Bangladesh Water Development Board – 2020

Post: Assistant Engineer (Civil)

Venue : Miscellaneous(Eden college & oters)

Date: 20.11.2020

Exam Taker: BWDB

Total Mark : 70

Written Part (Technical): 10*4= 40 Marks

Mcq Part: 30*1=30 Marks [Technical:15 & Non-Technical:15 (Bangla=5 English=5 GK=5)]

Written Part Technical:

Question: A water course has a culturable commanded area of 1200 hectares. The intensity of irrigation for crop A is 40% and for B is 35%, both the crops being Rabi crops. Crop A has a kor period of 20 days and crop B has kor period of 15 days. Calculate the discharge of the water course if the kor depth for crop A is 10 cm and for B it is 16 cm.

Solution:

(a) For crop A

Area under irrigation = 1200 x 0.40 = 480 hectares

Kor period = b = 20 days

Kor depth, δ = 10 cm = 0.1 m

$$\text{Duty} = \frac{8.64\ b}{\delta} = \frac{8.64 \times 20}{0.1} = 1728 \text{ hectares/cumec}$$

$$\text{Discharged required} = \frac{\text{Area under irrigation}}{\text{Outlet factor}} = \frac{480}{1728} = 0.278 \text{ cumec}$$

(b) For crop B

Area under irrigation = 1200 x 0.35 = 48 = 420 hectares

Kor period = b = 15 days

Kor depth, δ = 16 cm = 0.16 m

$$\text{Duty} = \frac{8.64\ b}{\delta} = \frac{8.64 \times 15}{0.16} = 810 \text{ hectares/cumec}$$

$$\text{Discharged required} = \frac{\text{Area under irrigation}}{\text{Outlet factor}} = \frac{420}{810} = 0.519 \text{ cumec}$$

Design discharge of water course = 0.278 + 0.519 = 0.797 cumec

Question: The Waramurngundi tannery with a wastewater flow of 0.011 m^3/s and a BOD_5 of 590 mg/L discharges into Djanggawul Creek. The creek has a 10 year, 7 day low flow of 1.7 m^3/s. Upstream of the Waramurungundi tannery, the BOD_5 of the creek is 0.6 mg/L. The BOD rate constants (k) are 0.115 day^{-1} for the Waramurungundi tannery and 3.7 day^{-1} for the creek. Calculate the initial ultimate BOD after mixing.

Solution:

Given: Tannery Q_w = 0.011 m^3/s, BOD_5 = 590 mg/L, Creek Q_r = 1.7 m^3/s

BOD_5 upstream of tannery = 0.6 mg/L, $k_{tannery}$ = 0.115 day^{-1}, k_{creek} = 3.7 day^{-1}.

Calculate the ultimate BOD of tannery wastewater

$$BOD_u = \frac{BOD_5}{(1 - e^{-kt})} = \frac{590}{(1 - e^{-0.115 \times 5})} = 1349.2 \text{ mg/L}$$

L_w = 1349.2 mg/L

Calculate the ultimate BOD of Djanggawul Creek

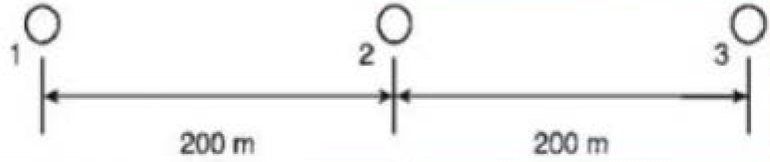
$$BOD_u = \frac{BOD_5}{(1 - e^{-kt})} = \frac{0.6}{(1 - e^{-3.7 \times 5})} = 0.6 \text{ mg/L}$$

L_r = 0.6 mg/L

Calculate the initial ultimate BOD by simple mass balance

$$L_0 = \frac{Q_W L_W + Q_r L_r}{Q_W + Q_r} = \frac{0.011 \times 1349.2 + 1.7 \times 0.6}{0.011 + 1.7} = 9.269 \text{ mg/L}$$

Question: Three pumping wells located along a straight line are spaced at 200 m apart. What should be the steady state pumping rate from each well so that the near steady state drawdown in each well will not exceed 2 m? The transmissibility of the confined aquifer, which all the wells fully penetrate is 2400 m^2/day and all the wells are 40 cm in diameter. The thickness of the aquifer is 40 m and the radius of influence of each well is 800 m.



Solution:

The following information is given in the above problem statement $S_1 \leq 2$ m, $S_2 \leq 2$ m and $S_3 \leq 2$ m, $T = 2400\ m^2/day = 27.8 \times 10^{-3}\ m^2/s$, $r_w = 0.2$ m, $b = 40$ m, $r_0 = 800$ m and $r = 200$ m. Let Q be the pumping rate from each well and h_0 be the head before pumping started. For well I, $S_1 = S_{11} + S_{12} + S_{13}$ where S_{ij} is the drawdown in well i due to pumping in well j. Thus, for the other wells, $S_2 = S_{21} + S_{22} + S_{23}$ and $S_3 = S_{31} + S_{32} + S_{33}$. By symmetry, $S_1 = S_3$. The drawdown in well 1 due to pumping in wells 1,2 and 3 respectively.

$$S_{11} = \frac{Q\ \ln\left(\frac{r_0}{r_w}\right)}{2\,\pi\,T} = \frac{Q\ \ln\left(\frac{800}{0.2}\right)}{2\,\pi \times 27.8 \times 10^{-3}} = 47.78\ Q$$

$$S_{12} = \frac{Q\ \ln\left(\frac{r_0}{r_{12}}\right)}{2\,\pi\,T} = \frac{Q\ \ln\left(\frac{800}{200}\right)}{2\,\pi \times 27.8 \times 10^{-3}} = 7.94\ Q$$

$$S_{13} = \frac{Q\ \ln\left(\frac{r_0}{r_{13}}\right)}{2\,\pi\,T} = \frac{Q\ \ln\left(\frac{800}{400}\right)}{2\,\pi \times 27.8 \times 10^{-3}} = 3.97\ Q$$

The drawdown in wells 1 & 3 are identical so total drawdown in the wells is $S_1 = S_3 = 47.48Q + 7.94Q + 3.97Q = 59.39\ Q$. The drawdown in well 2 due to pumping in wells 1, 2 and 3 are respectively,

$$S_{21} = \frac{Q\ \ln\left(\frac{r_0}{r_{12}}\right)}{2\,\pi\,T} = \frac{Q\ \ln\left(\frac{800}{200}\right)}{2\,\pi \times 27.8 \times 10^{-3}} = 7.94\ Q$$

$$S_{22} = S_{11} = 47.48\ Q$$
$$S_{23} = S_{21} = 7.94\ Q$$

The total drawdown in well 2 is $S_2 = 7.94Q + 47.48Q + 7.94Q = 63.36\ Q$. The relationships for $S_1 = 59.39Q$ and $S_2 = 63.36Q$ show that for the same discharge from all the wells, more drawdown at middle well; so using $S_2 \leq 2$ or $63.36Q \leq 2$, then the steady state pumping rate from each well should be $Q \leq 3.16 \times 10^{-2}\ m^3/s = 113\ m^3/hr$.

Question: Flood frequency computations for river at certain location by using Gumbel's distribution yielded. Peak flood is 40809 m^3/s and 46300 m^3/s for 50 year and 100 year return period respectively. Estimate the design flood magnitude for return period 500 year. Also determine the design scouring depth using Lacy's regime equation if d_{50} of bed material is 0.005 cm.

Solution:

$x_{100} = \bar{x} + K_{100}\,\sigma_{n-1}$ and $x_{50} = \bar{x} + K_{50}\,\sigma_{n-1}$

$(K_{100} - K_{50})\,\sigma_{n-1} = x_{100} - x_{50} = 46300 - 40809 = 5491$

$$But, K_T = \frac{y_T}{S_n} - \frac{\overline{y_n}}{S_n}$$

Where, S_n and $\overline{y_n}$ are constants for the given data series.

$$(y_{100} - y_{50})\frac{\sigma_{n-1}}{S_n} = 5491$$

$$y_{100} = -\left[\ln.\ln\frac{T}{T-1}\right] = -\left[\ln.\ln\frac{100}{100-1}\right] = 4.60015$$

$$y_{50} = -\left[\ln.\ln\frac{T}{T-1}\right] = -\left[\ln.\ln\frac{50}{50-1}\right] = 3.90194$$

$$\frac{\sigma_{n-1}}{S_n} = \frac{5491}{(4.60015 - 3.90194)} = 7864$$

$$y_{500} = -\left[\ln.\ln\frac{T}{T-1}\right] = -\left[\ln.\ln\frac{500}{500-1}\right] = 6.21361$$

$$(y_{500} - y_{100})\frac{\sigma_{n-1}}{S_n} = x_{500} - x_{100}$$

$$(6.21361 - 4.60015)\ x\ 7864 = x_{500} - 46300$$

$$x_{500} = 58988\ m^3/s$$

Question: Calculate scour depth of river having width 500 m. Unit discharge 50 $m^3/s/m$. $d_{50} = 0.1$ mm. design discharge 80% of bank full discharge.

Solution:

Design discharge, $q = 50 \text{ x } 0.8 = 40\,m^3/s/m$

$$f = 1.76\sqrt{d_{mm}} = 1.76\sqrt{0.1} = 0.55$$

Lacey's normal scour depth, $R' = 1.35\left(\frac{q^2}{f}\right)^{1/3}$

$$R' = 1.35\left(\frac{40^2}{0.55}\right)^{1/3} = 19.27\ m$$

Question: Sieve analysis was performed on a soil in the lab, determine fineness modulus.

Sieve size	3/8	4	8	16	30	50	100	150	200	Pan
Soil retained (gm)	0	20	10	30	40	30	40	20	10	0

Solution:

Sieve Size	Soil retained (gm)	% Retained	% Cumulative Retained
3/8	0	-	
#4	20	10	10
#8	10	5	15
#16	30	15	30
#30	40	20	50
#50	30	15	65
#100	40	20	85
#150	20	10	-
#200	10	5	-
Pan	0	0	-
Total	200	100	

$$F.M = \frac{10 + 15 + 30 + 50 + 65 + 85}{100} = 2.55$$

Question: A rigid retaining wall 6 m high has a saturated backfill of soft clay soil. The properties of the clay soil are γ_{sat} = 16.5 kN/m³, and unit cohesion c_u = 10 kN/m². For undrained condition ($\varphi = 0$) etermine (a) the expected depth of the tensile crack in the soil (b) the active earth pressure before the occurrence of the tensile crack, and (c) the active pressure after the occurrence of the tensile crack. Neglect the effect of water that may collect in the crack.

Solution:

$\boldsymbol{Since\ \varphi = 0, K_a = tan^2 45 = 1}$

at $z = 0$, $\sigma_a = K_a\,\gamma\,z - 2\,c\,\sqrt{K_a} = 1 \times 16.5 \times 0 - 2 \times 10 \times 1 = -20$ kN/m²

at $z = H$, $\sigma_a = K_a\,\gamma\,H - 2\,c\,\sqrt{K_a} = 1 \times 16.5 \times 6 - 2 \times 10 \times 1 = 99$ kN/m²

The depth of tensile crack, $z_o = \dfrac{2\,c}{\gamma\,\sqrt{K_a}} = \dfrac{2 \times 10}{16.5 \times 1} = 1.21$ m

The active earth pressure before the crack occurs.

$$P_a = \frac{1}{2} K_a\,\gamma\,H^2 - 2\,c\,\sqrt{K_a}\,H$$

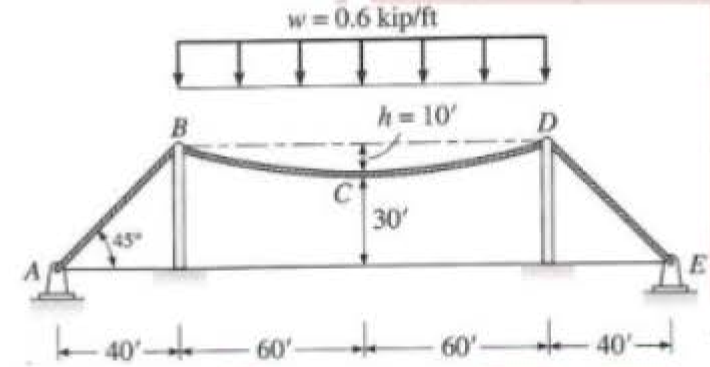
$$P_a = \frac{1}{2} \times 1 \times 16.5 \times 6^2 - 2 \times 10 \times 1 \times 6 = 177 \text{ kN/m}$$

The active earth pressure after the tensile crack occurs.

$$P_a = \frac{1}{2}(K_a\,\gamma\,H - 2\,c\,\sqrt{K_a})(H - z_o)$$

$$P_a = \frac{1}{2}(1 \times 16.5 \times 6 - 2 \times 10 \times 1)(6 - 1.21) = 189.205 \text{ kN/m}$$

Question: A cable-supported roof carries a uniform load as shown. If the cable sag at mid-span is set to 10 ft., what is the maximum tension in the cable between points B and D.

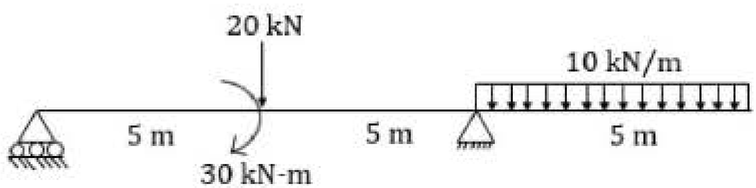


Solution:

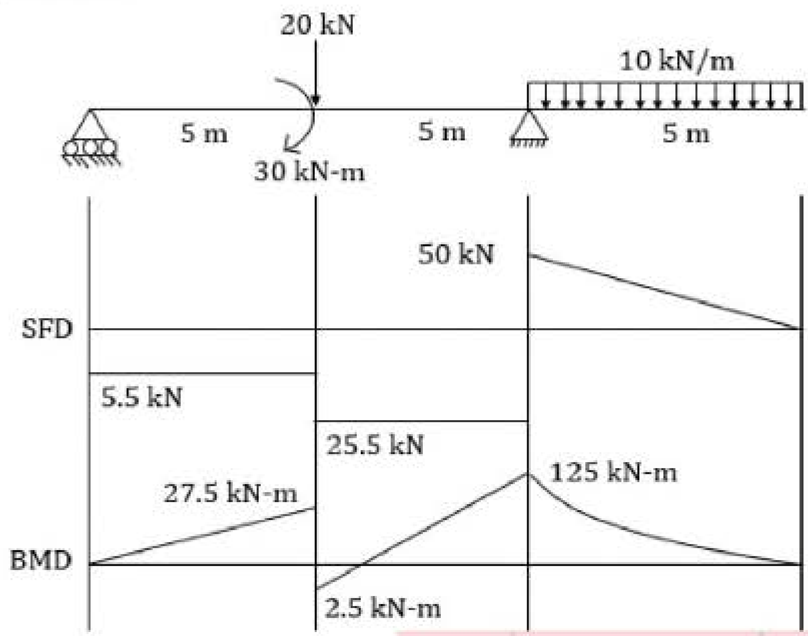
Tension in the cord at C, $Q = \frac{w L^2}{8h} = \frac{0.6 \times 120^2}{8 \times 10} = 108$ kip

Maximum tension, $F' = \left[Q^2 + \left(\frac{wL}{2}\right)^2\right]^{1/2} = \left[108^2 + \left(\frac{0.6 \times 120}{2}\right)^2\right]^{1/2} = 113.84$ kip

Question: Draw shear force and bending moment diagram for the following beam.



Solution:



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MCQ Part Technical:

01.If the base period of a 6-hour hydrograph of a basin is 84 hours, then a 12 hours unit hydrograph derived from this 6 hour unit hydrograph will have a base period of

a) 72 hours
b) 78 hours
c) 84 hours
d) 90 hours

Solution:

.Base period of derived UH
TB = tB + (D - d)

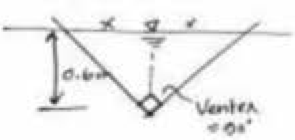
where
tB is base period of known UH
D is duration of derived UH
d is duration of known UH.

So the base period for 12 hr UH will be, 84 + 6 = 90 hr

Design Integrity
All about Civil Engineering

02.Triangular channel of vertex angle 90. depth 0.6m . Discharge 1m3/s . Whats the froude number ?

Solution :



$\tan\theta = \frac{x}{0.6}$

$\Rightarrow \tan 45 = \frac{x}{0.6}$

$\therefore x = 0.97,\ B = 2\times0.97 = 1.94\ m$

$A = 0.5\times1.94\times0.6 = 0.582\ m^2$

$d \approx A/B = 0.582/1.94 = 0.3$

$Q = AV$

$\Rightarrow 1 = 0.582\times V$

$\therefore V = 1.71\ m/s$

$F_r = \frac{V}{\sqrt{gd}} = \frac{1.71}{\sqrt{9.81\times0.3}} = 1.00$

Ans

03. If the pressure carried by a CBR specimen at 2.5 mm penetration is 3.5 N/mm2, the CBR of the soil is

[A]. 10%

[B]. 35%

[C]. 50%

[D]. 70%

Solution:

The standard plunger size is 50mm, and the load for 2.5mm penetration is 1370 kg.

So, Stress Ps= Load / Area
Ps= 1370*9.8/ area
= 6.84 N/mm2

So, CBR= P/PS *100
= 3.5/6.84 * 100
= 51%
= 50%.

04. If the discharge of a sewer running half is 628 1.p.s., i = 0.001, and n = 0.010, the diameter of the sewer, is

[A]. 1.39 m
[B]. 1.49 m
[C]. 1.59 m
[D]. 1.69 m

Soilution:

Solve by Manning's equation:
V=1/n^R*(2/3)*s*(1/2),
Q/A=1/n*R*(2/3)*i*(1/2),
Q/(pi*D*2/4)=1/n*(D/4)*(2/3)*i*(1/2).
Sewer running half;
So put D=d/2,
and put other given data,
Finally d=1.688 m.

05. A wide rectangular channel if normal depth increase by 20% , the discharge increased by ,

[A]. 10
[B]. 15
[C]. 35.5
[D]. 41.3

Solution:

Area before increasing depth

$A = B y_1$

Area after increasing depth by 20%

$A_2 = B y_2$

$= B \times 1.2 y_1$

$A_2 = 1.2 B y_1 = 1.2 A$

We know that

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} \times A$$

R = hydraulic radius = $y/2$ for a wide Rectangular channel

$$\therefore Q_1 = \frac{1.49}{n}\left(1.2\,y/2\right)^{2/3} \times S^{1/2} \times 1.2A$$

$$= \frac{1.49}{n}\left(y/2\right)^{2/3} \times S^{1/2} \times A \times 1.2^{2/3+1}$$

$$= Q \times 1.2^{5/3}$$

$Q_1 = 1.355\,Q$

$\therefore$ Increase in discharge is 35.5%

hence option (C) is right.

06.A shaft turning 150 r.p.m. is subjected to a torque of 150 kgm. Horse power transmitted by the shaft is

A. π

B. 10π

C. $\pi 2$

D. $1/\pi$

Solution:

Where
N = The speed in r.p.m.
T = the torque in kgm.

Therefore,

P=2*(π)*N*T/4500.
= 2*π*150*150*10/60*746watt.
= 10π.

07. 1 Bag Cement = 1.25 cft

08.The maximum deflection of a cantilever beam of length l with a point load W at the free end is

[A]. $\frac{Wl^3}{3\,EI}$

[B]. $\frac{Wl^3}{8\,EI}$

[C]. $\frac{Wl^3}{16\,EI}$

[D]. $\frac{Wl^3}{48\,EI}$

Answer:

[A]. $\frac{Wl^3}{3\,EI}$

09. If D1 and D2 are depths of water upstream and down stream of a hydraulic jump, the loss of head at the jump, is

[A]. $\frac{(D_2 - D_1)^3}{D_1 D_2}$

[B]. $\frac{(D_2 - D_1)^3}{2D_1 D_2}$

[C]. $\frac{(D_2 - D_1)^3}{3D_1 D_2}$

[D]. $\frac{(D_2 - D_1)^3}{4D_1 D_2}$

Answer: D

Others (Full question N/A)

10. Cd for Sharp crested weir
11. Unit Hydrograph related
12. Maximum channel section for cross drainage work
13. Head loss of jump
14. RL related