3.5 Method Statement

3.5.1 Introduction

What are method statements? Method statements are a description on how work will be executed in an efficient and secure way. The method statements provide information, illustration, and descriptions for the employees who will bring these works into reality. Method statements are usually made for high risk, complex works that require clear and definitive guidelines. They are also known as the safe systems of work because they provide a logical and comprehensive sequence of events detailing the work must be carried out. The information in a method statement need not be lengthy, but just need to be able to communicate with the reader and deliver the information a clear and concise way. As the risk increases, the need for the method statement increases as it provides a safe path of work for the employees as it is usually created after the risk assessment is conducted.

For our project, we decided to make one comprehensive method statements which summarizes the Swimming Pool construction, it includes: swimming pool excavation, concreting and finishing.

3.5.2 Management Structure (For the three method statements)

For the project, exists a management structure that serves to keep the project's activities functional at maximum efficiency while maintaining both the quality control and safety to the highest standards possible. These managers are the Project Manager, Quality Control / Quality Assurance Manager, Site Manager, and the Health & Safety Manager. These managers need to have efficient communication channel in order to keep the project in complete harmony where minimal items conflict with each other.

3.5.2.1 Responsibilities of Each Manager

- **Project Manager**
  - The project manager is responsible for managing the other managers such as the QA/ QC, HSE, and the Site managers.
  - Responsible for overseeing all the work that is related to the project, whether it is onsite or offsite
  - Responsible for coordinating with the managers of each field to make sure that all the activities are done efficiently, on time and as specified by the specs and drawings
  - Responsible for ensuring that all work is documented, logged and reported whether it was work done, safety incidents or movements across the site.
  - Responsible for making sure that all the managers have the capacity to work and preform their respective duties.
- **Site Manager and Supervisors**
  - Responsible for choosing the site supervisors who, who in turn will be responsible for handling and managing all the site work.
  - Responsible for making sure that the labor working on site are qualified by taking the suitable training for the activities they are working on.
  - Responsible for making sure that the labor is constantly guided to take the proper health and safety briefings and training.
  - Responsible for ensuring that the right equipment is present when required.
  - Responsible for suppling the PPE and the suitable equipment for the safety of the labor on site
  - Responsible for ensuring that all hazards are removed from the site area.

- **Health and Safety Manager and Supervisors**
    - Responsible for choosing the HSE supervisors who, who in turn will be responsible for handling and managing all the HSE work.
    - Responsible for making sure that all personnel have access to the suitable PPE
    - That Training and briefings are conducted to make the personnel aware of the risks present on site and how to handle them using the proper procedures.
    - Responsible for making random and scheduled safety inspections to make sure that the safety standards are being followed.
    - Responsible for ensuring that all incidents are reported, logged, documented, and that action is taken to counteract the faulty situation.
    - Responsible for putting a halt to the project if the site does not meet the safety standards set.
    - Responsible to conduct risk assessments and studies and create plans to minimize or remove these risks.
- **Quality Control & Quality Assurance Manager and Supervisors**
    - Responsible for choosing the QA/ QC supervisors who, who in turn will be responsible for handling and managing all the QA/ QC work.
    - Responsible for making all the proper testing for the materials that enter or leave the site to make sure they meet the required standards specified in the specs.
    - Responsible for making random and scheduled inspections for the equipment, tools and material being used on site.
    - Responsible for making corrective plans for any faults found.
    - Responsible for making sure that the test equipment is always present and are in functioning condition.

3.5.2.2 Communication Through Reports

For all managers to keep up to date with each other's work, weekly and monthly reports need to be made which give a summary for all the activities that were performed in this duration. These reports must include the following, with photo evidence if possible:

- A list with the names of the personnel that worked on the project.
- The locations on which work was done.
- The equipment utilized and for what activities.
- The materials utilized and on what activities they were used for.
- The activities that were worked on.
- Any damages or losses that occurred.
- Any expenses incurred with proper.
- The waste produced and they method of disposal.
- All quantities of materials used, such the volume of concrete, the weight of steel, etc.
- Any changes to the topography of the site.
- Whether the work performed was finished on time, and if not, what is the new plan of action.
- The plan for the next duration before the next report is due.

3.5.3 Swimming Pool Method Statement

3.5.3.1 Scope

- **Scope in Project:**
  - Location

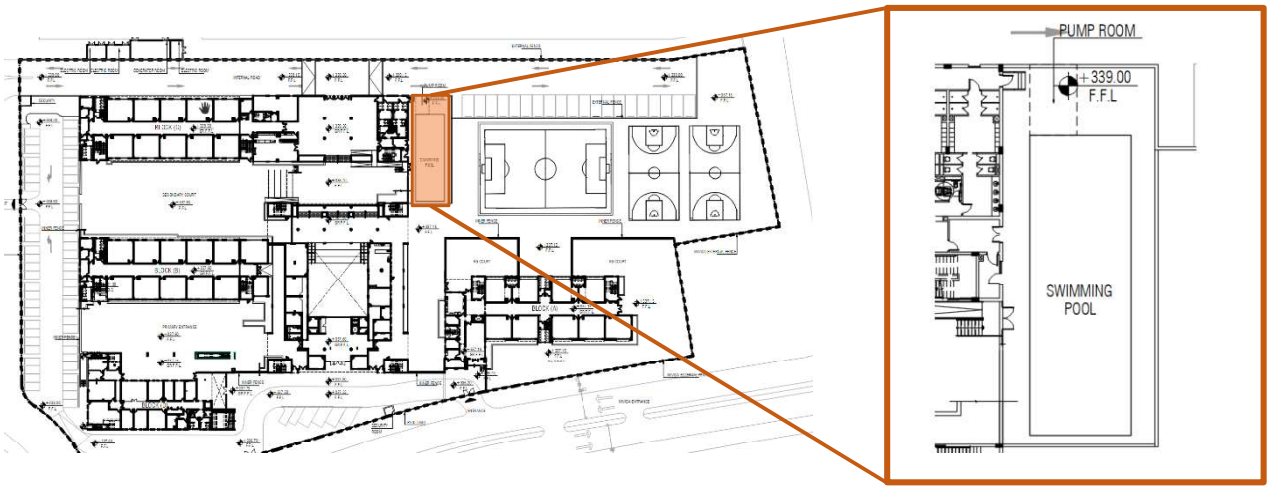

Figure 160 Location of Swimming Pool in Project

  - Dimensions

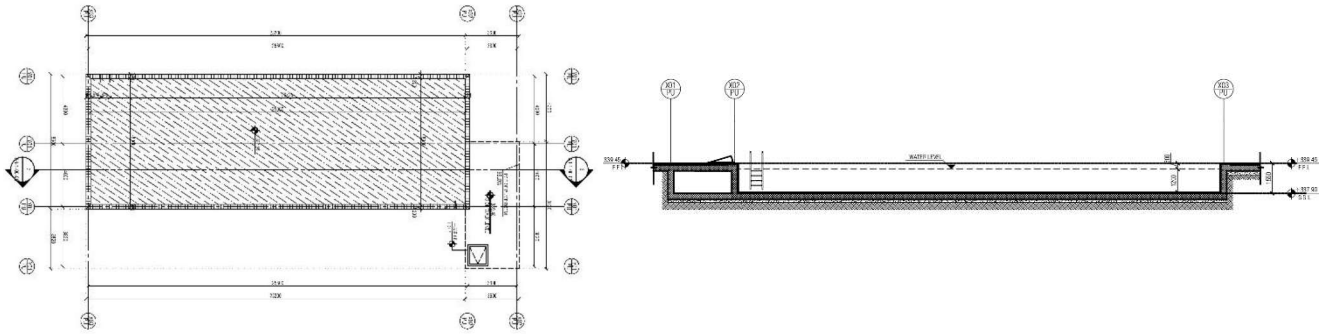

Figure 161 Plan and Cross Section of Pool

  - The dimensions of the pool are
    - Width: **25.6 Meters**
    - Length**: 8.6 Meters**
    - Depth:
      - Total: **1.55 Meters**
      - From Water Surface to Pool Surface: **1.2 Meters**
  - Price
    - The Total Price in the BOQ: **EGP 2,647,551**
- **Why the swimming pool is important**
  - Now adays, a swimming pool is considered an integral part of any school as it helps boost their energy and introduces physical education in morale inducing activity. It helps the students relax and refresh their energy in a mundane school life. It also aids them exercise which removes excess fat and helps them keep healthy. Swimming pools are also used in water therapy to help them keep their blood circulation

3.5.3.2 Scope of Our Work

3.5.3.2.1 Description of System used in our project.

The system used in our project is the below ground concrete pool which will utilize a network of pipes that filter the water around using pumps places in an adjacent pump room.

3.5.3.2.2 Materials

- **Soil**
  - Backfilling and imported clean sand soil that will be compacted on layers of 250 mm to 95% of dry density.
- **Concrete**
  - Plain Concrete with 28-day strength of 25 MPa that are going to use for the underlaying footings
  - Reinforced Concrete with 28-day strength of
    - 35 MPa that is going to be used for the raft and the pool walls
    - 30 MPa that is going to be used for the slabs
- **Steel**
  - Steel for the rebar of the reinforced concrete.
- **Metals**
  - Stainless steel stairs
  - Galvanized steel stair ladder
  - Galvanized steel access door
- **Thermal and Moisture Protection**
  - Vapor Barrier
  - Sheet Water Proofing
  - Waterproofing
- **Finishes**
  - Plasterworks
    - 20 mm for interior walls and ceiling
  - Mosaic Sheet
  - Stone Works
  - Epoxy Flooring
  - Painting
    - For internal walls and ceiling
- **Plumbing**
  - PVC Class-5 pipes
    - 40, 50, 75, 100 mm
  - Circulation pump sets
    - SP-CP-01,02,03 with 2 being working and 1 standby
  - Sand Filters
    - with 6-way multiport valves
    - SF-01,02 with capacity of 100 Gpm
  - Fittings
    - ABS
      - Bottom inlet fitting, vacuum fitting and main drain
  - Submersible pump
    - Duplex submersible pump 1 working and 1 backup

- **Fire fighting**
  - Fire extinguishers
    - Dry chemical fire extinguisher
    - Portable carbon dioxide fire extinguisher
- **HVAC**
  - Metal Duct Work
    - Galvanized ductwork
  - Roof Top Fan
  - Air outlets
    - Exhaust side grill
- **Electrical**
  - Distribution panel boards
  - Low voltage cables
  - Raceways, boxes and fittings
    - Technical lighting outlets
    - Lighting switches outlets
    - Socket outlets
    - Disconnect switch
  - Wiring devices
    - Electrical sockets
    - Switch disconnectors
    - Lighting fixtures
    - Earthing system
    - Power earthing system
    - Low current earthing system

3.5.3.3 Sequence of Work

3.5.3.3.1 Site Inspection

1) The surface area on which the swimming pool will be placed shall be thoroughly inspected by the Contractor to ensure that the grading is suitable for work.
2) Existing structures must be noted so that they will not clash with the construction process of the swimming pool
3) The site inspector should be an engineer who should take note of surrounding structures, unnatural soil and problems that may arise in the construction period. They should also make an examination for the type of excavation that should be used, whether it will be mechanical, hand or both in order to make proper arrangements.

3.5.3.3.2 Surveying

4) Before the excavation starts a surveying, team must mark location of the swimming pool. These marks will represent the axis of the swimming pool and the pump room. However, these marks will not be placed directly over where the axis will be as this part will be excavated. Thus, they will be offset from the axis line by a decided distance that will be noted down by the construction engineer. These marks can be made using wasted steel bars of minimal diameter, and the bars shall be hammered into the ground and then concrete will be poured over them to fix them. The marking shall not be for the four corners for the swimming pool and the pump room only, as they should be placed consequently between the four corners at equal intervals.
5) The surveying team is preferred to use a total station; however, a theodolite or manual equipment will suffice. The surveying team shall take reference from the nearest benchmark or the reference point recognized and utilized by the construction engineers of the site as the swimming pool will be constructed later in the lifetime of the construction period.
6) The surveying team shall be present during the construction period of the swimming pool and pump room to make sure that the depths, coordinates and spans are always exact.
7) The surveying crew should take ground elevations to calculate the depths that will be made at each point.

3.5.3.3.3 Excavation

8) Before work can start
    a. The site must be first cleared of any obstructions before any equipment or labor are permitted to start working.
    b. Barricades must be installed, and signboards must be visible so no persons can wander into the construction area.
    c. Make sure that the personnel who will be working are briefed about the safety procedures and risks involved in the construction process and that everyone has taken safety training that is up to date. All personnel must be equipped with their personal equipment such as safety boots, helmets, and high visibility jackets. All equipment used must be issued safety certificates that ensure that they were properly tested and were found to be fully functioning
    d. Make sure that the crew is informed about the procedures that are implemented in case of emergencies and when encountering utility lines.
    e. The surveying team shall make lines using white powder to mark the borders of the excavation are in which the crew will work in.

9) Starting the excavation
    a. Mechanical excavation should be utilized using a wheeled loader. The loader is ideal for this type of job as the excavation are is rectangular and is wide enough for the loader to maneuver in. Using the loader will only need a ramp for which a loader must go up and down to remove the soil. The only advantage of using a loader instead of a backhoe excavator is that its production rate is much higher than a backhoe, thus the loader will take less time to finish the work which will translate to less rent time which will decrease the costs.
    b. Place barricades around the excavating machine to prevent any injuries from occurring to other equipment or wandering persons.
    c. The excavator will start removing soil form the swimming pool area while the surveying team does periodic checks to make sure that the excavation depth does not exceed the required.
    d. If over excavation occurs, then it shall be backfilled using adequate material that is acceptable to the engineer. The backfill material must be controlled within +/-2 % of optimum moisture content and compacted in accordance with the specs of the project.
    e. The depth of excavation will include the following
        i. Depth from ground surface to top of slab
            1. **1.55 meters**
        ii. Thickness of RC slab
            1. **0.3 meters**
        iii. Thickness of PC blinding layer
            1. **0.1 meters**
        iv. Thickness of compaction
            1. **0.5 meters divided into two 0.25-meter layers**
        v. Total excavation depth
            1. **1.55 + 0.3 + 0.1 + 0.5 = 2.45 meters from ground surface to the point at which the loader will stop**.

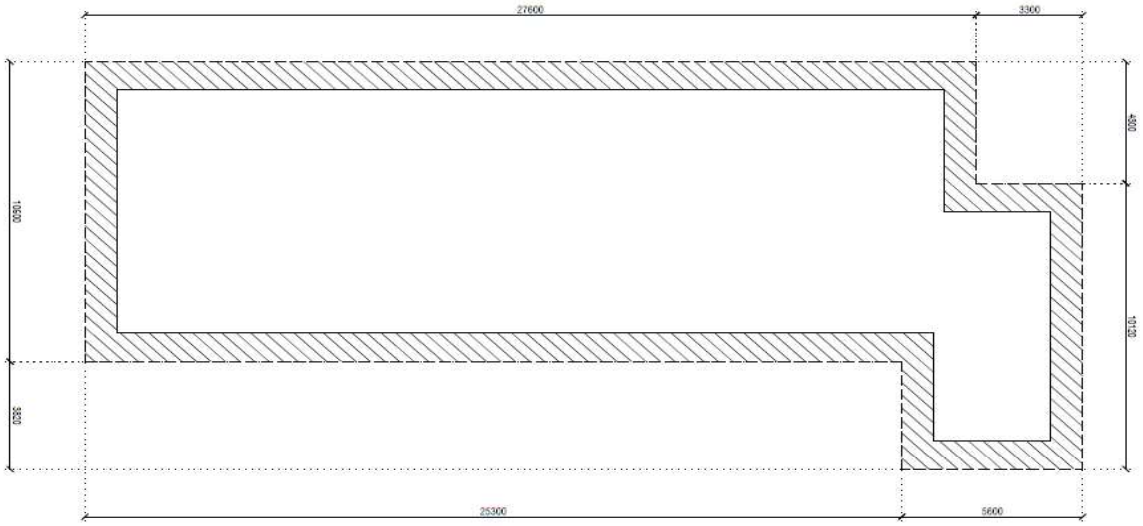

Figure 162 Excavation Shape

The shaded part is 1 meter in width and it there to give space for the labor to work in and the unshaded part shows the area of the pool in which the work will be done.

f. Surface Leveling and Compaction

i. As soon as the excavation reaches the desired level, the surface shall be leveled while taking extreme care to protect the bottom of excavation until the blinding layer shall be placed.

ii. After the leveling is complete, an inspection will be made to make sure that the surface is level and is at the correct.

iii. The soil will be compacted in accordance with the specs, using a handheld vibratory compactor coupled with drenching the area with water.

1. The soil will be replaced with clean sand soil imported from out of site.
2. The compaction will be done 1 layer at a time with each being 250 mm thick and there will be two layers.

iv. After the compaction of each layer of soil, tests should be made in accordance with ASTM D 1557 and ASTM D 1556.

v. After all the proper testing and inspection is done for the each of the multiple layers of compaction, we can go to the concreting part of the execution process.

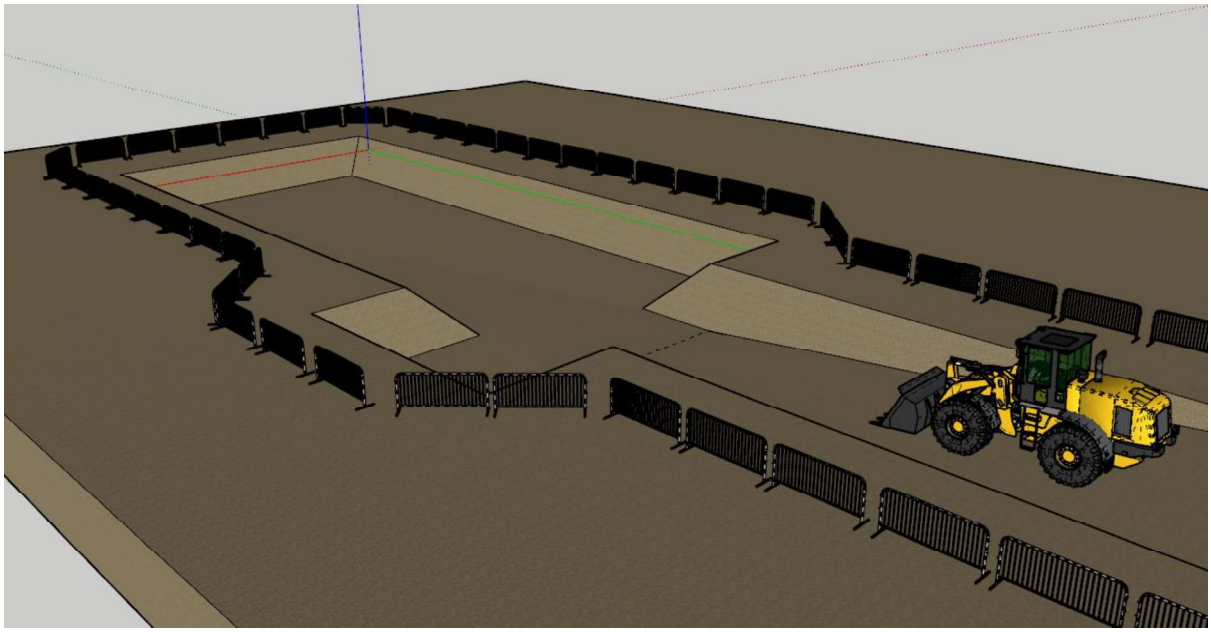

Figure 163 Excavation of Swimming Pool

3.5.3.3.4 Plain Concrete Foundation

10) A small amount of formwork will be placed around the edges of the excavation to hold down the concrete being poured. Formwork will consist of a timber board with a dimension of 4x2 inches that will support the sides of the plain concrete as it is being poured. The PC layer boundaries will be offset from the boundaries of the outer layer of the walls of the pool and pump room by 350 mm.
11) A plain concrete base of thickness 100 mm will be poured on the level bottom surface of the pool using a concrete pump and leveled by using concrete screens. Vibrators must be used to ensure proper compaction occurs.
12) The PC will be left to harden for 2 days, then work will start on the masonry. In concurrence with the removal of the formwork for the plain concrete.

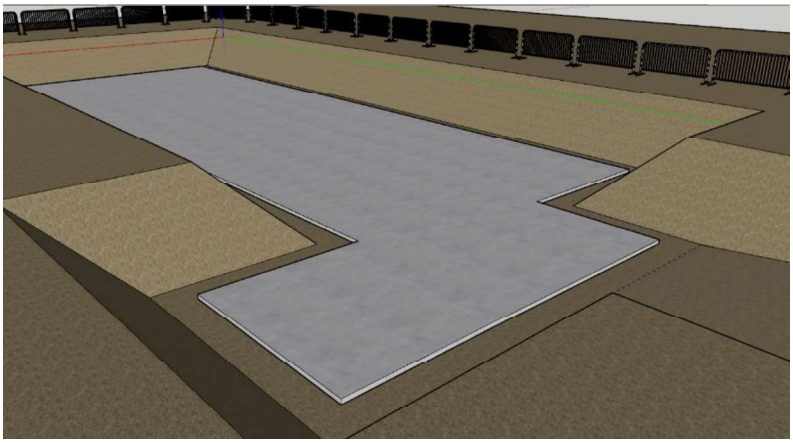

Figure 164 PC Foundations

3.5.3.3.5 Masonry for the Swimming Pool and Pump Room Walls

13) Blocks of thickness 250 mm will be placed on the outer perimeter of the PC concrete foundation with an inner offset of 100 mm. after they are laid on the perimeter, they will be inspected and approved by the engineer, then the walls be erected to the height of the pool walls of 1.85 meters.
14) After the walls are erected, they will be inspected to make sure that they are vertically and horizontally level.

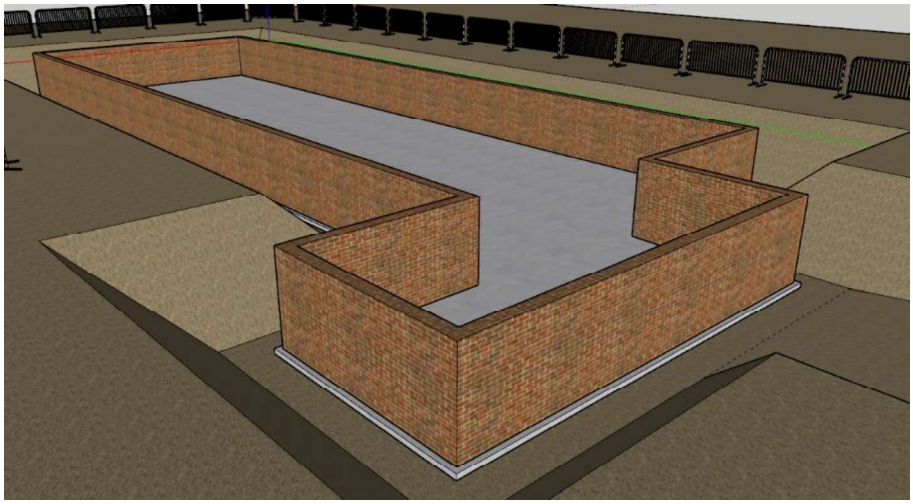

Figure 165 Swimming Pool Masonry

3.5.3.3.6 Insulation Between the Floors and the Walls

15) The water proofing sheet will be resembled in the 4 mm polyethylene waterproofing sheet. The sheet will be spread from the upper parts to wall to the other walls, encasing the whole excavated are in a waterproofing sheet.
16) A 50 mm cement screed layer shall be laid on the surface of the polyethylene sheet part that resides on the floor in order to prevent the steel bars of the reinforcement from puncturing the sheet

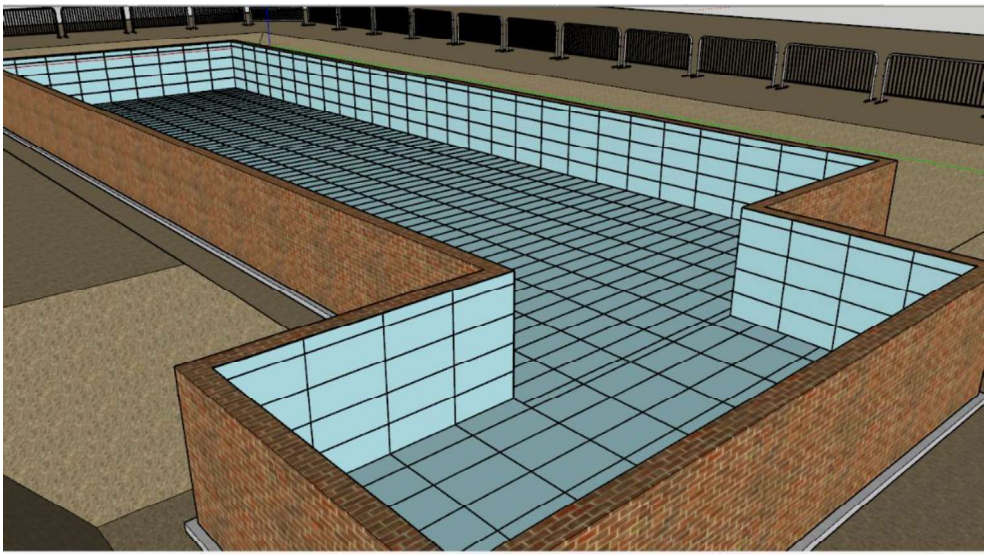

Figure 166 Swimming Pool Insulation

3.5.3.3.7 Reinforcement of the Swimming Pool Floor Slab

17) The rebar of the slab can now begin by cutting the steel bars and placing them on the cement screed after giving it enough time to dry off. Covers will be placed between the bottom mesh and the concrete screed of 50 mm. The corner between the wall and slab will have a loop shaped steel reinforcement as shown in the figure below. The steel mesh shall be laid on a cover of 50 mm to make sure that no leakage occurs. The reinforcement shall be compromised of steel bars with diameter of 12 mm in spacing of 150 mm in 2 layers, top and bottom, in both ways. And there will be a cover of 20 mm from the upper mesh to the concrete surface.
18) There will be two meshes, un upper mesh and a lower one. The lower mesh will be placed first. The lower mesh will have its bars bent at the edges so that they can extend to form starter bars at the edges of the slab. The upper mesh will be placed after that as shown in the figures below

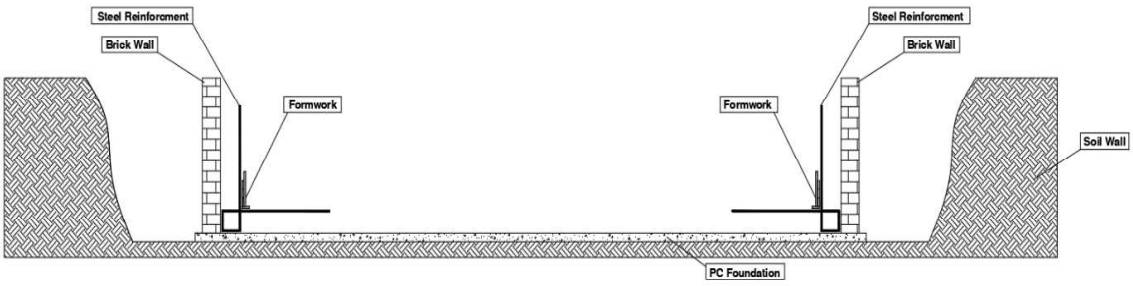

Figure 167 Pool Floor Rebar and Formwork

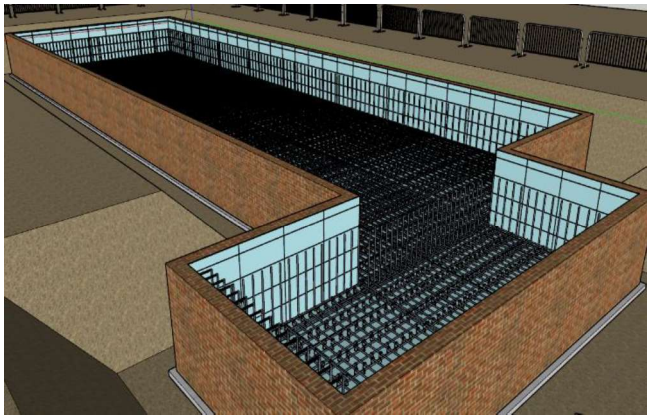

Figure 173 Slab Lower Rebar

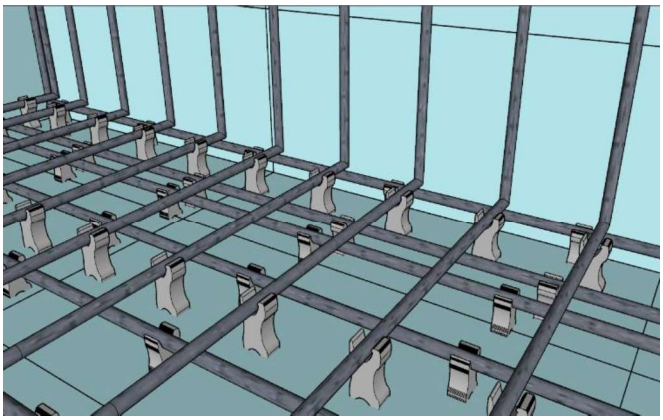

Figure 173 Slab Lower Rebar Detail 1

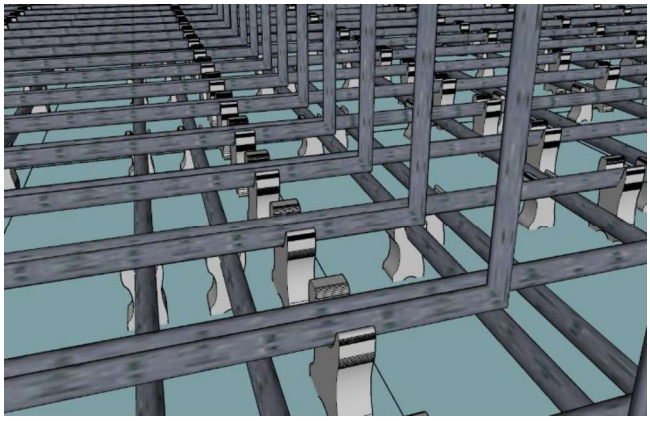

Figure 173 Slab Lower Rebar Detail 2

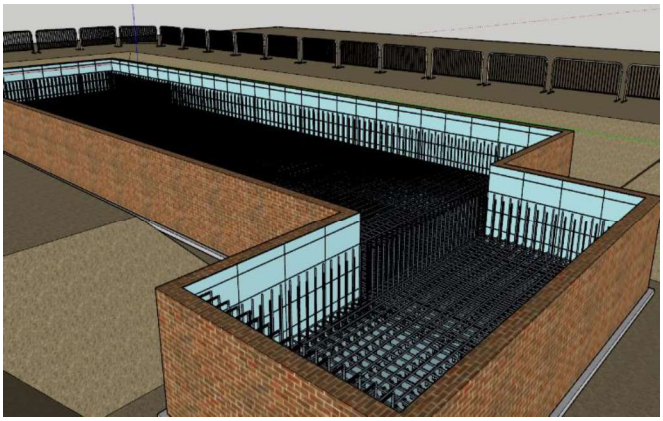

Figure 173 Slab Upper Rebar

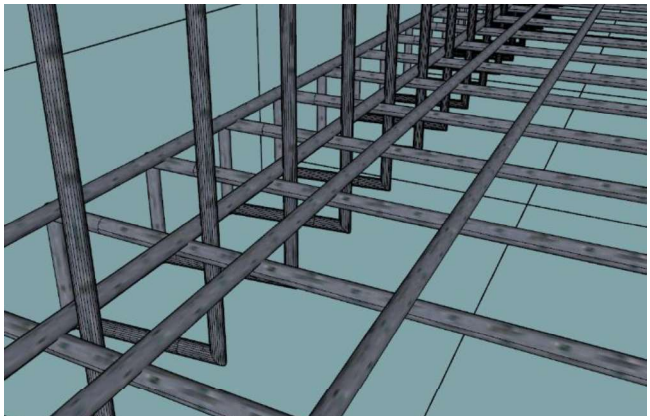

Figure 173 Slab Upper Rebar Detail 2

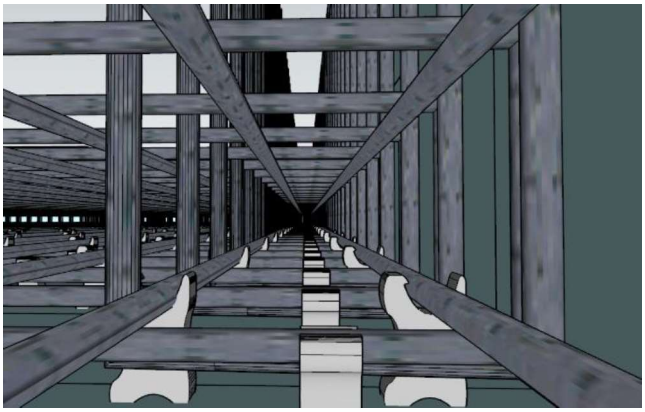

Figure 173 Slab Upper Rebar Detail 3

3.5.3.3.8 Formwork for the Wall Necks

19) Formwork for the necks of the walls of the pool shall be also made. This formwork will consist of the 4” by 2” boards that are vertical stacked over each other form the short side to create a neck that is 300 mm tall in order to pour 250 mm of concrete in it, this formwork will be away from the brick wall a distance of 300 mm with a cover of 50 mm from the outer side and 20 mm on the inner side. The necks will also have the starter bars placed in them in a staggered manner, so the part where the steel bars overlap does not occur always at the same location, in order to remove any weak points.
20) The plumbing works shall be fitted between the steel bars reinforcement and conduits for the electrical wires must be also installed between the rebar of the slab and walls.

3.5.3.3.8.1 Waters tops Execution Sequence

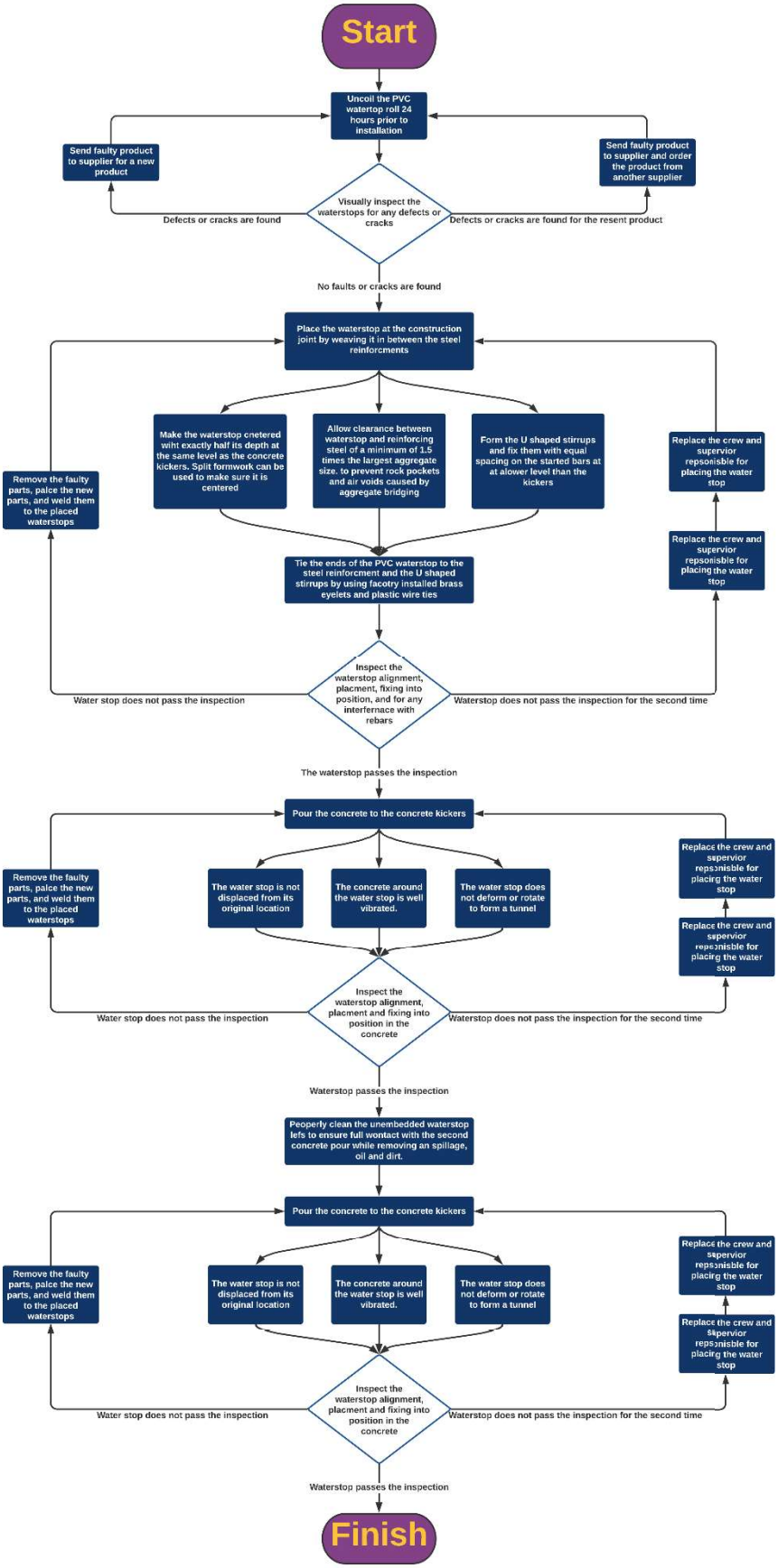

Figure 174 Fixing the Water stops into Place

21) The PVC water stops must be fixed in place at the wall necks, this is done by adding U-shaped stirrups every 500 mm that are fixed to the vertical steel bars in the wall reinforcement. The PVC water stop is fixed to the U-shaped stirrups by poking small holes in the edges of the water stop and tying them to the stirrups using wires. The water stop must be fully centered in the wall reinforcement.
22) The formwork must be thoroughly cleaned from any dust or debris that will affect the flow of the concrete.
23) The formwork can be doused in water to make sure that the wood expands in order to prevent leakage.
24) The starter bars must be covered using plastic sheets to prevent any concrete from being dropped on them which will have to be cleaned later for the bars to bond with the concrete.
25) Kickers must be placed at the wall necks at a height of 250 mm in order to stop concrete from being poured past this point.
26) The engineer must inspect the formwork to make sure that is level both horizontally and vertically, that it is structurally sound as in there are no loose objects and that all the components are fixed together so that they won't fail from the weight of the concrete.

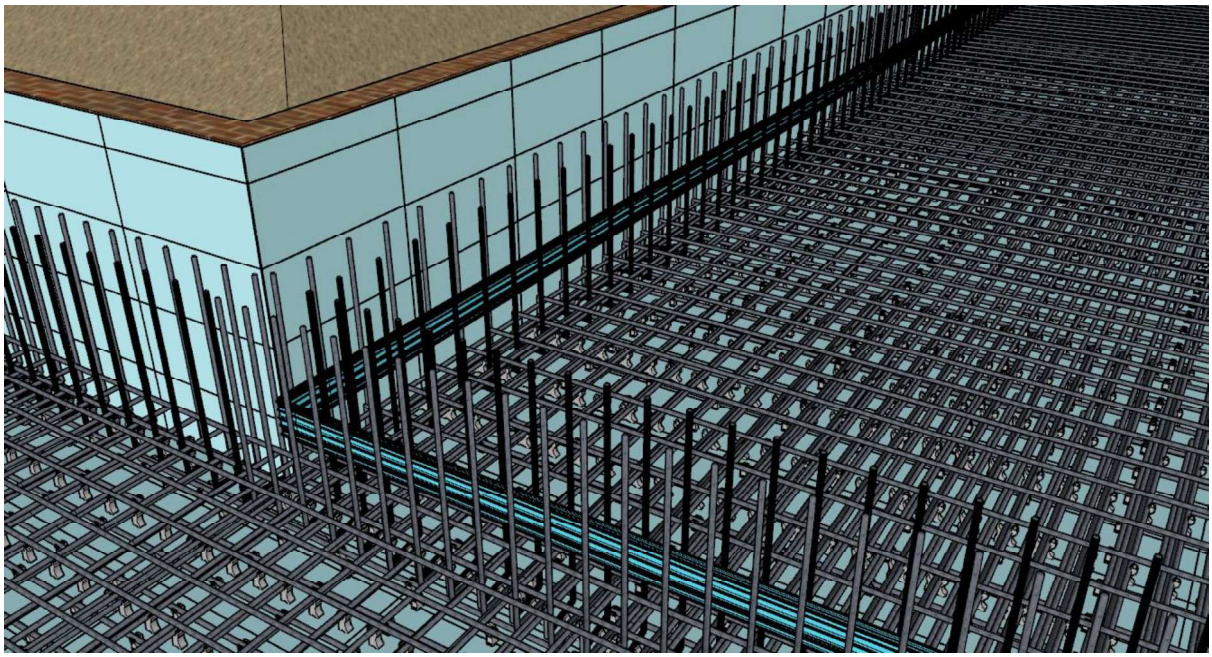

Figure 175 Water stops Placement

3.5.3.3.9 Concreting of the Swimming Pool Floor Slab

27) Concrete will be poured in the wall formwork first and then it will flow to the slab using a concrete pump. The pouring level of the concrete must not be too high in order to remove the possibility of honeycombing. When pouring care must be taken so that the PVC water stops will not be bent as they can forma tunnel where the concrete will not reach them, thus creating a weak point. The amount of concrete to be poured is 80.4 m3
28) The whole entirety of the pool wall neck will be poured together with the slab. Thus, creating a strong floor that is not weak in any point, while the
29) Labor should be present with screens and vibrators. The screens will be used to move the flowing concrete to where it didn't reach yet, while the vibrators will be utilized to make sure that concrete is properly compacted.
30) Care must be taken so that the concrete only covers half the PVC water stops and that the concrete is poured is poured to the slab level and the 250 mm wall neck level.
31) The surveying team must be present to make sure that the concrete was poured to the correct level at multiple increments.
32) After the concrete is poured and smoothed using the surface screens. It will be left to cure. It is essential that an adequate water volume is added on equal interval in order to allow the concrete to cure correctly.
33) After pouring the concrete, it will be left to harden for 2 days so that the workers can step on it and work on its surface.

3.5.3.3.10 Removing Formwork

34) The original formwork for the concrete necks will be removed in order to fix new formwork that will be more suitable for the taller walls.

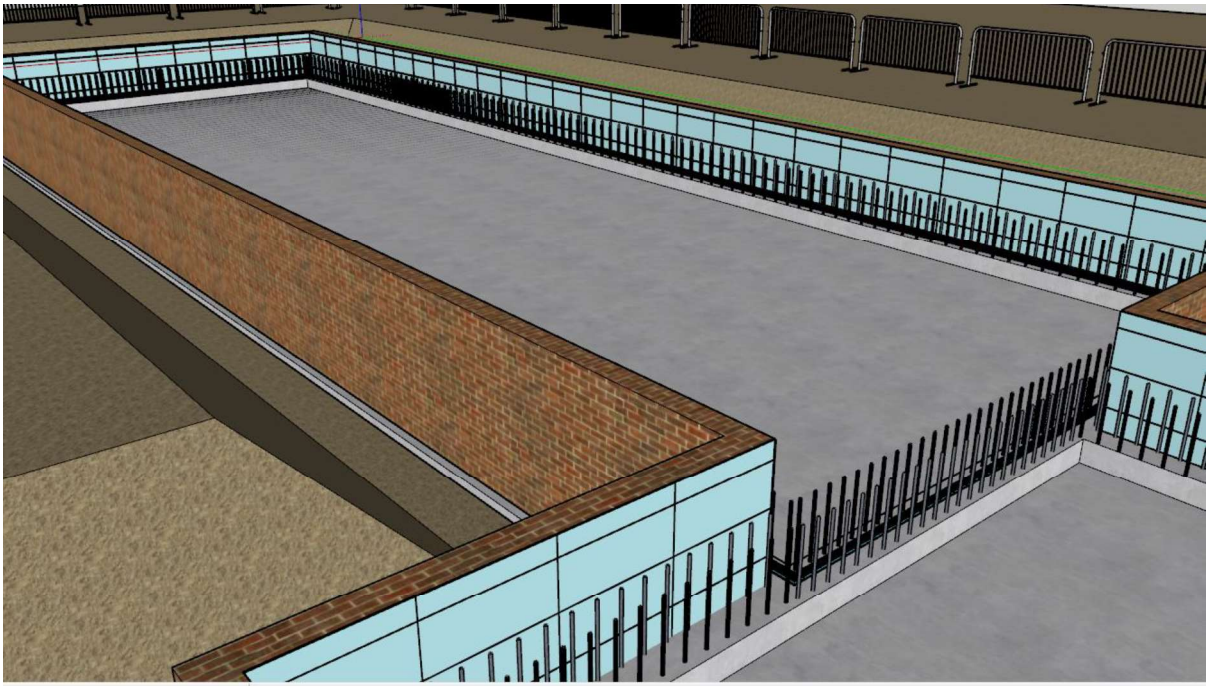

Figure 176 Swimming Pool Concrete Slab

3.5.3.3.11 Reinforcement of the Swimming Pool Walls

35) The steel bars are placed in the wall necks by fixing them to the started bar, they will have the same reinforcement as the slab. These bars will have the same spacing and thickness as the slab reinforcement.

Figure 178 Wall Rebar

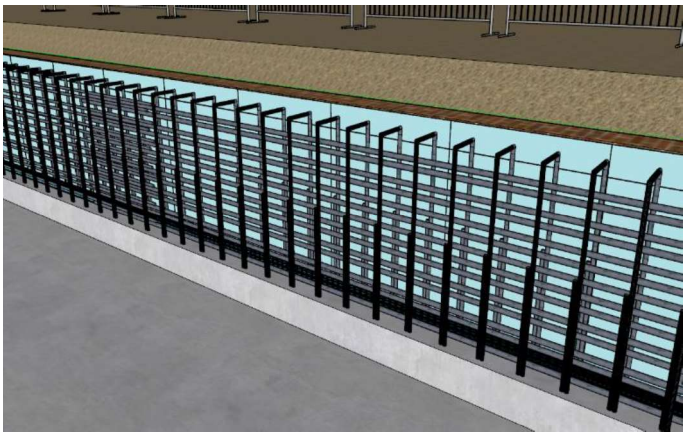

Figure 178 Wall Rebar 2

3.5.3.3.12 Formwork of the Swimming Pool Walls

36) New formwork will be fixed for the walls of the swimming pool. This formwork, like before, will be timber and will consist of 2 main components: the beam and the board. The beam will be 2" by 2" and the board will be as before, 4" by 2". As before the boards (4" by 2") will be stacked together on their short side to form the surface on which the concrete will be touching. As seen in the figure.

37) These boards must be vertically supported, which will be done by the main beams (2" by 2"). These beams will hold the boards in position by being fixed to them using nails. The boards will be placed on increments of 1 meter alongside the boards. These beams will be also supported from the other side by boards that are fixed axially on the beams to give more stability and rigidity to the frame. The boards will be places at an increment of 200 mm.

38) So now since the boards that are going to be main contact of the concrete are stacked horizontally on the short side are stabilized by the vertical beams, we need to stabilize the beams. We already gave them some small rigidity with the boards on the other side, but these will not be enough. So vertical beams (2" by2") will be

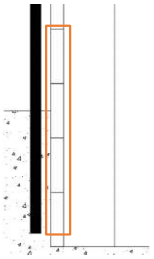

Figure 179 the boards stacked on top of each other to make a formwork wall that will encase

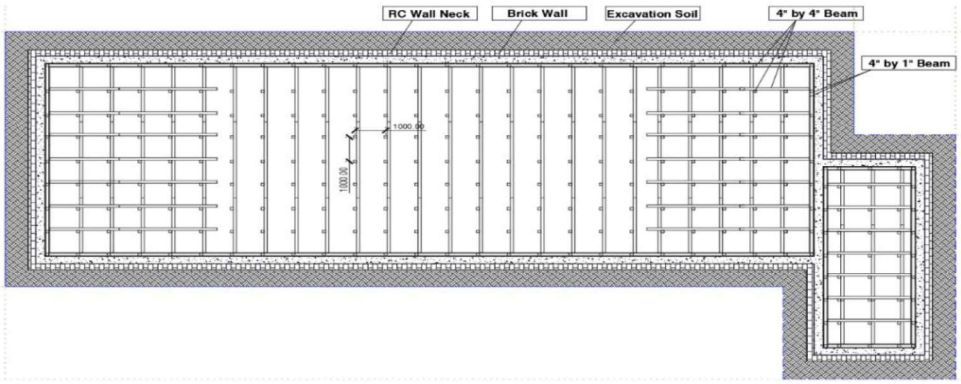

Figure 180 Formwork Plan

placed on the poured slab surface with increments of 1 meter in both directions. As shown in the figure below

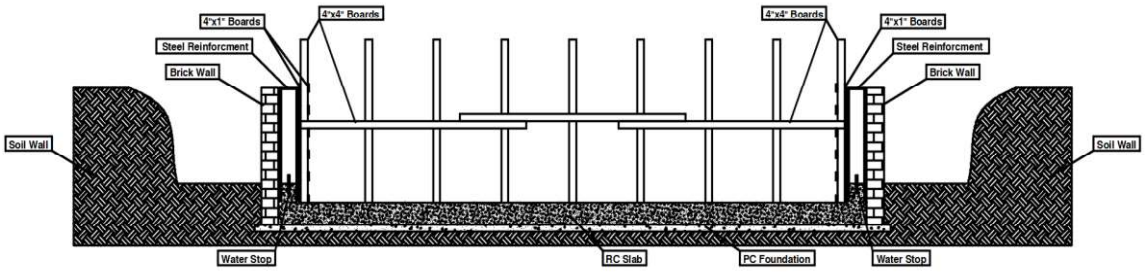

Figure 181 Cross Section of Wall Formwork

39) As seen in the figure above, the beams (4" by 2") is supported by horizontal beams that are stabilized by vertical beams that form a square lattice of 1 by 1 meter. Before the formwork close off the reinforcement, any plumbing works and electrical conduits need to be installed first.
40) This style of formwork will remove the need for tie rod which if present will create weak points and will require to be cut drilled and grouted.
41) After the formwork is constructed, it needs to be inspected by the engineer and the surveying team to make sure that is level and structurally viable.
42) After the inspection is done, then the formwork will be dusted and doused with water to make sure that it all gaps all closed by expansion of wood. The starter bars must clean from any dried concrete from the previous pouring activity.

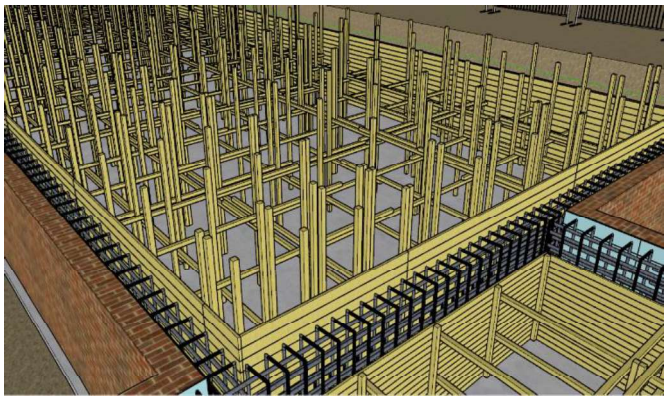

Figure 184 Swimming Pool Wall Formwork

Figure 185 Swimming Pool Wall Formwork Detail 1

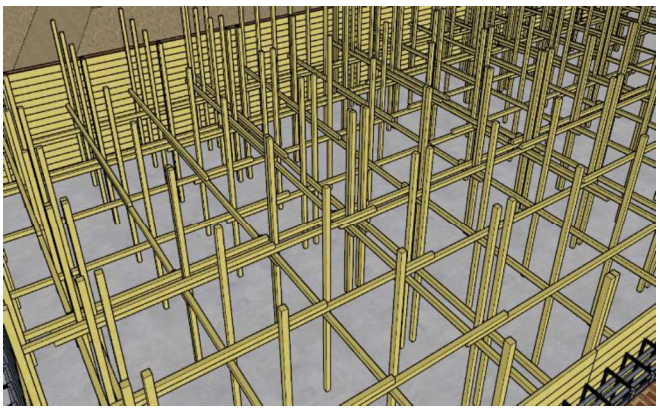

Figure 183 Swimming Pool Wall Formwork Detail 2

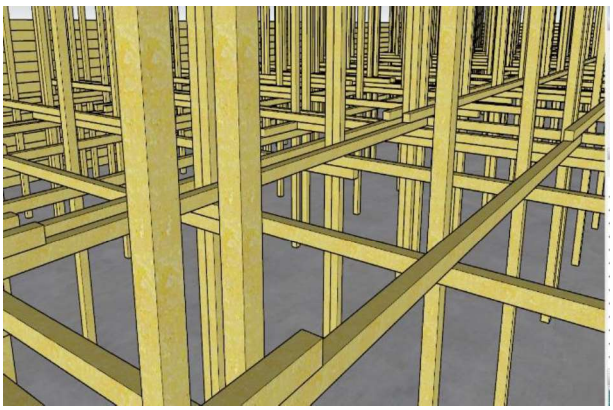

Figure 182 Swimming Pool Wall Formwork Detail 3

3.5.3.3.13 Wall Formwork of the Pump Room

43) The pump room has a roof with an access point on top where the personnel will utilize it for maintaining the swimming pool pumps. This access point will be utilized for allowing the carpenters and other labor to remove the formwork after the pouring is done. This access point will be also used for the consultants to inspect the undercarriage of the roof formwork.
44) The walls of pump room will receive the same treatment as the swimming pool roof. So, the style of the formwork will be the same except for a few changes. The timber boards which are 4" by 2" will be stacked vertically on the long side with the short sides facing upwards like in the figures above. The boards will be stacked from the poured slab to a height of 1.2 meters high, this height is limited to allow the formwork for the roof formwork to be placed so that the roof concrete level will be the same as the swimming pool level.
45) After the boards are placed around the reinforcement, they will be supported by vertical beams (2" by 2"). These will be placed at an increment of 1 meter in order to provide adequate bracing. These vertical beams will support the stacked boards all way around the pump rooms.
46) These vertical bracing will be in turn placed by horizontal beams (2" by 2"). These beams will be placed at a height of 1 meter and will be placed where the verticals beams are placed in order to brace them and remove any translations due to the loads placed on them by the concrete poured. The beams will be also present in the middle of the room to form a lattice so that they will also support the roof formwork.
47) The horizontal beams will overlap when placed on each other and these overlaps will be fixed in place by using metal clamps.
48) This style of formwork will remove the need for tie rod which if present will create weak points and will require to be cut drilled and grouted.
49) After the formwork is constructed, it needs to be inspected by the engineer and the surveying team to make sure that is level and structurally viable.
50) After the inspection is done, then the formwork will be dusted and doused with water to make sure that it all gaps all closed by expansion of wood. The starter bars must clean from any dried concrete from the previous pouring activity.

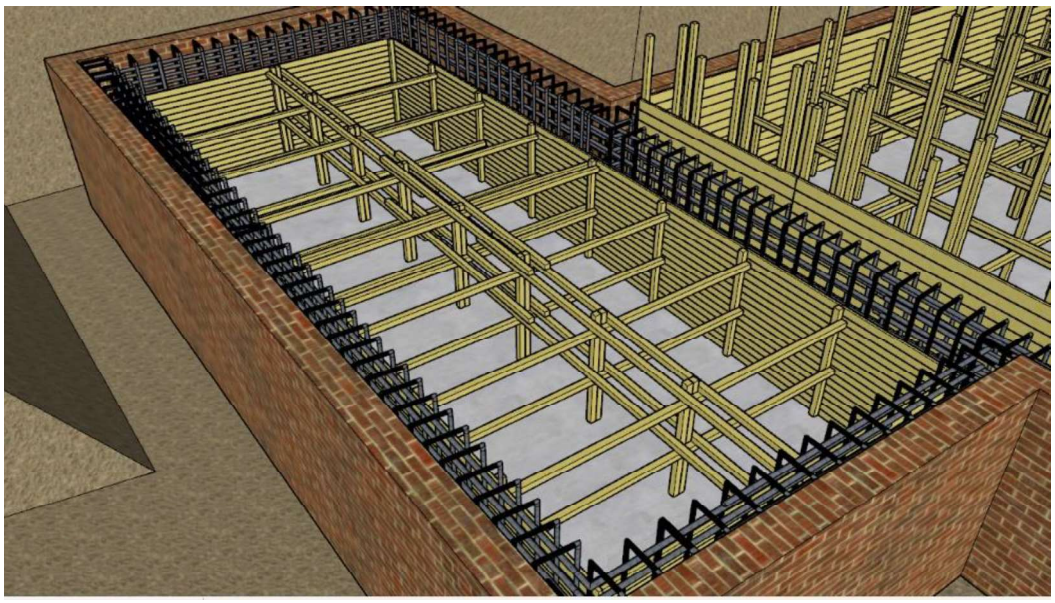

Figure 186 Pump Room Wall Formwork

3.5.3.3.14 Roof Formwork of the Pump Room

51) The roof formwork will be done after the wall formwork is done as the wall formwork will be double utilized for the roof formwork as well.
52) After the vertical beams are braced by the horizontal beams. The tops of the vertical beams will have the same horizontal bracing by using the (2” by 2”) beams. These beams will support the horizontal boards. The boards will be stacked horizontally with the short edges touching as the wide part will be the one facing the concrete.
53) Care needs to be taken so that there are no voids in the formwork in which the concrete can exploit the week point and either break the formwork or get drained from it.
54) After the formwork is constructed, it needs to be inspected by the engineer and the surveying team to make sure that is level and structurally viable.
55) After the inspection is done, then the formwork will be dusted and doused with water to make sure that it all gaps all closed by expansion of wood

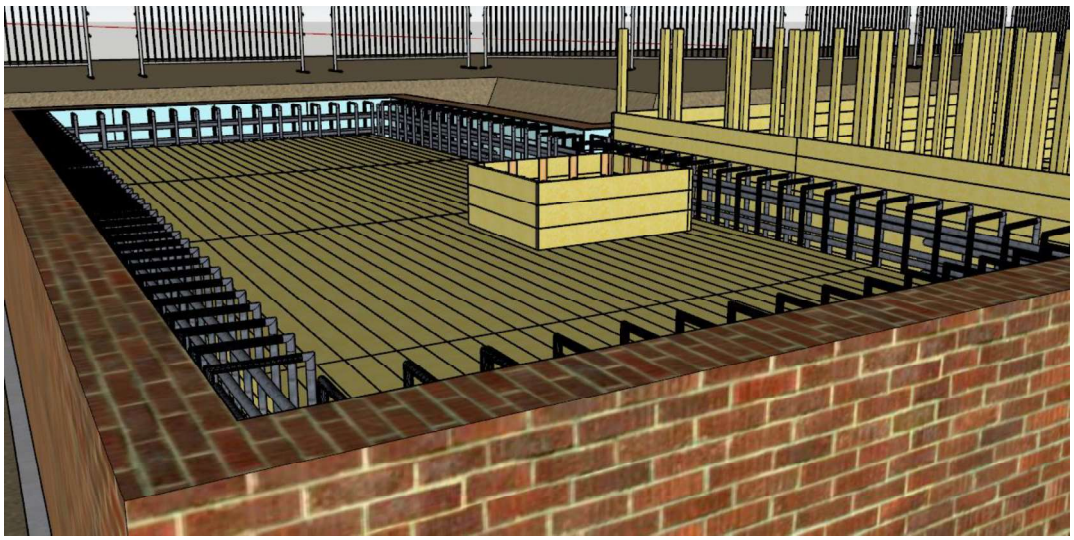

Figure 187 Roof Formwork Detail 1

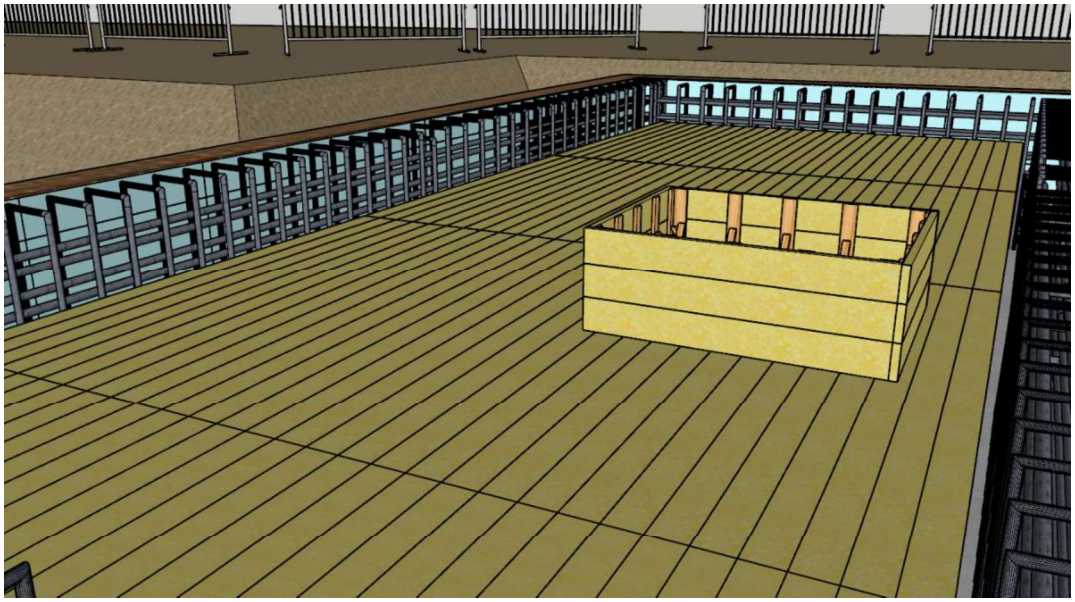

Figure 188 Roof Formwork Detail 2

3.5.3.3.15 Roof Reinforcement for the Pump Room

56) The reinforcement for the pump roof will be divided into two meshes, the upper mesh and the lower mesh. Both meshes will have the same spacing and the same diameters as the slab and wall reinforcements.
57) The lower mesh will be placed first with the ends bent upwards to reach the edges of the upper mesh.
58) The upper mesh will be placed on (كراسي) so that they can maintain their vertical spacing. The upper mesh's steel edges will be bent downwards so that it connects with the wall reinforcement. As shown in the figures below

3.5.3.3.15.1 Roof Reinforcement for the Pump Room Access Panel

59) The roof has an access panel which requires that the reinforcement goes around it. In order to do the that, the mesh at the access point will morph into one.
60) The bars perpendicular to the surface will be bent to form a steel bar called (شوكه) like the one used at cantilevers. Thus, the bars will be part of the upper and lower meshes.

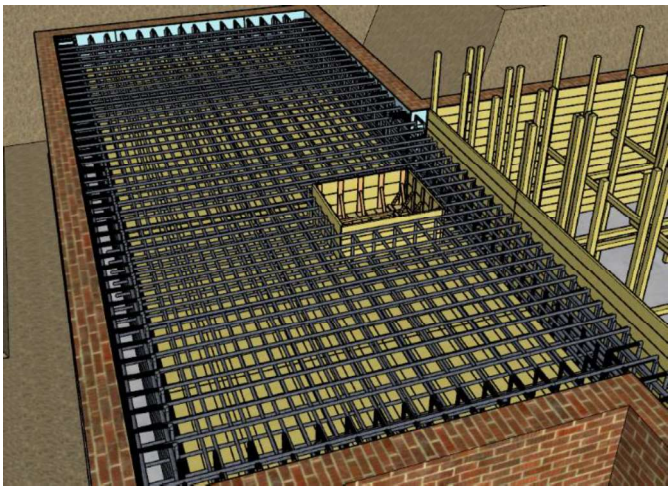

Figure 192 Roof Total Rebar

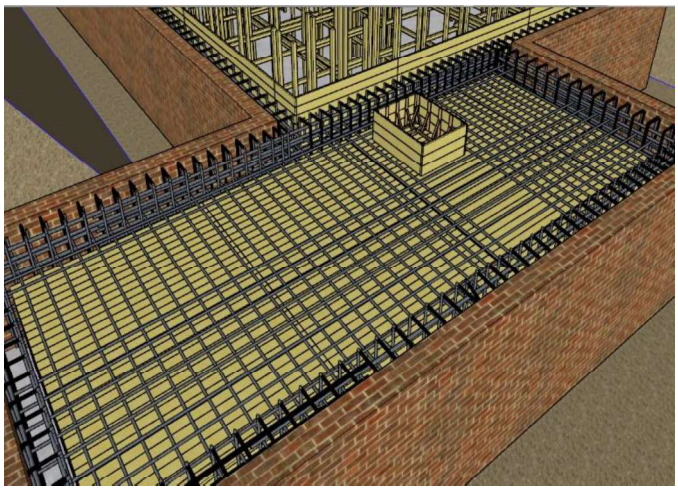

Figure 192 Roof Lower Mesh

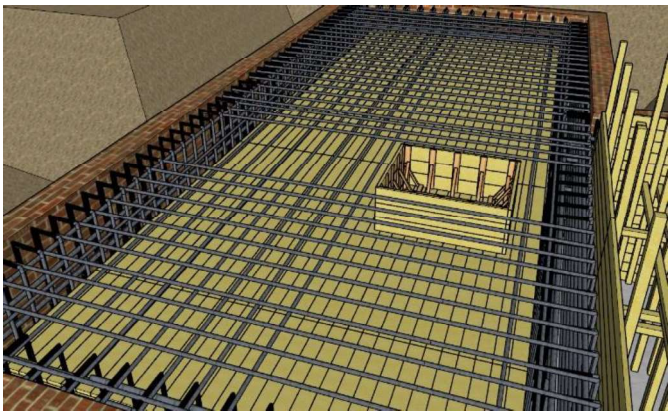

Figure 192 Roof Upper Mesh

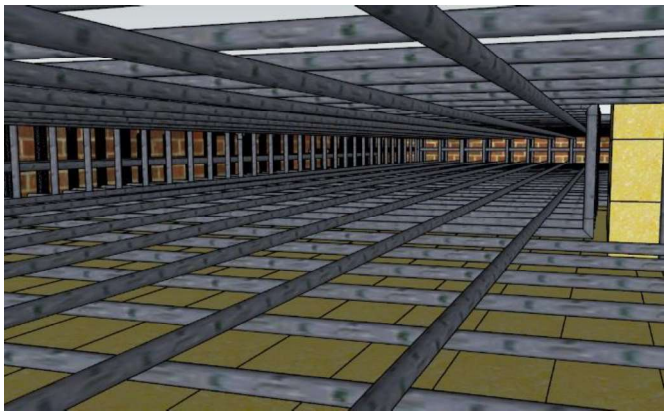

Figure 192 Roof Rebar Detail

3.5.3.3.16 Concreting for the Swimming Pool Walls, Pump Room Walls and Roof

61) The concrete will be poured for the walls and the roof of the pump room using a concrete pump. The same type of concrete for the slab will be used for the walls. When pouring the PVC water stop must not bend as it might form a tunnel. Vibrators and small surface screens must be present to make sure the concrete is well compacted and that the surface is smooth after pouring. The surveying team must check that the concrete reached the correct level.
62) Since the height of the wall is relatively small, 1.35 meters, the entirety of the walls of the swimming pool and pump room will be poured at the same time.
63) After 1 day the formwork will be removed and curing by water shall be administered on equal time intervals to make sure that that the concrete cures successfully.
64) After the removal of the formwork and the curing are done, the part where the pipes and drains come out of the concrete need to be conditioned by hollowing out the surrounding part of the drain/ pipe and then replacing it with water tight mortar in order to eliminate the weak points.

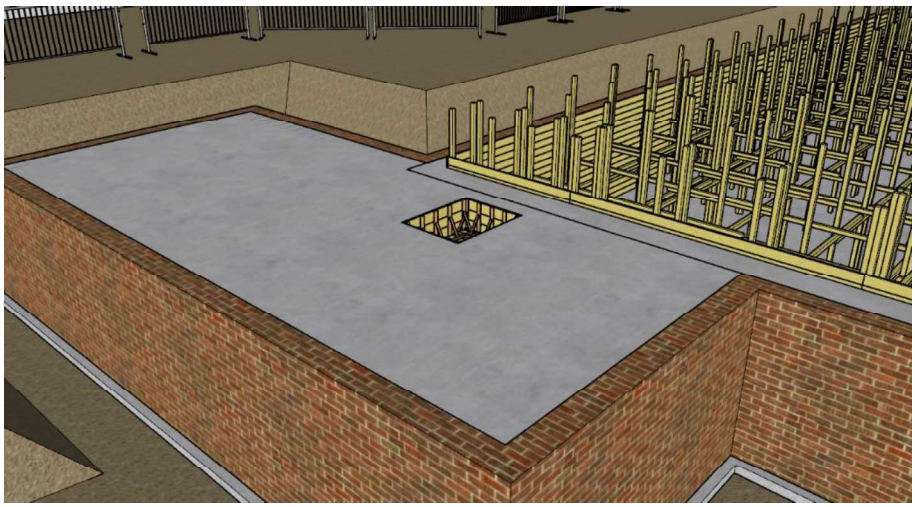

Figure 194 Roof and Wall Concrete

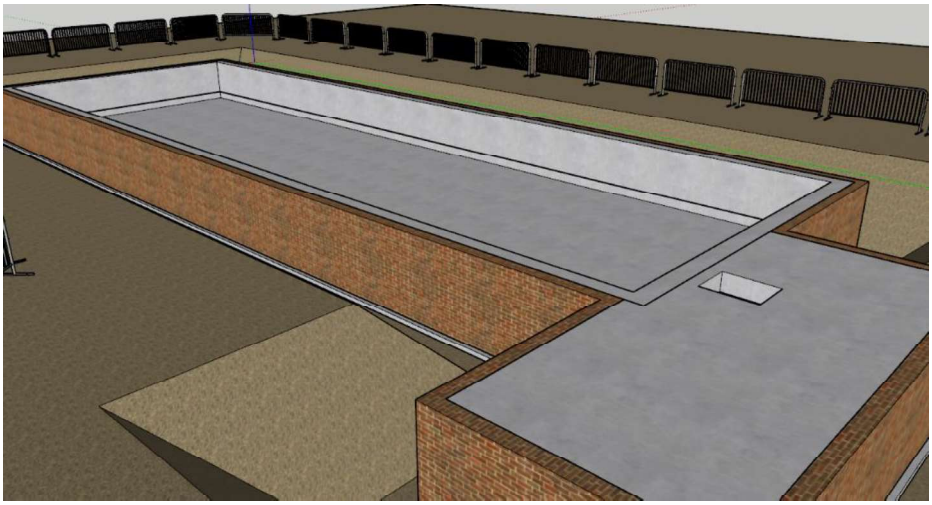

Figure 194 Roof and Wall Concrete

3.5.3.3.17 Testing

65) The swimming pool testing must be done after the concrete is left to gains strength for at least 14 days. This will allow the concrete to gain enough strength so it can hold the water on its own without needing the lateral support of the soil from the outside boundaries. This will be especially applicable in the case of our swimming pool as the water depths is less than 1.5 meters.
66) The swimming pool must be tested in order to make sure that it is watertight, and no leakages occur.
67) Each compartment will be tested alone.
68) Before the testing, inspection must take place to make sure that there are not cracks or area of concern before filling the pool with water.
69) Each compartment will be filled with water with the water level being 75 mm below the overflow sill. The rate of which the water is poured is 2m vertical rise per 2 hours.
70) After being left from 7 to 21 days to let the concrete absorb the water.
71) The water level should then be measured and recorded using a hook gauge with Vernier control for 7 days.
72) Since the pool has inaccessible belly and side, the eater level will be tested once per day, and the water that pass through the drains and pipes must be taken into account as well with isolation valves being checked for water leakage as well.
73) If the drop of water level over the 7-day period does not exceed the lesser of (1/500) * (average water depth) or 10 mm with the deduction of water leakage from the valves, drains, condensation and evaporation. The evaporation part can be reduced by covering the swimming pool with a thick tarp.

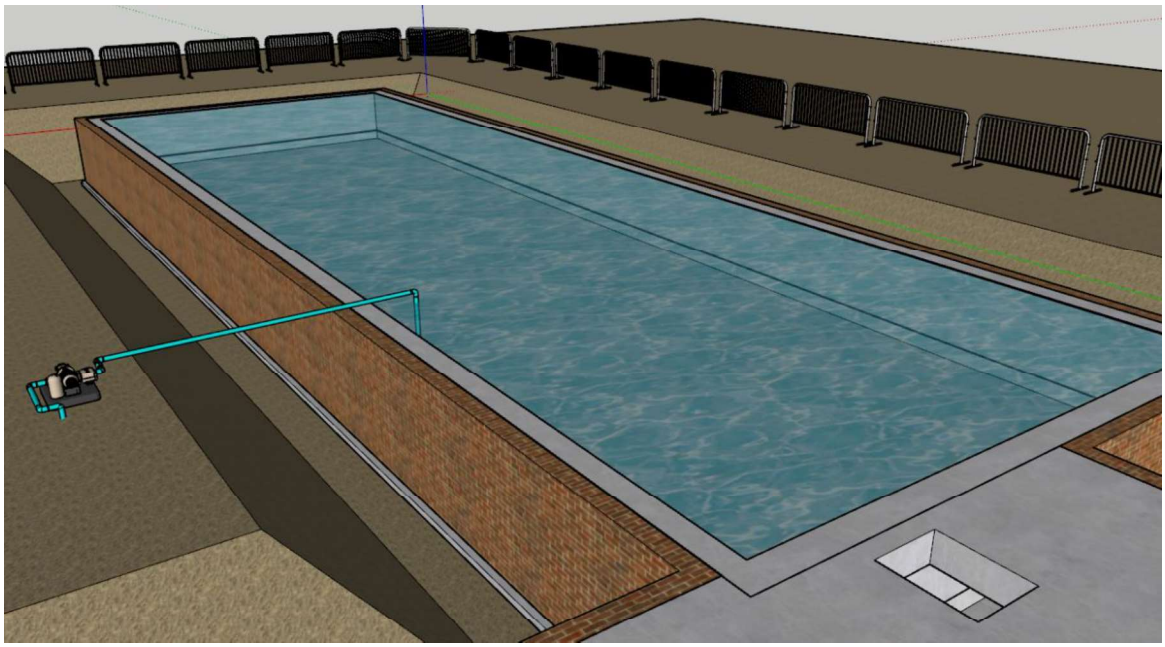

Figure 195 Swimming Pool Leakage Testing

3.5.3.3.18 Backfilling

74) The excavated parts on the outside layer of the brick wall must be filled back again.
75) Clean sand imported from outside of site will be used for backfilling.
76) The backfilling should be done on layers not exceeding 250 mm and that are compacted using manual compactors adequate water volumes to reach no less than 95% dry density.
77) Proper on point tests should be taken at each layer in order to make sure that the layer meets the requirements.

3.5.3.3.19 Finishes

78) The swimming pool must be fully drained from the water and be left to completely dry using evaporation.
79) After the water is fully evaporated, the surface of the concrete must be thoroughly cleaned and made ready for the plastering.
80) Before the plastering work starts, all pipes, pumps and electrical works must be installed, tested, and inspected.
81) Once the surface is ready and all predeceasing work is done. The plastering mix will be prepared and be applied on the surface.
82) The thickness of the plaster for the first coat will be 4 mm thick which will provide a rough texture for the next coat to latch on.
83) The first coat will be water cured for at least 48 hours before the second coat can be applied.
84) After the proper passing of time, the second coat will be placed using the same material. The second coat will have a thickness of 20 mm which brings the total thickness to 24 mm.
85) The finished plasterwork needs to be water cured for a period of at least 3 to 4 days with an interval of 3 to 4 times per day.
86) After the plaster is water cured for an appropriate period, the plaster work must be inspected to make sure that it is level and is ready for the tiles to be placed.
87) The mosaic sheets must be fabricated into the patterns that were approved by the consultant with the bedding being 25 mm that is made from grout.
88) The sheets will be fixed in place by the bonding additive using non marking rubber mallet so that the sheets will be strongly bonded with the additive and the plaster beneath. With the grouting being done according to the project specs while taking care to clean any excess spills.
89) After the sheets are fitted, the engineer will inspect them to make sure that they are bonded correctly and that they are level.
90) A second water tightness test will take place for each compartment alone following the same steps as before.

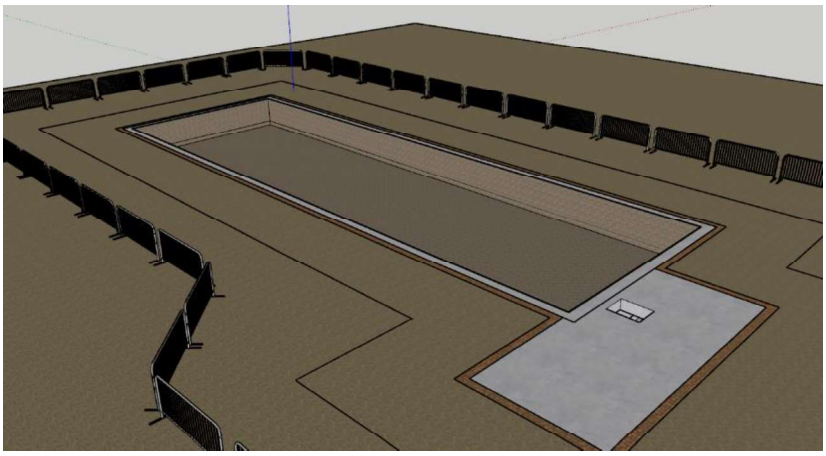

Figure 196 Swimming Pool Backfilling and Finishes

3.5.3.4 Mobility and Movement Inside the Construction Area

- **During the excavation**
  - Equipment such as trucks and loaders will need to be move in and out of the excavation pit. This calls for a need of a ramp. The ramp will allow easy access for personnel and heavy equipment. For the heavier equipment to be able to utilize this ramp, it needs to have a slop of 10%. Therefore, the ramp will be 24 meters long at the lowest point of excavation.
  - The ramp will be excavated using loaders.
  - After the excavation work is done and the heavier equipment are not needed to go down to the excavation pit, the ramp will be backfilled and compacted on layers of maximum of 250 mm using a vibratory compactor with the adequate volume of water for drenching.

- **After excavation**
  - After the excavation is completed and the ramp is backfilled, the labor will still need to go down the pit and smaller equipment will need to be used in the pit.
  - The personnel will utilize ladders to have vertical mobility in and out of the pit.
  - There will be multiple ladders at different access points around the pit, at least one for each chamber.
  - The ladders must be firmly fixed in place to make sure that they don't slip. They can be fixed in place by digging them in in the bottom soil.
  - The soil on which the ladder needs to be checked to make sure that it can withstand the force of the ladder and the labor using it.
  - Not personnel will be allowed to carry equipment or material when using the ladder.
  - The HSE and QA/ QC supervisors must make regular and random inspections on the ladders to make sure that they are safe and are up to the task.
  - As for the equipment and materials, they will be moved in and out of the excavation pit using the mobile crane.
  - The mobile crane will lift the materials and equipment needed on wooden pallets and drop them off or carry them out of the pit.
  - The concrete will be poured using a mobile concrete pump that utilizes a telescopic boom which will extend to the excavation bit.

3.5.3.5 Tools

3.5.3.5.1 Materials

- **Timber formwork**
  - 2” by 2” beams
  - 4” by 2” boards
- **Steel bars of different diameters**
  - The steel bars will be used for the reinforcement of the concrete in the shape of formed bars and stirrups.
- **Steel wires**
  - Used to tie the steel bars together so they won’t be separated when the concrete is poured and to generally fix them in location
- **Concrete**
  - The concrete will be used as the main structural element of the swimming pool when coupled with the steel bars to make reinforced concrete. Plain concrete will be also used to make the blinding layer under the RC foundation/ base to protect it.
  - Cement, water, fine and coarse aggregates
- **Spacers**
  - Used to create a space between the formwork and the reinforcement steel bars.
- **PVC water stops**
  - Will be used at the construction joints to reduce the severity of their weakness.
- **Polyethylene sheets**
  - Will be used for insulation between the PC and RC foundations/ bases.
- **Cement screed**
  - The screed will be made from water, cement, and fine aggregates to be applied on the floor of the pool after the polyethylene sheet is applied to create a preventative layer that will stop the sheets from being punctured by the reinforcement.
- **Small concrete mixer**
  - The small concrete mixer will be used to mix the cement screed.
- **Water**
  - Used for compaction, water tightness tests and cleaning
- **Formwork release agent**
  - This agent will be applied on the insides of the formwork on the surface that will be in contact with the concrete being poured.
- **Clean sand**
  - Clean sand imported from out of site will be used for backfilling purposes.

3.5.3.5.2 Manpower

3.5.3.5.2.1 Skilled Labor

- **Surveyors**
  - They ensure that the elevations and coordinates of the work done is preformed according to the drawings and that the points of the work are relatively correct to each other.
- **Carpenters**
  - They are responsible for erecting and the dismantling of the formwork
- **Steel fixers and smiths**
  - They are responsible for shaping the steel bars by cutting, shaping, bending, connecting the steel bars that go into the reinforcement of the concrete.
- **Machinery Operators**
  - Responsible for operating the heavy machinery on site such as the loaders, compactors, and cranes.
- **Concrete (Pouring)**
  - Cast and pour the concrete.
- **Testing Crew**
  - The crew that is usually attached to the quality management engineer, they conduct compressive strength and leakage tests among other things.

3.5.3.5.2.2 Semi-Skilled Labor

- **Drivers**
  - Responsible for operating the trucks that carry the soil from the excavation pit to the dumping site.
- **Helpers**
  - These are the labor that are responsible for the manual excavation if needed on site.
  - They conduct the work that does requires some technical knowledge, like installing the water stop.

3.5.3.5.2.3 Unskilled Labor

- **Helpers**
  - The labor that is attached to the skilled labor that conduct the not so highly technical work.

3.5.3.5.3 Equipment

- **Wheeled Loader excavator**
  - Used to excavate the soil in order to create the suitable depth for the swimming pool to be constructed and placed.
- **Total station**
  - Used to locate and identify the points that form the boundaries of the construction area, determine the elevations of the established elements and generally to make sure that everything is placed in its correct position.
- **Manual vibratory compactor**
  - It is used to compact the soil with the addition of water to make the soil reach 95% of its dry density.
- **Manual shovel**
  - Shovels to be used when excavating using the loader is deemed to be inaccurate or may cause harm to existing structures or harm to the labor, such as excavating around electricity cables.
- **Water Tank**
  - The water tank will be used to store water that is used in the various activities of construction.
- **Mobile crane**
  - The mobile crane will lift the heavy equipment and tools into the excavation pit such as the pump, reinforcement bars and formwork.
- **Concrete pump**
  - The concrete pump truck will pump the concrete from the mixer into the formwork
- **Concrete truck mixer**
  - The concrete truck mixer will deliver the concrete from the mixing plant into the site to the swimming pool construction area.

3.5.3.6 Quality Control

- **Surveying**
  i) Surveying equipment must always be present to make sure that all the levels made using the different materials and equipment is correct
- **Excavation**
  i) Take photographs before the start of the work for the environment and nearby locations to the planned work area.
  ii) Revise the soil report to make confirm the location of the groundwater tables in order to determine if dewatering equipment are necessary. Confirmation for whether the soil will be used for replacement needs to be done in order to prepare storage area for them.
  iii) Check utility plans to make sure that there are not exiting infrastructure works like gas lines, electrical cables or water lines.
  iv) Check the approved disposal site to make sure it is ready to accept the fresh soil and that the hauling path is clear from any obstruction.
  v) Protect any existing infrastructure works.
  vi) Make sure that proper drainage is placed and fully operational.
  vii) Upon completion of excavation, conduct the following tests:
  viii) Determine average volume hauled for each type of hauling equipment, record the daily amounts and compare them to the drawings in order to create quantity surveys
  ix) Examine all excavating equipment for compliance with General Safety Requirements.
- **Soil replacement and compaction**
  i) The proctor test must be done for each of the compacted layers before moving on to the next one (one test per certain area).
- **Formwork**
  i) Checks for the straightness if the formwork by using a plumb bob which is placed between the upper and lower formworks, the distance is measured and compared to the drawings
  ii) The clear cover should be checked to make sure that the covers on the bars are touching the interior sections of the formwork and the brick wall.
  iii) Make sure that the lateral bracings are firmly placed to the support the vertical formwork from all point and that the boards are adequately braced and tied together.
  iv) The boards should form an angle of 90 degrees with the vertical beams, and the lateral beams as well. This can be checked by making measurements for the diagonals and if the 4 sides make a rectangle, not a trapezoid, then it is acceptable.
- **Rebar**
  i) Ensure that the surface below the bars is cleaned out with no visible remains before pouring. It is suggested to use an air compressor in the cleaning process.
  ii) When steel bars are to be placed vertically, ensure that there are no bars that are tilted.
  iii) Stirrups should be attached at appropriate distances.
  iv) Make sure that the primary and secondary steel bars in both upper and lower meshes are arranged in a correct manner as to having the right diameters coupled with the proper spacing specified by the drawings.
  v) Make sure that the steel bars connections have a proper overlapping span of at least (60*bar diameter).
  vi) The primary and secondary steel bars must be tied together using steel wires.
  vii) Chairs must be used to make sure that the bars maintain their clear cover

- **Plastering**
  i) Ensure that the surface of the wall is fully even by placing patches of mortar at places of recess.
  ii) Mortar that is rich in cement is then sprayed across the wall to give a rough texture for the plastering to hold onto.
  iii) Add nets over the weak points in the wall to avoid cracking due to expansion behavior.
  iv) Add nets over the outer corners of the walls.
  v) After carrying out the plastering, determine the finishing surface level of the wall to ensure that it is smooth and flat.
  vi) Check the verticality of walls and ensure that they're parallel and perpendicular to one another
  vii) there can be presence of hollow sounds after the plastering is done.
- **Pouring**
  i) Check the temperature of the fresh concrete to make sure it meets the specs.
  ii) The time of travel of the concrete truck must be noted as if it exceeds the certified time, it will be rejected. This can be checked from the ticket carried by the driver to know the time of departure, that the duration for the initial setting time was not exceeded, and that the concrete mix is the one matching the specs and drawings
  iii) Slump test must be done on site to determine if the workability meets the standard.
  iv) Six cube molds of concrete are taken each with dimensions of 15 cm by 15 cm by 15 cm from the concrete poured. The compressive strength for 3 of the cubes will be tested after 7 days while the other 3 will be tested after 28 days from the date the samples were taken.
  v) Visual inspections for honeycombing and hammer tests can be performed especially for heavily reinforced sections.
  vi) While pouring the concrete it is important to make sure that each segment took its share and that no segment is left out.
  vii) Adequate vibration should be used to minimize the presence of voids. So, in order to allow for optimum compaction, the concrete must be poured on horizontal layers of 500 mm maximum.
  viii) The must be poured at the furthest point form the entry point first so that the workers will not have to disturb it when getting out of the work area.
  ix) The temperature of the steel bars must be nearly the same as the temperature of the concrete in order to ensure that proper adhesion occurs. So, the temperature of the steel bars must be regulated by either covering them up with thick tarp or spraying them with water in the summer or by pouring in the later hours of the day in the winter.
  x) Air blowers can be used on the formwork before concreting to make sure that no residue or debris will be in contact with the fresh concrete poured, especially the metal ties which can corrode inside the hardening concrete,
- **Mosaic Tiles:**
  i) When adding the tiles, ensure that the expansion of the tiles due to weather conditions is taken into consideration. This can be done by filling the spaces between the mosaic tiles with rubber (a material that is free to expand).
  ii) Use a good mortar when sticking the mosaic tiles to the walls and floor so that they don't budge or fall off.
  iii) Make sure that all the tiles are aligned together so that the result is visually pleasing to the patrons.
  iv) Clean the surface of the mosaic tiles after placing them and ensure that there are no remains; these can injure the patrons if not removed adequately.

3.5.3.7 Health and Safety Requirements

3.5.3.7.1 General Outline

Safety briefing should be made before any personnel is allowed on site to give them a clear and comprehensive idea about the risk and hazards and how to deal with them. All personnel should be equipped with their personal protection equipment the minimally consist of a hard hat, safety boots and eye protection. This equipment must be of the correct specifications and size for all users.

Table 58 Health and Safety Hazard Plan

Activity	Hazard	Level of Risk	Safety Plan	Revised Risk Level
Excavation	Workers falling into the pit	High	• Barriers are to be placed around the excavation pit and marked clearly using high visibility markers. • Notices and signs are to be placed in equal intervals to notify about the existence of the excavation pit.	Low
	Equipment falling on workers in excavation pit	High	• Storage areas for the used materials and equipment must be at least 5 meters away from the edges of the excavation pit. • Workers must always wear the PPE to negate the damages of falling objects on the workers	Low
	Obstruction of sight due to low visibility in the lower depths	Moderate	• Enough lighting to be placed in the dark area in the excavation pit to allow the workers to have clear sight of their surroundings.	Low
Excavation, formwork, reinforcement, pouring, resting, and backfilling.	Trucks, crane, loader or any other vehicles falling into pit due to lack of visibility	High	• The drivers must first conduct an inspection tour around the excavation are to make sure that they are aware of their surroundings. • Any moving vehicle must have a guide on the ground to give the driver instructions about the terrain.	Low
	Moving vehicles colliding with other equipment and/or personnel	Moderate	• Briefs about the moment of vehicles can be made for the personnel on the site • The paths of equipment must be clearly marked to ensure that equipment or materials are placed in that path.	Low
Concreting	Fresh concrete can cause skin irritation, chemical scarring, and respiratory problems, (if the water to cement ration is very low)	Moderate	• Clean water must be always present at all time to allow workers to wash their eyes and skin if the concrete encounters their skin • Face masks such as the N95 masks shall be used to make sure that the workers do not inhale any cement particles. • In addition to wearing their PPE, the labor must be equipped with alkali resistant gloves that cover the exposed parts of their arms, as well as boots that are knee high which will not allow the seepage of wet concrete.	Low

3.5.3.7.2 Permits

3.5.3.7.2.1 Introduction

In order to perform complex and risky operations, permits are usually required. Permits are issued by the respective authority in respect of the works and allow the Contractor to excavate and move earthworks. In order to receive such permit, a procedure must be followed where the Contractor is obligated to follow some precautions. In order to receive such permits, some information need to be identified about the parties, procedures and definitions.

3.5.3.7.2.2 General Requirements and Definitions to Obtain a Permit

3.5.3.7.2.2.1 Parties and their responsibilities

- **Person Conduction Business or Undertaking**
  - The PCBU in this project is REDCON Inc.
  - The responsibility of the PCBU is to provide and maintain:
    - A work environment without risks to health and safety
    - Safe plant and structures
    - Safe system of work
    - Safe use and handling of storage, plants, structures and materials
    - The welfare of the labor and employees with work related to the excavation
    - Training for the personnel working in the excavation.
- **Workers**
  - The workers in our project are the employees under REDCON Inc. and these include the
    - Apprentices
    - Employees
    - Trainees
    - Subcontractors
  - Their responsibilities include:
    - Taking the initiative to maintain their own health and safety
    - Making sure that their actions do not cause harm to themselves and others
    - To operate within the procedures set by the PCBU and comply with their instructions.
- **Officers**
  - In our project the officers are the site, QA/QC, HSE, construction supervisors. Where they are personnel that have significant influence over the management of the business and its undertaking.
  - They are responsible for practicing due diligence to ensure that their instructions match the health and safety laws.
  - Each officer has their own individual duties, they are not joint duties.
- **Other people at the workplace**
  - These include the volunteers, customers, passers-by and visitors, and they are responsible to take reasonable care of their health and safety
- **Competent Person**
  - An individual who through training, experience and qualification has earned the merit and knowledge to carry out a task

3.5.3.7.2.2.2 Managing Risks

- **Identify the hazards through**
  - Physical inspections
  - Tas analysis
  - Engaging with workers
  - Process analysis
  - Consulting guidance and standards
  - Hazard and operability analysis (HAZOP)
  - Accident investigation analysis
- **Asses the risks**
  - The likelihood of the hazard or risk is happening
  - The degree of harm that will be caused by this risk
  - The information available for that risk
  - The available and suitable ways on how to reduce the risk or eliminate it.
- **Control risks**
  - Eliminate the risk
  - Minimize the risk
    - Substitution
    - Isolation
    - Engineering controls
- **Review Controls**
  - Need to regularly monitor and review controls to make sure they are still effective
- This can be seen in the table above for obtaining permits for the excavation and the confined space entry permits

3.5.3.7.2.3 Obtaining the Permits

In order to obtain the permits, these questions need to be answered:

- **Excavation:**
  - Is a Safe System of Work in place and will it be implemented?
  - Does the dig involve deep excavations i.e. greater than 1.25m?
  - Have the proposed dig location(s) been surveyed for presence of existing services?
  - Have underground services been established in the location of the excavation(s)?
  - Are there any overhead lines in the vicinity of the excavations?
  - Will secure hoardings, barriers, guardrails, toe boards, signage be provided as required?
  - Has a Risk Assessment been carried out and control measures actioned?
- **Confined Areas:**
  - Will the Contractor adhere to the Code of Practice for Working in Confined Spaces?
  - Has a Risk Assessment been carried out specifically identifying the risks associated with Confined Spaces?
  - Have the Risk Assessment Control Measures/Actions been implemented?
  - Have the Contractors personnel been provided with suitable training or instruction by the Contractor for Working in Confined Spaces?
  - Have the Contractors personnel received training and qualifications to operate equipment for working in Confined Spaces?
  - Has all equipment to be used been maintained, serviced and checked to ensure it is safe to use?
  - Have the Contractors personnel who are going to work in the space have suitable PPE?
  - Did the Contractor confirm testing of atmosphere in space(s) will be carried out and results submitted to Estates Office prior to works commencing?
  - Did the Contractor confirm that space will be securely isolated from all sources of ingress of dangerous fumes, liquids, water, steam, materials etc. whilst works are being undertaken?
  - Did the Contractor confirm that space will be purged of all dangerous fumes, liquids, water, steam, materials etc. prior to works commencing?
  - Did the Contractor confirm that space will be securely isolated from all energy sources including electrical power, mechanical power, heat etc.?
  - Did the Contractor confirm that a Hot Works Permit will be completed if Hot Works are due to be carried out in the space(s)?
  - Has the Contractor taken all practicable precautions or to eliminate or reduce the risk of Confined Spaces?

Special Storage and Handling Requirements

3.5.3.7.3 General Notes

- **Purchasing of materials**
  - Before any material is purchased, a random sample must be inspected by the QC engineer to make sure that it meets the specifications and requirements of the project.
- **Entering and leaving storage**
  - No material can be logged, entered be admitted to and from storage before inspection, whether visual, physical, or chemical, by the QC engineer.
- **Recording**
  - Before entering the storage area, all materials must be clearly labeled with a description, the entry date and any handling requirements (if present) to make sure that they are stored correctly and do not pass their expiry date. This shall be done by the storekeeper
- **Handling the equipment**
  - Manual handling of equipment is always preferred as more care can be taken. However, for heavier objects, tools can be used such as a wench or a forklift. But withing the store container, the handling will be always done manually (by hand).
  - The personnel handling the equipment must have undergone extensive training on the handling techniques of the different types of equipment and materials stored.
  - If any materials are placed on pallets, clearance under the pallets must be always checked before any lifting is done by the forklift.
  - Materials stacked on each other must be the same.
- **Storage**
  - It is preferred to have each activity's materials and equipment to be stored in the same zone in order to increase the efficiency of site deliveries.
  - Materials shall always be protected except when they are near the installation site and are in use by the working crew,
  - Protective casing, coverings, or tarps must be placed on items and materials of unique nature in order to avoid unwarranted contact with external elements.
  - The storage area must be leak proof, dry and moisture proof as well.
  - The storage area must be shaded by either a solid roof or a heavy tarp that covers the 4 sides and roof.
  - Minimum number of windows s required in the storage area to avoid having direct sunlight in contact with the materials and to keep the storage are as cool as possible.
  - All materials must be stored on wooden planks which gives clearance between 150 to 200 mm in order to avoid moisture or spilled water from accessing the stored materials through the contact with the ground.
  - The floor of the storage area must be made from lean cement concrete or two layers of laid bricks on well consolidated earth.
  - Spacing of 600 mm should be maintained between all materials and the walls in order to transfer of water or humidity from the materials to the walls.
  - No smoking is allowed in the storage areas.

3.5.3.7.4 Specific Notes

- **PVC water stops**
  - The PVC water stop must be stored in a shaded cool are, preferably cover at all time away from contact with direct sunlight. Sunlight contains UV rays which can irreversibly later the chemical composition of the PVC as it is plastic in nature.
- **Cement**
  - The cement bags must be grouped together as tightly as possible to reduce the flow of air between the stacks.
  - To avoid the risk of lumping under pressure, the number of bags stacked on each other shall not be higher than 10 bags.
    - When the number of bags exceeds eight, the stack shall be staggered as in one being length wise and the other being cross wise to minimize the risk of toppling.
  - Encase the cement bags in waterproof bags to avoid moisture from coming in.
  - The cement stacked together must be of the same type, if not, then it will be stacked in different groupings.
  - The QC engineer must take great care in ensuring that the bags coming in and out of the site are not open and do not have any tears.
  - Any cement stored for a duration of more than 3 months must be discarded of immediately.
- **Water**
  - The water stored must be fresh water with the least amount of Chlorides, Sulphates, TSS, Alkali carbonate and bicarbonate, Acid, Sugar, Organic materials, and Oils
  - The pH of the water must be monitored intervalley
  - The water used in the production of concrete or cement screed must follow TS 3440
  - Water must be stored in tanks of which the sides will made from concrete or bricks
  - The water must be easily accessible for either draining or filling
  - The path for the water must never be blocked by either material or equipment
  - Contact with organic material is heavily prohibited.
- **Wood formwork**
  - It is imperative that the wooden formwork is kept away from any type of moisture by following the general notes
  - The formwork must be cleaned on regular intervals.
  - The formwork is to be stored in stacked in member lengths with each group being from the same length. The layers shall be different in terms pf either being cross wise and length wise.
  - The individual members must have a minimum spacing of 25 mm in order to allow air flow.
  - The longer pieces are placed in the bottom while the shorter pieces are placed at the top. With one side of the stack must attain vertical alignment.
  - Minimum spacing between the different stack must be 800 mm.
  - If formwork is going to be stored for a long time, then weights are to be placed on the stack to prevent warping and the ends of the formwork beams and boards shall be coated in tar.

- **Steel bars and sections**
  - The main mission when storing steel bars or any structural steel in general, is to prevent corrosion, scaling, distortion and rusting.
  - Humid conditions are very destructive for steel reinforcement storage; therefore, it is advised to coat them is cement wash before they are stacked.
  - It is better for the stacks to be for steel bars of the same length and diameters
  - The stacks are preferred to be on platforms of minimum clearance of 200 mm
  - Ends of different bar types shall be painted differently for easier finding and cataloging.
- **Bricks and Masonry Blocks**
  - The bricks must be placed on very firm ground.
  - For ease of cataloging and logging, the bricks must be placed on stacks the depend on type with each stack being a maximum of 50 bricks long, 4 bricks wide, and 10 bricks high.
  - The bricks can be also stacked based on strength or geometrical shape.
  - Bricks must be handled with car, no throwing or dumping is permitted in any way or shape, they are to be moved in small quantities carefully and laid down with ease.
  - Bricks must be placed as close to the building site as safely possible in order to reduce the effort of carrying the bricks on long distances as movements can damage the corners of the bricks.
- **Aggregates**
  - The aggregates need a very hard surface that is also dry to rest on.
  - Contact with any foreign objects must be minimized such as dust or organics.
  - Fine and coarse aggregates must be stored separately, preferably in different rooms, or being divided with a hard cover. Fine aggregates must not be placed in a wind path that will lower their volume.
- **Paints and bitumen**
  - Any flammable materials must be stored in an enclosed container which are placed in a well-ventilated area that is away from heat, sparks, flame or smoke.
  - The floor of the container must be covered with a 100 mm thick layer of sand.
  - The wires and any electrical components must not be stored or fitted in the same room which houses the paints and bitumen.

3.5.3.8 Waste Management Plan

3.5.3.8.1 Brief

- The site waste management plan (SWMP) aims to minimize the total quantity of the produced waste on the construction site by creating a plan where it is decided what happens to disposed materials, such as throwing them out, reuse, or recycle them. In our project, a SWMP needs to be developed in accordance with the ASTM E 1609 before the construction process starts and then this plan will be updated during the construction period.
- The benefits of creating a SWMP is that it raises the standard of health and safety on the site, reduces costs, improves the reputation, and lowers the negative environmental impact produced by the site.
- The waste management hierarchy is as follows: Reduce, Reuse, Recycle and Dispose.
- In order to create the SWMP, we must look at what the materials can become waste and how we can prevent the materials from becoming waste.
- In order to better manage the plan, all waste must be logged and recorded to determine the volume of waste produced and the action taken in order to deal with it.

3.5.3.8.2 General Note

- All waste must be first minimized by making sure that no excess amounts is ordered, and that careful handling and application is done in order to minimize the waste produced.
- All wasted materials must be investigated to determine whether they can be used in other activities in other construction zones first before taking the decision to dispose of them.
- Hazardous Materials
    - It is best to minimize the amount of hazardous materials that is wasted from the beginning, any leftover hazardous materials can be used for other activities.
    - When wasted, hazardous materials must not be mixed with the other non-hazardous materials, and be kept separately away from any heat, sparks and flames. It must be disposed of in concealed containers and the guidelines of the manufacturers must be followed profusely

3.5.3.8.3 Types of waste produced

- **Insulation – Bituminous**
  - Hazardous.
- **Concrete**
  - Set concrete can be broken down and be made into aggregates for future reuse, therefore it is best to be sold to a recycling plant
- **Bricks**
  - Wasted bricks can be used in the same activities for other zones and area. However, if no other activities can be found, the bricks can be broken down to be either used as aggregates by in specialized plant or be used in landscaping with minor treatments.
- **Ceramic**
  - Ceramic materials will be sent to specialized recycling plants.
- **Untreated Wood**
  - The untreated wood can be either given to recycling plants or be given to furniture manufactures who will use to make particleboards.
- **Plastic**
  - Plastic materials will be sent to specialized recycling plants.
- **Iron and steel**
  - The steel needs to be
- **Unused or unset cement**
  - Hazardous material
- **Paints**
  - Hazardous material
- **Adhesives**
  - Hazardous material
- **Packaging**
  - Packaging can be given to specialized recycling plants.

3.5.3.9 Logistic Plan

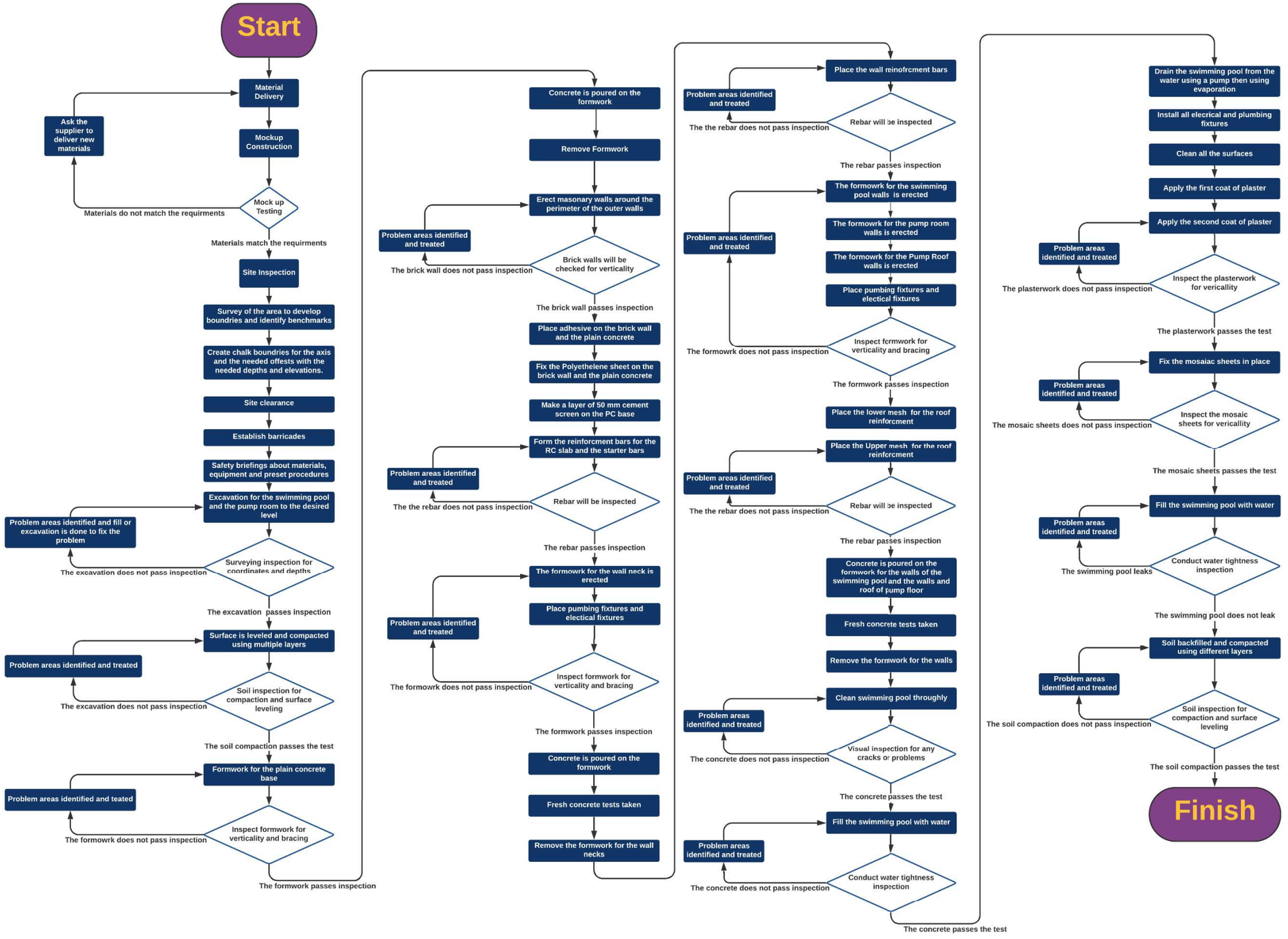

Figure 197 Swimming Pool Logistic Plan

3.5.3.10 Swimming Pool Bar Chart

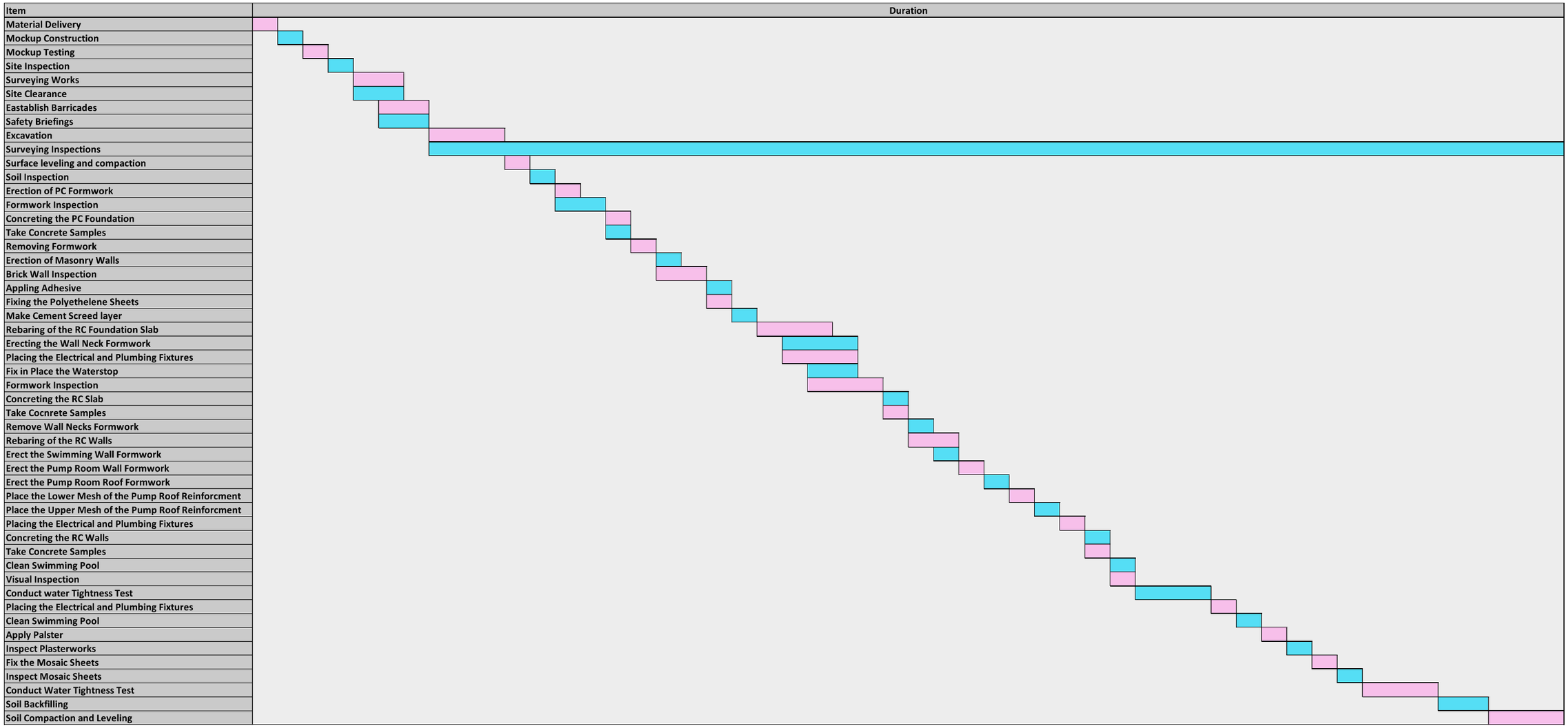

Figure 198 Swimming Pool Bar Chart

3.5.3.11 Alternative Method

Types of pools that can be used instead of the reinforced concrete type used in our project.

3.5.3.11.1 Below Ground

3.5.3.11.1.1 Fiberglass

- **Brief**
  - Manufactured unit offsite and is brought in to the install location, therefore a hole is excavated and a material is spread over the location where the pool is going to reside in and then the pool is placed in the hole, gets filled with water, and a material is used to fill the void between the pool shell and the soil walls, backfilling.
- **Advantages**
  - Very low maintenance as the inner surface is very smooth and non-porous, thus the algae does not have anywhere to hide or imbed into and the chemicals work more efficiently, and the time required for maintenance is relatively lower.
  - Very quick installation time.
  - Low cost of Ownership.
- **Disadvantages**
  - Shape and size are not customizable
    - The fiberglass swimming pools come from a catalogue, so if you don't like an of the preset shapes or sizes, they won't be suiting you.

3.5.3.11.1.2 Vinyl Liner

- **Brief**
  - They are constructed using wall panels that are laid around the perimeter of the pool. Theses panels can be vinyl products, plastic, or metals, steel or aluminum, however when using metals, it is advised that a saltwater chlorinator is not used.
  - The main issue with the vinyl liner is that it will eventually leak and will need replacing, so it is useful when a large pool is required for the least cost and when the pool will not be used after 3 to 5 years, before the next replacement will be required.
- **Advantages**
  - Low initial cost
  - Customizable shape, although they are mostly rectangular, they can have multiple different shapes and sizes
- **Disadvantages**
  - Average life expectancy is low, thus needs replacing every 5 to 10 years.
  - Not ascetically pleasing.

3.5.3.11.1.3 Concrete

- **Brief**
  - Excavate a hole, install steel rebar to create a steel web, pour concrete on the inside to create a shell and apply plaster on the interior with the addition of tiles
- **Advantages**
  - Customizable shape and size form Olympic to L-shaped
- **Disadvantage**
  - Require a higher level of maintenance as the interior is very rough and porous which provides an ideal environment for algae to grow in, thus requiring more time and chemicals to clean therefore making the maintenance more laborious and costly.
  - Take more time to install.
  - Relatively high cost of Ownership over the lifetime of the swimming pool
    - Cleaning
    - Re-plastering

3.5.3.11.2 Above Ground

- **Brief**
  - Above ground swimming pools are prefabricated pool shells that reside on the ground surface, just like the fiberglass pools, but the main difference is that they don't need excavation
- **Advantages**
  - Low initial cost
  - Portable and movable
  - Easy to maintain
  - Customizable size
  - Easy and take less time to install
- **Disadvantages**
  - Fencing or a barricade might be required
  - Can cause damage to underlaying surface of which the pool will reside on.

3.5.3.11.3 Manufacturers of Swimming Pools

- **E.MAK**

- **Edarah Construction**

- **Ocean Pools**

3.6 Specification Analysis

3.6.1.1 Material Description

The at most critical material is the PVC water stop as it is unique in its usage as the only other piece of the project that uses it is the water tank. This item will greatly influence the duration of the project and the following costs that are also time sensitive.

Water stops were essential for the construction of the swimming pool as they stop the leakage that occur at the construction joints. Ideally, any concrete structure that is meant to hold up water will be poured in one piece in order to avoid having any weak points in which water can escape from. But when the tank is large, it will need to be poured on different phases. In the case of the swimming pool, the slab was poured first with a 250 mm notch at the edges that represented the wall necks. And then the walls of the swimming pool were poured after that. This created a weak point as the part on which the walls lie on the slab will create a passage in which the water can escape from. So there needs to be wall that prevents this clear access, this is the part in which the PVC water stop comes in. the water stop is placed on a 90-degree angles with the concrete surface. It is connected to the slab using U shaped stirrups and is attached to the slab when the concrete is poured. Then it connects to the walls when they are poured. This stops the water when it tries to escape from the small void between the wall and the slab.

3.6.1.2 Relevant Specification

- The relevant specification is in (Division 07 – Thermal and Moisture Protection) under water stops. This section includes specifications for:
    - Sheet waterproofing
    - Polyethylene sheet waterproofing
    - Cold fluid-applied waterproofing
    - Modified cement waterproofing
    - Roofing and deck insulation
    - Joint sealants
- The specifications only mention type of water stops which is 4 mm thick ribbed water stops
- The water stop must adhere to the following quality control tests
    - ASTM D71 for the specific gravity
    - ASTM D4 for the Hydrocarbon content
    - ASTM D6 for the volatile matter
    - ASTM D217 for penetration requirements
- Other items included in the water stops specs
    - Adhesive
    - Concrete cut nails

3.6.1.3 List of Drawings that Contain Water stops

- The drawings that include the water stops are the water tank and swimming pool structural details
    - GN-ST-1-16-00-1C
    - GN-ST-1-17-00-1C
    - GN-ST-1-18-00-1C
    - GN-ST-1-19-00-1C

3.6.1.4 Location of Water Stops in the Drawings

3.6.1.4.1 Swimming Pool

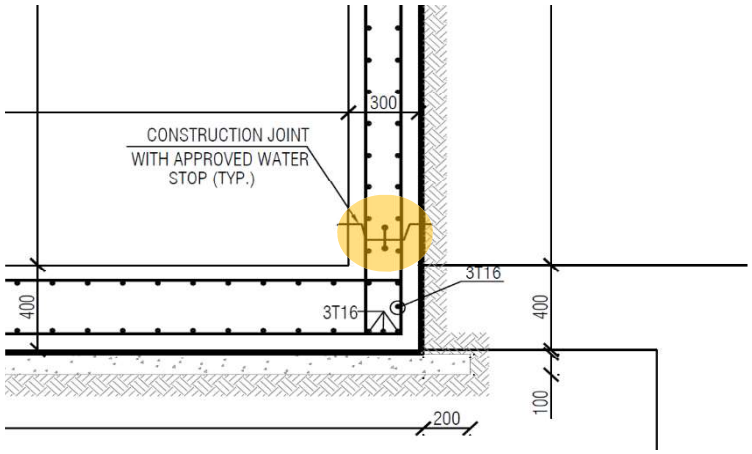

Figure 199 Water Stops Location in Swimming Pool

3.6.1.4.2 Water Tanks

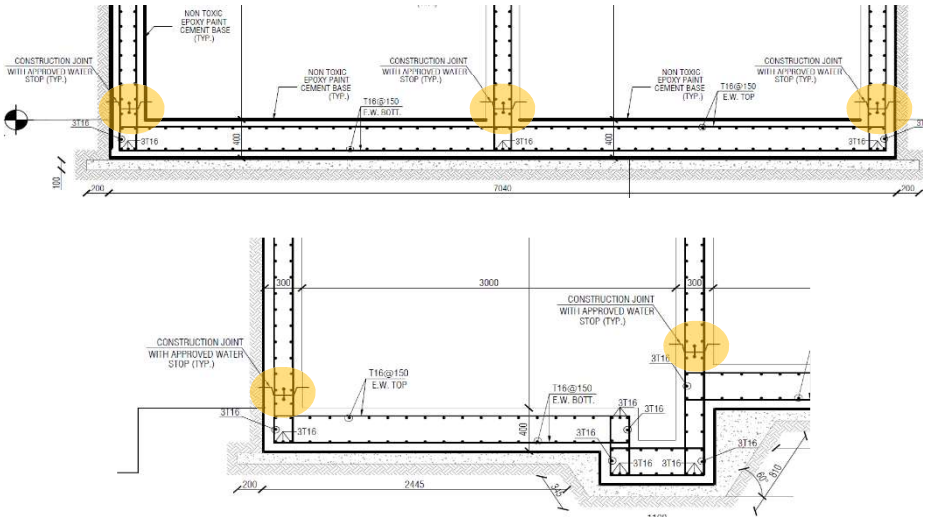

Figure 200 Location of Water Stops in Water Tank

3.6.1.5 Local Suppliers

- Name
  - Sika Egypt For Construction Chemicals S.A.E., Obour City, Egypt
- Factory Location
  - El-Obour City
- Contact
  - Mobile +2012-23908822
  - Mobile +2012-83074200
  - Mobile +2012-83073999
  - Mobile +2012-83073888
- Cairo Office
  - Contact
    - Fax +202-21806637
    - Mobile +2012-23999700

3.7 Method Statement BIM Model

Below are screengrabs from the SketchUp model developed for the Swimming Pool method statement

3.7.1 SketchUp and Lumion Models Screengrabs

Figure 201 Site Excavation

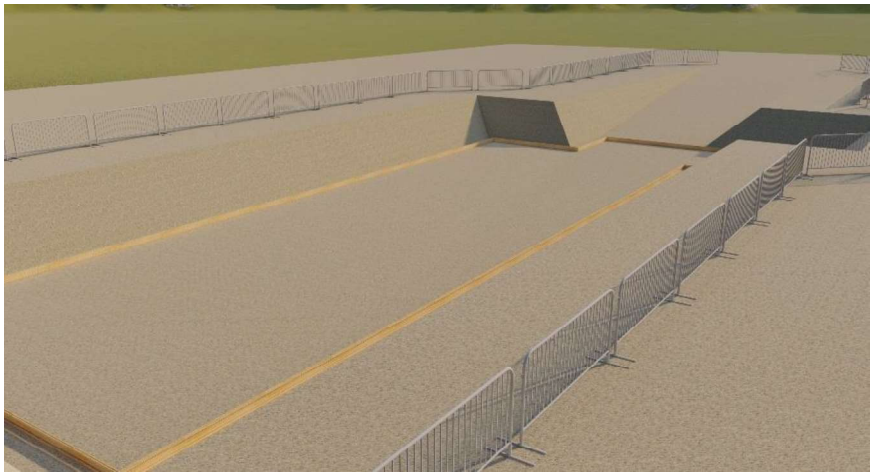

Figure 204 PC Formwork

Figure 203 PC Concrete Pouring

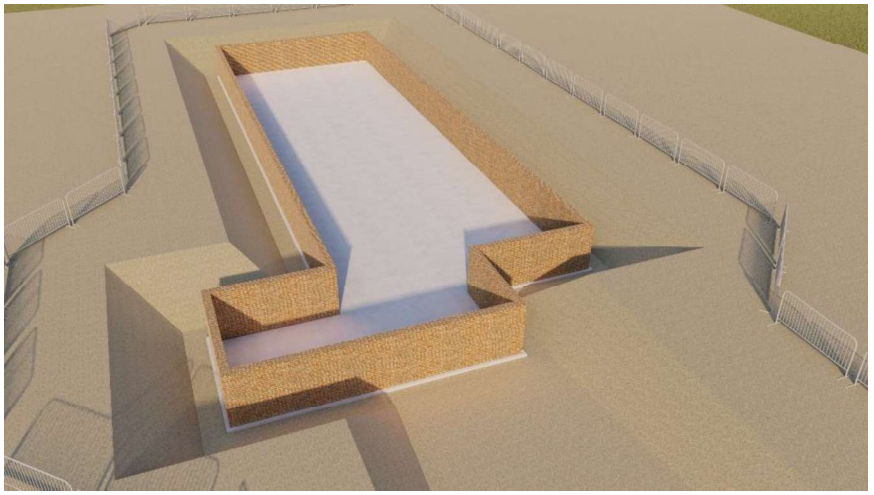

Figure 202 Brick Wall Erection

Figure 206 Slab Reinforcement D1

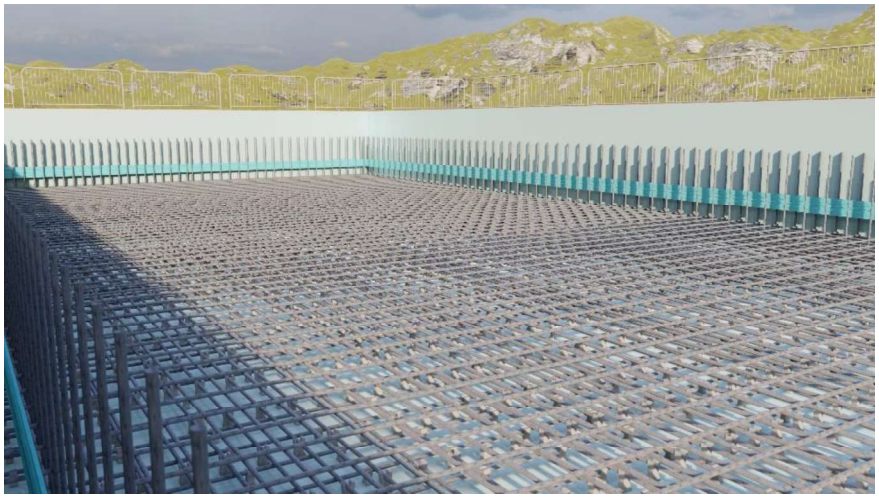

Figure 205 Slab Reinforcement D2

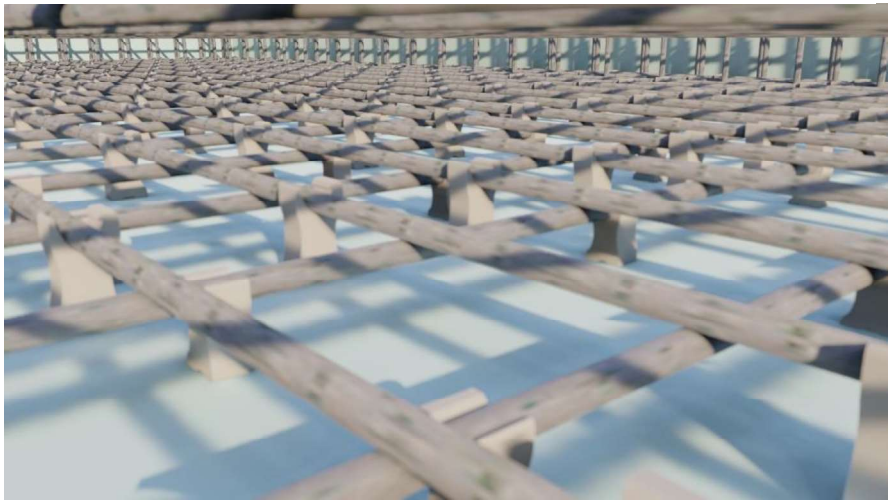

Figure 208 Slab Reinforcement D3

Figure 207 Slab Reinforcement D4

Figure 211 Slab Concrete Pouring

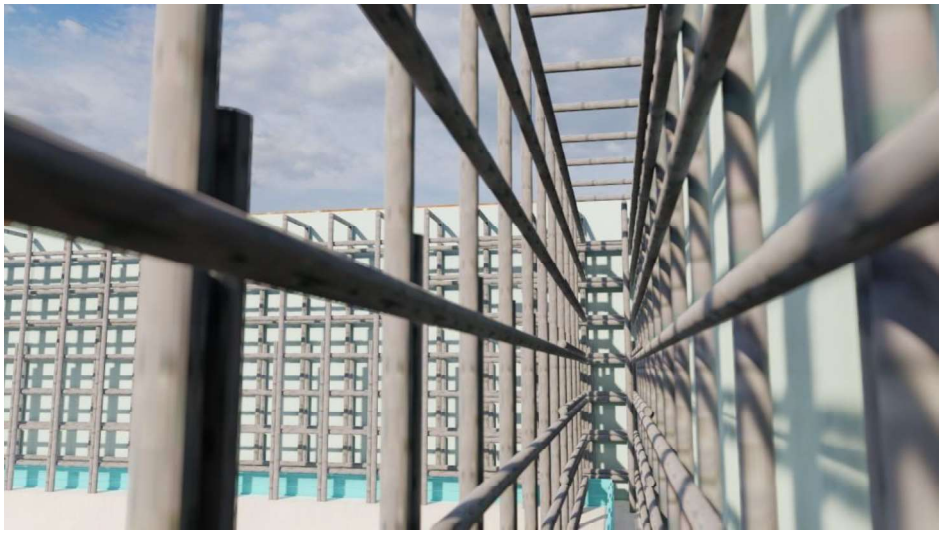

Figure 212 Wall Rebar

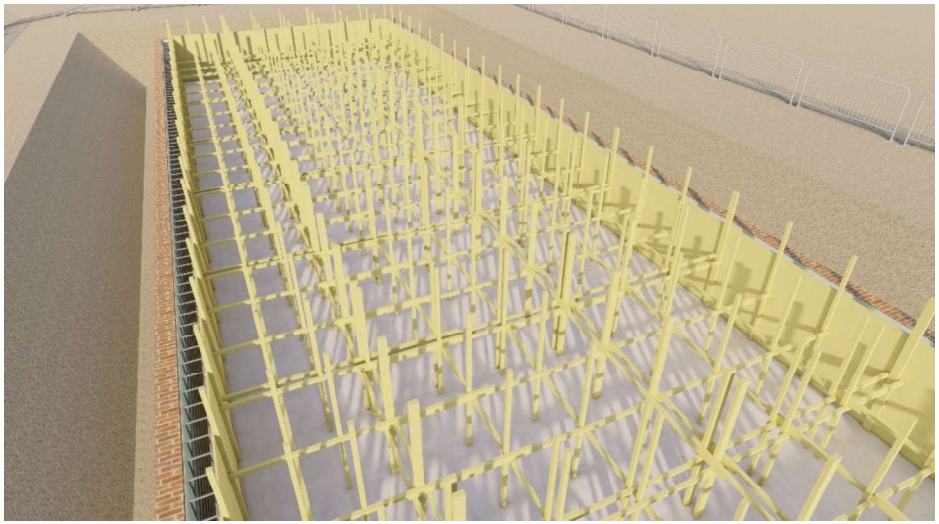

Figure 210 Wall Formwork

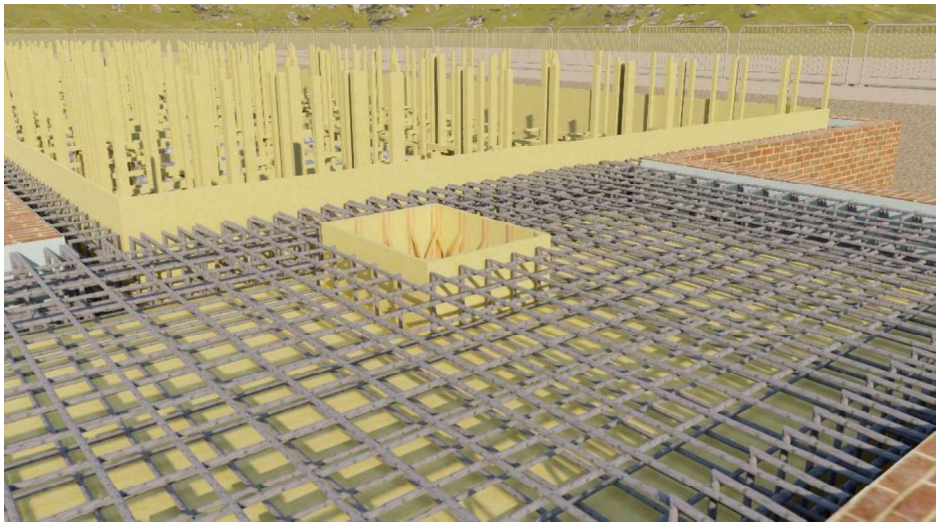

Figure 209 Roof Formwork and Rebar

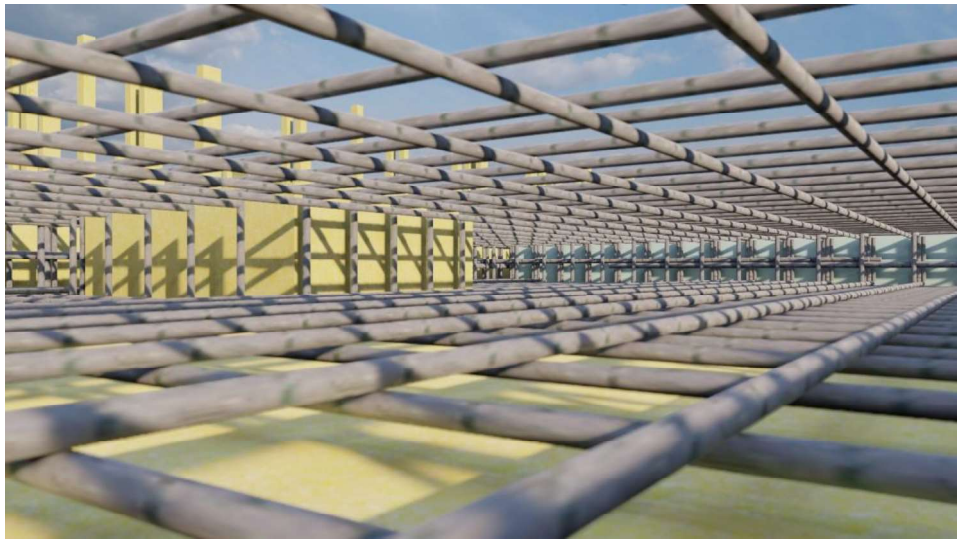

Figure 216 Roof Rebar

Figure 215 Roof and Wall Pouring D1

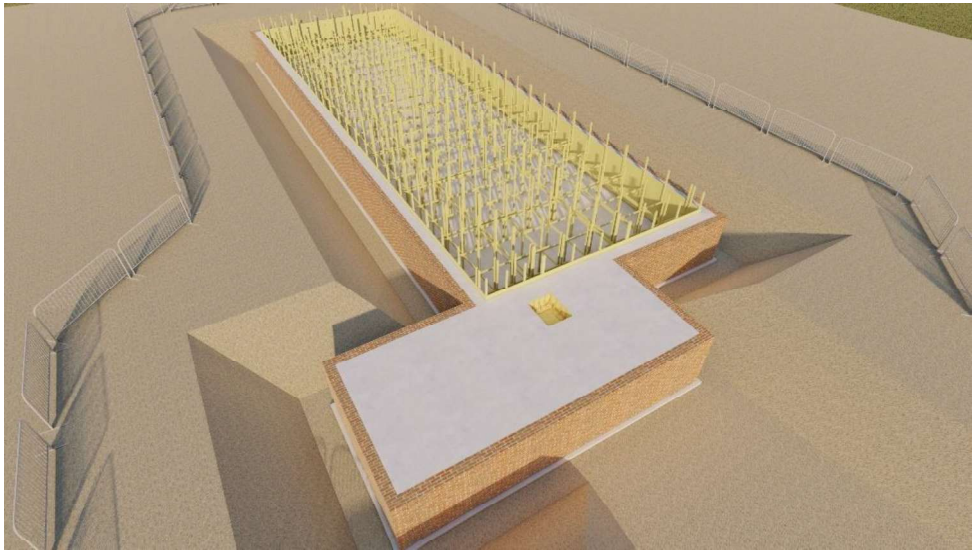

Figure 214 Roof and Wall Pouring D2

Figure 214 Roof and Wall Pouring D3

Figure 220 Mosaic Sheet Installation

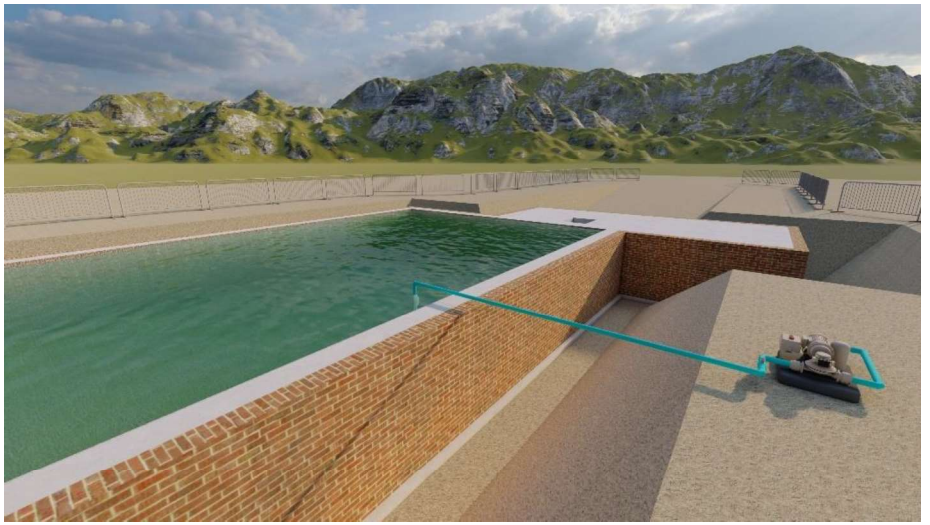

Figure 220 Water Tightness Test

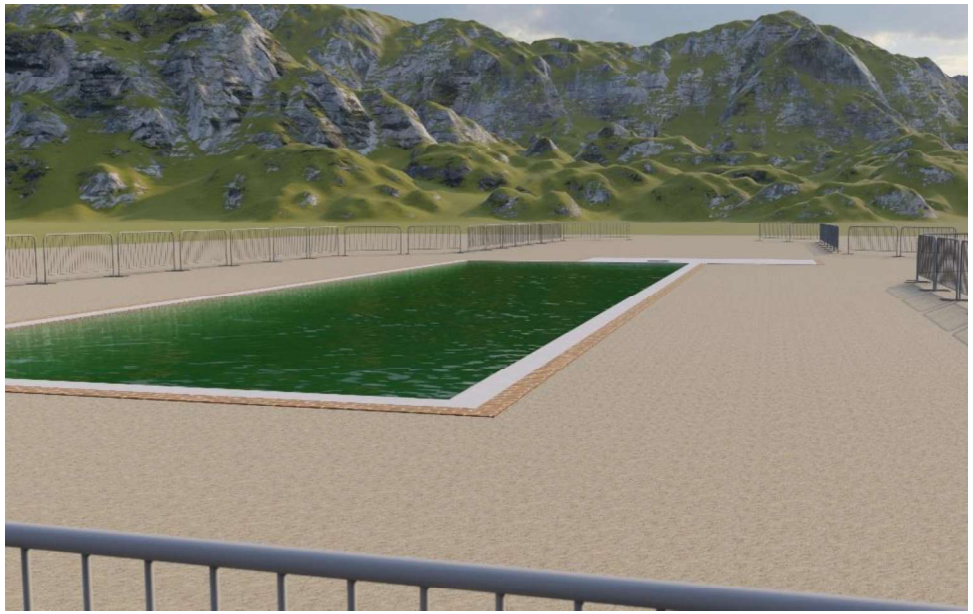

Figure 220 Backfilling Works

Figure 220 Finished Swimming Pool

3.7.2 Navisworks Screengrabs

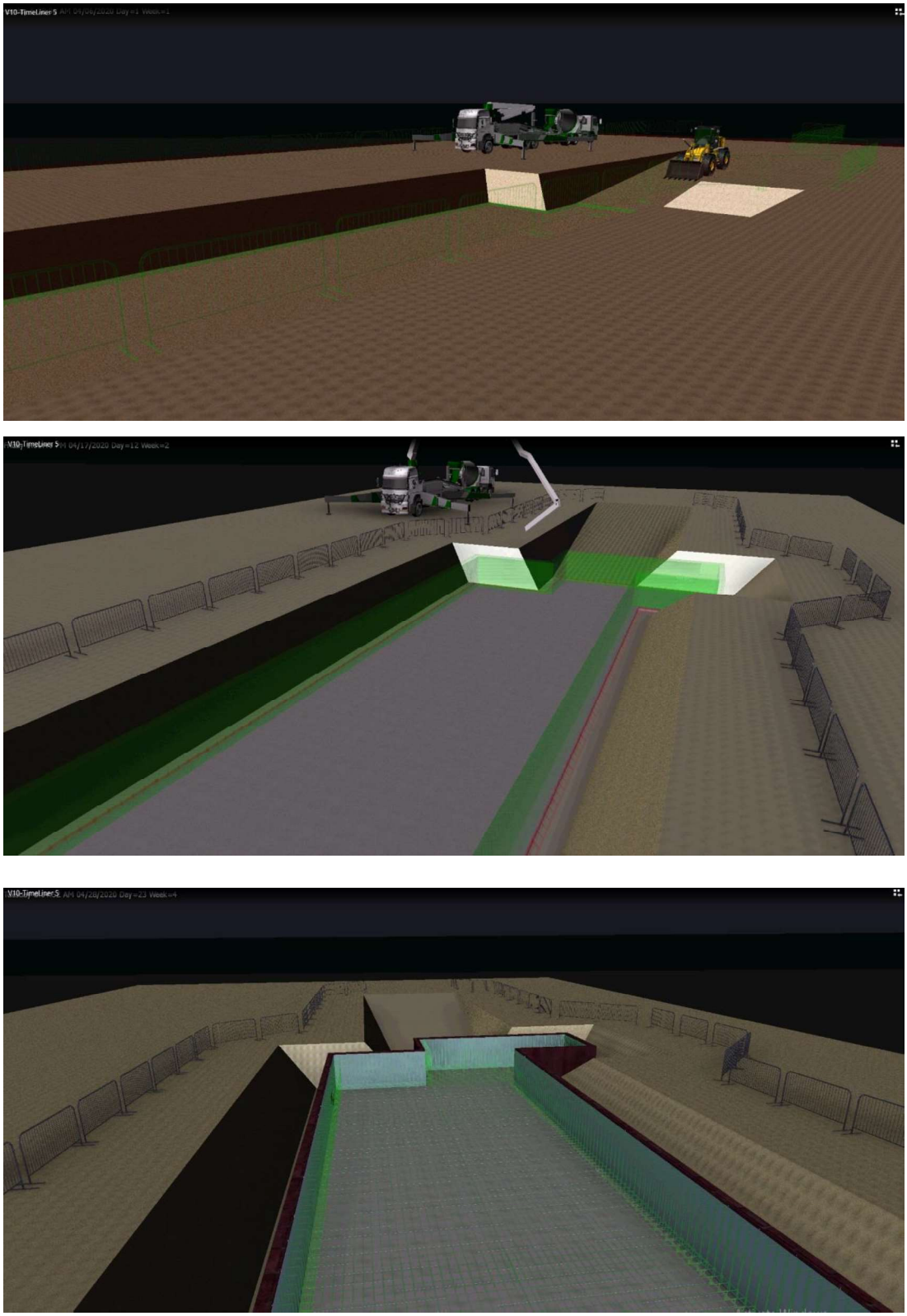

Figure 221 Navisworks Screengrabs 1

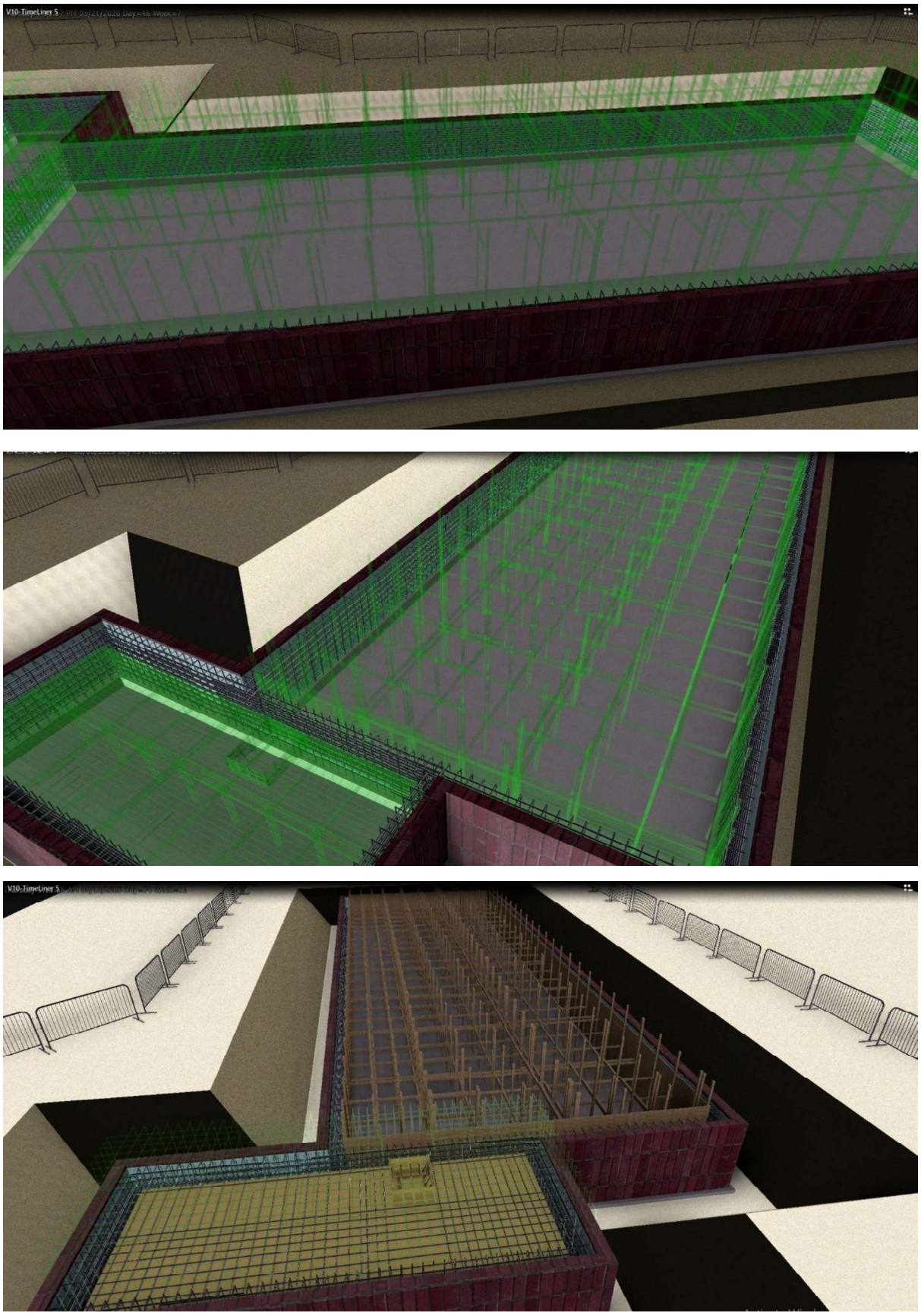

Figure 222 Navisworks Screengrabs 2

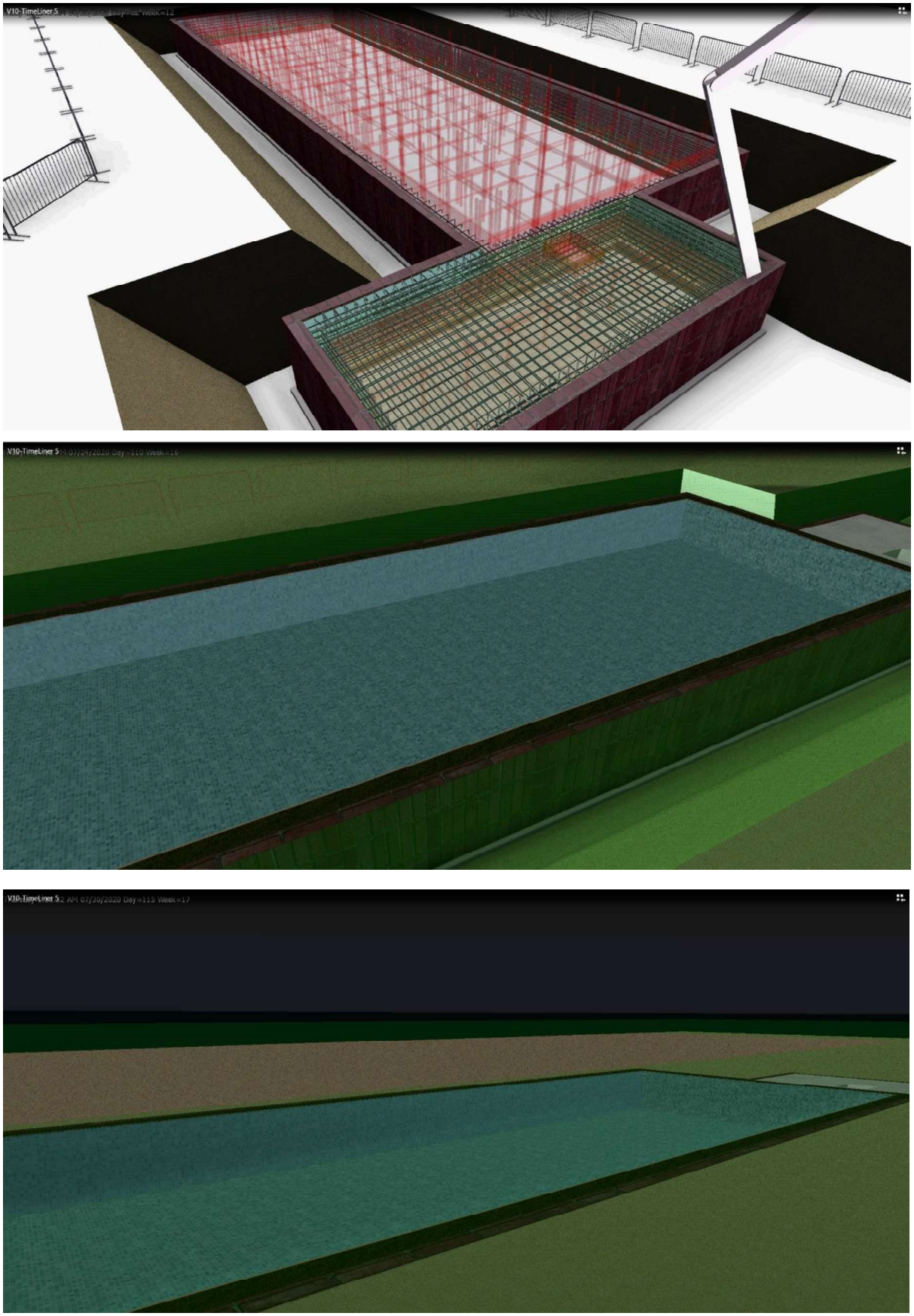

Figure 223 Navisworks Screengrabs 3