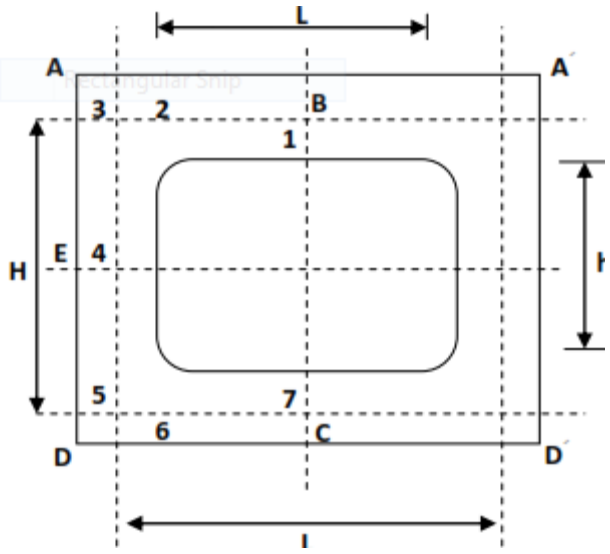
Reference	Calculations	Output

❖ حسابات التصميم الانشائي

❖ Box Culvert Design :-



$\Upsilon s=18\ kn/m^3$ $\Upsilon_w=9.81\ kn/m^3$

$\Upsilon_c=24\ kn/m^3$

$T_S=T_W=T=300\ mm$ $c=50\ mm$

$\emptyset=30^o$

$H=0.5\ m$ $l_{span}=3000\ m$

$w=1\ m$

- **Loads :-**

1. **Dead load :-**

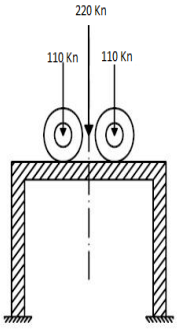
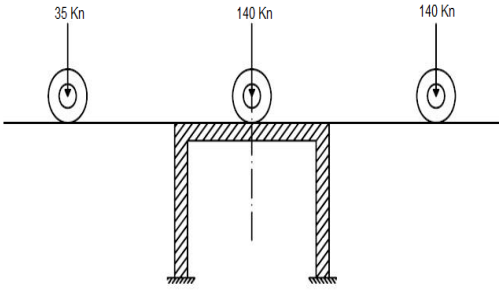
- S.w top slab :

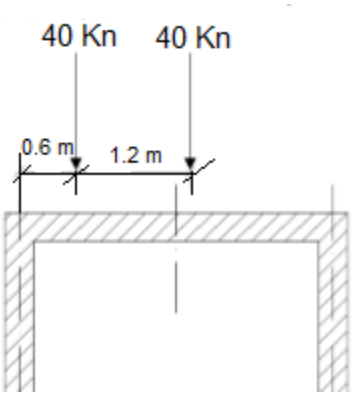
$$Dc_{top} = t^* \Upsilon_c * w = 0.3*1*24 = 7.2 kn/m$$

- S.w of two haunch :

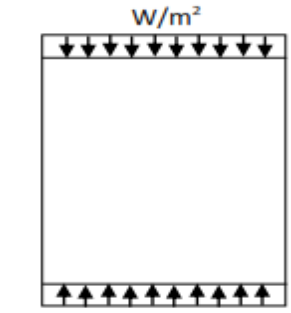
$$Dc_{haunch} = 2*h*t^2*w* \Upsilon_c = 2*0.5*0.3^2*1*24 = 2.16\ kn/m$$

Reference	Calculations	Output
	S.w of wall :-	
	$Dc_{wall} = t*l*w* \Upsilon_c = 0.3*3.3*1*24 = 23.76$ kn	
	2. Earth pressure :-	
	Earth pressure vertical :-	
	$Ev = f_e * \Upsilon s * h * w$	
	$F_e = 1 + 0.2\frac{h}{b} = 1 + 0.2[\frac{0.5}{3.3}] = 1.03$	
	$Ev = 1.03*18*0.5*1 = 9.27$kn/m	
	Earth pressure horizontal :-	
	$Eh = \Upsilon * h * w$	
	$\Upsilon_{max} = \Upsilon s * k_o$	
	$k_o = 1 - \sin \emptyset = 1 - 0.5 = 0.5$	
	$\Upsilon_{max} = 0.5*18 = 9$	
	$\Upsilon_{min} = 0.5\ \Upsilon s * k_o = 0.5*9 = 4.5$	
	Earth pressure at the top slab :-	
	$Eh_{max} = 9*0.5 = 4.5$kn/m	
	$Eh_{min} = 2.25$	
	Earth pressure at the bottom slab :-	
	$Eh_{max} = 34.2$ kn/m	
	$Eh_{min} = 17.1$ kn/m	
	3. Live load surcharge :-	
	H= 3.8 m	
	$H_{eq} = 0.9 - 0.1(H-3) = 0.82$	

	$Ls= \Upsilon s*k_o* H_{eq}*w$	
Reference	Calculations	Output
	k_o=1-sin $\emptyset = 1 - 0.5 = 0.5$ Ls=0.5*18*0.82*1=7.38 **3- Water load :-** □ **For top slap :-** Wa= zero □ **For buttom slap :-** Wa=h*w* Υ_w=9.81*3*1=29.43kn/m **4- Live load :-**  TANDEM LOAD  TRUCK LOAD من الواضح ان العربة ثنائية المحاور (tandem) تعطي عزوم أكبر من الشاحنة التصميمية	

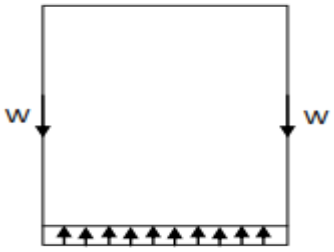
Reference	Calculations	Output
	أولا نوزع الحمولة الحية علي شريحة التوزيع عرض الشريحة:- $E = 2440 + 0.12\ (S) = 2440+0.12*3000 = 2.8\ m$ طول الشريحة:- $E_{span} = L_T + LLDF(H) = 254+1*500 = 0.754\ m$ للتوزيع علي الشريحة $110/2.8*0.754 = 52.381$ لتركيزها في العرضي فقط $52.381*0.75 = 40\ kn$ الموقع الذي يعطي أكبر عزم:-  $M_{max} = 11.52\ Kn.m$ أقصي قص يحدث عندما يكون المحور الأول فوق الدعامة (الحائط) $V_{max} = 64\ Kn$	

Reference	Calculations	Output



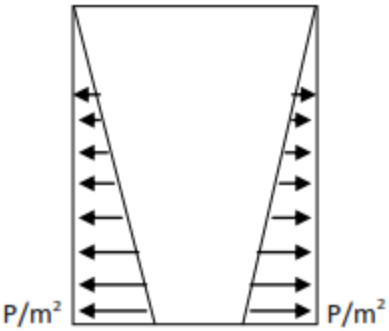
Case (2): Distributed Load

Dc_a= 7.2 Kn/m
Ev = 9.27 Kn/m



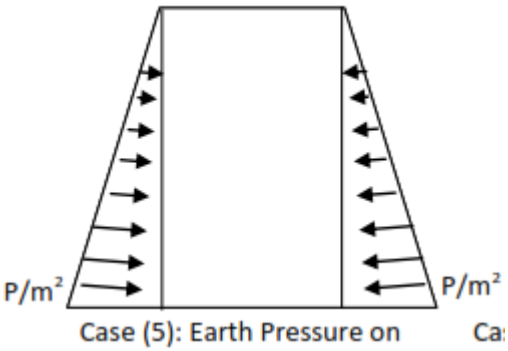
Case (3): Weight of side wall

Dc_b = 25.9 Kn



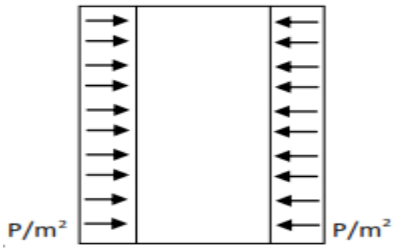
Case (4): water Pressure on Vertical Side Walls

WA = 29.43 Kn/m



Case (5): Earth Pressure on Ca

Eh_{max} = 4.5 kn/m
Eh_{min} = 2.25 kn/m



Case (6):Uniform Lateral Load on Side Walls

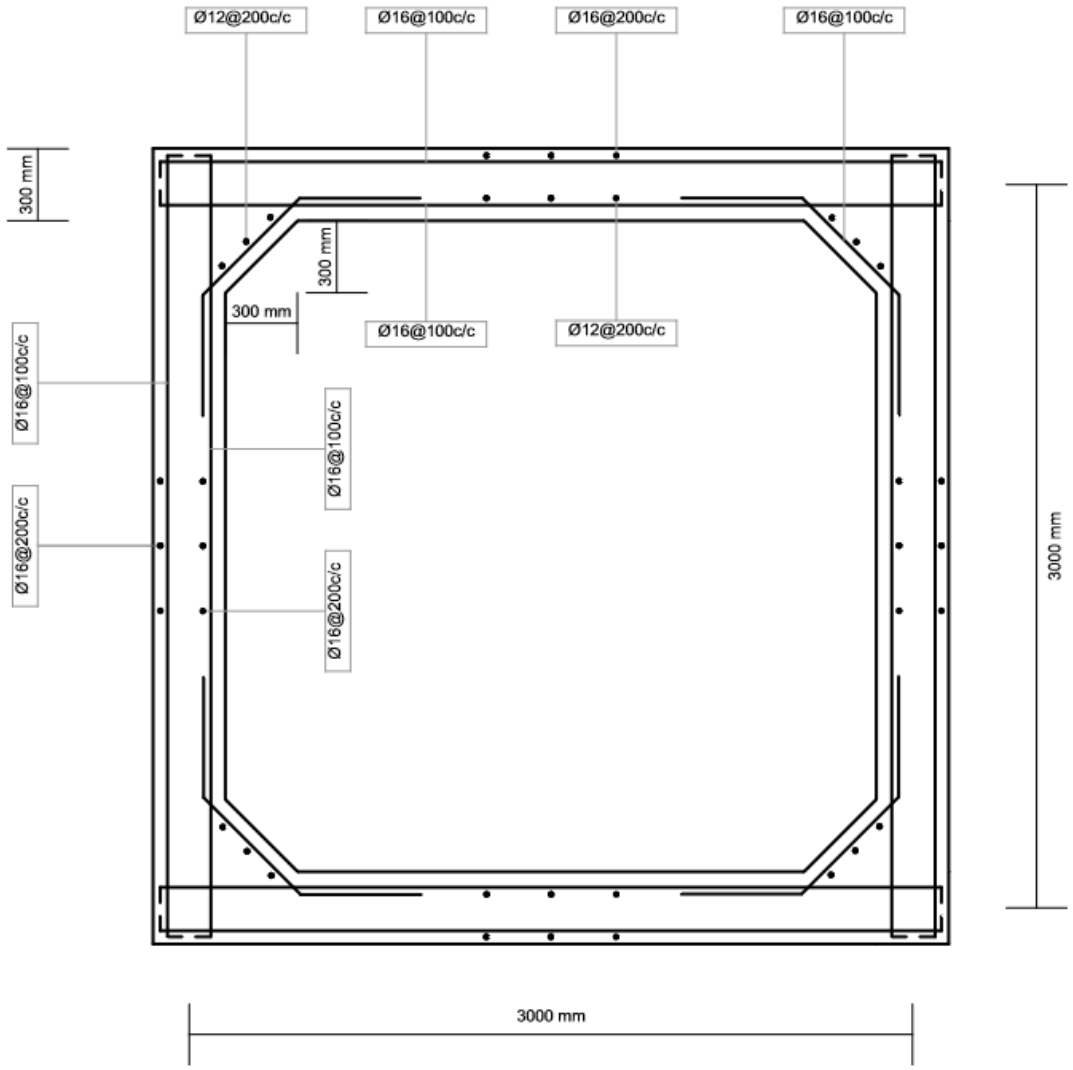
	Eh_{max} = 29.7 kn/m Eh_{min} = 14.85 kn/m L.S = 7.38 Kn/m	
Reference	Calculations	Output
	B=1000mm D=300-60-16/2=232mm f `c=35 N/mm$^2$ fy=420 N/mm$^2$ Mu=48.33 kn.m Ø=0.9 Mn=Mu/Ø=53.7 Ru=Mn/bd$^2$=0.997 ρ =0.85f `c/fy*[1-$\sqrt{1-\frac{2Ru}{0.85f`c}}$] =0.0024 $\rho_{min}$=1.4/fy=0.0033 $\rho_b$=0.85f `c*в/fy(600/600+fy)= 0.0333 ρ_{max}=0.6 ρ_b=0.02As= ρbd= As= ρbd= Ø16@200	773 mm^2 1010 mm^2

Reference	Calculations	Output
	B=1000mm D=300-60-16/2=232mm f `c=35 N/mm$^2$ fy=420 N/mm$^2$ Mu=82.23 kn.m Ø=0.9 Mn=Mu/Ø=91.367kn.m Ru=Mn/bd$^2$=1.697 ρ =0.85f `c/fy*[1-$\sqrt{1-\frac{2Ru}{0.85f`c}}$] =0.0042 $\rho_{min}$=1.4/fy=0.0033 $\rho_b$=0.85f `c*в/fy(600/600+fy)=0.033 ρ_{max}=0.6 ρ_b=0.02 As= ρbd=	967 mm^2 1010 mm^2
	Ø16@200 B=1000mm D=600-60-16/2=532mm f `c=35 N/mm^2	

Reference	Calculations	Output
	fy=420 N/mm^2 Mu=-58.48 kn.m Ø=0.9	
	□ Mn=Mu/Ø=64.978	
	□ Ru=Mn/bd^2=0.23	
	□ ρ =0.85f `c/fy*[1-$\sqrt{1-\frac{2Ru}{0.85f`c}}$] =0.0005	
	□ ρ_{min}=1.4/fy=0.0033	
	□ ρ_b=0.85f `c*в/fy(600/600+fy)=0.033	
	□ ρ_{max}=0.6 ρ_b=0.02	
	□ As= ρbd=	1772 mm^2
	Ø16@100	2010 mm^2
	Wall design :- $R_n=M_n/(f `c* b*h^2)$=0.021 $K_n= P_n/( f `c* b*h)$ =0.041 γ = 0.6 From aci design handbook SP-17M(09) Interaction diagrams	

	As=0.01Ag=3000mm^2 As=3000/2 =1500mm^2 for each face Ø16@100	 1500 mm^2 2010 mm^2
Reference	Calculations	Output
	Distribution steel : $As_{dist}=1750As/L^{0.5}=0.31As<0.5As$ Take $As_{dist}=0.5As$ Top slab :- Top reinforcement $As_{dist}=886$ Ø16@200 Bottom reinforcement $As_{dis}=387$ Ø12@200 Side wall :- Outside face $As_{dist}=750$ Ø16@200 Inside face $As_{dis}=750$ Ø16@200 Bottom slab :-	 886 mm^2 1010 mm^2 387 mm^2 566 mm^2 750 mm^2 1010 mm^2 750 mm^2 1010 mm^2

	Top reinforcement As_{dis}=484 Ø12@200	484 mm^2 566 mm^2
Reference	Calculations	Output
	Bottom reinforcement As_{dist}=886 Ø16@200	886 mm^2 1010 mm^2
	Check for shear :- Max shear V=184.59 Kn $Vn=0.17 * \lambda * \sqrt{f`c} b * d$ =635.05 Kn $Vn > V$ OK	



شكل (4-4) مقطع العبارة