Concrete and Building in Haiti

Priorities and Plans

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Introduction

We have a very large job ahead of us. As I think of it, I'm reminded of what my father told me. If you want to eat an elephant, you do it one bite at a time. In front of us we see the future Haiti with adequate housing, employment, and opportunities to worship.

I also remember what Helen Roenfeldt told me. If you want to move a mountain with a shovel, concentrate on the shovel and not on the mountain, otherwise you will become discouraged.

The preliminary path that is outlined here will take many years to implement, but the goal, **quality housing for the people of Haiti** is worth it.

To develop a concrete company in the city of Gonaives which will deliver quality concrete and allow the building of low-cost disaster-proof homes, we need to start by taking a number of little steps, bites, or shovelfuls.

Standards and Codes

Haiti has no building codes or standards for construction materials. It will probably be at least ten years before building codes can be adopted and longer before they are fully implemented. That leaves a lot of time for building substandard structures.

Construction manuals which follow international standards have been imported into Haiti, but in residential and small commercial construction, they are not being used because the infrastructure is not available to produce the raw materials needed, and the contractors do not understand the concepts and requirements of those standards.

Mandating that international standards be used will either eliminate construction because the infrastructure is not available to produce the raw materials needed to follow the international standards, or it will result in contractors continuing to use the same materials and techniques.

The concept being developed in this document is to incorporate the customs and conditions of Haiti into a system so the Haitian contractors will have a system which, while not following international standards, will allow the production

of quality concrete and the construction of disaster-resistant housing and will help develop a mind-set of quality construction.

Quality Concrete

- Test wells to identify water sources that will not incorporate excess chlorides into the concrete.
- Develop an infrastructure to deliver quality water to building sites.
- Produce a fine aggregate (sand) which can be used for quality concrete. This can be done by locating, importing, and installing a plant to size and wash aggregate, at a quarry owned by the Lutheran Church of Haiti, or it can be done by locating and mining a river sand that has appropriate gradation, or it can be done by building a stationary screening plant and useing water to wash the screen.
- Produce a large aggregate which can be used for pouring house foundations, sidewalks, footings, etc.
- Develop an infrastructure to deliver the quality aggregate to job sites, either as aggregate or as concrete.
- Teach and, more importantly, prepare others to teach, concrete technology that is appropriate for the conditions in Haiti.
- Identify someone in Haiti, and train that person, to replace me so that the work will continue when I can no longer function.
- Develop a method for testing compressive strength of concretes. There are several alternatives:
    - Determine whether there is an appropriate lab in the Gonaives area which could do the testing.
    - Obtain a compression test machine and train someone to produce cubes and cylinders for quality control. Since it would be expensive to bring in someone to certify the machine every year, testing with it would not meet ASTM standards, but would allow reasonably close estimates of compressive strength.
    - A low-cost alternative would be to design and locally fabricate a press to test 5 cm cubes. This can be done with an eight-ton hydraulic jack that has a port to attach a pressure gauge. Such a press could test the concrete (stuccos) that is applied to concrete domes, SCIP systems, and Imison Systems, and concrete that is used to produce concrete block, but would not be sized to test concrete produced using larger

aggregate (for foundations, footings, sidewalks, Insulated Concrete Forms, etc.).

- Obtain a small skid steer loader and a monolithic concrete mixer to use at job sites to mix concrete, especially concrete with fine aggregate.

- Bring someone to the US to learn to operate and maintain volumetric mixer trucks. One of his primary jobs in Haiti would be to train others to operate and maintain mixer trucks. If the right person were chosen, he could head up the ready-mix company. Dixie Alexis appears to be an excellent candidate for the position.

- Develop a ready-mix industry using volumetric mixer trucks (due to routine traffic delays, rotating drum mixer trucks have limitations). This includes, but is not limited to, importing volumetric mixer trucks, building an infrastructure to load trucks, and training crews to operate and maintain the trucks. (Oldcastle has a fleet of such trucks and retires a few each year. This would be an excellent place to start discussions.).

- Import and operate one or more concrete pumps. There is a trade-off here, in that using concrete pumps can result in better-placed concrete, but it will result in eliminating jobs (bucket brigades). This part of the development should probably be very slow and tied in with other projects which result in job creation. Concrete pumps are high-maintenance machines and require precisely formulated concrete to pump.

- Develop an attitude that quality concrete is much cheaper in the long run.

After the concrete industry is established in the City of Gonaives, the natural outgrowth would be to expand the industry beyond Gonaives. Areas which could readily be served as the company expands would include Cap-Haitian (North), Port-de-Paix (North West), Fort Liberty (North East), and Hinche (Central Plateau region). If we start the expansion too soon, our resources will be split, so little or no progress will be made.

Quality Block Production

Currently the church owns a 3-cell, hand-operated concrete block machine which is not in operation because of the inability to produce quality block.

- Identify an aggregate gradation which can be used for producing quality block.

- Obtain aggregate of that gradation by purchasing or by installing appropriate equipment in the quarry to wash and size the aggregate.

- Place the current block machine in operation and modify the formula as needed to produce quality block.

- Locate and obtain a larger concrete block machine, preferably one which has a capacity of triple the capacity of the current machine. Such machine will probably use hydraulics to operate.

- Upgrade the existing electrical power generator to be able to run the block plant and a washing / screening plant at the same time. Produce a fine aggregate (sand) which can be used for quality stucco.

Quality Stucco Production

Currently stucco is produced by mixing Portland cement with sand and water. Workability and body are developed from the clay that is in the sand. While current stucco quality is better than current block or concrete production, it could be improved by reducing the quantity of clay in the sand.

- Produce a fine aggregate (sand) which can be used for quality stucco.

- Determine conditions where a hurling trowel, or a trowel & hawk, is the most efficient way to apply stucco. Currently stucco is applied by hurling with a mason's trowel.

- Determine when a mortar sprayer and air compressor become a better way of applying the stucco.

Quality House Foundations

Numerous house foundations are installed on the surface, poured below the brackish water table, poured with low-quality concrete, or constructed with boulders and low-quality mortar. Within a few years the low-quality foundations result in angle cracks in walls. This results in stresses placed on concrete roofs which are held up by the walls.

- Working with Haitian contractors, develop guidelines for house foundations that are installed on the surface.

- Working with Haitian contractors, develop guidelines for house foundations that are installed in brackish water trenches.

- Working with Haitian contractors, develop guidelines for pouring house foundations with quality concrete.

- Working with Haitian contractors, develop guidelines for building house foundations with boulders and quality mortar.

Disaster-Resistant Housing

To develop a construction industry in Gonaives for building disaster-proof homes and small commercial buildings:

- Examine the use of bamboo to replace all or part of the rebar used in high-chloride areas. I will be discussing this with Dr. John Matthys, recently retired from University of Texas at Arlington. Several years ago he had a PhD student working on the use of bamboo for reinforcement.
- Determine varieties of bamboo which would be appropriate for growing in Haiti and the infrastructure which would be needed to move from bamboo starts (cuttings) to bamboo rebar.
- Determine the cost and feasibility of importing basalt rebar and basalt rope into Haiti.
- Identify types of construction which can be used for producing disaster-proof homes, including, but not limited to:
    - High-pressure air-form concrete domes,
    - Low-pressure air-form concrete domes,
    - structural concrete insulated panels,
    - Imison system,
    - reinforced masonry,
    - insulated concrete forms,
    - tilt wall construction.
- Develop a detailed information sheet on each type, including:
    - pros,
    - cons,
    - sources of information,
    - vendors,
    - infrastructure needs,
    - costs,
    - etc.
- Monolithic Dome Institute waived the tuition for Herb to attend a workshop on building EcoShell domes which are disaster-resistant and appropriately sized for use in Haiti. They are probably the cheapest form of disaster-resistant housing. (Herb attended and learned a lot.)
- Domes are more applicable to rural Haiti and in the areas of extreme poverty than in the moderate-priced areas in the cities.

- With the cost of land in the cities and with the hope that conditions will improve and allow for expansion, preliminary discussions with people in Haiti 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 roofs are preferred.
- Design a one-story model home.
- Design a two-story model home.

Design Considerations

- Design each model home so additional stories can be added at a later date. This usually involves a flat concrete roof. There are reports of resistance in Port-au-Prince to living under a concrete roof since numerous people were trapped under failing concrete roofs during the earthquake in 2010.
- What is the potential to overturn a 3 story SCIP house? Would earth anchors be adequate?
- Design foundations / footings for multistory structures for different soil conditions in Haiti. We need an engineer for this.
- Identify the different soil conditions in the Gonaives area.
- Should model homes be designed with outside or inside staircase, or should they be designed with the option of either?
- What size of footprint should the model houses have?
- Size of kitchen? How should kitchen be outfitted?
- Size of bathroom? How should bathroom be outfitted?
- Number of rooms?
- Size of rooms?
- Window sizes? Is there a standard window size in Haiti?
- Termites are a problem. Are aluminum or vinyl windows readily available?
- While vinyl windows can be directly incorporated into SCIP structures, if they ever have to be removed, problems develop. A window buck makes installation and removal easier. Wood will be attacked by termites. What is the preferred substitute – treated lumber or plastic lumber? Is treated lumber and / or plastic lumber available in Haiti at a reasonable cost?
- Number of windows per room.

- Should windows be high and open at the top for heat transfer?
- Should vents be available close to the floor level to assist in air circulation?
- Would thermal chimneys be useful in keeping the inside temperature close to the ground temperature? How tall would they need to be?
- Is there an EPS expander in Haiti? (Expanded Poly Styrene)
- What would be the cost of building an EPS expander in Haiti in dollars and in permits?
- What is the relative cost of importing container-loads of EPS to Haiti vs building and operating an EPS expander?
- EPS is outlawed in Haiti for making cups and plates. Will this cause problems when trying to import EPS or build an EPS expander?
- Should the houses be designed as duplexes or triplexes?
- Most houses in Haiti start with a perimeter wall to provide security for equipment stored on site. Would a design using the perimeter wall as one or two walls of the structure be acceptable?
- Would a design using the perimeter wall as the back wall for a group of homes and a central courtyard be an acceptable design?
- For tying second story to the first, the standard method is to allow rebar to extend up. This can be done with SCIP construction. How well would basalt rebar hold up in such a situation?
- Unless basalt rebar has been shipped from the factory with a bend in it, it is difficult to bend. How deep would a basalt rebar anchor need to be to provide adequate anchorage?
- Would placing the basalt rebar at different angles provide sufficient anchorage?
- As long as steel rebar is used with concrete that is made with water that contains less than 500 mg/liter of chlorides, are there any other problems which may cause significant deterioration of the rebar if left exposed for 10 or more years? Would “painting” the rebar improve the situation without reducing the bond when the next story is added?

Detailed Quality Concrete Construction Manual

- Working with a core of experts who understand the conditions in Haiti, and a core of experts who understand quality concrete, develop a detailed construction manual for producing quality concrete.

- The manual will be written in English, edited, and published as an e-book.
- The manual will be translated into Creole, and published as an e-book and a print book.
- The manual will be used as textbooks for seminars.
- Copies of the manual will be donated to Haitian contractors.
- Inquiries have been received about translating the manual to Spanish and using it in Belize and in Costa Rica. Since it will be written specifically for conditions in Haiti, it would need to be adapted for conditions in other countries; however, much of the material would be applicable without adaption. The adaptation and translation are beyond the scope of this document.

Detailed Disaster-Resistant Housing Construction Manual

- Working with a core of experts who understand the conditions in Haiti, and a core of experts who understand disaster-resistant housing, develop a detailed construction manual.
- The manual will be written in English, edited, and published as an e-book.
- The manual will be translated into Creole, and published as an e-book and a print book.
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Seminars

Develop a series of seminars and supporting documentation on producing quality concrete and building disaster-resistant housing. Develop the infrastructure so Haitian contractors and engineers can present the seminars at no cost to the attendees and a reasonable pay for those presenting the seminars.

Assess Potential of Minerals

A piece of land owned by Pastor Benoit has been identified as containing potentially valuable minerals. During September representative samples were collected and assays of three representative samples were done. The assay results indicate that it would not be economically feasible to proceed with development of the property. Prior to tabling the project, it is necessary to produce a final report which will:

- Quantify the potential value of the minerals.
- Quantify the potential cost of extracting the minerals.
- Determine a mining method which would not pollute the clear river which is located below the mineral deposit.
- Determine whether more time and money should be expended to assess the potential of the deposit.

Other Projects

- Continue presenting concrete seminars in the Gonaives area.
- Replace the roof on the seminary. (John Rougeux, send dimensions to Herb.)
- GPIS states that they are going to build a SCIP plant in Haiti.

Financing Growth

The above-listed steps will require the dedication of a number of volunteers as well as paid staff. Equipment will need to be found, repaired, imported to Haiti, assembled, and operated.

Currently the Lutheran Church of Haiti is facing a tough financial time, having 220 Lay Pastors and 350 teachers in our Christian day school system. This does not leave extra money to purchase, repair, import, and install equipment. The Lutheran Church of Haiti is not receiving financial assistance from outside Missions or Churches.

We need to find people who would be interested in investing in each of the project areas listed above. They will have to come up with the equipment. Then a plan can be developed to share the profit.

Herb Nordmeyer is willing to work on the project as long as finances and health allow the work to continue. His goal is to empower Haitians to take over as much of the work as they can, as soon as they can. He is involved in a number of other projects which are important to many people, so he is limited in the amount of time he can devote to this project.