3-3 النماذج الحسابية :

3-3-1 تمهيد :

تتناول هذه الجزئية حل مثالين لخزانات تحت ارضية ، يشمل الحل كل من التحليل و التصميم و اختبارات التشقق ، تم التحليل بالطريقة التقربية ، بينما تم التصميم وفقا لمتطلبات الكود الهندي (IS3370) .

النموذج الاول هو عبارة عن خزان ارضي التربة المحيطة به تصنف كاتربة جافة (Dry Soil) لذلك توجد حالتين من التحميل للحصول علي العزوم القصوى ، الحالة الاولي (case 1) (عندما يكون الخزان ممتلئ و غير محاط بتربة ، والحالة الثانية (case 2) عندما يكون الخزان فارغ و تحت تأثير التربة المحيطة .

اما النموذج الثاني فيه التربة المحيطة بالخزان تصنف كاتربة رطبة (Wet soil) و لذلك هنالك اربعة من حالات التحميل ، الحاله الاولي (case 1) هي الخزان ممتلئ والتربة المحيطة به جافة ، و الحالة الثانية (case 2) هي الخزان فارغ والتربة المحيطة مشبعة ، والحالة الثالثة (case 3)هي الخزان ممتلئ والتربة مشبعة ، بينما الحالة الرابعة (case 4) عندما يكون الخزان فارغ و التربة المحيطة به جافة ، لكن في الحقيقة اقصي عزم يتم الحصول عليه من الحالتين الاولتين فقط .

	Sudan university of since and technology	Page. No: (1)
Ref	Calculation	Output
	Example 1 : Design an underground tank of internal dimensions 6m*3m*3m.The soil surrounding the tank always remains dry . the tank shall be provide with a roof slab . the soil weights 1600N per meter^3 having an angle of response of 30° . use 20 concrete and Fe 250 steel . Solution : 1- Walls : 1-1 Analysis of walls : Unless otherwise mention it will be taken that the soil surrounding the tank is not liable to be removed at any stage . The tank will therefore be designed for the following critical cases : Case 1: when the tank is full . Case 2: when the tank is empty . All walls will be designed as propped cantilevers .	

	Sudan university of since and technology	Page. No : (2)
Ref	Calculation	Output
	Maximum soil pressure $16000 \times 3 \times \frac{1 + sin30°}{1 - sin30°} N/meter^2 = 16000 N/meter^2$ *→Maximum water pressure* $= 9810 \times 3 = 29430 N/meter^2$ *→Net max pressure* $P = 29430 – 16000 = 13430\ N/meter^2$ *→Max B.M producing tension away from the water face* $= \frac{pn^2}{33.5} = \frac{13430 \times 3^2}{33.5} Nm = 3608.06 Nm$ *→Max B.M producing tension near from the water face* $= \frac{pn^2}{15} = \frac{13430 \times 3^2}{15} Nm = 8058 Nm$ *→Maximum bending moment producing tension near the water face* $= \frac{ph^2}{33.5} = \frac{16000 \times 3^2}{33.5} Nm = 4298.5 Nm$	 $\underline{\underline{8058 Nm}}$ $\underline{\underline{4298.5 Nm}}$

<table>
<tr><td></td><td>Sudan university of since and technology</td><td>Page. No :
3</td></tr>
<tr><td>Ref</td><td>Calculation</td><td>Output</td></tr>
<tr><td></td><td>

→Maximum bending moment producing tension away from the water side

$$=\frac{ph^2}{15}=\frac{16000\times 3^2}{15}Nm = 9600Nm$$

The result obtained for the above two cases are tabulated below

Case	*B.M producing Tension on water face (Nm)*	*B.M producing Tension away from water face(Nm)*
Case1	*8058*	*3606.9*
Case2	*4298.5*	*9600*

2-1 Design of walls :

The outer walls of an underground tank must also be designed from cracking stress consideration cracking stress means the actual tensile stress in concrete due to bending moment this stress must be limited to 1.6N/m^3 to satisfy this condition the wall must be sufficiently thick . the overall thickness D may be determined by assuming the moment of resistance of 0.2667bD^2 Nmm .

</td><td>9600Nm</td></tr>
</table>

	Sudan university of since and technology	Page. No : 4
Ref	Calculation	Output
	IN our case equating the moment of resistance to the maximum bending moment . *We have* $0.2667 \times 1000D^2 = 9600 \times 1000 \quad \therefore D = 189.7\ mm$ *Let us provide a thickness of 200mm providing an* *effective cover of 40mm effective depth =200 – 40 = 160mm steel for bending moment of 9600 Nm* $= \frac{9600 \times 1000}{125 \times 0.86 \times 160} mm^2 = 558 mm^2$	
T-4 @ IS3370	***Provide 12*****mm dia. Bars @200 mm centers (565mm^2)** $\frac{8004000}{115 \times 0.86 \times 160} mm^2 = 509 mm^2$	
T-4 @ IS3370	**Provide 12mm. dia. Bars @180 mm centers (628mm^2)** Provide also distribution steel of 10mm diameter bars at 240 mm centers near each face .	**<u>565mm^2</u>** **628mm^2**
	Provide 10 mm. dia. Bars @240 mm centers (372mm^2) 3-1 Cracking stress of walls :	

	Sudan university of since and technology	Page. No : 5
Ref	Calculation	Output
T-21 @ SI3370 T-21 @ SI3370	❖ Position of actual neutral axis. Taking moments about the neutral axis $= 1000\frac{n^2}{2} + (13-1)628(n-40)$ $1000\frac{(200-n)^2}{2} \div (13-1)565(200-\mathrm{n}-40)$ Solving we got n=88.4cm → Moment for resistance determined from the tension zone may be taken as total tension $\times\ 0.82d$ Cracking stress due to a B.M of 9600Nm This B.M produces tensile stress be C_r Total tension = $1000 \times 111.6\frac{C_t}{2} \div (13-1)565 \times \frac{71.6}{111.6}C_t \quad N$ Equating the M.R to B.M $60150C_t \times 0.82 \times 160 = 9600 \times 1000$ $\therefore C_t 1.22\ N/mm^2 (less\ than\ 1.6Nm^2)$ Cracking stress due to a bending moment of 8058 Nm This bending moment produces tension near water face .	$\therefore C_t 1.22\ N/mm^2$

	Sudan university of since and technology	Page. No : 6
Ref	Calculation	Output
T-21 @ SI3370	Let the tensile stress in concrete to C_r →Total tension $= 1000\times 88.4 \times \frac{C_t}{2} \div (13-1)\times 628 \times \frac{48.4}{88.4} C_t \quad N.$ $=48330C_t$ →Equating the M.R to the B.M $48330C_t \times 0.82 \times 160 = 8058 \times 1000$ $C_t = 1.24\ \mathrm{N/mm^2}$ (less than $1.6\ \mathrm{N/mm^2}$) ## 2- roof slab : ## 1-2 analysis of roof slab : Loads. Dead load (150mm) = 3750 N/m^2 Live load = 1500 N/m^2 Total = 5250 N/m^2 Consider a one meter wide strip of the slab Maximum bending moment $= \frac{5250\times 3.2^2}{8} Nm = 6720\ Nm$	C_t = 1.24 N/mm^2 6720 Nm

	Sudan university of since and technology	Page. No : 7
Ref	Calculation	Output
T-4 @ SI3370	## 2-2 Design of roof slab : n the usual concrete mix (M 15) be used for the roof slab and using Fe 250 steel , $0.87\times 1000d^2 = 6720\times 1000 \quad \therefore \text{d} = 88\text{mm}$ Provide cover of 40 mm effective depth available $150 - 40 = 110\ mm$ and will. Therefore, not be included in the B.M $A_s = \frac{6720\times 1000}{140\times 0.86\times 110} = 507\ mm^2$ **Provide 12 mm Φ bars @ 200 mm c/c** Distribution steel $=\frac{0.3}{100} 150\times 1000mm^2 = 450mm^2$ Spacing of 10 mm diameter bars $= \frac{79\times 1000}{450} mm = 150\ mm\ centers$ **Provide 10 mm Φ bars @ 150 mm c/c**	Roof thickness 150 mm $507\ mm^2$

	Sudan university of since and technology	Page. No : 8
Ref	Calculation	Output
	3- Base slab : **3-1 Analysis of base slab :** Design of the base slab. When the tank is full. Consider one meter run of the tank weight of the roof slab $3.4 \times 0.15 \times 25000 = 12750\ N/m$ Walls : $2 \times 0.2 \times 3 \times 25000 = \underline{30000\ \text{N/m}}$ Total $\underline{= 42750\ \text{N/m}}$ (Note. Water pressure on the base slab and the weight of base slab will be directly counteracted by ground pressure calculation). Net upward reaction $= \frac{42750}{5} = 8550\ N/meter^2$ B.M at the center due to the above loading $= 21375(1.6 \times 1.25)Nm = 7481.25\ Nm$ Producing tension on the water side. Water pressure and soil pressure action on the wall will producing a moment of 8004 Nm of the same type	$\underline{7481.25\ Nm}$

	Sudan university of since and technology	Page. No : 9
Ref	Calculation	Output
	∴ total bending moment at the center $= 7481.25 + 8058\ Nm = 15539.25\ Nm$ Produce tension on water side. B.M. at the end. <u>Hogging bending moment</u> = 8058 Nm <u>Sagging bending moment</u> $= 8550 \times \frac{0.9^2}{2} = 3462.75\ Nm$ ∴ Net B.M. $8058 - 3462.75 = 4541.25\ Nm$ *Produce tension in the water side.* ***Case 2. When the tank is empty .*** *For this condition B.M. at center due to vertical loads* *= 7481.25 Nm* *Produce tension on the water side.* *B.M. due to soil pressure on the vertical walls = 9600 Nm* *Produce tension away from water side.*	<u>$15539.25\ Nm$</u> <u>4541.25 Nm</u>

	Sudan university of since and technology	Page. No : 10
Ref	Calculation	Output
	$\therefore\ Net\ B.M. at\ the\ center = 9600 - 7482.25$ $= 2118.75\ Nm$ *Producing tension away from water side.* *B.M. at the end* $= 3462.75 \div 9600\ Nm = 13062.75\ Nm$ *Produce tension away from the water side* *The results obtained for the above tow cases are tabulated below :*	$\underline{\underline{2118.75\ Nm}}$ $\underline{\underline{13062.75\ Nm}}$

Case	*B.M.at end section (Nm)*	*B.M. at mid span (Nm)*	*B.M. produce tension*
Case 1	*4595.25*	*15539.25*	*On the water*
Case 2	*13062.75*	*2118.75*	*Away form water side*

2-3 Design of base slab :

Let the thickness of the base slab D mm.

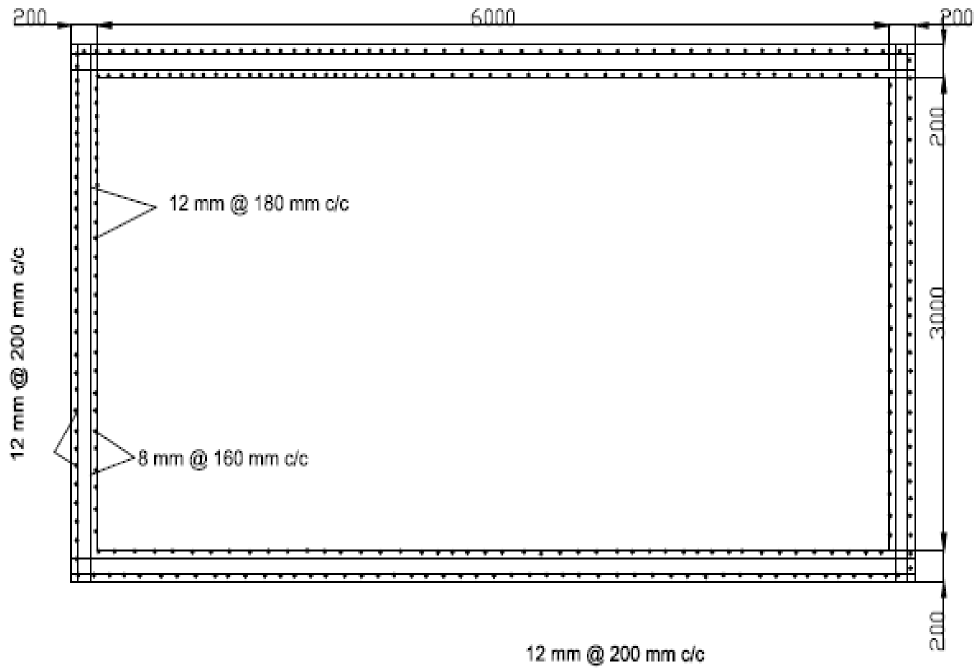
From cracking stress consideration equating the moment of resistance to max B.M. we have,

	Sudan university of since and technology	Page. No : 11
Ref	Calculation	Output
	$= 0.2667\ bd^2 = 0.2667 \times 1000\ D^2$ $= 15485.25 \times 1000$ *D = 240 mm* *Let us provide an overall depth of 250 mm* *Let the effective cover be 60 mm* $\therefore Effective\ depth \quad = 250 - 60 = 190\ mm$ *Steel for bending moment of 15485.25 Nm* $= \frac{15539.25 \times 1000}{115 \times 0.86 \times 190} = 827\ mm^2$ *Spacing of 12 mm bending bars* $= \frac{113 \times 1000}{834} = 135\ mm$ **Provide 12 mm diameter bars at 110 mm centers (1027 mm^2)** *Steel for bending moment of 13062.75 Nm* $= \frac{13062750}{125 \times 0.86 \times 100} mm^2 = 639\ mm^2$ *Spacing of 12 mm diameter bars =* $\frac{113 \times 1000}{834} = 176.8mm$	Base slab thickness 250 mm

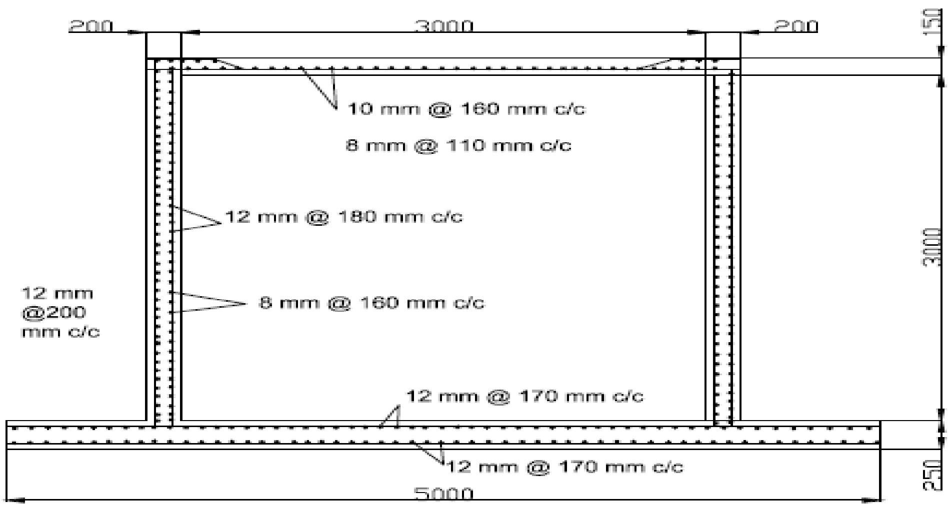
	Sudan university of since and technology	Page. No : 12
Ref	Calculation	Output
T-21 @ IS3370	***Provide 12 mm diameter bars at 170 mm centers (665 mm^2)*** Provide also distribution steel of 10mm diameter bars at 200mm centers near each face . *3_3Check for cracking stress* *→Position of actual neutral axis taking moments above the neutral axis , we have* $1000\frac{n^2}{5}+(13-1)\times 1027(n-60)$ $=1000\frac{(250-n)^2}{2}+(13-1)665(250-n-60)$ n = 123 mm cracking stress due to a bending moment of 15539..25Nm this bending moment produces tension on the water face let the tensile stress in concrete be C_t total tension = $1000\times 123\times\frac{C_t}{2}+(13-1)1027\times\frac{83}{123}C_t\ N$ $=70880C_t\ N$	

	Sudan university of since and technology	Page. No :13
Ref	Calculation	Output
T-21 @ SI3370	Equating the moment of resistance to the bending moment 70880 $C_t \times 0.82 \times 190$ $= 15539.25 \times 1000$ $C_t = 1.562\ N/mm^2$ (less than $1.60\ N/mm^2$) Cracking stress due to a bending moment of 13062.75 Nm This bending moment produce tension away from the water side let the tensile stress in concrete be C_t →Total tension $= 1000 \times 127 \times \frac{C_t}{2} + (13-1) \times 665 \times \frac{83}{127} C_t N$ →Equating the M.R to the B.M $68700 C_t \times 0.82 \times 190 = 13062.75 \times 1000$ $C_t = 1.22\ N/mm^2$ (less than $1.6\ N/mm^2$)	$C_t = 1.562\ N/mm^2$ $C_t = 1.22\ N/mm^2$

التفصيلات الانشائية



مسقط افقي



قطاع عرضي

	Sudan university of since and technology	Page. No : 1
Ref	Calculation	Output
	Example 2 :- design an R.C tank of internal dimensions 12m * 3.5m * 3.5m . the tank is to be provided underground. The soil surrounding the tank is likely to get wet. Adopt suitable working stress. Soil weights 18000 N/m^3. use M 20 concrete and fe 250 steel. **Solution** . **<u>the following cases arise</u> :** **Case 1.** Tank is full and the surrounding soil is dry. **Case 2**. Tank is empty and the surrounding soil is water-logged. **Case 3**. Tank is full and the surrounding soil is water-logged. **Case 4**. Tank is empty and the surrounding soil is dry.	

	Sudan university of since and technology	Page. No : 2
Ref	Calculation	Output
	1- Walls : **1-1 Analysis of walls :** The tank will therefore be designed for the following critical cases : **Case 1**. Tank is full and the surrounding soil is dry. **Case 2**: Tank is empty and the surrounding soil is water-logged. ***case1*** : **Tank is full and the surrounding soil is water-dry.** All walls will be designed as propped cantilevers. Maximum soil pressure $18000 \times 3.5 \times \frac{1 \div sin30°}{1 \div sin30°} N/meter^2 = 21000\ N/m^2$ →*Maximum water pressure* $= 9810 \times 3.5 = 34335 N/meter^2$ →*Net max pressure* $P = 34335 – 21000 = 13335\ N/meter^2$	

	Sudan university of since and technology	Page. No : 3
Ref	Calculation	Output
	→Consider one meter run of the wall →*Max B.M producing tension away from the water face* $\frac{pn^2}{33.5} = \frac{13335 \times 3.5^2}{33.5} Nm = 4876.2Nm$ Maximum bending moment producing tension near the water face $= \frac{\text{ph}^2}{15} = \frac{13335 * 3.5^2}{15} = 10890.2\text{Nm}$ ***Case 2.*** : **Tank is empty and the surrounding soil is water-logged.** Pressure intensity exerted by wet earth at the bottom of the wall. $= wh\frac{1 - \sin 6°}{1 + \sin 6°} = 18000 * 3.5 * \frac{1 - \sin 6°}{1 + \sin 6°}$ $= 51075.83\ N/m^2$ Consider one metre run of the wall Maximum bending moment producing tension away from the water face . $= \frac{ph^2}{33.5} = \frac{51075.828 * 3.5^2}{33.5} = 18676.98\ N.m$	$\underline{\underline{4876.2Nm}}$ $\underline{\underline{10890.2\text{Nm}}}$ $\underline{\underline{18676.98\ N.m}}$

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4</td></tr>
<tr><td>Ref</td><td>Calculation</td><td>Output</td></tr>
<tr><td></td><td>→Maximum bending moment producing tension away from the water face

$= ph^2/15 = \frac{51075.828*3.5^2}{15} = 41711.93$ Nm

The bending moment computed above are tabulated below :

<table><tr><th>Case</th><th>B.M producing Tension on water face (Nm)</th><th>B.M producing Tension away from water face(Nm)</th></tr><tr><td>Case1</td><td>10890.2</td><td>4876.2</td></tr><tr><td>Case2</td><td>18676.98</td><td>41711.93</td></tr></table>

2-1 Design of walls

From cracking stress consideration an overall depth to satisfy $M=0.2667bd^2$

$\frac{1}{6}fbD^2 = \frac{1}{6} * 1.6bD^2 = 0.2667bD^2$

May be provided.</td><td><u>41711.93 Nm</u></td></tr>
</table>

	Sudan university of since and technology	Page. No : 5
Ref	Calculation	Output
T-4 @ SI3370 T-4 @ SI3370	$0.2667*1000*D^2=41730000$, D= 395.3mm Let us provide thickness of 400mm. Let us effective cover to the reinforcement be 40mm Effective depth = 400-40 = 360 mm Steel for a bending moment of 41711.93 Nm $=\frac{41711.93*1000}{125*.86*360}=1077.82mm^2$ Spacing of 18 mm diameter bars = $=\frac{254*1000}{1077.82}=235.66\,mm$ ***Provide 18*mm dia. Bars @210 mm centers (1211mm^2)** Steel for abending moment of 18680 Nm $=\frac{18676980}{115*.86*360}=524.57mm^2$ Spacing of 12mm diameter bars $\frac{113*1000}{524.57}=215mm$ ***Provide 12*mm dia. Bars @180 mm centers (578mm^2)** →Provide also distribution steel of 10mm diameter bars at	$1077.82mm^2$ $235.66\,mm$ $524.57mm^2$ $215mm$

	Sudan university of since and technology	Page. No : 6
Ref	Calculation	Output
T-21 @ SI3370	110 mm centers near each face . 3-1 Cracking stress of walls : Position of actual neutral axis : Taking moments about the neutral axis , we have $= \frac{1000n^2}{2} + (13-1)1411(n-40)$ $= \frac{1000(400-n)^2}{2} + (13-1)628(400-n-40)$ (n = 196.4 mm) Cracking stress due to bending moment of 41711.93 Nm Let the maximum tensile stress in concrete be c_1 →Total tension $= \frac{1000*196.4}{2} + (13-1)1411 * \frac{156.4}{196.4}ct= 111700C_t$ Equating M.R to the B.M 111700 c_1 * 0.82*360 = 41711930 C_1 = 1.20 N/mm^2 (less than 1.6 N/mm^2)	C_1 = 1.20 N/mm^2

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Ref	Calculation	Output
T-21 @ SI3370	Cracking stress due to a bending moment of 18676.98 Nm → Let the maximum tensile stress in concrete be c_t . →Total tension $= \frac{1000*203.6*c_t}{2} + (13-1)628*\frac{163.6}{203.6}c_t = 107900\ c_t$ →Equating the M.R to the B.M $107900\ C_T * .82 * 360 = 186676980$ $c_t = 0.64\frac{N}{mm^2}$(less than 1.6 N/mm^2) 2- roof slab : 1-2 analysis of roof slab : **Loads :** Dead load (150mm) 25*150=3750 N/m^2 Live load =1500 N/m^2 Total = <u>5250 N/m</u>^{2} ❖ Consider a one meter wide strip of the slab. →Maximum bending moment	$c_t = 0.64\frac{N}{mm^2}$

	Sudan university of since and technology	Page. No : 8
Ref	Calculation	Output
T-4 @ SI3370	$= \frac{5250 * 3.9^2}{8} = 9981\ N.m$ **2-2 Design of roof slab :** If the concrete mix (M15) be used for the roof slab : $0.87*1000d^2$=9981*1000 , d= 108 mm ,effective cover of 40mm the effective depth available = 150-40 = 110 mm A (st)= $\frac{9981000}{140*0.86*110} = 753.62mm^2$ Spacing of 12mm diameter bars $= \frac{113*1000}{753.62} = 149.94$mm ***Provide 12*mm dia. Bars @120 mm centers** Distribution steel $= \frac{0.3}{100} * 150 * 1000 = 450mm^2$ Spacing of 10mm diameter bars $= \frac{79 * 1000}{450} = 150\ mm\ centres$	M=9981 $N.m$ Roof thickness 150 mm $753.62mm^2$ $450mm^2$

	Sudan university of since and technology	Page. No : 9
Ref	Calculation	Output
	***Provide 10*mm dia. Bars @150 mm centers** **3- Base slab :** **3-1 Analysis of base slab :** →Assume 0.5m thick base . up left pressure = 9810*4=39240 N/m^2 Consider one meter run of tank →Weight of roof = 4.3*.15*25000 N = 16125 N →Weight of tow walls = 2*0.4*3.5*25000=70000 N →Base slab. =0.5*x*25000=12500x N →Weight of soil on the projecting portions of the base slab. = (x-4.3)3.5*18000 N = 63000(x-4.3) N →Total up thrust = 39240x N	

	Sudan university of since and technology	Page. No : 10
Ref	Calculation	Output
	Equating the download and upward forces 16125+70000+12500x+63000(x-4.3)= 39240x X= 5.09m Let us provide a base width of 5.5 meters The base slab well be designed for case 1 and 2 Mentioned earlier. ***case1*** : **Tank is full and the surrounding soil is water-dry.** →Weight of the roof slab =16125 N/m →Weight of the two walls= 70000 N/m →Total =86125 N/m **Note** . water pressure on the base slab and the weight of the base slab well be directly counteraeted by ground pressure and well not therefor be included in the B.M computations. →Upward reaction due the net load	

	Sudan university of since and technology	Page. No : 11
Ref	Calculation	Output
	$= \frac{86125}{5.5} = 15659.09$N/m →B.M at the center due to the above loading $= \frac{8625}{2}(1.95 - 1.375) = 24761$ Nm (Producing tension on the water side .) Water pressure lateral soil pressure on the vertical walls will produce a moment of 10890.2 Nm of the same type . Total bending moment at the center. = 24761+10890.2= 35651.2 Nm (Producing tension near water face .) →B.M at the end <u>Hogging bending moment</u> = 10890.2 Nm <u>Sagging moment</u> $= \frac{15659.09*0.8^2}{2} = 5010.9$ Nm →Net bending moment = 5879.3 Nm	<u>35651.2 Nm</u> <u>5879.3 Nm</u>

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Ref	Calculation	Output
	(Producing tension on the water face) ***Case 2.*** : **Tank is empty and the surrounding soil is water-logged.** →Intensity of upthrust exerted by water in the soil = 9810*4= 39240 Nm^2 →Net upward pressure = 15659.09+39240 = 54899.09 N/m^2 Consider one meter run of the tank →B.M at the center $= \frac{54899.09*5.5}{2}(1.95 - 1.375)$= 86809 Nm (Producing tension on the water side) →But B.M at the center due to saturated earth pressure on the vertical walls = 41711.93 Nm (Producing tension away from the water side) . →Net B.M at the center = 86809-41711.93 =45097.07Nm	45097.07 Nm

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Ref	Calculation	Output
	(Producing tension on the water side) . →B.M at the end Sagging moment = 41711.93 Nm Cantilever moment (sagging) = $= \frac{54899.09*0.8^2}{2} = 17567.7\,Nmm$ →Total B.M at the end = 41711.93+17567.7= 59279.63 Nm (Producing tension away from the water sie .) **Summary of moment for the base slab** *2-3 Design of base slab :*	59279.63 Nm

Case	B.M at end section (Nm)	B.M at mid span (Nm)	B.M produce tension
Case 1	5879.80	35651.20	On water side
Case 2	59279.63	45097.07	away from water side

From cracking stress consideration , equating the moment

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Ref	Calculation	Output
	of resistance to the maximum bending moment , we have = 0.2667bD^2 = 0.2667*1000D^2=59297.7*1000 (D=471 mm) Thickness provided = 500 mm Let us provide an effective cover of 60mm → Effective depth = 500-60 =440m Steel a bending moment of = 58297.7 Nm As= $\frac{59279.63*1000}{125*.84*440} = 1253.27\ mm^2$ Spacing of 18mm diameter bars $= \frac{254*1000}{1253.27} = 202mm$ **Provide 18mm. dia. Bars @180 mm centers (1413mm^2)** Steel for a bending moment of 45097.07 Nm As= $\frac{45097.07*1000}{115*.86*440} = 1036.33mm^2$	Base slab thickness 500 mm 1253.27 mm^2

	Sudan university of since and technology	Page. No : 15
Ref	Calculation	Output
T-21 @ SI3370	Spacing of 16 mm diameter bars $= \frac{201*1000}{1036.33} = 202mm$ **Provide 16 mm. dia. Bars @160 mm centers** **($1256mm^2$)** →Provide also distribution steel of 10mm diameter bars at 80 mm centers near each face . **(3-3) Check for cracking stress :** Position of actual neutral axis $1000\frac{n^2}{2} + (18-1)*1256(n-60)$ $= 1000\frac{(50-n)^2}{2} + (18-1)1698(500-n-60)$ n=253 mm Cracking stress due to a bending moment of 59297.63 Nm This bending moment produces tension away from the water side . →Let the maximum tensile stress in concrete be c_r →Total tension	**$1256mm^2$**

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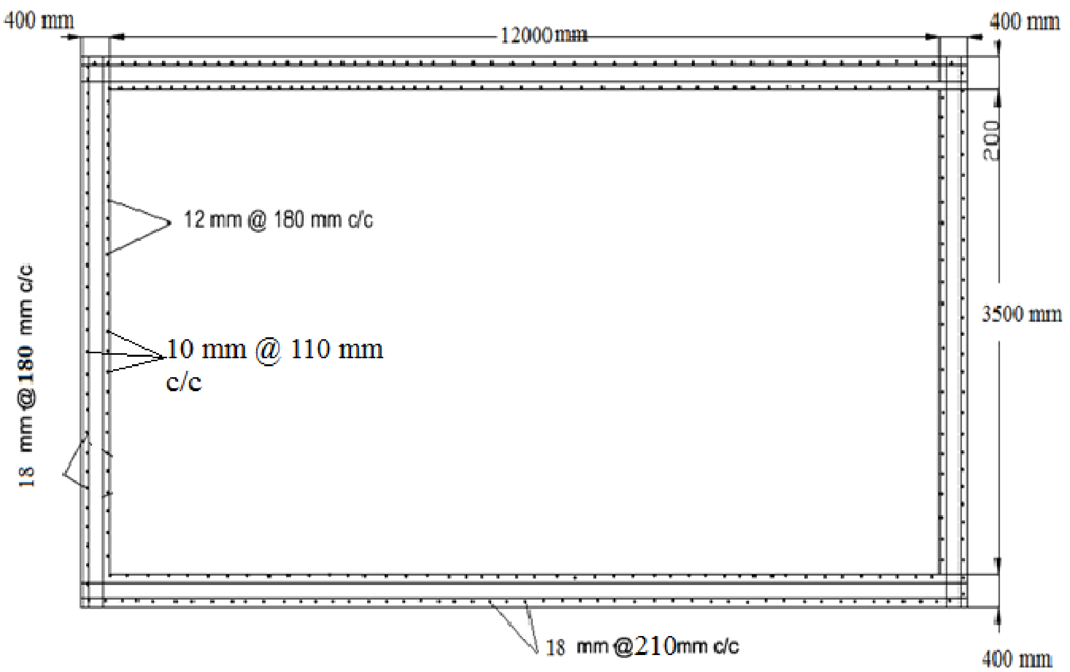
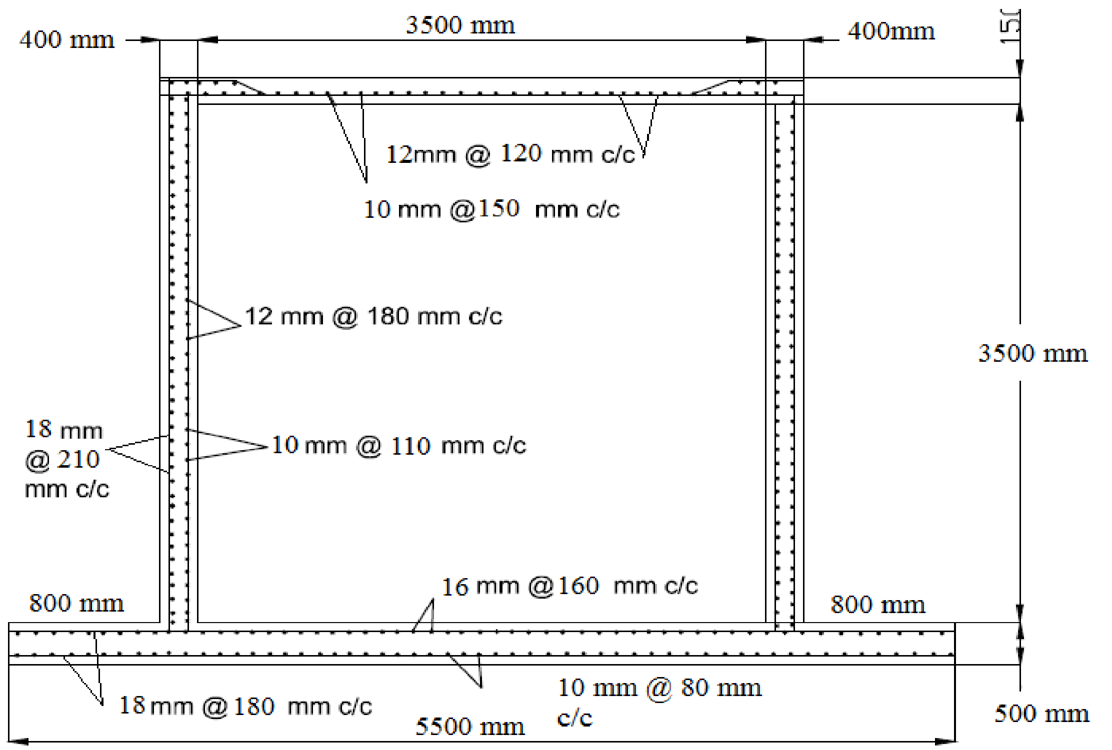
Ref	Calculation	Output
T-21 @ SI3370 T-21 @ SI3370	=1000*247*ct/2+$(18-1)*1693*\frac{187}{257}$ct= 188900ct →Equating the M.R to B.M 188900C_t*.82*440=59279.63*1000 C_t=1.12 N/mm^2 (less than 1.6 N/mm^2) Cracking stress due to bending moment of 45097.07Nm This bending moment produces tension near the water side →Let the maximum tensile stress in concrete be c_t →Total tension = (1000*253*ct)/2+$(18-1)1.253*\frac{198}{263}$ct= 138000ct →Equating the M.R to the B.M 138900C_t*.82*440=45097.07*1000 C_t=0.9N/mm^2(less than 1.6 N/mm^2)	 C_t=1.12 N/mm^2 C_t=0.9N/mm^2

التفصيلات الانشائية



مسقط أفقي



قطاع عرضي