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Qassim University College of Engineering

Summer Training (GE406)

Hosted By:

Fada Engineering Consulting Company

Semester 445

Submitted by:

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ACKNOWLEDGEMENT:

First, I thank Allah Almighty who inspired me and inspired my family and friends to help and encourage me during my summer training period, and I extend my sincerest gratitude to my mother who encouraged me throughout my university journey.

Also, I would like to express my sincerest appreciation and gratitude to the faculty members for their commendable efforts for their eagerness to educate us and prepare us to be creative Engineers.

Finally, I thank Fada Company for hosting us, and everyone who contributed to our educational training.

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1.0-INTRODUCTION

This report will demonstrate all the skills and knowledge learned during the two months period.

The essence of this report is about the construction of a water ground tank which is utilized as a water distribution network for Conference Center at Qassim University.

Also, it will involve the processes at which the tank is constructed, and analyzed using CSI software.

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2.0-PLANE REINFORCEMENT DETAILING.

A (14.9 m *7.6 m) rectangular water concrete tank, shown in figure (1), the tank is divided into two main areas,

pumping room (7 m * 3 m) and the water storage room (11 m * 7 m).

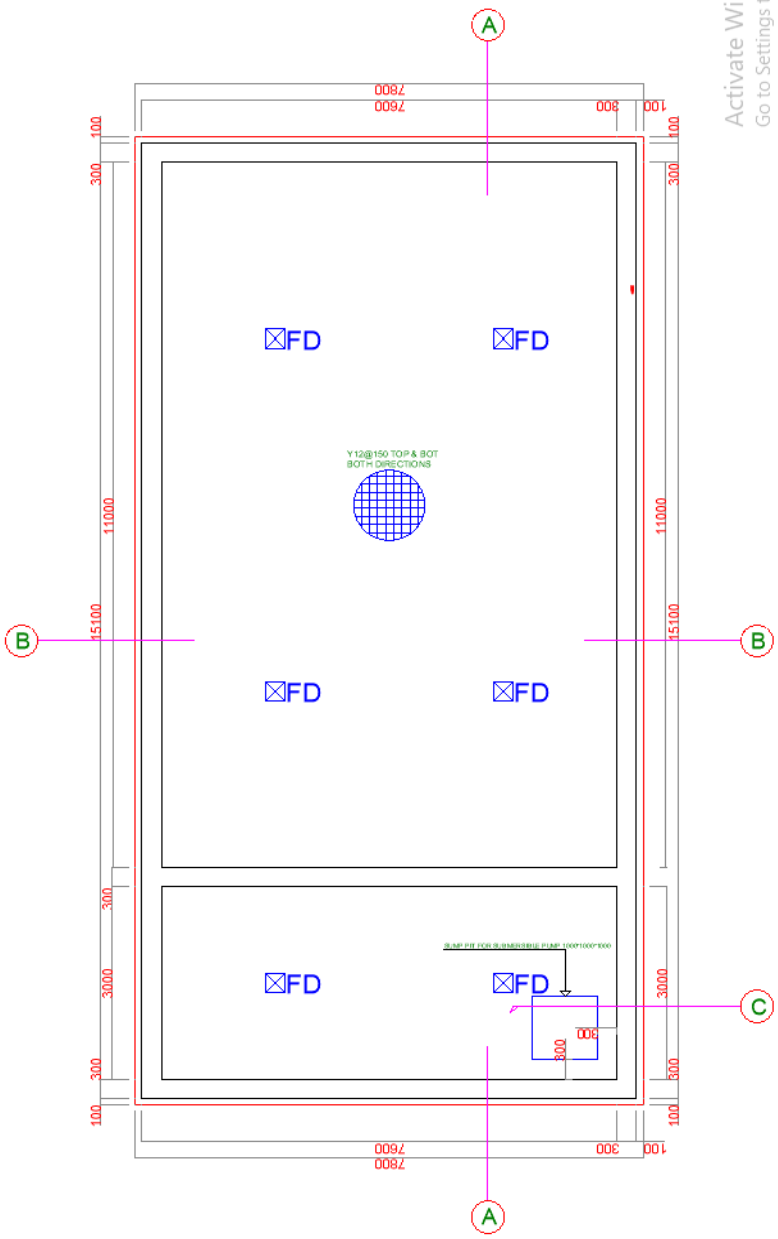

Figure 1Water Tank and Pump Room Base

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Figure (2) shows tank coordinates with the attached Table (1)

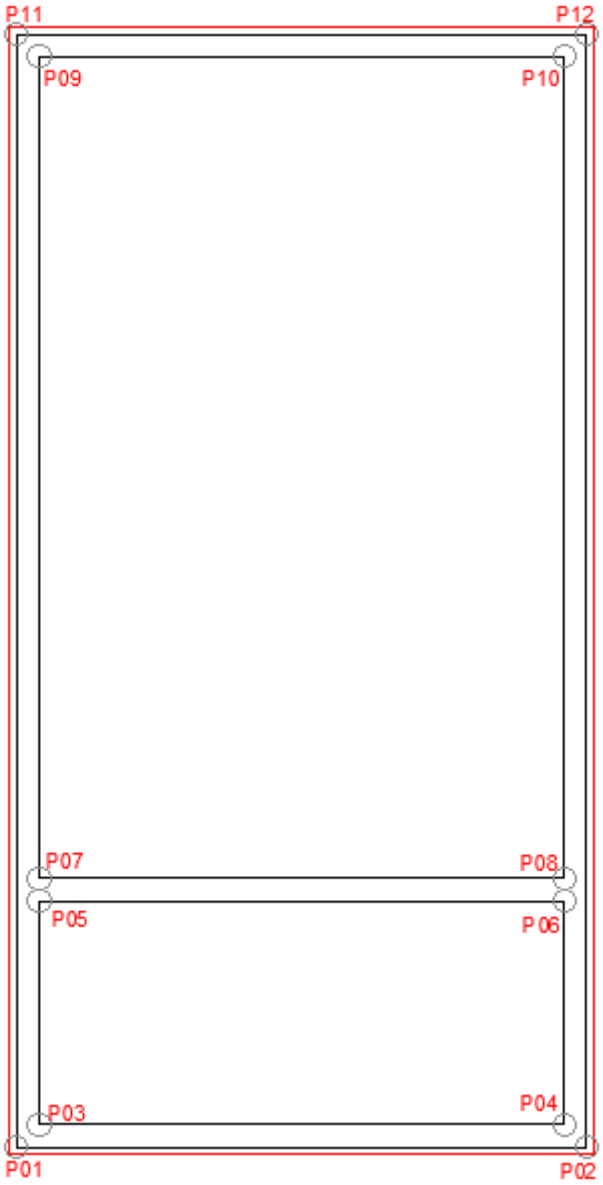

Figure 2:Water Tank and Pump Room Coordinates

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Table 1: Water Tank Coordinates

COORDINATES		
POINTS	EASTING	NORTHING
P01	49516.068	11933.155
P02	49516.755	11391.586
P03	49516.394	11398.884
P04	49516.027	11391.912
P05	49518.382	11399.155
P06	49519.015	11392.183
P07	49516.681	11399.182
P08	49519.313	11392.21
P09	49529.636	11400.176
P10	49530.268	11393.205
P11	49530.877	11400.502
P12	49531.594	11392.933

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Figure (3) shows that we have a 300 mm retaining wall and (400 mm * 700 mm) beams, and a slab thickness of 200 mm.

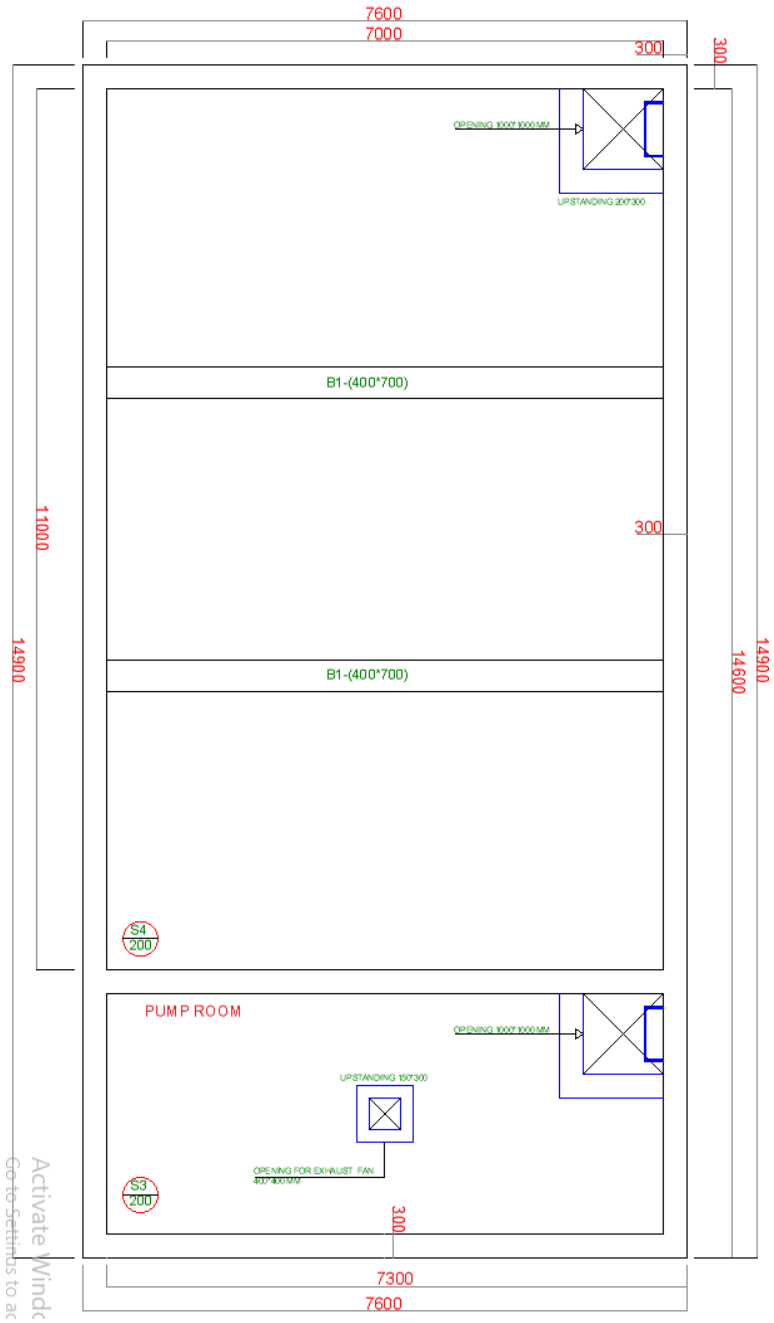

Figure 3:Water Tank and Pump Room Slab

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Figure (4&5) shows BB section reinforcement detailing, from the footing level to the slab level, also it shows that the tank elevation of (4 m).

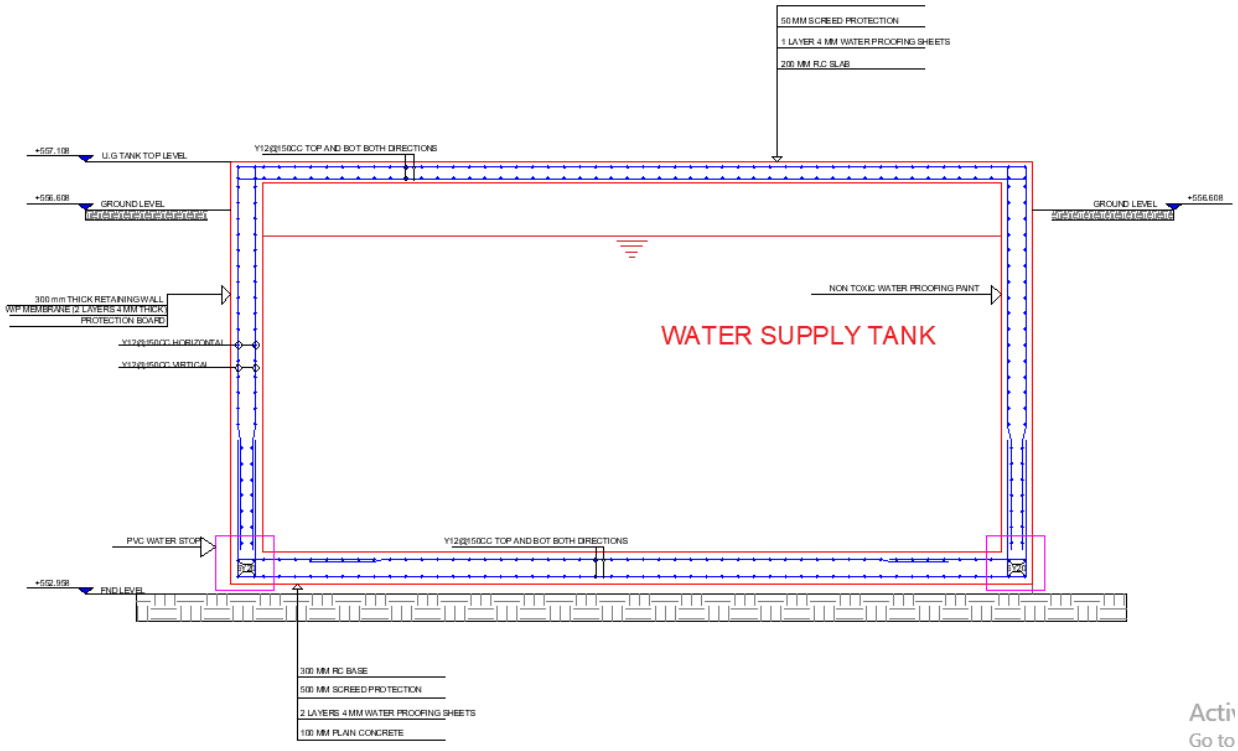

Figure 4: Section B

Figure (6) shows section B reinforcement detailing.

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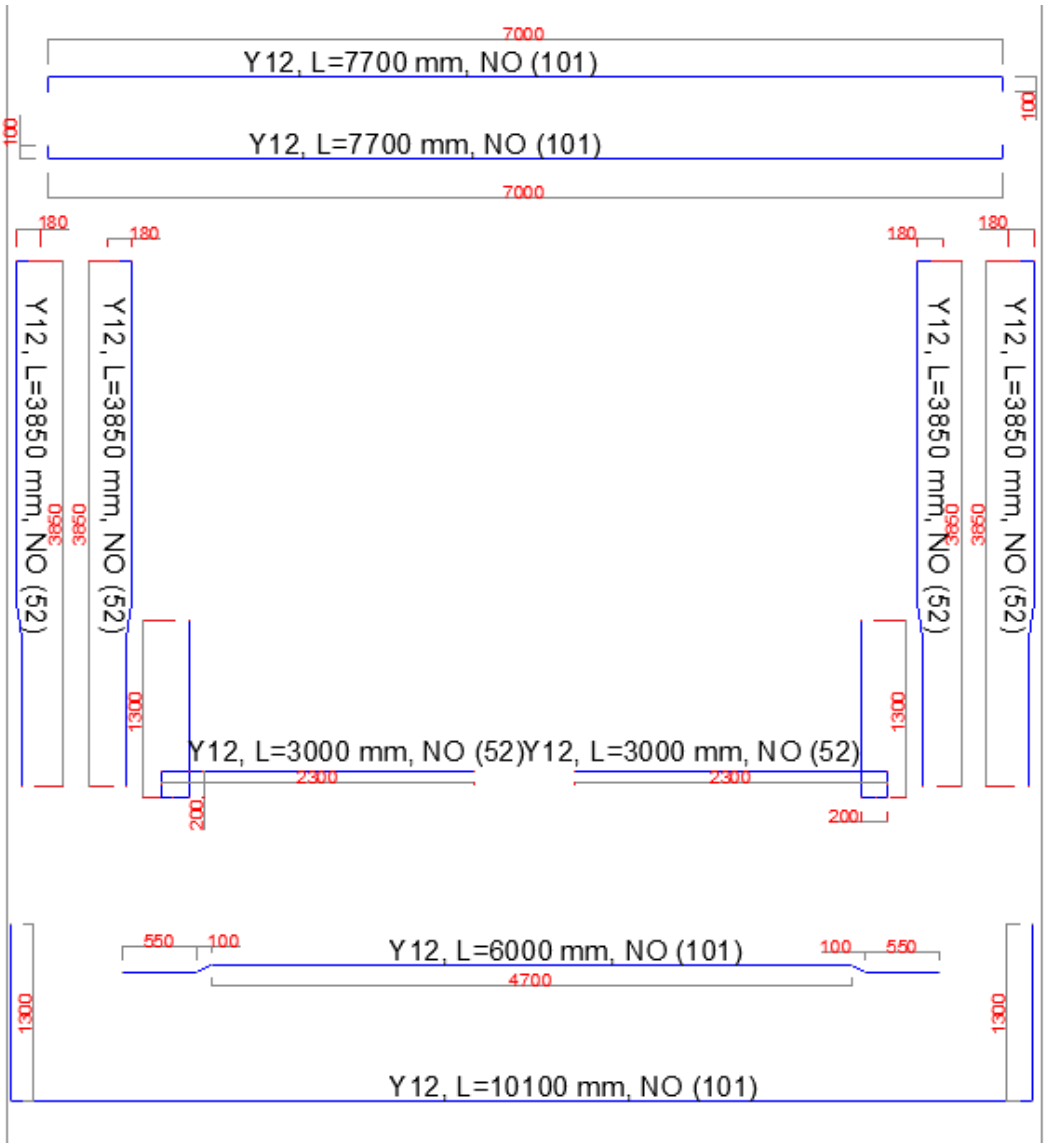

Figure 5: Section BB Reinforcement Detailing

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Figure (7&8&9) shows A section reinforcement detailing, from the footing level to the slab level, also it shows the beams reinforcement cross section reinforcement.

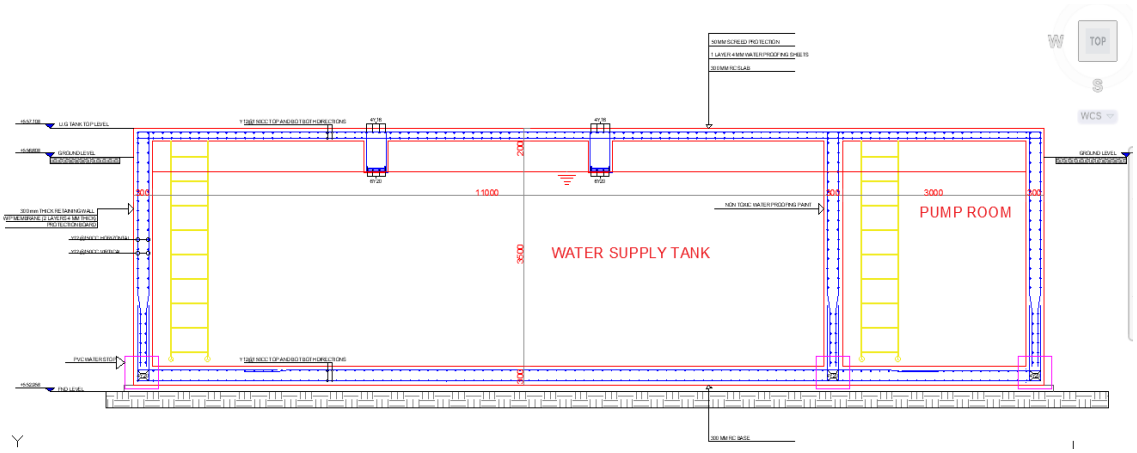

Figure 6: Section A

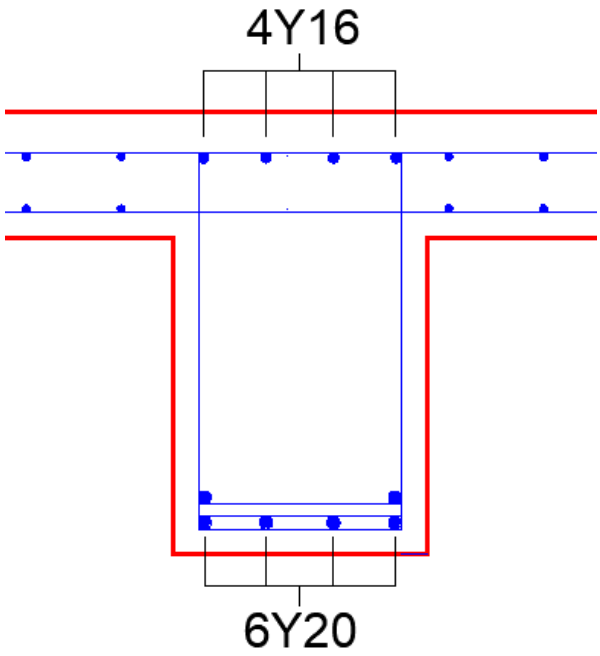

Figure 7: Beam Section

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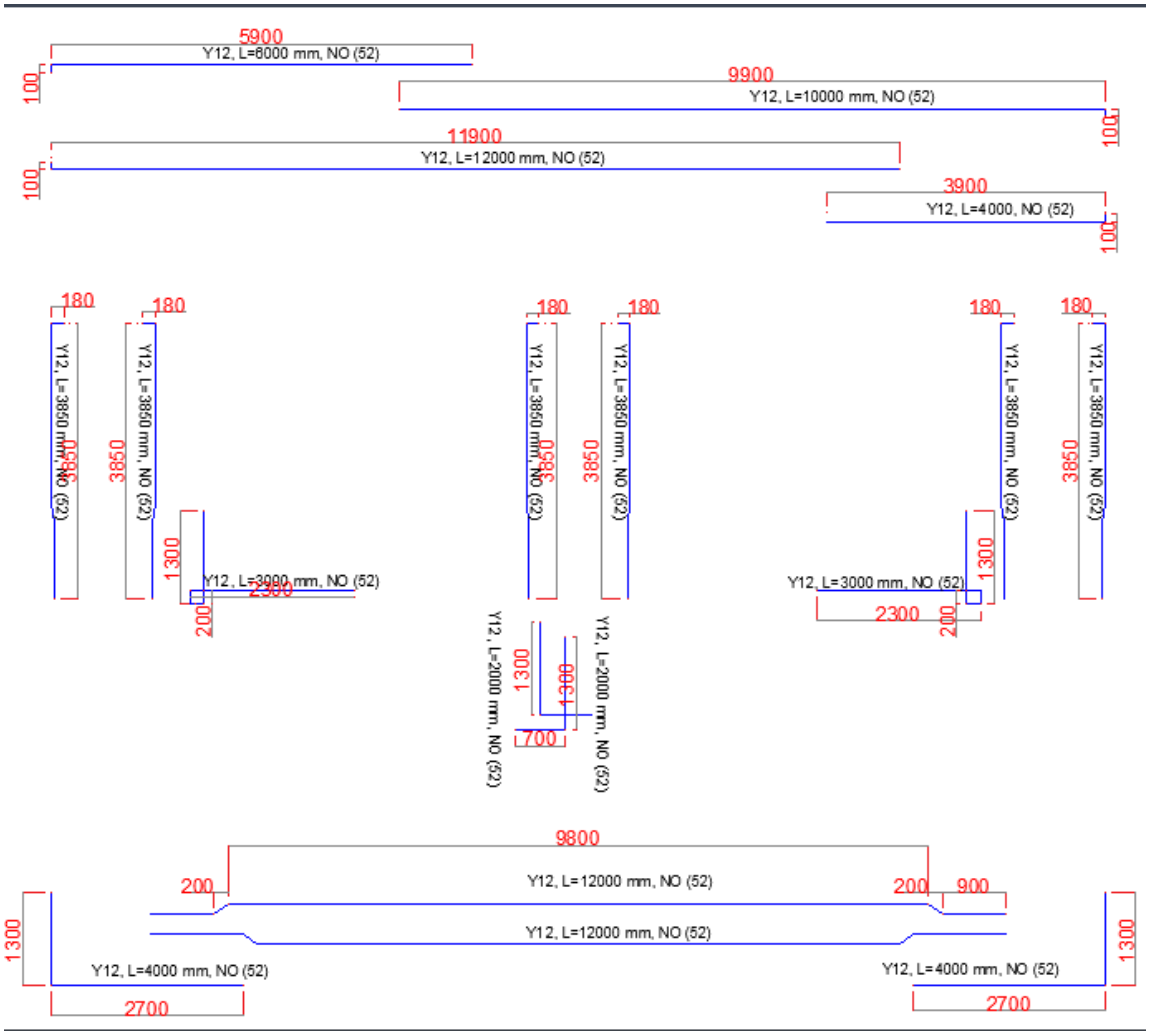

Figure 8: Section A Reinforcement Detailing

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Figure (10) shows slab reinforcement detailing.

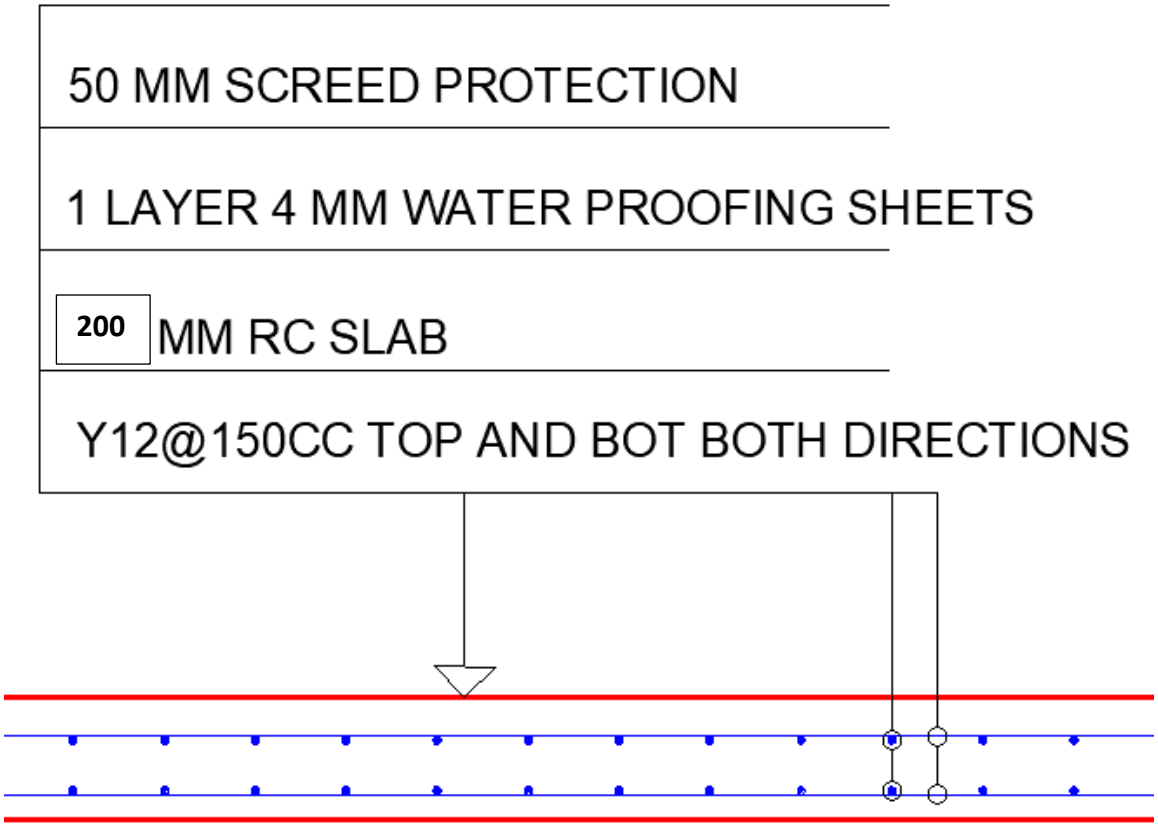

Figure 9: Slab Section

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Figure (11) shows the raft reinforcement detailing.

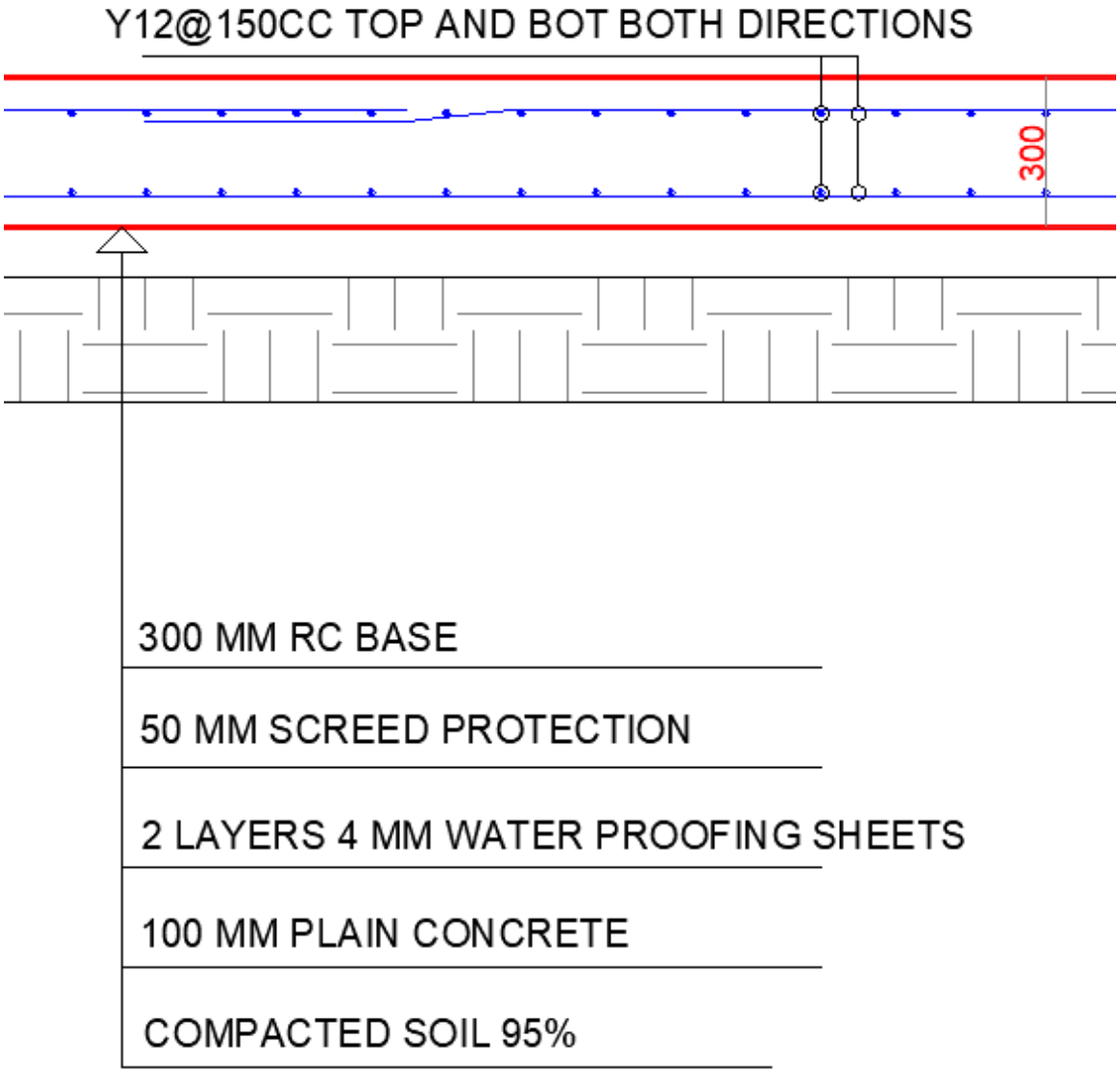

Figure10 : Raft Foundation Section

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Figure (12) shows the retaining wall reinforcement detailing.

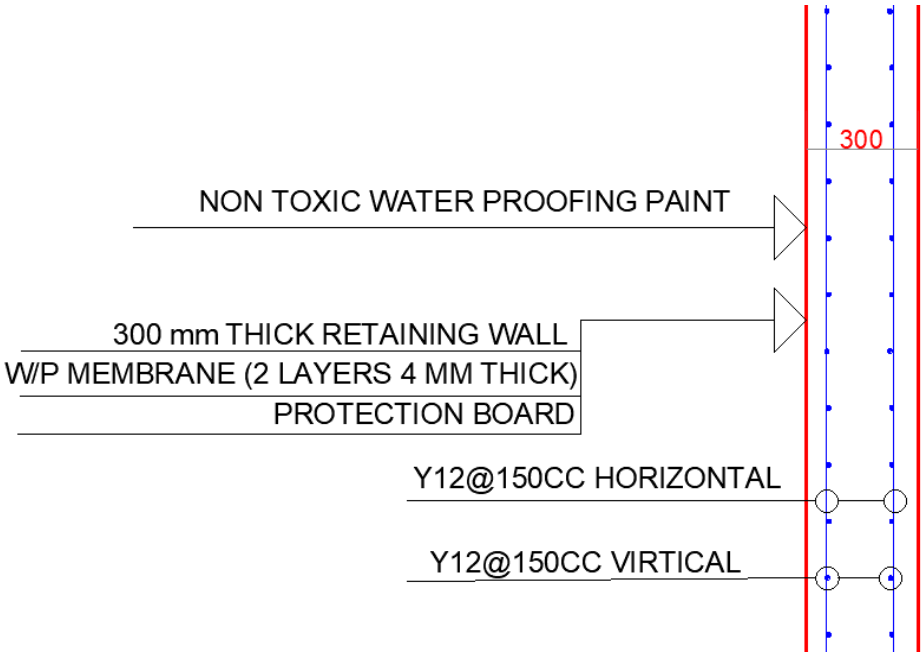

Figure 11: Retaining Wall Section

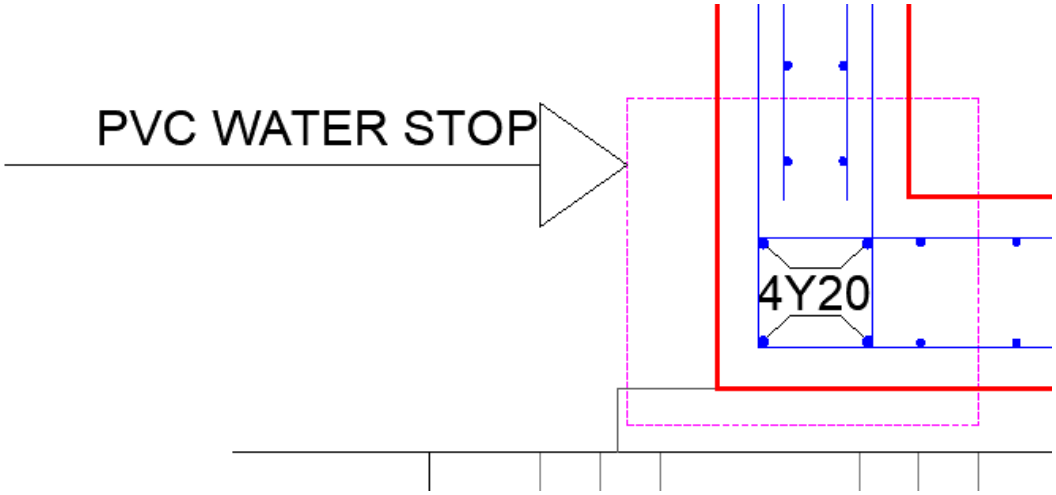

Figure 12: Retaining Wall Convergence with the Raft Section

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3.0-CONSTRUCTION PROCEDURE

3.1.1-Allocate the Water Tank Location

Surveying the desired construction area using modern devices for measurement's , which includes the work of photographing, measuring, and determining the dimensions of the land and its neighbors, its direction, and its coordinates, and this is with the aim of issuing a survey decision for the segment of the land.

Figure 13: Theodolite

Figure 14: Automatic Leveling

Note that we didn't get the chance to observe some of the initial procedures, sense the project started before our summer training period, thus from surveying through excavation, intel foundation construction unfortunately hasn't been covered in the report.

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3.1.2-Excavation

After determining the levels and measurements by the surveying engineer, they are carried out by the excavation contractor, making sure that the measurements are correct.

Figure 15: Excavator

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3.1.3-Compaction

The compaction process is preformed to strengthen (increase the bearing capacity) the soil.

After excavation process, compaction process takes place on 25 cm layers, and make sure that the soil is compacted 95% using sand cone test compared to laboratory tests as mentioned in the plane.

Figure 16: Roller

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3.1.4-Plain Concrete

Applying nylon sheets on the soil directly to prevent moisture from penetrating the 10 cm plain concrete.

Plain concrete has many advantages such as:

1-Protecting the foundation from the effects of moisture, as it isolates the base from moisture and soil.

2-Leveling the soil surface at the appropriate level, while achieving the required slope ratio, which facilitates carpentry and rebar works.

Figure 17:Plain Concrete

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3.1.5-Isolation

Adding 2 overlapping layer of 4 mm water proofing sheets over the 10 cm plain concrete and using DERMAPRIMER liquid to insure a perfect adhesion between the sheets.

Two layers of bitumen are placed over the plain concrete for the purpose of filling the gaps, to reduce the rise of moisture into the raft.

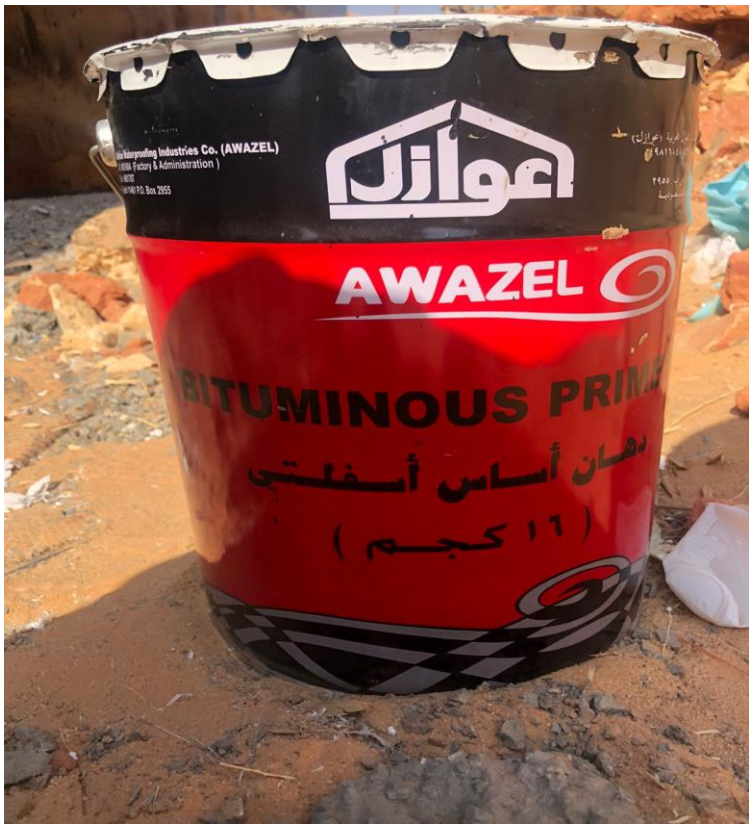

Figure 18:DermaPrimer Liquid

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3.2.0-Screed Protection

After applying the isolation rolls, it is recommended to apply a 50 mm screed plain concrete type which contains thinner mixtures of cement and aggregates, which will give a smooth surface, and more importantly, when the labor place the reinforcement do not scratch the water proofing sheets installed earlier.

Figure 19: Screed Protection

`

3.3.0-Raft Foundation

This type of foundation spreads the load of the structure over a larger area than other foundations, uniformly distributing the pressure on the ground.

And here where my first day of summer training started, unfortunately I missed all the previous events.

Figure 20: Raft Foundation

The reinforcement of the footing is Y12@150 mm top and bottom,

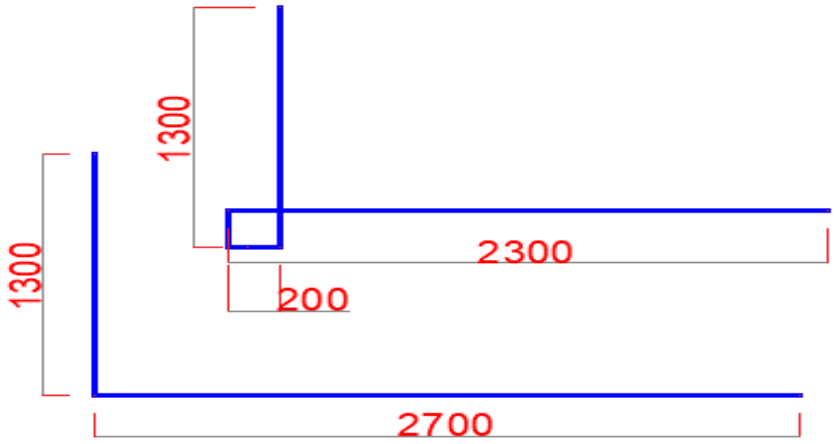

Figure 21:Footing Development Length

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3.4.0-Retaining Wall

A wall built to resist the pressure of liquids or earth backfilled, sand, or other granular material behind it after it has been built. It is generally required in the construction of hill roads, embankments, abutments, and side walls of bridges and so on. Depending on the site conditions, the type of material to be bonded and the height of the wall to be built.

3.4.1-PVC Water Stop

It is typically a centrally placed seal between joints within concrete to prevent water from passing through the joints.

Figure 22: Water Stop

It is placed before pouring the foundation concrete, at which, half of the water stop roll is embedded in the foundation, and the other half will be covered by the wall concrete pouring.

By this way, the water will not be able to infiltrate outside of the tank.

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3.4.2-Carpentry Works-1

Firstly, the type of wood used is plywood, which one of its advantages that it gives a smooth surface of concrete.

The internal face plywood is lowered using the crane and then installed by the workers, see figures (25)

Figure 23: Lifting the plywood by the crane

`

3.4.3-Reinforcement Works

After the installation of the plywood, Steel rebars are installed and attached on the plywood boundary and separated by a 50 mm concrete cover.

Figure 24: 50 mm Concrete Cover

`

Figure 25: Wall Reinforcement's

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A tie rod is used to tighten the wooden concrete wall pot from both sides, figures (28) show the pipe inserted in the plywood.

Figure 26: Water stop Tie Rod Pipe Installation

Basically, how it works, the water stop is placed centrally within the wall and attached with two tie bars separately through pipes in the plywood sheets

`

3.4.4-Carpentry Works-2

After installing the reinforcement and the water stop tie rod pipe, an exterior plywood is applied on the reinforcement.

Figure 27: Installing 2nd Face of Plywood

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After That, Ltzana wood is installed vertically on the plywood sheet, To leave a part of the pipe at the edge of the Ltzana wood end to be filled with insulating materials, and in order to distribute the strength of the wood along the whole wall frame, and to facilitate the possibility to control the wall width.

Figure 28: Installing Vertical Ltzana Wood

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Lastly, horizontal Ltzana wood is placed on the vertical ones, and tightened using a tie rod from both sides with a circular nut and a rectangular plate.

Figure 29: Outer Face

Figure 30: Inner Face

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3.4.5-Supporting The wall Before Casting

Jack’s post is a steel post used in the construction trades for temporary support of ceilings, walls and trenches consisting of two primary parts, the main part of the post, and the jack screw or other adjustable fitting on one or both ends. Both ends are normally fitted with flat metal plates on the end, providing additional support area.

So, in case of supporting the wall of the tank, the posts are placed on the tank wall in 3 layouts, one is supported at the bottom of the wall, the second is supported at the center of the wall, the third is supported at the top of the wall and repeating this pattern every 90 cm of the wall.

This procedure is applied on both wall sides, to grantee a safe and successful concrete casting.

Figure 31:Exterior Supporting Jack's posts

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Figure 32: Interior Supporting Jack's posts

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3.4.6-Concrete Casting

The concrete is poured for the wall at a height of 20 cm. After that, the vibrator is used to distribute the concrete in the critical areas, then the pouring begins in batches at a height of 50 cm. After filling half of the wall with concrete, the concrete is left to rest, then after 15 minutes, the remaining half is filled in batches of 50 cm.

Figure 33: After Casting

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3.5-Concrete Tests

- Slump test.

The slump is a measure indicating the consistency or workability of cement concrete, thus the higher the slump the higher the workability.

Slum allowance is 2.5 cm, for example if the client asks for a slump of 17 cm and got 14 or 20 cm, he has the right to refuse it.

In our case of wall casting, it is expected to order a high value of slump sense the wall is 3.5 meter high, to achieve a high workability to avoid segregation of the concrete.

- cylinder crushing test.

Compressive strength is the capacity of material or structure to resist or withstand under compression. The Compressive strength of a material is determined by the ability of the material to resist failure in the form cracks.

The ordered concrete type is C35, or the desired strength of concrete is 35Mpa. So, we should take 6 samples, test 3 samples after 7 days which should achieve at least 70% of the required strength, the other 3 after 28 days which should achieve 100% of the required strength.

Figure 34: Cylindrical Concrete Samples

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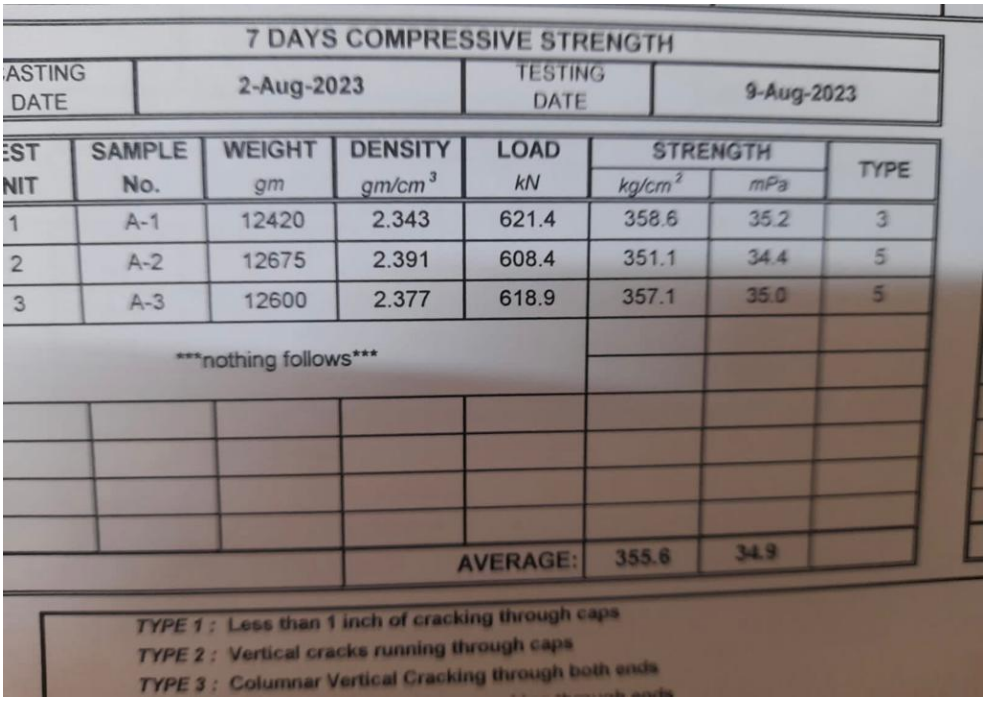

7 DAYS COMPRESSIVE STRENGTH

ASTING DATE	2-Aug-2023	TESTING DATE	9-Aug-2023

EST NIT	SAMPLE No.	WEIGHT gm	DENSITY gm/cm^3	LOAD kN	STRENGTH kg/cm^2	STRENGTH mPa	TYPE
1	A-1	12420	2.343	621.4	358.6	35.2	3
2	A-2	12675	2.391	608.4	351.1	34.4	5
3	A-3	12600	2.377	618.9	357.1	35.0	5
nothing follows							
				AVERAGE:	355.6	34.9	

TYPE 1 : Less than 1 inch of cracking through caps
TYPE 2 : Vertical cracks running through caps
TYPE 3 : Columnar Vertical Cracking through both ends

Figure 35: Crushing Test Results After 7 Days

Figure (37) shows, that the concrete reach it's required strength in the first 7 days.

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3.6.0-Water Tank Slab

3.6.1-Carpentry Works

Firstly, the jack's posts are held as a frame in the tank base to prepare them to carry the plywood, which is used as a mold for casting the concrete, then, the layer of Ltzana wood is installed and carried by the Jack's holding plates. See figure (38).

Figure 36: Jack's Posts Frame

`

After that, another layer of Ltzana wood is intensified above the first layer in the opposite direction. See figure (39).

Figure 37: Ltzana Wood installation

`

Lastly, the plywood is installed above the Ltzana wood layer. See figure (40).

Figure 38: Plywood Installation

`

3.6.2-Beam Reinforcement's

The beam reinforcement is spliced with the wall reinforcements. See

Figure 39: Beam Reinforcement's

`

3.6.3-Slab Reinforcement's

The type of slab used is flat slab, which has a top and bottom reinforcement both directions.

Figure 40: Slab Reinforcement's

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3.6.4-Concrete Casting

The concrete is casted in layers, followed by the use of the concrete viberator.

Figure 41: After Casting the Slab

Pressure release cowls. See figure (43).

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3.6.5-Tank Openings

The tank has 3 openings, two for maintenance, and one for the exhaustion fan. See figures (44)

Figure 42: Maintenance Opening

`

3.7-Wall isolation [Finishes]

Adding overlapping layers of 4 mm water proofing sheets over the wall and using bitumen liquid to insure a perfect adhesion between the sheets and the wall.

Figure 43: Isolation Rolls

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4.0-TANK ANALYSIS

The tank will be checked to be structurally safe against failure modes using Etabs software.

4.1-Problem Definition

- A Rectangular tank of 14.9∗7.6∗4 $m3$, It is divided into a water tank with 11∗7 $m2$, and a pump room of 3∗7 $m2$.
- There is a possibility for the water truck to stand around the sides of the tank with surcharge live load of 12 KN/m^2
- Soil Backfill above the tank=0.5 m
- The soil classification is sandy soil with average unit weight and cohesion of γ=1.8 $ton/m3$=18 $KN/m3$, C=0 $KN/m2$
- Friction Resistance ∅=20°
- Live load above the tank slab $L.L$=0.5 Ton/m^2=5 $KN/m2$
- Soil Bearing Capacity of qs=2 $KG/Cm2$=20 $Ton/m2$ = 200 $KN/m2$
- Compressive strength of concrete and yield strength of steel, $f'c$=35Mpa, fy=420Mpa
- Water Unit Weight = 10 KN/m^2
- **It is required to check the tank reinforcements within the applied loads.**

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4.2-DXF File

Prepare the DXF file using AutoCAD software, importing it to Etabs software.

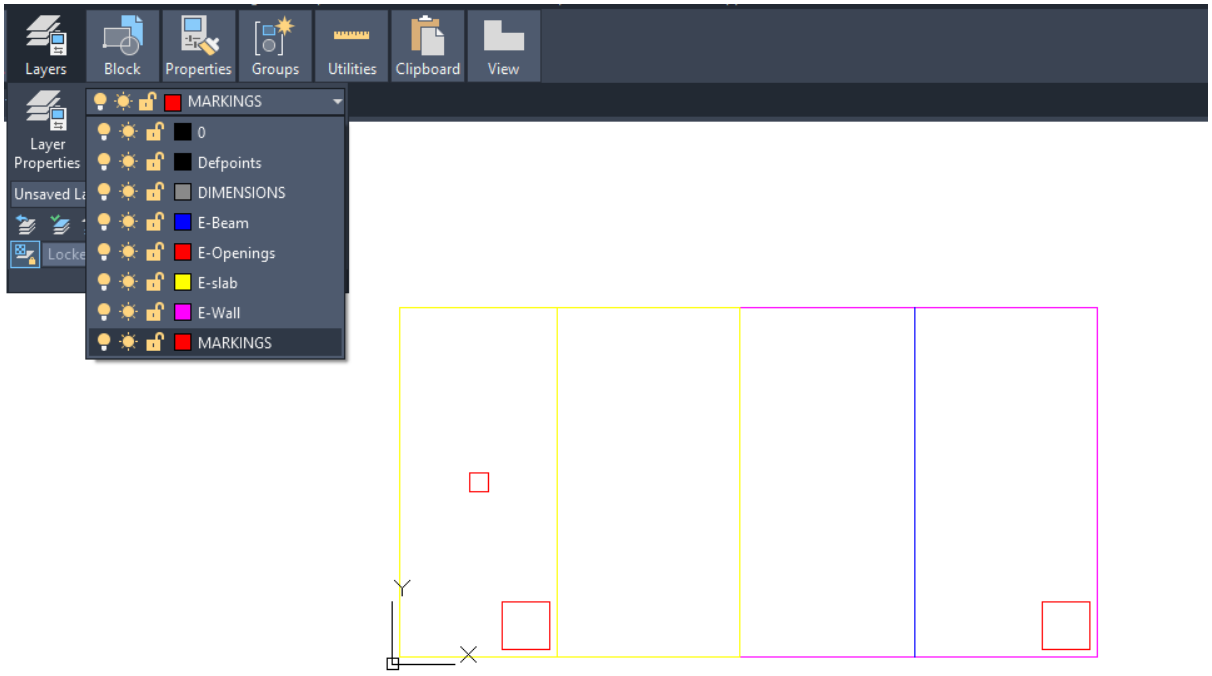

Figure 44:DXF File

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4.3.0-Programe Definitions

4.3.1-Material Properties

Which include the compressive strength of concrete (section 3.5), and the yield strength of steel.

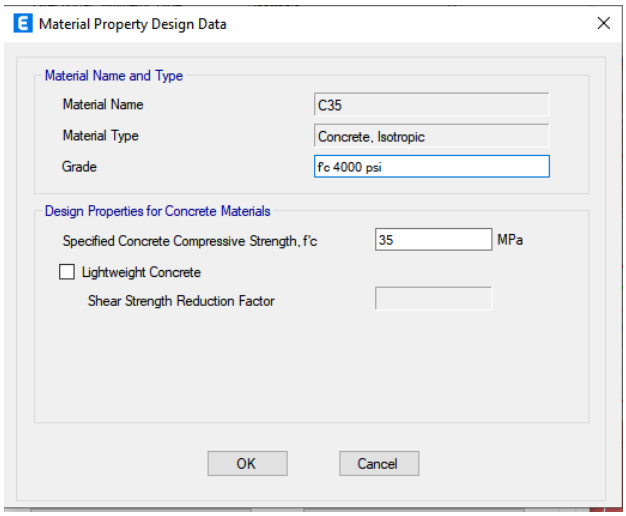

Figure 45:Define Concrete Properties

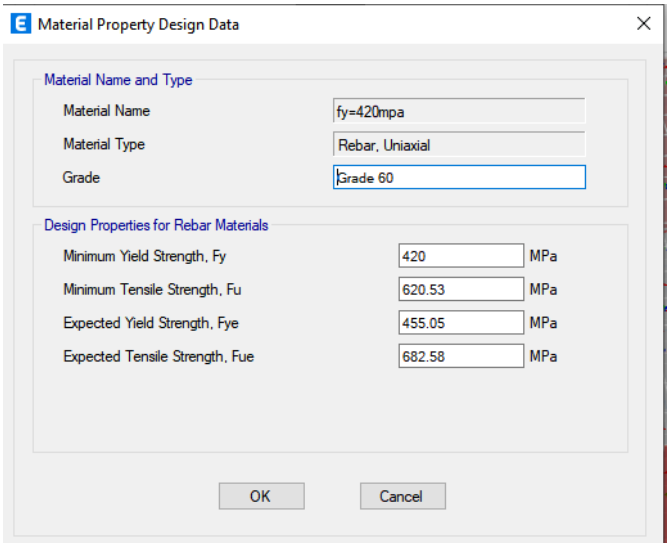

Figure 46: Define Steel Properties

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4.3.2-Sections

Beam section of 400*700 mm.

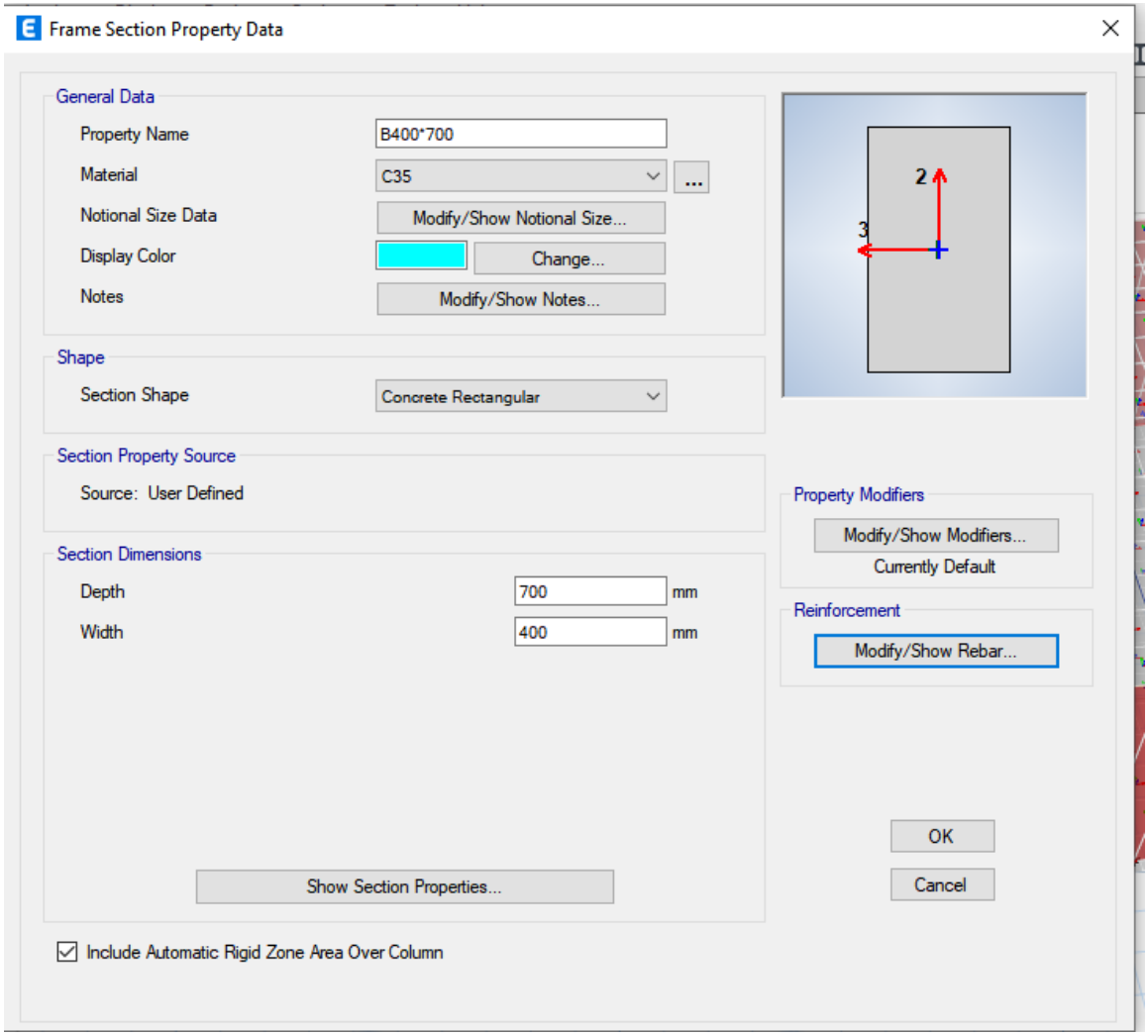

Figure 47: Define Beams

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Slab section of 20 cm thickness and base thickness of 30 cm.

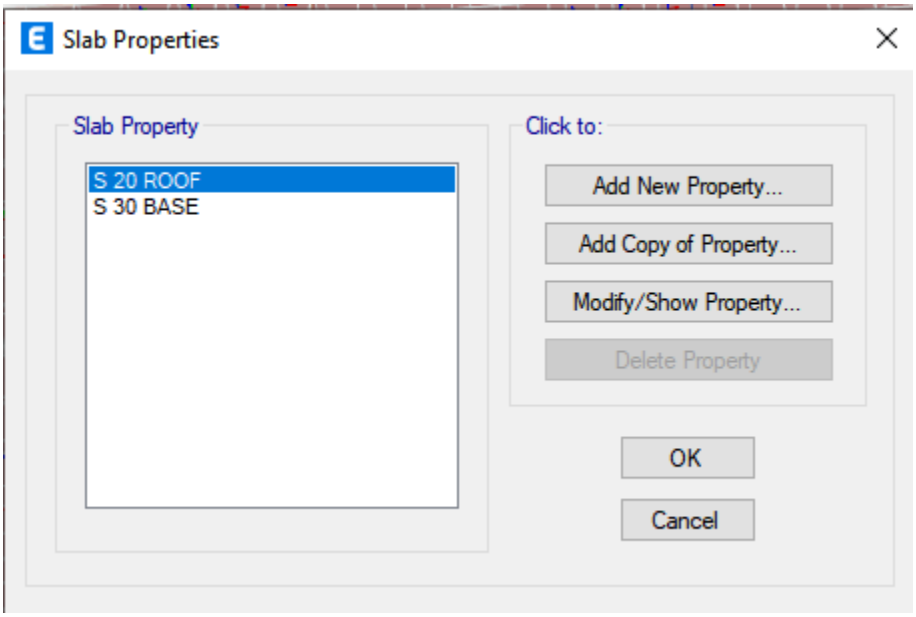

Figure 48: Define Slabs

Wall section of 30 cm.

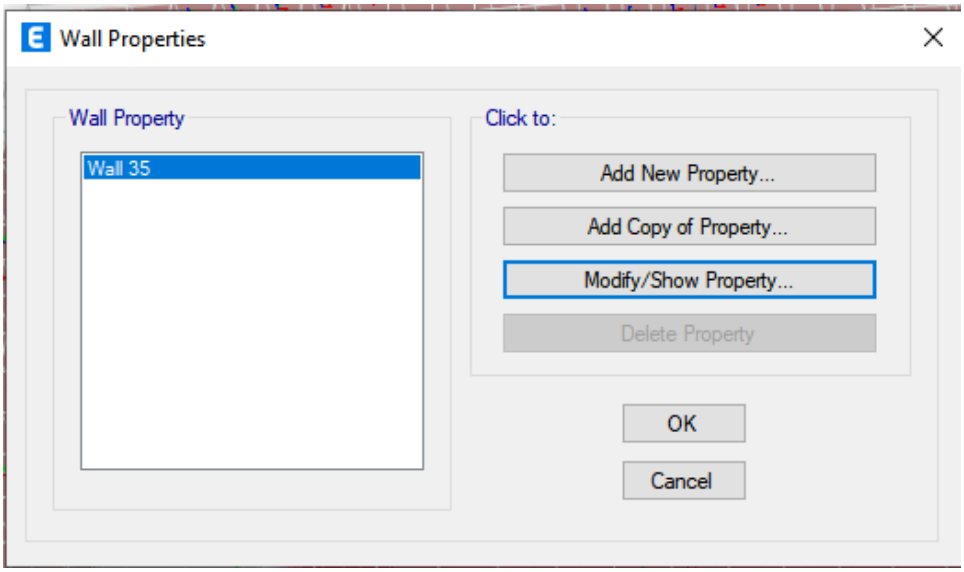

Figure 49: Define Walls

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4.3-Drawings

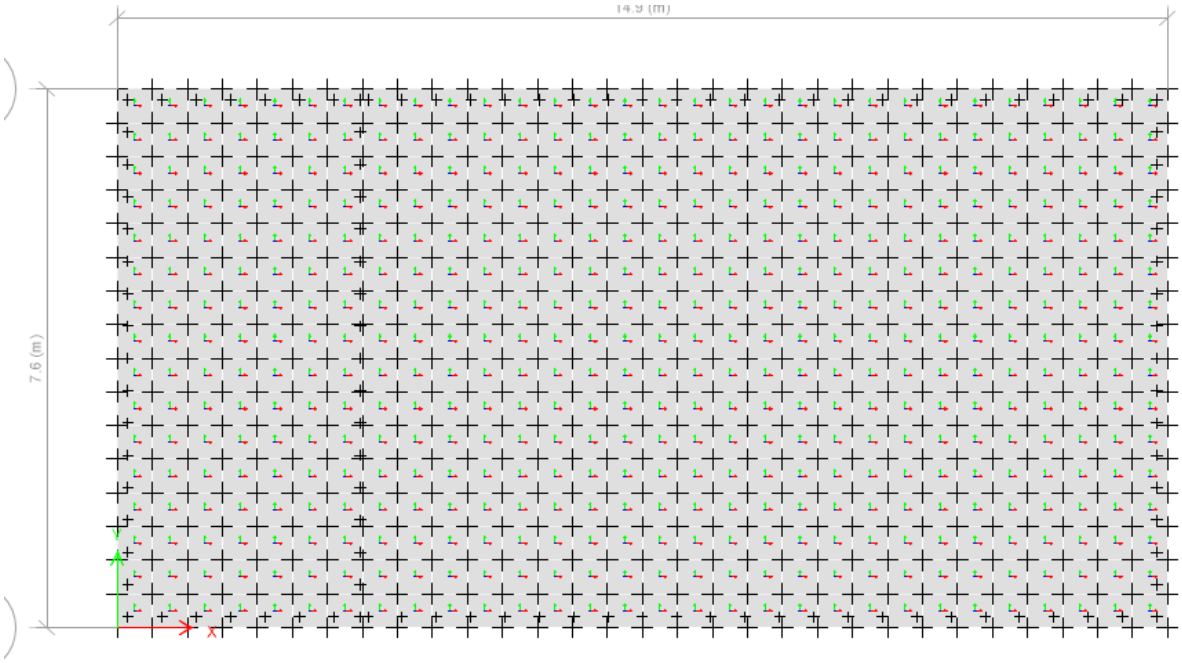

Figure 50:Footing Drawing

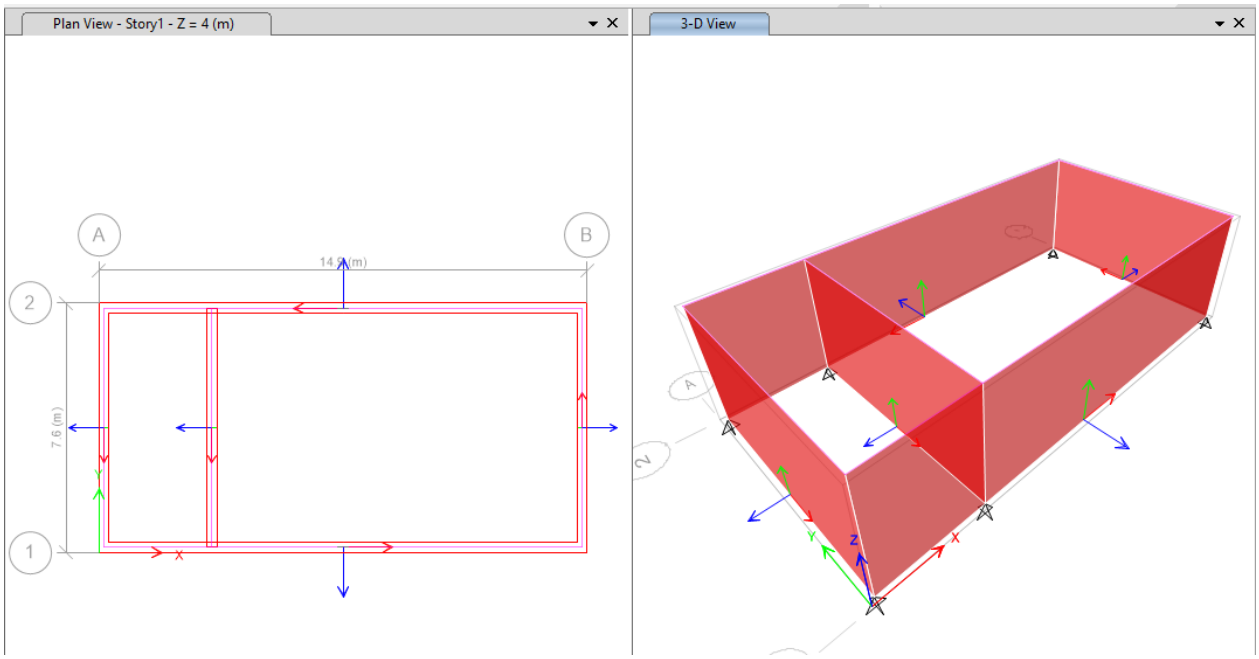

Figure 51:Walls Drawing

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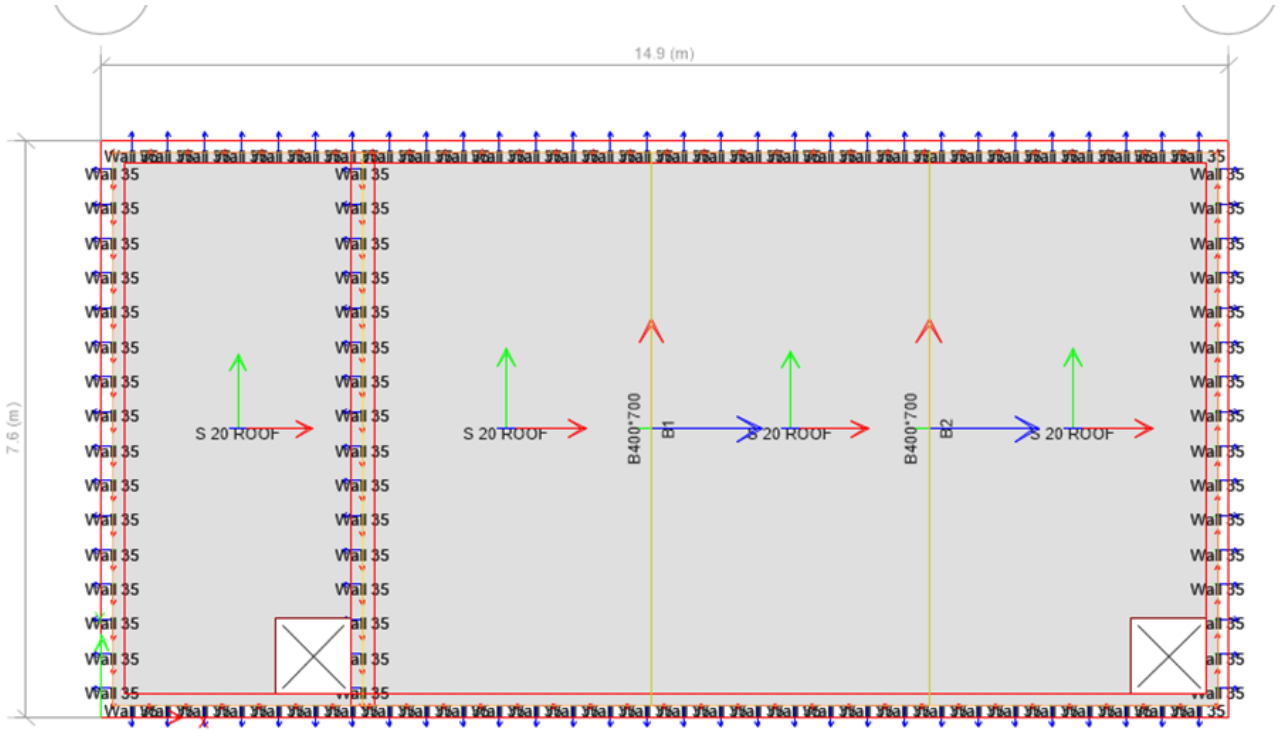

Figure 52: Slab and openings Drawing

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4.4-Loads

4.4.1-Load Patterns

1- Self-weight of concrete (Self Calculated)

2- The wall is exposed to water pressure (Wpw).

3- The wall is subjected to soil pressure or (Spw).

4-Live Load

5-Super Dead Imposed Load (Bak Roof)

6-Weight of water on base (Wwbase)

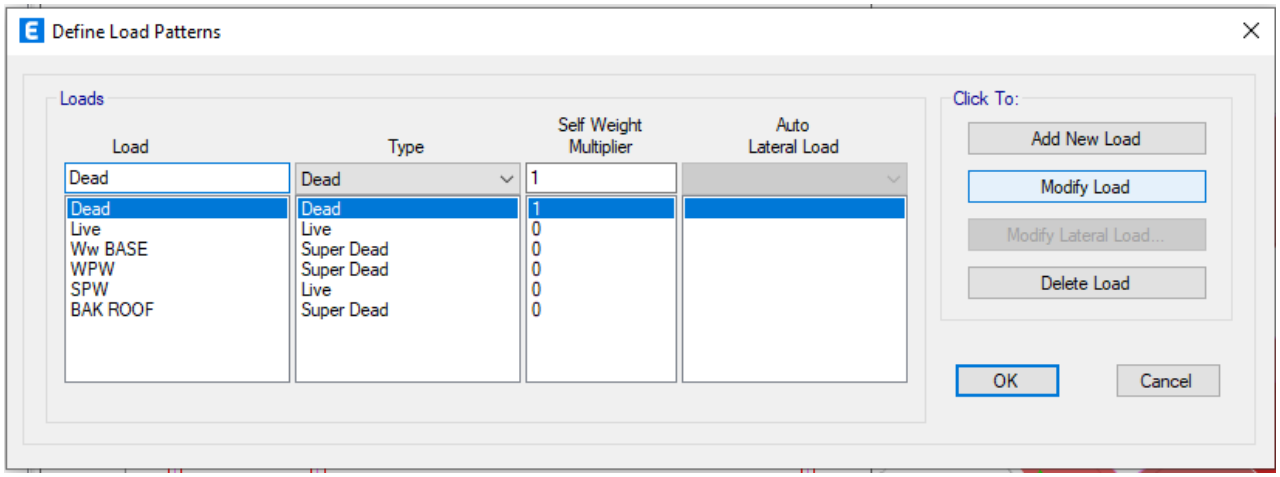

Figure 53: Define Load Pattern

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4.4.2-Load Combinations

4.4.2.1-Working

It is defined as the actual loads that acts on the structure, without and factorization.

$$W1=D.L+Wwbase+BAK\ ROOF+LL$$

$$W2=Wpw$$

$$W3=Spw$$

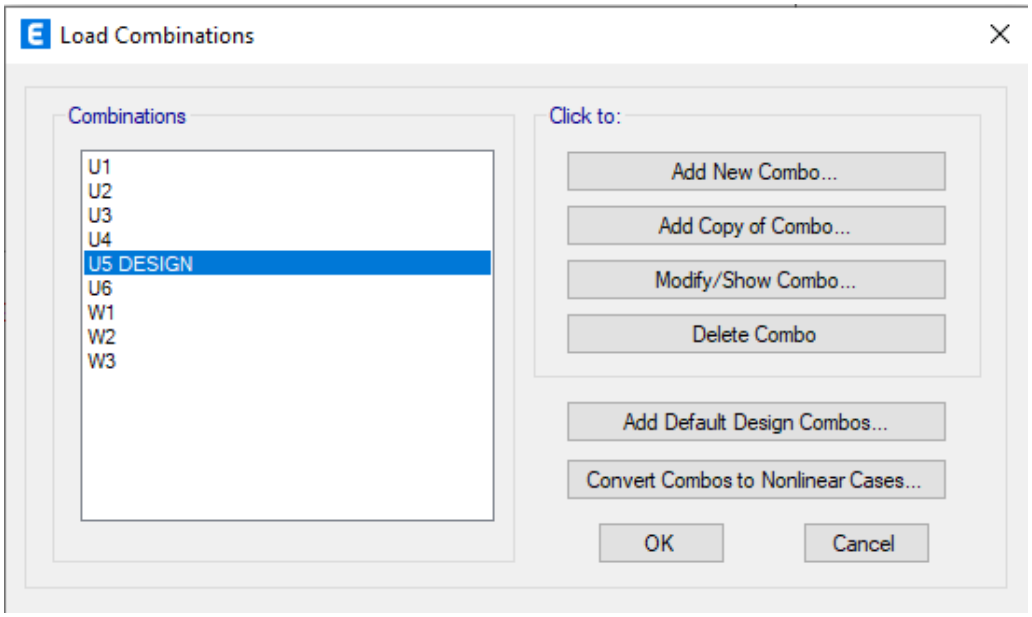

Figure54 : Define Load Combinations

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4.4.2.2-Ultimate

It is defined as the amplified working loads that the structure will be design in accordance.

$$U1=1.4D.L+1.4Wpw$$

$$U2=1.7\ Spw$$

$$U3=1.4Wpw+1.4Wwbase$$

$$U4=1.4D.L+1.7Spw$$

$$U5D=1.4D.L+1.4Wpw+1.4BAK\ ROOF+1.7L.L+1.4Wwbasw$$

$$U6=1.4D.L+1.4BAK\ ROOF+1.7L.L+1.7Spw$$

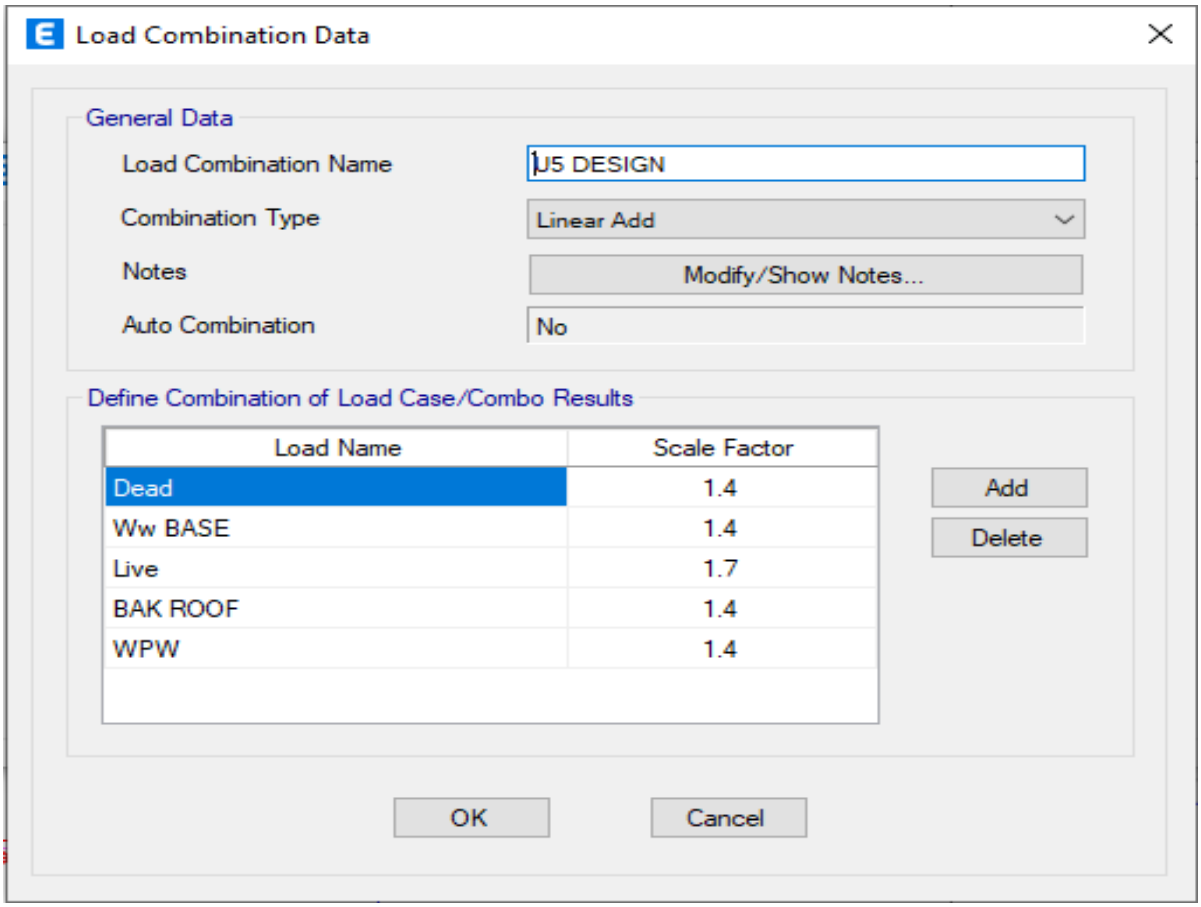

Figure 55: Load Factors

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4.4.3-Load Assigning.

4.4.3.1-Wall

1-Water Pressure on the wall. $P = \gamma * Z = 10\ KN/m3 * 4\ m = 40\ KN/m2$

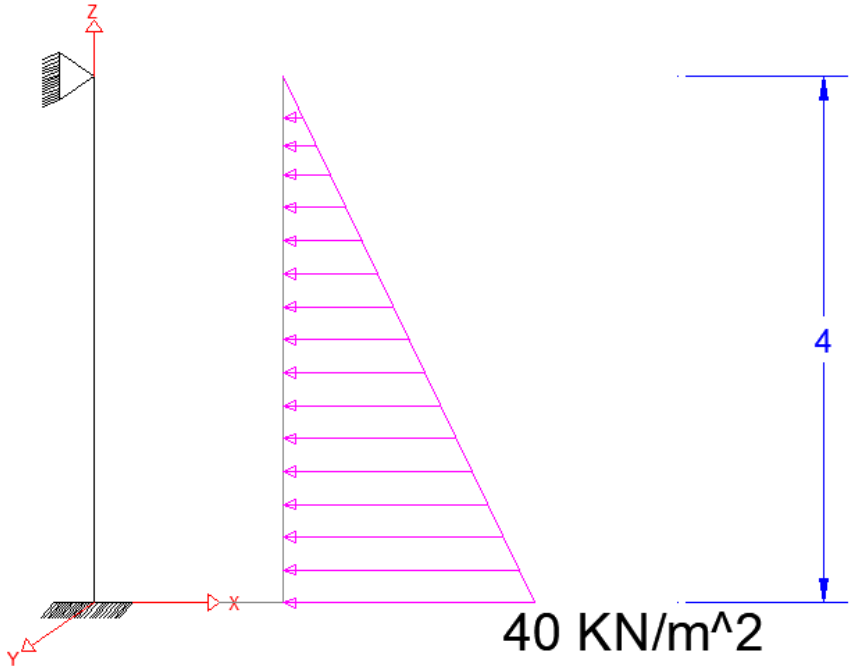

Figure 56: Load Distribution of water on the wall

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General equation of stresses distribution. $P=Ax+By+Cz+D$

It is noticed that when standing in the X & Y axis we find that the pressure is constant, while standing in the Z axis the pressure increases by descending .

So, since the change in pressure with respect to the change in displacement is constant, thus x=0 & y=0.

Find the value of the coefficients from the general equation. It is known that the pressure P=40 KN/m^2 at the point z=0 at the coordinates principle.

$P = A(0) + B(0) + C(0) + D = D = 40$ **≫≫≫≫≫D=40**

Find the value of the coefficients from the general equation given the pressure P = 0 at the point Z = 4.

$P = Cz + D = C(4) + 40 = 0$ **≫≫≫≫≫C=−10**

`

Assigning water loads (Wpw) according to the direction of local axis No. 3 (blue), from inside of the tank to the outside, and entering stress coefficients.

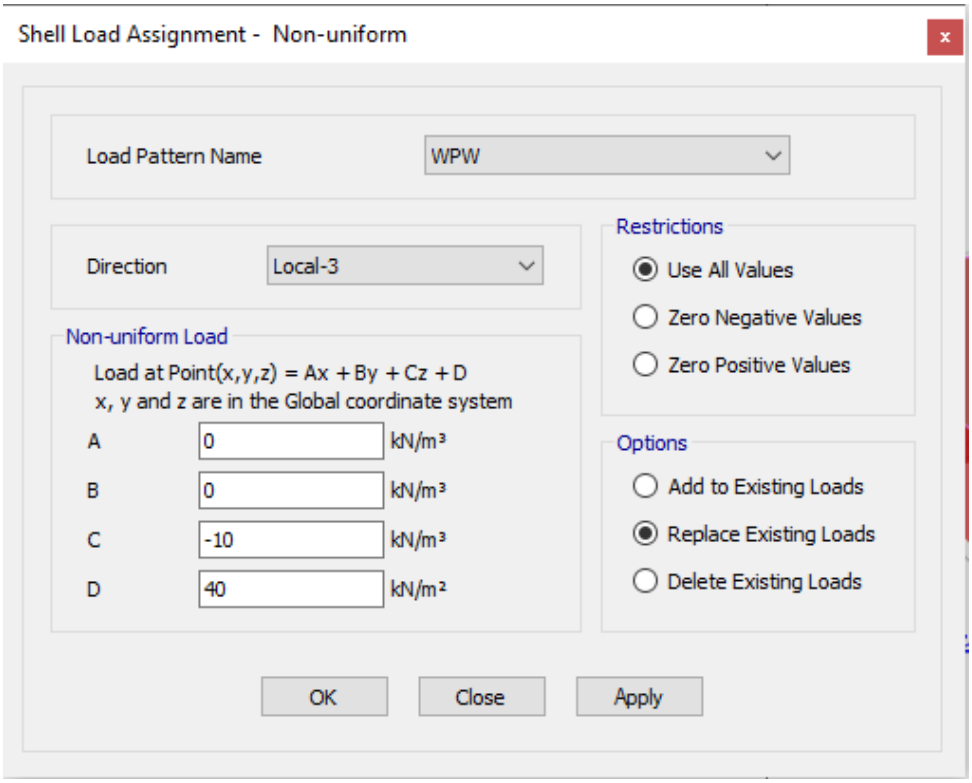

Figure 57: Assign Coefficients

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2-Soil Pressure on the wall

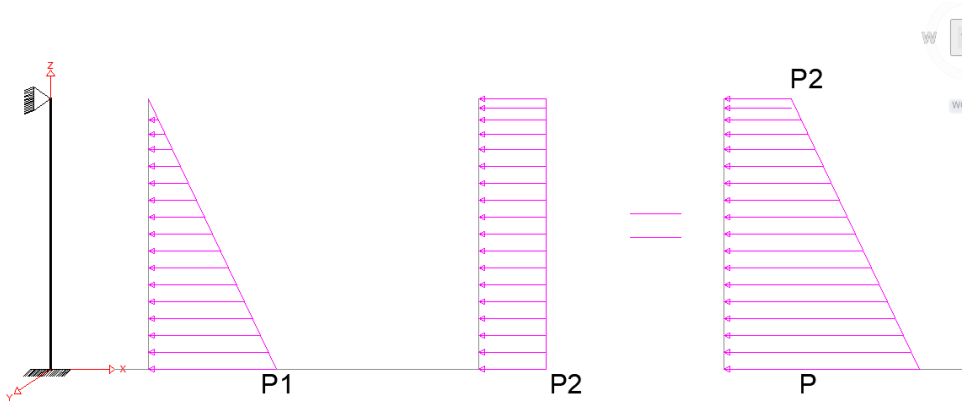


Figure 58: Soil Pressure Distribution

-Soil pressure below the tank wall (P1)

-The of soil pressure generated by the live loads around the tank (P2)

-Assume the soil is at rest $K0=1-sin\emptyset=1-sin20°=0.66$

- We calculate the value of soil pressure by means of the Terzaghi relationship

$P1=\gamma*Z*Ka-2Cz*\sqrt{K}0=18*4*0.66=47.52\ KN/m2$

-We calculate the soil pressure resulting from live loads

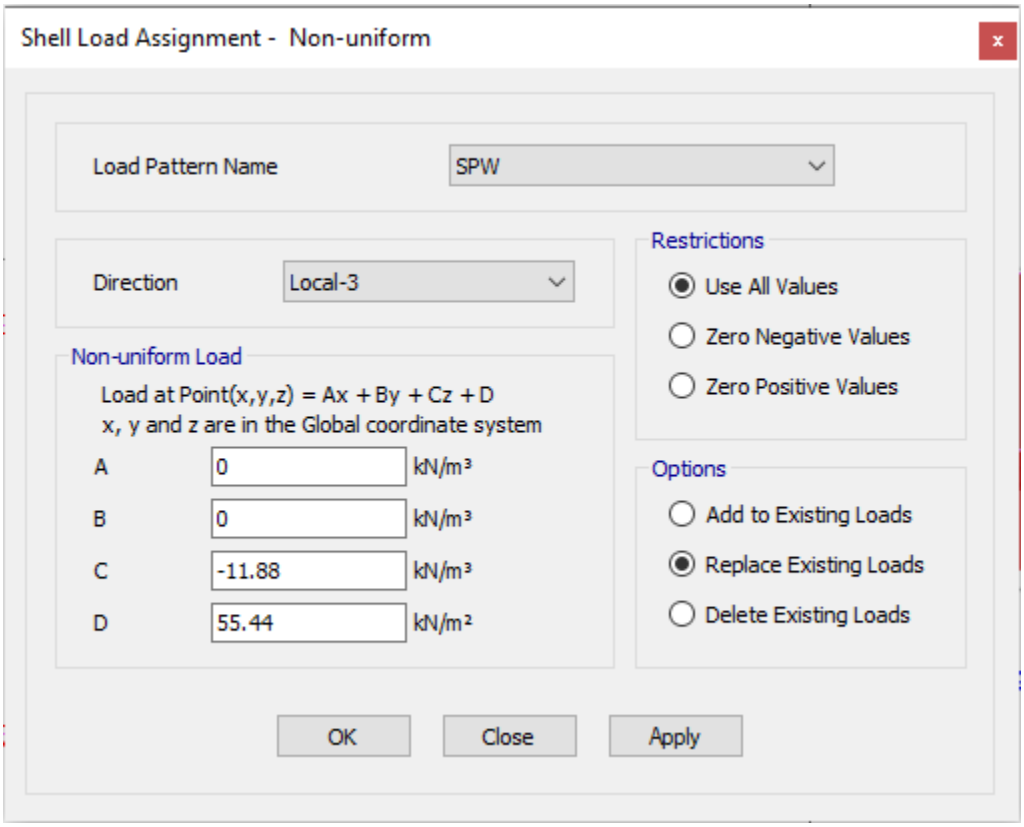
$P=47.52+7.92=55.44\ KN/m2$

- Find the value of the coefficient (D) from the general equation, known pressure P=55.44 KN/m^2 at the point z=0 at the coordinate principle. >>>>> D=55.44

- Find the value of the coefficient (C) from the general equation known as the pressure P2=7.92 KN/m^2 at point Z=4. >>>> C=-11.8

`

Assigning soil loads (Spw) according to the direction of local axis No. 3 (blue) from the outside of the tank to the inside (i.e., opposite of water direction) and entering the stress coefficients.



Noting that the direction is changed from the load cases tap.

`

4.4.3.2-Slab

1-Live loads above the of the tank slab L.L = 5 KN / m3

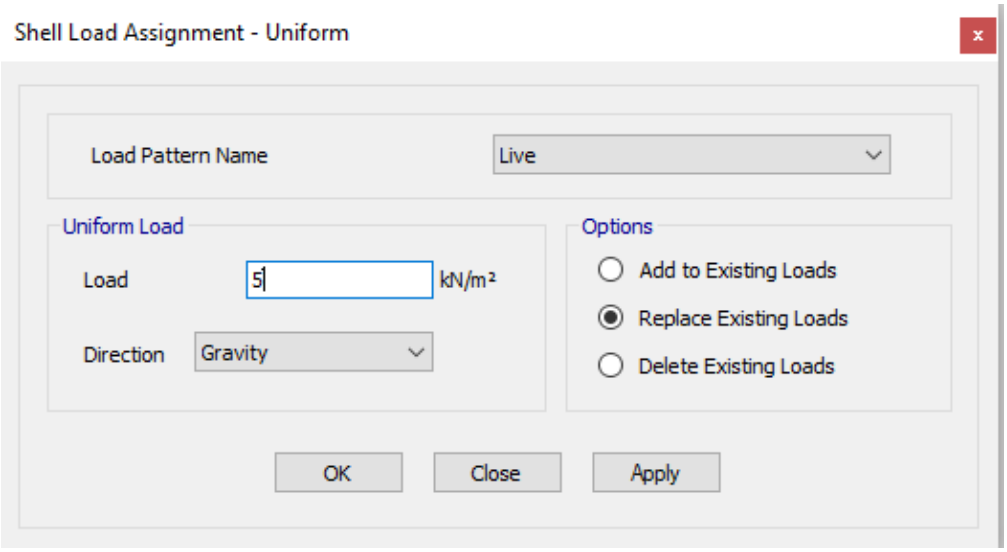


Figure 59: Slab Live Loads

2-Bakfill loads above the tank slab $BAK\ ROOF = \gamma s * h = 18 * 0.5 = 9\ KN/m^2$

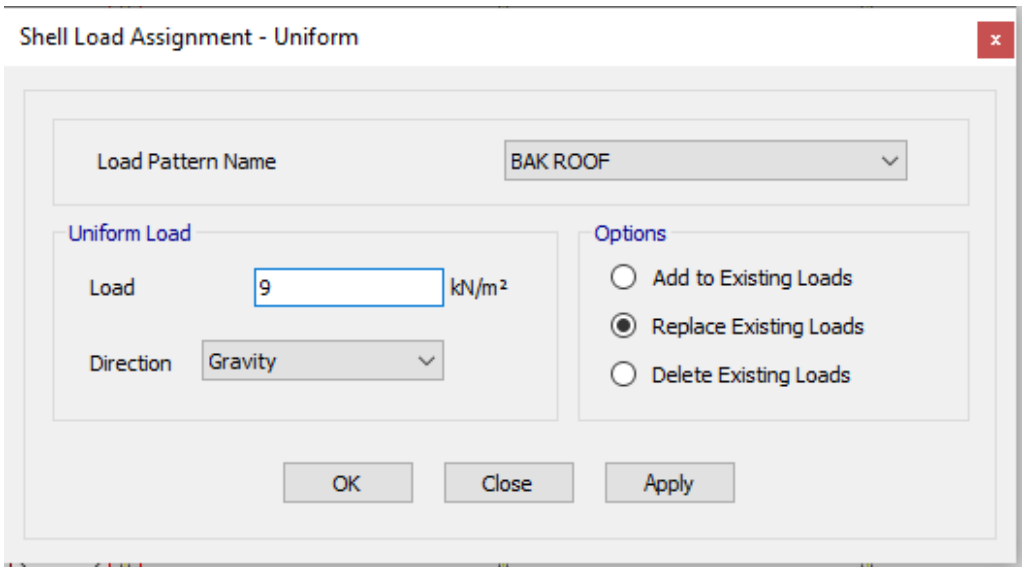


Figure 60:Slab Super Imposed Dead Load

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4.4.3.3-Base

1-Uniform weight of water Wwbase=40 KN/m2

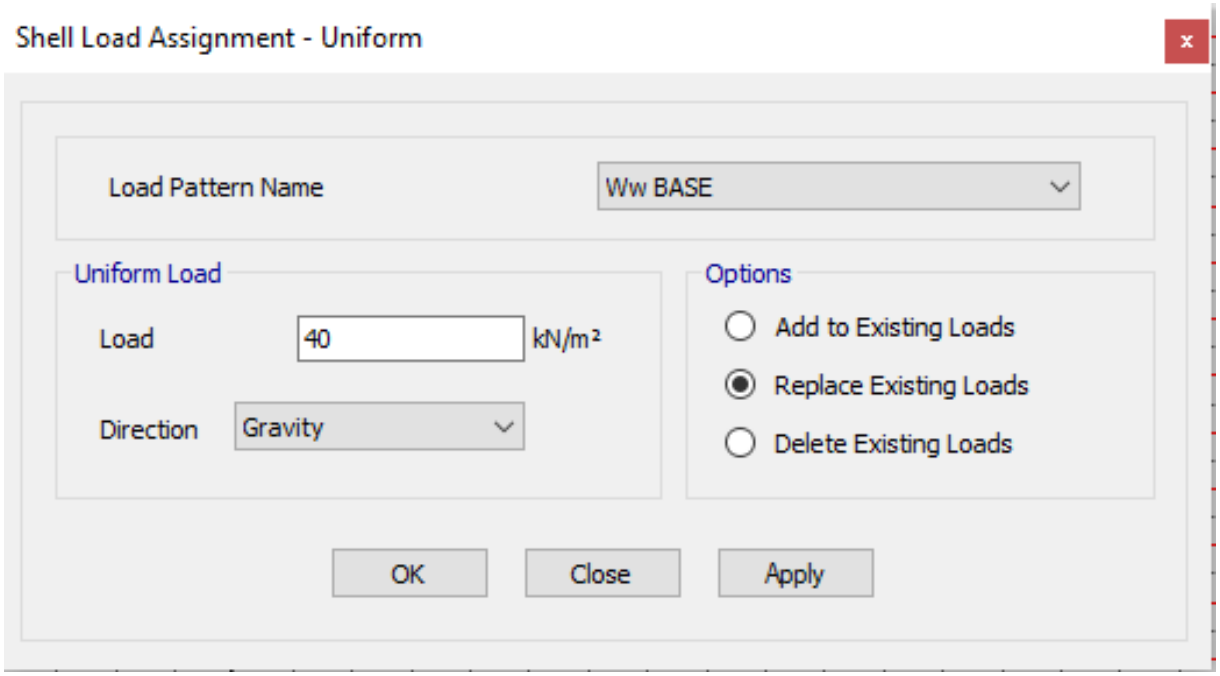

Figure 61: Raft

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2-Area Spring: the settlement of soil is proportional with the contact pressure, and can be defined by the relation $Ks = P/s$, where:

P: contact Pressure (Kpa)

S: Settlement (Unit Length)

Ks: Spring Constant, (which is related to the bearing capacity of soil)

Previous studies proved that mostly for a soil that have a bearing capacity of 200 KN/m2 the modulus of subgrade reaction (Ks=30000 KN/m/m^2).

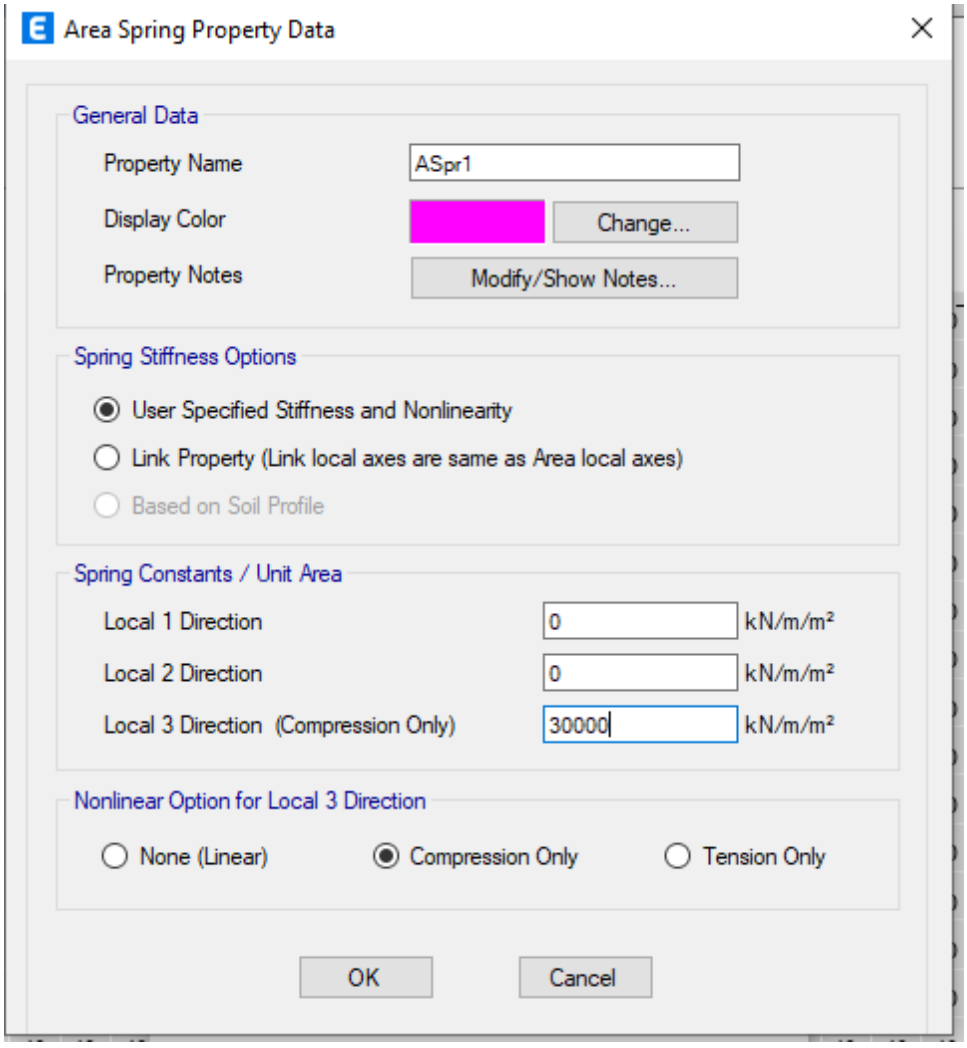

Figure 62:Area Spring

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4.5-Running the Model

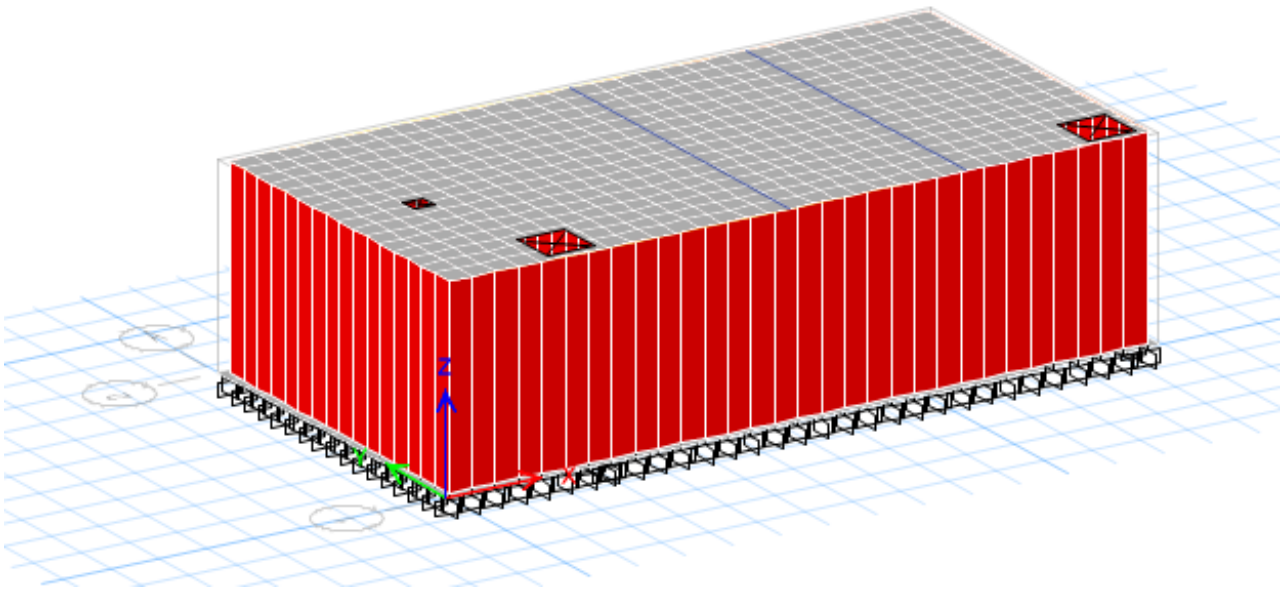

Figure 63: 3D Model

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4.5.1-Slab Check

First input the reinforcement's as given in the plan which is Y12@150CC both directions.

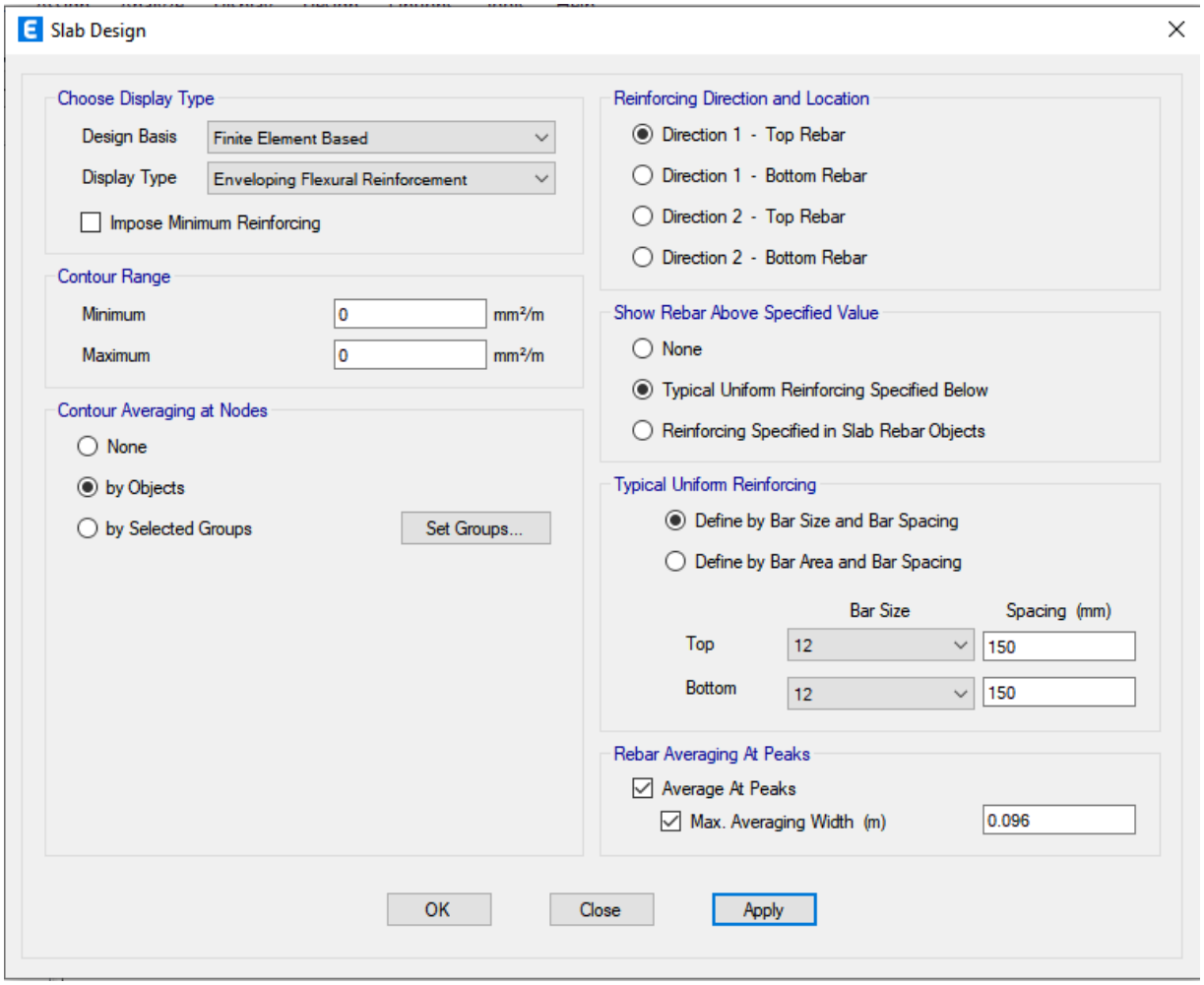

Figure 64: Entering Reinforcement's

Run the model and check all directions.

`

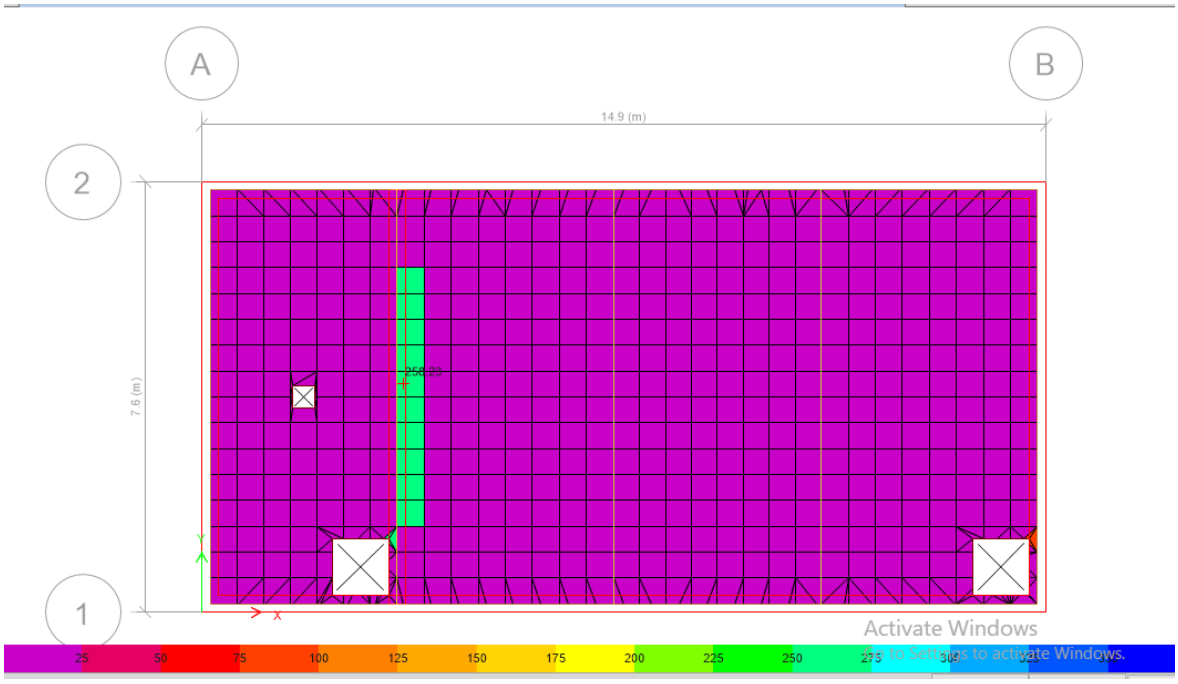

Figure 65: Direction 1 Top Rebar

Direction 1 top rebar require additional reinforcements of 259 mm^2 in the cyan rectangular.

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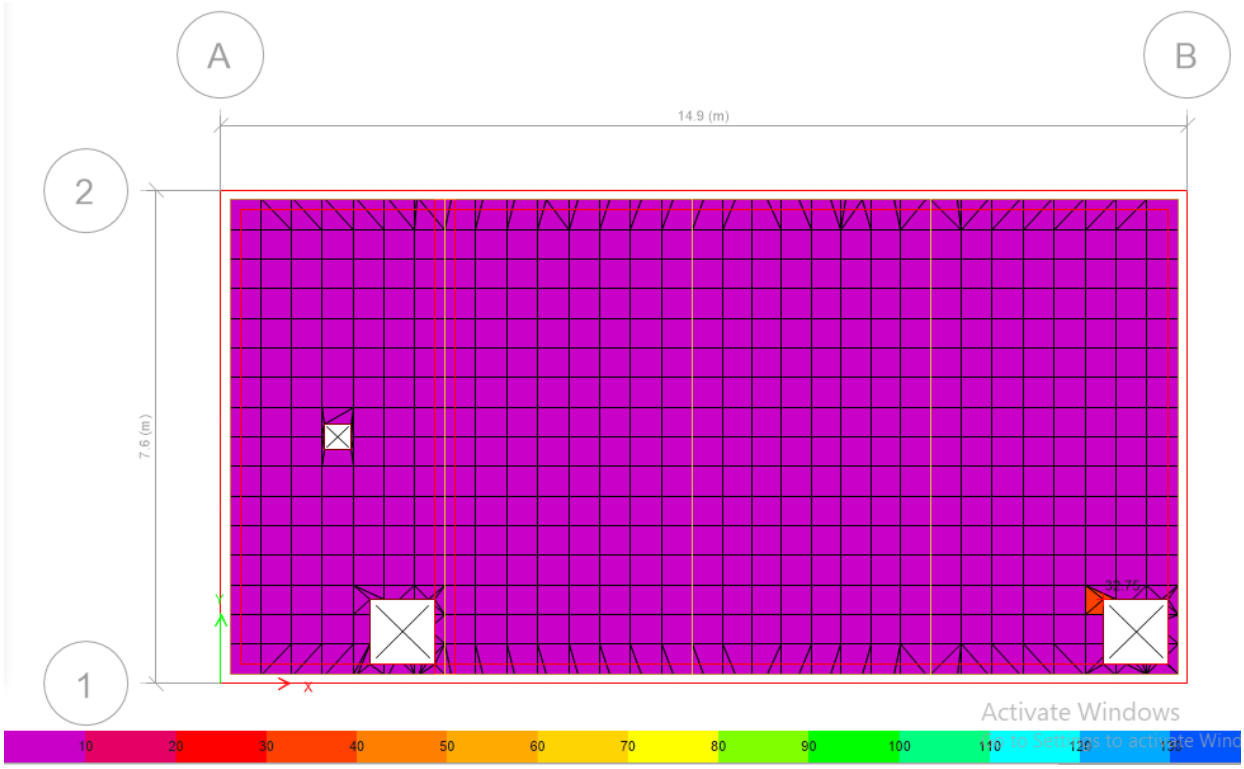

Figure 66: Direction 1 Bottom Rebar

Direction 1 bottom rebar require additional reinforcements of 33 mm^2 in the orange rectangular.

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4.5.2-Beam Check

The beam is automatically designed in Etabs software.

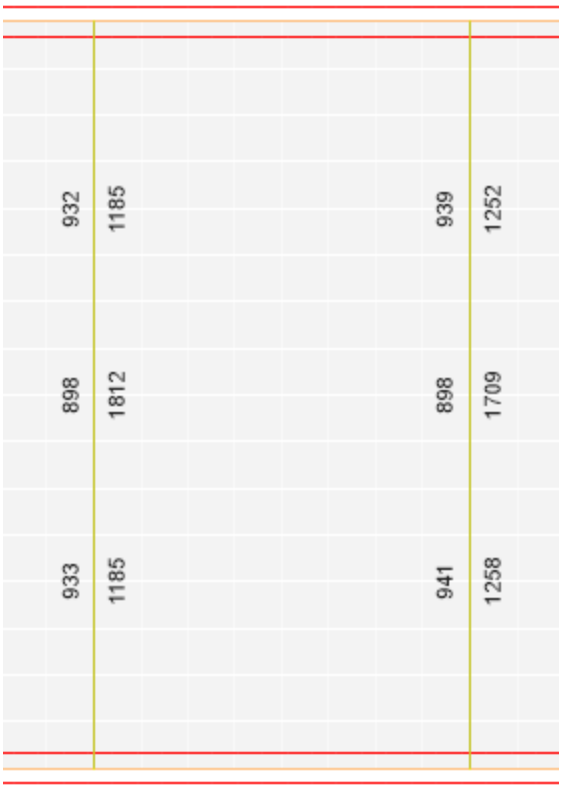

Figure 67: Beam Reinforcement's

So, to verify we have a maximum AS=1812 mm^2 main reinforcement's, using Y20 yields

$n = \frac{As}{Abar} = \frac{1812}{314} = 5.77 \cong 6\ bars$, which is exactly consistent with the plan.

`

4.6-Discussion

The reinforcement of the slab and the beams has been verified and compared with the values mentioned in the plan. However, the reinforcement of the wall, unfortunately cannot be evaluated from ETABS software because there is no function that supports retaining wall design. However, the wall data is defined to find the values of the normal, shear forces and moment so that we can design it manually. It is also recommended to design the raft using SAFE software, but due to time constraints, it will not be possible to learn the manual design, as well as learn the SAFE software for raft design.

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5.0-CONCLUSION

To sum up, this report purpose is to show what I have learned during my summer training journey of 7 weeks, so firstly, the water tank structural plane is redrawn in AutoCAD software from the original plane that the office has for the purposes of understanding the plane details, and also to develop my AutoCAD skills, secondly the procedure at which the tank is constructed has been explained, noting that unfortunately my summer training period started at the end of raft construction, and lastly the water tank is analyzed using ETABS software.

`

6.0-REFERENCES

1-Saudi Loading Code [SBC301 & SBC304-2018].

2- Principles of Foundation Engineering, SI Seventh Edition BRAJA M. DAS.

3- Design Reinforced Concrete, James_K_Wight_James_G_MacGregor.

4- Eng. Meshal Hamada course to design ground water tanks.

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7.0-APPENDIX

Al-Qassim University
College of Engineering

جامعة القصيم
كلية الهندسة

COOPERATIVE PROGRAM COMMITEE

Form: ST-11

Certificate of Originality

I am the signer in the hereafter certify that all submitted documents or work regarding my summer training program is completely related to my own effort and I am the original creator of it. No one else *"especially student in the same or similar training program"* has any contribution in the creating or maintaining of this work, except the advices from my field advisors. In case the vice versa has been proven, I shall accept whatever academic punishment as stated in similar situations at the college regulations.

Date: 9/7/2023

Name: Faisal Abdulaziz Alshobromi Signature:

شهادة الأصالة

أتعهد أنا الموقع أدناه بأن الوثائق والأعمال المقدمة مني بخصوص برنامج التدريب الصيفي هي من صميم انتاجي ومجهودي الشخصي وبأنني المنشئ الأصلي لها. كما أشهد بأنه ليس لأحد آخر " لاسيما الطلاب الذين أنهوا أو يؤدون حالياً برنامجاً مماثل أو مشابه لهذا البرنامج " أي فضل في اخراج هذا العمل ، ماعدا بعض النصائح من المشرف الميداني.

واذا ثبت عكس ذلك فإني أقبل بتطبيق العقوبات المدرجة بشأن حالات الغش المنصوص عليها بلائحة الكلية.

تاريخ: ٢٠٢٣/٧/٩

الاسم: فيصل عبدالعزيز الشبرمي التوقيع:

- 30 -

Figure 68: Certificate of Originality