Tovu Fresh Water System

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The Honor Journey

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TOVU FRESH WATER SYSTEM

OVERVIEW

PROJECT LOCATION

The target community for this project is Tovu in Totoya Island shown in Figure 1. It is the chiefly village also known as Dawaleka. The Paramount Chief of Totoya is known as the Gone Turaga na Roko Sau. This title is currently held by Roko Josefa Cinavilakeba.

Figure 1 Tovu Village

COMMUNITY NEEDS

After meeting with Turaga na Roko Sau on October 22, 2018, a summary of the community needs was discussed. The community currently has a dam that captures groundwater and feeds it into a 10,000 L cement tank. The community has 3 5200 L plastic tanks that were delivered to the village over 1 year ago. Roko Josefa (Turaga na Roko Sau) stated his wishes were to connect the plastic tanks to the existing cement tank that has a capacity of 10,000 L. He also requested these tanks be installed on a reinforced cement foundation inside of a shade structure. There is also a need to raise the height of the dam by 800 mm and add a retaining wall along the side of the dam structure to prevent flooding from a nearby stream that runs parallel to the system. According to Roko Sau, there is a tree directly adjacent to the dam. This leaves that fall from this tree often create debris in the water system. He would like to install greenhouse netting above the water source to keep the leaves out.

THE HONOR JOURNEY'S ROLE

The Honor Journey is non-profit organization that aims to not only implement drinking water solutions for global communities, but to preserve the health of the oceans, support education, honor indigenous culture, and to raise awareness of the impacts of climate change on the coastal communities who often contribute to it the least. The Honor Journey agreed to provide funding for the materials required to build the reinforced concrete foundation, shade shelter, and plumbing to connect the tanks. The Honor Journey will also pay for half of the shipping fees and provide seven volunteers to assist in labor of the project.

DESIGN

The design for Tovu's Fresh Water System included a reinforced concrete foundation and a timber shade shelter. The design was completed by Taylor Broussard (University of North Florida Civil Engineering Graduate) and Roko Josefa Cinavilakeba (Professional Architect). The design was checked by Maika P.V. Tuicakau (Structural Engineering Professor at Fiji National University). General design constraints included the limitation of funds for the project, local materials, and tools in Tovu.

REINFORCED CONCRETE FOUNDATION

The reinforced concrete foundation must provide enough strength capacity to support 3 5,200 L plastic water tanks. The tanks are 2.3 m in height and have a diameter of 2m and weigh approximately 125 kg when empty. Therefore, the foundation must have the strength capacity for approximately 22,100 kg.

A thickened slab-on-grade foundation design was chosen. The design includes a 5 meter squared slab that is thicker on the perimeter and in a cross through the middle of the slab. This thickening forms an integral footing. Reinforcement rods were included in the design to provide tensile strength to the thickened edges. Two layers of wire mesh were also included in the reinforced concrete design in order to prevent cracking. The foundation is to be placed on 200 mm of compacted gravel on a leveled ground surface. Design requirements include a concrete cover of 50 mm minimum all around and a lap length of 40d which means 40 times the diameter of the reinforcement bar. The overall design can be seen in Figure 2.

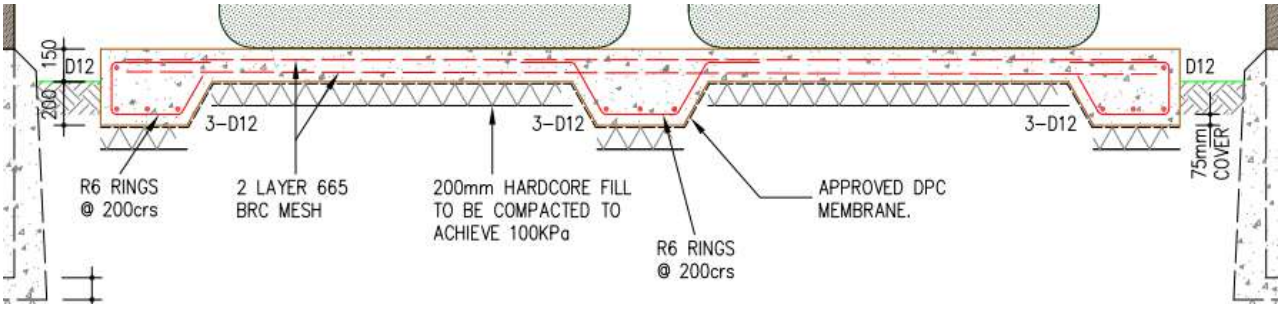

Figure 2 Foundation Design

The foundation design also includes a detail for anchoring the tanks into place as shown in Figure 3.The anchor is a hook made of steel reinforcement supported by two anchor bars on either side. The positioning of these hooks can be seen in Figure 4.

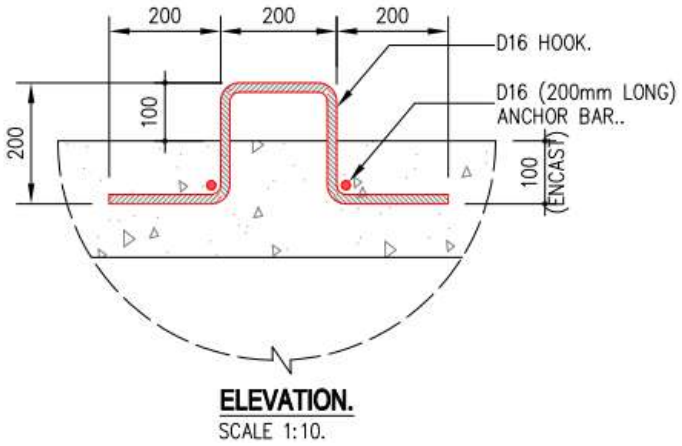

Figure 3 Anchoring system

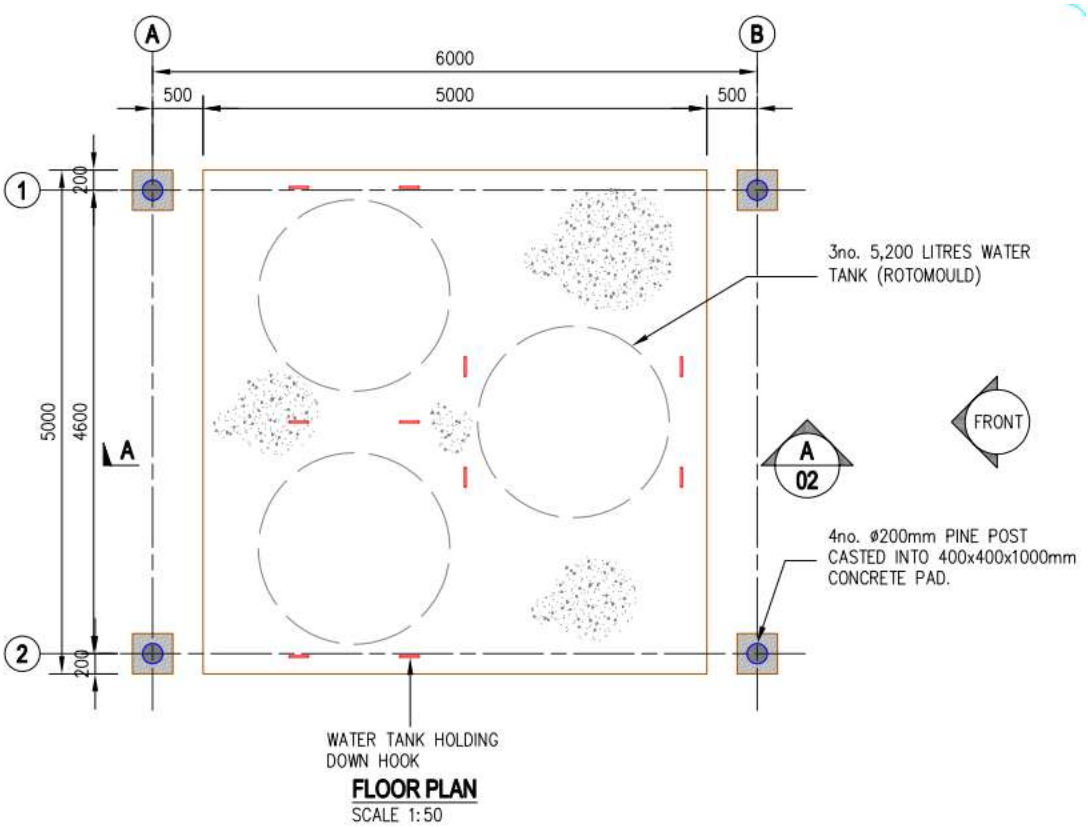

Figure 4 Floor Plan

TIMBER SHADE STRUCTURE

A shade structure must be included in the design of Tovu's Freshwater system to protect the water tanks from UV radiation and to keep the temperature of the water at an acceptable level. The design of the shade structure is presented in Figure 5. It includes vertical supports with two treated pine posts cast into concrete pad 400 mm x 400mm x 1000mm. The roofing components include 2 supporting beams (200 x 75 mm) that should be bolted into the posts with 2 M12 bolts, rafters (200 x 50mm) strapped to supporting beams at 1200 mm centers, and purlins (75 x 50 mm) strapped to rafters at 500 mm centers. The top layer of the roof is corrugated iron sheets. The pitch of the roof should be slanted in the direction of efficient drainage.

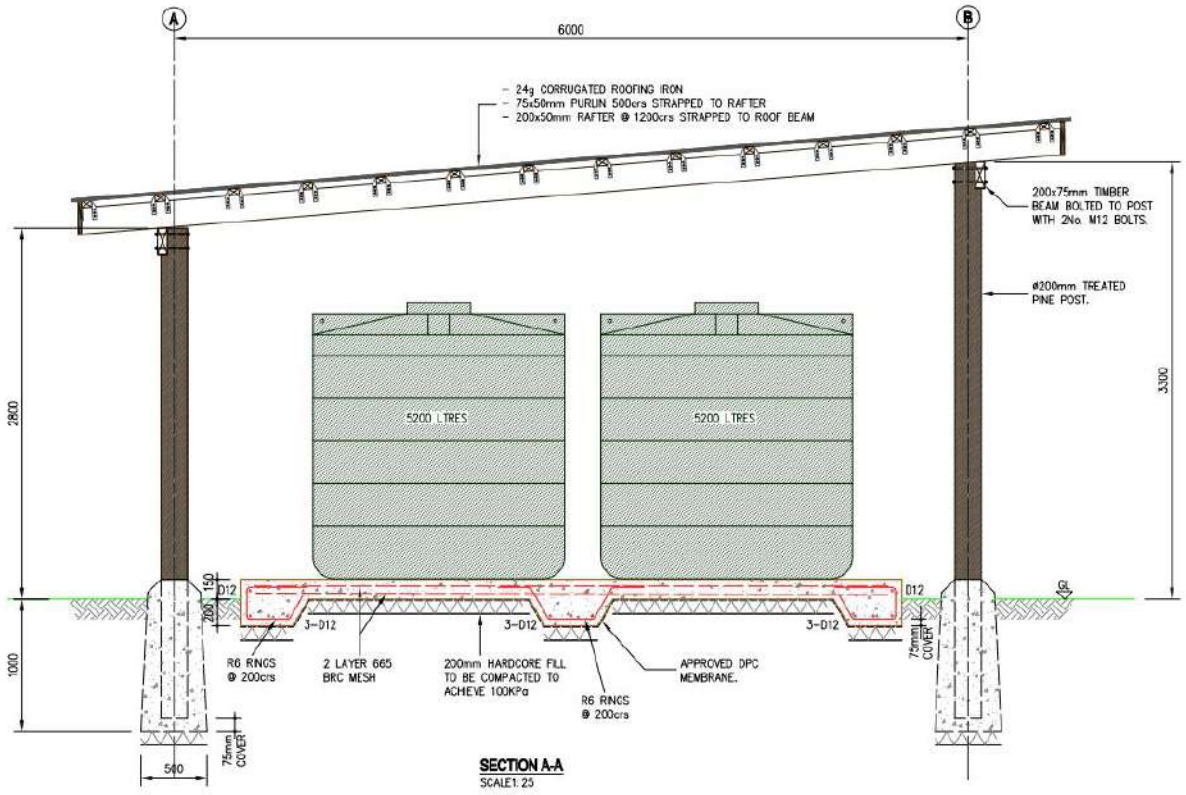

Figure 5 Design Overview

TOVU CONSTRUCTION TRIP

WORK SUMMARY AND DESIGN ADAPTATIONS

All of the materials were delivered to the Lomaiviti Princess II ferry at the Narayan Jetty. The Honor Journey Team boarded the ferry in Suva on November 6, 2018. The team and the materials arrived in Tovu on November 7, 2018. After becoming acclimated to the community and having a day of rest, the team began carrying materials up to the job site. Originally, Roko Sau had requested the water project be built at the cement tank site that was at the top of the community. After speaking with the community and with Roko Sau, it was understood that the tank in that location would only serve a few houses and was fed from an unreliable stream source. The decision was made to install the plastic water tanks at the cement tank site that is located a lower point in the community and fed from a reliable spring source. The next step was to begin collecting sand from the beach, this activity is shown Figure 6. It was observed that this practice puts the community in danger from storm surge, rising sea levels, and coastal erosion. It is recommended that for future construction projects, sand should be purchased from a Quarry or collected from a source that does not put the village at risk. On November 12, the team constructed the mold for the foundation and began leveling the site. The site was leveled with shovels and a water level.

Figure 6 Sand Collection

Next the perimeter edges of the tank floor were dug to a depth of 400mm. Large stone was collected from the community creek and small gravel was collected from the beach in the nearby community Ketei. This was a very laborious task and required a lot of man and woman power! After the perimeter was dug, large stones were laid down and smaller gravel was compacted around it to a height of 200mm. Compacted gravel was not used on the thickened portion of the slab due to lack of material and time. It was decided that the team did not have the adequate resources or skill to bend the rebar into the rings specified in the design. Instead, the team decided to bend simple stirrups around 4 longitudinal bars, two on top, two on bottom. The rebar stirrups are shown in Figure 7 and Figure 8 Rebar Stirrups.

Figure 7 Rebar Placed on Compacted Gravel

Figure 8 Rebar Stirrups

A mistake was made while cutting the stirrup lengths, instead of cutting 1 m segments of the long bars, multiple long bars were completely cut into small segments. This reduced the amount of longitudinal bars available. Four bars of rebar approximately 4 m long were taken from an ongoing church construction site. Due to this restriction in material it was decided that only one thickening would run through the center of the slab instead of two as the design called for. The reinforcement for the 5 thickened sides of the slabs were placed with small stones. This layout can be seen in Figure 9.

Figure 9 Thickened Sections

On November 15 the team prepared the mix and poured the cement for the slab. Figure 10 is a photo of the team pouring cement. The thickened portions were poured first. After they were finished with the thickened portions, the team took a one-hour lunch break. This resulted in an un-uniform pour of the slab.

Figure 10 Pouring Cement

The plastic membrane was placed on the foundation floor. As shown in Figure 11, one layer of wire mesh was seated on top of the membrane with small stones.

Figure 11 Installation of Plastic Membrane and Mesh Wire

The mix design used was based of Senirusi's experience and was composed of 6 parts gravel, 5 parts sand, 2.5 parts cement, and 4 parts water. Due to the lack of rebar, the anchoring system was not installed. On November 16, the team dug post holes, installed rebar spikes into the posts, placed the posts into the ground, and poured cement around them. Figure 12 shows this progress. Due to the lack of gravel, the cement mix consisted of water, sand, and cement. This mix was poured over medium sized aggregate which was placed in the post hole continuously while cement was being poured.

Figure 12 Installation of Posts

The roof structure was installed on November 20th and the tanks were placed on the slab. Due to the lack of time, the plumbing for the tanks was not initiated. The last progress reached on the 2018 Honor Journey Team trip to Tovu is shown in Figure 13. An inventory of leftover materials was recorded and is presented in **Error! Reference source not found.**. In addition, Seni Rusi requested a list of plumbing materials to install the tanks properly.

FINISHED PRODUCT

Figure 13 Finished Product