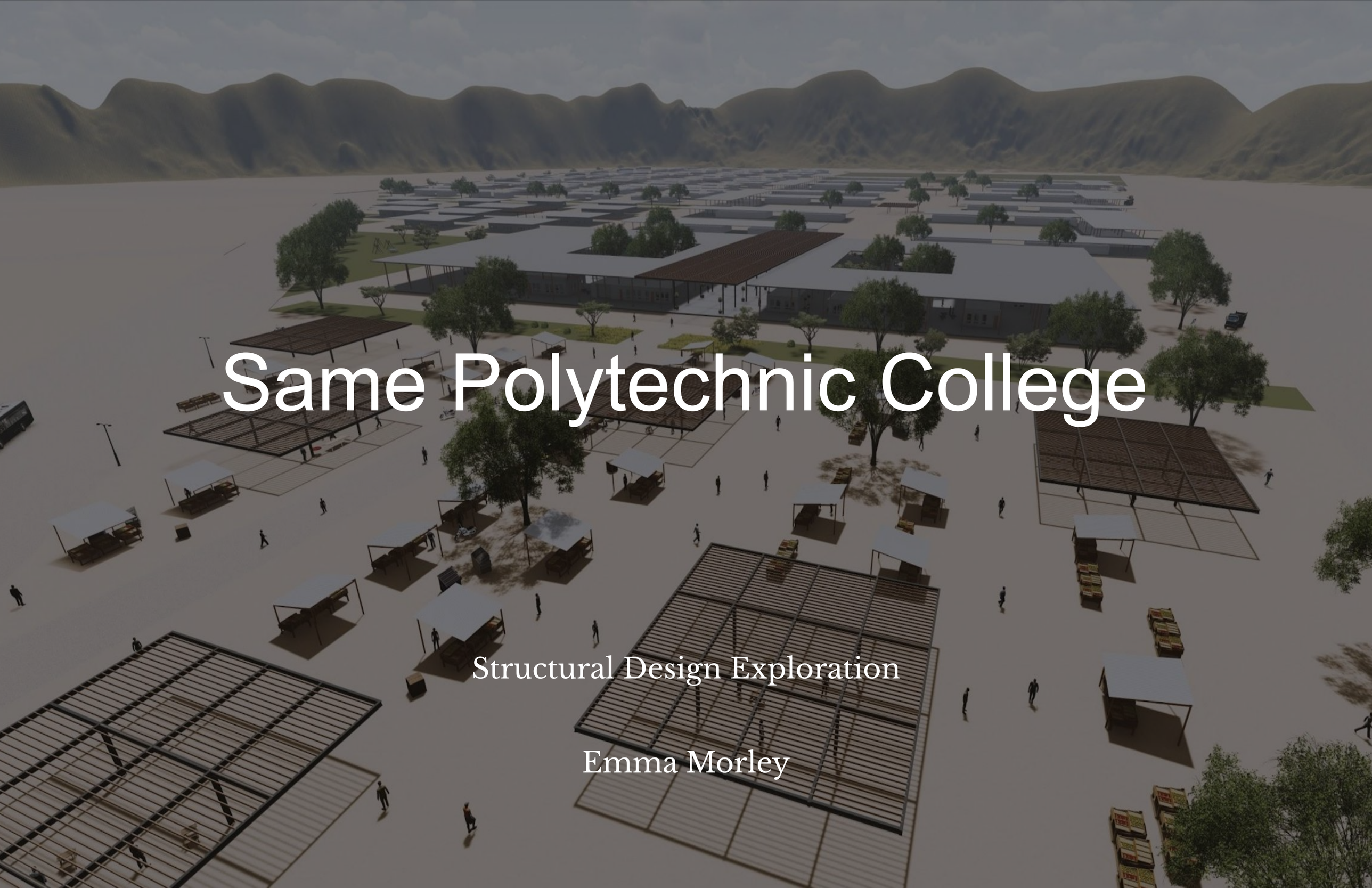

Same Polytechnic College

Structural Design Exploration

Emma Morley

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Narrative

The Same Polytechnic College is a response to a lack of vocational training and higher learning opportunities for residents of Same, Tanzania and surrounding areas. The College will address the region's need for skilled farmers, builders, teachers, and entrepreneurs by providing a pathway from secondary school graduation to continued education. This will generate a framework that strengthens the East African economy by supplying the region with educated professionals that make impactful contributions to society.

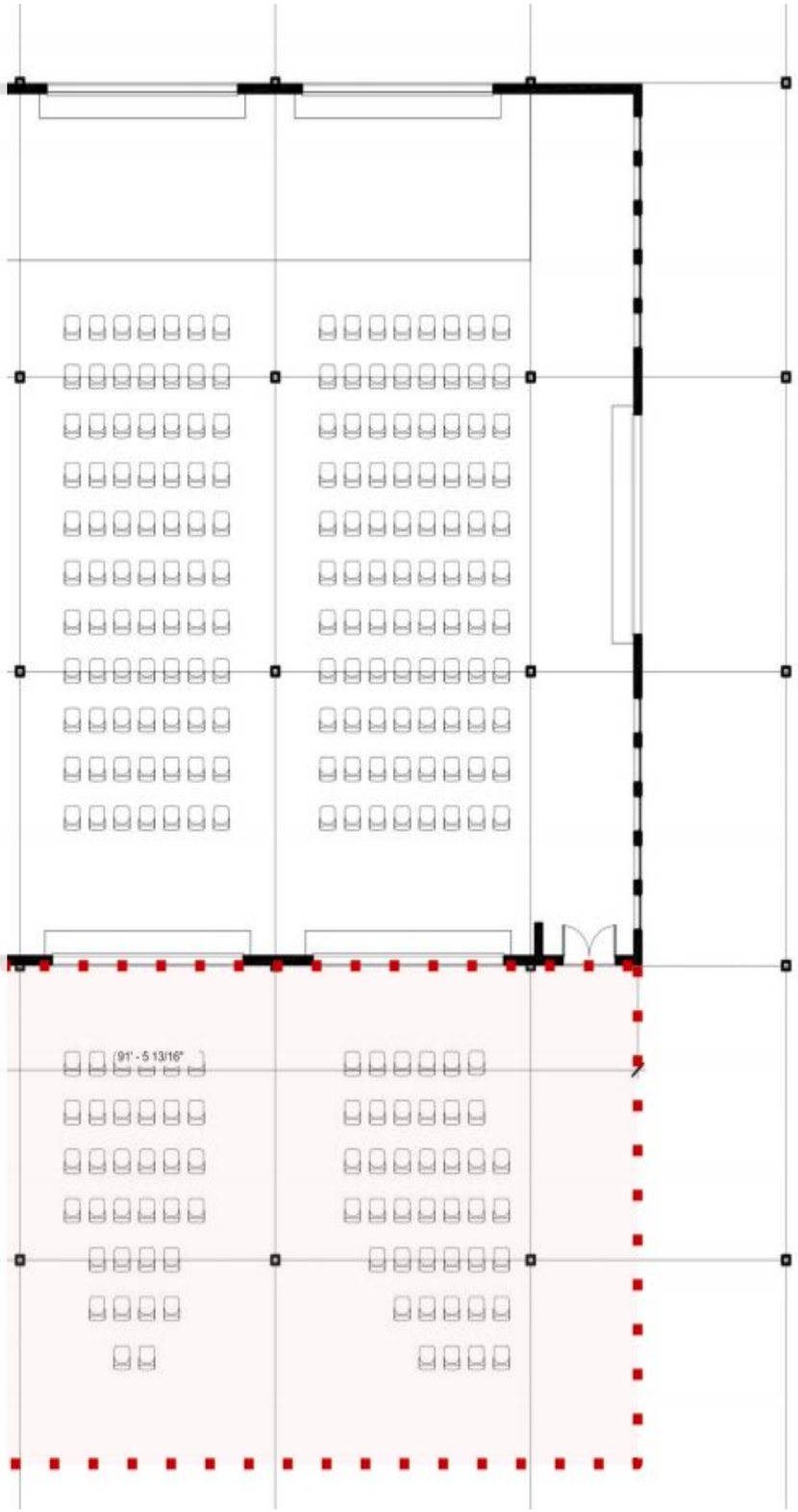
Construction will occur following a five-phase development plan, and the buildings will utilize simple but effective architectural techniques and modular structural design. These solutions are low-cost by nature, and will function as an inspiration for new local buildings.

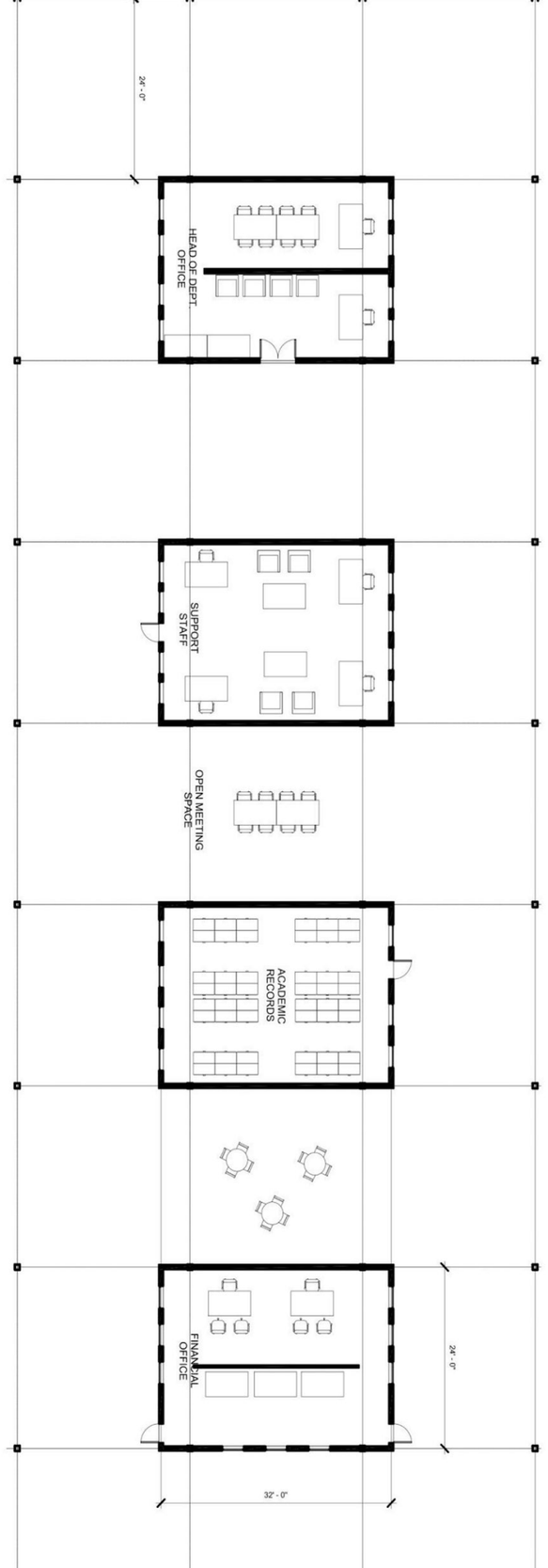
After travelling to Same in August of 2017 to complete an initial site visit with preliminary construction, students participated in a design lab to create an architectural design for Phase I - Classroom and Housing Modules. The preliminary structural design explores the different structural options in order to provide an initial cost estimate.

Project Description

Phase I covers the construction of the first classroom and student housing buildings. This phase will also be used to get a feel for the cost and construction of the following four phases. The two building designations follow a similar design principle: a masonry substructure that is unattached from a steel or timber superstructure.

By leaving the superstructure unattached from the substructure, two sustainable design goals are accomplished. First, the design remains simple by eliminating technical connections between the different materials and building heights. Second, local materials, such as masonry blocks, can be employed despite the typically low strengths they provide. Both of these points allow the local community to easily provide the necessary maintenance for the buildings over time.





Design Constraints

Cost and Maintenance

Swahili does not have a word for maintenance; therefore, in order for the buildings to be sustainable, simplicity in construction is important. While modular construction helps reduce cost because the buildings are repeatable, simplicity in design allows for local engineers and contractors to easily replace features of the buildings over time.

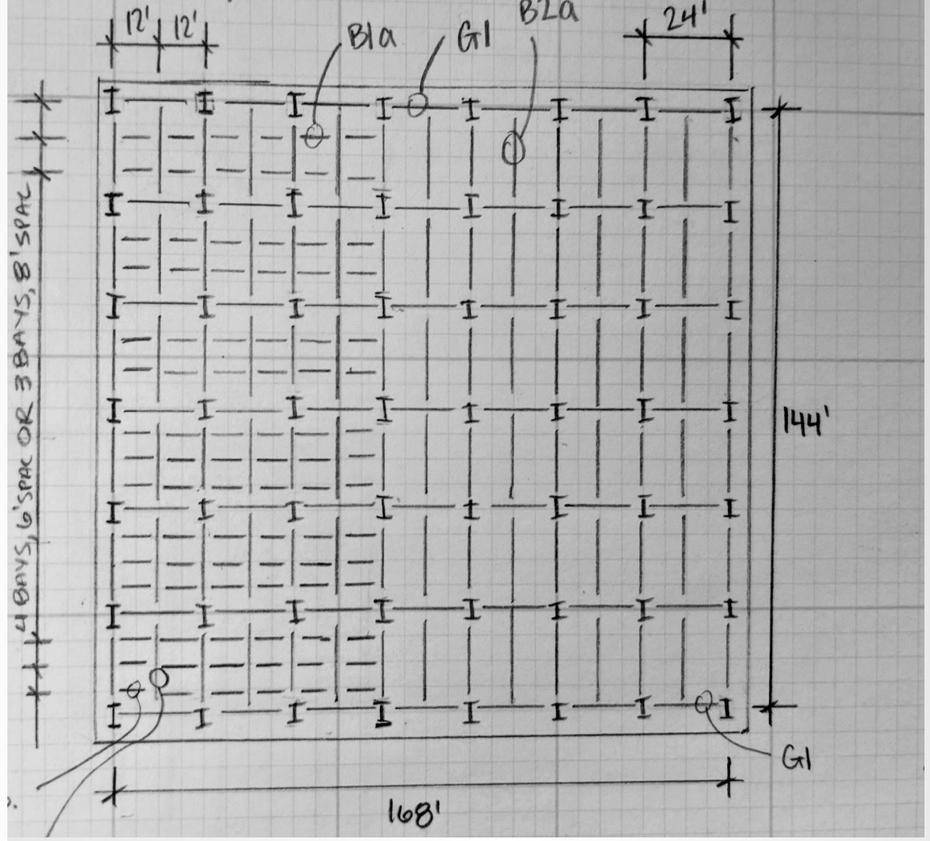
Material Availability

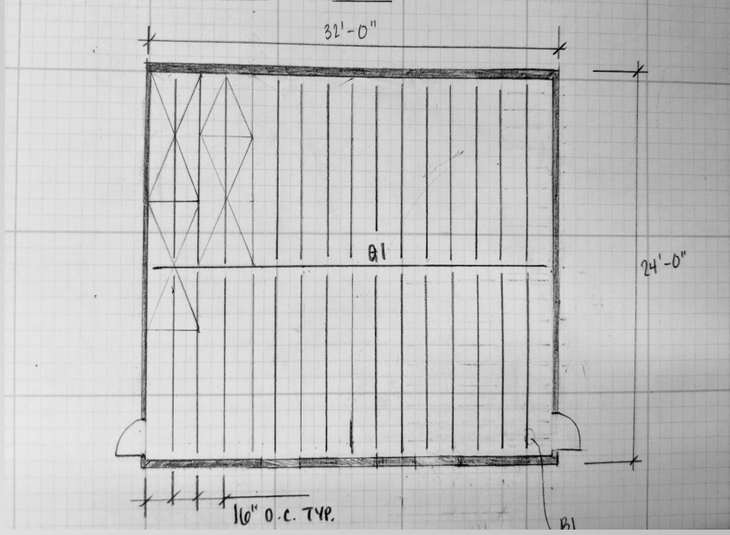
Softwood timbers that are commonly used for construction in the U.S. are not available in Same - the commonly used timber is eucalyptus. Using testing data and ASTM standards to accurately predict the strength, the design has been completed using sweetgum, which has similar properties to eucalyptus.

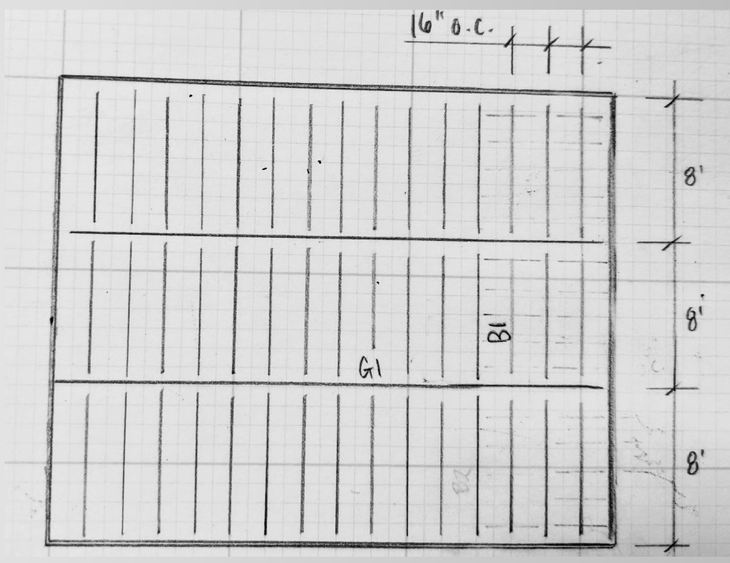
The masonry blocks used in Same are made by a local mason using a mixture of sand and water. The design utilizes these blocks, which have a low compressive strength similar to bricks.

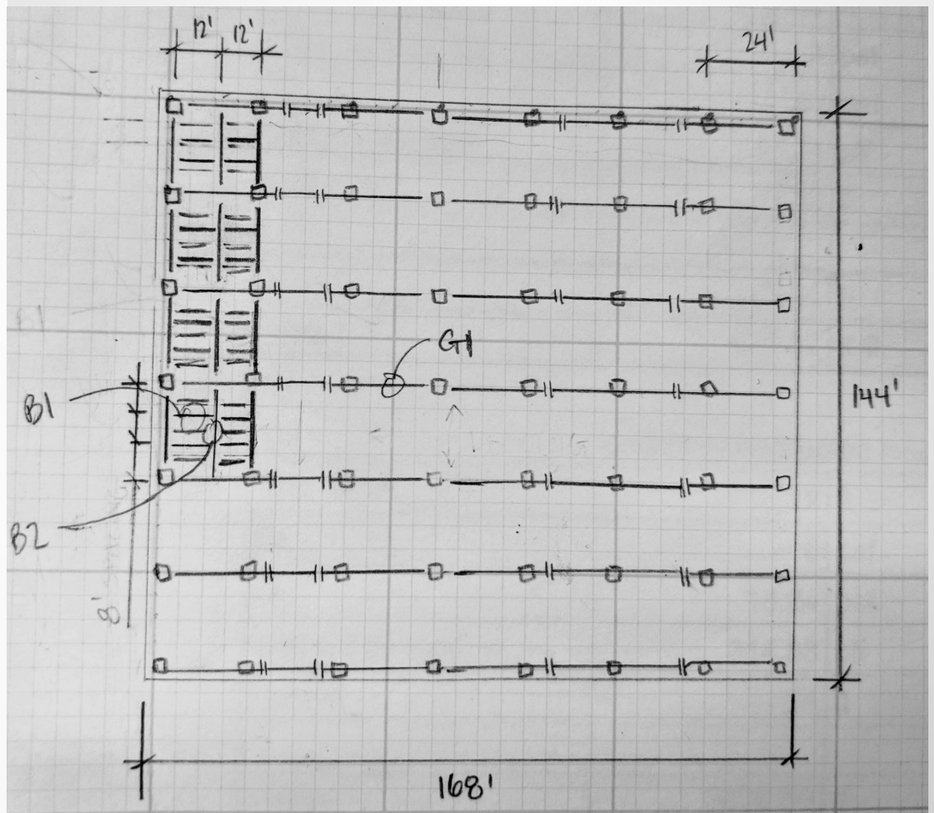
Constructability

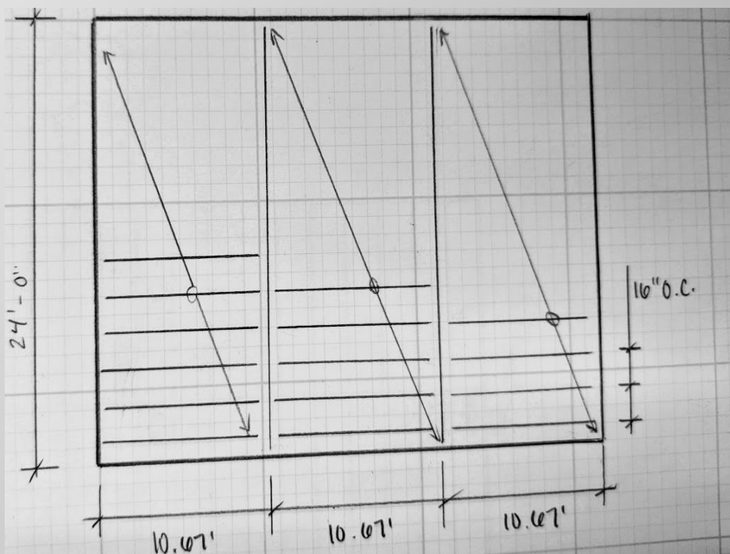
There is a lack of construction materials in Same; many must be ordered from Dar Es Salaam. The steel and timber sizes, rebar sizes, and connections must be kept simple. Because the design is modular, once one building is constructed, the other buildings will be easier.











Design Summary

To provide the most cost-effective and constructable solution, a timber truss system or steel framing should be utilized. Building trusses would use more labor, which may be more cost effective due to low labor costs. Smaller members would be used for the truss compared to the hinged girders, making the materials cheaper.

If Glu-Lam beams are available in the area, it may be more efficient to use this option, however, it should be considered that it is easier to replace a truss system than a Glu-lam beam, since a truss system can be built by hand while a Glu-lam beam would have to be ordered from a nearby city.

Steel framing may be more expensive due to local availability, and shipping costs may increase the price. Additionally, it may be difficult to find a skilled welder for the steel connections. However, steel would have the longest lifespan of the materials, so less maintenance would be needed.

Next Steps

For the full structural design, a few more aspects should be considered. The preliminary design does not include openings for the courtyard spaces. It also does not consider openings in the masonry substructures. Connections should also be further studied based on availability of hardware in the field.

Appendix

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