Concrete and Building in Haiti
As of November 29, 2013

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Introduction

On November 1, 2013, I departed San Antonio and headed back to Haiti. I tagged along with a team from St. Paul Lutheran Church, Westin, Florida.

Since returning, I've worked on the Plans and Priorities report, and spent time working with Dr. Richard Klingner, a structural engineer with a great deal of expertise in designing earthquake-resistant structures, and who introduced me to the Blondet Manual. We also discussed roof joists for building lightweight roofs.

Dave Stevenson, with Advanced Structural Panel Industries, supplied me with a copy of the USAID Primer on Two-Story Confined Masonry Houses, as well as numerous comments.

Jim Farrell, President of BlastCrete and MetRock SCIP, furnished a lot of valuable input and review of documents in progress.

Both Dave Stevenson and Jim Farrell have expressed willingness to help get SCIP technology into Haiti.

Jesse Lilligren, who has built all over the world following disasters, has reviewed documents in progress and furnished valuable input.

Architect Paul Miertschin suggested using a smaller dome for structural integrity and then building confined masonry or other building techniques to expand it. He is also looking into building several smaller dome homes and using shade cloth to provide open living area between several small domes.

Nolan Scheid, owner of Pacific Asset Development, furnished me with information concerning low-pressure concrete domes.

Even though I have previously reported that Haiti does not have a building code, I find that Haiti's Ministère des Travaux Publics, Transports et Communications (MTPTC) (Ministry of Public Works, Transport and Communication) adopted a building code which ICC (International Code Council) helped them write.

Several Haitian building contractors and others provided input on the preferred type of house in the Gonaives area.

In driving through the streets on Gonaives, new construction was observed which was cracking before it was completely built.

Blondet Manual

What I will refer to as the Blondet Manual is titled *Construction and Maintenance of Masonry Houses for masons and craftsmen, Marcial Blondet, editor*. It was written for the reconstruction of Peru, using confined masonry following the 2007 earthquake. Rather than being like most construction manuals, it uses cartoon-type pictures to illustrate various concepts. Probably the first time a person who was illiterate used it, it would be helpful if a person went through the document with him and read the text. After that the pictures are adequate to remind the builder what needs to be done during each step of the process.

We are allowed to use the Blondet Manual, in whole or in part, if we give credit to the people who developed it.

There is a reference on the internet that the Blondet Manual has been translated into Creole; however, the link that is listed does not function, and the website where that reference was found has not been updated since 2010.

Confined masonry is the predominate method of construction in Haiti for residences and commercial buildings which are three stories and under. The learning curve for contractors building with confined masonry would be shorter than for them building with any other technology. Whether the translated version is found or not, this is a major step in developing a plan for building with confined masonry in Haiti.

The Blondet Manual provides plans for building a lightweight concrete roof using hollow clay units.

USAID Primer

The USAID Primer provides a plan for building a two-story confined masonry home, each story being 25 square meters and each story functioning as a separate apartment. The plans are not as user-friendly as the Blondet manual. The USAID Primer has plans for building a lightweight concrete roof using 15 cm CMU lying on their sides. So far I have not found any of the clay roofing units mentioned in the Blondet Manual in Haiti.

In Haiti, especially in the areas we are interested in, a lean-to kitchen and a separate latrine would be better than the indoor kitchen and indoor restroom that are proposed in the USAID Primer.

Roof Joists for Lightweight Concrete Roofs

There are several systems available to build concrete roof joists which are nominally 0.6 meters wide, 4-, 6-, or more meters long, and are constructed as arches. The arch of one I looked at is approximately 9 inches high. The roof joists are placed adjacent to each other and a thin layer of concrete is poured in the valley formed by two adjacent trusses. If a floor for a second story is to be developed, the valleys can be filled with concrete. Such a roof will weigh about 1/3 as much as a conventional concrete roof. If the valleys are filled in to produce a floor for the second story, that slab will weigh about half as much as a conventional concrete floor slab.

There are molds with vibrators for making the roof joists. There are plans for building a bottom mold and then producing the channels from stucco and wire. A deterrent against using a permanent bottom mold is that the channel needs to cure for three or more days before the channel can be moved and another channel can be produced. The bottom mold can also be constructed from EPS. The EPS remains part of the roof joist and provides insulation for the structure.

With the EPS integral mold, the channel can be built any level place the mold can be set.

Low-Pressure Concrete Domes

Besides the domes built by Monolithic where the air-form requires an air pressure of seven inches of water, there are air forms which require an air pressure of only about two inches of water (cheaper blower). With the low-pressure dome, one cannot stand on the inflated dome like one can stand on an inflated Ecoshell dome. Thus, if one wants to build a low-pressure dome that is over about 5.5 meters in diameter, one needs to have a boom truck or scaffolds to arch over the dome. The low-pressure air-forms are cheaper and lighter; thus one can be transported in a suitcase. Countering these advantages is the negative that the low-pressure air-forms are not reusable.

James with SudaGlass, a distributor of basalt rope states that the rope can be tied. Monolithic Domes had reported that placing strong bends in basalt rope substantially weakens it. If the basalt rope can be tied, a “net” could be tied which could be placed over the top of the dome and would simplify placing the basalt rebar on the dome.

Dome Safe Room With Additions

If a small quick-to-construct dome were built that was disaster-proof, and it had appropriate doors, masonry infill rooms could be added to it. An alternative to this would be to build two domes nominally three meters apart and build a masonry infill room in between them.

An alternative would be to build clusters of four small domes and attach an awning to the four domes to provide outdoor living space. In the event of a hurricane or other high wind event, the awning would have to be taken down. Using a square frame and twisting the frame to produce a hyperbolic paraboloid would reduce the flapping in the breeze, but I have not examined how it would impact the hanging of the awning.

Building Code

MTPTC enacted a building code, which was developed in conjunction with the ICC, in January, 2013. Most of the people I have talked to in Haiti have not heard of the code, and there are news reports of inspectors with police backup being forced off of jobsites by “unruly” mobs of citizens. While building codes are important, if the materials required to build with them are not available and people are not trained in using those materials, serious problems will develop. My current copy of the code is in French.

Perimeter Walls

Most residential property, except in areas of extreme poverty, is surrounded by a perimeter wall. Usually the perimeter wall is nominally 2.4 meters high. Some of those walls are topped to prevent intruders from climbing over them. Most common alternatives are broken glass bottles imbedded in the concrete bond beam around the wall, barbwire, and razor wire. In discussions about the reasons for the wall, the following comments were made:

The wall is the first thing built so it will be more difficult for thieves to steal the building supplies and any equipment.

After the house is built, the perimeter wall makes it more difficult for thieves to steal property.

If a daughter goes to a community latrine after dark, she will be pregnant by the time she is 13.

To save money, the perimeter wall can serve as one wall of the house.

Designing a Model Home

With the cost of land in Gonaives, and with the hope that conditions will improve and allow for expansion, preliminary discussions indicate that for the most part a building system which can be built as a one-story building, but later expanded to two or three stories, is preferred. As a result, flat concrete roofs are preferred. There are reports that in the area of the 2010 earthquake, Pout-au-Prince and points west, there is a resistance to concrete roofs. A portion of the hope for the future is that there are a number of Haitians who live overseas and are sending back money to build homes that they hope to retire in.

Based on the current culture of Haiti, domes appear to be best suited for rural and low-density housing in Haiti, and for areas of extreme poverty. In these areas, they have a very real potential.

We need to:

- Design a one-story model home.
- Design a two-story model home.
- Design each model home so eventually it can become a three-story home at some later date.

Parameters for designing the models should include:

- Appropriate foundations for the different soil conditions in the Gonaives area.
- The footprint of the model houses should be about 24 square meters.
- Model homes should be designed with outside staircases, since they are more practical where space is limited.
- Kitchen will probably be a lean-to outside the house. This will limit smoke and heat buildup in the house.
- Sanitary sewers are not common in most parts of Gonaives. Rather than a bathroom in the house, an outside latrine which is cleanable should be used. If houses are build as pods using the courtyard concept, one latrine could serve a pod of houses, and the fence can serve as protection for those using the latrine at night.
- When a conventional window is installed in a confined masonry wall, the window needs to be faced, top, bottom, and sides, with concrete beams and columns. This tends to get expensive. Since the temperatures in Haiti seldom reach a point where windows need to be closed to keep heat in the house, and since ventilation is needed year-round to keep the temperatures down, it is appropriate to use decorative block (screen block) with mosquito netting over the openings. The same decorative block can be used for windows in SCIP, Imison, and dome structures.
- To simplify construction, the top of the decorative window block should be even with the top of the doors.
- Ideally there should be a door in front and one in back leading to the lean-to kitchen.
- Termites are a serious problem. Wood is expensive and needs to be eliminated wherever possible.
- Thermal chimneys would be useful in keeping the inside temperature close to the ground temperature.

Concrete Quality

The huge problem in Haiti is getting concrete and especially getting good-quality concrete.

We have started a program to identify water in the Gonaives area that is low in chlorides.

After the first of December, I'll be meeting with a gentleman who owns a sand and gravel operation and is known for his ability to think outside the normal ways that things are done. Hopefully we can come up with a lower cost way to size the aggregate and to remove the clay from the fine aggregate.

Working with Dr. Klingner, we have a design for foundations to protect the rebar in the foundation from brackish soils. This will reduce the need for importing basalt rebar and in training contractors to use basalt rebar.

By using Structural Concrete Insulated Panels (SCIP) with low-chloride water, and by isolating the foundation from brackish soils, chloride degradation problems should not occur. This system will produce a much cooler home than confined masonry. Also, consideration should be given to using SCIP for roofs of confined masonry structures.

By using Imison technology with Neopor insulation and galvanized steel reinforcing with low-chloride water, and by isolating the foundations from brackish soils, chloride degradation problems should not occur. This system would use about as much concrete as SCIP and would provide an equal amount or more insulation.

Notes

I will not be traveling to Haiti in December, 2013.

Plans are not finalized for trips in 2014.

I now have internet access most evenings when I am in Haiti.

If you would like any of the documents mentioned in this report, I will send you the link so you can download them.