RAMMED EARTH FLOOR

OBSERVATIONS FROM THE RWINKWAVU MODEL HOMES

SHARON | DAVIS design

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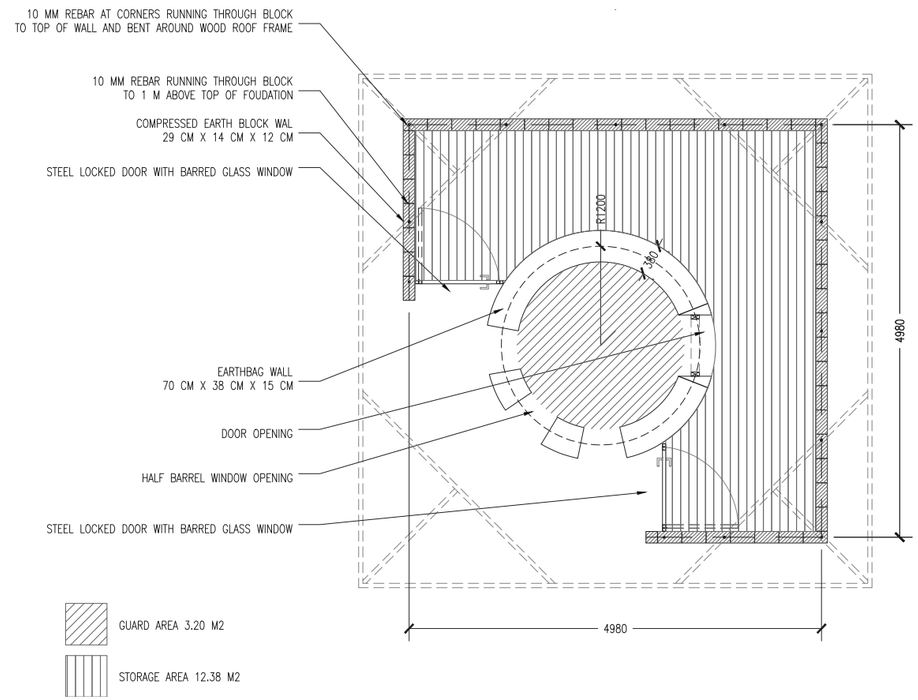
1. Introduction

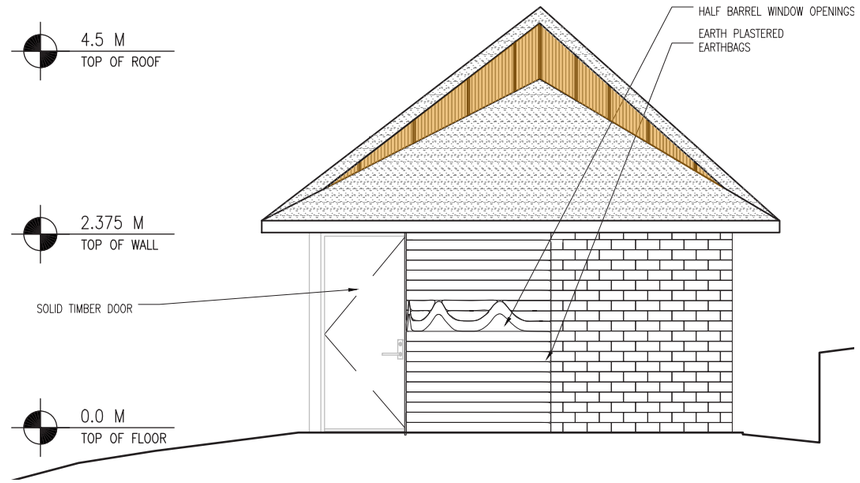
Sharon Davis Design was commissioned by Rwanda Village Enterprises (RVE) to design a ninety-five (95) unit housing development on a 13-hectare site in Rwinkwavu, Rwanda. While collaborating closely with the local community to develop the criteria for the housing and general master plan approach, it became clear to the team that understanding the local construction means and methods would be critical in the success of the project. Guard House1 was to be the first structure built. It served as an initial prototype, evaluating the feasibility of various construction techniques for future affordable housing applications.

Situated within a larger experimental housing development for Rwanda Village Enterprises, one of the main goals for this project was to experiment with easily replicable earth-based material construction within the village of Rwinkwavu and surrounding areas. Foundations were constructed of reinforced, stabilized rammed earth. The compacted earth floor was sealed with local soybean oil. Exterior walls utilize compressed earth block, and the inner circular wall is an earth bag, finished with an earth-based plaster. In addition to the assembly, residents of the village directly engaged in the production of earth blocks and earth bags to construct the walls. These building technologies proved to be dependable for minimizing construction cost and providing jobs for local laborers.

1. Further information on the Guard House can be found on our website.



Guard House Floor Plan



Guard House Elevation

Drawings should not be used for construction purposes.

1.1 Design Approach: Rammed Earth Floor

Rammed earth floors were selected as the most practical approach for this project considering the budget and site constraints. An ancient technique that dates back thousands of years, rammed earth floors are an enduring and environmentally friendly flooring approach.

In this project, the rammed earth floor was composed of four distinct layers with all the required materials locally sourced.

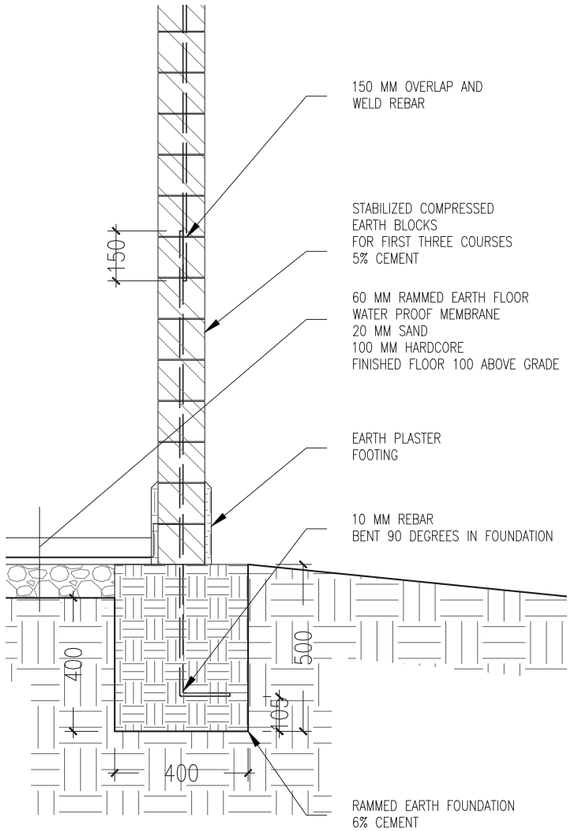
Layer 1: gravel

Layer 2: laterite

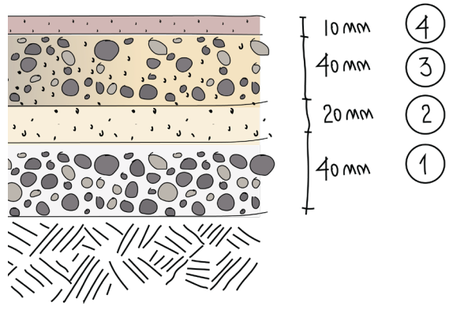
Layer 3: laterite, gravel, fine sand, clay, water, anti-termites

Layer 4: clay-water mix, fine sieved, sand

The following is a guideline of the step-by-step process and materials used to achieve the rammed earth floor in this prototype first building of our master plan for Rwinkwavu.



Initial Design Intent
Shown for reference only, not for construction use.



Construction Layers of the Rammed Earth Floor

2. Process

2.1 Digging and Leveling

The Guard House has approximately 15.5m2 flooring area. The first step was to prepare the site for the new rammed earth floors; this meant digging down to -80mm below the top of foundation walls. Two (2) helpers were able to complete this task in a half-day of work.

Both helpers started by removing dirt accumulated on the top surface and then proceeded by digging down to 80-90mm below the top of the foundation and taking out the topsoil. This provided the needed depth to host all the required layers which would cover an anticipated thickness of 100 - 110mm; with 80mm thickness of the floor below grade and 20-30mm above.

2.2 Leveling and Compacting

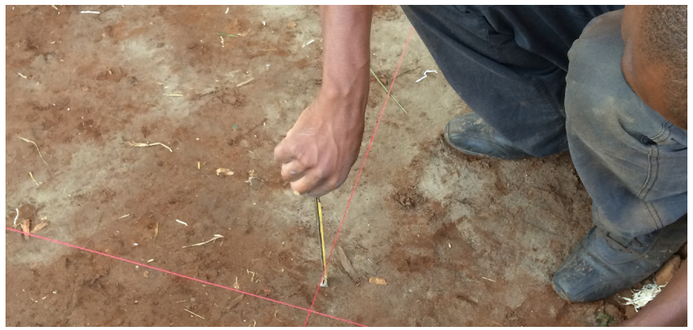
After excavation, the soil was leveled, and guiding strings were set up to mark the top of the finished floor for reference.

Leveling

Using a wooden level tool (B), the soil was leveled with the help of two masons and two helpers. All rocks and large debris were removed prior to compacting the soil to -80mm from the finish floor elevation.

Compacting Soil

Using wooden hand tampers made on site, soil was compacted as required (C). The level actively was monitored by using the guiding string lines.



A

B

C

Hand Tamper

80mm above
Compacted soil

2.3 First Layer

Description

Layer 1: 40mm thick
Material: Gravel
Size: 25-35mm diameter

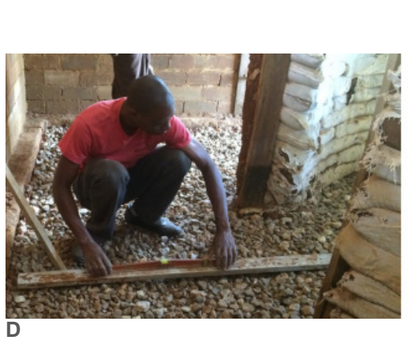
Quantities and Costs

Area: 31 sqm
Gravel: 11 wheelbarrows
Water: 60 liters

Labor

Mason: 1 person
Helpers: 3 people

After leveling, the first layer of gravel was added on top of the compacted soil (D). Water was poured on top to assist with compaction and to allow aggregates to be pressed firmly in contact with the soil below (E). The same hand tampers were used to compact all the layers of the floor (F). Finally, the level of the compacted gravel was checked prior to proceeding with the next phase (G).



D

E

F

G

2.4 Second Layer

Description

Layer 2: 20mm thick
Material: Laterite (with small rocks)
Size: 5-30mm diameter

Quantities and Costs

Area: 31 sqm
Gravel: 7 wheelbarrows
Water: - liters

Labor

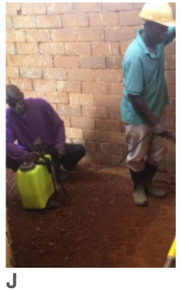
Mason: 1 person
Helpers: 3 people

Once gravel compaction was completed, seven (7) wheelbarrows of laterite were added above (H), leveled, and compacted to make a 20mm thick layer (I). This laterite is composed of soil and small rocky particles.

After compaction, anti-termite liquid was poured on top to prevent termites from affecting the floor (J). Normally, anti-termite treatment is added before the very first layer but adding it in the middle of the floor layers as we did, worked as well.

H

I



J

J

2.5 Third Layer: Preparation

Description

Layer 3: 40mm thick
Material: Laterite, gravel, fine sand, clay, water, anti-termites
Size: fine sand sieved with 1mm mesh

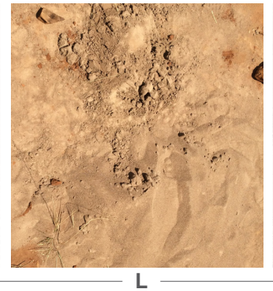
Ratios

2 x 1 x 1 (Sand, gravel, laterite)

First, clay was mixed with water; 3kgs of clay with 100 liters of water and 500ml of anti-termites was added (K). The goal was to make a liquid to mix all the required aggregates. This meant that the clay needed to be saturated but not fully suspended.

Before adding clay, all dry materials were blended (L), and then liquid clay was added to the mix gradually as the mixing continued until it became a stiff uniform mix ready to be poured (M).

K



L

M

2.6 Third Layer: Application

Description

Layer 3: 40mm thick
Material: Gravel, fine sand, clay, water, anti-termites
Size: Fine size sieved with 1mm mesh

Ratios

2 x 1 x 1 (Sand, gravel, laterite)

The stiff mix of clay, sand, gravel, and laterite was poured on top of the compacted laterite (N). With the use of 40mm tube the edge and thickness of the layer are set (O). Steel tubes were used to level the top and wooden floats smoothen the surface (P).

This layer was poured 20mm below the top of foundation and 20mm above to cover the foundation.

The surface was left to dry for 3 more days before proceeding to the next layer (Q).


O


N


P


Q

2.7 Fourth Layer

Description

Layer 4: 10mm thick
Material: clay-water mix, fine sieved sand
Size: 1mm sand

Ratios

1 liter of clay-water mix x 1 shovel of sand

Before applying the fourth layer of fine sand screed, we tested the finish on a small outdoor mock-up (R) on which we used a mix of five (5) shovels of sand with four (4) liters of water to get a stiff sand which was then poured and hardened using a steel float. To make the top surface smooth and even, a steel float coated with the clay-water mix was used.
The surface was left to dry for some time and checked to see if cracks appeared. Cracks were sealed with the same sand mix used earlier with a few drops of clay-water and a trowel (S). Once dry, five (5) coats of flax oil were applied (T). Oil surface took 1 week to dry after which, the floor was ready to be used. (U)


R


S


T


U