Tanzanian Cement Block

Senior Project: Tanzania Block Wall Testing

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Introduction

Background

The construction plans for a polytechnic college are being developed in the town of Same, Tanzania, Africa. This project is sponsored by the Mbesese Initiative for Sustainable Design (MISD), a non-profit that has partnered with design firms such as ARUP and KLA architects to complete the work. Considering that the site is located in rural Tanzania, material availability is limited. A local block maker produces a mechanically pressed brick that consists solely of sand, cement and water. The bricks are unconventional when compared to those made in the United States. The purpose of this study is to understand the block material characteristics, quantify the block compressive strength, and develop an analytical model when a block wall is loaded out-of-plane.

Purpose

The blocks in Same, Tanzania do not include a coarse aggregate, while in the United States, a ratio of approximately 40-60% coarse to fine aggregate ratio is used. Locally made bricks are available in limited dimensions; 6"x9"x18" and 5"x9"x18", so the construction for the Tanzania Polytechnic College should be based on this constraint. The original goal of this research was to replicate manufacturing processes and to investigate the compressive strength properties of blocks made similarly to those made in Same, Tanzania. After visiting the site and lessons learned during Fall 2017, the goal was changed to include the construction of a model wall and to investigate its out-of-plane strength and stiffness.

The absence of coarse aggregate in the block mixture is expected to impact the strength and workability of the mix. Typically, the appearance of blocks with no coarse aggregate will be smooth and fine grained. In addition to aesthetic considerations, structural elements are also evaluated on performance criteria - typically strength or capacity. Mortar concrete typically contains a greater cement ratio than typical concrete to ensure that the particles in the mixture bond ("The Role of Aggregate in Concrete Countertop Mix Formulas"). Based on the mix design for the blocks, it is assumed that the strength of the blocks will be weaker than traditional concrete blocks due to the absence of coarse aggregate, and the effect coarse aggregate has on the overall strength of the mix.

With the out-of-plane analysis, adequate testing of the composite walls made up of these blocks, and with the material testing of the blocks and rebar, it is expected that the capacity of a wall loaded out-of-plane can be predicted by using its material properties. This prediction will be based on the compressive strength of a mortar cube and the material properties for steel reinforcement. Based on this data, the maximum force and corresponding displacement of an assembled masonry block wall will be calculated and compared to a wall assembly test.

The purpose of this experiment is to replicate building practices that will be used when constructing buildings for the technical college in Same, Tanzania. This includes the mix proportions for the blocks and defining the mortar joint mix and mortar dimensions when constructing walls. The results, if successful, will establish values for block strength, material stiffness, and a predictive model for walls loaded out-of-plane.

Process

Spring Quarter 2017

Block Construction

The bricks made in Same are a specific size; 6”x9”x18” or 5”x9”x18” (W x H x L). Replicating this size was a priority to develop accurate predictions and better understand constructability issues, such as weight. The brick was made using the material proportions shown in *Table 1* below. The group used wood formwork to construct the blocks, since the goal was to create a brick of unique size with three triangular grooves along the block faces. This allows for the placement of reinforcement between blocks (see *Figure 5*). An image of the wood formwork is shown in *Figure 11* and *Figure 12* in Appendix A.

The block making process included constructing the formwork, casting the brick which was made with the ingredients shown in *Table 1*, and then removing the bricks. This process was ultimately stopped for reasons described in Lessons Learned.

Table 1: Spring Mixture Content

Ingredients	Mixture (%)	Mixture Content by weight (lbs)	Tanzania Measurements (buckets)
Sand	80	280	4
Cement	7	23	.50
Water	13	28.4	.75

Note: Tanzania measurements, 5 gal. Buckets

Block Strength Testing

Individual compressive strength tests were performed on the bricks at 7, 14, 21 and 28 days. The testing showed that the bricks had very low compressive strength and failed with inconsistent crack patterns (see *Table 2*). Based on the testing results, changes were made to the overall block making process as noted below.

Table 2: Spring Brick Testing

Days Curing	Average Failure Stress (psi)	Failure mode
7	122	Top and bottom corners crushed
14	167	Spalling at top and bottom
21	171	More spalling, but some cracks propagating at very slight angle
28	179	cracks down center, edges chipped away in long slivers

Figure 1: Failure mode at 7 days of curing (top left), failure mode at 14 days of curing (top middle), failure mode at 21 days of curing, and failure mode at 28 days of curing (bottom left and bottom right)

Lessons Learned

These results indicated that the construction process caused premature cracking, low compressive strength (relative to other tests), and damaged units when removing from the forms. The formwork resulted in many imperfections as summarized below:

- Since the formwork edges were not cut to a uniform height, the blocks were not pressed sufficiently, and sufficient consolidation was not achieved.
- The formwork had to be disassembled after each batch of blocks was cast and, taking apart the formwork after every batch took a toll on the plywood. Additionally, the screws could not always go into the same holes that they were in initially, and the wood started to split.
- The blocks were cured on a thin piece of plywood and warped the plywood, which caused the blocks to cure with a curved surface, which in turn caused stress concentrations on blocks during compression testing.

This process was a clear example of Cal Poly's motto: Learn by Doing. Even though the first quarter of building bricks did not go as planned, it enabled the group to determine how not to build the bricks. Based on this learning experience and knowing one of the team members was visiting Tanzania in Summer 2017, the group would revisit the process and block composition in Fall 2017.

Fall Quarter 2017

Construction Process

Based on lessons learned in Spring 2017 and a building trip to Tanzania during Summer 2017, there were many tips and suggestions for a new block making process. In Tanzania the bricks were compressed with a mechanical brick press, then cured on stiff wooden platforms. Coincidentally, it was discovered that the ARCE department had a manual brick press. This was the best way to compact the bricks in a manner similar to the method used in Tanzania, but the bricks would be smaller (6"x12"x6"). The bricks manufactured in Tanzania have triangular grooves on three sides which allow rebar to fit between adjacent blocks. To simulate this, a metal jig/form was built to fit inside of the brick press. The images below show the blocks made for the experiment. See the *Tanzania Brick Making Manual* at the end of the report for step by step instructions for making the blocks, and for illustrations showing the entire process.

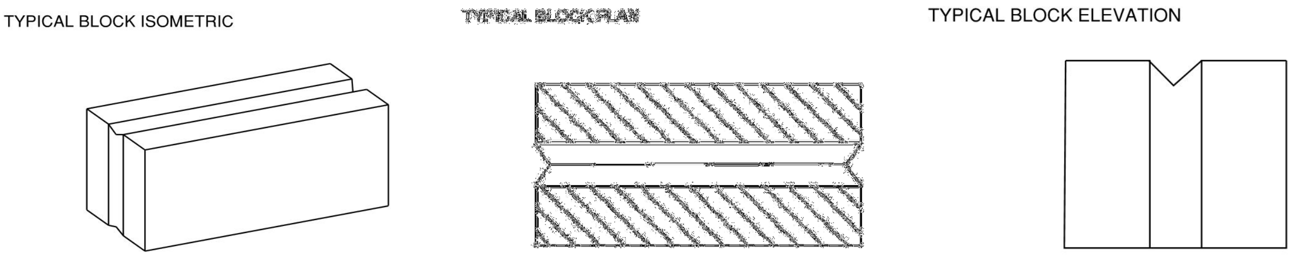

Figure 2: Isometric, plan view, and elevation of blocks

The concrete mixture was poured into the brick press without measuring the quantity. The concrete mixture was evenly distributed within the block formwork, then the lid the brick press was used to screed off the excess mixture in order to keep the volume of concrete mix used for the bricks consistent. After compressing the block mixture, the units were removed, set on a piece of wood, and cured under damp burlap fabric as shown below. The burlap sack is to help slow the process of water evaporation especially in hot, dry conditions that would be seen in Africa. Finding a way to slow the process of water evaporation in Tanzania, even if it is as simple as keeping the blocks out of the sun.

Figure 3: Cured bricks can be seen next to the burlap sack that is covering the wet, recently compressed bricks

Testing

Three (3) different tests were completed for the study, material tests for the steel reinforcement and the compressive strength of the brick. The third test used a wall assembly which was loaded out-of-plane.

The steel reinforcement was tested in tension using the Tenius Olson machine to develop a stress-strain curve. One of the test results is depicted in *Figure 4* and a summary of the test data is provided in *Table 3*. The average yield strength, f_y, for the steel sample was slightly greater than 50 ksi. The stress at plastic, f_{pl} is once the steel is subjected to strains beyond yield and behaves in a non-linear manner. This is also the point when strain hardening occurs until the rebar reaches an ultimate load over its area, f_u.

The compressive test for the bricks was not as simple. A leveling material, hydrocal, was applied to the top and bottom surfaces to minimize the stress concentrations and prevent premature crushing of the blocks. The blocks were tested as whole units and compressive tests were conducted with smaller brick samples which measured 2”x2”x4”. This was necessary since the application of the hydrocal material was not uniform for each block.

The compressive strength of the bricks, f'_m, accounts for the grooves when determining the bearing area. In other words, the net bearing area equals the top surface area of the block minus the cross-sectional area of the groove. The compressive strengths noted were measured at 35 days after casting the blocks. *Table 4* on the next page shows the values for the bricks.

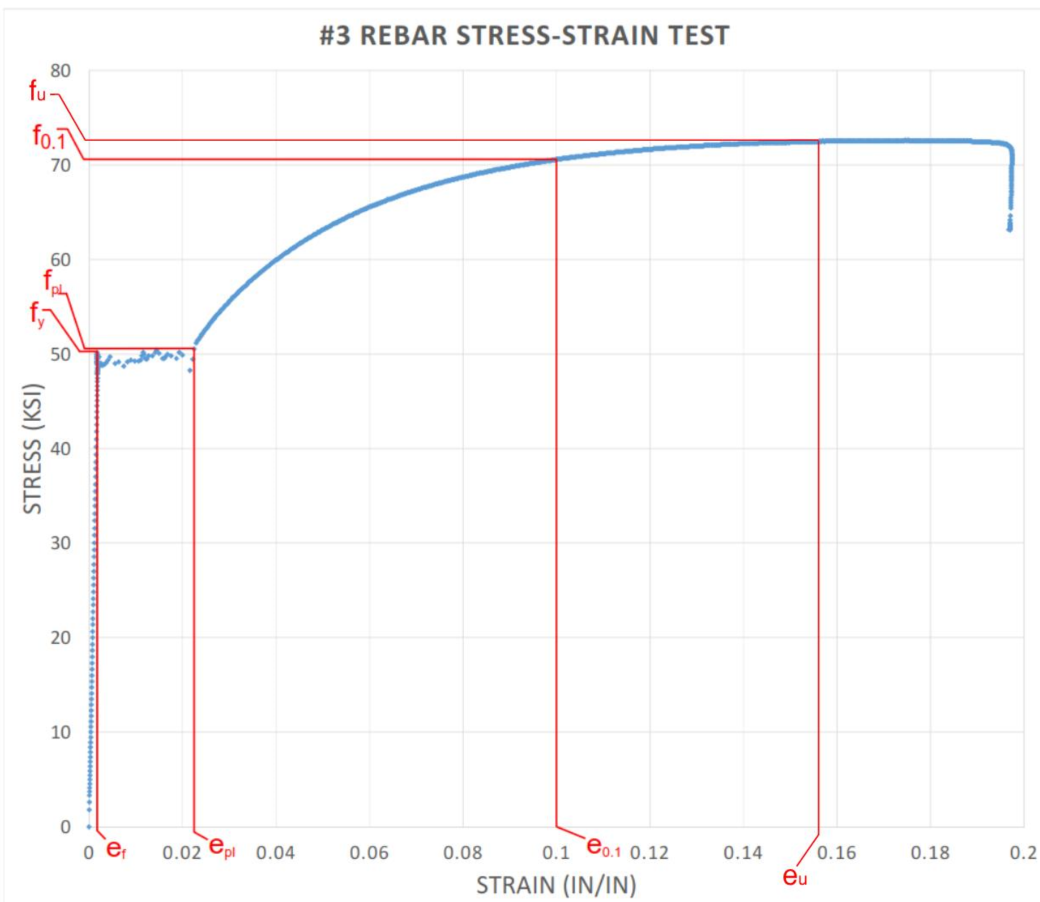

Figure 4: Stress-Strain Curves for #3 Rebar Tensile Test

Table 3: Rebar Tensile Test Results Summary		
Label	**Stress (ksi)**	**Strain (in/in)**
f_y	50.2	0.00172
f_{pl}	51.9	0.0239
$f_{0.1}$	70.6	0.1000
f_u	72.5	0.1576

Table 4: Compressive Block Testing					
Brick	**Width (in.)**	**Length (in.)**	**Area (in.^{2}) ***	**Load (lb)**	**Calculated Stress (psi)**
1	6.13	12.1	55.9	12,200	290
2	6.06	12.1	55.5	15,800	379
3	6.00	11.9	53.6	11,300	280
4	6.13	12.1	55.9	12,400	295
Average	-	-	-	-	311

*total net area is without the grooves

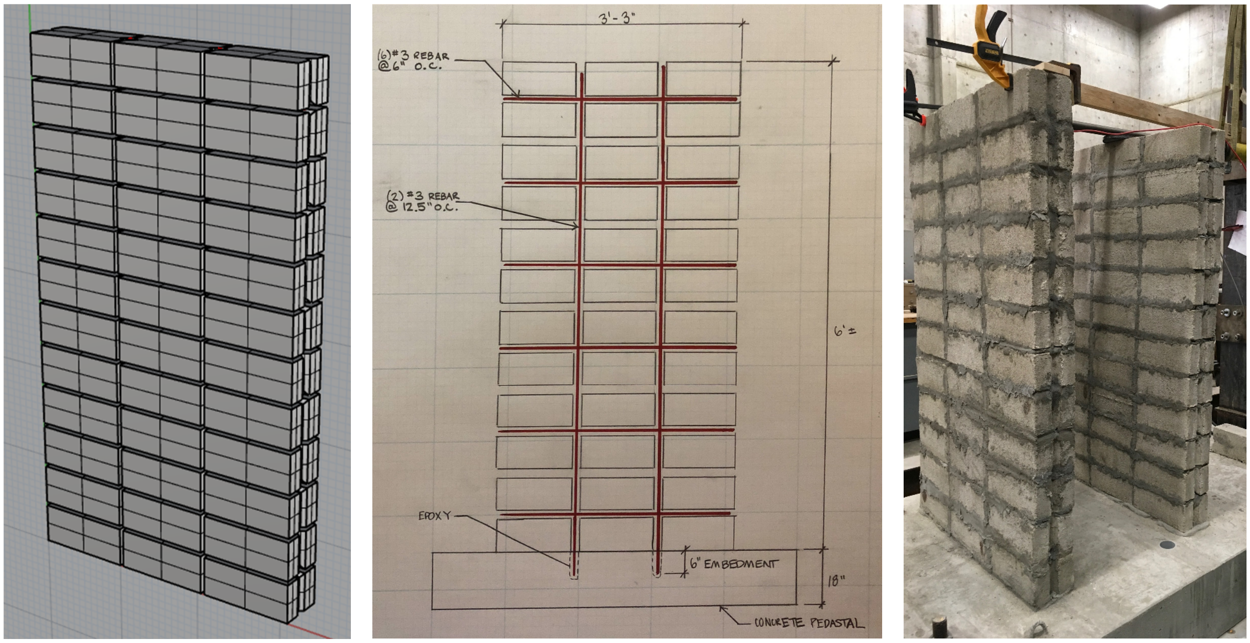

Figure 5: 3D rendering of brick configuration (left), rebar location (middle), and photograph of walls (right)

Figure 5 shows a model of the wall used for construction. There was horizontal reinforcement at 10.5" o.c. starting at the first mortar joint, not including the base, shown as a red line in the center figure. There were also two vertical bars. The vertical reinforcement was epoxy grouted into the concrete base with a 6-inch embedment. The concrete base measured 4'-0"x6'-0" in plan and 18 inches thick. The load was applied as a distributed force along the top of the wall. A force-displacement graph was recorded for each wall test with recorded measurements at 0.1 seconds intervals. These graphs are displayed below in *Figure 8* on page 12.

For the wall test, a 10,000 pound jack and a displacement measurement tool were connected to a steel wide flange frame. *Figure 6* on the next page shows the loading apparatus at the top of the wall. *Figure 7* on the next page is a sketch of the setup needed to push the wall with labeling for each component part. The test setup included a variable length threaded rod, which was used because the two walls were constructed one foot apart, and parallel to one another. This allowed the mechanism to reach the respective walls when they were being tested. This test set-up allowed for rotation in all directions using an alignment shim. This shim was connected to a steel angle that had a 2x4 piece of timber on each face where it touched the wall. All of these precautions were taken so the wall was loaded evenly, and to avoid concentrated pressure points. The outside wall was tested first, and then the second, inner wall was tested, also shown in the image in *Figure 6*. This was done so that the walls could be constructed closer together due to limited space available in the testing area.

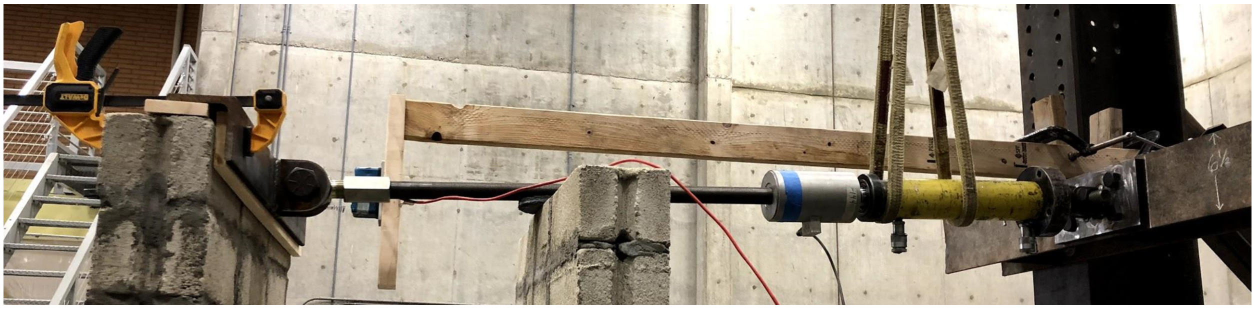

Figure 6: Imagine of Elevation View of Wall Testing Mechanism

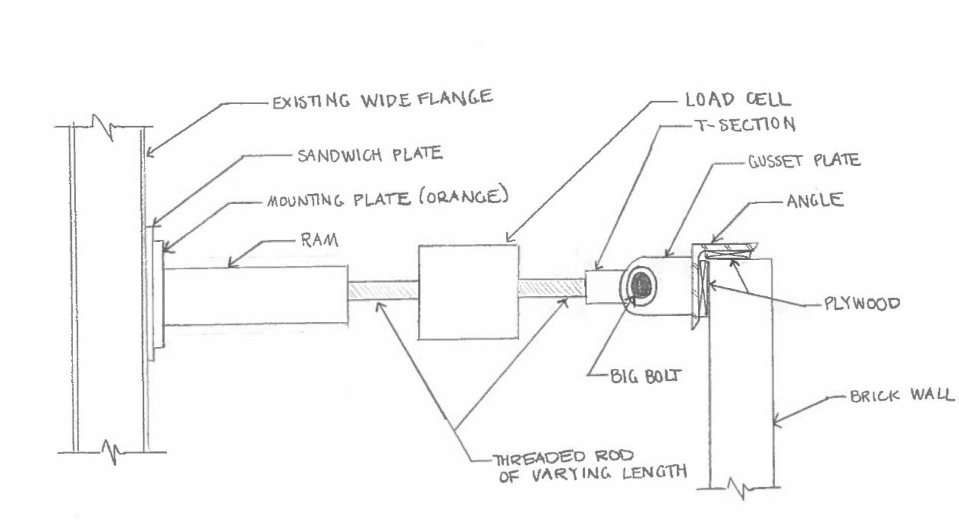

Figure 7: Sketch of Elevation View of Wall Testing Mechanism Setup

During testing, the applied force applied was recorded along with the horizontal displacement at the top of the wall. *Figure 8* shows the results of Wall 1 and Wall 2, as well as, the predicted force-displacement based on the tested material properties.

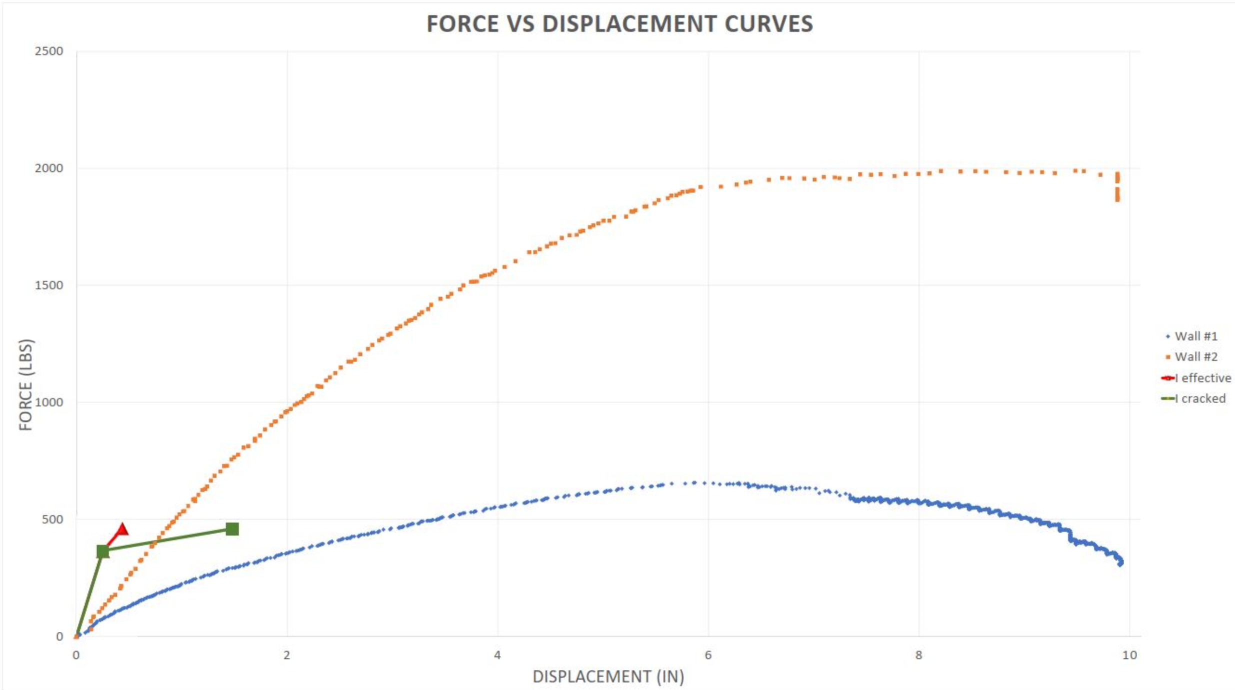

Figure 8: Force vs. Displacement for Wall Testing #1, #2 and Predicted Values

Interpretation of Data

Based on all the testing information, the bricks were found to be very brittle due to the lack of coarse aggregate, temperature conditions during mixing, and proportions used to make the mix. The wall testing showed that it failed in a ductile manner. It was expected that crushing would govern, but it seems as though the steel yielded first. As the wall was loaded some observations were made. Some of these included the separation of mortar joints. Since the load was applied at the top of the wall, the largest bending moment can be found at the base of the wall, it was expected the mortar to fail there, but it separated at the 2nd and 3rd courses first for both walls, as shown in *Figure 9*. The separation also showed poor bonding between the mortar and brick which could be caused due to the brick being mostly sand and a high water to cement ratio.

A big difference between the two walls was that the load capacity was much different with a maximum load for Wall 1 being about 600 lbs and Wall Two being about 1900 lbs as shown in *Figure 8*. This may have been due to the specific bricks used in each wall. Wall 1 consisted of bricks from one of the first batches, which was made in extreme heat conditions. The second wall consisted of 'better' bricks, and the construction process was more effective which could have helped. The difference between the wall strengths can be attributed to the difference in the making of the block batches. The first batches of blocks, which were used for Wall 1, cured at an accelerated rate due to lack of moisture, this issue was fixed during the second batch due to weather and the addition of the burlap sack.

The prediction for the wall strength, shown in *Figure 8*, was less than the tested capacity for the wall, and the calculated stiffness did not correlate with tests. The reason for the discrepancies was not determined. Additional studies should be conducted to better understand the out of plane capacity and wall stiffness. The calculations for the predicted loads and displacements were based on the results of the rebar stress-

strain test shown in *Figure 4*. Three points were used, the yielding strength (f_y), the plastic strength (f_{pl}), and the strength at a strain of 0.1 ($f_{0.1}$). While the load predictions remained the same, two sets of displacement values were calculated. One used an equation from the masonry code to calculate I_{eff}, and one used an assumption that $I_{eff} = I_{CR}$ once M_{CR} is surpassed. The equations and code references can be found in the calculations in Appendix B.

Figure 9: Mortar Joint Failure in Wall 1 Testing

Lessons Learned

Throughout this process, many lessons were learned. Since there was inexperience in the making of the brick and building of a wall, all while working with a new material, there were many unexpected obstacles that forced us to improvise during the experiment.

The small pieces of plywood where the wet blocks cured were reused once the brick was strong enough to be transferred to the ground. However, these rectangular pieces were beginning to warp from having a moist brick sit on them. This started to slightly affect the shape of the subsequent bricks as the curing surface was no longer flat. This defect changes the shape, and causes stress concentrations on the blocks during compression testing.

After the first batches of bricks, a professor suggested a cracking prevention was necessary by using a moist burlap sack to cover the curing bricks. This provides a humid environment for the bricks to cure in and reduced the water evaporation rate. This process was followed for the remaining batches of bricks; however, a regimented moistening schedule for the burlap may have provided stronger results.

The metal jig that formed the triangular groove on three sides was very sharp, and some of the bricks cracked down the middle at the groove. To fix this problem, the edges of the jig were rounded. In *Figure 10* below, the first image shows the original shape of the wedge in the block, the second image shows the triangle with the corner slightly rounded, and the third image shows what an ideal wedge curve would look like in order to minimize the stresses in the concrete.

On some days, the outdoor temperature was 104ºF while mixing concrete for the bricks, as a result, the mixture would begin to appear extremely dry, and it was sprayed with water periodically. The spinning concrete mixer would cause the mixture to dry and small spheres would begin to form. While spinning, the dried mixture would begin to form small to medium spherical clumps, these spheres would become larger rendering the mixture unsuitable for compacting blocks.

Finally, when constructing the wall, wetting the bricks allowed the mortar to bond to the bricks much better. Otherwise, the bricks absorbed the water from the mortar, and the mortar dried too soon, instead of bonding to the bricks.

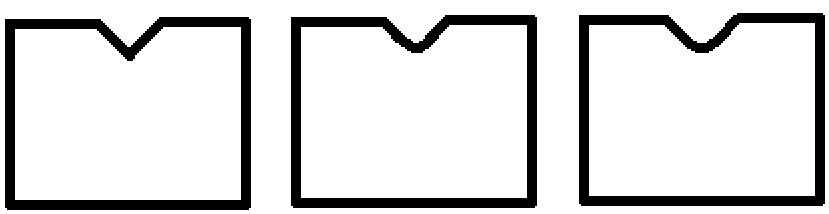

Figure 10: Rebar wedges in the bricks

Next Steps

As this project progressed, the group learned many things. The "Next Steps" section is intended to identify the most useful avenues to pursue in furthering this project. The best next steps are:

- Construct a lot more bricks
    - The bricks are used to construct the wall, but also for individual compression tests and then some bricks may crack and cannot be used for testing.
    - A waste factor should also be calculated on how much volume of the mix is lost to the mixer, the press and just the transportation or human error.
- Compressive strength tests at 14, 28, 35 and 44/56 days
    - This is to show the curing process of the bricks and when they gain their maximum strength. This is important to know how soon the bricks can be used in construction after they are made
- Construct a couple of walls with an architectural feature for out-of-plane
    - This feature could be a brick pattern or an opening. This will be important because it will occur in the final structure. Windows are necessary and a pattern makes the entire design more interesting. An architectural pattern might require the brick size to be changed to allow for tolerance within the mortar joint. If this change is made, planning and communication would help the brick makers in Tanzania understand what revisions to the manufacturing process are required.
- Reinforcement bond test
    - The testing for this idea would be a little difficult in that it would require the brick to be bolted or fixed to something and have a piece of rebar embedded between the bricks that can then be pulled out. This test would show what is the required development length so that the rebar can reach full capacity or yield before separating for the system.
- Absorption test
    - This would be used to see how the bricks hold up against weathering and whether additional steps need to be addressed in the construction of a wall to be used outdoors.
- In-Plane wall test
    - This would only be required if the walls in the project will be used as a structural element or load bearing. As of now, the walls will be just standing 'alone' with no additional loading other than its own weight.

Acknowledgments

As a group we extend a special thanks to the many people involved in this project. Those included are Kevin Dong who gave us the opportunity to work on this project and then very patiently watch us get through making bricks, testing and correct all our mistakes along the way. There are also those who helped in constructing the bricks during the hottest time of the year; John Dato on multiple occasions, Chris Martinez and Enrico Alvaro. There was also the shop technician that this entire project would have been impossible without, Vince Pauschek. Enrico Alvaro also helped with the initial testing mechanism setup and was an assistant to Vince. Thank you again to those listed below:

Kevin Dong

Vince Pauschek

John Dato

Enrico Alvaro

Chris Martinez

Contact Information

Those working on this project are listed below with names and emails if any clarification is needed in regards to the Tanzania Block Testing Report.

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Appendix A - Images

Figure 11: The brick formwork from Spring 2017. This photograph was taken mid-pour, since one batch of concrete filled one wooden formwork.

Figure 12: The brick formwork from Spring 2017. This photograph was taken after two out of four batches were completed. Afterwards, the team had to wait for the concrete to be dry enough for the formwork to be taken apart.

Appendix B - Calculations

[Sections of the code referenced on right margin of calculations]

Wall Force-Displacement Prediction

A_s	=	2×0.11 in.^{2}	=	0.220 in.^{2}
b	=	36 in.		
d	=	3 in.		
h	=	6 in.		
H	=	6 ft.		
E_s	=	29,000,000 psi		
y_t	=	$h/2$	=	3 in.
f_y	=	49,636 psi		
f_{pl}	=	50,545 psi		
$f_{0.1}$	=	70,636 psi		
f'_m	=	311 psi		
f_r	=	133 psi		[2013 Building Code Requirements and Specification for Masonry Structures - Table 9.1.9.2 - Modulus of rupture]
E_m	=	$900 f'_m$	=	279,900 psi
n	=	E_s / E_m	=	103.608
a_y	=	$\frac{A_s f_y}{0.80 f'_m b}$	=	1.219 in.
c_y	=	$\frac{A_s f_y}{0.64 f'_m b}$	=	1.524 in.
a_{pl}	=	$\frac{A_s f_{pl}}{0.80 f'_m b}$	=	1.242 in.
c_{pl}	=	$\frac{A_s f_{pl}}{0.64 f'_m b}$	=	1.552 in.
$a_{0.1}$	=	$\frac{A_s f_{0.1}}{0.80 f'_m b}$	=	1.735 in.
$c_{0.1}$	=	$\frac{A_s f_{0.1}}{0.64 f'_m b}$	=	2.169 in.
ρ	=	$\frac{A_s}{bd}$	=	0.00204
A_{sMIN}	=	$\frac{3\sqrt{f'_m}}{f_y} bd$	=	0.115 in.^{2}
ρ_{MIN}	=	$\frac{A_{sMIN}}{bd}$	=	0.00107
I_g	=	$\frac{bh^3}{12}$	=	648 in.^{4}
I_{CRy}	=	$nA_s(d-c_y)^2 + \frac{bc_y^3}{3}$	=	92.133 in.^{4}
I_{CRpl}	=	$nA_s(d-c_{pl})^2 + \frac{bc_{pl}^3}{3}$	=	92.649 in.^{4}
$I_{CR0.1}$	=	$nA_s(d-c_{0.1})^2 + \frac{bc_{0.1}^3}{3}$	=	138.157 in.^{4}

$$M_{CR} = \frac{f_r I_g}{y_t} = 28{,}728 \text{ lb-in.} = 2{,}394 \text{ lb-ft.}$$

$$M_{ny} = (A_s f_y)\left(d - \frac{a_y}{2}\right) = 26{,}103 \text{ lb-in.} = 2{,}175 \text{ lb-ft.}$$

$$M_{npl} = (A_s f_{pl})\left(d - \frac{a_{pl}}{2}\right) = 26{,}457 \text{ lb-in.} = 2{,}205 \text{ lb-ft.}$$

$$M_{n0.1} = (A_s f_{0.1})\left(d - \frac{a_{0.1}}{2}\right) = 33{,}139 \text{ lb-in.} = 2{,}762 \text{ lb-ft.}$$

$$\frac{M_{CR}}{M_{ny}} = 1.101 \rightarrow 1.000$$

$$\frac{M_{CR}}{M_{npl}} = 1.086 \rightarrow 1.000$$

$$\frac{M_{CR}}{M_{n0.1}} = 0.867 \rightarrow 0.867$$

If >1.0, use 1.0 as I_{eff} cannot be greater than I_g.

$$I_{effy} = \left(\frac{M_{CR}}{M_{ny}}\right) I_g + \left[1 - \left(\frac{M_{CR}}{M_{ny}}\right)^3\right] I_{CRy} = 648.000 \text{ in.}^4$$

$$I_{effpl} = \left(\frac{M_{CR}}{M_{npl}}\right) I_g + \left[1 - \left(\frac{M_{CR}}{M_{npl}}\right)^3\right] I_{CRpl} = 648.000 \text{ in.}^4$$

$$I_{eff0.1} = \left(\frac{M_{CR}}{M_{n0.1}}\right) I_g + \left[1 - \left(\frac{M_{CR}}{M_{n0.1}}\right)^3\right] I_{CR0.1} = 470.304 \text{ in.}^4$$

[2013 Building Code Requirements and Specification for Masonry Structures - 5.2.1.4.2]

$$F_{CR} = \frac{M_{CR}}{H} = 399 \text{ lb}$$

$$F_{ny} = \frac{M_{ny}}{H} = 363 \text{ lb}$$

$$F_{npl} = \frac{M_{npl}}{H} = 367 \text{ lb}$$

$$F_{n0.1} = \frac{M_{n0.1}}{H} = 460 \text{ lb}$$

$$\delta_y = \frac{F_{ny} H^3}{3 E_m I_{effy}} = 0.2487 \text{ in.}$$

$$\delta_{pl} = \frac{F_{npl} H^3}{3 E_m I_{effpl}} = 0.2521 \text{ in.}$$

$$\delta_{0.1} = \frac{F_{n0.1} H^3}{3 E_m I_{eff0.1}} = 0.4350 \text{ in.}$$

$$\delta_y = \frac{F_{ny} H^3}{3 E_m I_g} = 0.2487 \text{ in.}$$

$$\delta_{pl} = \frac{F_{npl} H^3}{3 E_m I_g} = 0.2521 \text{ in.}$$

$$\delta_{0.1} = \frac{F_{n0.1} H^3}{3 E_m I_{CR0.1}} = 1.4808 \text{ in.}$$

$I_{eff} = I_{CR}$; $M_u > M_{CR}$
[2012 Design of Reinforced Masonry Structures - 3.9.6]

Coordinates

Using I_{eff}	Using I_{CR}
(0, 0)	(0, 0)
(0.2487, 363)	(0.2487, 363)
(0.2521, 367)	(0.2521, 367)
(0.4350, 460)	(1.4808, 460)

Works Cited

Girard, Jeff. “The Role of Aggregate in Concrete Countertop Mix Formulas.” *The Concrete Countertop Institute*, 30 Mar. 2011, www.concretecountertopinstitute.com/blog/2011/03/the-role-of-aggregate-in-concrete-countertop-mix-formulas/.

Tanzania Brick Making Guide

First, get the correct proportions and weights of materials needed for the batch. Each batch will make 10-11 bricks. The mixture content for one mix is below. Put all the materials (sand, cement and water) into buckets for ease in mixing process. Make sure when weighting the material that the bucket weight is not included.

Material	Weight per mix
	lbs
Sand	280
Cement	23
Water	28.4

Second, the mixing process is described below:

Put into the large mixer out in the yard

a. Put half of sand and cement in
b. Spin
c. Slowly pour half of water in while it spins
d. Mix for about a minute
e. Stop
f. Put the rest of the sand and cement in
g. Spin
h. Slowly put the rest of the water in while it spins
i. Let mix for about 5 minutes
j. Stop occasionally to scrape off sides and crevices where sand and cement get stuck to the walls of the mixer

Lastly, follow the step by step pictures on how to work the brick press. When done with the press make sure to clean it as well as possible (water and scrub brushes), this is concrete so if some is left the machine will stop moving after the concrete has cured.

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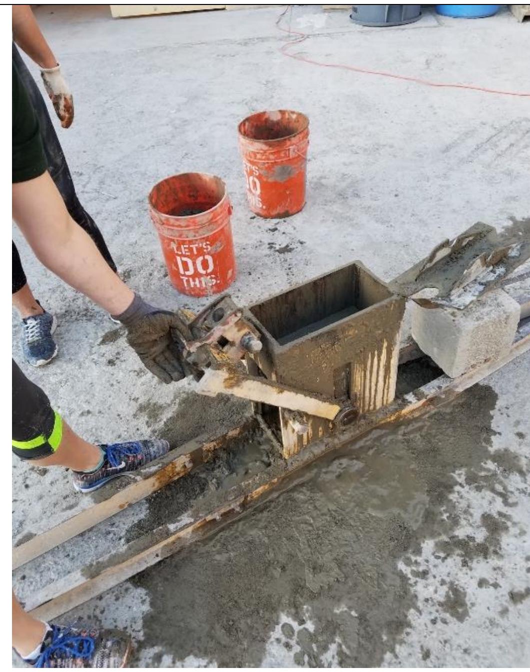
<td>
</td>
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<tr>
<td>Step 1: Mechanism setup
A large crowbar will help with leverage underneath the mechanism (there is a bar to where the pushing can be done) supported on a brick for larger movements</td>
<td>Step 2: Check mechanism movement
Make sure it moves all the way up and down smoothly. If not a little WD40 on the moving parts and around edges of the sliding plate inside</td>
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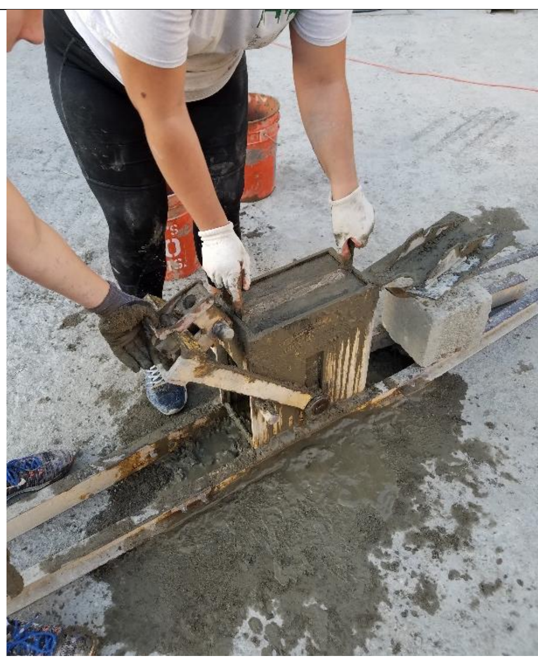
<td></td>
<td>
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<tr>
<td>Step 3: Groove form in mechanism</td>
<td>Step 4: Mechanism setup with grooves
Mechanism must be all the way down to allow lid to slide over the top</td>
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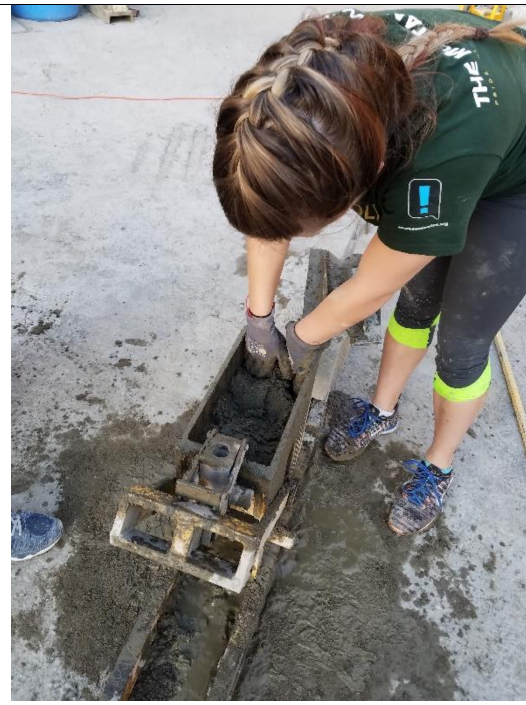
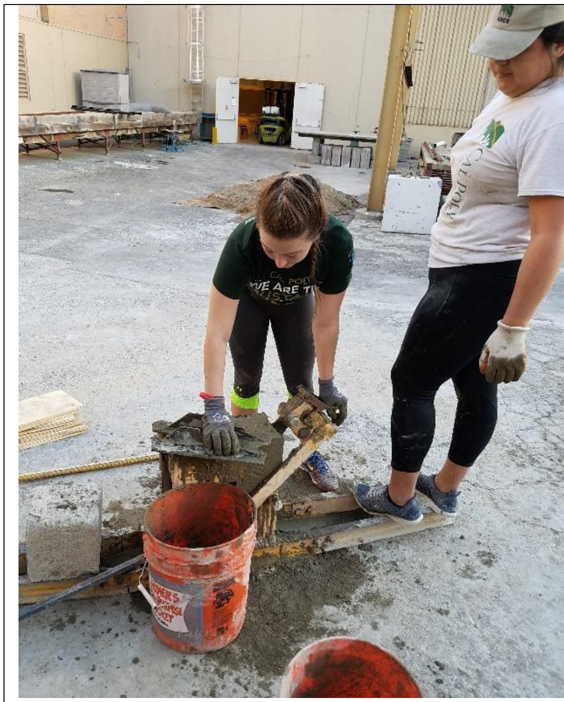
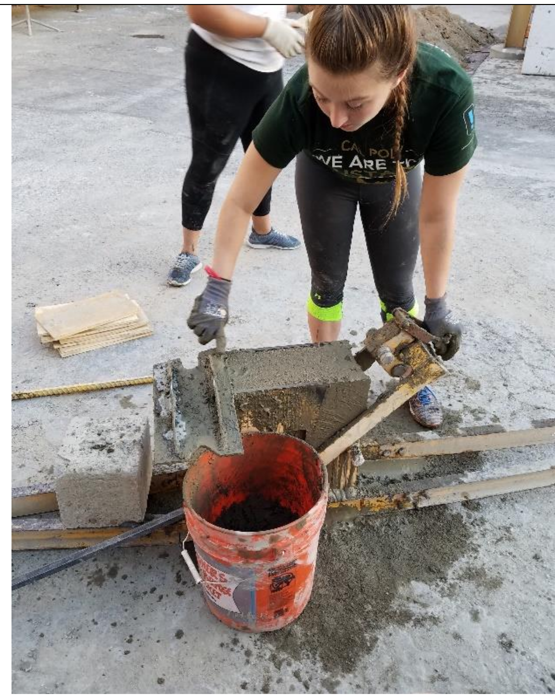
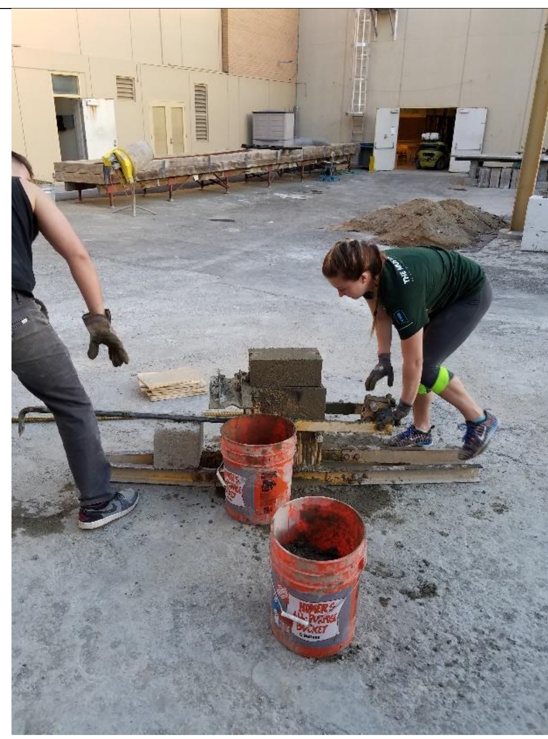
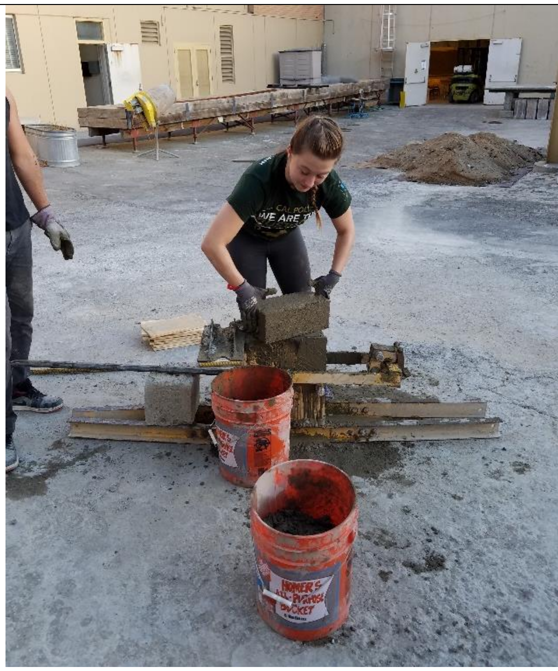
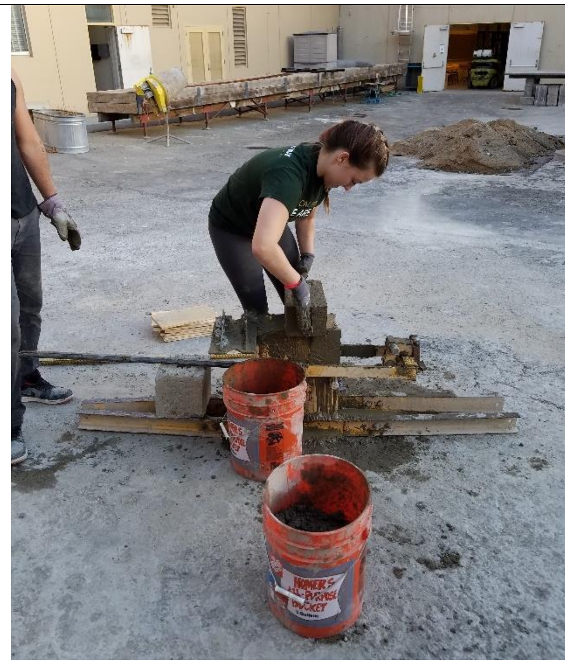
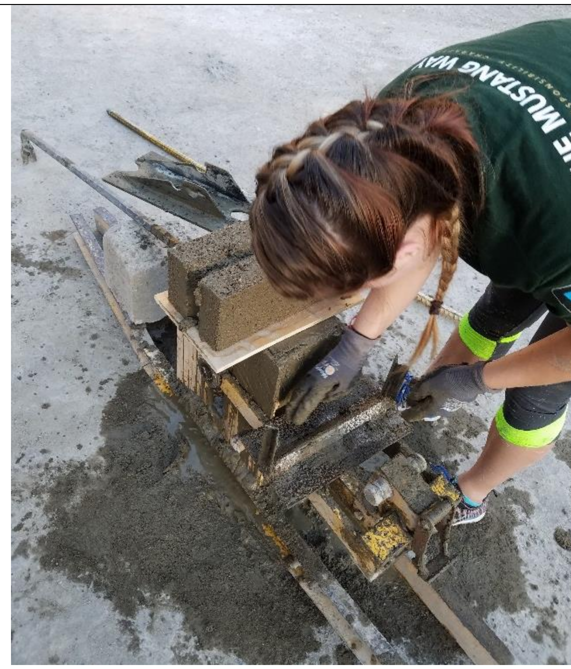
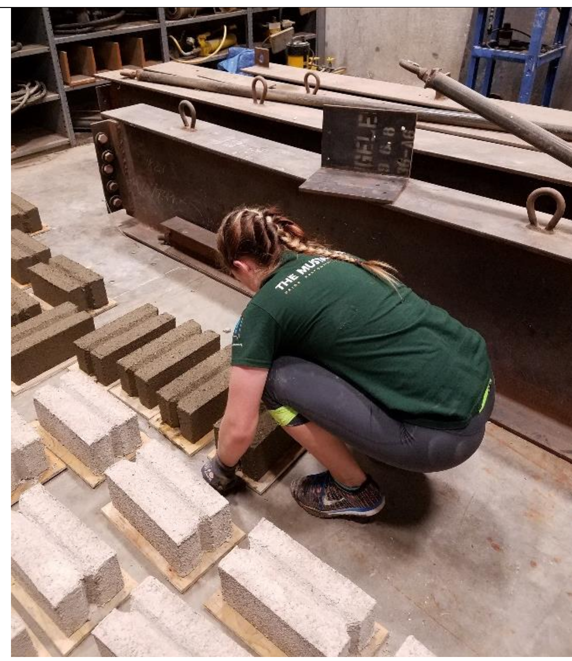
	
Step 5: *Mix poured in mechanism with bucket*	**Step 6:** *Mix compacted by hand per half layer*
	
Step 7: *Mechanism full of mix* Make sure it is more than full, over the top a little so the next step can be done.	**Step 8:** *Moving lid across top of block* This a ‘screeting’ process, so save the excess.

	
Step 9: *Removing excess mix*	**Step 10:** *Compressing block* The moveable bar will now be placed in the slots on the lid, then the rebar can be placed in the hole for compression.
	
Step 11: *Human weight compression* Two people must stand on the other side, otherwise it will start to lift.	**Step 12:** *Tamping Block compaction* Almost pumping the brick. Water will be seem oozing out the top sides of the mechanism.

	
Step 13: *Remove lid after compression*	**Step 14:** *Align lid to avoid indentations*
	
Step 15: *Pushing down on mechanism* Do this slowly, otherwise the brick may start to fall apart. Also this is where the crowbar comes in for leverage to help lift the brick up.	**Step 16:** *Block lifted out of mechanism* Make sure the mechanism is all the way up, so the brick can be twisted without getting caught.

	
Step 17: *Move block perpendicular* Putting fingers along the steel grooves and twisting the brick 90 degrees.	**Step 18:** *Block moved perpendicular* This is to be able to flip the brick over completely to remove the steel U piece.
	
Step 19: *Place plywood base on top block* Make sure wood is not warped. A layer of some sealent may be good on the wood so the moisture from the brick isn't absorbed.	**Step 20:** *Hand Placement prep for block flip* Hands top and bottom of the brick (one on the wood, the other on the steel plate)

	
Step 21: *Block flip* Tricky process, make sure the two people are in sync. If the brick is too dry it may fall apart in this process, if so.. just start over	**Step 22:** *Flip successful* CAREFUL
	
Step 23: *Place block and base down*	**Step 24:** *Pulling v-shaped groove off* Put fingers in the grooves, and lift off plate as parallel to the brick and uniform pressure as possible. Since the brick is wet there will be suction, try releasing this without sudden movement.

	
Step 25: *V-shape groove out*	**Step 26:** *Repairing imperfections*
	
Step 27: *Transport* Carefully	**Step 28:** *Curing* When all bricks are done for the day, putting a wet burlap sac careful over the top of them will help to slow the curing process and help against cracking (especially when the temperature gets hot)