafting Conventions, Representation of Different Materials in Section, Graphic Symbols

Material Symbols

The type of section line used to represent a surface varies according to the type of material. Symbols generally used for various materials are shown in figure 15. However, the general purpose of section line symbol used in most section view drawings is that of *cast iron.* The specific type of steel to be used will be indicated in the title block or parts list. Occasionally, with assembly section views, material symbols are used to identify different parts of the assembly.

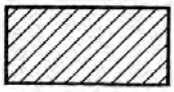
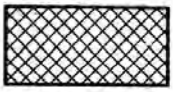
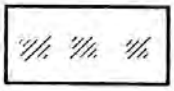
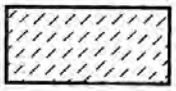
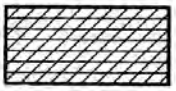
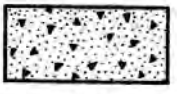
TYPE	CONVENTION	MATERIALS
METALS		STEEL, CAST IRON, COPPER AND ITS ALLOYS, ALUMINIUM AND ITS ALLOYS, ETC
		LEAD, ZINC, TIN, WHITE-METAL, ETC
GLASS		GLASS
PACKING AND INSULATING MATERIALS		PORCELAIN, STONEWARE, MARBLE, SLATE, ETC
		ASBESTOS, FIBRE, FELT, SYNTHETIC RESIN PRODUCTS, PAPER, CORK, LINOLEUM, RUBBER, LEATHER, WAX, INSULATING & FILLING MATERIALS
LIQUIDS		WATER, OIL, PETROL, KEROSENE, ETC
WOOD		WOOD, PLYWOOD, ETC
CONCRETE		

Figure 15. General symbols used to represent various materials in section view.

Drafting and Preparing Foundation Plans

A foundation plan is a top view of the footings or foundation walls, showing their area and their location by distances between centerlines and by distances from reference lines or boundary lines. Actually, it is a horizontal section view cut through the walls of the foundation showing beams, girders, piers or columns, and openings, along with dimension sand internal composition.

Here are Step-by-step Instructions for Drawing the Foundation Measurements of a Sample Building

Draw a solid line representing the outside dimensions of the walls of the building, this line will also represent the outside dimensions of the foundation wall.

Outside Wall

Draw a second solid line inside the first one to represent the inside dimensions of the building's walls. This line will also represent the inside dimensions of the foundation wall. The space between the two lines should be exactly the width of the planned walls to scale.

The Space Between the Two Lines

Subtract the width of the wall from the planned width of the foundation footing. Divide the remainder in two and convert the answer into the scale dimension being used in the drawing. This figure represents the distance between the inner side of the wall and the inner side of the foundation footing.

Draw a dotted line inside the drawing of the walls. This line represents the inner dimension of the footing. The space between it and the inside solid line (step #2) should be exactly the distance calculated in step #3.

Inside Edge of Footing

Draw a dotted line outside the drawing of the walls. This line represents the outer dimension of the footing. The space between it and the outside solid line (step #1) should be exactly the distance calculated in step #3.

With of Footing

On either side of the drawing's length, add a solid line exactly as long as the longest wall (that is, the longest outer solid line).

On either side of the drawing's width, add a solid line exactly as long as the longest wall (that is, the longest outer solid lines).

Length and Weight

Place a mark along each line from steps #6-7 wherever the outer wall turns a corner. Indicate the actual length of each straight section of wall.

Place a Mark along Each Line

Outside the lines drawn in steps #6-7, draw two more solid lines exactly as long as the length and width of the outer dotted line. Mark these lines to indicate the actual length of each straight section of foundation footing.

Underneath the completed drawing, write down what the footing and foundation wall will be made of and their cross-section dimensions.

The completed drawing is an actual scale drawing showing the trenches that must be dug for the footing and the dimensions of the foundation walls.

Floor Plans

In architecture drawing and building engineering, a floor plan is a drawing to scale, showing a view from above, the relationships between rooms, spaces, traffic patterns, and other physical features at one level of a structure.

Dimensions are usually drawn between the walls to specify room sizes and wall lengths. Floor plans may also include details of fixtures like sinks, water heaters, furnaces, etc. Floor plans may include notes for construction to specify finishes, construction methods, or symbols for electrical items.

Exterior Elevations

An exterior elevation is a view of a building seen from one side, a flat representation of one face. This is the most common view used to describe the external appearance of a building. Each elevation is labeled in relation to the compass direction it faces, e.g. looking toward the north you would be seeing the southern elevation of the building. Buildings are rarely a simple rectangular shape in plan, so a typical elevation may show all the parts of the building that are seen from a particular direction.

Sections

A cross section, also simply called a section, represents a vertical plane cut through the object, in the same way as a floor plan is a horizontal section viewed from the top. In the section view, everything cut by the section plane is shown as a bold line, often with a solid fill to show objects that are cut through, and anything seen beyond generally shown in a

thinner line. Sections are used to describe the relationship between different levels of a building.

In the Observation drawing illustrated here, the section shows the dome which can be seen from the outside, a second dome that can only be seen inside the building, and the way the space between the two accommodates a large astronomical telescope: relationships that would be difficult to understand from plans alone.

Exercises

Choose the correct answer from the given alternatives.

1. What is the primary purpose of engineering drawings?
   a. Decoration
   b. Communication of design ideas
   c. Storytelling
   d. Entertainment

2. Which of the following is not an engineering symbol?
   a. Diameter (Ø)
   b. Section Line (//)
   c. Music Note (♪)
   d. Center Line (CL)

3. What do building codes regulate?
   a. Structural safety
   b. Electrical installations
   c. Fire safety
   d. All of the above

4. What type of plan shows the top view of a building?
   a. Site plan
   b. Elevation
   c. Section plan
   d. Floor plan

5. What is used to represent doors and windows in architectural drawings?
   a. Thick solid lines
   b. Dashed lines
   c. Symbols
   d. Arrows

6. A foundation plan is drawn to represent.....

   a. The exterior design of a building

   b. The footing and foundation layout

   c. The electrical wiring

   d. The furniture layout

7. Site plans are important because they show.....

   a. Interior design details

   b. Elevation details

   c. The relationship between a building and its surroundings

   d. Plumbing layouts

8. What is an elevation drawing?

   a. A vertical projection of a building's side

   b. A foundation plan

   c. A 3D view of the building

   d. A floor plan

9. Conventional signs are used in drawings to.....

   a. Increase drawing size

   b. Make drawings more artistic

   c. Represent standard elements clearly

   d. Confuse the reader

10. Which governing body regulates building codes in Nepal?

    a. NASA

    b. NEC (Nepal Engineering Council)

    c. NBC (National Building Code)

    d. WHO

Write short answer to the following questions.

1. What are engineering symbols and why are they used?
2. Explain the importance of by-laws in construction.

3. Differentiate between a site plan and a location plan.
4. What is a foundation plan, and why is it essential?
5. What is the purpose of a sectional drawing?

Write long answer to the following questions.

1. Describe the different types of engineering drawings and their applications.
2. Explain the key components of a floor plan with an example.
3. Discuss the importance of building codes and how they impact structural safety.

Project Work

1. To prepare site plan and location plan.

Unit 7: Introduction to AutoCAD Course and Hardware

7.1 Overview of AutoCAD Release

AutoCAD is a commercial computer-aided design (CAD) and drafting software application. Developed and marketed by Autodesk, AutoCAD was first released in December 1982 as a desktop app running on microcomputers with internal graphics controllers. Before AutoCAD was introduced, most commercial CAD programs ran on mainframe computers or minicomputers, with each CAD operator (user) working at a separate graphics terminal. Since 2010, AutoCAD was released as a mobile- and web app as well, marketed as AutoCAD 360.

This unit mainly aims to assist the reader to use AutoCAD 2007 with a series of interactive exercise. These exercise will be backed up with activities, thus allowing the reader to practise the new skills being demonstrated.

The software is developed by the Autodesk and it will support both 2D and 3D formats.

History of AutoCAD

AutoCAD= Automatic Computer Aided Design

Version 1.0 (Release 1) to till now, they are updating new version .

7.2 Overview of Fundamental of Computer (hardware/software) Hardware

Hardware is the physical component that we can actually touch and feel like disk, display screen, keyboard, printers, etc. The display and storage devices are also called hardware devices.

Software

It is untouchable. It exist as ideas, concepts and symbols, but it has no body. A computer without software is like a book full of blank page. It is collection of instructions. Examples of software are Ms-word, AutoCAD, Power Point, etc.

Characteristics of AutoCAD

AutoCAD is the use of computer system to assist in the certain modification or analysis of

a design. AutoCAD software is used to increase the productivity of design or improve the quality of design, improves communication through the documentation and to create a data base for manufacturing. AutoCAD output is often in the form of electronic files for printing. It is used in many fields for creating a technical drawing.

Benefits of AutoCAD

- Improves productivity in drafting
- Shortens preparation time for drawing
- Reduced manpower requirements
- Customer modification in drawings are easier
- Low wastage in drawing
- Improves drawing accuracy
- Develops better design
- Editing is possible
- Production of orthographic projection with dimension and tolerance
- Hatching of different sections with various patterns are possible

7.3 Overview about Peripheral Devices

Auxiliary devices (equipment) used in computer (keyboard, mouse, scanner, etc.), output (printer, plotter, speaker, etc.), storage (floppy disk, pen drive, CD drive etc.), communication (microphone, modem, router, etc.) or other function under a direct control of computer are known as peripheral devices.

Printer and Plotter Printer

Printer is an external hardware output device that take an electronic data stored on a computer or other devices, and generates a hardcopy of text. Printers are most popular computer peripheral device; and are commonly used to print the text and graphics. There are two types of printers. They are:

- Impact printer
- Non-impact printer

Plotter

Plotter is a computer hardware device much like a printer that is used for printing vector graphics. Plotter is widely used for plotting the drawings on AutoCAD. A plotter gives a hardcopy of the output. It draws picture on a paper using a pen. Plotters are used to print

design of machine, plan for building, etc. There are two types of plotter, they are:

- Drum plotter
- Electro static plotter

7.4 Starting a New Drawing

7.4.1 Setting up a drawing starting from scratch, using wizard, using and creating a template file

All drawing starts from either, a default drawing template file or a custom drawing template file that you create. Drawing template file stores in default settings style and additional data.

Starting from Scratch

It starts an empty drawing using default imperial or metric settings. We can change the measurement system for a given drawing by using measurement system variable.

Drawing 1.dwg that opens when you start the program is a drawing that is started from scratch. The default drawing boundary is 12” by 9” in imperial settings.

Using a Wizard

Setting up a drawing using a step by step guide, you can choose from two wizards: quick wizard setup and advanced wizard setup.

Click File Menu » New

- In the Create New Drawing dialog box, click Use a Wizard.
- Click Quick Setup or Advanced Setup.
- Complete the wizard pages using the Next and Back buttons to move forward and backward.
- On the last page, click Finish.

Quick Setup

It displays the quick setup wizard in which you can specify the units and areas for the new drawing. The quick setup wizard also changes setting such as text height and snap spacing to an appropriate scale.

Advanced Wizard Setup

It displays advanced setup wizard, in which you can specify the units, angle measure, angle direction and area for new drawing. The advanced setup wizard also changes settings such

as text height and snap spacing to an appropriate scale.

Creating a Template File

A drawing template file contains standard settings. Select one of the template files supplied, or create your own template files. Drawing template files have a .dwt file extension.

When you create a new drawing based on an existing template file and make changes, the changes in the new drawing do not affect the template file. You can use one of the template files supplied with the program, or you can create your own template files.

- Unit type and precision
- Title blocks, borders, and logos
- Layer names
- Snap, Grid, and Ortho settings
- Grid limits
- Dimension styles
- Text styles
- Linotypes

By default, drawing template files are stored in the template folder, where they are easily accessible.

Opening an Existing Drawing File

You open drawings to work on them just as you do with other Windows applications. In addition, you can choose from several alternative methods.

To open a drawing, you can

- Use Open on the File menu to display the **Select File** dialog box.
- Double-click a drawing in **Windows Explorer** to launch **AutoCAD®** and open the drawing. If the program is already running, the drawing opens in the current session rather than in a second session.
- Drag a drawing from **Windows Explorer** into AutoCAD.

If you drop a drawing anywhere outside the drawing area—for example, the command line or the blank space next to the toolbars— the drawing is opened. However, if you drag a single drawing into the drawing area of an open drawing, the new drawing is not opened but inserted as a block reference.

Use Design Center to Open Drawings

Use the Sheet Set Manager to locate and open the drawings in a sheet set.

7.5. Screen Layout of AutoCAD and Setting Preferences (Setting units and scale, Managing drawing area by using multi-view setup and limits)

The screen design is a part of the interface development and is a result of the story boarding described in section. These sections below the various pieces as described along with their required and expected functionality. A title bar that has the AutoCAD symbol and the current drawing name is displayed on top of the screen. See in figure 2-1.

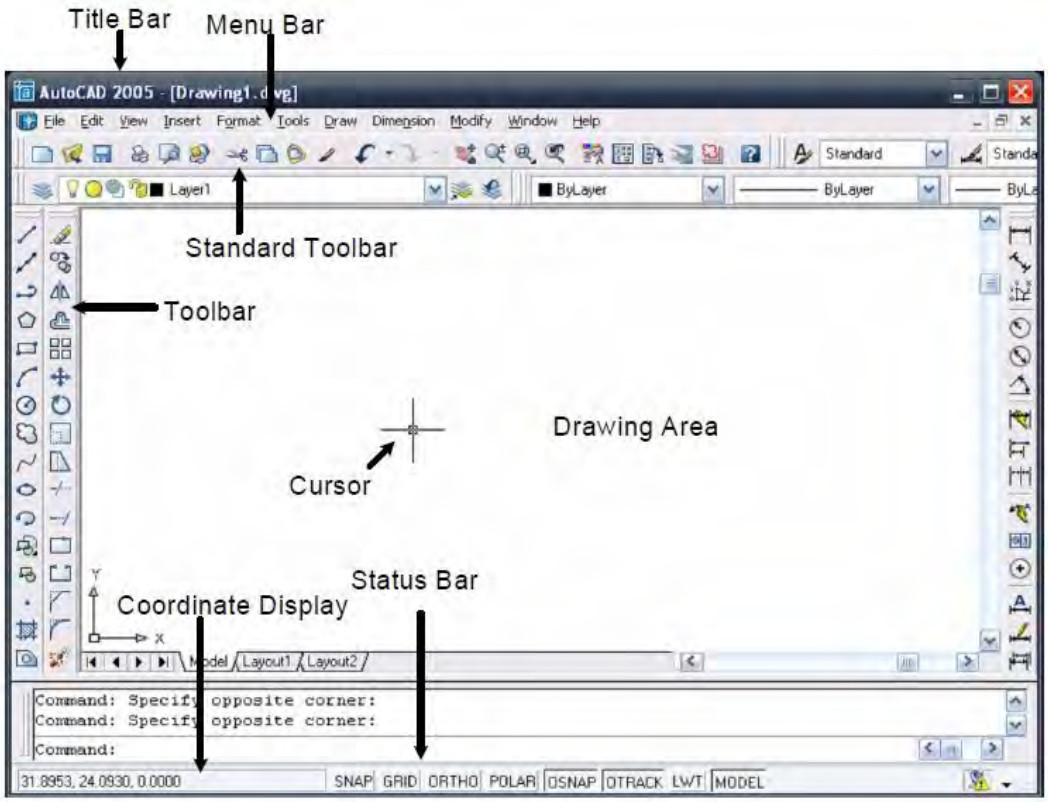


Fig: Layout of CAD

Drawing Area

The drawing area covers the major portion of the screen. Here, you can draw various objects and use various commands. To draw the objects, you need to define the coordinate point, which can be selected by using your pointing device. The position of the point device is representing on the screen by the cursor. There is a coordinate system icon at the lower left

corner of the drawing area.

7.5.1. Command Window

The commanding window is present at the bottom of the drawing area and has the Command prompt where you can enter the commands. You can change the size of the window by placing the cursor on the top edge and then dragging it. You can also press the F2 key to display the AutoCAD Text window, which displays the previous commands and prompts.

7.5.2. Status Bar

The status bar is displayed at the bottom of the screen. This bar contains some important useful information and buttons that will make it easy to change the status of some AutoCAD function. There are some components in status bar are given below.

7.5.3. Toolbar

In windows, the toolbar is an easy and convenient way to involve a command. Each toolbar contains a group of buttons representing various AutoCAD commands. When you move the cursor over the buttons of a toolbar, the button gets lifted and three-dimensional box encloses the button on which the cursor is resting. The name of button is also displayed below the button. You have to invoke the command, left click is done.

Setting Units and Scale

Unit Setting

- Click application button and then choose units. The drawing units' dialogue box appears and then fills up setting as per requirement.
- Choose a linear unit type from the length type drop down list. Choose the type of unit representation that's appropriate for the work. Engineering and architectural units are displayed in feet and inches.
- From the length precision drop down list choose the level of precision we want when AutoCAD displays coordinates and linear measurements.
- Choose an angular unit type from the angle type drop down list.
- From the angle precision drop down list, choose the degree of precision we want when AutoCAD displays angular measurements.

- In the insertion scale, choose the units measurements for this drawing.
- Click OK to exit the dialogue box and save the setting.

Setting and Use of Drafting Aids

- Use the grid display and snap mode drawing aids to locate points quickly and precisely.
- Draw orthogonally using the ortho mode drawing aid.
- Draw an angles using the polar tracking drawing aid
- Use basic object snaps to locate precisely relative to existing objects
- Refer objects snaps to locate complex points.
- Use advanced object snaps to locate points using acquired points and alignment path.
- Locate point relative to multiple objects by using the object snap tracking feature to display multiple intersecting alignment path tracing vectors.
- Control dynamic input setting
- Use construction line to increase productivity and precision when creating multiple view drawing.

Computer Graphics

Computer graphics means the creation manipulation and display of image on the computer screen. Hardware graphics is the graphics representation of the range of specification of the hardware components of computer.

Types of Computer Graphics

There are two types of computer graphics:

Raster

Raster graphics is a cell-based representation of map features commonly called bitmap image. A bitmap image uses a grid of individual pixel where each pixel can be different color of shade. Raster object is used to display pixels on the screen and retrieve pixel values. This object is the collection of raster brands in memory and manages the arrays of pixels and their ancillary data.

Raster images consist of a rectangular grid of small squares or dots known as pixels. For example, a photograph of a house is made up of a series of pixels colorized to represent the appearance of a house. A raster image references the pixels in a specific grid.

Raster images, like many other drawing objects, can be copied, moved, or clipped. You can modify an image with grip modes, adjust an image for contrast, clip the image with a rectangle or polygon, or use an image as a cutting edge for a trim.

The image file formats supported by the program include the most common formats used in major technical imaging application areas: computer graphics, document management, engineering, mapping, and geographic information systems (GIS). Images can be bitonal, 8-bit gray, 8-bit color, or 24-bit color. Images with 16-bits color depth are not supported starting with AutoCAD 2007.

Several image file formats support images with transparent pixels. When image transparency is set to on, the program recognizes those transparent pixels and allows graphics in the drawing area to "show through" those pixels. (In bitonal images, background pixels are treated as transparent.) Transparent images can be gray-scale or color.

Note: Although the file name extension is listed in the following table, the file format is determined from the file contents, not from the file extension.

Vector

Vector graphics use mathematical relationship between point and path connecting them to describe can image. Vector images are composed of points, lines and polygons. The shape of a vector path is determined by points that are plotted along the path. A vector objects stroke color follows the path. All vector data stores in x,y coordinates or a series of a x,y coordinates. We can use a variety of tools and techniques to draw and edit vector objects.

Pixel

A pixel is usually very small so, we don't notice the individual pixel. They all combine to make up image. Each pixel has a specific color value assigned to it, depending upon what color we are working in is defined differently. A computer screen displays 72 pixels per inch.

Bitmap

Image requires higher resolution for a smooth appearance bit maps are used for photograph and image.

Use of Raster Image Format

- Continuous tonal image photographs
- Use on the web where there are no vector formats currently supported.

Use of Vector Image Format

- Logos which is generally a few solid color and needed to be at variety size
- Creating specialized objects of 3D in AutoCAD programs.

Differences between Vector and Raster

Raster Images	Vector Images
1) Resolution dependent	1) Resolution independent
2) Zigzag curves	2) Smooth curves
3) Large file size	3) Small size file

Vector and Raster Images

AutoCAD is a vector based drawing application but we can also work with raster image in it. A vector image is composed of instruction on how to form shapes with specific values and does not use pixels. Whereas, raster image uses a grid of small square is known as pixels, where each pixel has a specific values, such as color. Raster graphics are resolution dependent and the quality of the raster image is determined by the amount of information stored in each pixel. The photographs look more accurate as raster image, because the gradients are smoother, within the photographs. Some of the examples of raster image formats are Tagged Image File Format (TIFF), Portable Network Graphics (PNG), Graphics Interchange Format (GIF) and Joint Photographic Exports Groups (JPEG).

Raster Object and Vector Applications

An image drawn on the CRT screen can be produced using two different techniques raster or v ector point and imaging software use raster technique where as freehand drawing and animation software use vector. Most graphic output devices e.g. printer / monitor are raster based device.

Data Storage and Retrieval

Data storage often called storage or memory is a technology consisting of computer components and recording media used to retain digital data. It is a core function and fundamental components of computer.

Drawing Exchange Format (DXF)

DXF and DXB files are two forms of drawing interchange files that we can use with the program. A DXF (drawing interchange format) file is an ASCII description of a drawing

file. It is used to share drawing data between applications, often other CAD programs.

A DXB (Drawing Interchange Binary) file is a specially coded binary version of a DXF file produced by programs such as Auto Shade.

You can convert a DXF or DXB file to DWG format by opening the file and saving it in DWG format. You can then work with the resulting drawing file as you would with any other drawing file, and you can import it into another drawing as an xref or a block.

Exercises

Choose the correct answer from the given alternatives.

1. What is AutoCAD primarily used for?

   a. Gaming b. Engineering and architectural drawings

   c. Photo editing d. Video animation

2. Which of the following is NOT a peripheral device used with AutoCAD?

   a. Plotter b. Printer c. Joystick d. Scanner

3. What does the AutoCAD command “UNITS” do?

   a. Changes the display color

   b. Sets measurement units for the drawing

   c. Deletes objects

   d. Copies elements

4. Which command is used to start a new drawing in AutoCAD?

   a. NEW b. OPEN c. SAVE d. PLOT

5. What is the function of a plotter in AutoCAD?

   a. Modifying drawings

   b. Printing large-scale engineering drawings

   c. Saving files

   d. Erasing lines

6. What does the AutoCAD command “LIMITS” control?

   a. Text size b. Drawing area boundaries

   c. Line thickness d. Color settings

7. The “Zoom” tool in AutoCAD helps to.....

   a. Modify objects b. Change the layout

   c. View details at different scales d. Save files

8. What is the default file format for AutoCAD drawings?

   a. .DWG b. .PDF c. .DOCX d. .JPEG

9. What is the role of system settings in AutoCAD?

   a. To configure preferences for a user's workspace

   b. To create new layers

   c. To delete files

   d. To add colors to drawings

10. AutoCAD is commonly used in which field?

    a. Civil engineering b. Fashion design

    c. Medicine d. Agriculture

Write short answer to the following questions.

1. What are the main components of AutoCAD's screen layout?
2. Why is a plotter used in engineering drawings?
3. Explain the significance of setting units and scale in AutoCAD.
4. What is the purpose of a multi-view setup in AutoCAD?
5. How can a user open an existing drawing in AutoCAD?

Write long answer to the following questions.

1. Explain the step-by-step process of starting a new drawing in AutoCAD.
2. Discuss the importance of AutoCAD in civil engineering.
3. Describe the various system settings in AutoCAD and how they impact drawings.

Unit 8 : Auto CAD Commands

8..1 Drawing Commands

The commands on Auto CADD (Automatic Computer Added Design and Drafting) are used for drawing any objects, shapes, building etc. in new work space command. The examples of drawing commands area :

Line (L enter)

Circle (C enter)

Arc (A enter)

Polyline (Pl enter)

Polygon (Pol enter)

Rectangle (Rec enter)

Co-ordinate Input methods

8.1.1. Coordinate Input Methods

(a) Directive Method

- Move the cursor in a direction and type the distance
- Nonced to type coordinates, just specify direction by clicking and give distance value

(b) Absolute Co-ordinate System

Syntax : x, y

Use absolute co-ordinate system when you know the precise x and y values of the location of the point from the origin.

Here, example

Command: L enter

Line specify first point: 10, 10 enter Specify next point: 10, 60 center

Specify next point: 60, 60 enter

Specify next point: 60, 110 enter

Specify next point: 110, 110 enter

Specify next point: 110, 10 enter

Specify next point: 10, 10 enter or C enter Specify next point: <ENTER>

C. Relative Co-ordinate system

Syntax: @ x, y

Use relative co-ordinate system when we know the precise x and y values of the location of a point in relation to the previous point.

1st point is always identified by absolute co-ordinate system. Here,

Command = L enter

LINE specify first point: 10, 20 enter Specify next point: @ 50, 0 enter Specify next point: @ 0, 40 enter Specify next point: @ -50, 0 enter

Specify next point: @ 0, -40 enter or C enter Specify next point: <ENTER>

D. Polar Co-ordinate System

Syntax = @ distance (x) < Angle (ɵ)

Use polar co-ordinate system when we know the distance and an angle of a location of a point with reference to a previous point. 1St point is always identified by absolute co-ordinate system.

Here,

Command = L enter

LINE specify first point: 10, 20 enter Specify next point: @ 50 < 0 enter Specify next point: @ 40 < 90 enter Specify next point: @ 50 < 180 enter

Specify next point: @ 40 < 270 enter or C enter Specify next point: <ENTER>

Drawing commands

Construction line = XL Enter or enter Line = L enter

Polyline = PL enter Polygon = POL enter Rectangle = REC enter Arc = A enter

Circle = C enter

Revision cloud = REVCLOUD enter Spline = SPL enter

Ellipse = EL enter Point = PO enter Hatch = H enter Gradient = GD enter Modify Commands Erase = E enter

Copy = CO or CP enter Mirror = MI enter Offset = O enter

Array = AR enter Move = M enter Rotate = RO enter Scale = SC enter Stretch = S enter Trim = TR enter Extend = EX enter Break = BR enter Chamfer = CHA enter Join = J enter

Fillet = F enter Lengthen = LEN enter Explode = X enter

8.1.2 Point, Line, Polyline, Multiline, Construction line

Point

This command is used to draw the point of different types. Command: Po enter

To change the point types, Command = DD P TYPE enter

Line

This command is used to draw the line of certain dimension. 'ORTHO' made should be 'ON' to draw the line either horizontal or vertical, show the direction and enter dimension value.

Command: L enter

Polyline

This command is similar to the line but doesn't break at all vertices and the number of segments of lines act as a single line. Command: PL enter

Multiline

This command is used to draw parallel line simultaneously. Command: ML enter

Construction Line

This command creates a line of infinite length. This line is mostly used for making elevation.

Command: XL enter For Horizontal: H enter For Vertical: V enter

For inclined (angular): A enter

8.1.3. Circle, Arc, Ellipse, Donut

This command is used to draw the circle with given radius, diameter, two points, three points, etc.

Command: C enter

Arc

This command is used to draw an arc (of a circle). Minimum three points are required to draw an arc.

Command: A enter

Ellipse

This command is used to draw an elliptical object with given major and minor axis.

Command: EL enter

Donut

This command is used to draw the cross – section of rod, pipe,etc.

Command = Do enter

8.1.4 Polygon, Rectangle, Spline, Solid, etc.

Polygon

This command is used to draw regular polygon, such as square, pentagon, hexagon etc.

Command: - POL enter

RI = Inscribe in circle = Radius = Center to

Rc = Circumscribed about circle = Radius = midpoint

Rectangle

This command is used to draw rectangle in any size. The command is mostly used (to draw) for making column in building plan.

Command: - REC enter

Spline

This command is used to draw non – uniform curves. Command: - SPL enter

Solid

This command creates a solid hatch with in a selected closed boundary. (Minimum number of points for solids is 4).

Command: - So enter

8.1.5 Hatching and Gradient

Hatch are representatively pattern of lines that fill in an area. Most type of drafting makes use of hatching.

Command: - H enter

Hatch and gradient dialog box is approved.

Choose the desired hatch pattern.

Click on add pick point or select object.

Pick internal point of object or select the required object.

Click on preview. If hatch is right, click accept, otherwise click on modify.

Then, change the scale and angle and click on ok.

Gradient are the representing pattern of colors. It is mainly used for window in building elevation.

Command: - GD<Enter>

Choose the desired gradient color.

Click on add pick point.

Pick internal point or (select objects / remove boundaries): <pick inside region

Click on OK.

Text (multi-line and single line / true type fonts)

Every drawing includes text that explains the object in the drawing. You can easily format and edit text to provide a professional appearance to your drawing.

The common text height for note is 1/8" to 1/12" or 2mm to 3mm. There are two types of text setting: -

Single line text

Multi line text

Single line text:

Command: - DT enter

Specify start point of text: - Click anywhere. Specify height: Specify desired height of text. Specify rotation angle of text: O enter

Write the required text.

Multiline text

Command: M TEXT enter

Specify first corner: click anywhere.

Specify opposite corner: click opposite corner.

Text formatting box is approved. You can manage the text style, text height, etc. in this box. Now you can write the required text.

Unit setup

The process of managing the drawing units in Auto CAD is called unit setup. You can set the desired unit with precision by using this command.

Command: - UN enter

Process

Go format menu

Click on units

Or, Command: - UN enter Units dialog box is approved.

Length Type	Precision	Insertion scale
Decimal	0	Millimeter
Architectural	0’ – 01/8”	Inces
Engineering	0’ -0.0”	Inches

Select the desired unit type.

Dimension Setup

A dimension style is a collection of dimension setting that controls the appearance of dimension such as arrow head style, text height and text position and lateral tolerances.

Command: - D enter

Dimension style manager dialogue box is approved.

Click on New to create new dimension style.

Enter name and click on continue.

Manage desired lines, symbols and arrows, text, fit, primary units, alternate units and tolerances for a new dimension set up.

Click on OK.

Click on set current and close.

Numerical

Command: - L enter

Line specify first point = 5, 2 enter

Specify next point = @ 8 < 0 enter Specify next point = @ 2 < 90 enter Specify next point = @ 3 < 180 enter Specify next point = @ 7 < 90 enter Specify next point = @ 5 < 210 enter Specify next point = @ 7 < 0 enter Specify next point = < Enter >

Absolute System

Command: - L enter

Line specify first point = 5, 2 enter Specify next point = 5, 9 enter Specify next point = 10, 11 enter Specify next point = 10, 4 enter Specify next point = 13, 4 enter Specify next point = 13, 12 enter

Specify next point = 5, 2 enter or C enter Specify next point = < Enter >

In polar System

Command: - L enter

Line specify first point = 10, 10 enter Specify next point = @ 35.4 < 90 enter Specify next point = @ 50 < 45 enter Specify next point = @ 50 < 315 enter Specify next point = @ 50 < 225 enter Specify next point = C enter

Absolute co-ordinate System

Command: - L enter

Line specify first point = 10, 10 enter

Specify next point = 10, 45.4 enter Specify next point = 60, 95.4 enter Specify next point = 95.4, 60 enter Specify next point = 45.4, 10 enter Specify next point = C enter

Relative co-ordinate System

Command: - L enter

Line specify first point = 10, 10 enter Specify next point = @ 0, 35.4 enter Specify next point = @ 50, 50 enter Specify next point = @ 50, 150 enter Specify next point = @- 50, -50 enter Specify next point = C enter

Absolute System

Command: - L enter

Line specify first point = 5, 2 enter Specify next point = 5, 6 enter Specify next point = 10, 11 enter Specify next point = 15, 6 enter Specify next point = 8, 2 enter

Specify next point = C enter or 5, 2 enter

Relative system

Command = L enter

Line specify first point = 5, 2 enter Specify next point = @ 0, 4 enter Specify next point = @ 5, 5 enter Specify next point = @ 5, -5 enter Specify next point = @- 7, -4 enter

Specify next point = @ - 3, 0 enter or C enter

<Enter>

8.2 Modify Commands

Modify commands can be used from pull – down modify menu, modify toolbar or directly entering shortcut command.

Erase

This command is used to remove undesirable object from drawing area. Command: - E

<enter>

Trim

This command is used to remove/cut the object from its cutting edge. Command: - TR <enter><enter>

Note:

Single object cannot be trim.

Object fixed at one or two end, this object also can't be trim.

Break

This command is used to remove certain portion of object which is given in two or one point.

Command: - BR <enter>

Copy, Mirror, Offset, Array Copy

This command is used to make one or more duplicates of original object.

Command: - CO <enter> / CP enter

Mirror

This command is used to copy of mirrored objects (to make mirror of an object with a respect to a mirror line).

Command: - Mi <enter>

Note: Erase source object = N enter

Offset

This command is used to make parallel line, arc or concentric circle. Command: - O <enter>

Array

This command is used to make multiple copy in certain pattern. Command: - AR <enter>

There are two types of array:

Rectangular array

Polar array

Move, Rotate, Scale, Stretch

Move

This command is used to displace the objects from its original position. Command: - M <enter>

Rotate

This command is used to tilt the object by fixing its base point in any direction. Command: - Ro <enter>

Scale

This command is used to increase or decrease the size of the object in multiplying factor.

Command: - SC <enter>

Stretch

This command is used to change the length or breadth of the portion of the object. Command: - S <enter>

Lengthen, Extend Lengthen

This command is used to increase or decrease the length of a line. Command: - LEN <enter>

Extend

This command is used to prolong the linear line of its certain boundary. Object need boundary to extend.

Command: - Ex <enter><enter>

Chamfer, Fillet Chamfer

It is used to make level shape with given dimension of cutting/trim edge. Command: - CHA <enter>

Fillet

It is used to make rounded edge with given radius of cutting/trim edge. Command: - F <enter>

Exercises

Choose the correct answer from the given alternatives.

1. Which of the following is NOT a coordinate input method in AutoCAD?

   a. Absolute b. Relative c. Random d. Polar

2. Which command is used to draw a straight line in AutoCAD?

   a. ARC b. LINE c. SPLINE d. POLYGON

3. What does the TRIM command do?

   a. Deletes objects b. Extends objects

   c. Removes extra parts of an object d. Creates a new drawing

4. How do you create a perfect circle in AutoCAD?

   a. Using the LINE command b. Using the ARC command

   c. Using the CIRCLE command d. Using the SPLINE command

5. Which command is used to duplicate an object in AutoCAD?

   a. COPY b. MIRROR c. OFFSET d. EXTEND

6. What is the function of the ARRAY command?

   a. Creates multiple copies of an object in a pattern

   b. Deletes an object

   c. Rotates an object

   d. Splits an object

7. The FILLET command in AutoCAD is used to.....

   a. Delete objects b. Create a rounded corner between two lines

   c. Extend objects d. Add text to drawings

8. Which command is used to change the length of an object?

   a. LENGTHEN b. SCALE c. OFFSET d. STRETCH

9. The command used to divide an object into equal segments is.....

   a. SPLIT b. DIVIDE c. PART d. CUT

10. What is the function of the OFFSET command?

    a. Duplicates an object at a specified distance

    b. Rotates an object

    c. Deletes an object

    d. Changes the scale of an object

Write short answer to the following questions.

1. What is the difference between absolute and relative coordinate input?
2. How does the TRIM command function?
3. What is the purpose of the POLYLINE command?
4. Explain how the MIRROR command is used.
5. What is the function of the CHAMFER command?

Write long answer to the following questions.

1. Explain the different coordinate input methods used in AutoCAD.
2. Describe how to use the ARRAY command and its different types.
3. Compare and contrast the FILLET and CHAMFER commands in AutoCAD.

Unit 9: Feature

9.1. View Tools

To Display a Toolbar

- To display the menu, click Quick Access Toolbar drop-down > Show Menu Bar.
- To display a toolbar, click Tools menu > Toolbars and select the required toolbar.

Inquiry Command

i) Area

To find an area and perimeter of any selected object Command: - AA enter (point selection method) Specify first corner point or [object / Add / subtract]: -

<Pick corner> P1

Specify next corner point or press ENTER for total:-

<Pick corner> P2

Specify next corner point or press ENTER for total: -

<Pick corner> P3

Specify next corner point or press ENTER for total: -

<Pick corner> P4

Specify next corner point or press ENTER for total: -

<Pick corner> P5

Specify next corner point or press ENTER for total: -

<Pick corner> P6

Specify next corner point or press ENTER for total: -

<Pick corner> P1

Specify next corner point or press ENTER for total: -

<ENTER>

Now, area and perimeter of selected object will be displayed on command line.

9.2. Layers Concept, Match and Change Properties Layer

Layers offer powerful features that enables you to show differences in all the various

elements of your drawing. In an architectural drawing, for example, you will commonly create layer for wall, door, window, column, text, etc.

When you do efficient work in AutoCAD, first of all you create layer, assign a layer name and change the properties of layer. Then, you can draw object in this layer.

Properties of Layer

It manages the line type

It manages the line weight

It manages the line color

It manages to separate different object

It manages to lock the object

Creating new Layer

Click on the layer property manager on the layer tool bar. Or,

Command: LA enter

Layer property manager dialogue box is approved

You can add necessary layer for your drawing by the following process:

Click on new layer button

Enter name for the layer

On the same line, as the new layer click on color and choose the required color

On the same line, click on the line type, choose the required line type

On the same line, as a new layer, click on line weight and choose the required line weight

All the layers are completed, then, click on apply and OK

9.3. Measure and Divide Measure

It creates point object or block at major interval along the length or perimeter of the object.

Command: - ME enter

Divide

To divide a line in any required segments. Command: DIV enter

Object Selection Method

When modify command is entered in command prompt window the task to be done is followed by the word “SELECT OBJECT” prompt. To activate the selection method, enter

keyboard selecting object prompt. Object can be selected by different ways.

Pick Box Selection

Window selection (W)

Crossing window selection (C)

Window polygon selection (WP)

Crossing window polygon selection (CP)

Fence selection (F)

Last object selection (L)

Previous object selection (P)

Select all (All)

Pick Box Selection Method

This method is simplest and mostly used object selection method. By using this method, individual object can be selected by clicking it.

Window Selection

The window selection option invoked by typing 'W' at the select object prompt. OR,

Movement: - Left to right Shade: - Blue

Result: - All objects which lie entirely within the window (blue shade) will be selected.

Crossing Window Selection

The crossing window selection option invoked by typing select object prompt.

OR, Movement: - Right to left

Shade: Green

Result: All objects which lie entirely within the window (green shade) and which cross the window border will be selected.

Fence selection

The fence selection option invoked by typing 'F' at the select object prompt. Fence option allows us to draw a multi – segment line, like a polyline. All objects which cross the fence will be selected.

Window polygon selection

This option invoked by typing 'WP' at the select object prompt. The object which lie entirely within the window polygon will be selected and the object which lie partially within the window polygon will not be selected.

Crossing Window Polygon Selection

This option invoked by typing 'CP' at the select object prompt. The object which lie entirely within the window of those which cross the window, will be selected.

Last Object Selection

This option invoked by typing 'L' at the select object prompt. The lastly drawn object will be selected.

Previous Object Selection

This option invoke by typing 'P' at the select object prompt. By using this option, the object will be selected that was selected on previous selection.

Select all

This option invoked by typing 'all' at the select object prompt. The whole object within the working area will be selected. This option also can be done by: -

'Ctrl + A'

Erase, Trim, Break Modify command

Modify commands are those commands of Auto CADD which are used for editing any objects on working area.

Command: AA enter

Specify first corner point or [object/add/subtract]: O enter Select Object: <select polyline object>

Now, area and perimeter of selected object will be displayed on command line.

ii. Distance

To know the distance between two points, angle in XY plane, angle from XY plane etc.

Command: DI enter

DIST specify first point: <click first point> Specify second point: <click second point>

Now, distance, angle in XY plane and angle from XY plane will be displayed.

9.4. Working with Block (9.5) W-block and Extern References

Block

A block in CAD is a collection of object combined into a single, reusable unit. Block helps reduce file size, maintain consistency and save time.

Creating a Block

- Use the command BLOCK or B command
- Select object, name the block and set a base point

Inserting a Block

- Use the INSERT command to place a block into the drawing.

Editing a Block

- Use the BEdit command for modify the block

Exploding a Block

- Use the explode command to break a block

WBLOCK

WBLOCK stands for Write Block. It is a command used to save a selected set of object or a block as a separate drawing files (.dwg). It is used to export part of drawing to use in other projects. To create a reusable block file. To reduce the size of complexity of large drawings.

Syntax

- WBLOCK, Enter
- Select the object or block name
- Specify base point insertion point
- Specify file name and save location
- Click ok. It create a seperate DWG file.

External References

External references (x refs) are drawing or image that are linked into current drawing. They help image large project by allowing multiple team numbers to work on seperate files that are connected to a master drawing.

Syntax

- XREF Enter
- Click attached drawing/image/pdf and select file.
- Set the insertion point, scale and rotation. The file appears as a references.

9.5. Plotters and Plotting the Drawing

Plotter

- A plotter is an output device that produces high-quality drawings by moving a pen or

other writing tool across a piece of paper or other media

- It can produce continuous lines and curves with high precision
- Generally slower than printers due to the detailed drawing process

Printer

- A printer is an output device that produces text and images by spraying or transferring ink or toner onto paper
- It produces dots or pixels to create images and text
- It is faster than plotters for printing documents and images.

Exercises

Choose the correct answer from the given alternatives.

1. Which command allows you to measure distances in AutoCAD?

   a. MEASURE b. DIST c. LENGTH d. SCALE

2. What is the purpose of the LAYER command?

   a. To group objects together

   b. To organize objects into different categories

   c. To create a 3D model

   d. To delete objects

3. What does the MATCH PROPERTIES command do?

   a. Copies objects

   b. Deletes objects

   c. Copies properties from one object to another

   d. Saves the drawing

4. Which command is used to divide an object into equal segments?

   a. SPLIT b. DIVIDE c. PARTITION d. CUT

5. What are external references (XREF) used for in AutoCAD?

   a. To insert external drawings into the current drawing

   b. To delete an object

   c. To scale an object

   d. To measure an object

6. What is the main advantage of using layers in AutoCAD?

   a. Faster printing

   b. Better organization and control of drawing elements

   c. Creating 3D models

   d. Deleting objects

7. What is the function of the PLOT command?

   a. To change the scale of the drawing

   b. To print the drawing on paper

   c. To delete objects

   d. To add dimensions

8. What does the CHANGE PROPERTIES command do?

   a. Modifies an object's attributes

   b. Deletes an object

   c. Rotates an object

   d. Saves a drawing

9. The command used to divide an object into a specified number of equal segments is.....

   a. MEASURE b. PARTITION c. SPLIT d. SCALE

10. What is the function of the BLOCK command in AutoCAD?

    a. To delete objects

    b. To create a reusable group of objects

    c. To rotate objects

    d. To plot drawings

Write short answer to the following questions.

1. What are layers in AutoCAD, and why are they used?
2. Explain the function of the MATCH PROPERTIES command.
3. How is the PLOT command used in AutoCAD?
4. What is the purpose of external references (XREF) in AutoCAD?
5. How do you divide an object using the DIVIDE command?

Write long answer to the following questions.

1. Describe the concept of layers in AutoCAD and explain their importance.
2. Explain how to use external references (XREF) and their advantages.
3. Discuss the various plotting and printing options in AutoCAD.

Project Work

1. Draw plan section and elevation of two room building in Auto CAD.

Reference

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ब्यन्जनकार मोहनमान, गाह्रो लगाउने प्रबिधि

चौधरी महेश कुमार, गाह्रो लगाउने प्रबिधि