DETAILS EXPLANATIONS

CE : Paper-2 (Paper-8) [Full Syllabus]

[PART : A]

1. It is the angular deviation of any object from magnetic north direction.

2. Peg interval is the fixed distance (usually one chain) which is used in locating a curves.

3. Delta is the quantity of water required for any crop to come to it's maturity measured in terms of depth.

4. **P.** $45^{o}30'30''$ → **2.** N$45^{o}30'30''$E
Q. $145^{o}0'30''$ → **4.** S$34^{o}59'30''$E
R. $245^{o}30'0''$ → **3.** S$65^{o}30'$W
S. $345^{o}0'0''$ → **1.** N15^{o}W

5. For fecilitating drainage of rainwater.

6. Tar is a viscous black liquid which is artificaially distilled whether Bitumen can be naturally occuring.

7. ***Sir Able's Method :***
The timber surface is cleaned and coated with dilute solution of sodium silicate, then cream like paste of staked fat lime is then appled.

8. ***Area-Velocity Method :*** Velocity is measured either by current meter or by floating boat method and consequently area is calculated.

9. To reduce uplift force in dam-foundation.

10. It is the measurement of the initial static stability of a floating body.

11.
$$\text{M.B.} = 178^{o}$$
$$\text{T.B.} = 180^{o}$$
$$\text{T.B.} = \text{MB} \pm \text{MD}$$
$$\text{MD} = 2^{o}\text{E}$$

12.
$$\frac{\text{Weight of water}}{\text{Weight of cement}} = 0.45$$

$$\therefore \text{ Weight of cement} = \frac{40}{0.45} = 88.89 \text{ kg}$$

For M20 1 : 1.5 : 3

Wt. of sand $\Rightarrow 88.89 \times 1.5 = 133.33$ kg

13. It is portion of stream flow that is sustained between precipitation events.

14. It is the discharge having maximum value following the precipitation.

15. Cofficient of runoff is the percentage of percipitation that appears as runoff.

16. It should faulfill the health parameter requirements agricultureal requirements and should be with the permissible limits of all parameter.

17. It is the section which gives maximum discharge for a given c/s area.

18.
- Hand Rail
- Rise
- Riser
- Tread
- Nosing etc.

19. Vent pipes are installed in any building for excertion of foul gases.

20.
- Igneous rocks
- Sedimentary rocks
- Metamorphic rocks

[PART : B]

21. ***For Plain CC slab :***

We know; unit weight of cc-plain = 24 kN/m^3

∴ Spacing between contraction joints :

$$L_c = \frac{2s_c}{wf}\times 10^4 = \frac{2\times 0.8\times 10^4}{2400\times 1.5} = 4.44 \text{ mm}$$

For Reinforced cement concrete slab :

Total cross rectional area of steel. A_s in one direction along the slab width.

$$A_s = \frac{3.5\times\pi\times 1.0^2}{0.3\times 4} = 9.16 \text{ cm}^2$$

$$\text{Spacing} \Rightarrow \frac{200 s_s A_s}{b h w f} = \frac{200\times 1200\times 9.16}{3.5\times 20\times 2400\times 1.5} = 8.72 \text{ m}$$

22. It should be the highest of the following :
- Find the length of transition curve based on allowable rate of change of centrifugal-acceleration.
- Based on rate of change of super-elevation.
- That based on empirical formulas.

23. Calculation of instrumental constants :

M = Length of tracing arm × It's Circumpherence

$$M = 4.09 \times 2.5 = 10.225 \text{ m}^2$$

$$\text{Area of zero-circle} = \pi(L^2 + 2L.a + R^2)$$
$$= \pi(4.09^2 + 2 \times 4.09 \times 1.22 + 6.28^2)$$

$$M = 208 \text{ m}^2$$

Now $$A = M(F - I \pm 10I + C)$$
$$= M(F - I \pm 10N) + MC$$
$$= 10.225(8.215 - 2.286 - 20) + 208$$
$$= -143.88 + 208 = 64.12 \text{ square-inch}$$

24. From sag equation :

$$h = \frac{wl_1d_1}{8P} = 20.35 \text{ cm(given)}$$

Taking $l_1 = d_1$(approximately), we get

$$h = \frac{wl_1^2}{8P}$$

$$w = \frac{8ph}{l_1^2} = \frac{8\times100}{20\times20} = \frac{20.35}{100} \text{ N/m}$$

$$w = 0.407 \text{ N/m}$$

25. Echo sounder is an instrument which records the depth of water electronically. It consists of a transmitter and a receiver. The instrument is kept at the water surface. The transmitter emits an impulse (pressure) wave which travels to the river bed and is reflected back as an echo and caught by the receiver. The time interval between the starting of the impulse and receiving back of the echo is converted into the depth of water from the velocity of sound in water (1470 m/s).

26. ***Following factors should be considered :***

- Consideration of Inertia forces.
- Graded filter at down stream of core.
- Graded filter at upstream of core.
- Highly pervious downstream shell.
- Extra free board.
- Thick-core
- Larger section near top.

27. For equation of consumptive use :

$$C_u = K\Sigma\frac{P}{40}(1.8T+32)$$

or $$C_u = \frac{0.60}{40}[7.75(1.8 \times 20 + 32) + 7.88(1.80 \times 15 + 32) + 7.94(1.80 \times 15 + 32) + 7.36(1.8 \times 16 + 32)]$$

$$C_u = \frac{0.60}{40}[527+507.47+468.46+447.49]$$

$$C_u = 29.26 \text{ cm}$$

28. ***Water soluble (Leachable) type preservative :***

These preservatives are inorganic or organics salts seluble in water. Some of these are zince chloride, boricacid and borax, sodium fluoride, sodium pentachloroare non-reeping, non-staining, and non-inflammable. Timber treated with such preservatives can be painted or varnished when dry. But these are subject to leaching, hence not satisfactory for esxternal use.

29. ***Pozzolanic action :*** A pozzolana is a finely ground silicious material which as such does not possess cementitious property in itself but reacts in the presence of water with calcium hydroxide at normal temperature to form compounds of low solubility having cementitious properties. The action is known as pozzolanic action.

Pozzlana + $Ca(OH)_2$ + H_2O $\rightarrow$ C-S-H(gel)

30. Alkalis are mainly in the form of soda and potash. The alkalis act as a flux in the kiln during buring and they cause bricks to fuse, twist and warp. As a result the bricks are melted and they loose their shape. Further, the alkalies remaining in bricks will absorb moisture from the atmosphere, when bricks are used in masonry. Such moisture when evaporated, leaves behind grey or white deposits on the wall-surface. The appearance of the building as a whole is then seriously spoiled.

31. Given, weight density, $w = 16\ N/m^3$

Temperature, $T = 25^oC$

$T = 25 + 273 = 298^oK$

Pressure $\Rightarrow$ $P = 0.25\ N/mm^2 = 25 \times 10^4\ N/m^2$

(i) Using relation $w = \rho g$; density is obtained :

$$\rho = \frac{w}{g} = \frac{16}{9.81} = 1.63\ kg/m^3$$

(ii) $$\frac{p}{\rho} = RT$$

$$R = \frac{p}{\rho T} = \frac{25 \times 10^4}{1.63 \times 298}$$

$$= 616.85\ N\text{-}m/kg.k$$

32. Diameter of cylinder = 15 cm

$\therefore$ Radius = 7.5 cm

Length of cylinder = 100 cm

Initial height of water = 70 cm

When axial depth is zero, the depth of paraboloid = 100 cm

Using the relation, $Z = \frac{\omega^2 R^2}{2g}$

We get, $100 = \frac{\omega^2 \times 7.5^2}{2 \times 9.81}$

$\Rightarrow$ $\omega = \sqrt{\frac{100 \times 2 \times 981}{7.5 \times 7.5}}$

$\omega = 59.05$ rad/sec

$\therefore$ Speed N given by :

$$\omega = \frac{2\pi N}{60}$$

$$N = \frac{60\omega}{2\pi} = \frac{60 \times 59.05}{2\pi}$$

$$N = 563.88 \text{ rpm}$$

[PART : C]

33. Given, Length of pipe, L = 2000 m

Lower transmitted = 110.3625 kW

Pressure at inlet P = 490.5 N/cm^2

$= 490.5 \times 10^4$ N/m^2

$\therefore$ Pressure head at inlet,

$$H = \frac{P}{pg} = \frac{490.5 \times 10^4}{1000 \times 9.81} = 500 \text{ m}$$

Pressure drop = 98.1 N/cm^2

$= 98.1 \times 10^4$ m^2

$\therefore$ Loss of head $h_f = \frac{98.1 \times 10^4}{Pg} = \frac{98.1 \times 10^4}{1000 \times 9.81} = 100$ m

Co-efficient of friction, f = 0.0065

Head available at the end of the pipe

$= H - h_f = 500 - 100 = 400$ m

Let the diameter of the pipe = d

Now power transmitted is given by,

$$P = \frac{Pg \times Q \times (H - h_f)}{1000} \text{kW}$$

or $110.3625 = \frac{1000 \times 9.81 \times Q \times 400}{1000}$

$$\theta = \frac{110.3625 \times 1000}{1000 \times 9.81 \times 400} = 0.02812$$

But discharge, $Q = \text{Area} \times \text{Velocity} = \frac{\pi}{4} d^2 \times v$

$$\therefore \quad \frac{\pi}{4} d^2 \times v = 0.02812$$

$$\therefore \quad \dot{V} = \frac{0.2812 \times 4}{\pi d^2} = \frac{0.0358}{d^2}$$

The head lost due to friction,

$$h_f = \frac{4f \times L \times V^2}{d \times 2g}$$

But $h_f = 100$ m

$$100 = \frac{4 \times f \times L \times V^2}{d \times 2g}$$

$$= \frac{4 \times 0.0065 \times 2000 \times V^2}{d \times 2 \times 9.81}$$

$$= \frac{2.65 \times V^2}{d} = \frac{2.65}{d} \times \left(\frac{0.0358}{d^2}\right)^2$$

$$= \frac{0.003396}{d^5}$$

From equation $V = \dfrac{0.0358}{d^2}$

$$100 = \frac{0.003396}{d^5}$$

or $d = \left(\dfrac{0.003396}{100}\right)^{1/5} = 0.1277$ m

$$d = 127.7 \text{ mm}$$

Efficiency of power transmission is given by equation

$$\eta = \frac{H - h_f}{H} = \frac{500 - 100}{500}$$

$$= 0.80 = 80\%$$

34. ***As per IS : 1077 - 1992 cod*** Bricks are classified on the basis of minimum compressive strength which has been kept at 3.5 MPa. Each class of rbicks which have beemn already divided based on compressive strength shall further be divided into subclasses A, B etc.

The properties which are associated with the classification are:

- ***General Quality of Bricks :*** Bricks having smoth rectangular faces and shape corners and emitting a clear ringing sound when struck against each other are classified under subclass A. Bricks having a slight distorition and round edges, provided no difficulty arease on the accorent in laying of uniform course have been classified under subclass B.

- ***Dimensions and Tolerance :*** According to IS : 1077-1992 the standard size of common building bricks is as follows :
  19 cm × 9 cm × 9 cm
  19 cm × 9 cm × 4 cm
  The dimension of bricks when tested by stacking 20 bricks should be within the limits specified by IS : 1077 : 1992.
- ***Water Absorption of Bricks :*** When tested in arrordance with the procedure laid down in IS : 3495-1992, after immersion in cold water for 24 hours the average water absorption of common building bricks should not be mare than 20% by weight upto class 125 and 15% by weight for higher classes.
- ***Efflorescence :*** According to IS : 3495 - 1992 the ratting efflorescence should not be more than moderate upto class 12.5 MPa and slight for higher classes.
- ***Strength of Bricks :*** As per IS : 1077 - 1992 common building bricks should have a minimum strength of 3.5 MPa. Also, the compressive strength of any individual brick should not fall below the average compressive strength specified for the corresponding class of bricks by more than 20%.

35. ***Non-Destructive Tests of Concrete :***

Non-destructive tests of concrete is an indirect method in which speciman are not loaded to failure and as such the strength inferred or estirmated cannot be expected to yield absolute values of strength. These methods therefore attempt to measure some other properties of concrete from which an estimate of its strength, durability and elastic barameters are obtained. Some such properties of concrete are hardness, resistance to penetration of projectiles, rebound member, resonant frequency and ability to allow ultrasonic pulse velocity to propagate through it.

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 angles the properties of hardness concrete.

Some of the non-destructive test methods are :

- Surface hardness tests
- Rebound tests
- Penetration and pull out techniques.
- Dynamic or vibration tests
- Combined methods
- Radioactive and nuclear methods
- Magnetic and electrical methods
- Acoistics emission techniques

Dynamic or Vibration Method : This is an important method used is testing concrete strength and other properties. The fundamental principle on which the dynamic or vibration methods are based is velocity of sound through a material. A mathematical relationship could be established between the velocity of sound through specimen and its resonant frequency and the relationship of tese two to the modulus of elasticity of the same material. The relationships which are derived for solid mediums considered to be homogeneous, isotropic and perfectly elastic, but they may be applied to neterogeneous material like concrete.

Fiber Reinforcement Concrete :

Plain concrete passesses a very low tensile strength, limited ductility and little resistance to cracking. Internal imicrocraks are inherently bresent in the concrete and its poor tensile strength is due to the propagation of such microcrakes, eventually loading to brittle facture of the concrete.

It has been recognised that the admission of small, closely spaced and uniformly dispressed fibres to concrete would act as crack arrester and would substantially improve its static and dynamic properties. This types of concrete is known as fiber reinforced concrete.

Fiber reinforced concrete can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispresed suitable fibers. Continuous meshes, woven fabrics and long wires or roads are not considered to be discrete fibers.

The fibers can be imagnized as an aggregate with an extreme deviation in shape from the rounded smooth aggregate. The fibers interlock and entangle arround aggregate particles and considerably reduce the workability. While the mix becomes more cohesive and less prone to segragation. The fibers suitable for reinforcing the concrete have been produced from steel, glass and organic palymers.

The major factors affecting characteristics of fiber reinforced concrete are water cement ratio, percentage (volume fraction) of fibers, diameter and length of fibers. Fiber reinforced concrete has special application in hydrulic structure, air field and highway pavements, beidge decks, heavy duty floors and tunnel linings.

36. ***Quantity of Run-off :*** Drainage area consists of

- Pavement area

$$= 3.5 \times 400 = 1400 \text{ m}^2 = A_1,$$

with $C_1 = 0.8$

- Area of shoulder and adjoining land

$$= 8 \times 400 = 3200 \text{ m}^2 = A_2,$$

with $C_2 = 0.25$

- Area of land on the other side of the drain

$$= 25 \times 400 = 10000 \text{ m}^2 = A_3$$

with $C_3 = 0.35$

Total drainage area = 1400 + 3200 + 10000 = 14600 m^2

$$A_d = \frac{14600}{1000} = 14.6$$

Weighted value of run-off coefficient

$$C = \frac{A_1C_1 + A_2C_2 + A_3C_3}{A_1 + A_2 + A_3} = 0.371$$

The maximum distance of flow across the land upto longitudinal drain is 25 m along the reserve land with average turf and cross slope 2%. Therefore, inlet time, T_1 from f_{ig} = 11 min.

Time of flow T_2 along longitudinal drain of length 400 m on loamy soil with a speed of 0.8 m/sec $= \frac{400}{0.8 \times 60} = 8.33$ min

Total duration of rain fall

$$= 11.00 + 8.33 = 19.33 \text{ min}$$

From f_{ig} corresponding to 19.33 mim duration and 25 years period, rain fall intensity = 125 mm/hr

$$i = \frac{125}{(60 \times 60)} = 0.0347 \text{ mm/sec}$$

$$\theta = CiA_d = 0.371 \times 0.0347 \times 14.6$$
$$= 0.188 \text{ m}^3\text{/sec}$$

Cross Section :

- Area of cross section of flow in the drain is given as :

$$A = \frac{\theta}{V} = \frac{0.188}{0.8} = 0.235 \text{ m}^2$$

Assuming bottow with of drain as 0.5 m, slope of 1.0 vertical to 1.5 horizontal and depth of flow d, tap width

$$= (0.5 + 3d) \text{ m.}$$

Area of cross section of flow in drain is given by

$$0.235 = (0.5 + 0.5 + 3d)\frac{d}{2} = 0.5d + 1.5d^2$$

i.e., $1.5d^2 + 0.5d - 0.235 = 0$

Solving the quadratic equation,

$$d = \frac{-0.5 \pm \sqrt{0.5^2 - 4 \times 1.5(0.235)}}{2 \times 1.5} = 0.263 \text{ m}$$

Therefore, the average depth of the drain may be taken as 0.40 m, after allowing a free board of about 14 cm.

Slope of Drain :

- When the depth of flow in the trapezoidal drain is 0.263 m, the slope sides of the trapezium is equal to 0.474 m.

  Wetted perimeter = 0.5 + 2 × 0.474 = 1.448 m

$$\frac{\text{Are}}{\text{Wetted perimeter}} = \frac{0.235}{1.448} = 0.162$$

$$V = \frac{R^{2/3}S^{1/2}}{\eta}$$

$$S^{1/2} = V \times \frac{\eta}{R^{2/3}} = \frac{0.8 \times 0.025}{(0.162)^{2/3}} = 0.0672$$

$$S = 0.00452 \text{ or } 1 \text{ in } 221$$

Therefore, provide a longitudinal slope of 1 in 220.

37. ***Inductive Methods :***

Inductive methods are based on the experience and judgement of the irrigation engineer. Generally, standard tables of duties of different crops prepared on board zonal basis are used for the determination of the quantity of water required. However, these m,methods are empirical, as they do not take into account the physical and chemical properties of soils and the climatic conditions. Different inductive methods are prevalent in various states. Broadly speaking, these methods can be subdivided into 3 types.

- Water Allowance method
- Outlet discharge factor method
- Standard duties method

- ***Water Allowance Method*** in this method, a suitable water allowance is fixed for the entire culturable commanded area after considering. The percentage of the cropped area under different crops and their water requirements.

  For example, for the Nangal Hydel channels, the following values of water allowance were adopted.

  (i) Perennial areas 0.168 cumecs per 1000 hectares of CCA (i.e. 5953 ha/cumec)

  (ii) Non-pernnial area 0.213 cmecs per 1000 hectares of CCA (i.e., 4695 ha/ cumec)

  Duties at the head of canal for preparing irrigation projects, sometimes the discharge at the head of the canal is estimated from the duty at the head.

  The following are the typical values for North India.

  Sugarcane and rice = 600 ha/cumec,

  Rabi = 1800 ha/cumec

  and Kharif = 1200 ha/cumec

- ***Outlet Discharge Factor Method :*** the outlet discharge factor is duty of water at the outlet. The outlet discharge factors have been standardised by various agencies for different types of crops. Knowing the irrigated area and the outlet discharge factor, the discharge required in the Kharif and Rabi Seasons are calculated, and the channel is designed for the greater of the two discharges.

- ***Standard Duties Method*** in this method, the discharge required month-wise is calcualted from the standard duties of various crops and the areas irrigated. The channel is then designed for the maximum of discharge in any month.

Consumptive Use Method :

As already discussed, the consumptive use of water for different crops depends mainly on the meterological factors. Therefore, the water requirements for various crops depend on the length of the growth period and the seasonal changes. The nature and type of soil affects only the frequency and depth of irrigation as discussed in chapter. A shollow soil requires more frequent irrigation as compared to a deep soil. However, the total amount of water required for a crop remains practically the same if the methological conditions remains the same. The field irrigation requirements (F.I.R.) are determined from the consumption use and application efficiency, as already discussed.

For each month, the discharge required for different crops is found from the monthly consumptive use and the irrigated are from the relation;

$$\text{Discharge} = \frac{\text{Area to be Irrigated}}{8.64\left(\frac{B}{\Delta}\right)}$$

Where, B is equal to 30 days
and D is the field irrigation
requirement of the crop in that month.

The total discharge required for the month is obtained by adding up the discharges required for different crops. The channel is desigend for the maximum of monthly discharges, after making a suitable allowance for the conveyance efficiency.

38. A brief description of the various pans is given as :

- ***U.S. Class-A Evapotranspiration :***
  This is perhaps the most commonly used evaporation pan. the pan consists of a shollow vessel about 1.21 m in diameter and 25.5 cm deep. The pan is made of unpainted galvenised iron sheet. Where there is corrosion problem, it is made of monel sheet. The water in the pan is filled to a depth of 20 cm. When the depth of water reduces to 18 cm, it is refilled. Water surface level is measured daily. This is placed 15 cm above ground on a wood-plank.
- ***Colorado-Sunkenpan :***
  This type of pan is burried into the ground such that the water level is at the ground level. The pan is 92 cm^2 in plan and 46 cm deep. It is made of unpainted galvanised iron sheet. the main advantage of the sunken pan over class-A evaporation pan is that its radiation and aerodynamics characterstics are closer to those of a reservoir.
- ***U.S. Gelogical Survey Floating Pan :***
  The pan is 90 cm^2 in plan and 45 cm deep. It is supported by drum floats in the middle of a raft of the size 4.25 m × 4.87 m. The pan is set afloat in a lake to simulate the characterstics of a large reservoir. The water level in the pan is kept the same as that of the lake. Diagonal waffles are provided in the pan to reduce waveaction and wash. the pan has the following disadvantages :

(i) The cost of maintainance is high.

(ii) It is difficult and inconvinient to take measurements.

- ***I.S. Standard Pan :***

  IS : 5973-1970 gives the specification of IS : standand pan, which is a modified form of U.S. class-A rvaporation pan. The pan consists of a shallow vessel made of copper sheet of 0.9 mm thickness, tinned inside and painted outside-the pan is 1.22 mm in diameter 25.5 cm in depth. It is installed on a wooden grillage platform 10 cm above the ground surface.

39. ***Observation from A to C :***

$S = 2.425 - 0.765 = 1.66$ mm

Distance $AC = K.S\cos^2\theta = 100 \times 1.66\cos^2 10^o12'$

$= 160.8$ m

$$V = \frac{K.S\sin 2\theta}{2} = \frac{100\times 1.66}{2}\sin 20^o 24$$

$= 29.931$ m

Let the elevation of A = 100.00 m

$\therefore$ R.L. or C = 100 + 1.38 + 28.931 – 1.595

= 128.716 m

Observation from B to D :

Distance $BD = K.S\cos^2\theta = 100 \times 2.04\cos^2 12^o30'$

$= 194.4$ m

$$V = K.S.\frac{\sin 2\theta}{2} = \frac{100\times 2.040}{2}\sin 45^o$$

$= 43.107$ m

R.L. of B = 100 + 6.50 = 106.50 m

R.L. of D = 106.50 + 1.42 – 43.107 – 1.84

= 62.973 m

Length and gradient of CD :

Length of AC = 160.8 m

R.B. of AC = $546^o30'$ w

Hence AC is in the third quadrant.

Latitude of AC = $-160.8\cos 465^o30' = -110.7$

Departure of CA = $-160.8\sin 46^o30' = -116.6$

Length of BD = 194.4 m

R.B. of B.D. = $N84^o45'E$

Hence BD is in the first quadrant

Latitude of BD = $194.4\cos 84^o45' = +17.8$

Departure of BD = $194.4\sin 84^o45' = +193.6$

Now,

Total latitude of A = +212.3	Total departure of A = –186.8
Add latitude of AC = –110.7	Add departure of AC = –116.6
Total latitude of C = +101.6	Total departure of C = –303.4

Similarly,

Total latitude of B = +102.8	Total departure of B = –96.4
Add latitude of BD = +17.8	Add departure of BD = +193.6
Total latitude of D = +120.6	Total departure of D = +97.2

Thes the total co-ordinates of the points C and D are known.

Latitude of line CD

= Total latitude of D – Total latitude of C

= 120.6 – 101.6 = +19.0

And departure of line CD

= TOtal departure of D – Total departure of C

= 97.2 –(–303.4) = +400.6

The line CD is, therefore, in the fourth quadrant.

Length CD = $\sqrt{(19.0)^2 + (400.6)^2}$ = 401.1 m

∴ Gradient of CD = (128.716 – 62.973) ÷ 401.1

= 1 in 6.1 [falling]

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