DETAILS EXPLANATIONS

Hydrology & Water Resource Engg + Construction materials + Water Supply and Sanitary Engineering

[PART : A]

1. Cement is extremely ground material having adhesive and cohesive properties which provide a binding medium for the discrete ingredients.

2. Poor lime contains more than 30% of clay. So, it slakes very slow. It is also called Impure or Lean-lime.

3. If excess water in the mix comes up at the surface causing small pores through the mass of concrete, it is called bleeding.

4. These tests are slump cone test, compaction factors test, Vee-Bee test, Flow Table test.

5. Preservation is a process used to increase the life of timber and to protect the timber structure from attacking agencies like fungi, insects etc.

6. Although these materials assist in burning but if they are not completely burnt, bricks become porous.

7. It is used to indicate the consistency of mortar-mix which may range from stiff to fluid.

8. 'Threshold Odor Number' is the ratio of final volume at which odor is hardly detectable and the sample volume.

9. In slow sand filters :-

Depth of sand used = 90 – 110 cm

Frequency of cleaning = 1 – 3 months

10. Settling Velocity

$$V_S = \left[\frac{4}{3}\frac{gd(G-1)}{C_D}\right]^{1/2}$$

11. Flow Velocity

$$V = 83.5R^{2/3}.S^{1/2}$$

12. Carbonaceous Organic Matter

$$\xrightarrow[\text{Aerobic}]{\text{Oxidation by}} SO_4^{2-} + \text{Energy}$$

13. Secondary Pollutants are H_2SO_4, Ozone, Formaldehydes, Peroxyacetyl-Nitrate (PAN) etc.

14. Factor of Safety = $\frac{\text{Restoring Moment } (M_R) \text{ About Toe}}{\text{Over Turning Moment } (M_o)}$

F.S. = $\frac{M_R}{M_o} > 1.5$

15. It is the short straight reach in the reverse order curvature developed by a river when it deviates from axial-path.

16. Lacey regime scour - depth = $1.35\left(\frac{q^2}{f}\right)^{1/3}$

17. $\Delta = \frac{8.64B}{D}$

Where Δ = Delta in (m)

B = Base period in Days

D = Duty in hectare/Cumec

18. **Aridity Index**

$$A.I. = \left(\frac{PET - AET}{PET}\right) \times 100$$

PET = Potential - Evapo-transpiration

AET = Actual - Evapo-transpiration

19. Base flow is the delayed flow that reaches the steam essentially as ground water flow.

20. Dickens formula for peak flood discharge

$Q_P = C_D.A^{3/4}$ m^3/sec

A = Area of catchment (Km^2)

C_D = Dicken's constant

[$6 \le C_D \le 30$]

[PART : B]

21. **Bulking of Sand :**

In the case of aggregates there is another effect of the presence of moisture viz. bulking which is an increase in the volume of a given mass of sand (fine aggregate) caused by the films of water pushing the sand particles apart. For a moisture content of about 5 - 8% this increase of volume may be as much as 20 – 40% depending upon the grading of sand.

22. Causes of Corrosion

(i) Congested reinforcement in small concrete sections
(ii) Excessive water-cement ratio
(iii) Improper Construction methods
(iv) In-adequate design procedure
(v) In-sufficient cover to steel from exposed concrete surface
(vi) Presence of moisture in concrete
(vii) Presence of salts

23. Sir Abel's Process :

This process is for fire-resistance of timbers. In this process, timber surface is cleaned and it is coated with a dilute solution of sodium silicate. A creme-like paste of slaked fat lime is then applied and finally, a concentrated solution of silicate of soda is applied on the timber surface.

24. Decreasing rate of growth method :

Since the rate of increase in population goes on reducing as the cities reach towards saturation, a method which makes use of the decrease in the percentage increase, in many a times used, and gives quite rational results. In this method, the average decrease in the percentage increase if worked-out, and is then subtracted from the latest percentage increase for each successive decade.

25. Pressure-filters

Pressure filters are just like small rapid gravity filters placed in closed vessels, and through which water to be treated is passed under pressure.

Rate of filteration $\rightarrow$ 6000 – 15000 lit/hour/m^2

$= (\text{Rapid Sand filter} \times 2)$

The pressure filters are less efficient then the rapid gravity filters, in removing bacteria and turbidities.

26. $$\frac{(BOD)_5}{(BOD)_u} = 0.68$$

$$(BOD)_5 = 0.68(BOD)_u$$
$$(BOD)_5 = 0.68 \times 250$$
$$(BOD)_5 = 170 \text{ ppm}$$

27. Characterstics of Hollow Bricks

These are also known as cellular or cavity bricks. Such bricks have wall thickness of about 20 to 25 mm. They are prepared from special homogeneous clay. They are light in weight about one third the weight of the ordinary bricks of the same size. The use of such bricks leads to speedy construction. They also reduce the transmission of heat, sound and damp.

28. (i) Water Conveyance Efficiency (η_c) :

It is the ratio of water delivered to the field and the water delivered from the reservoir. So it basically shows the losses in canals.

(ii) Water Storage Efficiency (n_s) :

It is the ratio of actual water stored in the root zone and the water needed to store to bring the water content upto the field capacity.

29. Blaney Criddle Method :

It expresses the consumptive use in terms of temperature and day time hours. If C_u is monthly consumptive use, it's value is given by [C_u = K.f] (inches)

Where, K = Crop-factor to be determined for each crop, it's value depends upon certain environmental conditions

f = monthly consumptive use factor

$$= t \times \left(\frac{p}{100}\right)$$

t = mean-temperature in °F

p = percentage of day time hours of the year, occuring during the period

30. Dalton's Law :

The rate of evaporation is proportional to the difference between the saturation vapour pressure at the water temperature, e_s and the actual vapour pressure in the air, e_a. Thus,

$$E = K(e_s - e_a)$$

Where, E = Rate of evaporation (mm/day)

e_s = Saturation vapour pressure of air (mm)

e_a = Actual vapour pressure of air (mm)

$(e_s - e_a)$ = Saturation Deficiency

31. By Rational Method :

Peak-Discharge

$$Q_P = \frac{1}{36}.K.P_c.A$$

$$\Rightarrow \quad Q_P = \frac{1}{36} \times 0.48 \times 3 \times \frac{2 \times 10^6}{10^4}$$

$$\Rightarrow \qquad Q_P = \frac{1}{36} \times 0.48 \times 3 \times 200$$

$$\Rightarrow \qquad Q_P = 8 \text{ m}^3/\text{sec}$$

32. Unit hydrograph :

It is the hydrograph of direct runoff resulting from one unit depth (1 cm) of rainfall excess occuring uniformly over the basin and at a uniform rate for a specified duration (D hours).

Time Invariance : The first basic assumption is that the direct-runoff, response to a given effective rainfall in a catchment is time invarient.

This implies that the DRH for a given ER in a catchment is always the same irrespective of when it occurs.

[PART : C]

33. (i) Chemical Composition Test :

Ratio of percentage of lime to percentage of silica, alumina and iron-oxide known as lime saturation factor (LSM), when calculated by the formula.

$$\left\{ \frac{CaO - 0.7SO_3}{(28SiO_2 + 12Al_2O_3 + 0.65Fe_2O_3)} \right\}$$

shall not be greater than 1.02 and not less than 0.66.

- Ratio of percentage of Alumina (Al_2O_3) to that of Iron-oxide (Fe_2O_3) shall not be less than 0.66.
- Weight of insoluble residue shall not be more than 4%.
- Total loss on ignition shall not be more than 5%.
- Weight of Magnesia shall not be more than 6%.

(ii) Normal Consistency Test

The normal (standard) consistency of a cement paste is defined as that consistency which will permit a vicat plunger having 10 mm diameter and 50 mm length to penetrate a depth of 33 to 35 mm from the top (or 5-7 mm from bottom) of the mould.

Vicat - Apparatus : Vicat apparatus assembly consists of a plunger 300 gm in weight with a length of 50 mm and diameter of 10 mm and a mould which is 40 mm deep and 80 mm in diameter.

(iii) Soundness Test :

The soundness of cement is determined either by 'Le-chatelier's method' or by means of a 'Autoclave' test.

No satisfactory test is available for deduction of soundness due to excess of calcium sulphate. But it's content can be easily determined by chemical analysis.

(iv) Strength Test :

(a) Compressive Strength Test :

Three cubes are tested for compressive strength at 1 day, 3 day, 7 day and 28 day where the period of testing being reckoned from the completion of vibration.

The compressive strength shall be the average of the strengths of three cubes for each period respectively.

(b) Tensile Strength Test :

Six briquettes and average tensile strength is calculated.

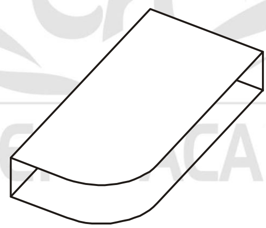
Load is applied steadity and uniformly, starting from zero and increasing at the rate of 0.7 N/mm^2 in 12 seconds.

OPC should have a tensile strength of not less than 2 MPa and 2.5 MPa after 3 and 7 day respectively.

34. Shape of Bricks :

1. Bullnose Brick:

A brick moulded with a rounded angle is termed as a bullnose. It is used for a rounded quoin.



Bullnose-Brick

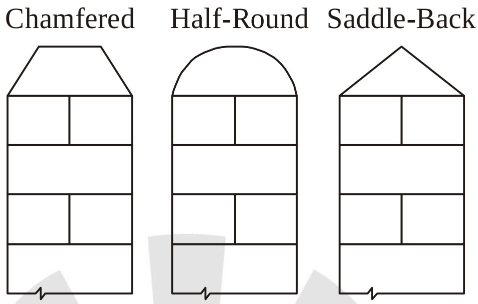
A connection which is formed when a wall takes a turn is known as quoin.

2. Channel Bricks

The bricks are moulded to the shape of a gutter or a channel and they are very often glazed. The bricks are used to function as drain.

3. Coping-Bricks

These bricks are made to suit thickness of walls on which coping is to be provided.



Such bricks take various forms such as chamfered half-round or saddle back.

4. Cownose Bricks

A brick moulded with a double bullnose on end is known as cow-nose.

5. Curved Sector Bricks

These Bricks are in the form of curved sector and they are used in the construction of circular brick masonry pillars, brick chimneys.

The perforation may be circular, square, rectangular or any other regular shape in cross-section.

The water absorption after immersion for 24 hours in water should not exceed 15% by water.

6. Hollow Bricks :

These are also known as cellular or cavity bricks. Such bricks have wall thickness of about 20-25 mm. They are prepared from special homogeneous clay. They are light in weight about one-third the weight of the ordinary bricks of the same-size.

7. Paving-Bricks : These Bricks are prepared from clay containing a higher percentage of iron. Excess iron variety the bricks at a low temperature. Such bricks resist better the abrasive action of traffic.

8. Perforated Bricks :

Perforated Bricks are used in the construction of brick panels for light weight structures and multi-storeyed framed structures.

35. Fire Demand

It is the amount of water required per day to achieve the fire solutions.

The rate of fire demand is sometimes treated as a function of population and is worked out on the basis of empirical formulas:

I. Kuichling's Formula :

$$Q = 3182\sqrt{P}$$

Q → Amount of water (lit/min)

Q → Population in thousands

II. Freeman's Formula :

$$Q = 1136\left[\frac{P}{10}+10\right]$$

III. National Board of Fire Underwriters Formula

(a) For a congested high valued city

(i) Where population < 2 lac

Q = 54600 lit/min for first fire

Q = 9100 – 36400 lit/min for a second fire.

(b) For a Residential city

(i) Small or low building:

Q = 2200 lit/min

(ii) Larger or higher buildings:

Q = 4500 lt/min

(iii) High value, apartments, tenements

Q = 7650 to 13500 lt./min

(iv) Three storeyed buildings in density build up sections

Q = 27000 lt/min

IV. Buston's Formula

$$Q = 5663\sqrt{P}$$

The probability of occurance of a fire, which inturn, depends upon the type of the city served, has been taken into account in developing a above formula on the basis of actual water consumption in fire fighting for Jabalpur city of India. The formula is given as:-

$$Q = \frac{4360\,R^{0.275}}{(t+12)^{0.757}}$$

Where, R = Recurrance interval of fire i.e. period of occurance of fire in years, which will be different for Residential, Commercial and Industrial-Cities.

$(R)_{minimum}$ = 1 year

t = duration of fire in minutes

t_{min} = 30 min

36. Mean Rainfall Data :

To convert the point rainfall values at various stations into an average value over a catchment the following three methods are in use:

(i) Arithmatic Average Method :

When the rainfall measured at various stations in a catchment show little variation, the average precipitation over the catchment area is taken as the arithmatic mean of the station values.

$$P_{avg} = \frac{P_1 + P_2 + P_3 + ... + P_n}{n}$$

In practice this method is used vary rarely.

(ii) Thiessen Polygon Method :

In this method the rainfall recorded at each station is given a weightage on the basis of an area closest to the station.

$$P_{avg} = \frac{P_1A_1 + P_2A_2 + ... + P_nA_n}{A_1 + A_2 + ... + A_n}$$

where P_1, P_2, ... P_n are the rainfall datas of Area A_1, A_2 ,....A_n. The Thiessen polygon method of calculating the average precipitation over an area is superior to the arithmatic average method.

(iii) Isohyetal method :

An Isohyet is a line joining points of equal rainfall magnitude. The recorded values for which areal average P is to be determined are then marked on the plot at appropriate stations. Neighbouring stations outside the catchment are also considered.

$$P_{avg} = \frac{A_1\left(\frac{P_1 + P_2}{2}\right) + A_2\left(\frac{P_2 + P_3}{2}\right) + ... + A_{n-1}\left(\frac{P_{n-1} + P_n}{2}\right)}{A_1 + A_2 + ... + A_{n-1}}$$

37. Assume 30% of BOD load removed in primary sedimentation i.e. = 210 × 0.30 = 63 mg/lt

So, Remaining BOD = (210 – 63) = 147 mg/lt

Percent of BOD removal required

$$= (147 - 30) \times \frac{100}{147} = 80\%$$

BOD load applied to the filter

= flow × concent of sewage (kg/day)

$$= 6 \times 10^6 \times \frac{147}{10^6} = 882 \text{ kg/day}$$

To find out filter volume, using NRC equation.

$$E_2 = \frac{100}{1+0.44\sqrt{\left(\frac{F_{1BOD}}{V_1 \cdot R_{F_1}}\right)}}$$

$$80 = \frac{100}{1+0.44\sqrt{\left(\frac{882}{V_1}\right)}}$$

$V_1 = 2704 \text{ m}^3$

Depth of filter = 1.5 m,

$$\text{Filter Area} = \frac{2704}{1.5} = 1802.66 \text{ m}^2$$

Diameter = 48m < 60 m

$$\text{Hydraulic loading Rate} = \frac{6\times10^6}{10^3} \times \frac{1}{1802.66}$$

$$= 3.33 \frac{\text{m}^3}{\text{day.m}^2} < 4$$

$$\text{Organic-loading rate} = 882\times\frac{1000}{2704} = 326.18 \frac{\text{gm}}{\text{dm}^3} \simeq 320 \text{ g/d/m}^3$$

38. Estimation of storm water discharge drain of separate system.

Overall runoff coefficient

$$C = \frac{A_1C_1 + A_2C_2 + A_3C_3 + ... + A_nC_n}{A_1 + A_2 + A_3 + ... + A_n}$$

$$C = \frac{\{(0.15\times0.90)+(0.15\times0.80)+(0.25\times0.15) +(0.20\times0.40)+(0.15\times0.1)+(0.10\times0.50)\}}{0.15+0.15+0.25+0.20+0.15+0.10}$$

C = 0.44

Therefore quantity of storm water,

$$Q = \frac{C.I.A.}{360}$$

$$Q = \frac{0.44\times30\times300}{360} = 11 \text{ m}^3/\text{sec}$$

Estimation of sewage discharge for sanitary sewer of separate system

Quantity of Sanitary sewage

= 300 × 350 × 200 × 0.80

= 16800 m^3/day = 0.194 m^3/sec

Considering peak-factor of 2, the design discharge for sanitary sewers = 0.194 × 2 = 0.389 m^3/sec.

Estimation of discharge for partially separate system.

Storm water discharge falling on roofs and paved courtyards will be added to the sanitary sewer. The quantity can be estimated as :

Average coefficient of Runoff

$$= \frac{\{(0.90\times15)+(0.80\times15)\}}{30} = 0.85$$

$$\text{Discharge} = \frac{0.85\times30\times90}{360} = 6.375 \text{ m}^3/\text{sec}$$

Therefore total discharge in the sanitary sewer of partially separate system

= 6.375 + 0.389 = 6.764 m^3/sec

and the discharge in storm water drains

= 11 – 6.375 = 4.625 m^3/sec

39. The various types of linings can be grouped into two categories :-

(a) Exposed and Hard Surface Lining

(b) Buried Membrane Lining

(a) Exposed and Hard Surface Lining

Exposed linings include all linings exposed to wear, erosion and deterioration effect of the flowing water, operation and maintenance equipments and other hazards. Such linings are constructed across of cement concretes and mortars, ashphaltic materials, bricks, stones and exposed membranes. This lining includes :

(i) Cement Concrete

The in-situ concrete lining is one of the most conventional type of lining which has successfully been used in India and other parts of the world. It is more preferable than any other lining where channel is to carry high velocity water because of it's greater resistance to erosion. Velocities upto 2.5 m/s are generally considered permissible.

(ii) Shot Crete Spacing

In this type of lining cement mortar is applied by pneumatic pressure. The lining may be considered with or without reinforcement. Although reinforcement (in the form of mesh or expanded metal), when laid over earth subgrade, it increases it's useful life.

(iii) Soil-cement :

Asphaltic concrete has greater ability to withstand changes in the subgrade. This lining can be used for repairing cement concrete lining. It is not weather resistant.

(iv) Brick-lining :

This type of lining has been extensively used in india and elsewhere. This lining is economical where aggregates for concrete lining are not available.

In addition to these linings, exposed and hard surface lining also include Earth lining, Asphaltic-concrete lining etc.

(b) Buried Membrane Lining :

Hot asphaltic lining, prefabricated asphalt materials, plastic film and a layer of bentonite and other types of clays protected by earth or gravel cover are cheap linings. These linings can be provided immediately after completion of excavation or even later.

Consideration for Selection :

Type of subgrade, position of water table, climatic conditions, availability of materials, size of canal, service requirements and experience are the major factors affecting the economy and selection of suitable lining material.

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