

Concrete & Building in Haiti

Preparation for Building Homes for Jubilee

As of February 5, 2015

By: Herb Nordmeyer

Introduction



This report is the culmination of the work done concerning building low-cost, disaster-resistant houses in Jubilee. Jubilee is one of the worst slums in Haiti. It is located less than a kilometer south from downtown Gonaives. There are no reliable estimates of the population of Jubilee.

On Wednesday, January 21, 2015, we scoured building supply stores in Port-au-Prince checking out availability and cost of various items we would

need to build in Jubilee.

Figure 1 A typical house in Jubilee

On Thursday, January 22, 2015, we walked an area owned by the City of Gonaives which is on the back side of Jubilee. It is currently used as a garbage dump, and the concept is to develop it into housing for residents of Jubilee. On Thursday evening, January 22, 2015, we met with the steering committee from Jubilee to discuss the project.



Figure 2 The garbage dump south of Jubilee.

On Friday, January 23, 2015, we planned to dig soil samples to determine foundation needs, to take GPS readings, and to determine elevations. Haitian roads had a talk with the springs of the pickup which was going to transport us, so we were delayed. Repairs were not complete until late on Saturday.



On Sunday, January 24, 2015, we attended worship at the Lutheran Church in Jubilee. After the service John and I headed out into the dump to take GPS readings and dig soil samples. Since there was not a place to change clothes, I stood beside our van and changed clothes in the street. It did not raise any eyebrows. I then dropped one of the batteries for the GPS into an open sewer. We did get two holes dug and samples collected.

Figure 3 Roadside sewer

Monday, January 25, 2015, I helped with a medical clinic in Andre. We were to head back to Jubilee on Tuesday, but a rain storm on Monday night flooded access to the area. We could not get back in until Thursday morning. Tuesday and Wednesday I helped with medical clinics.

We had a tentative meeting with the Mayor of Gonaives on Wednesday morning, but the President of Haiti came to town, so our meeting was cancelled.

On Thursday morning, January 28, we made it to the Jubilee dump and walked the entire site taking GPS readings and elevations.



Figure 4 One of the paved streets in Jubilee

We were invited to the Mayor of Gonaives' home for a Thursday evening meeting. During that meeting he approved our project and agreed to write the Introduction to the book we are developing on low-cost, disaster-resistant homes in Jubilee.

Friday was spent taking care of last-minute details, packing, and heading about halfway to Port-au-Prince. Saturday, January 31, 2015, we left our motel way before breakfast and made it to the Port-au-Prince airport by about 7:00 am. Got home at 10:00 pm that night.

Location

- Jubilee is a slum which is a part of the City of Gonaives.
- It is located about half a mile SSE of downtown Gonaives.
- It started out as a dumping ground for unwanted trash, including people.
- Jubilee has been a collecting point for those who have nothing.
- In recent years some streets have been paved in Jubilee, and some community latrines have been added.
- We are looking at property behind Jubilee which is currently a garbage dump.
- It is owned by the City of Gonaives and at the end of Rue Lamartrniere - that is the street the Lutheran church is on.
- No signs that it has been used as a landfill.
- Initial walking indicated it is about 23 hectares (60 acres) in size.
- Sandy-loam or sandy-silt soil at the surface.
- Lowest portion of the property is the west side and the junction between Jubilee and the dump. The southeast side is highest. Slight slope to the rear of the property.



Utilities

Most, if not all, of the residences in Jubilee do not have electricity.

Running water is not available. There are periodic sources of water which people go to and haul water in buckets to their homes. At the moment, I do not know if the water is provided by local wells or via a city service.

There are no sewer connections in Jubilee. The city has installed community latrines which need to be pumped out periodically.

Beside some of the streets there are open ditches which serve as storm sewers and sanitary sewers. Periodically, collected debris is shoveled onto the street.

To get to the dump behind Jubilee, garbage trucks drive through Jubilee. Periodically garbage is spilled from the trucks onto the streets of Jubilee.

At the moment, I do not know of any garbage collection in Jubilee.

Water, electricity, and sewage may some day be available in Jubilee, so each house which is constructed will have pipes laid so such utilities may be installed at some future date without having to tear up the foundation.

To provide sanitary waste disposal, a latrine will be installed on each block. This document does not address the design of the latrines or who will be responsible for installing them.

Some streets in Jubilee are paved and have concrete drains alongside of them. Other streets are unimproved.



Figure 5 Unimproved street three days after a heavy rain.

Streets will need to be installed to serve the new area of Jubilee, but this document does not address that area other than to suggest width and frequency.

Population of Jubilee

So far, Herb has not found any record of a census of the population of Jubilee. Even the leaders of Jubilee do not know how many people live there. One report by the Lutheran Church of Canada estimated the population as being about 12,000 in 2011. To obtain an estimate, Helen will mark the boundaries of Jubilee on a map and Herb will count houses based on an aerial photograph of the areas. Orlando, one of the leaders in Jubilee, stated that all of the houses in Jubilee were occupied. Since many families consist of 8 or 9 members, Herb will make a preliminary population estimate by multiplying the number of houses by 7. Speculation indicates the population may be as high as 25,000.

Legal & Political Decisions

A committee is being formed of the leaders of Jubilee. Pastor Benoit will be on the committee, or head of it. The Mayor of Gonaives will be involved for some of the decisions to be made. They will be making the decisions. Herb will be involved in technical and engineering decisions, but the committee will be involved in the political and community decisions.

Following are questions which go beyond the engineering and construction of the houses. The committee needs to address them with input from the Lutheran Church of Haiti and the City of Gonaives.

- Who will own the homes?
- Who will pay for the land if a payment is required?
- How will funding of the construction be handled?
- How will rent be determined?
- Where will rent money go?
- Who will decide who gets which house?
- How much sweat labor will each family which gets a house be expected to contribute?

Factors Impacting Density of Housing

Space per person	UN recommendation - nominally 3.75 sq meters (40 sq ft)
People per family	8 to 9
Number of stories	based on soil conditions, we are limited to one story
Garden space	need to include a garden space, size to be determined by the committee
Trees	Trees help make these houses into homes; we need to include trees. Currently in Jubilee, there are very few trees.
Streets	Street width and accessibility

Layout of Streets

- Assume 20 m (65.6 feet) wide streets.
- Layout based one hectare blocks.
- Streets will be 100 m (328 feet) apart in each direction.
- Housing portion of block will be 80 m (262.5 feet) x 80 m.

We can set stakes for laying out the streets, but the City of Gonaives should be involved since we hope that the city will develop and maintain the streets.

Compromises

- Pastor Benoit challenged Herb to develop or find technology so we could build earthquake- and hurricane-proof houses at \$1,000 US for material cost.
- In Haiti, the material cost for a 6.1 m EcoShell dome meeting those requirements with a concrete floor will be about \$2,000 US.
- In Haiti, the material cost for a 4 m x 7 m confined masonry house meeting those requirements will be about \$3,500 US.
- Other building techniques, such as Structural Concrete Insulated Panels, would cost about the same as for confined masonry.
- Several panel construction techniques were examined which would cost more.

- To meet the \$1,000 US goal, we would need to use the EcoShell dome technique and reduce the size to 4.6 m (half the size) and remove the concrete floor.
- The steering committee from Jubilee stated that the City of Gonaives will not approve a project which does not have a concrete floor.
- The building site has a high water table. We will need to place a vapor barrier on the ground and build the foundation and slab above grade. Building on the elevated foundation requires a concrete slab so we can pressurize the balloon form for the EcoShell.
- Since there are chlorides in the water, steel rebar tends to degrade within a few years. As a result, we need to move from steel reinforcing to basalt reinforcing.
- Since the average family has 8 or 9 members, we need to stay with the 6.1 m dome. As a result, we need to increase our budget per house from \$1,000 US goal to \$2,000 US practical.
- This may impact fund-raising, but at the moment we do not know how it will.

Construction Techniques

Dome - EcoShell

- Most space per cubic meter of concrete.
- Dome shape.
- Produces an earthquake- and hurricane-proof house with minimal materials.
- Minimal footings and foundation are required.
- Can be built with basalt reinforcement which is not attacked by chlorides, like steel rebar is. This results in a more permanent structure that is not destroyed by deteriorating rebar.
- Difficult to expand.
- Built with a balloon form, so once we decide on a size, we need to spend \$3,000 to \$4,000 US for another balloon form if we want to change the size of the homes we are building.
- Cost per unit, without finishing (doors, windows, painting, internal walls) will be about \$2,000 US for a 6.1 m dome. This would provide 29.5 sq meters (314 sq ft) of interior space.
- Can be built with ventilation blocks for windows, or can be built with window bucks so conventional windows can be installed.
- Installing a center hole in the dome with a short pipe extending above the dome (with a rain cap on it) will produce a thermal chimney. This will encourage hot air collecting near the ceiling to exit the dome and be replaced with cooler outside air. A roof turbine will accomplish the same thing.

- Vines can be planted to grow on the outside of the dome. This will reduce the thermal transmission through the dome which would cause the interior to heat.
- With the concrete surface of the dome, water will be shed and little or no water will penetrate through the dome skin unless there are cracks in the concrete. To eliminate any leakage, a silicone-based water repellent (Silane and Siloxane-based water repellent) is recommended, or the dome can be coated with an elastomeric paint.



Figure 6 EcoShell I home under construction.

Confined Masonry

- This is the indigenous building technique of Haiti.
- Can be built one story, and later a second and third story can be added.
- Looks like a normal house.
- With minor changes in the currently used building techniques, a hurricane- and earthquake-resistant structure can be built.
- With light-weight roofing block Herb has developed, can pour a flat roof that weighs about 40% less than a conventional flat roof.
- Cost, for a house with the same space, will be about \$3,000 to \$3,500 US depending on the foundation needs.
- Based on our soil survey, a substantial foundation will be needed in the proposed building site.



Figure 7 Confined Masonry Construction

Cylinder Home

A modification of the dome is a cylinder which is several stories high and one apartment or two apartments on each story. Construction is more complex than the EcoShell dome but has many of the structural advantages of the dome. Building multiple stories will require a more enhanced foundation.

For a three-story, 6.1 m (20 feet) diameter cylinder, an outside stairway could be installed and one apartment would be on each level. With a three-story, 9.14 m (30 feet) diameter cylinder, two apartments could be installed on each level.

The steering committee from Jubilee preferred the dome concept to the confined masonry concept, since it would result in more homes built with the same number of dollars. Prior to our survey of the soil (we would need a larger foundation), they also expressed interest in moving towards three-story cylinder homes as they gained experience in dome construction.

Soil Samples and Foundation Needs

On January 25, 2015 we took soil samples from two locations at the proposed building site. One location was about 20 m into the site from the end of Rue Lamartrniere. The second location was about 100 m further into the site, and in line with Rue Lamartrniere.

Due to the loss of a battery from the GPS unit, we were not able to measure the elevation or provide GPS locations.

Earlier, at the church, the elevation was measured at 12.2 m (40 feet). At the City of Bryan, on the edge of Jubilee, the elevation was also measured at the same elevation.

Garbage was not located on the surface of either site, but was located within one m of both sites.



Figure 8 Collecting soil sample

Site 1

- 0 cm to 25 cm - Sandy-loam or sandy-silt soil.
- 25 cm to 36 cm - Clay content increased so that by 30 cm Herb was able to roll cylinders of soil between his fingers. Soil was packed and very hard to dig with the tools available (hand garden trowel).

Site 2

- 0 cm to 30 cm - Sandy-loam or sandy-silt soil - consolidated, but easier to dig than Site 1.
- 30 cm to 45 cm - Clay content increased so that by 30 cm Herb was able to roll cylinders of soil between his fingers. The soil was moister than at Site 1.



- 45 cm to 60 cm - Clay content increased, and moisture content increased so Herb was able to squeeze the soil and it would extrude between his fingers.

Figure 9 Soil collected about 15 cm below surface

Discussion with residents in area

- It was a 5-minute walk to a body of water (mouth of Baie Grammont).
- Ground water was about 1.2 m from the surface.

Soil samples will be transported to Texas, and Herb will do analytical work on them. Based on observations, it appears that the following are true:

- The soil has very little bearing strength when wet.
- For building a confined masonry structure which is one story in height, to be earthquake- and hurricane-resistant, the footings will probably need to be 70 cm wide. For building a confined masonry structure which is 2 or 3 stories in height, the footings will probably need to be closer to 1 m in width to provide earthquake and hurricane resistance. The footing requirements will add substantially to the cost of building a confined masonry structure on this site.
- Similar enhanced footings would be required for building cylinder homes.
- The EcoShell dome is a lightweight structure, and the weight of the structure is shared between the footings and the slab. Based on 6.1 cu m (8 cu. yds.) of concrete needed for a 6.1 m (20 feet) dome, the weight of the structure would be 14,230 kg (32,000 lbs). Approximately half of that would be the slab which would be bearing directly on the soil surface. 7,840 kg (17,250 pounds) would be the weight of the dome shell. If we calculated all of that weight to be

- The above calculations are slightly misleading since they apply the entire weight of the shell of the dome onto the footing. Since the slab is poured in conjunction with the footings and is tied to the footings with a permanent reinforcing material (basalt rebar), the weight will be spread to the outer portions of the slab. If we assume that the force will be applied to the outer 1 m (3.3 feet) of the slab (a conservative estimate), the weight would calculate to be 0.09 kg per square cm (188 lbs per square foot). This is well within the bearing capacity of the soil.
- As a result, Herb has concluded that of the building technologies examined, the EcoShell is the only one which can be cheaply and safely built on the site.

Why Domes Are Inherently Earthquake- and Hurricane-Resistant

- Buildings come apart where leverage can be exerted; with a dome there are few portions of the structure where leverage can be exerted.
- The dome, with the foundation, becomes one unit and behaves as one unit.
- No permanently attached overhangs to be torn from the structure.
- Use adequate permanent reinforcement in the footer and the slab.
- Easy to ensure that all concrete is well consolidated.
- Use 8 bags of Portland per cubic meter (6 bags per cubic yard) of concrete for the footing and the slab.
- Use 10.6 bags of Portland per cubic meter (8 bags per cubic yard) of concrete (stucco) for the dome.
- Screen clay out of the sand and gravel.
- In areas where steel rebar deteriorates, replace with basalt rebar.
- The dome itself is reinforced with basalt rope, so the shell can be thin, but structurally strong.
- The basalt reinforcement does not need to be covered with 5 cm of concrete to protect it from corrosion, so the shell of a basalt-reinforced dome can be much thinner. Currently we are working with 2.5 cm in thickness when excellent quality control is practiced. We will not go that thin, because we want to incorporate a safety factor.
- The double curve (spherical shape) of the dome makes it strong even though the walls are thin.
- The dome is securely tied to the slab and footings.

Size of Structures

- UN states that 28 m² (300 sq ft) is adequate for a family of 8 in a tropical area.
- That would require a 6.1 m EcoShell or a confined masonry house which is 4 m (13.1 feet) by 7 m (23 feet).

Layout on Lot and Fences

This is an area which needs to be addressed by the committee.

- Fences need to be incorporated into the overall plan.
- As one of my students told me last year when I suggested that we could build more houses if we did not build as many fences, "If you do not build a fence, by the time your daughter is 13 years old, she will make you a grandfather."
- Many of the lots in Jubilee are not much more than 10 m by 15 m. If we used that size lot we could put 40 houses per hectare.
- Do we want to divide each block into discrete lots, or do we want to place the houses around a common area?
- If discrete lots were used and they were 20 m (66 feet) wide by 40 m (132 feet) deep (about the size of a standard US lot), 8 houses could be built on each hectare.
- If the houses were laid out around the perimeter and the center areas would be commons for gardens, then we could easily double the density of housing without impacting the livability.
- Prior to more development in this area, we need to determine the cultural needs and desires of the people and the amount of garden space/yard per family. We want to help them build houses which will improve their lives.
- Plans should include a latrine for each block. It would be more accessible to the residents and more protection would be provided to the young ladies if the common area concept was used and a single perimeter fence was built around each block.

Who Would Build the Houses?

One of the first questions asked by the steering committee was who would build the houses. Would we bring in **outsiders** or would we teach the residents of Jubilee to build the houses?

Herb's response was that this was their project, and he was there to help them. His idea was to use the 6 of them as his team, and he would train each of them to be in charge of building future houses. He thought he could train each of them with the construction of one house. They liked that idea.

Each member of the steering committee was given a copy of the EcoShell I book (in English), and Herb explained he was working on a supplement which would give specific instructions for building the 6.1 m (20 feet) dome. He also stated that he proposed having the manual translated into Creole and published so each member of the building crew (and building inspectors and others interested in the technology) could have a copy. Autographed copies of the

manual could be given to each person or group which donated money to build a house in Jubilee.

They also asked if they found clients outside of Jubilee whether they could take the concept beyond Jubilee and charge these people for building them homes. Herb stated that he could see nothing wrong with that as long as the clients paid for the materials which were used.

The leaders could see the advantages of building a construction business based in Jubilee, using Jubilee residents, and bringing money from other portions of Gonaives into the Jubilee community.

Clearing the Land

Based on the geology of the site observed, with the top 25 cm being a sandy-loam or a sandy-silt, and the lower soil being clay, it is recommended that when the site is cleared, it be scraped to remove any garbage, but not be scraped any deeper than necessary to remove the garbage. This will provide the most stable ground to work on.

If the bottom of the 30 cm (12 inch) forms are set at ground level, and then fill (sandy-loam or sandy-silt) is brought in from the areas which will end up being ditches along the roads, there will be a minimal disturbance of the soil in the area, and the top of the slab will be about 30 cm (12 inches) above grade.

Drainage Plan and Elevation of the Slabs

It appears that the highest areas of the dump are to the east of an extension of Rue Lamartiniere (the street the Lutheran church is on). Currently it appears that some of the rain falling on the dump flows along the streets of Jubilee, but most of it flows to the west. Elevations need to be taken so a drainage plan can be developed so this building project will not negatively impact existing homes in Jubilee.

The western portion of the dump is currently not being used and on Thursday morning was covered with water. Building in that area would result in additional problems.



Figure 10 Mud flat on west side of dump site

Meeting with the Mayor

On the evening of Thursday, January 28, 2015, Herb, Pastor Benoit, and Rose Augustine met with the Mayor of Gonaives in the Mayor's home. Herb explained the project and furnished the Mayor copies of books he is working on. The Mayor asked numerous questions and gave his blessing to the project. He made land available for us to build our initial houses; and after they are built, if we have done what we have said we are going to do, he will make more land available. After the meeting, he walked us out to Pastor Benoit's pickup. The pickup would not start, so the Mayor helped him get it started.

Sources of Help

Dan Hildebrand built a 40-foot dome, near Port-au-Prince, and has some equipment in Haiti. He sent word that when Herb gets back to Texas, he wants to talk about how we can make use of some or all of that equipment. Herb saw a photo of the work in progress and knows that he had an air compressor and a MortarSprayer.

Pierre Labaze contacted David South concerning building domes in Haiti. David South is getting Pierre and Herb together so they can discuss how they can help each other.

Donations

A commitment has been made to fund one house, and there are a several of others who are discussing funding a house.

One lady is asking all of her friends to donate a dollar each and encouraging each of them to ask all of their friends to donate a dollar each.

If you would like to donate to the project, it can be done in several ways:

Mission:Haiti

A [501\(c\)\(3\)](http://missionhaiti99.org/) organization, so donations are tax exempt.

<http://missionhaiti99.org/>

Click on "Donate Now."

You will be taken to a site to donate via PayPal.

Then click on "Contact Us."

Send a message as to how much you are donating and that you want it applied to the Homes for Jubilee project. You may further specify how you would like it to be applied. Choices include:

Donate a Home for Jubilee - \$2,000

Donate towards building a home in Jubilee

Donate to support the infrastructure for Homes for Jubilee

Shepherd of the Hills Lutheran Church

A [501\(c\)\(3\)](http://shepherdlutheran.com/) organization, so donations are tax exempt.

<http://shepherdlutheran.com/>

Drop a check in the collection plate, or
Send a check to:

Shepherd of the Hills Lutheran Church
Attn: Shirley Yoakum, Treasurer
6914 Wurzbach Rd.
San Antonio, TX 78240

Specify how you would like the money applied. Choices include:

Haiti Mission Fund
Donate a Home for Jubilee - \$2,000
Donate towards building a home in Jubilee
Donate to support the infrastructure for Homes for Jubilee
Donate to support travel expenses for those working with the

Homes for Jubilee Project

Nordmeyer, LLC

Herb does not have a tax exempt status. He is responsible for his expenses on his trips to Haiti. Donations to SHLC and ear-marked to support travel expenses will, in part, be used to fund Herb's travel.

HerbNordmeyer@gmail.com.

<http://www.helphaitibuild.com/> (just started building this website)

If you would like to donate directly to Herb Nordmeyer, you may do so through:

Nordmeyer, LLC
213 CR 575
Castroville, TX 78009-2120

If you have a corporation and would like to hire Herb as a consultant and specify that he do the work on the Homes for Jubilee Project, he will be glad to develop an invoice and send it to you, even if it is for 3 hours of work at \$1.00 per hour (One of Herb's relatives has offered to make such a donation.).

Time Frame

Herb needs to meet with David South, President of the Monolithic Dome Institute, to ensure he is covering all requirements on the building project.

Herb needs to tabulate the GPS data and elevations and plot them out on a map to lay out the prime areas on the site for building.

Herb needs to put together documents so interested parties can start raising funds. Our initial goal should be enough cash:

- to purchase necessary capital equipment (balloon form, etc.) and ship to Gonaives (about \$7,000 US).
- to build 5 domes (\$10,000 US).
- If we do not have enough to build 5 domes, we need enough to purchase and ship basalt rebar and basalt rope to Gonaives to build 5 domes. That would require about \$2,500 US. Fund-raising for the domes could then continue after that shipment was made.

By March 1, 2015, Herb needs to finish the construction manual and furnish a copy to Lophane so it can be translated. The preliminary translation needs to be furnished to the Mayor of Gonaives so he can write an introduction. After it is translated, Herb needs to arrange for publishing. To have books published for transfer to Haiti by April 15, the translation needs to be complete by April 1.

By February 15, 2015, order the EcoShell Balloon Form

By March 15, 2015, deliver the balloon form to John so he can arrange for Mission:Haiti to ship it.

Pour the slab for the first house the third week of April, 2015.

Erect the dome the 4th week of April, 2015.

Pour the slab for the second house the 4th week of April, 2015.

Last of April, have a meeting to discuss successes, failures, and plan for future building.