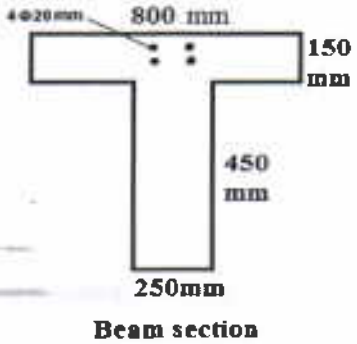
University of Technology
Building and Construction Engineering Department
Final Term Exam/ 1st Attempt / 2016-2017

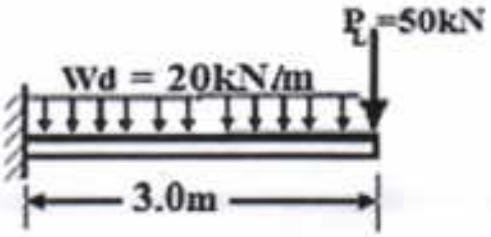
Subject : Reinforced Concrete Design II | **Stage : 3rd class**
Division: All Branches | **Time : 3 hours**
Examiner : Committee | **Date : 4/6 /2017**

Note: Use f'c= 21 MPa and fy= 350 MPa for solving all questions.
Solve only **Three** questions.

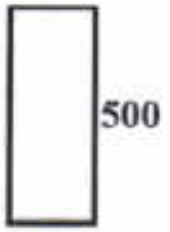
Q.1:The beam shown in the figure below is a part of **flat roof not supporting or attached to non-structural elements likely to be damaged by large deflection**. Check if the deflection does not exceed the limit of ACI-Code 318 (Table 9.5-b). If the beam supports a distributed dead load including its own weight of 20 kN/m and a concentrated live load of 50 kN. (d = 530mm) $\Delta_{free\ end}=\frac{WL^4}{8EI}$, $\Delta_{free\ end}=\frac{PL^3}{3EI}$



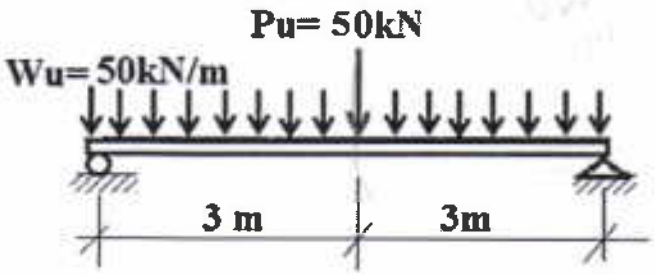
Beam section



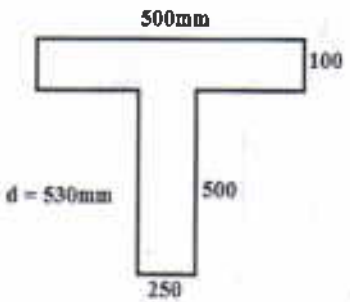
Q.2-a): A simply supported beam AB with the cross section as shown below; Find:
1- Spacing required for 12mm stirrups diameter.
2- The distance at which the stirrups required.



d = 430mm



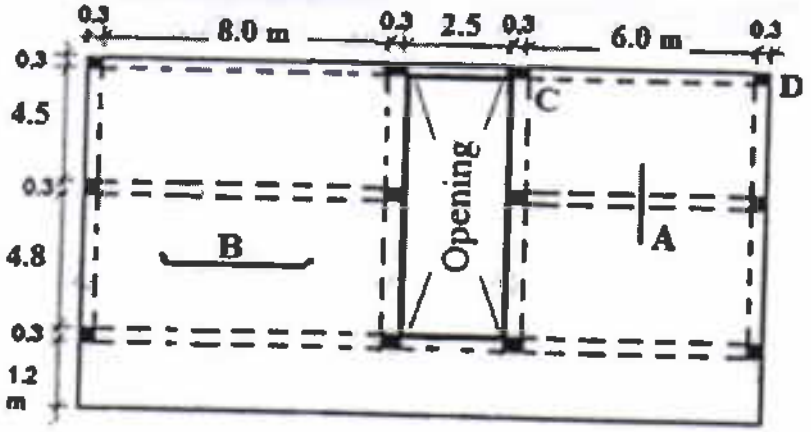
Q.2-b) The T-beam section shown in the figure is under pure torsion, find:
1- The maximum torsion moment that the beam could withstand without torsion reinforcement.
2- The maximum torsional moment with Ø10mm stirrups for the web only (do not design for torsion reinforcement).

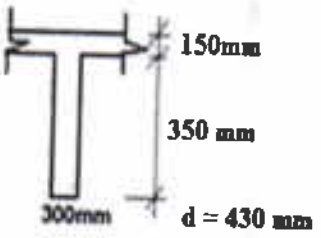


Q.3: A concrete slab with 150 mm thickness supports a service dead load of 6 kN/m^2 including its own weight and a service live load of 3 kN/m^2, find:

1- Area of steel reinforcement required for the slab at points A and B using Φ12mm.

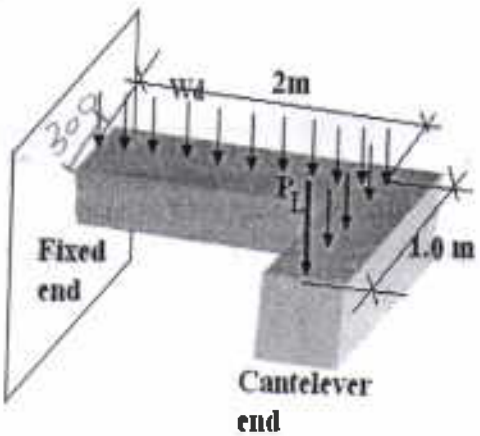
2- Total loads on the beam CD.





Beam Section

Q.4: A cantilever concrete beam supports a distributed service dead load of 10kN/m including its own weight and a concentrated service live load of 20kN at the cantilever end. Check if the critical section can withstand the torsion and shear loads (use stirrups with 12mm diameter).



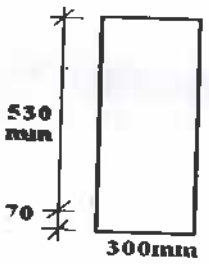


TABLE 9.5(b) — MAXIMUM PERMISSIBLE COMPUTED DEFLECTIONS

Type of member	Deflection to be considered	Deflection limitation
Flat roofs not supporting or attached to nonstructural elements likely to be damaged by large deflections	Immediate deflection due to live load L	$\ell/180^*$
Floors not supporting or attached to nonstructural elements likely to be damaged by large deflections	Immediate deflection due to live load L	$\ell/360$
Roof or floor construction supporting or attached to nonstructural elements likely to be damaged by large deflections	That part of the total deflection occurring after attachment of nonstructural elements (sum of the long-term deflection due to all sustained loads and the immediate deflection due to any additional live load)†	$\ell/480^‡$
Roof or floor construction supporting or attached to nonstructural elements not likely to be damaged by large deflections		$\ell/240^§$

*Limit not intended to safeguard against ponding. Ponding should be checked by suitable calculations of deflection, including added deflections due to ponded water, and considering long-term effects of all sustained loads, camber, construction tolerances, and reliability of provisions for drainage.

†Long-term deflection shall be determined in accordance with 9.5.2.5 or 9.5.4.3, but may be reduced by amount of deflection calculated to occur before attachment of nonstructural elements. This amount shall be determined on basis of accepted engineering data relating to time-deflection characteristics of members similar to those being considered.

‡Limit may be exceeded if adequate measures are taken to prevent damage to supported or attached elements.

§Limit shall not be greater than tolerance provided for nonstructural elements. Limit may be exceeded if camber is provided so that total deflection minus camber does not exceed limit.

Make use of these equations:

Deflection:

$$Ig = Ic + A.d^2 \quad M_{cr} = \frac{0.62*\sqrt{f'c}*Ig}{yt} \quad , \quad \frac{b\,x^2}{2} = n*As(d-x) \quad or \quad x = \frac{n\,As\left[\sqrt{1+2\frac{d*b}{nAs}}-1\right]}{b}$$

$$I_{cr} = \frac{b*x^3}{3} + n*As(d-x)^2 \quad n = \frac{Es}{4700\sqrt{f'c}} \quad I_{eff} = \left(\frac{Mcr}{Ma}\right)^3 (Ig - Icr) + Icr \le Ig$$

Two ways:

$$Mu = coeff.*Wu*Ln^2 \quad Ru = \frac{Mu}{\emptyset bd^2}\ , \ \mu = \frac{fy}{0.85f'c} \quad \rho = \frac{1}{\mu}\left[1-\sqrt{1-\frac{2*Ru*\mu}{fy}}\right], \quad As = \rho*b*d$$

$As\ should\ be \ge As\ min = \rho_{min}*b*h$

Area of shrinkage and temperature reinforcement shall provide at least the following ratios of reinforcement area to gross concrete area, but not less than 0.0014:

(a) Slabs where Grade 280 or 350 deformed bars are used 0.0020

(b) Slabs where Grade 420 deformed bars or welded wire reinforcement are used 0.0018

(c) Slabs where reinforcement with yield stress exceeding 420 MPa measured at a yield strain of 0.35 percent is used ..... $\frac{0.0018*420}{fy}$

Shear:

$$\emptyset Vc = 0.75*\frac{\sqrt{f'c}}{6}bw\,d, \quad S_{req} = \frac{Av*fy*d}{Vs}, \quad Vud = \emptyset(Vc+Vs) \le 5\emptyset Vc \ for\ adequate\ sections$$

$$If\ Vs \le 2Vc\ \ then\ \ Smax \le \frac{d}{2}, \quad 600mm, \quad \frac{3\,Av\,fy}{bw}, \quad \frac{16\,Av\,fy}{bw\sqrt{f'c}}$$

$$If\ Vs > 2Vc\ \ then\ \ Smax \le \frac{d}{4}, \quad 300mm, \quad \frac{3\,Av\,fy}{bw}, \quad \frac{16\,Av\,fy}{bw\sqrt{f'c}}$$

Torsion:

For T-section $T_{neg} \le \phi \frac{\sqrt{f_{c'}}}{12}\frac{A_{cp}^2}{p_{cp}}$, $\sqrt{\left(\frac{V_{ud}}{b_w*d}\right)^2 + \left(\frac{T_{ud}P_{oh}}{1.7A_{oh}^2}\right)^2} \le \emptyset\,\frac{5}{6}\sqrt{f'c}$,

$x = b_w - 2*Cover - d_b \quad ; \quad y = h - 2*Cover - d_b$

$A_{oh} = x.y \quad ; \quad p_{oh} = 2(x+y) \quad \emptyset Vc = 0.75\frac{\sqrt{f'c}}{6}bw*d$

$Vs = \frac{Vud-\emptyset Vc}{\emptyset}$ If $\emptyset Vc > Vud$ then $\emptyset Vs = Vud - \emptyset Vc$ will be nagative then $\frac{Av}{S} = 0$

$\frac{Av}{S} = \frac{Vs}{fys*d}$ due to shear force $\frac{At}{S} = \frac{Tud/0.75}{1.7*Aoh*fy} \ge 0.175\frac{bw}{fy}$

$\frac{As_{total}}{S} = \frac{Av}{S} + 2\frac{At}{S} \ge \frac{0.35\,bw}{fys} \ge \frac{bw*\sqrt{f'c}}{16\,fys}$ Spacing for torsion $S_{max} \le \frac{P_{oh}}{8} \le 300mm$

$S_{req} \le \frac{A_{bar}}{As_{total}/_S}$ then $Al = \frac{A_t*P_{oh}}{S}*\frac{fys}{fyl}$ and $Al_{min} = \frac{5*Acp*\sqrt{f'c}}{12\,fyl} - \frac{A_t*P_{oh}}{S}*\frac{fys}{fyl}$

Notes:

- The longitudinal reinforcement should be distributed inside the stirrups as layers.
- Spacing between center line of each layers less or equal 300mm.
- $d_{bar\,l} \ge \frac{S}{24} \ge 10mm$ ($S = is\ spacing\ of\ stirrups\ (web\ reinforcement)$)

Table (1) Coefficients for negative moments in slabs†

$M_{x,neg} = C_{x,neg} w l_x^2$
$M_{y,neg} = C_{y,neg} w l_x^2$ where w = total uniform dead plus live load

Ratio $m = \frac{l_x}{l_y}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
0.85	$C_{x,neg}$		0.060	0.065	0.066	0.082	0.083	0.057	0.049	0.072
	$C_{y,neg}$		0.031		0.034				0.046	0.021
0.80	$C_{x,neg}$		0.065	0.061	0.071	0.083	0.086	0.051	0.055	0.075
	$C_{y,neg}$		0.027		0.029				0.041	0.017
0.75	$C_{x,neg}$		0.069	0.056	0.076	0.085	0.088	0.044	0.061	0.078
	$C_{y,neg}$		0.022		0.024				0.036	0.014

Table (2) Coefficients for dead-load positive moments in slabs†

$M_{x,ms} = C_{x,ms} w l_x^2$
$M_{y,ms} = C_{y,ms} w l_x^2$ where w = total uniform dead load

Ratio $m = \frac{l_x}{l_y}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
0.65	$C_{x,ms}$	0.074	0.032	0.054	0.050	0.036	0.054	0.065	0.044	0.034
	$C_{y,ms}$	0.013	0.006	0.014	0.009	0.004	0.007	0.014	0.009	0.005
0.60	$C_{x,ms}$	0.081	0.034	0.062	0.053	0.037	0.056	0.073	0.048	0.036
	$C_{y,ms}$	0.010	0.004	0.011	0.007	0.003	0.006	0.012	0.007	0.004

Table (3) Coefficients for live-load positive moments in slabs†

$M_{x,ms} = C_{x,ms} w l_x^2$
$M_{y,ms} = C_{y,ms} w l_x^2$ where w = total uniform live load

Ratio $m = \frac{l_x}{l_y}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
0.65	$C_{x,ms}$	0.074	0.053	0.064	0.062	0.055	0.064	0.070	0.059	0.054
	$C_{y,ms}$	0.013	0.010	0.014	0.011	0.009	0.010	0.014	0.011	0.009
0.60	$C_{x,ms}$	0.081	0.058	0.071	0.067	0.059	0.068	0.077	0.065	0.059
	$C_{y,ms}$	0.010	0.007	0.011	0.009	0.007	0.008	0.011	0.009	0.007

Table (4) Ratio of load w in l_x and l_y directions for shear in slab and load on supports†

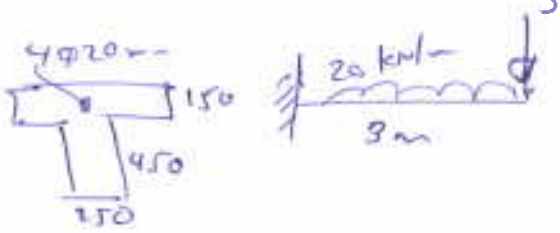
Ratio $m = \frac{l_x}{l_y}$		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
0.80	W_x	0.71	0.71	0.33	0.71	0.92	0.86	0.49	0.55	0.83
	W_y	0.29	0.29	0.67	0.29	0.08	0.14	0.51	0.45	0.17
0.75	W_x	0.76	0.76	0.39	0.76	0.94	0.88	0.56	0.61	0.86
	W_y	0.24	0.24	0.61	0.24	0.06	0.12	0.44	0.39	0.14

1st Attempt / Reinforced Concrete Design II

4/6/2017

$f'_c = 21\ MPa$, $f_y = 350\ MPa$

Q.1



$I_g = \frac{250(600)^3}{12} = 4.5 * 10^9\ mm^4$

$M_{cr} = \frac{0.62\sqrt{21} * 4.5 * 10^9}{300 * 10^6} = 42.618\ kN.m$

$M_{a(D)} = \frac{20(3)^2}{8} = 90\ kN.m$, $M_{a\,D+L} = 90 + 50*3 = 240\ kN.m$

$n = \frac{200000}{4700\sqrt{21}} \approx 9$ $\quad nA_s = 9 * \frac{\pi(20)^2}{4} * 4 = 11309.73\ mm^2$

$\frac{250x^2}{2} = 11309.73(530 - x)$ | OR $x = \frac{11309.73\left(\sqrt{1 + 2\frac{250*530}{11309.73}} - 1\right)}{250}$

$x = 178.37$ $\quad = 178.37\ mm.$

$I_{cr} = \frac{250(178.37)^3}{3} + 11309.73(530 - 178.37)^2 = 1.871 * 10^9\ mm^4$

$I_{eff\,D} = \left\{\left(\frac{42.618}{90}\right)^3\left[4.5 - 1.871\right) + 1.871\right\} * 10^9 = 2.150 * 10^9\ mm^4$

$I_{eff\,D+L} = \left\{\left(\frac{42.618}{240}\right)^3(4.5 - 1.871) + 1.871\right\} * 10^9 = 1.886 * 10^9\ mm^4$

$\Delta_{i-D} = \frac{20(3000)^4}{8 * 4700\sqrt{21} * 2.150 * 10^9} = 4.372\ mm$

$\Delta_{i-(D+L)} = \frac{20(3000)^4}{8 * 4700\sqrt{21} * 1.886 * 10^9} + \frac{50000(3000)^3}{3 * 4700\sqrt{21} * 1.886 * 10^9}$

$= 16.0631\ mm.$

$\Delta_{i-(L.L)} = 16.063 - 4.372 = 11.691\ mm$

$\Delta_{allowable} = \frac{L}{180} = \frac{3000}{180} = 16.667\ mm > 11.691\ mm$

$\therefore$ adequate.

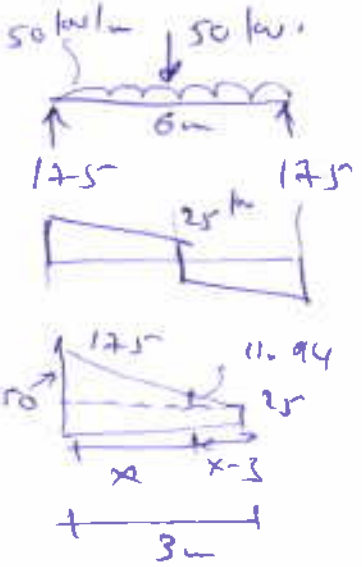
أرصدة الحسابات مفرزة بحسب الدليل

فرع 00620

دليل	قيد	عملة	حساب	اسم	إقامة	رصيد	IQD مدين	IQD دائن
251600	حسابات جارية دائن	IQD	00013240007	شركة وادي ارض	R	975,000.00	0.00	975,000.00
			00013250002	شركة وادي الت	R	354,000.00	0.00	354,000.00
			00013260008	شركة وادي سحر	R	325,000.00	0.00	325,000.00
			00013280009	شركة وهج الما	R	475,000.00	0.00	475,000.00
			00013290005	ا شركة وهج قصة	R	1,000,000.00	0.00	1,000,000.00
			00013300005	شركة وهج لمعا	R	3,030,000.00	0.00	3,030,000.00
			00013310001	شركة يثرب للم	R	116,471.00	0.00	116,471.00
			00013320007	شركة يعقوب ال	R	485,000.00	0.00	485,000.00
			00013330002	شركة يعقوب سج	R	1,930,000.00	0.00	1,930,000.00
			00013340008	شركة يوكسل ال	R	140,000.00	0.00	140,000.00
			00013350003	شركة يوم الما	R	1,469,200.00	0.00	1,469,200.00
			00013360009	شركةابن العربي	R	100,000.00	0.00	100,000.00
			00013370004	شركةاخوان الم	R	980,000.00	0.00	980,000.00
			00013380000	شركةارض الحضا	R	29,000.00	0.00	29,000.00
			00013390006	شركةارض العاصي	R	500,000.00	0.00	500,000.00
			00013400006	شركةالبان ابي	R	15,000.00	0.00	15,000.00
			00013410002	شركةالبر الام	R	290,600.00	0.00	290,600.00
			00013430003	ل شركةالحديثة	R	1,400,000.00	0.00	1,400,000.00
			00013440009	شركةالحوراءل	R	789,963.00	0.00	789,963.00
			00013450004	ل شركةالخواطر	R	5,000.00	0.00	5,000.00
			00013480001	شركةالرجاء لب	R	90,000.00	0.00	90,000.00
			00013500007	شركةالشرقيةل	R	532,802,726.00	0.00	532,802,726.00
			00013510003	شركةالعصاء ال	R	500,000.00	0.00	500,000.00
			00013520009	شركةالقانت ال	R	374,567,000.00	0.00	374,567,000.00
			00013530004	شركةالقصة ابي	R	500,000.00	0.00	500,000.00
			00013540000	شركةالمناخ ال	R	200,000.00	0.00	200,000.00
			00013550005	شركةالمورد لب	R	2,500,000.00	0.00	2,500,000.00
			00013560001	شركةالنبع للت	R	200,000.00	0.00	200,000.00
			00013570006	شركةالنظر ابي	R	358,240,000.00	0.00	358,240,000.00
			00013580002	شركةالنفذ لخد	R	79,000.00	0.00	79,000.00
			00013610004	ل شركةالنواهل	R	79,000.00	0.00	79,000.00
			00013650006	شركةالوهج للا	R	79,000.00	0.00	79,000.00
			00013660002	شركةاليمام ال	R	457,771.00	0.00	457,771.00
			00013670007	شركةبياض العز	R	286,662.00	0.00	286,662.00
			00013700009	شركةتاجد حمود	R	140,000.00	0.00	140,000.00
			00013750007	ل شركه التاجر	R	3,707,500.00	0.00	3,707,500.00
			00013780004	شركه التوازن	R	346,840,000.00	0.00	346,840,000.00
			00013800000	شركه الغضباء	R	500,000.00	0.00	500,000.00

Q.2

(A) R = Vat face of support $= \frac{50 \times 6}{2} + \frac{50}{2} = 175$ kN



$V_{ud} = 175 - 50 * 0.43 = 153.5$ kN.

$\phi V_c = 0.75 \frac{\sqrt{21}}{6} * 300 * 430 / 1000 = 73.89$ kN

$\frac{\phi V_c}{2} = 36.94$ kN.

$\frac{150}{3} = \frac{11.947}{3-x} \Rightarrow x = 2.761$ mm

$\phi V_s = 153.5 - 73.89 = 79.61$ kN.

check with $\leq 4 \phi V_c = 295.576$ kN. section adequate.

$\leq 2 \phi V_c = 147.78$ k. Then

$S_{max} = \frac{d}{2}$ 6 600 | $\frac{3 A_v f_y}{b_w}$ | $\frac{16 A_v f_y}{b_w \sqrt{f_c'}}$

$= \boxed{215 \text{ mm}}$ | 600 mm | $\frac{3 * 226 * 350}{300} = 791$ mm | $\frac{16 * 226 * 350}{300 \sqrt{21}} = 920.6$ mm

govern.

$S_{req} = \frac{0.75 * 226 * 350 * 430}{79.61 * 1000} = 320.4$ mm > 215 mm

use $\phi 10$ mm @ 210 mm c/c upto $x = 2.76$ mm

Q.2 (B) $A_{cp} = 500 * 100 + 250 * 500 = 175000$ mm^2

$P_{cp} = 2(500 + 600) = 2200$ mm.

$T_{req} = \frac{0.75 \sqrt{21}}{12} \left[\frac{175000^2}{2200 * 10^6} \right] = 3.987$ kN-m.

$x = 250 - 80 - 10 = 160$ mm $\quad y = 600 - 60 - 10 = 530$ mm

$A_{oh} = 160 * 530 = 84800$ mm^2

$P_h = 2(160 + 530) = 1380$ mm

$T_{ud\,max} = 0.75 * \frac{5\sqrt{21}}{6} * \frac{1.7 (84800)^2}{1380 * 10^6} = 25.37$ kN-m

أرصدة الحسابات مفرزة بحسب الدليل

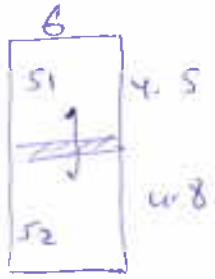
فرع 00620

دليل	قيد	عملة	حساب	اسم	إقامة	رصيد	IQD مدين	IQD دائن
251600	حصلات جارية دائن	IQD	00012780005	شركة عين رادة	R	2,410,760.00	0.00	2,410,760.00
			00012790001	شركة عيون الب	R	35,000.00	0.00	35,000.00
			00012800001	شركة فجر الصب	R	479,000.00	0.00	479,000.00
			00012810007	شركة قنة الاق	R	500,000.00	0.00	500,000.00
			00012820003	ا شركة قبة قصر	R	525,000.00	0.00	525,000.00
			00012830008	شركة قصر الله	R	49,000.00	0.00	49,000.00
			00012840004	شركة قمة ابدا	R	950,000.00	0.00	950,000.00
			00012850009	شركة قمر اعال	R	350,000.00	0.00	350,000.00
			00012880006	شركة كوسك ال	R	490,000.00	0.00	490,000.00
			00012890002	شركة لبنان ال	R	360,000,000.00	0.00	360,000,000.00
			00012900003	شركة لمعان نج	R	550,000.00	0.00	550,000.00
			00012920005	شركة مؤنه المث	R	975,000.00	0.00	975,000.00
			00012930000	شركة مبرا الش	R	63,000.00	0.00	63,000.00
			00012940006	شركة مجلس شيو	R	100,000.00	0.00	100,000.00
			00012950001	ا شركة مجموعة	R	1,500,000.00	0.00	1,500,000.00
			00012960007	ا شركة مجموعة	R	414,199.00	0.00	414,199.00
			00012970002	ا شركة مجموعة	R	58,378.00	0.00	58,378.00
			00012980008	ا شركة مجموعة	R	129,000.00	0.00	129,000.00
			00013000001	د شركة مجموعة	R	250,000.00	0.00	250,000.00
			00013010007	م شركة مجموعة	R	2,975,000.00	0.00	2,975,000.00
			00013020003	شركة مدار الب	R	250,000.00	0.00	250,000.00
			00013030008	شركة مرسى الا	R	1,000,000.00	0.00	1,000,000.00
			00013040004	شركة معالي ال	R	40,000.00	0.00	40,000.00
			00013050009	شركة مملكة مي	R	60,000.00	0.00	60,000.00
			00013060005	شركة مهر الخل	R	100,000.00	0.00	100,000.00
			00013070000	شركة نافذة ال	R	500,000.00	0.00	500,000.00
			00013080006	شركة نجوم الم	R	1,050,000.00	0.00	1,050,000.00
			00013090002	شركة نخبة الا	R	490,000.00	0.00	490,000.00
			00013100003	شركة نخبة الص	R	90,000.00	0.00	90,000.00
			00013110009	شركة نخبةالاي	R	490,000.00	0.00	490,000.00
			00013130000	شركة نهر مجرى	R	975,000.00	0.00	975,000.00
			00013140006	شركة نوارس ال	R	630,000.00	0.00	630,000.00
			00013150001	شركة نور الاف	R	1,065,210.00	0.00	1,065,210.00
			00013170002	شركة نور الخل	R	59,681.00	0.00	59,681.00
			00013180008	شركة نور الصب	R	446,145.00	0.00	446,145.00
			00013210000	شركة هدير الع	R	200,000.00	0.00	200,000.00
			00013220006	شركة همسة جما	R	1,000,000.00	0.00	1,000,000.00
			00013230001	شركة واحة الا	R	627,000.00	0.00	627,000.00

Q.3 ①

$W_u = 1.2 * 6 + 1.6 * 3 = 7.2 + 4.8 = 12$ kN/m²

Point A: $S_1 \Rightarrow m = \frac{4.5}{6} = 0.75$ case 6



M_a^- Table ① $= 0.088 * 12 * (4.5)^2 = 21.38$ kN.m/m

$S_2 \Rightarrow m = \frac{4.8}{6} = 0.8$ case 5

$M_a^- = 0.083 * 12 * (4.8)^2 = 22.95$ kN.m/m

$\frac{M_1}{M_2} = \frac{21.38}{22.95} = 0.93 > 0.8$ use the larger (22.95) kN.m/m

Point B $S_3 \Rightarrow m = \frac{4.8}{8} = 0.6$ case 5

M_b^+ Table (9.3) $= (0.003 * 7.2 + 0.007 * 4.8)(8)^2 = 3.53$ kN.m/m

M_u kN.m/m	R_n	ρ	A_s min	Notes: $d_{av} = 150 - 20 - 12 = 118$ mm
22.95	1.831	0.00553	652.78	$m = \frac{350}{0.8 * 21} = 19.6$
3.53	0.282	0.00812 use min ρ	300 m²/m	$A_{min} = 0.002 * 1000 * 150 = 300$ mm²/m

$R_n = \frac{M_u * 10^6}{0.9 * 1000 (118)^2}$

$\rho = \frac{1}{19.6}\left[1 - \sqrt{1 - \frac{2 * R_n * 19.6}{350}}\right]$

Q.3 ② wt. on beam CD:

wt. of beam $= 0.3 * 0.5 * 24 * 1.2 = 4.32$ kN/m

wt. from $S_1 = \frac{0.88 * 12 * 4.5 * 6}{2 * 6} = 23.76$ kN/m

$\Sigma = 28.08$ kN/m

أرصدة الحسابات مفرزة بحسب الدليل

فرع 00620

دليل	قيد	عملة	حساب	اسم	إقامة	رصيد	IQD مدين	IQD دائن
251600	حسابات حارية دائن	IQD	00012270004	شركة ربوع دبا	R	313,000.00	0.00	313,000.00
			00012280000	شركة رحيق امو	R	688,000.00	0.00	688,000.00
			00012310002	شركة رواد الخ	R	500,000.00	0.00	500,000.00
			00012320008	شركة روعة دعا	R	250,000.00	0.00	250,000.00
			00012330003	شركة رياض الك	R	1,990,000.00	0.00	1,990,000.00
			00012340009	شركة ريل الع	R	975,000.00	0.00	975,000.00
			00012350004	شركة ريناج بي	R	975,000.00	0.00	975,000.00
			00012360000	ا شركة ريحانة	R	-2,999,805,000.00	-2,999,805,000.00	0.00
			00012380001	شركة ساحل جدة	R	458,000.00	0.00	458,000.00
			00012390007	شركة سلسلة ال	R	490,000.00	0.00	490,000.00
			00012400007	شركة سما اسطو	R	1,090,000.00	0.00	1,090,000.00
			00012410003	شركة سما اسوا	R	169,000.00	0.00	169,000.00
			00012420009	ب شركة سما الق	R	120,000.00	0.00	120,000.00
			00012430004	شركة سما بغدا	R	765,195.00	0.00	765,195.00
			00012450005	شركة سمبراميس	R	83,274.00	0.00	83,274.00
			00012460001	شركة سومسه لبي	R	360,000,000.00	0.00	360,000,000.00
			00012470006	شركة سومر للم	R	195,959.00	0.00	195,959.00
			00012480002	شركة شجرة الك	R	95,000.00	0.00	95,000.00
			00012500008	ا شركة شلالات	R	410,000.00	0.00	410,000.00
			00012520000	شركة شمس الوط	R	1,054,000.00	0.00	1,054,000.00
			00012530005	شركة شموخ بنا	R	234,203.00	0.00	234,203.00
			00012550006	شركة شموخ بلا	R	1,000,000.00	0.00	1,000,000.00
			00012570007	شركة صرح سومر	R	130,415.00	0.00	130,415.00
			00012590009	شركة صفوة الج	R	100,000.00	0.00	100,000.00
			00012600009	شركة صوت الرع	R	250,000.00	0.00	250,000.00
			00012610005	شركة طيبة الم	R	50,000.00	0.00	50,000.00
			00012620001	شركة عبدالرسو	R	165,000.00	0.00	165,000.00
			00012630006	شركة عبر الخل	R	75,000.00	0.00	75,000.00
			00012650007	شركة عبرالمشر	R	300,525.00	0.00	300,525.00
			00012660003	شركة عبق السو	R	264,900.00	0.00	264,900.00
			00012670008	ل شركة عراقنا	R	966,000.00	0.00	966,000.00
			00012680004	شركة عرش البا	R	1,604.00	0.00	1,604.00
			00012690000	شركة عطر زهرة	R	607,720.00	0.00	607,720.00
			00012700000	شركة عطر نعيم	R	815,000.00	0.00	815,000.00
			00012710006	شركة عقلب الخ	R	70,000.00	0.00	70,000.00
			00012720002	شركة علي عادل	R	990,000.00	0.00	990,000.00
			00012730007	شركة عين العي	R	10,256,000.00	0.00	10,256,000.00
			00012740003	شركة عين الذب	R	11,000.00	0.00	11,000.00

Q.4

shear

$W_D = 10 \times 1.2 = 12$ kN/m

$P_L = 20 \times 1.6 = 32$ kN.

$R = V_u$ at face of support $= 32 + 3 \times 12 = 68$ kN.

$V_{ud} = 68 - 0.53(12) = 61.64$ kN.

Torsion

$T_u = 32 \times 1 + 12 \times 1 \times 0.5$

$= 38$ kN.m

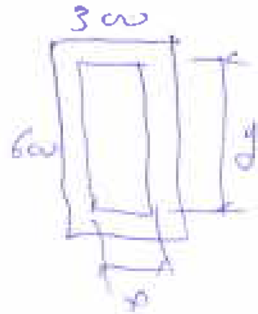
$T_{ud} = 38$ kN.m

$$T_{neg} = \frac{0.75\sqrt{21}}{12}\left(\frac{(300 \times 600)^2}{2(300 + 900) \times 10^6}\right) = 5.155 \text{ kN.m} < 38 \text{ kN.m}$$

تكمل الـ تصميم الى

$x = 300 - 80 - 12 = 208$ mm

$y = 600 - 80 - 12 = 508$ mm



$A_{oh} = 208 \times 508 = 105664$ mm²

$P_h = 2(208 + 508) = 1432$ mm.

$$\sqrt{\left(\frac{61.64 \times 1000}{300 \times 530}\right)^2 + \left(\frac{38 \times 10^6 \times 1432}{1.7(105664)^2}\right)^2} \leq \phi \frac{5}{6}\sqrt{21}$$

$0.15029 + 8.21953 \leq 2.864$

$2.893 \leq 2.864$

$\approx$ approximately equal.

either change $\phi 12$ to $\phi 10$ or change the dimension of cross section. كمل ايا منهم صحيح

If completed: $\phi V_c = 0.75 \frac{\sqrt{21}}{6} \times 300 \times 530 / 1000 = 91.079 \text{ kN} > V_{ud}$

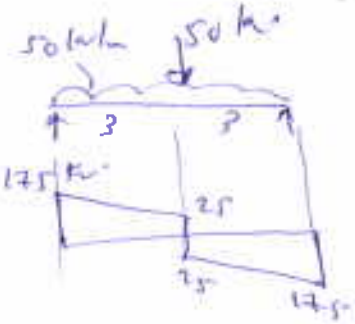
$\therefore$ pure torsion no shear $\frac{A_v}{s} = 0$

$$\frac{A_t}{s} = \frac{(38/0.75)10^6}{1.7(107100)350} = 0.795 \text{ mm} \geq 0.175 \frac{b_w}{f_y} = 0.15$$

governs.

Q.2 (A)

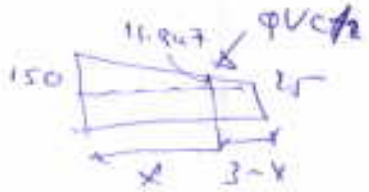
$R = V_{at\ face\ of\ support} = \frac{50 \times 6}{2} + \frac{50}{2} = 175$ kN.



$V_{ud} = 175 - 50 \times 0.43 = 153.5$ kN.

$\phi V_c = 0.75 \times \frac{\sqrt{21}}{6} \times 300 \times 430 / 1000 = 73.894$ kN.

$\frac{\phi V_c}{2} = 36.947$ kN.



$\frac{11.947}{3-x} = \frac{150}{3} \Rightarrow x = 2.761$ m.

$\phi V_s = 153.5 - 73.894 = 79.606$ kN.

$\leq 2\phi V_c = 147.78$ kN. ok.

$\leq 4\phi V_c = 295.576$ kN. ok.

$S_{max} = \frac{d}{2}$ or 600 or $\frac{3 A_{sh} f_{yh}}{b_w}$ or $\frac{16 A_{sh} f_{yh}}{b_w \sqrt{f'_c}}$

$= 215$ mm or 600 or $\frac{3 \times 226 \times 530}{300} = 791$ mm or $\frac{16 \times 226 \times 350}{300\sqrt{21}} = 920.6$ mm

use $S_{max} = 210$ mm.

$S_{req} = \frac{0.75 \times 226 \times 350 \times 430}{79.606 \times 10^3} = 320.45 > 210$ mm

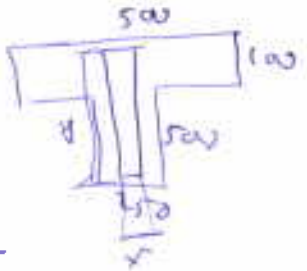
use $\phi 10$ mm @ 210 c/c and $x = 2.76$ m

Q.2 (B)

$A_{cp} = 500 \times 100 + 250 \times 500 = 175000$ mm^2

$P_{cp} = 2(500 + 600) = 2200$ mm

$T_{ucr} = \frac{0.75\sqrt{21}}{12} \left(\frac{(175000)^2}{2200 \times 10^3} \right) = 3.987$ kN.m



$x = 250 - 80 - 12 = 158$ mm

$y = 600 - 60 - 12 = 528$ mm

$A_{oh} = 158 \times 528 = 83424$ mm^2

$P_h = 2(158 + 528) = 1372$ mm

$T_{ud\ max} = 0.75 \times \frac{5\sqrt{21}}{6} \times \frac{1.7 (83424)^2}{1372 \times 10^3} = 24.698$ kN.m

Q.4 q.1/1 ans

$S_{max} \le \frac{P_t h}{8} \le 300\ mm$ | $S_{req} = \frac{113}{0.795} = 142.1\ mm$

$\frac{1432}{8} \le 300\ mm$

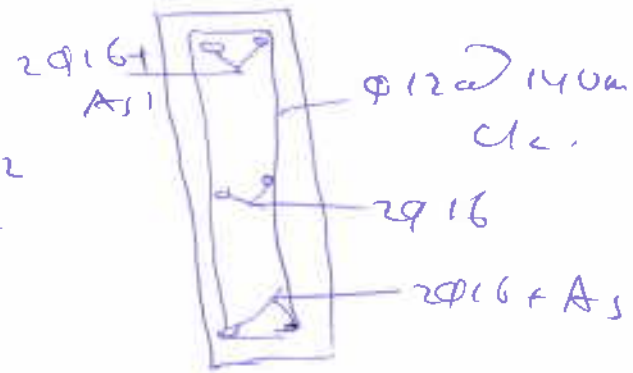
179 mm > governs.

use ☐ φ12 @ 140mm c/c.

$A_l = \frac{A_t}{S} P_t h = 0.795 * 1432 = 1138.44\ mm^2$

$A_{l\,min} = \frac{5 * 300 * 600 \sqrt{21}}{12 * 350} - 1138.44 = -157.54\ mm^2$

use 3 layers



area of each layer $= \frac{1138.44}{3} = \frac{2\pi D^2}{4_2}$

$D = 15.539$

use 16 mm.

$d_{l\,min} \le \frac{S}{24} \le 10\ mm$

$\frac{140}{24} \le 10\ mm$

5.83

use 2φ16 mm.