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Affordable Solutions to Pit Latrine Collapse

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the Collaboratory for strategic partnerships and applied research

Outline of Presentation

- Background
- Design Specifications
- Designs
  - Sandbags
  - Rebar-reinforced fabric
  - Ferro-cement
- Future Work

Our Vision

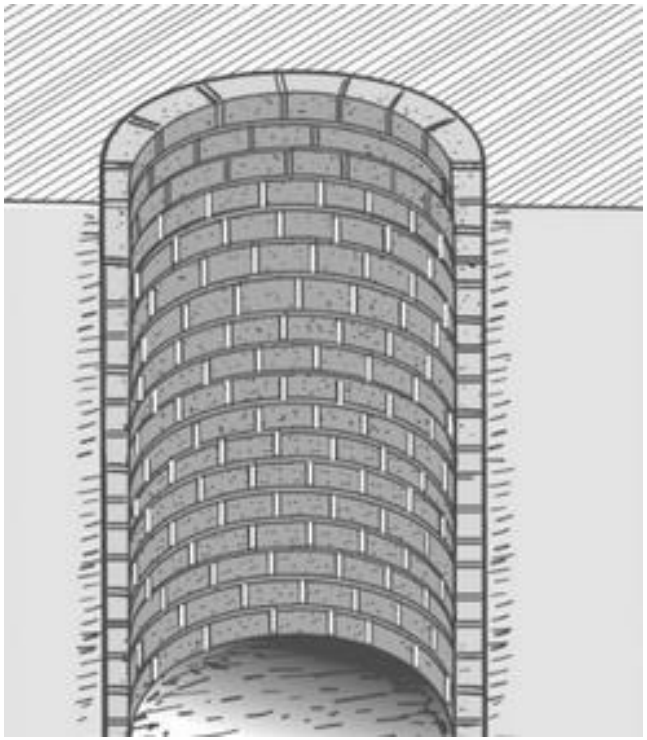
We believe all should have access to safe and proper sanitation, that as Christians we are called to serve those in need with our God given talents and that we have the right engineering skills to positively contribute to this need.

Background

- Pit latrines are holes dug in the ground that provide a means for people to relieve themselves
- They are common in developing countries where indoor plumbing does not exist

Problem

- Developing countries use pit latrines for sanitation
- Expensive to line pits
- Unlined pits can collapse
- Leads to fear in using them
- Increases open defecation
- Causes health concerns



Cavanna, Debus and Nikiema, 2011

Location, Client, and Need

World Vision®

Need: affordable liners that will resist soil pressures

Previous Work

- Designed liners and conducted on-campus testing
- Site trip to Ghana (Nadigri):
  - Conducted testing
  - Connected with the community
  - Gathered feedback
  - Studied failed latrines
  - Learned what materials are local
  - Met with local government and organizations

Design Specifications

- Inexpensive (less than $40)
- Resistant to soil pressures
- Uses locally available materials
- Allows liquids to escape
- Materials resist decomposition
- Environmentally safe
- Easy to construct and install
- Accommodates a family of ~7 for 3-5 years

Designs

- Sandbags
- Rebar-reinforced fabric
- Ferro-cement

Sandbag

http://www.stormtec.net/buy/

Chicken wire

http://www.homedepot.com/

Rebar

https://www.cmcconstructionservices.com/rebar-6173

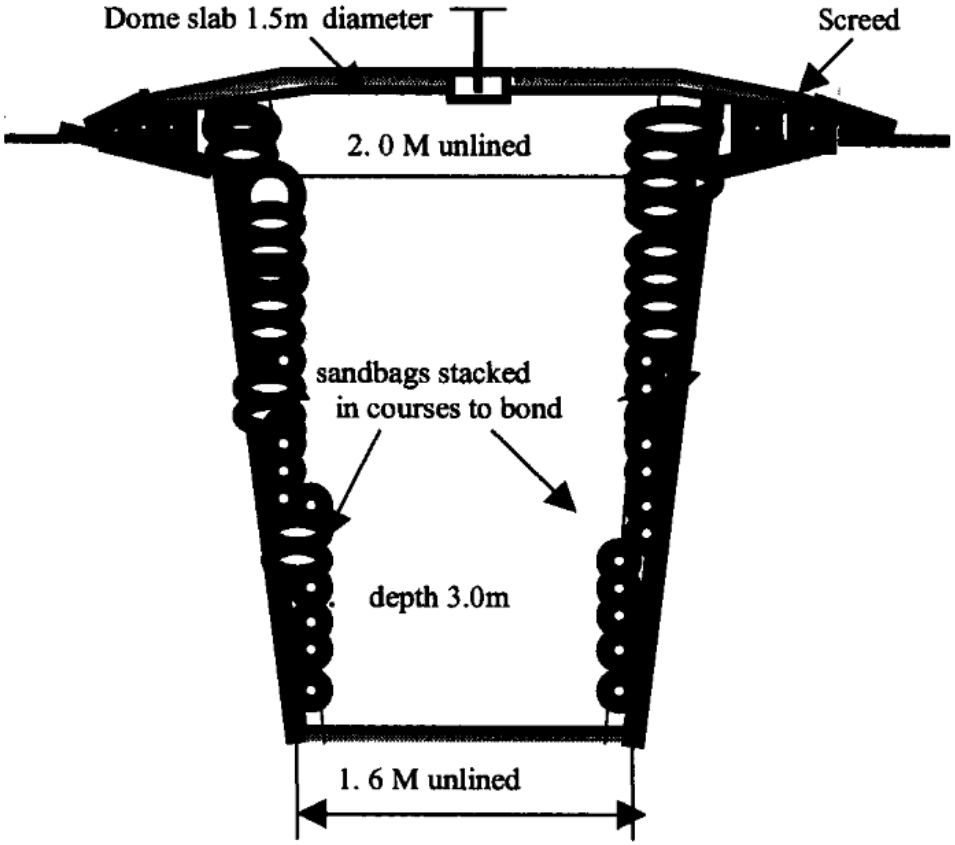
Cement

http://www.homedepot.com/

Sandbags

Sandbags

- Research indicated resistance to soil pressure
  - 800 liners tested; no pits collapsed
- Cost: $40 per latrine



(Barasa 2000)

Sandbags

PROS

- Affordable
- Locally available
- Resistant to soil pressures
- Simple design/assembly
- Allows liquids to escape

CONS

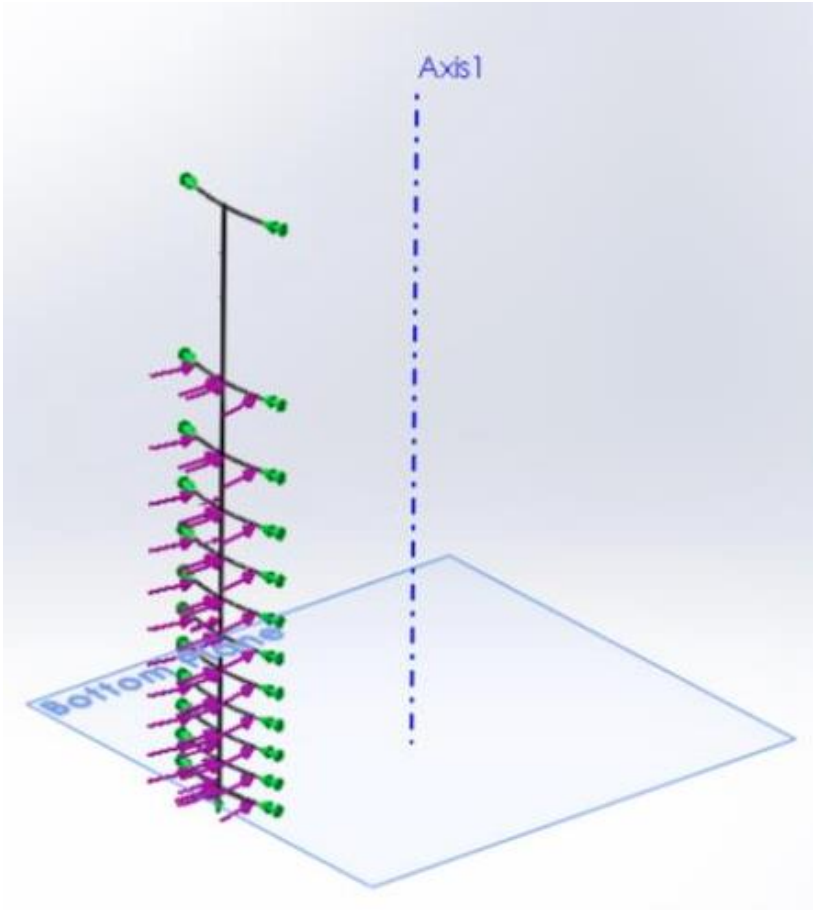
- Very labor intensive
- Plastic remains in soil

Rebar-reinforced fabric

PROS

- Locally available materials
- Allows liquids to escape
- Materials resist decomposition
- Environmentally safe
- Inexpensive
- Resistant to soil pressures

Rebar-reinforced fabric



11.5 mm Rebar

- 6 rings, 10 stakes
- 5 bars needed
- Total cost of frame = $32

7 mm Rebar

- 12 rings, 15 stakes
- 9 bars needed
- Total cost of frame = $18

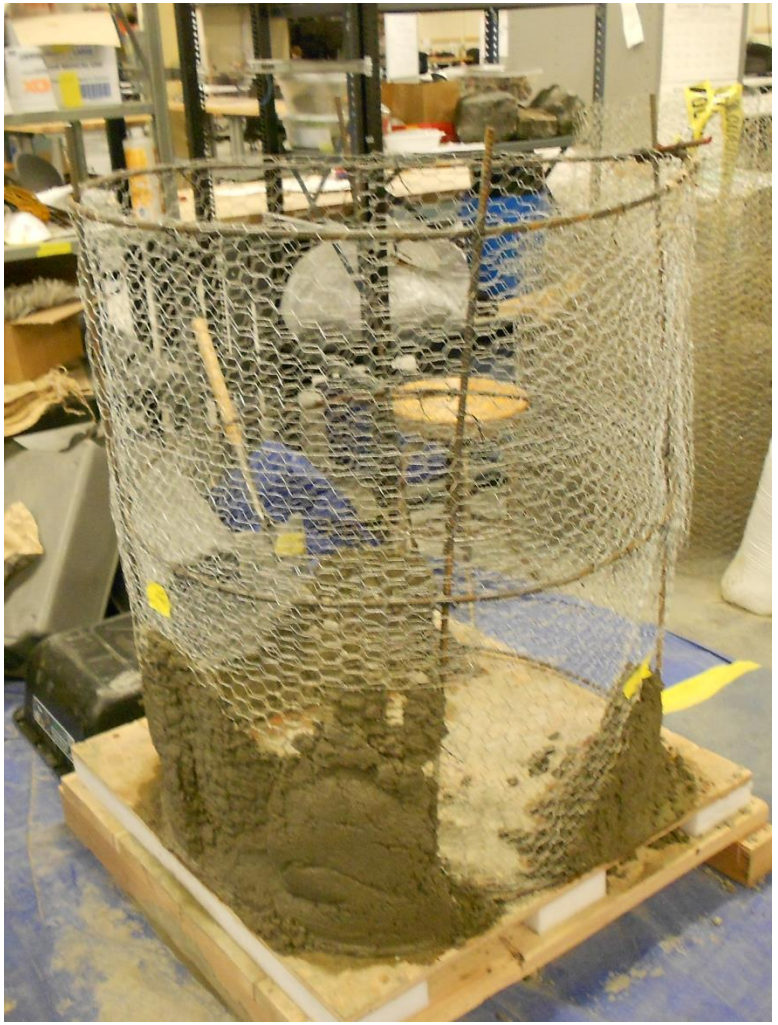
- Fabric will be an additional $5-$17 per liner

Rebar-reinforced fabric

- Full liner costs between $26 to $40 depending on combination of materials

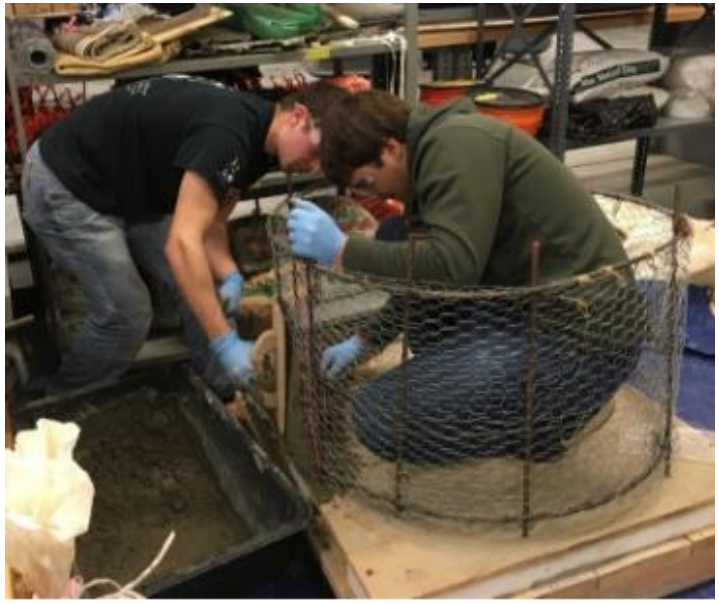
Ferro-cement

- Uses similar frame as rebar-reinforced design
- Instead of fabric, cement is used



Two Methods of Application

Direct



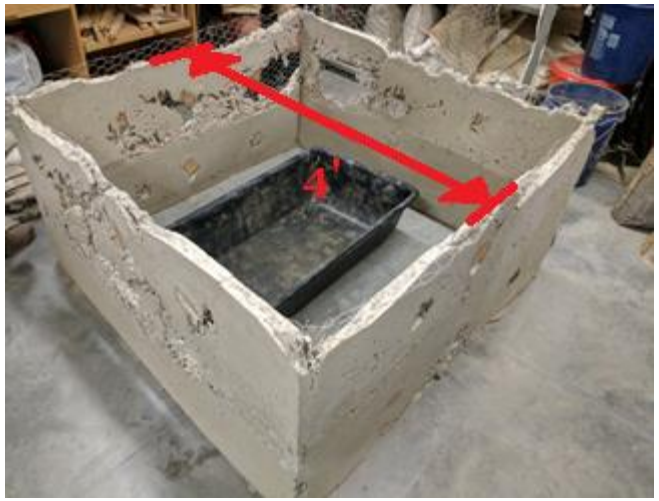
Cast in mold

Problems

- Last year:
  - Wrong sand to cement ratio
- This year:
  - 3:1, 4:1, and 2.5:1 sand to cement ratios were found to be most common
  - 3:1 was easiest to apply using direct application method

Cast In Mold Method

- Cast in mold method was tested due to its easy application of cement to liner and reduced amount of chicken wire
- Small and large scale models were built



Ferro-cement

PROS

- Locally available materials
- Inexpensive

CONS

- Difficult to construct
- Unknown Strength

Conclusions

- Decisions:
  - Sandbag, Rebar-reinforced fabric, and Ferro-cement liners will be considered as viable liner designs
- Future Work:
  - Further testing of all three needs to be done
    - On Messiah's campus
    - In Ghana in January of 2018

Acknowledgements

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Questions?