UNIT – I – CONCRETE TECHNOLOGY

Cement- Grade cement - manufacture of Cements - Concrete chemicals and application - Mix design Concept-Mix Design As per BIS & ACI methods- manufacturing of concrete – Batching –mixing – transporting placing – compaction of concrete – curing and finishing - testing of fresh and hardened concrete - quality of concrete - Non destructive testing

PART - A

TWO MARK QUESTIONS AND ANSWERS

1. What are the properties of cement?

i) It gives strength to the masonry
ii) It gives an excellent binding material
iii) It is easily workable
iv) It is posses a good plasticity
v) It is stiffness or hardness early

2. What are ingredients used in production of cement?

i) Silica
ii) Lime
iii) Alumina
iv) Sulphur trioxide
v) Iron oxide
vi) Magnesium oxide

3. What are types of cement?

i) Acid-based cement
ii) Blast furnace cement
iii) Colored cement

iv) High alumina cement
v) Ordinary Portland cement
vi) Rapid hardening cement
vii) Sulphate resisting cment
viii) Water proof Portland cement
ix) Low heat Portland cement
x) Water repellent cement
xi) Expanding cement
xii) Portland pozzolana cement
xiii) Quick setting cement

4. State the functions of the ingredients of Portland cement?

- Cao - controls strength and soundness, its deficiency reduces strength and setting time.
- Si O_2 – gives strength, excess of it causes slow setting
- Al_2 O_3 -- responsible for quick setting if in excess, it lowers the strength.
- Fe_2O_3 – gives color and helps in fusion of different ingredients.

5. What are the tests to be conducted to ensure the cement supplied at the site is good?

- Physical test
  - Sieve method
  - Air permeability test
  - Wagner turbidity test
- Consistency test
- Soundness test - Le-chatlier method
- Strength test
  - Compressive strength
  - Tensile strength

6. What is the purpose of adding admixture in concrete?

- To improve the strength of concrete
- To accelerate the initial setting of concrete
- To retard the initial set
- To improve workability
- To inhibit the corrosion of concrete
- To increase the durability of concrete
- To increase the resistance to chemical attack.

7. What are the factors that affect workability of concrete?

Factors that affect workability of concrete are

- Water content
- Micro proportions
- Size of aggregates
- Shape of aggregates
- Surface textures of aggregate

8. What are the tests to find the workability of concrete?

Workability of concrete can be determined by

- Slump test
- Compacting factor test
- Flow test
- Kelly ball test
- Vee bee test

9. What are methods adopted in compaction?

- Hand compaction
  - Rodding
  - Ramming

- Tamping

- Compaction
  - Internal vibrator
  - Form work vibrator
  - Table vibrator
  - Platform vibrator
  - Surface vibrator (screed vibrator)
  - vi)Vibratory roller
- Compaction by pressure and jolting
- Compaction by spinning.

10. What are the characteristics of good concrete?

- It should have high compressive strength. The compressive strength should not be less than 15.5 N/ mm^2.
- On hardening, it should exhibit minimum shrinkage.
- It must be adequately dense. The density of a good concrete should be about 24 kN/m^3.
- It must be adequately durable to resist the effects of weathering agencies.
- It should have minimum creep
- It should have minimum thermal expansion so as to provide good resistance to fire.

11. What do you mean by the term "Workability"?

The quality of concrete satisfying the requirements like concrete without segregation, for placing without loss of homogeneity, compacting properly, presence of certain quantity of water is termed as workable concrete.

12. What are the factors that affect the workability of fresh concrete?

- Water content
- Mix proportion

- Size of aggregates
- Shape of aggregates
- Surface texture of aggregates
- Grading of aggregates
- Use of admixtures

13. Write the properties of sulphur impregnated concrete.

- It develops high compressive strength at an early age.
- It can be reused and remoulded without any wastage.
- It has good chemical durability and high strength.

14. Write the advantages of high grade cement.

- It is used for making stronger concrete.
- Although they are little costlier thn low grade cement, they offer 10 – 20% savings in cement consumption.
- Faster development of strength.

15. What are the special methods of making high strength concrete?

- Seeding
- Revibration
- High speed slurry mixing
- use of admixtures
- Inhibition of cracks
- Sulphur impregnation
- Use of cementitious aggregates

16. Why high strength concrete is used for concrete repairs?

High strength concrete for concrete repair is used to provide a concrete with improved resistance to chemical attack, better abrasion resistance, improved resistance to freezing and thawing and reduced permeability.

17. List some of the construction chemicals commonly used.

- Concrete curing compounds
- Polymer bonding agents
- Polymer modified mortar for repair and maintenance
- Mould releasing agents
- Installation aids
- Floor hardeners and dust proofers
- Guniting aid
- Construction chemicals for water proofing.

18. What are the construction chemicals used for water proofing?

- Integral water proofing compounds
- Acrylic based polymer coatings
- Mineral based polymer modified coatings
- Protective and decorative coatings
- Chemical DPC
- Waterproofing adhesive for tiles, marbles and granite
- Injection grout for cracks
- Joint seals

19. What are the types of admixtures?

- Plasticizers
- Super plasticizers
- Retarders and retarding plasticizers
- Accelerators and accelerating plasticizers
- Air retaining admixtures
- Pozzolanic or mineral admixture
- Damp proofing and water proofing admixtures

20. What is the purpose of using accelerators?

- To permit earlier removal of formwork
- Reduce the required period of curing
- Advance the time that a structure can be placed in service
- In the emergency repair work
- Partially compensate for the retarding effect of low temperature during cold weather concreting.

21. Define mix design.

Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible.

22. What are the variable factors to be considered in connection with specifying a concrete mix?

- Water cement ratio
- Cement content or cement – aggregate ratio
- Gradation of the aggregates
- Consistency

23. What are the various methods of proportioning?

- Arbitrary proportion
- Fineness modulus method
- Maximum density method
- Surface area method
- Indian road congress, IRC 44 method
- High strength concrete mix design
- Mix design based on flexural strength
- ACI committee 211 method

- DOE method
- Indian standard recommended method IS 10262 – 82

24. What is meant by statistical quality control?

The aim of quality control is to limit the variability as much as practicable. Statistical quality control method provides a scientific approach to the concrete designer to understand the realistic variability of the materials so as to lay down design specifications with proper tolerance to cater for unavoidable variations. The acceptance criteria are based on statistical evaluation of the test result of samples taken at random during execution.

25. What are the common terminologies used in the statistical quality control?

- Mean strength
- Variance
- Standard deviation
- Coefficient of variation

26. How will you calculate the standard deviation?

It is the root mean square deviation of all the results. This is denoted by σ.

$$\sigma = \sqrt{\sum (x - \bar{x})^2} / \sqrt{n-1}$$

27. List out the Non destructive testing?

- Rebound hammer
- Pull –out test
- Dynamic or vibration method
- Pulse velocity method
    - Mechanical sonic pulse velocity method
    - Ultrasonic pulse velocity method
- Nuclear method
- Magnetic method
- Radioactive method

- Electrical method

28. Write the stages of manufacturing of concrete?

- Batching
- mixing
- transporting
- placing
- compaction of concrete
- curing and finishing

PART - B

SIXTEEN MARK QUESTIONS AND ANSWERS

1. Explain the slump test?

Slump test is the most commonly used method of measuring consistency of concrete. It can be employed either in laboratory or at work site. It is not a suitable method for very wet or very dry concrete. However, it can be used to check quality of concrete and gives an indication of the uniformity of concrete from batch to batch.

Additional information on workability and quality of concrete can be obtained by observing the manner in which concrete slumps. Quality of concrete can also be further assessed by giving a few tappings or blows with tamping rod to the base plate and observing the flow. The apparatus far conducting the slump test, essentially consists of a metallic in the form of a function of a cone having the internal dimensions as under

Bottom diameter : 20cm
Top diameter : 10cm
Height : 30cm

The thickness of the metallic sheet for the mould should not be thinner than 1.6mm. The internal surface of the mould is thoroughly cleared and freed from super flow moisture. The mould is then filled in four layers, each approximately (1/4) of the height of the mould. Each layer in tamped 25 times by the tamping rod taking care to distribute the strokes evenly over the grease section.

After the layer has been rodded, the concrete is struck off level with a trowel and tampering rod. The mould is remould from the concrete immediately by raising it slowly and carefully in a vertical direction. This allows the concrete to subside. This subsidence is referred as SLUMP of concrete. The difference in level between the height of the mould and that of the highest paint of the subsided concrete is measured. This difference in height in mm, is taken as slump of concrete.

The pattern of slump is shown in fig. It indicates the characteristics of concrete in addition to the slump value. If the concrete slumps evenly it is called the normal slump. If one half of the cone slides down, it is called shear slump. In case of a shear slump, the slump value is measured as the difference in height between the height of the mould and the average value of the subsidence. Shear slump also indicates that the concrete is non-cohesive and shows the characteristic of segregation.

Despite many limitations, the slump test is very useful on site to check day-to-day as hour-to-hour variation in the quality of mix. An increase of the aggregates may mean for instance that the moisture content of the aggregates has suddenly increased as there has been sudden change in the grading of aggregate.

The slump test gives warning to correct the causes for change of slump value. Due to simplicity of the test it is popularly used to find workability of fresh concrete in spite if that many workability tests are in vogue.

2. Briefly explain the various Types of cement?

Acid, resistant cement:

It composed of following

i) Acid – resistant aggregate and such as quartz, quartizites etc.

ii) Additive such as sodium fluosilicate $Na_2\ SiF_6$

iii) Aqueous solution of sodium silicate or soluble glass.

The addition of additive sodium fluosilicate accelerates the hardening process of soluble glass and it also increases the resistance of cement to acid and water.

Then binding material of acid, resistant cement is soluble glass which is a water solution of sodium silicate, Nao_2, $nSiO_2$ or potassium silicate K_2 O. n SiO_2 where 'n' is glass modules.

The term glass modulas is used to indicate the ratio of the number of silica molecules to that of alkali oxide molecules and its value in soluble glass varies from 2.5 – 3.50

Blast Furnace Cement:

For this cement, the slag as obtained from blast furnace is used. The slag is a waste produced in the manufacturing process of pig-iron and it contains the basic elements of cement, namely alumina, lime and silica. The clinkers of cement are ground with bout 60 – 65 % of slag.

The properties of this cement are more or less the same as those of ordinary cement. Its strength in early day is less and hence it requires longer curing period.

Colored Cement:

The cement of desired color may be obtained by intimately mixing mineral pigments with ordinary cement. The amount of coloring material may vary from 5 – 10%. It this percentage exceeds 10% the strength of cement is affected.

The chromium oxide gives green color. The cobalt imparts blue color. The iron oxide in different proportions gives brown, red or yellow color. The Manganese dioxide is used to produce black or brown colored cement.

Expanding cement:

This type of cement is produced by adding an expanding medium like sulphate –aluminate and a stabilizing agent to the ordinary cement. Hence this cement expands whereas other cements shrink.

The expanding cement is used for the construction of water retaining structures and also for repairing the damaged concrete surfaces.

High alumina Cement:

This cement is produced by grinding clinkers formed by calcining bauxite and lime. The bauxite is an aluminum ore. It is specified that total Alumina content should not be less than 32% and ratio by weight of alumina to the lime should be between 0.85 to 1.30. This cement is known by the trade names of cement Fondu in England and Lumnite in America.

Hydrophobic Cement:

This type of cement contains admixtures which decrease the wetting ability of cement grains. The usual hydrophobic admixtures are acidol, naphthalene soap, oxidized petroleum etc.

When water is added to hydrophobic cement, the absorption films are turn off the surface and they do not in any way, prevent the normal hardening of cement. However, in initial stage, the gain in strength is less as hydrophobic films on cement grains prevent the interaction with water.

When hydrophobic cement is used, the fine pores in concrete are uniformly distributed and thus the frost resistance and the water resistance of such concrete are considerably increased.

Low heat cement:

The considerable heat is produced during the setting action of cement. In order to reduce the amount of heat this type of cement is used. It contains lower percentage of dicalcium silicate C_2 S of about 46 %

Pozzolana Cement:

The pozzolana is a volcanic powder. It is found in Italy near Vesuvius. It resembles surkhi which is prepared by burning bricks made form ordinary soils.

It can also be processed from Sholes and contain types of clays. The percentage of pozzuolana material should be between 10 – 30.

Quick setting cement:

This cement is produced by adding a small percentage of aluminium sulphate and by finely grinding the cement. The percentage of gypsum or retarded setting action is also greatly reduced.

The addition of aluminium sulphate and fineness of grinding are responsible for acceleration the setting action of cement the setting action of cement starts within five minutes after addition of water and it becomes hard like stone in less than 30 minutes or so.

Rapid hardening cement:

The initial and final setting times of this cement are the same as those of ordinary cement. But it attains high strength in early days. It contains high percentage of tricalcium silicate C_3 S to the extent of about 56%.

Sulphate resisting cement:

In this cement, the percentage of tricalcium aluminate C_3 A is kept below 5% and it results in the increase in resisting power against sulphates.

This cement is used for structures which are likely to be damaged by severe alkaline conditions such as canal linings, Culverts, siphons etc.

3. Explain the manufacture of cement?

Following three district operations are involved in the manufacture of normal setting or ordinary or Portland cement.

1. Mixing of raw materials
2. Burning
3. Grinding

Mixing of raw materials:

The raw materials such as limestone or chalk and shale or clay may be mixed either in dry condition or is wet condition. The process is accordingly known as the dry process or the wet process of mixing.

Dry process:

In this process, the raw materials are first reduced in size at about 25 mm in crushers. A current of dry air is then passed over these dried materials.

These dried materials are then pulverized into fire powder in ball mills and tube mills. All these operations are done separately for each raw material and they are stored in hoppers. They are then mixed in correct proportions and made ready for the feed at rotary Kiln. This finely ground powder at raw materials is known as the raw mix and it is stored in storage tank. Fig shows the flow diagram of mixing at raw materials by dry process.

The dry process has been modernized and it is widely used at present because of the following reasons.

Competition:

At present, several dry process cement plants are vying or competing with each other. The cement consumers in general and the practicing civil engineers in particular are greatly benefited by such competition.

Power:

The blending of dry powders has now perfected and the wet process, which required much higher consumption of power, can be replaced with confidence.

Quality of cement:

It is found that the quality of the production no longer depended on the skilled operators and workmen because temperature control and proportioning can be done automatically through a centralized control room.

Technology:

There has been several advances is instrumentation. Computerization and quality control, the application of the modern technology has made the production of cement by dry process more economical and of superior quality.

Following is the procedure of manufacture of cement by the dry process using modern technology.

i) Most of the cement factories are located very close to the limestone quarries. The boulders up to 1.2 m size are transported in huge dumpers up to 300 KN capacity and dumped into the hopper of the crusher.

ii) The hammer mill crushers of single stage are now used for crushing as against the time consuming two stage crushers used in earlier plants. The modern stacker – reclaimed system is now in use in most of the modern plants. The stacker helps in spreading the crushed materials in horizontal layers and the reclaimed restricts in the variation at calcium carbonate is crushed limestone to less than 1% thereby minimizing quality variation is the materials.

iii) The argillaceous or clay materials found in the quarry are also dumped into the crusher and stacked along with the limestone

iv) The crushed materials are checked for calcium carbonate, lime alumina, ferrous oxide and silica contents. In a similar way, if limestone is found to contain less content of lime, the high grade limestone is crushed and stored separately in the raw material hopper.

v) The additive material and crushed limestone are conveyed to the storage hopers. The raw materials are fed to the raw mill by means of a conveyer and proportioned by use of weight feeders which are adjusted as per the chemical analysis done on the raw materials taken from the hoppers from time to tome.

vi) The materials are ground to the desired fineness in the raw mill. In some of the modern plants, the high efficiency. Vertical grinding mills are installed The fine powder which energies as a result of grinding in the raw mill is blown upwards, collected in cyclones and fed to the giant sized continuous blending and storage silo by use of aeropole . The advantage of these silos is that one stage of pumping is eliminated which has inevitable in the traditional pattern of different silos for blending and storage.

vii) The material is dropped merely by gravity from the blending to the storage silo thereby conserving

viii) The material is than once again, pumped using an aerosol onto he pre heater. The most modern heater have five stage fro m 60 to 850 c has hard gas at temperature 1000 c is blown against the falling gradient the material from the bottom of the pre heater is fed to the rotary kiln due to the use of multi stage pre heater in the modern plant, the length of rotary kiln is considerably reduced there by resulting in saving maintenance cost and power requirement

Wet process:

In the earlier part of the century from 1913 to 1960 the wee process was used for the manufacture of cement. From 1913 onwards ‘cement industries

under went a no of changes mainly to suit the requirement of manufactures and government polishes till 1982.

All the cement plants setup of after 1980 use the dry process for the manufacture of cement. In this process the calcareous materials such as lime stone are crushed and stored in silos for storage tank now the crushed lime stone from silos and red clay from the basins are allowed fall in the channel in correct propos ion this channel leads the material to grinding mills where they are brought in to ultimate contact to form what is known as the slurry.

The grinding is carried out either in ball mill or tube mill or both. The slurry is let, to correcting basin where it is constantly stirred at the stage the chemical composition is adjusted as necessary. The corrected slurry is stored in storage tanks and kept ready to serve as feed for rotary kiln in this fig. show the flow diagram of mixing of raw materiel by the wet process.

It is thus seen that is case of mixing of raw materials by dry process the raw mix is formed and in case of mixing of raw materials by wet process the slurry is formed the remaining two operation namely burning in grinding are the same for both the process

Burning:

The burning is carried out in a rotary kiln as shown in fig the rotary kiln is formed of steel tube is diameter varies from 90m to 120m. it is laid at a gradient of about 1in 25 to 1in 30 the kiln supported at intervals by column of masonry or concrete the refractory lining is provided on the in side surface of rotary kiln it is so arranged that the kiln rotates at about 1to 3 revolution per mint about is longitudinal axis .

The corrected slurry is injected at the upper end of the kiln in the fig shows the rotary kiln for the wet process hot gases or planes or forced through the lawyer end of the kiln.

The portion of the kiln near its upper end is known as the dry zone and in this zone, the slurry of evaporated as the slurry gradually descends there is raise in temperature and in the next sections of kiln, the carbon dioxide from slurry is evaporated. These small pumps known as the modulus are formed at

the stage. this modulus then gradually roll down passing through zone of rising temperature and altimetry reach to the burning zone when temperature is about 1400 c to 500 c

In burning zone, the calcimined product is formed and modulus are converted into small hard dark greenness blue balls which are known as clinkers.

In the modern technology of dry process, the coal brought from the coal fields is pulverized in vertical coal mill and it is stored in silo it is pumped with required quantity of air through the burns. The preheated Raw material rolled down kiln and gets heated to such on extent that the carbon dioxide is driven with computation gases. The material is heated to temperature of nearly 1400 c to 1500 c when it gets fused together. The fused product is known as the clinkers or raw cement.

The size clinkers varies from 3mm to 20mm. and they are very hot when n the come out of burning zone of kiln . the clinker temperature at the outlet of kiln is nearly 1000c .A rotary kiln of small size is provide to cool down the hot clinkers. It is laid in opposite directions as shown fig. and the cooled clinkers having temperature of about 95 c are collected in containers of suitable size.

Grinding:

The clinkers as obtained from the rotary kiln are finally ground in ball mils and tube mills. During grindings a small gentrify. About 3 to 4 percent of gypsum is added. The gypsum control the initial setting time of cement. If gypsum is not added the cement. If gypsum is not added, the cement would set as soon as water is added. The gypsum acts as retorted and its delays the setting action of cement. It thus permits cement to the mixed with the aggregate and to be placed in position.

The grinding of clingers is modern plants is carried out in the cement mill which contains chromium steel balls of varies this balls with in the mill and grind the mixer which is collected in a Hooper and taken in bucket elevator for storage in silos.

The cement from silos is feet to the pacer machines. Most of the modern plans have electric backing plant having provision to account for the weight of

empty bags of different types and to ensure a 50kg net weight of cement bag with + or – 20g limits each bag of cement contains 50kg or 500N or about 0.035m3 of cement this bag are automatically discharge from the bakers to the conveyer belts to different loading are. They are carefully stored in a dry place.

4. What is high strength concrete? Explain the special methods of making high strength concrete.

Concrete is generally classified as

- Normal strength concrete (NSC)
- High strength concrete (HSC)
- Ultra high strength concrete (UHSC)

The advent of pre-stressed concrete technology Techniques has given impieties for working concrete of higher strength. Ready mixed concrete has taken its root in India now.

The manufacture of high strength concrete will grow to find its due place in concrete construction for all the obvious benefits. In modern batching plants high strength concrete is produced in a mechanical manner.

High strength concrete is defined as concrete with a 28 day design compressive strength over 41 Mpa.

Chemical admixtures such as water reducing admixtures is usually required o achiev lower water cement ratio and higher compressive strength..

These are special method making high strength concrete. They are given below

1. Seeding
2. Revibration
3. High speed slurry mixing
4. use of admixtures
5. Inhibition of cracks
6. Sulphur impregnation

7. Use of cementitious aggregates

Seeding:

This involves adding a small percentage pf finely ground, fully hydrated Portland cement to the fresh concrete mix. The mechanism by which this is supposed to method development is difficult to explain. This method may not hold much promise.

Revibration:

Concrete undergoes plastic shrinkage. Mixing water creates continuous capillary channels, bleeding and the strength of concrete. Controlled revibration removes all these defects and increases the strength of concrete.

High-speed slurry mixing:

This process involves the advantage preparation of cement –water mixture which's then blended with aggregates to produce concrete. Higher compressive strength obtained to more efficient hydration of cement particles and water achieved in the vigorous bending of cement paste.

Use of admixtures:

Use of water reducing agents are known to produce increased compressive strengths.

Inhibition of cracks:

Concrete fails by the formation and propagation of cracks. If the propagation of concrete sis inhibited, the strength be higher. Replacement of 2 – 3 % of fine aggregate by polythene or polystyrene "lenticules" 0.025mm thick and 3 to 4 mm in diameter results in higher strength. They appear to act as crack arresters without necessitating extra water for workability concrete cubes made in this way have yielded strength up to 105 Mpa.

Sulphur Impregnation:

Satisfactory high strength concrete have been produced by impregnating specimens for 24 hours, drying them at 120^0 c for 24 hours, immersing the specimen in molten sulphur under vacuum for 2 hours and then releasing the

vacuum and soaking them for an additional ½ hour for further infiltration of sulphur. The sulphur – unfiltered concrete has given strength up-to 58 MPa.

Use of cementitious aggregate:

Cement fondu is kind of clinker. This glassy clinker when finely ground results in a kind of cement. When coarsely crushed, it makes a kind of aggregate known as ALAG. Using Alag as aggregate gives strength up to 125 Mpa with water cement ratio 0.32.

5. Explain any two tests conducted on hardened concrete.

COMPRESSIVE STRENGTH

The compressive test for the concrete cubes were done as per IS 516-1959, 100 mm cubes were employed. Test specimens were stored in water for 48 hours before testing and tested immediately on removal from the water whilst they are still in a wet condition. Surface water and grits were wiped off and any projecting fins were removed. The weights of each specimen were taken before testing.

Cube placed in UTM for compression test

The cubes were placed on machine in such a manner that the load was applied to opposite sides of the cubes as cast. The tests were carried out at a uniform stress rate, after the specimen was centered in the testing machine (Fig 4.1). The loading was continued till the specimen reaches its ultimate load. The maximum load applied to the specimen was recorded. The compressive strength of the specimen is then calculated by dividing the maximum load applied to the specimen by the cross sectional area of the specimen.

SPLIT TENSILE STRENGTH

This is an indirect tension test method as per IS 5816-1999. The test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder, along the vertical diameter. When load is applied along the generatrix, an element on the vertical diameter of the cylinder is subjected to a horizontal stress of

$\sigma_t = 2P/\prod LD$

Where,

P is the compressive load on the cylinder

L is the length of cylinder

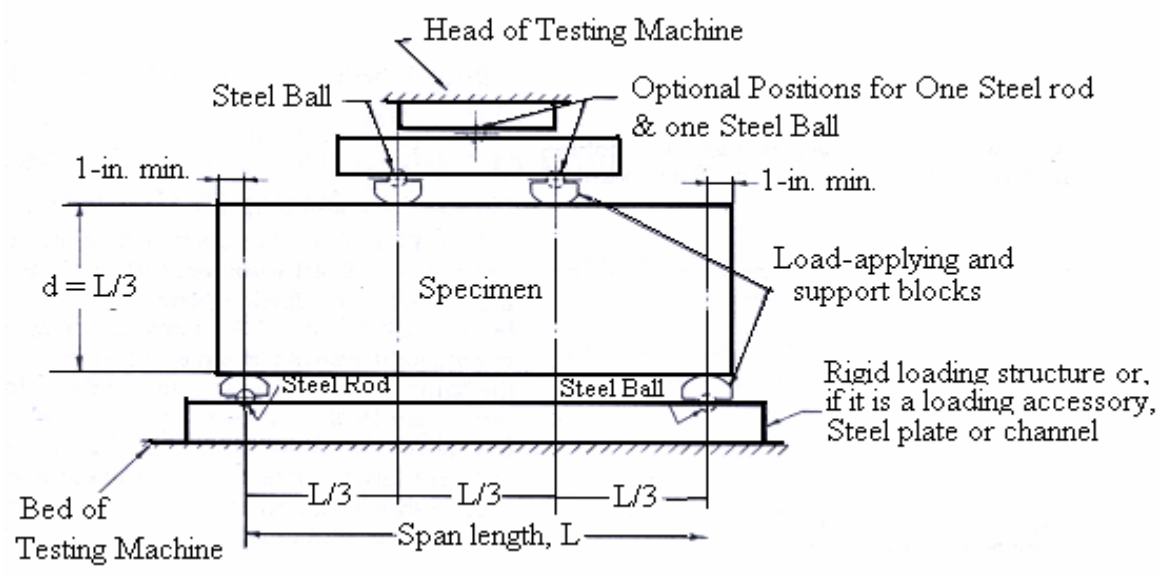
D is its diameter

In order to reduce the magnitude of the high compressive stresses near the point of application of the load, narrow packing plywood strips (25mm wide, 3mm thick and 20cm long) are placed between the specimen and loading platens of the testing machine. The packing strips were soft enough to allow distribution of load over a reasonable area, yet narrow and thin enough to prevent large contact area.

FLEXURAL STRENGTH

Flexural Test by Third-Point Loading

The specimens are loaded and tested in accordance with the ASTM Test Method. The third- point loading method with the forces applied perpendicular to the beam without eccentricity.



Flexural Test Set-up by Third Point Loading

Flexural strength test were carried out at the age of 28 days on the 100mm x 100mm x 500mm prism specimen using a universal testing machine of 100 tonne capacity with two point load. All the specimens were tested immediately after removal from the storage under water. Loading was applied continuously and without shock at a constant rate to the breaking point from this load the modulus of rupture, R, was calculated.

If the fracture initiates in the tension surface within the middle third of the span length, then, $f_b = PL/bd^2$

Where,

fb = Modules of rupture 'MPa'

P = Maximum applied load indicated by the testing machine 'N'

L = Span length 'mm'

b = Average width of specimen 'mm' at the fracture

d = Average depth of specimen 'mm' at the fracture

6 .Explain the factors influencing the choice of mix proportions.

Grade designation:

The grade designation gives characteristic compressive strength requirements of the concrete. As per IS 456-2000, characteristic compressive strength is defined as that value below which is not more than 5 percent of the test results are expected to fall.

It is the major factor influencing the mix design. Depending upon the degree of control available at the site, the concrete mix has to be designed for a target mean compressive strength which is somewhat higher than the characteristic strength.

Type and grade of cement

- The type of cement is important mainly through its influence on the rate of development of compressive strength of concrete.

- The choice of type of cement depends upon the requirement of performance at hand.
- The very high compressive strength is required e.g. in prestressed concrete railway sleepers high strength Portland cement of grades 43 and 53 conforming to IS: 8112-1989 and IS: 12269-1987, respectively, will be found suitable.
- The cement content in concrete varies almost inversely with the strength of cement used in the preparation concrete, i.e higher the strength of cement, lesser will be the cement content.
- On the other hand use of high strength cement permits higher water cement ration, which offers increased workability of fresh concrete.
- Moreover, greater fineness of 43 grade and 53 grade cement is another factor, which increases the workability. Fine particles reduce friction between aggregate , thus making concrete more workable

Maximum nominal size of aggregates

- The maximum nominal size of the coarse aggregate is determined by sieve analysis and is designated by the size higher than the largest size on which 15 percent or more of the aggregate is retained.
- The maximum nominal size of the aggregate to be used in concrete by the size of the section and spacing of the reinforcement.
- The nominal maximum size of aggregate may as large as possible, because larger the maximum size of aggregate smaller is the cement requirement for a particular water- cement ratio.
- The workability also increases with an increase in the maximum size of aggregate. However, the smaller size aggregates provide larger surface area for bonding with the mortar matrix which increases the compressive strength and reduce the stress concentration in the mortar-aggregate interface.

Grading of combined aggregate:

- The relative proportions of the fine and coarse aggregate in a concrete mix is one of the important factors affecting the strength of concrete.

- For dense concrete it is essential that the concrete and fine aggregates be well graded.
- Generally, the locally available aggregates do not confirm to the standard grading.
- The process of combining aggregates is aimed at obtaining a grading close to the coarsest grading of standard grading curves, the most economical mix having highest permissible aggregate water- cement ratio.

Water cement ratio

- The compressive strength of concrete at a given age and under normal temperature depends primarily on the water-cement ratio, lower the water-cement ratio greater is the compressive strength and vice-verse.
- The selection of the water-cement ratio for the target compressive strength at 28 day is concerned, fig 1 applicable for both ordinary Portland and Portland pozzolana cements with comparable validity.

Workability

- The workability of concrete for satisfactory placing and compaction is controlled by the size and shape of the section to be concreted, the quantity and spacing of reinforcement, and the methods to be employed for transportation, placing and compaction of concrete
- The aim should be to have the minimum possible workability consistent with satisfactory placing and compaction of concrete.
- It should be kept in mind that insufficient workability resulting in incomplete compaction may severely affect the strength , durability and surface finish of concrete and thus prove to be uneconomical in the long run.

Durability

- The durability of concrete can be defined and interpreted to mean its resistance to deteriorating influences which may reside the concrete itself, or to the aggressive environments.
- In addition, the cement content is chose to ensure alkalinity to provide a passive environment against corrosion of steel,eg.in concrete for

marine environment or sea water a minimum cement content of 350kg/m^3 or more is required.

- Moreover, the cement content and water-cement are so chosen as to provide a sufficient volume of cement paste to overfill the voids in the compacted aggregate.
- The blended cements like Portland pozzolana and Portland slag cement render grater durability to the concrete in sulphatic environments in sea water.

Quality control:

- The strength of concrete varies from batch to batch over a period of time.
- The source of variability in the strength of concrete may be considered due to variation in the quality of the materials, variations in mix proportions due to batching process, variations in the quality of batching and mixing equipment available, the quality of supervision and workmanship.
- Controlling these variations is important in lowering the difference between the minimum strength and characteristic mean strength of the mix and hence reducing the cement content.

7. Explain the Statistical quality control

- Concrete like most other construction processes, have certain amount of variability both in materials as well as constructional methods.
- The variation of strength from batch to batch and also within the batch
- It becomes very difficult to assess the strength of the final product
- Statistical quality control method provides a scientific approach to the concrete designer to understand the realistic variability of the materials.
- The acceptance criteria are based on statistical evaluation of the test result of the sample taken at random during execution
- This method provided a scientific basis of acceptance which is not realistic but also restrictive as required by the design requirements for the concrete construction.

- The compressive strength test cubes from random sampling of a mix, which are in the various operations involved in the making and testing of concrete.
- If a number of cube test results are plotted on histogram, the results are found so follow a bell shaped curve as “normal distribution curve”
- The results are said to follow a normal distribution curve if they are equally spaced about the mean value and if the largest number of the cubes have a strength closer to the mean value, and very few number of results with much greater or less value than the mean value

8. Write the advantages of Quality control

- Quality control means a rational use of the available resources after testing their characteristics and reduction in the material costs.
- In the absence of quality control there is no guarantee that over-spending in one-area will compensate for the weakness in another,e.g and extra bag of cement will not compensate for incomplete compaction or inadequate curing. Proper control at all stages is the only guarantee.
- In the absence of quality control at the site, the designer is tempted to over design, so as to minimize the risks. This adds to the overall cost.
- Checks at every stage of the production of concrete and rectification of the faults at the right time expedites completion and reduces delay
- Quality control reduces the maintenance costs.

PART – C

ASSIGNMENT QUESTION

1. List some of construction chemicals commonly used? Explain any five chemicals.
2. Explain in detail the non - destructive testing methods.
3. Indian standard method of concrete mix design (Grade M_{20})

(i) Design Stipulations:

i. Characteristic compressive strength required in the field at 28 days. = 20 MPa

ii. Maximum size of aggregate. = 20 mm (angular)

iii. Degree of workability. = 0.93 CF

iv. Degree of quality control. = Good

v. Type of exposure. = Mild

(ii) Test data for materials

i. Specific gravity of cement 3.15

ii. Compressive strength of cement at 7 days (As per the requirement of IS:269-1989). Satisfies

iii. (1) Specific gravity of coarse aggregates 2.60

(2) Specific gravity of fine aggregates 2.60

iv. Water absorption:

(1) Coarse aggregate 0.50%

(2) Fine aggregate 1.00%

v. Free (surface) moisture:

(1) Coarse aggregate Nil

(2) Fine aggregate Nil

vi. Sieve analysis is shown below:

1. Coarse Aggregate

Sieve sizes (mm)	**Fine aggregate (% passing)**	**Remarks**
20.0	84	Conforming to Table – 2, IS:383-1970.
12.5	6	
10.0	2.4	
6.3	4	
4.75	0	
< 4.75	0	

2. Fine Aggregate

Sieve sizes (mm)	Fine aggregate (% passing)	Remarks
4.75	96	Conforming to grading Zone III of Table 4 IS:385-1970
2.36	92	
1.18	30	
0.60	12	
0.30	2	
0.15	0	

4. Deign a concrete mix design for reinforced concrete work which will be exposed to the moderate condition. The concrete is to be designed foe a mean compressive strength of 30Mpa at the age of 28 days. A requirement of 25mm cover is prescribed. Maximum size of aggregate is 20mm uncrushed will be used. Sieve analysis shows that 50% passes through 600 micron sieve. The bulk specific gravity of aggregate is found to be 2.65.

UNIT II

CONSTRUCTION PRACTICES

Specifications, details and sequence of activities and construction co-ordination – Site Clearance – Marking – Earthwork - masonry – stone masonry – Bond in masonry - concrete hollow block masonry – flooring – damp proof courses – construction joints – movement and expansion joints – pre cast pavements – Building foundations – basements – temporary shed – centering and shuttering – slip forms – scaffoldings – de-shuttering forms – Fabrication and erection of steel trusses – frames – braced domes – laying brick –– weather and water proof – roof finishes – acoustic and fire protection.

PART - A

TWO MARK QUESTIONS AND ANSWERS

1. Define specification

The drawings of a structure will show the proportions and relative positions of its various parts. It is not possible to furnish the data regarding the quality of material and workmanship on the drawing due to the shortage of space. Hence, this information regarding the quality of materials and workmanship is conveyed in a separate document, which is known as specification.

2. Define masonry. What are the types of stone masonry?

Masonry is defined as the construction of building units bonded together with mortar. The building units may be stones, bricks or precast blocks of concrete. Depending upon the type of building units used, masonry may be of the following types

1. Stone masonry
2. Brick masonry
3. Hollow concrete blocks masonry
4. Reinforced brick masonry
5. Composite masonry

3. Define the following terms

Course - It is a horizontal layer of masonry unit.

Header – It is a full stone unit or brick which is so laid that its length is perpendicular to the face of the wall.

Stretcher – It is full stone unit or brick which is so laid that its length is along or parallel to the face of the wall.

Header course - A course of brick work showing only headers on the exposed face of the wall are known as header course or heading course.

4. Compare English bond and Flemish bond

- English bond is stronger than Flemish bond for walls thicker than $1^1/5$ brick
- Flemish bond gives more pleasing appearance than the English bond
- Broken bricks can be used in the form of bats in Flemish bond. However, more mortar is required
- Construction with Flemish bond requires greater skill to comparison to English bond

5. State the advantages of hollow concrete block masonry

- Concrete blocks are regular in size, requiring no dressing work.

Hence construction is very rapid.

- Blocks are light and therefore easy to handle.
- There is great saving in the material.
- Hollow blocks are structurally stronger than bricks.
- Thinner walls can be easily constructed, resulting in increase in the Floor area.

6. What are the factors affecting the choice of a flooring materials

- Initial cost
- Appearance
- Cleanliness
- Durability
- Damp resistance
- Sound insulation
- Smoothness
- Hardness

7. What are the various types of flooring?

- Mud flooring and muram flooring
- Brick flooring
- Flag stone flooring
- Cement concrete flooring
- Terrazzo flooring

8. What are ill effects of dampness in buildings?

The following are ill effects of entry of dampness

- Dampness gives rise to breeding of mosquitoes and create unhealthy living conditions
- Travel of moisture through walls and ceiling may cause unsightly patches

- Moisture travel may cause softening and crumbling of plaster, specially lime mortar
- The wall decoration is damaged, which is very difficult and costly to repair

9. Briefly explain the expansion joints

These joints are provided to allow the expansion of the slab due to rise in slab temperature. Expansion joints also permit construction of the slab and help to reduce the warping stresses. The gap width for this type of joint is 20mm to 25mm

10. State briefly the requirements of good foundation?

Foundation should be constructed to satisfy the following requirements

- The foundations shall be constructed to sustain the dead and imposed loads and to transmit these to the sub-soil in such a way that pressure on it will not cause settlement which would impair the stability of the building or adjoining structures.
- Foundation base should be rigid so that differential settlements are minimized, specially for the case when super-imposed loads are not evenly distributed.
- Foundation should be taken sufficiently deep to guard the building against or distress caused by swelling or shrinkage of the sub – soil
- Foundations should be located that its performance may not be affected due to any unexpected future influence.

11. What are the types of foundations?

Foundations may be broadly classified under two heads

1. Shallow foundations
    (a) Spread footings
    (b) Combined footings

(c) Strap footings

(d) Mat foundation

2. Deep foundations

(a) Pile foundation

(b) Pier foundation

(c) Caisson or well foundation

12 **What is meant by shoring? What are the types shoring?**

Shoring is the construction of a temporary structure to support temporarily an unsafe structure. Shores may be of the following types

1. Raking Shores
2. Flying Shores
3. Dead shores

13. State briefly the essential requirements of a good roof

- It should have adequate strength and stability to carry the superimposed dead and live loads
- It should effectively protect the building against rain, sun, wind,etc and it should be durable against the adverse effects of these agencies.
- It should be water proof, and should have efficient drainage arrangements.
- It should be fire resistant

14. Differentiate between comfort air conditioning and industrial air conditioning.

Comfort air conditioning **–** In this, the system aims at giving maximum human comfort to the occupants/users of the conditioned space.

Industrial air conditioning **–** In this, the conditioning creates, controls and maintains such as environment inside the conditioned space, that would suit best to the needs of the industry

15. Define air conditioning

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

16. What are the requirements of a good acoustic material?

- It should have high coefficient of absorption
- It should be efficient over a wide range of frequencies
- It should be relatively cheap and easily available
- It should give pleasing appearance after fixing
- It should be self supporting, and should afford easy fixing

17. What are the causes of fire?

Most fires are caused by carelessness. Common instances of carelessness are.

- Careless discarding of lighted ends of cigarettes, matches etc
- Smoking in unauthorized places.
- Indifferent maintenance of machinery including overloading and under or over lubricating of bearings
- Incorrect storage of materials
- Un- approved equipment and layout

18. Write a short note on fire hazards

Fire safety of buildings should be considered from three aspects

1) Possibility of loss or damage to life, referred to as *personal hazard*
2) Possibility of fire occurring and spreading inside the building itself, referred to as *internal hazard*

3) Possibility of fire spreading from an adjoining building or buildings or from across a street or road, referred to as *exposure hazard*

19. State briefly the essential requirements of form work

A good form work should satisfy the following requirements

- It should be strong enough to withstand all loads coming on it, such a dead load of concrete and live load during its pouring, compaction and curing.
- It should be stiff enough so that deflection is minimum
- It should be as be light as possible
- This form work should rest on non –yielding supports

20. What is meant by deshuttering?

It is the process of removal of formworks after the maturity period of concrete.

21. What are the methods of site clearance?

1. Pushing out
2. Digging out
3. Pulling out
4. Burning down
5. Cutting down
6. Destruction
7. Demolition of existing building

PART – B

SIXTEEN MARKS QUESTION AND ANSWERS

1. List out the sequence of activities in construction

Preparing the priority of execution of individual works of a project may be treated as the sequence of activities. The construction engineer should plan properly before starting the execution or construction. The list of activities form staring to the end of the project, called the sequence of activities, may leads to monitor the project execution

The following lists are example of sequence of activities for ordinary residential building

- Site clearance
- Marking based on the selected plan
- Foundation execution up to the regarding depth
- Laying foundation concrete
- Construction of foundation based on the specification
- Filling the sides of foundation wall using soil
- Basement construction
- Earth filling up to basement & consideration
- Providing DPC layer
- Placing the flooring concrete
- Construction of superstructure using brick

- Providing lintel/ lintel cum sunshades lofts etc
- Construction of brick work over lintel beams up to the roof level
- Providing the entering for concrete
- Laying reinforcement as per design
- Placing the concrete &applying water for cussing after one day
- Preparing doors, windows & ventilations
- Plastering work the ceiling
- Providing the electrical fitting like PVC pipes, switch boxes ect
- Plastering over the wall both inner & outer after fixing the doors & windows
- Providing water supply & sanitary arrangements
- Laying floor & wall tiles
- Whitewashing & colour working

2. Classify various types of stone masonry

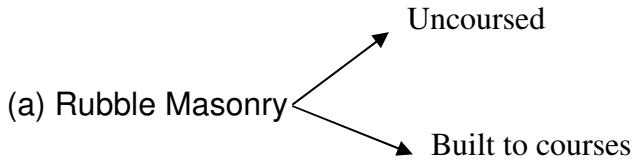
Depending upon the arrangement of stones in the construction degree of refinement used in shaping the stone and finishing adopted stone masonry can be classified as follows.

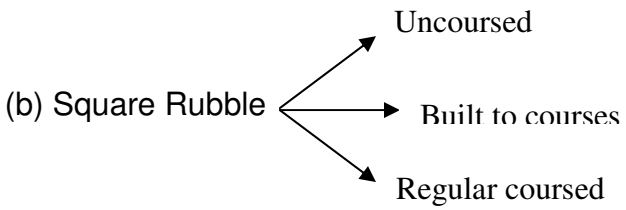
(a) Rubble Masonry

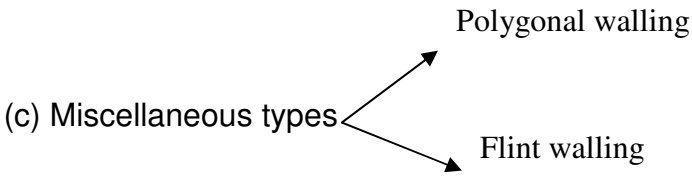
(b) Ashlar Masonry

(a) RUBBLE MASONRY

In the rubble masonry, the blocks of stone that are used are either undressed or comparatively roughly dressed. Rubble masonry may be out of the following types







1. Random Rubble : Uncoursed

- This is the roughest and cheapest form of stone walling. In this type of masonry, the stones used are of widely different sizes.
- The stones are not of uniform size and shapes, greater care and ingenuity have to exercised in arranging them in such a way that they adequately distribute the pressure overt the maximum area and at the same time long continues vertical joints are avoided.

2. Random Rubble : Built to courses

- The method of construction is the same as above except that the work is roughly leveled up to form courses varying from 30 to 45cm thick.
- All the courses are not of the same height. For construction of this type of masonry, quoins are built first and line is stretched between the tops of quoins.

3. *Square Rubble: Uncoursed*

- Square rubble masonry uses stones having straight bed and sides. The stones are usually squared and brought to hammer dresses or straight cut finish
- In the uncoursed square rubble, also sometimes known as square-snecked rubble, the stones with straight edges and sides are available in different sizes.

4. *Square Rubble: Built to courses*

- This type of masonry also uses the same stone as used as used for uncoursed square rubble. But the work is leveled up to courses of varying depth.
- The courses are of different heights. Each course may consist of quoins, jamb stones, bonders and throughs of the same height, with smaller stones built in between them upto height of the lager stones to complete the course.

5. *Square rubble : Regular coursed*

- In this type ,the wall consists of various courses of varying heights, but the height of stones in one particular course is the same

6. *Polygonal walling*

- In type stones are hammer finished on face to an irregular polygonal shape.
- Two types of polygonal walling maybe there:

In the *first type* the stones are only roughly shaped, resulting in only rough fitting. Such a work is known as rough picked.

In the *second type,* the faces of stones are more carefully formed so that they fit more closely. Such a work is known as close-picked work

7. Flint walling

- The stones used in this masonry are flints or cobbles, which vary in width and thickness from 7.5 to 15 cm and in length from 15 to 30cm

(b) ASHLAR MASONRY

Ashlar masonry consists of blocks of accurately dressed stone with extremely fine bed and end joints. The blocks may be either square or rectangular shape.

Ashlar masonry is of

1. Ashlar fine tooled
2. Ashlar rough tooled
3. Ashlar rock, rustic or quarry faced
4. Ashlar chamfered
5. Ashlar block in course
6. Ashlar facing

1. Ashlar fine tooled

It is the finest type of stone masonry work. Each stone is cut to regular and required size and shape so as to have all sides rectangular, so that the stone gives perfectly horizontal and vertical joints with adjoining stone. The thickness of courses is generally not less than 15 cm. the width of tone is not kept less than its height.

2. Ashlar rough tooled (Bastard ashlar)

In this type the beds and sides of each stone block are finely chisel dressed just in the same manner as for ashlar fine, but the exposed face is

dressed by rough tooling. A strip, about 25 mm wide and made by means of chisel is provided around the perimeter of the rough dressed face of each stone. The thickness of the mortar joint should not be more than 6mm.

3. Ashlar rock faced (rustic or quarry faced)

In this type, the exposed face of the stone is not dressed but is kept as such so as to give rock facing. This type of construction gives massive appearance. The height of each block may vary from 15 cm to 30 cm. The thickness of mortar joint may be upto 10 mm.

4. Ashlar chamfered

This is special form of rock-faced ashlar masonry in which the strip provided around the perimeter of the exposed face is chamfered or beveled at an angle of forty five by means of a chisel to a depth of 25 mm. Due to this, a groove is formed in between adjacent blocks of stone.

5.Ashlar block in course

This type of masonry is intermediate between rubble masonry and ashlar masonry. The face of each stone is hammer dressed and the height of blocks is kept the same in any course. This type of masonry is adopted in heavy works such as retaining walls, bridges etc.,

6.Ashlar facing

Ashlar facing masonry is provided along with brick or concrete block masonry, to give better appearance. The sides and beds of each block are properly dressed so as to make them true to shape. The exposed faces of the stone are rough tooled and chamfered. The backing of the wall may be made in brick masonry.

3. Write a note on hollow block masonry. List out the construction procedure for walls?

Hollow clay blocks are made of selected clay or diatomaceous earth which is dried and burned. The clay blocks are used to build foundations, walls, partitions, floors and other structural members. Even though the walls of the blocks are relatively thin, they are quit strong and light. These tiles are fire proof, resistant termite and free from decay caused by the contact of moisture or chemicals. Because of large amount of air within the cells of blocks, the thermal insulation is good.

Hollow clay blocks are manufactured in various shapes and sizes. The overall average thickness of the shells should not less than 2 cm and of the web not less than 1cm for end construction blocks. The area covered by grooves should not exceed 50% of the areas of cover faces. The load bearing main walls and partition walls should be constructed in 1:1:6 and non-load bearing main walls and generally constructed in 1:2:9.All blocks should dipped in water before use.

Construction procedure for walls

The method of construction the wall with concrete blocks is the same as that used for brick masonry. First, the corners or ends of the walls are constructed with a few courses of blocks. Mortar is applied to the bottom of the concrete block at the horizontal face members only. For vertical joints, the mortar is applied to the projections at the sides of the block. The following points should be kept in mind while supervising the construction work

- Before use, it should be ensured that the blocks are dry. They should not be drenched in water before use.
- Blocks of successive courses should be so laid that vertical joints are staggered.
- The joints should be 5-10mm thick, and should be uniform.
- The mortar used for construction should not be stronger than the concrete mix used for manufacture of blocks.

Generally cement-lime-sand mortar of mix proportion 1:1:10 is used.

- The blocks used for external walls should have absorption less than 10%. For internal walls, the absorption should be less than 15%

4. **Explain various cause and effects of dampness in buildings?**

Dampness is the presences of hygroscopic or gravitational reduction in strength of structural components of the building. Following are various causes of dampness in buildings:

1. **Moisture rising up the walls from ground**

All the structures are founded on the soils, and the sub structure is embedded into it. If the soil is previous, moisture constantly travels through it. Even in the case if impervious soils, lot of soil moisture may be present. This moisture may rise up into the wall and the floor through capillary action. Ground water rise will also result in moisture entry into the building through walls and floor.

2. **Rain water from wall tops**

If the wall tops are not properly protected from rain penetration, rain will enter the wall and will travel down. Leaking roofs will also permit water to enter.

3. **Rain beating against external walls**

Heavy showers of rain may beat against the external faces of walls and if the walls are nit properly treated, moisture will enter the wall, causing dampness in the interior. If balconies and chajja projections do not have proper outward slope, water will accumulate on these and could ultimately enter the walls through their junction. This moisture travel would completely deface interior decoration of the wall.

4. Condensation

Due to condensation of atmospheric moisture, water is deposited on the walls, floors and cellings.The moisture may cause dampness.

5. Miscellaneous causes

- *Poor drainage* at the building site.
- *Imperfect orientation* : walls getting less sunlight and heavy showers may remain damp
- *Imperfect roof slope*: Specially in the case of flat roofs
- *Defective construction*: Imperfect wall jointings, joints in roofs, defective throating etc.
- *Absorption of water* from defective rain water pipes.

EFFECTS OF DAMPNESS

The following are ill effects of entry of dampness

- Dampness gives rise to breeding of mosquitoes and create unhealthy living conditions
- This of moisture through walls and ceiling may cause unsightly patches
- Moisture travel may cause softening and crumbling of plaster, specially lime plaster
- The wall decoration is damaged, which is very difficult and costly to repair
- Electrical fittings get deteriorated, giving rise to leakage of electricity and consequent danger of short circuiting.

5.Explain various types of shallow foundation? Draw neat sketches

Shallow foundations are classified into

- Spread footings
- Combined footings
- Strap footings
- Mat foundation

Spread footings

Spread footings are those which spread the super-imposed load of wall or column over a larger area. Spread footings support either a column or wall. Spread footings are of

- Single footing for a column
- Stepped footing for a column
- Sloped footing for a column
- Wall footing without step
- Stepped footing for wall
- Grillage foundation

Combined footings

A spread footing which supports two or more columns is termed as combined footing. The combined footings are of

- Rectangular combined footing
- Trapezoidal combined footing
- Combined column-wall footing

Strap footings

If the independent footings of two columns are connected by a beam, it is called a strap footing. A strap footing may be used where the distance between the columns is so great that a combined trapezoidal footing becomes quite narrow, with high bending moments.

Mat foundation (Raft foundation)

A raft or mat is a combined footing that covers the entire area beneath a structure and supports all the walls and columns. When the allowable soil pressure is low, or the building loads are heavy, the use of spread footings would cover more than one half the area and it may prove more economical to use mat or raft foundation.

Rafts are divided into three types, based on their design and construction.

- Solid slab system
- Beam slab system
- Cellular system

6. Explain the underpinning methods? What are the component parts of scaffolding?

The process of placing a new foundation under an existing one or strengthening an existing foundation is called *underpinning* of foundations

Under pinning can be carried out by the following

1. Pit method
2. Pile method

1. Pit method

In this method, the entire length of the foundation to be under pinned is divided into sections of 1.2 to 1.5 m lengths. One section is taken up at a time. Form each section, a hole is made in the wall, above the plinth and needle is inserted in the hole. Needles may be either of stout timber or steel section. Bearing plates are placed above the needle to support the masonry above it. Needle is supported on either side of the wall on crib supports and screw jacks. The foundation pit is then excavated upto the desired level and new foundation is laid. When the work of one section is over, work on next section is taken up i.e.. Alternate sections are under pinned in the first round, and then the remaining sections are taken up. Shown in fig 1.If the wall to be under pinned is weak, raking shores may be provided.Similary, the floors may also be supposed, if required.

If an interior strong column exists, or if the foundation is to be extended only to one side, cantilever needle beams may be used in the place of central needle beam as shown in fig 2. Jack is placed between the column and the wall.The following points are note worthy in the pit method:

1. Alternate sections are taken up in the first round. The remaining intermediate sections are taken up. Only one section should be taken at a time.
2. If the wall is long, the work is started from the middle and is extended in both the directions.
3. If the new foundation is deeper, proper timbering of the foundation trench may be done

4. The needle beams etc. should be removed only when the new foundation has gained strength
5. It is desirable to do new foundation work in concrete
6. The needle holes etc.should be closed in masonry using mortar

2. Pile Method

In this method, piles are driven at regular intervals along both the sides of the wall.Generally, holes piles or under reamed piles may be used. The piles are connected by concrete or steel needles, penetrating through the wall. These beams incidentally act as pile caps also. This method is very much useful in clayey soils, and also in water- logged areas. The existing foundation is very much received of the load.

Component parts of scaffolding :

Standards - These are the vertical members of the frame work, supported on the ground or drums, or embedded into the ground

Ledgers - These are horizontal members, running parallel to thee wall

Braces - These are diagonal members fixed on standards

Putlogs - These are transverse members placed at right angles to the wall with one end supported on ledgers and other end on the wall

Transoms - These are those putlogs whose both ends are suppoted on ledgers

Bridle - This is a member used to bridge a wall opening supports one end of putlog at the opening

Boarding - These are horizontal platform to support work men and material these are supported on the putlogs

Guard rail - This is a rail, provided like a ledger, at the working level

Toe board - These are boards, placed parallel to ledgers, and supported on

putlogs, togive protection at the level of working platform.

7. Write short notes on

(i) Construction co-ordination

(ii) Types of piles

TYPES OF PILES

Piles may be classified as follows

(a) Classification based on function

Based on the function or the piles may be classified as

1. End bearing pile
2. Friction pile
3. Compaction pile tension pile
4. Anchor pile
5. Fender pile
6. Batter pile
7. Sheet pile

End bearing piles are used to transfer load through water or soft soil to a suitable bearing stratum Fig -1

Friction pile are used to transfer loads to a depth to a loads to a depth of a friction load carrying material by means of skin friction along the length of piles .Fig -2

*Compaction pile*s are used to compact loose granular soils Thus increasing their bearing capacity. The compaction piles themselves do not carry any load. Hence they may be of weaker material – sometimes of sand only. The pile tube, driven to compact the soil, is gradually taken out and sand is filled in its place thus forming a sand pile. Fig -3

Tension piles anchor down the structures subjected to uplift due to hydrostatic pressure or due to overturning. Fig -4

Anchor piles provided anchorage against horizontal pull from sheet piling or other pulling forces.Fig -5

Fender piles are used to protect water from structure against impact from ships or other floating objects. Fig -6

Batter piles are used to resist large horizontal or inclined forces. Fig - 7

Sheet piles are commonly used as bulkheads or as impervious cut off to reduce seepage and uplift under hydraulic structures.

(b) classification based on materials and compaction

1. **concrete piles**
    - (a) Pre-cast
    - (b) Cast-in-situ
        - (i) Driven piles: cased or uncased
        - (ii) Bored Piles : Pressure piles, under reamed piles and bored compaction piles
2. **Timber piles**
3. **Steel Piles**
    - (a) H- pile
    - (b) Pipe Pile
    - (c) Sheet Pile
4. **Composite pile**
    - (a) Concrete and timber
    - (b) Concrete and steel

Pre-cast concrete piles are generally used for a maximum design load of about 800kN.

Cast-in – situ concrete piles are generally used for a maximum design load of 75okN

Under reamed pile is a special type of bored pile having an increased diameter or bulb at some point in its length, to anchor the foundation in expansive soil subjected to alternate expansion and contraction

Concrete filled steel piles and H – piles are used as long piles with high bearing capacity. They are rarely used unless they reach a stratum of exceptionally high supporting capacity, since their cost is very high.

Composite piles are suitable where the upper part of a pile is to project above water table. Such a pile consists of a lower portion of untreated timber and an upper portion of concrete.

8.Explain how do you achieve fire resistance construction of the elements

a. Walls and columns
b. Floors and roofs
c. Wall openings

WALL AND COLUMNS

- Masonry walls and columns should be made of thicker section so that these can resist fire for a longer time and can also act as barrier against spread of fore to the adjoining areas.
- In the case of solid load bearing walls, bricks should be preferred to stones
- If walls are to made of granite and lime stone should be avoided.
- In the case of building with framed structure,R.C.C.should be preferred to steel
- If the frame work is of R.C.C, thicker cover should be used so that the members can resist for a longer time. It is recommended to use 40 to 50mm cover for columns.
- All walls, whether load bearing or non –load bearing, should be plastered with fire-resistive mortar.

FLOORS AND ROOFS

- For better fire resistance, slab roof is preferred to sloping or pitched roofs
- For better fire resistance, the floor should be either of R.C.C or of hollow tiled ribbed floor or of concrete jack arch floor steel joints embedded in concrete.
- If floor is made of timber, thicker joints at a grater spacing should be used, and fire stops or barriers should be provided at suitable interval.
- The flooring materials like concrete tiles, ceramic tiles, bricks etc.are more suitable for fire resistance
- Ceiling, directly suspended from floor joints should be of fire resistant materials like asbestos, cement boards, fibre boards, metal lath with plaster etc.

WALL OPENINGS

- From the point of view of the fire spread, openings in the walls should be a bore minimum.
- Openings serve means of escape.Hence these should be properly protected by suitable arrangements, in case of fire
- Doors and windows should be made of steel.Fire resistant doors can be obtained by fixing steel plates to both the sides of the doors
- Wire – glass panels are preferred for windows
- Rolling shutter doors should be used for garages
- In case of timber doors, minimum thickness of door leaf should be 4 cm and that of door frame as 5 to 10 cm

9. Write short notes on

(i) Stretcher bond

(ii) Header bond

(iii) English bond

(iv) Flemish bond

STRETCHER BOND

Stretcher bond is the one in which all the bricks are laid as Stretcher on the faces of the walls. The length of the bricks are thus along the direction of the wall. This pattern is used only for those walls whish have thickness of half bricks. Such as those used as partition walls, division walls or chimney stacks. The bond is not possible if the thickness of the wall.

HEADER BOND

Header bond is the one in which all the bricks are laid as headers on the faces of walls. The width of the bricks are thus along the direction of the wall. The pattern is used only when the thickness of the wall is equal to one brick (i.e. 18cm).The over lap is usually kept equal to half the width of brick (i.e. 4 ^{1}/2 cm).This is achieved by using three- quarter brick bats in each alternate course as quoins. This bond does not have strength to transmit pressure in the direction of the length of the wall. As such, it is suitable for load bearing walls. However, the bond is specially useful for curved brick work where the stretchers, if used, would project beyond the face of the wall and would necessitate inconvenient cutting. This is also used in construction of footings.

ENGLISH BOND

This is the most commonly used bond, for all wall thicknesses. This bond is considered to be the strongest.The bond consist of alternate course of header and stretchers. In this bond, the vertical joints of the courses come over each other, similarly, the vertical joints of the stretcher courses also come over

each other. in order to break the vertical joints in the successive courses, it is essential to place queen closer after the first header in each course

FLEMISH BOND

In this type of bond, each course is comprised of alternate headers and stretchers. Every alternate courser starts with a header at the corner. Quoins closer are placed next to the quoin header in alternate courses to develop the face lap. Every header is centrally supported over the stretcher below it. Flemish bond are of two types

1. Double Flemish bond
2. single Flemish bond

10. Write note on under reamed piles

Under –reamed piles are bored cast in situ concrete piles, having one or more bulbs formed by enlarging the bore holes for the pile stem by an under reaming tool. These piles find applications in widely varying situations in different types of soils where foundations are required to be taken down to ascertain depth to avoid the undesirable effects of seasonal moisture changes as in expansive soils or to obtain adequate capacity for downward, upward or lateral loads or take the foundations below scour level and for moments.Fig 1 shows various stages in the formation of a under – reamed pile. The equipment required for the construction of pile are

i. auger boring guide
ii. Spiral auger with extension rods
iii. Under reamer with soil bucket
iv. Concrete funnel

Procedure

1. The ground is leveled and the boring guide is correctly positioned. The boring guide consists of a square frame with two sets of flaps and four detachable arms having bolting arrangements at corners. Spikes are fixed; one in each arm. Soil inside the round collar is taken out. spiral auger is

lowered into the round hole rod of the auger. The auger is tightened, thus encircling the vertical hole. (Fig 1-a).When the auger becomes full of soil, the flaps are loosened, and the auger full with soil is taken out. The auger is again lowered and the process repeated, till the desired depth is reached. Thus a straight vertical bore hole of the specified diameter is obtained. If the soil is not self-supporting, drilling mud may be suitably sprayed round the wall of the bore hole.

2. The under – reamed, tool attached with a bucket at its end is than lower vertically down in the bore hole, with the help of boring guide.(Fig 1-b).The under reamed tool consists of an assembly of two blades fixed around a central shaft and a detachable bucket for holding the cut soil. A pin inserted when pressure is applied on the lowered under reamer assembly, the blades gradually widen or open out and cut soil which drops handle, due to which the blades foldout vertically, and the assembly is taken out for emptying the bucket. The under-reamer is then again lowered and the process of cutting the soil with the help of opened- out blades, till the required size of the under – ream bulb is obtained. The boring guide is removed.

3. The bulb so formed is inspected and measure with the help of a guide tool. The reinforced cage is then lowered in bore hole so formed, along with the bulb. A concrete funnel is then placed on the top of the bore hole.

4. Concrete is gradually placed in hole, and compacted. In the entail stages of concreting, the reinforcement cage can be raised and owered in concrete. Fig1-d shows the final form of the under-reamed pile so obtained

UNIT III

SUB STRUCTURE CONSTRUCTION

Techniques of Box jacking – Pipe Jacking -under water construction of diaphragm walls and basement-Tunneling techniques – Piling techniques - well and caisson - sinking cofferdam - cable anchoring and grouting-driving diaphragm walls, sheet piles - shoring for deep cutting - well points -Dewatering and stand by Plant equipment for underground open excavation.

PART - A

TWO MARK QUESTIONS AND ANSWERS

1. What is meant by diaphragm wall?

Diaphragm wall are structure elements, which are constructed underground to prevent the seepage into the excavated area.

2. What are the common uses of diaphragm wall walls?

- ✓ To provide structural support for the construction
- ✓ To provide retaining wall
- ✓ To provide deep diaphragms

3. List out the advantages of tunnel boring machines

- ✓ There is very less danger of fall outs in machine bored tunnels, since adjacent or surrounding rocks are undistributed as no blasting is done.
- ✓ Mucking is also safe and convenient, since muck is conveyed from the face to the rear of the machine and is loaded automatically by means to the rear of the machine and is loaded automatically by means of belt conveyors.
- ✓ Higher speed of excavation.

- ✓ Reduction in the tunnel supports requirement.
- ✓ Less manpower requirement.

4.List out the types of well point systems

1. Pumping from open sumps
2. Pumping from well points

   Well point systems are installed in two ways:

   a) Line system

   b) Ring system
3. Pumping from bored wells

5. List out the types of piles

(a) Driven piles – Timber, recast concrete,Prestressed concrete , steel H-section, Box and tube

(b) Driven and cast-in place piles

(c) Bored piles

(d) Composite piles

6. What are problems normally developed during deep excavations?

- To prevent the collapsing of sides of the trenches
- To prevent water oozing or coming out from the sides and bottom of the trenches

7. What are the remedial measures to avoid the problems deep excavation?

- Providing shoring for the trenches
- Dewatering of the trenches

8. What is caisson? What are the types of caisson?

Caisson has come to mean a box like structure, round or rectangular, which is suck from the surface of either land or water to some desired depth. Caissons are of three types:

(a) Box caisson

(b) open caisson

(c) Pneumatic caissons

9. What do you mean by Sheet piles?

Sheet piles are thin piles, made of plates of concrete, timber or steel, driven into the ground for either separating members or for stopping seepage of water. They are not meant for carrying any vertical load. They are driven into ground with help of suitable pile driving equipment, and their height is increased while driving, by means of addition of successive instalments of sheets.

10. Write the functions of sheet piles

1. To enclose a site or part thereof to prevent the escape of loose subsoil, such as sand, and to safeguard against settlement.
2. To retain the sides of the trenches and general excavation.
3. To protect river banks.
4. To protect the foundations from scouring actions of nearby river, stream etc. To construct costal defence works

11. List out the types of cofferdam

1. Cantilever sheet pile cofferdam
2. Braced cofferdam
3. Embankment protected cofferdam
4. Double wall cofferdam
5. Cellular cofferdam

12. What is a box caisson?

A box caisson is open at top and closed at the bottom and is made of timber, reinforced concrete or steel. This caisson is built on land, then launched and floated to pier site where is suck in position. Such a type of caisson is used where bearing stratum is available at shallow depth, and where loads are not very heavy.

13.What is line system? With neat sketches

This system is employed when excavation area is long. The header is laid out along the sides of the excavation, and the pumping is continuously in progress in one length as further points are jetted ahead of the pumped down section and pulled up from the completed and back filled lengths and repeated till entire length is completed. For narrow excavation, like trenches, header is laid

only on one laid, while for wide excavations, the header are required to be placed on both sides of the area

14. What is ring system? With neat sketches

When excavation is done in area of appreciable width, line system is inadequate. The ring system is used in such condition and the header main surrounds the excavations completely. This system is used for rectangular excavations such as for piers or basements.

16. Where is grout anchors used in constructions?

In most cases, however anchorages may be embedded below ground level, with backstays connecting them to adjacent towers, or they may constitute the end abutments of the end spans.

In addition to stability sliding, the anchorage structure must also be checked for stability against tilting and overturning.

17. Define Box Jacking

- Non –intrusive method beneath existing surface infrastructure
- Frequently used where an existing road or rail tracks is an embankment and space exists for the structure to be cast at the side
- Enables traffic flows to be maintained disruption

18 What are the techniques used in Box/Pipe Jacking?

Techniques used in Box/Pipe jacking require the construction of just two pits:

- The Trust
- Reception pits

Dimensions of the pits vary according to site conditions. Excavation of soil can be by manual or mechanical means depending on the type of machines used.

19 Give the applications of Box Jacking?

The applications of Box Jacking are:

- Underground Pipes
- Ducks and culverts

20. Give the advantages of Box/Pipe Jacking?

The advantages of Box/Pipe Jacking are:

- Environmentally friendly with minimal damage to the surface.

- Highly accurate and cost effective.
- Suitable for all kinds of profiles for a wide variety of soil conditions.
- Traffic congestion and additional pollution will not cause.
- Extremely suitable for all kinds of underground utility infrastructure.

21. List the disadvantages of Box/Pipe Jacking?

The disadvantages of Box/Pipe Jacking are:

- Limited tunnel run resulting in more required shafts (approximately every 1000 ft).
- Relatively straight alignment required (minimum radius of curvature approximately 400ft).
- Difficulty in replacing damaged pipe.

22. What is a tunnel? Give the advantages?

A tunnel is defined as an underground passage for transport of

Passengers, water, sewage, minerals, gas,etc.

Advantages:-

- The society of tunnel construction is increased by the improved modern methods of construction.

It is more economical than open cuts beyond certain depths.

23. What are the factors you will consider while selection of route in tunneling?

a) Geological conditions

b) Right of way

- Alignment restraints
- Environmental considerations

24. What is cofferdam?

A cofferdam is defined as a temporary structure which is constructed.So,as to remove water/soil from an area and make it possible to carry on the construction work under reasonably dry conditions.

25. What are the uses of cofferdams?

- To facilitate pile driving operations.
- To place grillage and raft foundations.
- To construct foundations for piers and abutments of bridges, dams, locks,etc,

26. What are the factors you will consider while selecting cofferdams?

The factors considered while selecting cofferdams are:

- The area to be protected by a cofferdam.
- The depth of coater to be dealt with i.e, shallow depth of deep depth.
- The possibility of overtopping by floods,tides,etc.
- The nature of bed on which the cofferdam is to test, (i.e;) previous layer or an impervious layer.

27. What is caisson?

The word caisson is derived from the French word ‘caisse’ meaning a box. In civil Engineering, a caisson is defined as a structure which is sunk through ground or water. They exclude water and semi fluid material during the process of excavations of foundations and which subsequently becomes an integral part of the substructure.

28. Give the uses of caissons.

The uses of caissons are:

- To reach the hard bearing structure for transferring the load coming on support for bridge piers and building columns.
- To serve as an impervious core wall of earth dams. When placed adjacent to each other.
- To provide an access to a deep shaft or a tunnel.

29. What is the difference between cofferdams and caissons?

The difference between cofferdams and caissons are:

- The main difference between a cofferdam and a caisson is that the former is a temporary structure while the latter forms the part of the permanent work.
- A cofferdam becomes uneconomical in cases where the place of the foundation work and small as compared to the depth of water under such circumstances, caissons are most suitable.
- The places at which cofferdam cannot be dewatered successfully, caissons are used.

30. What are the materials used for the construction of caissons?

- Cast iron
- Reinforced Cement concrete
- Steel
- Timber

31 What is grouting?

Grouting is an engineering and art combined to fill up the voids or cavities in rock or soilmasses with fluid that will increase the overall strength and impermeability of the mass.

32. Give the types of grouting.

- Chemical
- Cement
- Jet grouting

33. Give the characteristics of grouting materials.

The characteristics of grouting materials are:

- The grouting material has high permeability.
- No vibrations are used.
- Application requires no additional structure used.
- The properties are measurable.

- It has high strength and low deformability.

71. What is dewatering?

The process of removal of water from an area where the ground water table is high .

72. Give the methods of dewatering.

- Ditches
- Well point system
- Shallow well system
- Deep wall system
- Vacuum method (forced flow method)
- Electro osmosis method

PART- B

SIXTEEN MARKS QUESTION AND ANSWERS

1. Explain the working principle and constructional features of tunnel boring machine?

Tunnel boring machine (TBM) as mole recent developments in the tunnel driving technique. The function of TBM is to loosen the earth or break the rock continuously in the entire section of the tunnel, in to cuttings and convey to the rear of the machine, where it can be loaded into muck cars or dumpers or on to conveyor belts for the transportation to the ultimate disposal site.

Working principle and construction features of TBM

These machines perform the boring operation through rotation of the front head against the rock face. The mole has circular cutter head in the front provided with fixed cutters of desired shape. The cutter head while rotating is pressed against the rock to cut or pulverize it. The cuttings while failing down is collected in the buckets provided around the cutter head periphery. These buckets discharge the muck into a hopper to feed it into the belt conveyor leading

to the rear of the machine. This conveyor then discharges the muck either into the mine car or to another belt conveyor leading to the portal of the tunnel. The muck of cuttings can also be disposed off by using the slurry pipelines after mixing the fine muck into water to form slurry.

For driving through full- face on full-face TRMs number of cutter heads is mounted on a drum. The drum when rotates in one direction, the individually driven cutter heads having projected Tungsten carbide tipped tools can be rotated in another direction and the drum advances into the tunnel face, by providing a thrust with the help of hydraulic systems. The tips of the tools when worn out can be easily replaced. The tips are kept cooled by spraying a mixture of water and compressed air into the cutting area. This also suppress the dust formed during cutting.

2. Explain the various types of tunneling technique?

Tunneling techniques are

1. Drill jumbo
2. Loading and firing
3. Drilling

Drill Jumbo

Drill jumbos used in tunnels are also known as tunnel jumbos. A drill jumbo is a portable carriage having one more carriage having one or more working platforms equipped with columns, bars or booms to support and guide the drills, enabling the drills to perform drilling operation at any desired pattern. These platforms have arrangement for the supporting the compressed air pipes, water pipes. The booms are operated by hydraulic fluid or air and supports the drifters, and are equipped with control enabling the operator to spot a drill in any desired position conforming to the drilling pattern. The platforms are constructed as per the size of tunnel and can be raised or lowered so as to allow mockers or

hauling equipment to pass under the jumbo several drill can be operated from each platform for speedy excavation

The jumbos either on rails on pneumatic tyres depending upon the type of work. The jumbo can be equipped with electricity feeding cables, pneumatic concrete placers etc. Mobile jumbos of modern design with four wheel drive and centrally articulated steering speeds production and reduces tunneling costs

Loading and firing

Drilling pattern when followed produces most economical and efficient breakage of rock for a given tunnel, and is determined by conducting tests using different patterns. Explosive selected for working in tunnels should have low fumes characteristics. Ammonium nitrate explosives are therefore preferred over dynamics due to less toxic fumes

Drilling

For driving a tunnel number of holes are drilled as per drilling pattern in size and depth as decided depending upon the size of the tunnel and its formation Drifters are generally used for drilling in the tunnels where in water is used to remove the cuttings from the holes instead of compressed air to reduced the amount of dust in the air. Holes are drilled slightly deeper than the advance per round to taken care of loss in depth during blasting. Depth advanced due to drilling and blasting operation is called as one round.

3. Explain the methods o f ground water control?

Following methods of ground water control are adopted

1. Pumping from open sumps
2. pumping from well points
3. Pumping from bored wells

(1) Pumping from open sumps

This method is most commonly used where area is large enough for allowing excavation to be cut back to stable slopes and where there are no important structures close to the excavation to effect their stability by settlement resulting from erosion due to water flowing towards the sump. This method is also applicable for rock excavations.

This method costs comparatively low for installation and maintenance.In this method one or more sumps are made below the general level of the excavation.In order to keep the excavator area clear of standing water, a small grip or ditch is cut around the bottom of the excavation failing towards the sump.

For grater depths of excavation the pump is used or submersible deepwell pump suspended by chains and progressively lowered down.Pumps suitable for operating from open sumps are:

- Pneumatic sump pumps
- Self priming centrifugal pumps
- Monopump sinking pumps

Pumping is simple and less expansive, but has serious limitations. When fine sand or cohesion less soil lie below the water, this type of pumping removes the fine material from the surrounding soil and results in settlement of adjacent structures. To product it sumps lined with gravel filter are sometimes used.

(2) Pumping from wellpoints

This system comprises the installation of a number of filter wells generally 1m long, around the excavation. These filter wells are conducted by vertical riser pipes to a large dia header main at ground level which is under vacuum from a pumping unit. The water flows to the filter well by gravity and then drawn by the vacuum upto the header main and discharged through the pump. This system has the advantage that the water is filleted as it removed from the ground and carries almost no soil with it once steady discharge conditions are attained. This system has the limitation of limited suction lift. Therefore for deeper excavations the well points are installed in two or more stages.

The filter wells or well points are usually 1m long and 60 to 75mm diameter gauge screen surrounding a central riser pipe. The capacity of a single we;; point with 50mm raiser is about 10 lit/min. Spacing between two well points depends on the permeability of the soil and on the time available to effect the drawdown. In fine coarse sand or sandy gravels a spacing of 0.75 to 1m is required, while in silty sands of low permeability a 1.5m spacing is sufficient .In permeable course gravels spacing should be as low as only 0.3m.A normal set of wellpoint system comprises 50 to 60 points to a single 150 or 200mm pump with a separate 100mm jetting pump.

(3) Pumping from bored wells

Pumping from wells, for draw-down depth of than the meters can be under taken by surface pumps with their suction pipes installed in bored wells. When dewatering is required to be undertaken from a considerable depth,electrity driven submersible pumps are installed in deep bore holes with rising main to the surface. Since heavy boring equipment is used, installation of wells can be done in all ground conditions including boulders and rocks. Due to higher costs of installation, this method is adopted where construction period is long and other methods of dewatering are not possible.

Installation of bore well consists of sinking of a casting having a dia of about 20-30 cm larger than the inner well casting. The dia of inner well casting depends on the size of submersible pump. This inner well casing is inserted after complete sinking of borehole screen over the length where dewatering of the soil is required and it terminates in a 3-5 m length of unperforted pipe to act as a sump to collect any fine material which may be drawn through the filter mesh. Screen having slots are preferable to holes, since there is less risk of blockage from round stones.

4. What are various methods adopted to construct a diaphragm wall? Explain

1. Slurry trench technique
2. Soil mixing method
3. RC continuous diaphragm wall

4. Precast diaphragm wall
5. Glass diaphragm walls

Slurry trench technique

- The technique involves excavating a narrow trench that is kept full of an engineered fluid or slurry
- The slurry exerts hydraulic pressure against the trench walls and acts as shoring to prevent collapse
- Slurry trench excavations can be performed in all types of soil even below ground water table

Soil mixing method

- This is the method used to make continuous walls by churning up piled soil using an auger, pouring in cement milk and marking soil mortar columns in the ground using the soil as aggregate
- This is an in situ mixing and churning method
- In the method after completing excavation of the groove wall using an excavator, soil cement is produced by mixing and churning excavated soil
- The excavated soil is classified and graded with cement milk after being put through a tremie
- Then the soil cement is poured into the groove wall, after which the steel material is built as the core material

RC continuous diaphragm wall

- This method of building a very long continuous diaphragm wall
- Excavate a given groove between the surface and under ground using a stabilizing liquid
- Insert a given steel bar pour in concrete, thereby building a reinforced concrete wall underground.

Precast diaphragm wall

- With this method, a continuous trench or longer panels are excavated under self- hardening cement- bentonite (CB) slurry.
- The precast concrete wall sections are lifted and positioned by a crane

- The CB slurry sets to form the final composite wall
- The trench is excavated under bentonite slurry, which is then displaced with CB slurry.

Glass diaphragm walls

- For contained enclosure, a diaphragm wall system consisting of special glass panels with a sealing made out of glass are used.
- The panels are 50cm wide and upto 15cm long

5. Explain the component parts of pipe jacking?

Pipe jacking is specialist tunneling method for installing underground pipelines by assembling the pipes at the foot of an access shaft and pushing them through the ground with the minimum of surface disruption

Component parts of jacking systems

The pump unit has two distinct hydraulic systems

- A high pressure systems supplies oil for the main jacking cylinders and till intermediate jacking stations
- A low pressure system supplies oil, via hydraulic lines, for the boring head and conveyor. An auxiliary power pack may be easily installed to double the low pressure hydraulic flow. This may be necessary for larger and more powerful boring heads

Thrust yoke

The yoke is the frame that the main cylinders push against to advance the boring head and pipe. The ring provides a 360 degree surface against the pipe to minimize point pressure and reduce the chance of breakage.

Skid base

The skid base is the foundation of the pump unit and yoke. It also acts as a guide for launching the boring head and pipe into the ground.

Power packs

- Power packs with high and low pressure systems typically are matched with the multiple cylinder system.

- When tunneling, a lower pressure power pack may be selected to supply oil for the tunnel boring machine (TBM)
- Power required depend on the size and features of the boring head
- A mobile electric power pack may be positioned in the boring head/ TBM

Intermediate jacking stations

- Installing intermediate jacking stations is a simple economical way of adding and distributing thrust for pipe jacking
- The size and joint of the pipe, cost, length of push and versatility are important considerations that configure intermediate stations
- Most popular design is effective with a variety of pipe sizes and design. Each design consists of ram segments. Each segment has 5 rams. All stations are supplied oil by one set of lines from the power pack and operated from one point in the jacking shaft.

6 (i) List out the applications of a diaphragm wall.

(ii) Explain the methods of box jacking?

Applications of diaphragm wall

- As permanent and temporary foundation wall foundation walls for deep foundation for deep basements
- In earth retention schemes for highway and tunnel projects
- As permanent walls for deep shafts for tunnel access
- As permanent cut - off walls through the core of earth dams
- In congested areas for retention systems and permanent foundation walls
- Deep groundwater barriers through and under dams

Box Jacking

- Non –intrusive method beneath existing surface infrastructure
- Frequently used where an existing road or rail tracks is an embankment and space exists for the structure to be cast at the side
- Enables traffic flows to be maintained disruption

Procedure

- It involves the advancement of a site-cast rectangular or other shaped box using high capacity hydraulic jacks.
- An open ended reinforced concrete box is cast on a jacking base.
- A purpose designed tunneling shield is provided at its leading end and thrust jacks are provided at its rear end reacting against a jacking slab
- The box is then jacked carefully through the ground
- Excavation and jacking take place in small increments of advance.
- Measure are taken to ensure stability of the tunnel face and to prevent the ground from being dragged forward by the advancing box
- When the box has reached its final position the shield and jacking equipment are removed.

R.C.C box jacking

- Is adopted where it is not possible to constructed in situ R.C.C boxes
- These boxes are used for canal siphon, road under bridge and culvert for conveying water/service pipes
- The R.C.C box is cast over the thrust bed which is provided with – pockets both in longitudinal and traverse jacks
- The box is provided with a shield in front in front called “Front shield” Which pierces through the soil by cutting

Throustboring method

- Is a process of simultaneously jacking pipe through the earth while removing the soil inside the encasement by means of a rotating auger.
- In unstable soil conditions, the end of the auger is kept retracted back inside the encasement so as not to cause voids.
- In stable conditions, the auger can be successfully extended beyond the end of the encasemen

7.What are the methods of providing shoring for the trenches?

Methods for providing shoring for the trenches

1. Stay bracing
2. Box sheeting
3. Vertical sheeting
4. Runners
5. Sheet piling

(1) Stay bracing

- Carried out in moderately firm ground
- It is adopted when the depth does not exceed 2m
- The vertical sheets are placed opposite each other against the sides of the trench
- The vertical sheets are held in position by one or two rows of struts
- The sheets are placed at an interval of 3 to 4m and they extend to full depth of the excavation
- The normal sizes of
    - Polling boreds 200*40&200*50mm
    - Struts 100*100mm (For trench width upto 2m)
    - Structs 200*200 (For trench width more 2m)

2. Box sheeting

- Carried out in loose soil
- It is used when depth of excavation does not exceed 4m
- A box like structure is formed by providing sheeting,walls,structs and bracing
- In this arrangement, the vertical sheets are placed nearer and touching each other
- The sheets are kept in position by longitudinal rows of Wales, usually two and then,structs are provided across the wales

3. Vertcal sheeting

- Carried out in soft ground
- Adopted when the depth is about 10m

- This is similar to box sheeting except that the work is carried out in stages and at each stage, an offset is provided
- For each stage,vertical sheets,wales,structs and braces are provided as usual
- The offset is provided at a depth of 3 to 4m and it various from 30 to 60cm per stages
- Suitable for laying sewers or water pipes at considerable depths

4. Runners

- Carried out in extremely loose and soft ground which requires immediate support as the excavation progresses
- The runners which are long thick wooden sheets or planks are used in this arrangement
- One end of runner is made up of iron shoe
- These are driven by hammering about 30cm
- The wales and struts are provided as usual

5.Sheet piling

- Provided when large area is to be excavated for a depth grater than 10m
- Used when the soil is soft or loose
- Provided when the width of the trench is large
- It is also provided when the subsoil water is present

8. Write short notes on large reservoir construction with membranes and earth system

- The main problem in reservoirs is the loss of water due to seepage
- So even if the capacity of the reservoir is large much water by lost due to it
- It can be made impermeable by construction of impervious membranes on the embankment
- The impervious membrane can be placed on

1. The upstream face of the dam
2. Core inside the embankment

- Most of the major earth dams constructed before 1925 were provided
- with central concrete core walls or concrete slabs on the upstream face
- The impervious advantages for the impervious membrane placement in
- the upstream side or core of the embankment

Concrete slab

- Concrete slab can be used successfully up to a height of 150ft
- The performance of concrete slab will directly on the quality of concrete
- Even trough the earth earth embankment is not required to act as a water barrier, it should be well compacted in order to minimize post-construction settlement of the upstream slope
- When single reinforced slab is adopted,some leakage will occur due to the hairline cracks so drains should be provided.

Steel plates

- Steel plate can be used where reinforced concrete is used
- The life is approximately the same as that of concrete
- It can be directly placed on the soil containing appreciable percentage of silt or clay
- It is expansive but it has two advantages
- It is watertight
- It is more flexible and can adapt to differential settlement in a better manner

Asphaltic concrete

- They are less costly than concrete or steel
- They are more flexible than reinforced concrete and can adapt to differential settlement better
- They can be constructed quickly

- Under certain circumstances the leaks development are self-sealine
- The portion above the reservoir level are easy to repair than either concrete or steel

Advantages of upstream membrane

- When the membrane is on the upstream side optimum stability condition are produced ,so the volume of embankment can be reduced
- Since the upstream slab is exposed ,damage can be inspected and repaired easily
- The upstream membrane can be built after the embankment is completed
- Foundation grouting can be carried out while the dam is being built
- The membrane can serve a secondary function as wave protection

Internal impervious membrane

- Concrete is used mostly for internal membrane steel is used rarely
- Since it is not exposed for investigation very little reliable performance is available
- It is less influenced by embankment settlement and less likely to crack as a result

Advantages of internal membranes

- The area of the membrane is smaller than that of an upstream facing, so less material is required
- The surrounding embankment protects the internal membrane
- The core can be made almost watertight even if cracking develops, by placing thin layer of clay upstream
- A vertical extension of the core membrane below the base of the dam can be used through soil deposits in the foundation
- The length of the grout curtain in is shorter.

9 (i) write a note on use of H-piles.

(ii) Write a note on well sinking operations

1. H-Piles are used in construction of bridges where they can be driven through existing construction in small spaces
2. They are used useful for driving close to existing structures since they cause little displacement of soil. It can be withstand large lateral forces.
3. They require less space for shipping and storing than wood, pipe or precast concrete piles.
4. They do not require special slings or special care in handling.

Well sinking operation procedures

1. Laying the well curb

If the river bed is dry, laying of well curb presents no difficulty. In such a case, excavation upto half a meter above subsoil water level is carried out and the well curb is laid. If, however, there is water in the river, suitable cofferdams are constructed around the site of the well and is lands are made. The sizes of the island should be such to allow free working space necessary to operate tools and plane for movement of labour etc.When the island is made, the center point of the well is accurately marked and the cutting edge is placed in a level plane. It is desirable to insert wooden sleepers below the cutting edge at regular intervals so as to distribute the load and avoid setting of the cutting edge unevenly during concrete.

2. Masonry in well steining

The well steining should be built in initial short height of about 2m only. It is absolutely essential that the well steining is built in one straight line from the bottom to top. To ensure this steining must be built with straight edges preferably of angle iron. The lower portions of the straight edges must be kept butted with the masonry of the lower stage throughout the building of the fresh masonry. In no case should a plumb bob be used to built more than 5m at a time.

The well masonry is fully cured for at least 48 hours before starting the loading or sinking operations.

3. Sinking operations

A well is ready to be set in after having cast the curb and having built first short stage of masonry over it. The well is suck by excavating material from inside under the curb. In the initial stage of sinking, the well is unsuitable and progress can be very rapid with only little material being excavated out. Great care should therefore be exercised during this stage, to see the well sinks to true position. To sink the well straight it should never be allowed to go out of plumb.

Excavation and scooping out of the soil inside the well can be done by sending down workers inside the well till such a stage that the depth of water inside becomes about 1m.As the well sinks deeper, the skin friction on the sides progressively increases. To overcome the increased skin friction and the loss in weight of the well due to buoyancy, additional loading known as kentedge is applied on the well.

Pumping out the water from inside the well is effective in sinking of well under certain conditions. Pumping should be discouraged in the initial stage. Unless the well has gone deep enough or has passed through a ring of clayey strata so that chances of tilts and shifts are minimized during this process. Complete dewatering should not be allowed when the well has been sunk to about 10m depth.

4. Tilts and shifts

The primary aim in well sinking is to sink them straight and at the correct position. Suitable precautions should be taken to avoid tilts and shifts. The precautions to avoid tilts and shifts are as follows

1. The outer surface of the well curb and steinings should be as regular and smooth as possible.

2. The radius of the curb should be kept 2 to 4 cm larger than outside of well steining
3. The cutting edge of the curb should be of uniform thickness and sharpness since the sharper edge has a grater tendency of sinking than a blunt edge.
4. As soon as tilt exceeds 1 in 200, the sinking should be supervised with special care and rectifying measures should be immediately taken.

5. Completion of well

When the well bottom has reached the desired strata, further sinking of the well stopped .A concrete seal is provided at the bottom. The bottom plug is made bowl shaped so as to have inverted arch action. As generally under watering concerting as to done, no reinforcement can be provided. Under watering concreting is done the help of tremie.However if it is possible to dewater the well successfully, the concrete can be placed dry also.

After having plugged the well at its bottom, the interior space of the well is filled either with water or sand. It may even we kept empty. The well is capped at its top, with help of reinforced concrete slab. If however sand has been filled inside, top plug of lean concrete is interposed between the wall cap and sand filling as shown in fig.

UNIT IV

SUPER STRUCTURE CONSTRUCTION

Launching girders, bridge decks, off shore platforms – special forms for shells - techniques for heavy decks – in-situ pre-stressing in high rise structures, Material handling - erecting light weight components on tall structures - Support structure for heavy Equipment and conveyors -Erection of articulated structures, braced domes and space decks.

PART - A

TWO MARK QUESTIONS AND ANSWERS

1. What are the uses of offshore platform?

The uses of offshore platform are:

- Connect the offshore pipeline grid.
- Provide an efficient means to platform maintenance
- Locate compression, separation, production handling and other facilities.
- Conduct drilling operations during the initial development phase of an oil and Natural gas property.
- Oil & gas exploration
- Navigation aid towers.
- Bridges and causeways

- Ship loading & unloading facilities.

2. What are the types of offshore platforms?

The types of offshore platforms are:

- Converted jackup barges
- Fixed tower structures
- Tension leg platforms (TLP's)
- Stationary floating SPAR's

3. What are the classifications of bridge?

Segmental bridges are in two general categories. They are:

- Precast bridge
- Cable bridge

A cable stayed bridge is suspended by multiple cables. Main component of cable stayed bridge are inclined cables, towers, piers and the deck. The cable stayed deck is in compression, pulled towards the towers, and has to be stiff at all stages of construction and use.

4. What are skyscrapers?

Skyscrapers are the multistoried building. The construction of multi-storied building dependent on availability of materials, technology and the availability of services like elevators.

5. Give the uses of silos.

Silos are used to store large quantities of granular bulk solids and to store the green crops and converting them into sillage.

6. What are the types of cooling tower?

The types of cooling tower are:

- Mechanical draft cooling tower

- Natural draft cooling tower

7. What is Transmission Tower?

Transmission tower is a steel structure constructed to transmit the signals. Generally, it is used as towers for Television, Radio & Cell phones.

8. List out the types of domes?

1. Ribbed domes
2. Schwedler domes
3. Three way grid domes
4. parallel lamella domes
5. Geodesic domes

9. What are the erection methods of domes?

The erection of the domes can be done by following methods

1. Element method
2. Block method
3. Lift up method

10. List out the components of cable strayed bridges?

1. Inclined cable
2. Towers
3. Orthotropic deck

11. What are the erection methods of launching of heavy deck?

1. Balanced cantilever erection method
2. Progressive placing method
3. Span by span (or) Steeping form work method
4. Incremental launching method

12. What are the types of shells?

1. Barrel shells
2. Butterfly shells
3. Continuous cylindrical shells
4. Corrugated shells

5. Cylindrical shells
6. Multiple cylindrical shells
7. North light cylindrical shells

13. What are the methods of transporting light weight component?

There are totally four methods of transporting light weight components on tall structures

1. Cable ways
2. Rope ways
3. Belt conveyors
4. Hoists

14. List out the advantages of cable suspension bridges?

1. They require only cables and small light pieces of other materials
2. They can therefore be made of very large spans in place where, owing to the difficulty of transport, no other form of bridge would be economically feasible
3. They are most suitable for rocky gorges where intermediate supports are difficult to construct
4. They are light in weight
5. They present better architectural effect
6. The construction of towers in bed of river is avoided

15. List out the types of cable suspension bridges?

A suspension bridge with light load does not require stiffening. Under heavy loads the cable have to be stiffened so that they may not be put to large changes in shape

1. Unstiffened suspension bridge
2. Stiffened suspension bridge

16 What are the problems occurs in construction of cooling towers?

Some of the problems related to cooling towers include

1. Corrosion of towers
2. Scale formation
3. Clogging of nozzles
4. Fouling

17 List out the advantages of aerial rope ways?

1. Shortest route is taken which consumers less time
2. The loads can be automatically discharge at any height
3. Extremes of weather do not affect the operation
4. Ropeways with sufficient down grade in flavour of the load run without any consumption of power

18. List out the advantages and disadvantages of block method

Advantages

1. Better work control as erection work at high level can be maintained
2. Work efficiency can be enhanced

Disadvantages

1. Provision of special device for marking fine adjustments and assembling
2. Longer during for high level work
3. The use of temporary jig is indispensable for securing high precision in ground assembly

19.List out the advantages and disadvantages of element method

Advantages

1. **Little wastage in the transportation of the members**
2. No facility needed for ground assembly
3. Large spans can be easily constructed light hoisting equipment

Disadvantages

1. When height of the work increase the cost of temporary support increases
2. Also increase the work safety

20. What are the types of geodesic domes?

1. Frame single layered domes
2. Truss or double layered domes
3. Stressed skin domes
4. Formed surface domes

PART- B

SIXTEEN MARKS QUESTION AND ANSWERS

1. What are the advanced techniques used in offshore construction?

Some of the advanced technique in offshore construction includes the following

1. Jetty construction
2. Wharf construction

JETTY CONSTRUCTION

Definition

The term jetty denotes projecting or thrown out structure or structures built out in to deep water from the shore

Functions

1. Loading and unloading platforms
2. Additional berthing accommodation

Types

1. Open pilled
2. Pile cylinder
3. Screw cylinder

1. Open piled in jetties

- In this type usually 35*35 cm or 40*40 cm piles are used

- These piles are braced by 30*30 cm RCC bracings which may be precast or cast insitu type
- After driving the tops of the piles either cut off or lengthened as the case may be.
- Transverse deck beams are then constructed and connected to the top of the pile
- Finally RCC decking is constructed over the transverse beam and piles heads
- These jetties have continuous hard wood fending consisting of 25*12.5 cm
- Vertical members with 30*30 cm top and bottom horizontal fenders and required intermediate supports

2. Pile cylinder in jetties

- In this ,the piles are encased in concrete cylinder
- The weight of the structure is carried by the piles and the RCC cylinders only act as containers casing for these for these piles
- When the cylinders have attained the required depth which may be from 1.2 to 3m below the bottom, the piles driven through them.
- The cylinders are then filled up with concrete.
- This filling concrete may be plain or slightly reinforced.
- In some cases piles are driven first cylinder are subsequently placed over them
- The cylinders are then suck by weighing
- In such cases only the part above the original bottom level can be effectively filled with concrete.

3. Screw cylinder in jetties

- In the case of soft ground such as silty strata screw cylinders are adopted to enable the required load to be carried
- It is found that immediately after screwing some subsidence takes place on loading but after leave the ground for several months the

ground gets reconsolidated and settlement under the test becomes negligible.

- The screw is done by electric capstan.
- It is seen that the load for screwing increases when the screwing for the same reason is stooped some time and restarted.

Advantages of jetty construction

1. Piled or open jetties are cheaper
2. They are desirable
3. Timber jetties are quick in construction.
4. Cost of repair is nearly the same as that of concrete structures.

WHARF CONSTRUCTION

Definition

The landing places or platforms in the forms of the walls built near shore for vessels to berth are known as wharves. A wharf is quay but the term wharf is generally used for an open structure of piles or posts with bracings, jutting from the shore towards the sea

Functions

1. Loading and unloading of cargoes.
2. Working platform

Types

1. Open type wharf
2. Solid type wharf

1. Open type wharf

The decks in such cases are supported by piles or cylinders

- The deck is supported on piles
- These piles may be of timber, steel or RCC
- Sometimes large cylinder or caissons of steel or RCC are also used for this purpose.
- In deep water where soft bottom conditions require very long foundation supports, prestressed concrete piles are very useful.

- Another advantage of prestressed piles is that because of pre-compression the result tensile bending stresses are eliminated and hence the concrete does not crack.

2. Solid type wharf

Under thus category are sheet pile wharves, bulkheads, crib, caissons and gravity walls

- When the depth of water is within 15m and bottom conditions are suitable for supporting gravity type structure steel sheet pile cells are commonly employed.
- These shells utilize flat web steel pilling
- This pilling acts in tension to retain the fill inside.
- Thus a gravity wall of sufficient weight and adequate shearing strength to resist overturning or sliding at the base is formed.
- These cells may have circular shape or they may be in the form of straight walls with circular ends.

2. Explain the methods of aerial transporting?

There are totally 4 methods of transporting light weight component on the tall structure.

1. Cable ways
2. Rope ways
3. Belt conveyors
4. Hoists

1. Cable ways

- In cable way, while traversing, load can be raised or lowered at any point.

  This is useful in excavation work in dams, workpit, quarries etc.

- A cable way is support on two end supports and consists of the rack cable,

  the carriage, the traction rope and hoist rope as in fig

- One support having an operating gear is known as head tower, while the other is known as tail tower. A tower cable is stratched over these two end towers.
- The carriage is attached to a endless traction and is finally wound over the traction drum under the head tower. The hoist rope is supported, between the carriage and the head tower, on the carries hanging from the traction rope.
- The cableways generally operate at speed between 150 to 400m per minute during travel, and lowering, and lowering and usually carry a carriage load between 3 to 10 tons

2. Rope ways

Rope ways are of following two types:

- In first type, endless rope runs over pulleys and horizontal sheaves at the two end towers and is supported along its length on a series of pulleys mounted on intermediate towers. These are rotated by a diesel engine or electric motor at a speed of 5 to 6 km/hr. In this system same row is acting as a support as well as hauling rope for the carriers
- In second type, separate hauling and support rope are provided. Sometimes two support ropes with one hauling rope are also provided so that one carrier is drawn in the opposite directions on second supporting rope. Though this system is more expansive in initial cost, but due to large carrying capacities, higher speeds, and lesser wear and tear the system is economical and hence widely used as compared to that of first type

3 Hoist

- This the equipment used for lifting materials vertically
- It is operated from one or two points and does not carry operated
- There is an infinite variety of hoists suitable for different purposes the simplest is the chain hoist, which is operated by hand
- The hoist can operated by
  1. Electricity
  2. Diesel engine
  3. Compressed air
  4. Hand

4. Belt conveyors

- The belt conveyors is one of the most common form of material handling system used in mining industries and in construction project
- For transporting the materials for short distances conveyor may be a portable or a fixed unit
- Belt conveyor consists of a belt running over drums or pulleys provided at the end and are supported at intervals by a series of rollers known as idlers.
- It is capable of handling light or heavy, fine or coarse, wet or dry material
- It can handle hot materials up to 160° C
- It is lighter in weight in weight and consumes less power
- It operates without noise
- Any material can be kept on the belt and transported to the necessary distance
- Care should be taken to see the load carry capacity of belt and hence it requires regular inspection

3.Explain the various types of conveyors?

There are several kinds of conveyors, such as

1. Belt conveyor
2. Roller conveyor

3. Chain or cable conveyor
4. Pipe line conveyor
5. Screw conveyor

1. Belt conveyor

- Belt conveyors is one of the most common form of material handling system used in mining industries and in construction projects
- Heavy industries like steel fertilizer, chemical and cement etc,cannot function without belt conveyors
- In construction projects the belt conveyors are used for handling the material in asphalt plants etc.
- The belt conveyors are capable of conveying large quantities of material continuously over long distance at a fast speed.
- Belt used in the system are costly and perishable item and hence need to be carefully maintained.
- The belts are generally made of rubber covered over cotton or rayon laid up in piles.
- Belts are specified by width, number of piles, and weight of each laryer of ply.

2. Roller conveyor

- This is used to transport various shapes of product such as boxes or materials, which extend over several rollers.
- This type consists of rollers supported in frames over which material are allowed to move.
- They are driven by power or gravity. These are of different varieties and can move materials in horizontal direction as well as from the upper floor to lower floor etc.

3. Chain conveyor

This is moved by chains in horizontal direction and installed flush with floor or a little above it. This is used for moving barrels and heavy boxes. This is also used for moving grates of big boilers.

4. Pipe line conveyor

This is largely used for transporting dry, pulverized or granular materials, chemical powder, sand, cement etc. It can be operated by gravity, air pressure or some mechanical means.

Pipe line conveying systems is cleaned, dustfree, easy to install and requires lesser staff to handle or operated. Maintenance is also less since moving parts are not involved. This system is popular for handling cement on large scale construction works.

5. Screw conveyor

This type is used for transmitted materials in the paste or powder form with the application of rotating screw.These are driven by a motor from one end, and consists of a helix mounted on bearings at the ends, and also at intermediate points. This type of conveyor is also dust free by closing it. The material enters from one end and is carried to the other by the screwing action. Screw conveyors can be also be used for handling pulverized coal or other granular materials.

6. Elevating conveyors

The elevating conveyors are used for transporting dry granular materials in the vertical direction with the help of buckets and trays. These are known as known as bucket elevating conveyors or bucket elevators and carrying the material in bucket to vertical or near vertical positions. These are either

(i) Chain bucket elevator in which buckets are attached to one or two chains which move on two ends wheels

(ii) Belt bucket elevator in which bucket are attached to the belt moving on pulleys provided at two ends

4. Explain about the launching of heavy decks?

The various and processes that takes place in the eraction of heavy slab decks or girders are generally referred to as the launching of heavy decks.

Construction of the slab or girders in general can be classified into 2 stages

1.Cast in place segmental construction

2. Precast segmental construction

1.Cast in place segmental construction

- In cast in place construction, segments are cast one after another in their final location in the structure
- Special equipment is used such as

For cantilever type of construction

1.Travelling table forms

2. Flying forms

For span by span construction

a. Formwork units moved along a supporting gantry

a. Formwork units moved along a supporting gantry

- Each segment is reinforced with conventional steel and sometimes by vertical or transverse pre-stressing
- The segment are joined together by longitudinal post tensioning
- Because segment are cast end to end, longitudinal steel can readily be made continuous of the structure
- Strength development of concrete influence construction speed and deflection of the structure during construction

2. Precast segmental construction

- Precast segmental bridge construction can be done with joints several inches wide for which forms are built before the joint is filled with grout,motar,or concrete
- Formed joints are more readily built with span by eraction which provide support for the forms
- With formed joints, precast production can be speed because match is not required
- The segments are cast with one or more integral shear keys
- Usually there is no continuity of conventional longitudinal steel. Post tensioning establishes continuity

- When the segments are cast well in advance of erection, they will have less creep, shrinkage and deflection in the bridge than would the cast in place segments

5. Write note on

(i) Cable stayed bridges

(ii) Bowstring bridges

The cable strayed bridge is specially suited in the span range of 200 to 500 and thus provides a transition between the continuous box girder bridges and the stiffened suspension cable

Cable strayed girder bridges

In simple form, the cable provided above deck and connected to the towers would permit elimination of intermediate piers facilitating a lager width for purposes of navigation

Fan-shaped multi-stay cable system

The deck can be supported by a number of cables in the fan form or in a sharp form shows a typical fan-shaped cable arrangement with the anchorages at the tower distributed vertically down a certain length

Cantilever bridges

- The cantilever bridge with a single main span consists of an anchor arm at either end between the abutment and the pier, cantilever arm from either pier to the end of the suspended span and a suspended span
- This cantilever arrangements permits long clear span for navigation also facilities erection of steel work without the need for supporting centering from below
- The steel cantilever bridges came into general use for long span railway bridges because of their greater rigidity compared with suspension bridges
- Howrah bridges with a main span of 457 m was the third longest span cantilever bridges in the world at the time of its construction

- The weight of the structure and the labour involved in the construction of a cantilever bridge are large compared with a cable stayed bridge of the same clear span, so it is not so popular at present.

Arch bridge

- The arch form is best suited to deep gorges with steep rocky banks, which furnish efficient natural abutment to receive the heavy thrust exerted by the ribs
- The arch form is best-suited span in the range of 100-250m
- The arch profile is intended to reduce bending moments in the superstructure and will economical compared with simply supported girder or truss
- The fabrication and erection of an arch bridge would pose more difficult then girder bridge.

Bowstring bridges

A bowstring or tied arch design shaped like a bow with strung downwards allows a shallow deck to be used which reduces the height of approach embankment. Bridge of this type are aesthetically pleasing. Strong girder ties both ends of the support arch together. The girders connect horizontally between the arch spring points balancing the large horizontal thrust in the arch.

Foundation design is simple since the horizontal thrust is internally balanced in the arch. Hangers attached provide intermediate support for the girders. Bracings can be provided between the arches on the either side of the roadway for additional lateral stability.

6. What are the erection methods available for launching of heavy decks?

1. Balanced cantilever erection method
2. Progressive placed method

3. Span by span (or) stepping formwork method
4. Incremental launching method

1. Balanced cantilever erection method

General procedure

- Construction begins at permanent piers and is self supporting at all stages
- Segments are cantilever from a pier, alternating from one side to the other and a closure pour is made with the corresponding half span cantilevered from the next pier.
- Construction typically begins with a pier cap or girder segment called a pier table, built in place on top of the pier.
- The top of the concrete sections is operating at capacity during the entire erection sequence. Thus the construction loads must not increase significantly over what was assumed in design.
- Something must be done to resist overturning moment created by temporary of imbalance of the cantilever as segments are attached to cantilever ends
- This problem may be met by post tensioning the pier down to the pier stem, by adding temporary support on either side of the pier or stabilizing the cantilever with erection equipment.

In pre-cast segmental work

- Each added segment is immediately post-tensioned to the already completed portion of the structure
- These are various ways to deliver segments to cantilever positions
    1. Land of water based cranes
    2. Track or crawler cranes
    3. Floating cranes
    4. Self operating launching gantries.

In cast in place segmental cantilever construction

- The forms are supported on a movable carrier or form traveller which advances on rails attached to the deck of the completed structure abnd is anchor to the deck at the rear

- For balanced cantilever work atleast two travelers are needed working simultaneously.
- The work sequence includes the following steps
    a) Set up and adjust the carrier
    b) Set and align the forms
    c) Place the reinforcing steel and tend on ducks
    d) Place concrete
    e) Install post tensioning tendons in the segment and apply stress After the concrete has gained the required strength
    f) Remove the form wok
    g) Move carrier or traveller to the next position and repeat the cycle

Advantages

1. Navigable waterways
2. Travelled highways
3. Rail roads
4. For reinforced concrete bridges spans as long as 320 ft
5. Cable state construction

2. Progressive placed method

General procedure

- Progressive placing also starts at one of the end of a structure and proceeds continuously to the other end.
- The spans cantilever as segments are added, but unlike the balanced cantilever the work cantilever from one side of the pier
- The method works for pre-cast as well as cast-in-place segments
- If the bridge is cast in place, traveling forms are used as in a balanced cantilever.

- Because the cantilever is long in relation to construction depth, the temporary supports such as cable stays from above or pier bents below are used to limit stresses in the cantilever during construction
- Pre-cast segments are moved over completed portions of the deck to the tip of the cantilever where a swivel crane places them
- The first few segments out from the pier, perhaps as much as a third of the span, can be erected as free cantilever before stays or other temporary supports become necessary.

Advantages

1. Best suited for span in the range of 100-160ft
2. Advantages where site conditions prohibit the span-by-span method
3. Advantages where physical or environmental restrictions imped conventional access to pier location
4. This method permits transporting equipment and material for pier construction from above, over the partially completed structure.

3. Span by span (or) stepping formwork method

General procedure

- Construction preceeds from end of the bridge to the other a span at a time. with some kind of temporary support set up for the span being worked.
- This erection method is referred to as steeping from work when construction is cast in place

In cast-in-place work

- The temporary support is a form traveler which may be supported on the piers, or from the edge of previously completed construction at the joint location and at the forward pier
- For an above deck carrier, the large form work elements for one bridge segment are suspended on the rods during concreting

- After the segment has gained strength and has been post tensioned, the forms are relased and rolled forward by means of structural outriggers on both sides of the form traveler's superstructure.

In pre-cast segmental work

- One method is to assemble all of the segments for a single span on a steel erection truss spanning between two adjacent piers
- A crane places the segment on the assembly truss in approximately their final position
- After all of the segment are assembled to one span, positioned tensioning tendons are installed and stressed, and at the same the span is post-tensioned to the adjoining one
- Some alternative to using the movable erection truss are
    A. Assemble the segments on the ground below their final position and then lift into place
    B. Assemble on false work or fill in the final position'
    C. Assemble on false work parallel to the final position, then push laterally into place

- Other variations include
    1 Partial assembly on the ground
    2 Lifting into place on frame work
    3 Completion of the assembly on the false work
    4 Floated to position for lifting the span

4. Incremental launching method

General procedure

- Segments of the bridge super structure are cast inn lengths of 30-100ft in stationary of fonts just behind the bridge abutment
- Stringent control of dimensions is necessary at the casting site since errors are hard to correct and to launching costs.

- Each segment-generally one fourth, one third or one half of the regular span-is cast against the previous unit and post tensioned to it as soon as sufficient strength develops.
- The assembled units are pushed forward step by step to permit more segment to be cast or positioned behind the abutment
- Incrementally launched bridges may be either straight or curved, but the method is limited to structure with constant radius of curvature either horizontal or vertical
- Thus roadway geometry is sometimes dictated be the construction method contrary to usual practice
- Hydraulic jacks are used to move the superstructure out in the longitudinal direction and special temporary sliding bearings and proper lateral guides must be provided at both temporary and permanent piers

Advantages

1. Best suited to bridges with spans upto 200ft
2. Best adapted for 1000-2000 ft bridges unless other considerations such as severely restricted work area are involved

7. Explain the types of erection of braced domes?

Domes provide an easy and economic method of roofing large areas and are used frequently by the designers for its material economy and impressive beauty

Types of domes

1. Ribbed domes
2. Schwedlar domes
3. Three way grid domes
4. Parallel lamella domes
5. Geodesic domes

Ribbed domes

- Ribbed domes consists of a number of identical radial trussed or solids ribs interconnected at the crown and usually stiffened by a tension ring at the foundation

Schwedler domes

- A schwedler domes, one of the most popular types of braced dome, consists of merdional ribs connected together to a number of horizontal polygonal rings
- To stiffen the resulting structure so as to take the unsymmetrical loads, each trapezium formed by intersecting meridional ribs with horizontal rings is subdivided into two triangles by the introduction of a diagonal member.

Three way grid domes

- It consists of circular tubular rings interconnected with curved diagonal tublur members which are placed one on the top of the other
- Connections between the three intersecting layers of tubes are made by means of U-shaped rods and specially shaped bars which are placed respectively beneath and over the tubes are drawn together by means of two nuts screwed onto the threaded ends of the bar.

Lamella domes

- The lamella dome consists of a large number of similar units arranged in a diamond or rhombus pattern
- Each lamella unit has a length which is twice the length of a side a diamond.
- Roof coverings or purlins used to triangulate the diamond completes the stability requirement of the surface of the dome

Geodesic domes

- Special domes based on the mathematical principle embodying force distribution similar to those in atoms, molecules and crystals

- In this type of dome, the bracing members lie on great circle of a sphere, thus following the geodesic lines of the surface

8. Explain the construction sequence of chimneys

Sliform techniques for construction of chimneys

1. Slipform rises non stop at rate of 1foot/min approximately
2. Each jack is mounted to a yoke, to which is secured the inside/outside form sheets and working platform
3. Each jack rod is removed upon completion of shell. This layer typically 32”normial diameter holes internal to the wall, extending for the full height of concrete shaft
4. To protect from water entrained after chimney is completed, jack rod voids are capped top and bottom with grout.
5. Diameter of silpform assembly is controlled by radial adjustment fixed to each yoke frame and tapes of column or slope of wall is set by an adjustment at top of yoke frame
6. The thickness of concrete wall will be controlled by adjustment that are secured to inside form sheets and yoke frames
7. The construction of shaft i.e, slipping of form is usually conical and continuously a rate of 24hrs/day,5days/week basic with a temporary shutdown each weekend

UNIT V

CONSTRUCTION EQUIPMENT

Selection of equipment for earth work - earth moving operations - types of earthwork equipment - tractors, motor graders, scrapers, front end waders, earth movers – Equipment for foundation and pile driving. Equipment for compaction, batching and mixing and concreting - Equipment for material handling and erection of structures - Equipment for dredging, trenching, tunneling,

PART - A

TWO MARK QUESTIONS AND ANSWERS

1. What are the factors to be considered while selecting a tractor?

- Size of the dozer for a given job
- The type of work expected from the tractor dozer
- Example: bulldozing, ripping, land clearing, pulling a scraper
- The type and condition of hauled road
- Gradient of the haul road
- Distance to be moved
- Type of work expected to be taken from the equipment after the present job is completed

2. What are the advantages of crawler tractors?

- More tractive effort, hence can also operate on loose or muddy soil.
- In absence of tyres, can easily operate in rocky conditions, as there is no danger for the damage of the tyres.

- Where maintenance of haul roads is difficult, it can be easily travel, specially in rough terrains
- Crawler tractors are more compact and powerful and hence can handle difficult jobs as well

3. What are the advantages of wheeled tractors?

- Can travel at higher speeds during the operation and also from one job to another
- Can travel long distance at its own power, whereas crawler mounted needs trailers
- When work is spread over long area, these are found to be producing more output.
- Ease in operation. Operator feels less fatigue.

4. What are the applications of a bulldozer?

- Land clearing
- Stripping
- Side hill cuts
- Ditching
- Spreading
- Dozing rocks and frozen ground
- Maintaining haul roads
- Clearing the floors of borrow and quarry pits

5. What is a scraper?

Scrapers are the device to scrap the ground and load it simultaneously, transport it over the required distance, dump at desired place and then spread the dumped material over the required area in required thickness level, and return to the pit for the next cycle.

The scrapers are of three types

(a) Towed type
(b) Self propelled or motorized
(c) Self loading or elevating scraper

6. What are the advantages of elevating scraper?

- Better loading ability in loose free flowing materials
- Good finishing ability
- Can be operated independently
- Pusher tractor dozer is not required
- Smooth and complete unloading of bowl by reversing the elevator rotation
- Pulverizing and mixing action by the elevator places material in uniform and homogeneous state for compaction

7. List out the types of excavators.

Excavators are of following four types based on the type of carriers on which they are mounted

1. Crawler mounted excavator
2. Truck mounted excavator
3. Self propelled
4. Excavators barge or rail

8. What are the advantages of trencher?

- It is faster and cheaper method of trenching
- It digs only as much as is necessary. A 10cm pipe can be installed in a 15cm wide slot cut by a trencher
- It is a continuous process and is not like that of backhoe excavator i.e. dug lift-dump

9. What are the factors governed the output of a dragline?

Output or the performance of the dragline depends on the following factors

- Nature of soil

- Depth of cut
- Angle of swing
- Capacity of hauling units, if employed
- Mechanical condition of the dragline
- Efficiency and skill of the operator

10. What is a clamshell?

Clamshell is a machine having most of the characteristics of dragline and crane in common. Digging is done like a dragline and once the bucket is filled, it works like a crane. It is very useful for accurate spot dumping of material in a confined space in a vertical plane. It can be used for handling of loose or soft and medium hard materials only.

11. What are the main uses of a bulldozer?

- Clearance of shrubs and small trees
- Clearance of trees by using raised mould blade as a pusher arm
- Acting as a towing tractor
- Acting as a pusher to scraper machines

12. Write short note on Draglines.

Cranes are machines designed to move materials vertically (raise by rope pulley operation) or horizontally. The range of cranes available is very wide, from gear wheel to a complex tower crane. Therefore, choice must be based on:

- The loads to be lifted
- Height of lifting
- Horizontal distance to be covered
- Time period of lifting operations
- Utilization factors and
- Degree of mobility required

13. List out the construction equipment.

- Bull Dozers
- Graders
- Skimmers

- Scrapers
- Loaders
- Face Shovels
- Backhoe
- Draglines

14. Write short note on skimmers.

These excavators are rigged using a universal power unit for surface stripping and shallow excavation work up to 300 mm deep where a high degree of accuracy is required They usually require attendant haulage vehicles to remove the spoil and need to be transported between sites on a low loader. Because of their limitations and the availability of alternative machines, they are rarely used today.

15. What is dredging?

Dredgers are used for excavation from riverbed, lake or sea for purpose of deepening them. Dredging is an important operation in navigation canals, harbours, dams etc.

16. What is motor grader?

Motor graders are used for leveling and smoothening the earthwork, spreading and leveling the base courses in the construction of roads and airfield. It can be used for land reclamation, snow clearance, gravel road repairing, mixing of stabilizing materials such as tar, asphalt, cement and lime, maintaining quarry roads etc.

17. List out the material handling devices

1. Lifting and lowering devices (Vertical motion)

(a) Block and tackle
(b) Winches
(c) Hoists
(d) Elevators
(e) Pillar crane
(f) Overhead cranes

2. Transportation devices (horizontal motion)

(a) Wheel barrows and hand truck

(b) Narrow-gauge mine rail road

(c) Tractors and trailors

(d) Skids

(e) Pipe line

3. Combination devices (Lifting and lowering plus Transportation)

(a) Spiral chute

(b) Lift track

(c) Crane truck

(d) Forklift truck

(e) Conveyors of various types

4. Arial transport

(a) Cable ways

(b) Rope ways

18. How pumps are classified? Give example.

Pumps are of following types

1. Positive displacement pumps: These may be

(a) Reciprocating pumps

(b) Rotary pumps: These may be gear pumps, vane pumps, screw pumps etc

2. Rotodynamic pumps: These may be volute pumps, circular pumps, diffuser pumps, vertical turbine pumps, and centrifugal mixed flow and propeller types of pumps.

19. What is meant by 'Transit mixer'?

- Dry mix material are fed into the truck mixers for a dry batching plant, after measuring the quantities of various constituents other than water, i.e. aggregate, sand and cement.
- Transit mixers transport it to the work site and mix it during the journey using its own water supply. These transit mixers are provided with a suitable water system having sufficiently large water tank, a meter and a pump for supplying water for mixing and cleaning the drum.

20. What are the factors affecting the selection of a drilling equipment?

Major factors affecting the selection of drilling equipment are mentioned hereunder:

(a) Nature of terrain
(b) Required depth of holes
(c) Rock hardness
(d) The purpose for which holes are required to be drilled i.e fro blasting or grouting or for exploration purposes.
(e) The size of the project.

21. What are applications of a hoe?

i. For digging trenches, footings or basements
ii. To dug materials which are hard
iii. Where close trimming is required during excavation
iv. Where excavation is required below the ground level and then dumping
is done at a short range.

22. What are applications of a clamshell?

i. Where digging or dumping in a vertical plane i.e., below, at or above ground level is required
ii. Where material is relatively soft or medium hard
iii. For digging trenches
iv. For charging the materials in a bin or a stock pile

v. Where accurate dumping is required

23. What are the factors affecting the output of a scraper?

i. Size and mechanical condition of the scraper
ii. Hauling distance
iii. Condition of the haul road
iv. Characteristics of soil and work area
v. Efficiency

24. List out the applications of a motor grader.

i. Land clearance
ii. Snow clearance
iii. Material mixing]
iv. Hard surface cutting
v. Ditch filling or digging
vi. Bank cutting and reshaping

25. What are activities normally followed during concreting?

i. Batching
ii. Mixing
iii. Transporting
iv. Placing
v. Compacting
vi. Curing

26. On what basis you will select the equipment for the construction?

- Volume of the material to be removed
- Size of the machine used
- Depth of excavation
- Height to be lifted
- Soil type
- Duration of period

- Rented or purchased
- Production cost
- Spares availability
- Skilled operation

27. Bring out some difference between crawler and pneumatic type of wheels?

Crawler	Pneumatic type wheels
1. The crawler moves on an endless chain.	1. It moves on pneumatic tyres.
2. They are slow speed.	2. They are faster in speed.
3. They are used for uneven & rough ground.	3. They operate best on smooth roads.
4.They have a speed of about 12 Km/h.	4.They have a speed of about 50 Km/h.

28. What are the three types of scraper?

- Crawler-drawn scraper
- Two-axle scraper
- Three-axle scraper

29 What is the power shovel?

It is used to excavate the earth of all classes and load it into wagons. They are mounted on crawler tracks. It consists of a mountain, cab, boon, dipper, stric, hoist line.

30. Name some compaction equipment?

- Towed static smooth compactors
- Static sheep foot or pad foot compactors
- Static three wheel self propelled compactors
- Static tandem compactors
- Three axle static compactors
- Rubber tyred compactors

- Vibrator compactors
    - Tandem vibrator compactors
    - Towed vibrator compactors
    - Sheep foot & tamping foot vibrator compactors
    - Self-propelled vibrator compactors
    - Hand guided vibrator compactors

31. What are the types of conveyors?

- Belt conveyors
- Roller conveyors
- Chain conveyors
- Pipe conveyors
- Elevating conveyors

32. Give some advantages of belt conveyor?

- Its suitable levels eliminate a good deal of lifting and lowering of material.
- It require no stopping or standing but is continuous operation.
- Transportation is affected by friction between material being transported and the belt.
- It largely saves labor cost.
- No noise
- Carry the material horizontal, vertical, inclined.
- It can withstand 1600 C.

33. How do you calculate the output of the scraper?

- Size & Mechanical condition of the scraper
- Hauling device
- Condition of the haul road
- Characteristics of soil & work area
- Efficiency
- Output of scraper in bank volume/hr =Optimum loose volume loaded/trip x S x 60/ t x efficiency

  Where, S= Swell factor

t =cycle time/trip in minutes.

34. What are the uses of excavators?

It have various earthmoving jobs, like laying pipes, removing trees, excavation of drains, general earth moving jobs of cleaning area,loading,etc,It is also used for excavation of houses &building foundation, trenches for irrigation, sewage, cables, gas & oil pipe lines. Maintenance & cleaning of rivers, cannals, irrigation. It is also used for loading of material like earth, coal, aggregate, etc.

35.What is the application of dozer?

- Road cleaning
- Stripping
- Back filling
- Ditching
- Spreading
- Side fills & cuts

36. What does the output of dozer depend on?

The output of the dozer depends on:

- Size & condition of the dozer.
- Distance traveled by the dozer.
- Speed of operation.
- Characteristics of soil being handled.
- Surface on which dozer is operating, soil condition, etc
- Efficiency

PART - B

SIXTEEN MARK QUESTIONS AND ANSWERS

1. What are the factors must be taken into account during selection of earthwork equipment?

Following are the main points which should be considered in the process of equipment

Selection

1. Suitability for job conditions.

The equipment must meet the requirement of the work, climate and working conditions

2. Size of the equipment

Size of equipment should be such that it must be able to be used with other machine units. If the equipment selected is of large size, that will remain idle for most of the time or shall work on parts loads, which means production cost will be more . on the other side, if the equipment is of smaller size than desired, the equipment will not able to work with the matching equipment and hence other equipment will have to remain idle or to be allowed to work on part loads, which shall again be uneconomical

3. Standardization

It is better to have same type and size of equipment in the project. It means lesser spare parts reserve, more interchangeability of parts if required, easy for the operator to understand it, mechanics will able to maintain and repair better as they become expert by handling one type of equipment.

4. Availability of spare parts

While selecting a particular type or make of equipment, it should also be ensured that the equipment is of repute and is likely to be continued to be manufactured in future also. This is necessary for future standardization and ensuring spare parts supply. It is easy to dispose off such equipment after completion of project.

5. Availability of spare parts

While selecting a particular type or make equipment, it should be ensured that the spare parts will be available at reasonable price throughout the working

life of the equipment .It should also be ensured that the downtime of the equipments for want of spare parts may not be more. This is all the more necessary in case of imported equipments

6. **Multipurpose equipment**

   There are certain types of equipment which are not utillsed fully. Therefore if possible, they must be capable of performing more than one bucket arrangement or with rock breaker attachment.

7. **Availability of know-how**

   The equipment selected should be satisfactory handle by available operators and mechanics. Sophisticated equipment may give excellent performance but it may be difficult to handle and maintain it through available know-how.

8. **Use in future projects**

   When equipment completes only a part of their life in projects, it should be kept in view that the equipment can be used in future projects and may not be come obsolete.

9. **The economical aspects**

   While selecting the equipment it should be considered that the cost of unit production should be minimum.

10. **Reliability of the equipment**

    Equipment selected for project must be reliable one.

11 **Service support**

Service support should be available in the area of project where the equipment shall be used. Service after sales is a major criteria for selection of equipment.

12 **Operating requirement**

The equipment selected should be easy to operate and maintain, acceptable to the operator and should have lesser fuel consumption.

13. Past performance

If the equipment being purchased is of new make and model, it is desirable to enquire about its performance from other users, who are using this make and model.

14 The size and numbers should be such that full life is utilized in the project with very little residuals.

15. Reputation of the manufacturer.

16. Warranty or guarantee offered by the manufacturer

17 Use of standard components in the equipment

2. Write note on Tractors

Tractors are the machines which change energy of the engine into tractive energy. The tractors are primarily used to pull or push loads, but they are also used for mounting many types of accessories like, bulldozer blades, rippers, front end shovels, hoes, dragline, clamshells, trenchers as winches, side booms, front end bucket loaders, pipe layers etc

As two mentioned above the tractor is a basic equipment and available in two types, namely

(i) Craweler or track type

(ii) Rubber-tired or wheel-type

The tractor is a multi-purpose machine, light models of which are used for agricultural or short haulage works, whereas heavy models are employed for earth moving works, cranes, shoves or special rigs. Wheeled units are employed for light but speedy jobs, whereas crawler units are rugged machines and are used for heavy duty works, where more tractive power is required.

Tractor construction

Main constituents of a tractor are: Engine, clutch, transmission system, ground drive and controls

Diesel engine

- It is generally used as prime mover and mounted on the tractor frame and delivers the power through a clutch to the main power shaft.
- The power is transmitted from the engine to the fine drive through engine cluth, torque convertor, change speed gear box transmission to rear differential and then finally to the rear drive axle.
- The drive is also transmitted trough front differential to the front axle

Engine clutch

- Engine clutch is provided to disconnect the connect the engine from the rest of the transmission system so that gears can be changed to chang the speed of the tractor
- Care should be taken while changing the gears that the engagement of the clutch should be gradual to avoid undue strain on the surface of the cluch plates
- The clutch control in small and medium sized tractors is through pedal like that of a track, but in large tractors it is lever operated by land

Transmission system

- Transmission system provides speed reduction and multiplication of torque of the engine shaft, since final drive needs a high torque at a low speed.
- The power is than given to the drive axle through the differential, which changes the direction of the drive to 90 degree by using bevel gears and also reduces the speed upto some extent.
- The change in the speeds of the track is made directly by stopping power supply to one, while the other continues to rotate.

Power

- The power from grive axle is transmitted through wheels or crawler chains in wheeled tractors and crawler tractors respectively.
- Wheeled tractors generally have two large wheels in the rear and too smaller wheels in the front.

- To make rear heavy for better stability of the tractor, rear tyres are filled with water. The tread of one tyre should be selected carefully as its tractive efforts on a particular type of soil where its operates

Crawler tractors

- In crawler tractors, live axles rotate large toothed wheels known as drive sprockets at the rear of the track frame
- In front of each track frame and idler is provided. An endless track chain is mounted on the sprockets and idlers
- The chain is made of flat shoes pinned together end to end

Following main factors should be considered while selecting a tractor dozer.

a) Size of the dozer for a given job
b) The type of work expected from the tractor dozer
   Example bulldozuing, ripping, land clearing, pulling a scraper
c) The type and condition of hauled road
d) Gradient of the haul road
e) Distance to be moved
f) Type of work expected to be taken from the equipment after the present job is completed

3. Write note on Scrapers

Scrapers are the device to scrap the ground and load it simultaneously, transport it over the required distance, dump at desired place and then spread the dumped material over the required area in required thickness level, and return to the pit for the next cycle.

The scrapers are of three types

(d) towed type
(e) Self propelled or motorized
(f) Self loading or elevating scraper

Towed type

Towed scrapers are provided with either cable or hydraulic control.Althrough these are becoming obsolete but even then some contractors use them

because when coupled to a suitably powered crawler tractor; they can operated in extremely adverse conditions

Self propelled or motorized

Self propelled or motorized are most popular now-a-days. These are generally manufactured in ranges from 10-25m^3 .A motorized scraper needs push loading by a craweler mounted or wheeled tractor.Motorised scrapers have more hauling speed and hence are suitable for long distance hauling while crawler-towed scrapers travel at slower speed and can be used for short hauls only. The problem of loading by a pusher is overcome by the third type of scraper known as self loading or elevating scraper.

Construction: A scraper has following main parts

(i) **Bowl:** The bow is pan to hold the scraper dirt. It is hinged at the rear corners to the rear axle inside the wheels, and is capable of tilting down for digging or ejecting. The bowl size is specified to indicate the size of the scraper.

(ii) **Cutting edge:** The bowl has cutting edge attached at the bottom. The cutting edge is lowered into the dirt to make a shallow cut.

(iii) **Apron:** This is wall in front of the bowl, which opens and closes to regulate the flow of the earth in and out of the bowl. This can be open or closes in carrying position as well

(iv) **Tail gate or ejector:** These are the rear of the pan which is capable of forward ad backward movement inside the bowl. During loading it remains at its rear wall, while moves forward to help in ejecting the load during dumping

Operation

Operation of a scraper is described hereunder for an work application

(i) **Loading or digging:** Operator moves to the cut the ejector at the rear and the apron raised approximately to 40 mm.The bowl is then lowered to the desired depth of cut, increase engine speed, move forward in first gear keeping optimum depth of cut. When the bowl is full, the apron is closed and the bowl is then raised.

(ii) **Transporting:** The bowl is transported in high gear in raised position to provide sufficient clearance. During transporting position to provide clearance. During transportation, apron should be fully closed to prevent loss of the material and the ejector should remain in the rear position

(iii) **Unloading:** Unloading in a scraper is also termed as 'dumping and speading'.The bowl should be positioned to spread the material to the desired depth during this operation. A partial opening of the apron during the initial unloading will help in even spreading.For wet and sticky material,te apron should be raised and lowered repeatedly intil the materal behind it is loosened and drops out of the bowl.

For better efficiency in the scraping operations following points should be taken care of

(i) Keep the haul roads maintained

(ii) Pushers should utilize their waiting time in dressing the cut

(iii) Loading operation should be carried out downhill whenever possible

(iv) Excessive turning of a pusher should be avoided and scraper-pusher balance should be maintained.

4. Explain the working principle of a concrete mixing plant with sketch.

Concrete batching and mixing plant

As it name suggests the plant has main function of 'batching' and then 'mixing'. Batching means proportioning of ingredients concretive: aggregates, sand, cement and water separately for each batch. Batching and mixing plants used in construction field generally consists of the following main constituents.

(i) Aggregate feeders:

Aggregate feed bins are used for each of the size of the aggregate and sand, and control their quality, weighting system is used for important jobs, since control by volume is not perfect as it varies due to closeness of packing of the material. The aggregate fed bins are loaded by any of the following methods

(a) By shovels directly into the bins

(b) By lorries tipping directly into the bins

(c) Aggregate are stored in bulkhead at ground level

(ii) Cement silo:

Cement is stored in a silo which is filled from a cement carrier by pumping the cement into silo under pressure. Weigh batching is provided for measuring the quality of cement to be fed for each batch mix. This weighed cement is carried to the mixing unit through the conveyor belts which are totally enclosed to avoid any loss.

During filling under pressure by bulk tanker, cement laden air is vented to atmosphere through a filter. Cement/air filters are generally,"multisock" type having number of easy-to-renew nylon socks giving mixing filtration area. These nylon socks trap cement. Access door allows inspection and cleaning when necessary. Dust from the filters falls back into the silo when the shaker device is operated from ground level controls

Cement enters the silo through a valve provided on an inlet pipe connected either to a screw conveyor either to a screw conveyor or rotary blower pressurizing the pipeline, carrying cement, at about 0.4 bar. These are used to inject the cement received from either of the two sources from a bag splitting hopper, or from standing bulk cement carrier. The bay splitting hopper is of steel construction and is fitted with a bag splitting knife to cut the bag and a grill which allows cement to fall through into hopper whilst trapping the bag and any other destruction.

(iii) Water measuring device:

Concrete production requires exact quantity of water, therefore, a reliable and accurate water measuring device is required in the plants. Measured correct quality of water is fed during the period of charging a batch into the drum of the mixer. Water is filled from a tank into a measuring tank during the period when mixing takes place in the mixer. This water from the measurement tank is delivered to the mixer during the next batch when aggregate, sand and cement is charged into the drum of the mixer. Thus after each charge the

measuring tank is filled up from the water tank by the quantity needed for a batch for the supply to the next batch. This water from the measuring tank is supplied to the mixer through the adjustable spray bar so as to achieve homogeneous mix within a shortest time

(iv) Mixing unit:

Mixing unit consists of two parallel shafts made of cast steel provided with adjustable paddle mounted on external supports provided with bearings. The mixer discharges the mix into a hopper for delivering it to the concrete dumpers directly or into bin where the mix is stored temporarily. The mixer is then taken to the construction site. The mixer is then taken to the construction site. The walls of mixing units are made of wear resistant steel.

5. Explain the various types concreting equipments.

Concreting equipments

It is well known that the process of concreting involves batching, mixing, transporting, placing, Compacting and curing. Accordingly common concreting equipments are,

- Concrete mixers
- . Concrete Hauling Equipments
- . Concrete pumps for placement in different conditions
- Concrete vibrators for compaction

Concrete mixers

These are generally related to their designed output performance. Machines are decided based upon what mixing and placing methods are to be employed to mix and place a certain amount of concrete in a given time period. Generally, a batch mixing time of 5 minutes per cycle of 12 batches per hour can be assumed as a reasonable basis for assessing mixer output.

Concrete Hauling Equipments

(i) Wheel barrows

Transporting mixed concrete produced in a small capacity mixer is by wheel barrow. The run between the mixing and placing positions should be kept to a

minimum and as smooth as possible by using planks or similar materials to prevent segregation of the mix
within the wheelbarrow

(ii)Dumpers

These can be used for transporting mixed concrete from mixers up to 600-litre capacity and are available in two forms,

(iii)Ready Mix Concrete Mixers

These are used to transport mixed concrete from a mixing plant or depot to the site. Usual
capacity range of ready mixed concrete trucks is 4 to 6 rn3. Discharge can be direct into placing position into some form of site transport such as dumpier, crane skip or concrete pump.

(d) Concrete pumps for placement in different conditions

These are used to transport large volumes of concrete in a short time (say up to 100 m3 per hour) in both the vertical and horizontal directions from the pump position to the point of placing. The pump is supplied with pump able special concrete mix or with constant flow of ready mixed concrete lorries through out the pumping period. Concrete pumps are usually of a twin cylinder hydraulically driven form with a small bore pipeline (100 mm diameter) and can be trailer or lorry mounted. Pumping ranges may be up to 850.00 m vertically and 200 m horizontally depending on the pump model. It generally requires about 45 minutes to set up a concrete pump on site including coating the bore of the pipeline with a cement grout before pumping. After plumbing, the pipeline should be cleared and cleaned. Usually concrete pump and operator are hired for the
period required

(e) Concrete vibrators for compaction

(i) Poker or Internal Vibrators

These consist of a hollow steel tube casting in which is a rotating impeller which generators vibrations as its head comes into contact with casing. Poker vibrators should be inserted vertically and allowed to penetrate 75mm into any previously vibrated concrete.

(ii) External Clamp or Tamping Board Vibrators

These vibrators operate by shaking the formwork. Clamp vibrators powered by either compressed air or electricity whereas tamping board vibrators are usually petrol driven.

Formwork must be stronger than is traditional to withstand vibration.

6. Explain the working principle of four type of lifting equipment with sketches.

Lifting and lowering devices (Vertical motion)

These include

1. Block and tackle
2. Winches
3. Power Hoists
4. Elevators
5. Pillar crane
6. Overhead cranes

Block and tackle

- A Block and tackle arrangement of lifting loads through a vertical distance.
- This is one of the oldest and simplest device
- It is still used today for moving men and in hoisting machinery into position
- It is the most in expansive in cost but the most wasteful of manpower.

Power Hoists

- A power hoist, which is often operated between fixed guide rails, for lifting things vertically.

- There is infinite varity of hoists suitable for different purposes.
- The simplest is the chain hoist, which is operated by hand. There are hoists operated by compressed air ,diesel engine or by electric power
- The hoists are smaller to elevators except that a hoist does not carry the operated from one or two other points

Pillar crane

- This may be a stationary type or mobile type.
- It is used for light duty and for lifting loads upto 20 tonnes.
- All the movements to the crane are provided by gearing and electric motor drive.

Overhead

Fig shows an overhead traveling crane. Today all the big workshops, foundries, power houses, chemical plants, big repairing shops etc. have these cranes. These cranes have the advantage of providing large service area and freedom from obstruction on the floor. In these all the movements are controlled by the driver seated in the cabin

7. Explain the sequence of tunneling operations.

Tunnel construction is carried out in a well-planned sequence of operations. A particular operation may of the tunnel, method adopted for excavation and the characteristics of the formation encountered.

Following sequence of operations are generally adopted for driving the tunnel through rock:

1. Setting up and drilling
2. Loading the holes with explosives and firing
3. Ventilating and removing the dust resulted by explosion
4. Loading and hauling the muck
5. Removing groundwater from the tunnel, if necessary

6. Erection of supports for the roofs and sides, if necessary
7. Placing reinforcement
8. Placing the concrete lining
9. Curing and shuttering removal

8. Describe the working principle of a 'hoe' with a neat sketch.

This equipment is also known as drag-shovel or pull-shovel. Since the digging mechanism resembles to an ordinary garden hoe, this equipment is named as hoe. The equipment has an ability penetrate even the toughest of materials. Due to this ability these are commonly used in quarries which have tough digging conditions and are prone to flooding, rendering the use of conventional shovel operations impractical.

The drag shovels are extensively used in trench digging applications, and can dig easily to greater depth the level of the equipment. Like powers shovels, hoe also has accurate spotting of the digging bucket. The dumping into carrier units is difficult and not as a power shovel, and also has a slow working speed.

This shovel consists of a boom and stick; a jack boom and the bucket attached at the end of the stick. The lower end of the stick carries the bucket, while the upper end carriers a sheave having the hoist cable supported on a jack boom at the other end and passes on to the hoists drum. Therefore when a pull is applied to the hoist cable, the reaction at the stick hinge to move the boom with stick, up or down. Thus the boom can take and position in vertical plane.

Application:

- For digging trenches, footings or basements
- To dug materials which are hard
- Where close trimming is required during excavation
- Where excavation is required below the ground level and then dumping is done at a short range.