IDDS Botswana
Xg'ae Interlocking Blocks Project Report

PROJECT ABSTRACT

Traditional huts in Botswana, called rondavels, consist of rounded walls and thatched roofs. As people moved to using concrete blocks, rondavels were replaced with rectangular structures. There is an interest in reviving the traditional rondavels, while using stronger, longer lasting materials. This project is to make a system of producing strong, curved, interlocking blocks that can make rounded structures with a minimum amount of cement and water. The ideal block will be easy to use with minimal amount of specialized skills.

CONTEXT

Background
The need was identified for low cost, compressed soil blocks by a local community member during a Creative Capacity Building Workshop in April 2016.

Community Description
The community of D'Kar, is a small community in northern Botswana based on a church-owned farm. The San people, a formerly nomadic group, have been living here for the past two generations in mud and stick homes adapted from the Setswana people. The residents here do not own the land they live on. Instead, they are issued certificates of occupancy by the church. In the past decade, the community has grown beyond it's capacity and there is now limited land available for residents to occupy. Resources like cow dung for building homes is becoming more difficult to find due to cows being moved further away from the community due to overgrazing. Wood for building and burning is also becoming scarce. Many residents transport water in plastic containers by donkey cart from neighboring bore hole wells (i.e. on the church grounds).

Stakeholders

- Local team participants (Jacob Camm and G. Nkaketsang Ditsheko)
- The persons who presented the idea at the Creative Capacity Workshop in April 2016
- The local block maker
- Anyone who has been doing various building experiments, including building a rondavel using locally available materials on his land
- The local organizations (i.e. the church foundation) who have organized housing development for those in need.

Typical Users

- People in D'Kar who want to build a low-cost home or addition / out building
- People and communities in Botswana who want to revive the rondavel housing traditions
- People in counties in other parts of Africa or the world who may want to adapt the technology to fit their local needs

PATH Statement
During the floods in 2015, many of the traditional homes in D'Kar were damaged or destroyed. Because of this, there is a need within the community for more durable, cost-effective housing. Buildings made of concrete blocks are expensive—they require a lot of cement to produce, cement based mortar to hold together, and skilled labor to construct.

The team has designed and produced a press and mold which together produce cost-effective interlocking blocks. These blocks can be assembled into rondavels (traditional round houses) of all shapes and sizes with little to no mortar or skilled labor. This will empower local residents and others to design and construct their own comfortable, durable homes that support the health, safety, and well-being of the people of D'Kar and elsewhere in Botswana.

DESIGN PROCESS

Summary

Team Xg'ae spent time in the field interviewing community stakeholders and future users of these new technologies and blocks they would produced. Based on these conversations, the team chose a direction (a mold with a press) and began iterating on the interlocking block shape. Internet research and local history research was conducted regarding existing work on stabilized compressed soil blocks. Various versions of block shape and press mechanism were sketched, modeled, and made into working prototypes. Various local soils were combined in different proportions to make small sample blocks and tested to compare strength. Two different prototypes of the press and molds were produced and demonstrated for the community to gather feedback and develop next steps.

Concepts Description

An innovative block shape was developed that can build round structures of varying circumferences. A metal press made of steel will use levers to allow a single person to manufacture blocks using either a durable metal mold for larger scale production or a wooden mold. The intended user would be a community member who wanted to borrow the press to self-manufacture blocks or a local block maker who wants to expand their product line. Parallel development of a durable metal mold and a wooden mold allows for more individual end user innovation and variation in shapes and sizes of blocks.

Analysis and Experimentation

Block shapes – Mocking up block shapes in modeling clay and then using wood to simulate how the curved shapes would fit together and how the blocks would interlock.

Strength testing was conducted using different combinations of available soils, water and cement. Unites (parts) used to make samples were approximately 3 cu cm. Breaking force is measured in Kg using a bar and spring scale.

#	Common Sand	Grey Soil	Red Soil	Lake Mud	Cement	Water	Break Force
1	1	0	4	0	.5	.5	12.5
2	1	0	0	4	.5	.5	11.5
3	3	0	3	0	.5	.5	19.5
4	1	4	0	0	.5	.5	23

Table 1 - Sample soils block strength testing results

TECHNOLOGY/FINAL PROTOTYPE

The Block

- A block that is light enough and of a size that local women will be able to lift, hold, and carry it with ease
- Using the block needs to be less expensive than existing options

The Press and mold

- The machine needs to be easy to operate and produce blocks at a comparable speed to existing methods, molds and presses which are now is use locally

How It Works

Material used consist of :
Square tube 40x40mm, 35x35 mm. Steel tubing, flat mild
Steel and bolts and screws flat sheet metal 1.5mm thick. Wood was used as a replacement for mild steel.

Figure 1: CAD illustration of final press design

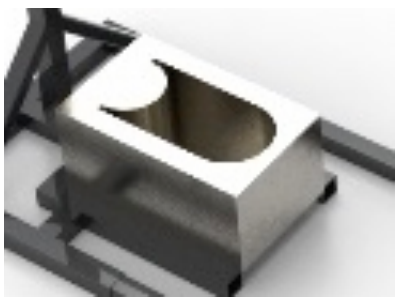

Figure 2: CAD illustration of mold

Performance
The first version of the press prototype had problems with balance. The base was lengthened. Blocks produced in the wooden mold were difficult to remove from the mold. Further development of the extraction system is needed. Blocks produced in the metal mold were easily extracted using the mold inserts.

Wooden Mold Tools and Materials:

- Plywood
- Glue
- Epoxy with filler
- General woodworking tools
- Car wax + rag

Steel Press Tools and Materials

- 2mm Steel Sheets
- Welder and welding materials
- General welding tools

LESSONS LEARNED

The team corrected the error by adding support structures in a form of expanding the base structures thus striking a balance when the press was in used.
Mold construction was challenging for both the metal and wooden molds. The current design of the block is difficult to manufacture easily and there are some

Community engagement
There have been several prior researchers who have come through this area, leaving a legacy of negative sentiment within the community. It was critical to have local partners, move slowly, and craft our questions with sensitivity and care.

The team engaged the local community at three points throughout the process:
1. In the beginning to better understand the local context
2. In the middle of the summit to review in-process wooden block prototypes and press concepts
3. At the end to review the completed wooden mold and steel press and molder prototypes

User feedback
Our user feedback was primarily positive with some competing information depending on the gender of the participant.

- "The design is interesting, keep going."
- "The block will stick to sheet metal so you need to find a way to easily peel it off"
- "The block is too heavy." (several women in the community)
- "The block is too small, it would take forever to build a house like that (points to the office)." (several men in the community)
- "The metal press will be too expensive to make."
- "Interlocking knobs won't be strong enough, you'll still need to use mortar."

Troubleshooting

- We discovered that the block design needed to be adjusted at the ends in order to prevent having brittle ends. The blocks were tested and they had problems at the round

corners. A possible alternative would be having to increase radius of corners so they are larger and more stable.

- The key "knobs" and "holes" included in the blocks from the wooden mold as well as the thin edges of the blocks from the metal mold will likely break when handled. Further block shape refinement (and molds) should include:
    - Determine a minimum thickness and radius of any part of the blocks (to increase strength and reduce breakage)
    - Improvement of the block extraction from the mold and amount of time required to make each block.

NEXT STEPS/PROJECT FUTURE

There is an opportunity to continue to develop the prototypes locally in D'Kar while exploring national partnerships, international mentorships, and parallel prototype development in Uganda.

Continuity/dissemination model

- Continued prototype development in D'Kar (G. Nkaketsang + Jacob) with the support of mentors and/or student groups
- Parallel developments + knowledge sharing of the prototype for use in Uganda (Bruce)
- Share experience and learning with superiors at Botswana Institute for Technology Research and Innovation (BITRI) in order to plant seeds for possible future collaborations (Oteng)

Action items

IDIN to identify a person who could begin a conversation with BITRI in order to:

- Identify possible partnerships
- Better understand if IDIN, These Hands, and BITRI might align, or work to align on the philosophy of co-creation as it related to the development of this project

Anticipated risks and challenges

- Being that the soil in DKar is very sandy and contains little clay, it is so far unclear what mix of local vs sand is needed in order to reduce the cement and water needs significantly when compared to the current concrete block method.
- More soil/sand/cement combination should be tested before concluding that this is a feasible method for DKar.

Anticipated needs for mentors and partners

- The team has strong creative abilities regarding design improvements with regard to molds and presses, however, more input could be helpful in the area of soil combinations and testing of block performance.
- Key stakeholders will determine the relative values of and mechanism for partnership between IDIN, BITRI, These Hands, the DKar Innovation Center.

CONTACT INFORMATION

Team Members and Point of Contact

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Community partners

G. Nkaketsang Ditsheko (D'Kar)
Jacob Camm (D'Kar)
Edward Morris (D'Kar)
Patrick (Local Pastor)
Daniel (Local cement block maker/supplier)

RESOURCES

- Interlocking Stabilised Soil Blocks (Appropriate earth technologies in Uganda) HS/1184/09E ISBN: 978-92-1-132150-0 UN-HABITAT P. O. Box 30030 00100 Nairobi GPO KENYA Tel: 254-20-7623120 Fax: 254-20-7623477 infohabitat@unhabitat.org www.unhabitat.org Printing: UNON, Publishing Services Section, Nairobi, ISO 14001:2004-certified
- Makiga Engineering http://www.makiga-engineering.com/index.php/products-services/makiga-machines/stabilized-soil-block-press
- Good Earth Trust (2009). Good Earth Trust ISSB Project Database. Uganda
- Auram Earth Construction Equipment Aspiration, Auroville 605 101, Tamil Nadu, India Phone: +91 (0)413-262 2278 / 262 2134 / 262 2651 – Fax: +91 (0) 413 - 262 2274 Email: aureka@auroville.org.in - Web: http//www.aureka.com