DETAILS EXPLANATIONS

CE : Paper-2 (Paper-2) [Full Syllabus]

[PART : A]

1. Specific speed of kaplan turbine is less than propeller turbine.

2. It can be used when surface tension forces are predominant along with inertia forces.

3. Mach-number $= \frac{V}{C}$

Mach-number $= \frac{800}{1200} = 0.67$

4. It is based on the principle of conservation of kinetic head into pressure-head.

5. It is the device to measure total distance by adjusting the length of pace of a person with total number of paces.

6. L.C. $= \frac{S}{n} = \frac{10'}{60} = 10''$

$\frac{10}{60} = \frac{10}{n} \Rightarrow n = 60$

Take 59 divisions and divide it into 60 parts.

7. The cross-hairs designed to give a definite line of sight. Consists of a vertical and a horizontal hair held in a flat metal ring called 'Reticule'.

8. With the right eye in postion at the eye-piece, sight the prism-mirror with the left eye. Swing the mirror untill the bubble appears to be evenly situated to the centre line.

9. A telescope is said to be normal or direct when the face of the vertical-circle is to the left and the bubble up.

10. Length of transition-curve on plain-terrain:

$$L = \frac{2.7V^2}{R} = \frac{2.7 \times 75^2}{200} = 75.93 \text{ m}$$

11. $K = 6.5 \text{ kg/cm}^3$

When $a = 75$ cm

$$K' = \frac{6.5 \times 75}{30} = 16.25 \text{ kg/cm}^3$$

12. The briquettes are tested in a tension testing machine. Cross sectional area of central portion is 38 mm × 38 mm, (1444 mm^2 or 14.44 cm^2).

13. Calcination is the heating of limestone to redness in contact with air.

14. These are mounted on the platforms or screeds, they are used to finish concrete surface, such as bridge floor, road, slabs, station platform etc.

15. Threshold odor number (TON), is the ratio of final volume at which odor is hardly detectable and sample volume.

16. When inversion layer exist above the emmission-source as well as below the source. Naturally the emitted plume will neither go up nor down.

17. Water present in the soil may be classified under three heads:

(i) Hygroscopic-water

(ii) Capillary water

(iv) Gravitational-water

18. It means that the Direct Runoff Hydrograph for a given effective Rainfall in a catchment is always the same irrespective of when it occures.

19. Relative stability : (S)

$$S = 100[1 - (0.794)^{t_{20}}]$$

$$S = 100[1 - (0.630)^{t_{37}}]$$

where, t_{20} = Time in days at 20°C.

t_{37} = Time in days at 37°C.

20. In hardness test, a scratch is made on brick surface with the help of a finger nail.

21. ***Working From Whole to Part :***

It is very essential to establish first a system of control points and to fix them with higher precision. Minor control points can be establish by less precise methods and the details can be located using these minor control points. By using this method prevention of accumulation of errors can be done.

22. Hypotenusal allowance

$$= 100\ (\sec\theta - 1)$$

$$= 100\ (\sec 10^\circ - 1)$$

$$= 1.54 \text{ links}$$

$$1 \text{ link} = 20 \text{ cm} = 0.20 \text{ m}$$

∴ Hypotenusal allowance

$$= 0.20 \times 1.54 = 0.3080$$

$$= 0.31 \text{ m}$$

23. If the vertical circle verniers do not read zero when line of sight is horizontal, the vertical angles measured will be incorrect. The error is known as the Index-error and can be eliminated either by applying index-correction or by taking both face observations.

24. Discharge

$$Q = \frac{2}{3}C_d\sqrt{2g}\ L_eH^{3/2}$$

$$= 1.84\ L_eH^{3/2} \text{ (For long rectangular weir)}$$

$$L_e = (L - 0.1\ nH)$$

$$= (14 - 0.1 \times 2 \times 0.52) = 13.896 \text{ m}$$

$$\therefore \quad Q = 1.84 \times 13.896 \times (0.52)^{3/2}$$

$$Q = 9.58 \text{ m}^3\text{/sec}$$

25. In the wet process, the limestone brought from the quarries is first crushed to smaller fragments. Then it is taken to a ball or tube mill where it is mixed with clay or shale as the case may be and ground to a fine consistency of slurry with addition of water. The slurry is stored in tank under constant agitation and fed into huge firebrick lined rotary kilns.

26. The momentum thickness is given by :-

$$\theta = \int_0^\delta \frac{u}{U}\left(1-\frac{u}{U}\right)dy = \int_0^\delta \frac{y}{\delta}\left(1-\frac{y}{\delta}\right)dy$$

$$\theta = \int_0^\delta \left(\frac{y}{\delta}-\frac{y^2}{\delta^2}\right)dy = \frac{1}{\delta^2}\int_0^\delta (y\delta - y^2)dy$$

$$\theta = \frac{1}{\delta^2}\left[\frac{\delta y^2}{2}-\frac{y^3}{3}\right]_0^\delta = \frac{1}{\delta^2}\left[\frac{\delta^3}{2}-\frac{\delta^3}{3}\right]$$

θ

27. ***Uses of Mortar :***

(i) To bind the building units such as bricks, stones.

(ii) To form an even and soft bedding layer for building units.

(iii) To form joints of pipes.

(iv) To hide the open joints of brickwork and stone work.

(v) To Improve the general appearance of structure.

28. $\because \quad V_1(100 - P_1) = V_2(100 - P_2)$

$$\Rightarrow \quad \frac{V_1}{V_2} = \frac{100-P_2}{100-P_1}$$

$$\Rightarrow \quad \frac{V_1}{V_2} = \frac{100-99}{100-96}$$

$$= \frac{1}{4} = 0.25$$

$\therefore$ Volume Reduction $\left(\frac{V_2 - V_1}{V_2}\right) \times 100\% = (1 - 0.25) \times 100\%$

$= 75\%$

29. ***COD (Chemical Oxygen Demand) Includes Oxygen Demand of :***

(i) Biodegradable organic matter.

(ii) Inorganic matter that can be oxidized easily.

(iii) BOD_5/COD ratio greater than 0.63 denotes biodegradability of water.

(iv) Nitrate concentrations above 45 mg/lt may cause methaemoglobinaemia or blue baby disease.

30. $d_{max} = 11\ RS_o$

Where, $R = \frac{B.y}{B+2y} \simeq y$ For wide channels

$d_{max} = 11 \times (0.8) \times 0.0041$ $B >> y$

$= 0.036\ m = 36\ mm$ $(B + 2y) \simeq B$

31. The equilibrium – discharge of S-Curve

$$q_s = \frac{A}{D} \times 10^4 \ m^3/hr$$

where A → Catchment area (km^2)

D → Duration in hours

$$q_s = \frac{270}{3} \times 10^4 = 90 \times 10^4 \ m^3/hour$$

$$q_s = \frac{90 \times 10^4}{3600} = 250 \ m^3/sec$$

32. Maximum probable flood (MPF) differs from the standard project flood (SPF) in that it includes the extremely rare and catastrophic floods and is usually confined to spillway design of very high dams. The SPF is generally around 80% of the MPF for the basin.

33. ***Non Destructive Testing :***

It is an indirect method in which specimen are not loaded to failure and as such the strength inferred or estimated can not be expected to yield absolute values of strength. These methods therefore, attempt to measure some other properties of concrete from which an estimate of it's strength, durability and elastic parameters are obtained.

Though non-destructive testing methods are relatively simple to perform, the analysis and interpretation of test results are not so easy. Therefore special knowledge is required to analyse the properties of hardened concrete.

Some of the non destructive test methods are :

(1) Surface hardness test
(2) Rebound hammer test
(3) Penetration and pull-out techniques
(4) Dynamic or vibration tests
(5) Combined methods
(6) Radioactive and nuclear methods
(7) Magnetic and electrical methods
(8) Acoustics emmission techniques

Fibre Reinforced Concrete :

Plain concrete possesses a very low tensile strength, limit ductility and little resistance to crackling.

Internal microcracks are inherently present in the concrete and it's poor tensile strength is due to the propagation of such micro-cracks, eventually leading to brittle fracture of concrete.

It has been recognised that the admission of small, closely spaced and uniformly dispersed fibres to concrete would act as Crack arrester and would substantially improve it's static and dynamic properties. This type of concrete is known as 'fibre-reinforced concrete.'

Fibre reinforced concrete can be defined as a composite material consisting of mixture of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibres. Continuous meshes, woven fabrics and long wires or rods are not considered to be discrete fibres. The fibres can be imagined as an aggregate with an extreme deviation in shape from the rounded smooth aggregate. The fibres interlock and intengle around aggregate particles and considerably reduce the workability, while the mix becomes more cohesive and less prone to segregation. The fibres suitable for reinforcing the concrete have been produced from steel, glass and origanic polymers.

34. ***Specimen Number-1 :***

The load penetration curve for specimen number-1 is consistently convex throughout and needs no correction.

Load-dial reading at 2.5 mm penetration = 34 division.

So, load at 2.5 mm penetration = $\frac{34 \times 190}{100}$ = 64.6 kg

CBR-value at 2.5 mm penetration = $\frac{64.6 \times 100}{1370}$ = 4.7%

CBR-value at 5.00 mm penetration = $\frac{48 \times 190 \times 100}{100 \times 2055}$ = 4.4%

So, CBR-value of sample 1 = 4.7%

Specimen Number-2 :

CBR-value at 2.5 mm penetration = $\frac{32.5 \times 190 \times 100}{100 \times 1370}$ = 4.5%

CBR-value at 5.0 mm penetration = $\frac{47 \times 190}{2055}$ = 4.3%

So, CRB-value of specimen 2 = 4.5%

Therefore mean CBR-Value = $\frac{4.7 + 4.5}{2}$ = 4.6%

35. ***Traffic-Capacity Studies :***

Before studying details of traffic capacity, it may be worthwhile to know the names of related terms :

(1) Traffic Volume $\rightarrow$ Vehicles per unit time.

(2) Traffic-Density $\rightarrow$ Vehicles per unit length.

Traffic capacity is the ability of a roadway to accomodate traffic volume. It is expressed as the maximum number of vehicles in a lane or a road that can pass a given point in unit time, usually an hour i.e., vehicles per hour/lane or road way. Capacity and volume are measures of traffic flow and have the same units. The capacity of a roadway depends on a number of prevailing roadway and traffic conditions.

(a) Basic capacity is the maximum number of passanger cars that can pass a given point on a lane or roadway during one hour under the most nearly ideal roadway and traffic condition which can possibly be attained. Two roads having the same physical features will have the same basic capacity ir-respective of traffic conditions, as they are assumed to be ideal. Thus basic capacity is the theoritical capacity.

(b) Possible capacity is the maximum number of vehicles that can pass given point on a lane or roadway during one hour under prevailing roadway and traffic conditions. The possible capacity of a road is generally much lower than the basic-capacity as the prevailing roadway and traffic conditions are seldom ideal. In a worst case, when the prevailing traffic condition is so bad that due to traffic congestion, the traffic may come to a stand still, the possible capacity of the road may approach zero.

(c) Practical Capacity is the maximum number of vehicle that can pass a given point on a lane or roadway during one hour, without traffic density being so great as to cause unreasonable delay.

36. Depth of tank = 4.0 m (given)

Out of this depth 0.6 m can be assumed as free board

Thuse, effective depth of tank

$$= 4 - 0.6 = 3.4 \text{ m} = H$$

Length of tank = 70 m

Flow velocity = 1.22 cm/sec

Specific gravity of solids = 2.65

Temperature T = 25^{o}C

Kinematic viscosity η = 0.01 cm^2/sec

Let the size of particle be 'd' and settling velocity $V_{s.}$

We know that for a particle to be removed in the settling tank, it must satisfy the relation :

$$\frac{V}{V_S} = \frac{L}{H}$$

$$V_s = \frac{VH}{L}$$

$$V_s = 1.22 \times \frac{3.4}{70} = 0.0593 \text{ cm/sec}$$

But settling-velocity V_S as per stoke's equation is

$$V_s = \frac{g}{18}(S_S - 1)\frac{d^2}{\eta} \quad \text{...for } d < 0.1 \text{ mm}$$

and $$V_s = 418(S_S - 1)\, d^2\left(\frac{3T+70}{100}\right) \text{...for } d < 0.1 \text{ mm}$$

$$\therefore \quad V_s = \frac{981}{18}(2.65-1)\frac{d^2}{0.01} = 0.0593$$

$$\Rightarrow \quad 0.0593 \times 18 \times 0.01 = 981 \times 1.65 \times d^2$$

$$\Rightarrow \quad d = 0.00256 \text{ cm} = 0.0256 \text{ mm}$$

also $$V_s = 418(2.65 - 1)\, d^2\left[\frac{(3\times 25)+70}{100}\right]$$

$$\Rightarrow \quad d^2 = \frac{0.0593\times 100}{418\times 1.65\times 145}$$

$$d = 0.077 \text{ mm} < (0.1 \text{ mm})$$

So, particle size = 0.0256 mm

Check against the scour of deposited particles :

$$V_d = \sqrt{\frac{8\beta}{f'}(S_S - 1)gd}$$

$$\beta = 0.04 \text{ for unigranular sand}$$

f' = 0.03 for settling tank

$$V_d = \sqrt{\frac{8\times 0.04}{0.03}\left[981\times(2.65-1)\times 0.0024\right]}$$

$= 6.44$ cm/sec > 1.22 cm/s

37. Since no two faces are parallel, the solid is not a prismoid and hence prismoidal formula will not be applicable. The total volume will be the sum of the vertical truncated prisms appearing in plan as ABCD, ABFE, DCGH, BCGF and ADHE.

The depth h at the centre = $\frac{5+8}{2}$ = 6.5 m.

The side widths w_1 and w_2 can be calculated from the formula

$$w_1 = \frac{b}{2} + \frac{m\times n}{m-n}\left(h+\frac{b}{2m}\right)$$

$$= \frac{30}{2}+\frac{10\times 1.5}{10-1.5}\left(6.5+\frac{30}{2\times 10}\right) = 15 + 14.1$$

Horizontal breadth of the slope to the right of DC = 14.1 m

Similarly,

$$w_2 = \frac{b}{2} + \frac{mn}{m+n}\left(h-\frac{b}{2m}\right)$$

$$= \frac{30}{2}+\frac{10\times 1.5}{10+1.5}\left(6.5-\frac{30}{2\times 10}\right)$$

$= 15 + 6.520$

$\therefore$ Horizontal breadth of the slope to the left of BA = 6.520

Prism ABCD :

Area = 30 × 20 = 600 m^2

Average height

$$= \frac{1}{4}(5+5+8+8) = 6.5 \text{ m}$$

Volume = 600 × 6.5 = 3900 m^3

Prism ABEF :

Area = (20 + 6.52) 6.52 = 172.9 m^2

Average height

$$= \frac{1}{4}(0+0+5+5) = 2.5 \text{ m}$$

Volume = 172.9 × 2.5 = 432.2 m^3

Prism CDGH :

Area = (20 + 14.1) × 14.1 = 480.8 m^2

$$\text{Average height} = \frac{1}{4}(0+0+8+8) = 4 \text{ m}$$

Volume = 480.8 × 4 = 1923.2 m^3

Prism ADHE and BCGH :

$$\text{Area} = 2\left[(30+14.1+6.52)\left(\frac{14.1+6.52}{2}\right)-\frac{14.1^2}{2}-\frac{6.52^2}{2}\right]$$

$$= 2\ (521.9 - 99.5 - 21.2) = 802.4 \text{ m}^2$$

Average height

$$= \frac{1}{4}(0+0+5+8) = 3.25 \text{ m}$$

Volume = 802.4 × 3.25 = 2607.8 m^3

∴ Total volume

= 3900 + 432.2 + 1923.2 + 2607.8

= 8863.2 m^3

38. The evaporation losses from water surface depend upon the following factors :

(1) Vapour pressure or humidity :

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

$$E_L \propto (e_w - e_a)$$

The above equation is known as dalton's law, where E_L = Rate of evaporation (mm/day) and C = constant, e_w and e_a are in mm of mercury.

(2) Temperature :

If the temperature is more, the saturation vapour pressure increases and the evaporation increases.

(3) Wind :

Wind removing the evaporated water from the zone of evaporation and consequently create greater scope for evaporation.

(4) Atmospheric-Pressure :

If the atmospheric pressure is more, naturally there will be lesser evaporation (Dalton's law) at high altitudes, the atmospheric pressure is less and hence the evaporation should be higher.

(5) Quality of Water :

The quality of water in the water body also affects the rate of evaporation, since the present dissolved salts in water reduces the saturated vapour pressure of water, which consequently reduce the rate of evaporation.

(6) Area of Water Surface :

Increasing the water surface area the contact of surface is more consequently the evaporation is more.

(7) Depth of Water :

By increasing the depth of waterbody evaporation decreases.

The rate of evaporation can be determined by the following method :

Water Budget Method :

This method involves writing the hydrological continuity equation for the lake and determining the evaporation from a knowledge or estimation of other variables. The continuity equation is written as:

$$P + V_{is} + V_{ig} = V_{os} + V_{og} + E_L + \Delta S + T_L$$

where, P = Daily precipitation

V_{is} = Daily surface inflow into the lake

V_{ig} = Daily ground water inflow

V_{os} = Daily surface outflow from the lake

V_{og} = Daily seepage outflow

E_L = Daily lake evaporation

ΔS = Increase in lake storage in a day

T_L = Daily transpirational loss

39. The optical principles of the surveying telescope are based on the fact that all parallel rays of light reaching a convex lens are bent when they leave it in such a manner that they intersect at a common point, called the focus and that all the rays passing through another point called the optical-center, pass through the geometrical center of lens without bending.

The surveyor's telescope is an adaptation of kepler's telescope which employ to convex lenses, the one nearest to the object is called the objective and the other near the eye is called the 'eye-piece'.

The object glass provides a real inverted image in front of the eye-piece which, inturn, magnifies the image to produce an inverted virtual image.

The line of sight or line of collimation is a line which passes through the optical center of the objective and the intersection of cross hairs. The axis of the telescope is the line which passes through the optical centers of objective and Eye-piece the cross hairs are placed infront of eye-piece and in the plane where the rear inverted image is produced by the objective. Thus, the eyepiece magnifies. the cross hairs also.

The distance from the objective of the image formed by it is connected with the distance of the object by the relation :

$$\frac{1}{V}+\frac{1}{U} = \frac{1}{f}$$

where, U = Distance of object from optical center

V = Distance of image from optical center

f = Focal length of objective

Focusing : For quantitative measurements, it is essential that the image should always be formed in the fixed plane in the telescope where the cross hairs are situated, the operation of forming or bringing the clear image of the object in the plane of cross hairs is known as focusing.

Complete focusing involves two steps :

(i) Focusing the eye-piece

(ii) Focusing the objective

❍❍❍