Architectural Design Guide

EMI EAST AFRICA

This document provides an introductory design guide for architects undertaking work in East Africa. The aim is to provide a basic overview of construction techniques that will assist an architect designing in an unfamiliar environment. It is not a comprehensive design guide for every situation. The recommended approach is to observe the site surroundings, evaluate what has been built before, identify site-specific constraints and to discuss these with the EMI project leader and host ministry.

1. Contents

2. Codes and Standards available at EMI EA

Country	Code or Standard	Date
Uganda	Building Control Regulations*	July 2005
Uganda	Standard Specifications for Building Works	July 2005
Uganda	A Handbook for Earthquake Resistant Construction and Seismic Safety	Nov 2003
Uganda	Standard Seismic Code of practice for Structural Designs	June 2003
Uganda	Ministry of Health Guidelines for Private Practice for Registered Nurses and Allied Health Professionals	May 2002
Uganda	Schools Facilities Grant (SFG) for Primary Schools; Technical Handbook for District and Urban Councils	Aug 2000
Rwanda	Kigali Master Plan Guide	Nov 2007
Rwanda	City of Kigali Building Code Final Draft	Aug 2007
Rwanda	Environmental Assessment Guidelines	2006
Sudan	Basic Package of Health Services for Southern Sudan	March 2006

** Refer to Appendix A for a full list of available Ugandan Building Codes*

Although these codes exist they are infrequently implemented on site. In general it is a good idea to establish what codes apply and the level of code compliance required with the ministry and your EMI team at the start of a project. Not all projects are able to meet international building code standards but every effort must be made to ensure that the design and construction will act to preserve human life in all situations.

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3. Design Guidelines

The following design guidelines have been developed from general observations made while working in East Africa. The sections below are organized with the related discussion, observation or general practices first followed by a bulleted list of design recommendations.

3.1
Climate + Microclimate

The climate within East Africa varies significantly from the wet tropical climate of the Congo River to the drier tropical equatorial uplands of Kenya and Uganda to the hot arid climate of northeastern Uganda and Southern Sudan. Local climate varies significantly within a small area due to changes in altitude and rainfall. With global climate change it is predicted that the temperatures in East Africa may rise between 3-4°C in the next 70 years.

- Discuss local climate factors with the local community to establish wind, rainfall, dust and other seasonal weather patterns.

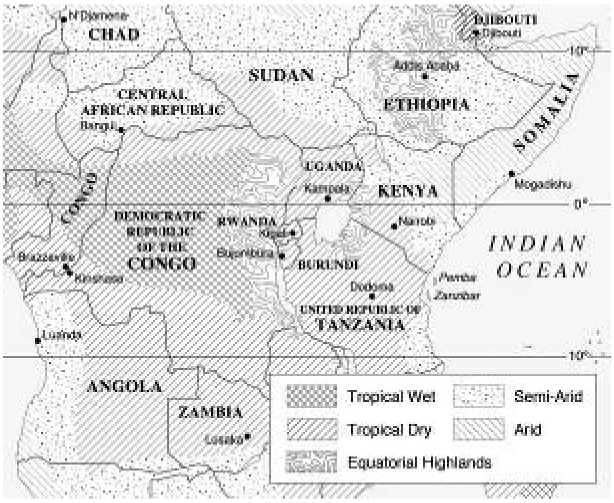

Figure 3.1
Climatic Zones and Latitude across Sub-Saharan Africa

3.2
Location + Siting

Buildings should be located to avoid wetlands, flooding zones, landslides and other natural hazards, including recently filled ground. Talk to the local community about what natural disasters have occurred in living memory (including earthquakes & changing weather patterns). This should give a good indication about potential problems.

3.3
Building Orientation + Shading

It is recommended that buildings are located on an east-west axis where possible to avoid unnecessary glare and overheating. Windows are minimized on the east and west elevations and large overhangs provided to the north and south to generate mid-day shade.

- The roof form is used to create large overhangs to shade walkways and outdoor seating areas.

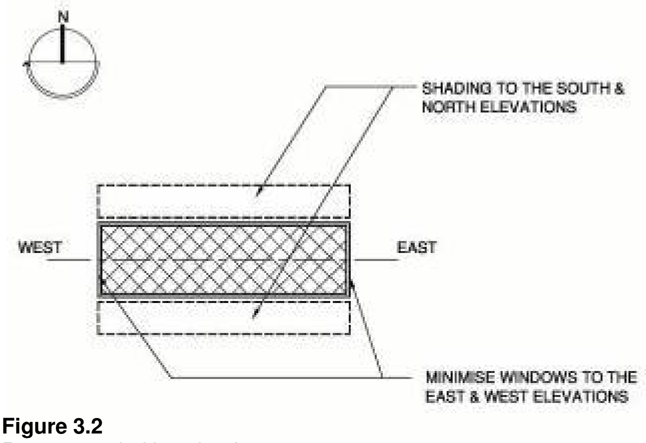

Figure 3.2
Recommended location for verandas and shading.

3.4
Building Shape

Avoid complex asymmetrical L-shaped or E,U,H,T-shaped buildings. Symmetrical, compact, simple buildings with a regular plan perform better when subjected to lateral loads such as earthquakes. Symmetrical location of stair cores and regular placement of window openings will reduce uneven movement during an earthquake.

A series of smaller regular buildings are better than one extremely large building for a number of reasons including cost, implementation, ease of construction and fundraising. In earthquake prone areas maintain a 3m minimum distance (5m recommended) between buildings.

3.5
Retaining Walls

Due to the common failure of retaining walls in East Africa all retaining walls should be freestanding and separated from the building. This separation distance is far enough to ensure that if the retaining wall collapses it will not interfere with the building structure.

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3.5
Retaining Walls cont.

All retaining walls have to be well drained, properly designed and constructed to minimize the possibility of collapse. In addition retaining walls should be a maximum of 1.2m high. If walls need to be higher than that refer to **Figure 3.3** which shows the use of multiple small walls. A lower cost and easier option than a retaining wall is to build an earth bank of 1:1 slope. This will prevent the bank from collapsing provided the earth is well drained and stabilized with planting. Where there is a minor slope a stepped foundation should be avoided, as they are prone to moisture build up and are more likely to fail during earthquakes.

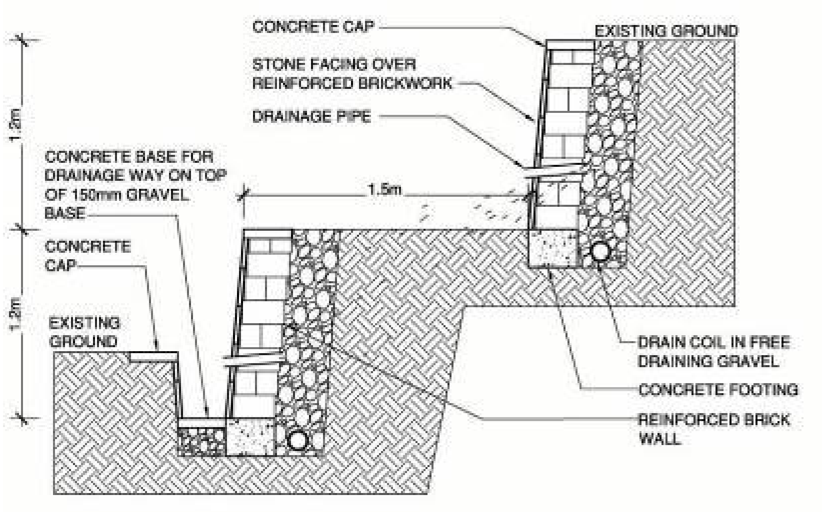

Figure 3.3
Cross-section through retaining wall

3.6
Site Drainage

East Africa receives a significant amount of heavy rainfall. All design must ensure that surface water is directed away from the buildings into formed drainage channels lined with flat stones or concrete. Some parts of East Africa receive more than 2m annual rainfall.

- The finished floor level of a building has to be a minimum of 250mm above ground level; 150mm above paving

3.7
Building on Fill

Provision has to be made on sloping sites to cut enough of the slope away to enable the building to be built on native ground and not on fill. There is typically not the machinery nor inspections to enable adequate compaction of fill.

- On sloping sites buildings are orientated along the contours to reduce the amount of cut required.

3.8
Multiple Storeys

Due to the variable quality of concrete and quantity of cement and steel used, and the quality of construction in East Africa, EMI EA recommends the number of storys in a building to be fixed at a maximum of two floors (ground + one floor).

- In most rural cases one story construction is recommended unless the construction quality can be monitored and inspected consistently during the construction process by a qualified construction manager.

3.9
Confined Masonry

This method of construction is used extensively throughout the developing world. In all cases the non-structural brickwork walls (local or factory fired) are built first and then the reinforced concrete columns and bond beams are poured using the in place brick walls as formwork. Refer to **Figure 3.4**. This type of construction will perform well in earthquake zones provided there are sufficient columns. Columns are to be located a maximum of 4m apart and the maximum opening size allowed between columns is 2.5m² (note all building designs should be checked by a Structural Engineer).

- Due to the small amount of allowable openings between columns this method is seldom used in East Africa.

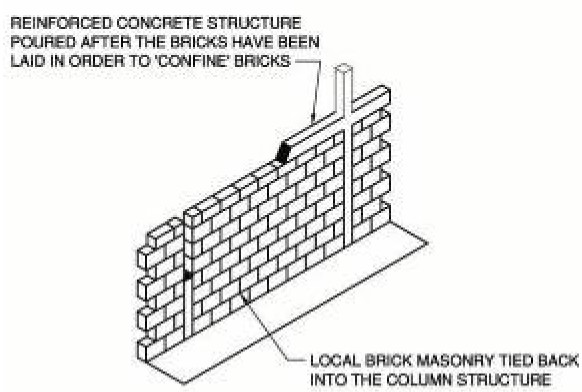

Figure 3.4
Confined masonry

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3.10
Reinforced Concrete Frame with Brick Infill
The standard method of building single story and multi-story buildings is to construct a reinforced concrete frame that is in-filled with non-structural brick. Refer to **Figure 3.5**.

- The bricks are tied back into the structure with horizontal strapping set into the brick mortar

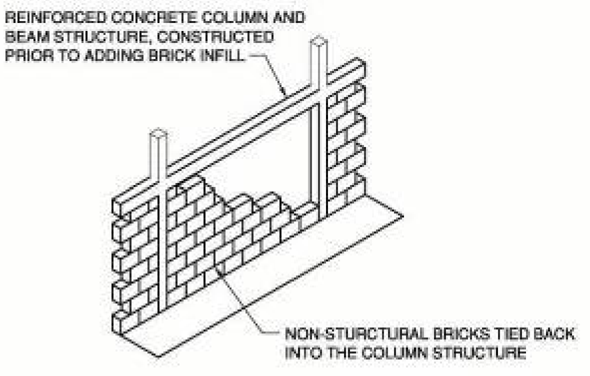

Figure 3.5
Reinforced Concrete frame with Brick Infill

3.11
Doors + Windows
Use modular doors and windows where possible. This will save time and cost. Most windows systems in East Africa consist of glazed casement windows and metal security bars within one frame. Above both windows and doors are fixed vents with mosquito mesh screens. These are often formed within the door or window frame.

- In order to simplify the construction it is best practice to design windows and vents in one frame that goes up to the underside of the ring beam.

3.12
Repetition of Building Elements
Any repetition of building blocks will save cost and allow for improved construction efficiency on site. This applies to floor plans and overall building sections and construction methods. This enables one building team to develop more efficient construction methods as the project progresses.

3.13
Flexibility of Space
Ministries will often undergo changes to their program over time and it is recommended that spaces be design to be flexible for future changes of use.

3.14
Designing for Disabilities
A difficulty in working with sloped sites and existing buildings is the implementation of disabled ramps and paths that are suitable for wheel chair access. Likewise in multi-story construction this is difficult without the use of lifts or elevators. The recommended approach to accommodate this is to ensure that no facility is provided on an upper level that is not provided on the ground floor level. For example a faculty library or reception area must always be placed on the ground floor level, whereas lectures can be scheduled on the ground level classroom when disabled students are in attendance, but otherwise may occur in an upper level classroom.
It is not generally required to provide disabled toilets on an upper level where there is no disable access to that level.

- Recommended threshold for external doors is 20mm max where there is a sloped covered porch
- Recommended disabled toilet stall size is 1.6x1.9m
- All doors have a rough opening of 1000mm to give a minimum clear opening of 860mm

The following slopes are recommended for landscaped paths and building entrances but steeper slopes are acceptable.

- Slope for exterior paths 1:20 or 5%
- Slope for entrance ramps 1:12 or 8%

3.15
Fire Egress
Fire egress is critically important in accommodation/dormitory buildings where people are sleeping. There are very few smoke alarms or early warning systems available and no quick release locking mechanisms for doors or windows. Plan for at least two means of escape from every sleeping area (work on the basis that if one escape is blocked by fire then provide another means of exit). Note that most windows are barred for security reasons and most external doors are locked using padlocks and the keys retained by staff members. There have been a series of fatal fires in school dormitories in Uganda where children have died because the only exit door was locked and the windows were barred. The whole issue of escape will need to be discussed with the ministry.

- Minimum number of exits from a dormitory is two.
- Minimum number of exits from a laboratory classroom is two.
- Maximum number of seats in a continuous row in an auditorium is 22 seats.

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3.17
Plumbing
In East Africa it is unusual to pre-plumb a building due to the lack of communication between trades people prior to construction commencing on site. Consequently all pipe work is chisled into walls or floors after the building has been constructed but prior to plastering. Under slab pipe work is not recommended unless carefully supervised during construction to check all joints are properly sealed.

- It is recommended that all plumbing fixtures (particularly toilets) to outside walls to enable easy access and maintenance.

3.18
Acoustics
Solid brick or block walls will provide adequate acoustic separation between classrooms and offices where the separating walls extend to the underside of the roof. Acoustic ceiling tiles are rarely used and are only effective when the metal grid is stopped at internal walls; metal grids continuous above two classrooms will transmit sound clearly from one room to another. Plaster ceilings perform well acoustically for speech absorption even without full height interior walls but any holes in the ceiling will allow sound to travel through to neighboring rooms. Sound insulation materials are unavailable. Rain noise on tin roofs is a big problem for speech clarity.

- A plaster ceiling is recommended where speech clarity is required during heavy rain (e.g. classrooms)
- A thatch roof is advisable for large open air structures where meetings will be carried out during heavy rain

3.19
Lighting
Windows are to be located in order to provide good natural light to every room to reduce power consumption. Power supply is irregular and electric lighting should not be relied upon. Long thin buildings provide the best natural light and ventilation when orientated on an east-west axis.

- Single loaded corridors are recommended to provide the best natural lighting for corridors and classrooms.
- A light colored ceiling provides good reflected light deep into a room.

3.20
Ventilation
Passive ventilation is best created through cross ventilation. This is normally achieved through open windows on opposite sides of the room and via vents above windows and doors. This enables ventilation to occur even when windows are closed and the room is uninhabited.

- Provide passive ventilation above all windows and doors
- Ensure all roof spaces have vents and insect screens
- Light colored reflective roofing materials can reduce heat gain through the roof by 16%. Refer to the table below for solar reflectance values for common roofing colours. The higher the Solar Reflective Index the better.

Colour	Solar Reflective Index (SRI)
Regal White	80
Silver Metallic	66
Colonial Red	30
Regal Blue	8
Matte Black	0

3.21
Internal Finishes
Standard internal finishes are:

Ceilings	Left open to the underside of the roof with the trusses exposed, or
	Enclosed with a wire mesh and plaster ceiling with a textured paint finish, or
	Enclosed with water resistant board on a timber grid (suitable for operating theatres and medical laboratories), or
	12mm plywood ceilings (not recommended due to water absorption), or
	Fibrous board acoustic tiles (not recommended due to water absorption)
Walls	15-25 mm plaster with paint finish on all interior walls, and
	15-25 mm plaster with paint finish on all exterior walls, or
	Exposed brick exterior walls with plaster finish on bottom 1m.
Floors	Sand cement leveling screed on 100mm min reinforced concrete slab, or
	Tiles, or
	Painted finish to leveling screed

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4. Recommended Building Practices

The following details do not show how things are typically constructed but give examples of EMI EA recommended construction methods developed from standard building practices here in East Africa.

4.1 External Foundation Wall

Local brick foundation wall with reinforced concrete slab.

- The skirt walk shown is a non-structural concrete 'skirt' that protects the buildings foundations and provides valuable space for washing and cooking. The typical size is 450mm wide x 100-150mm deep.

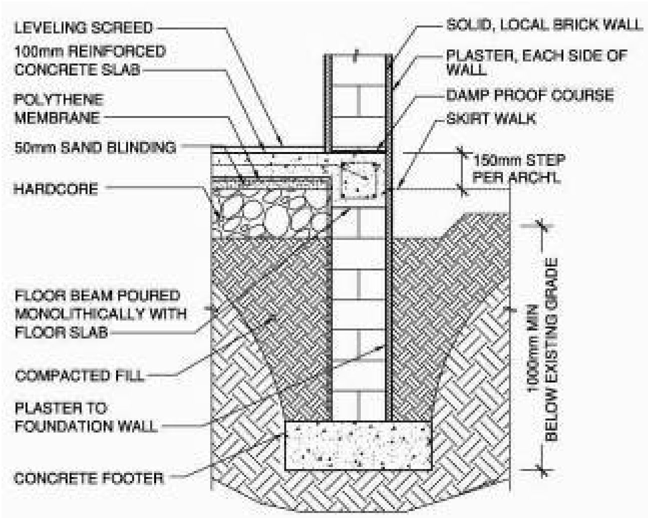

Figure 4.1
Recommended external wall and foundation detail

4.2 Internal Partition Wall

Local brick foundation internal partition wall foundation

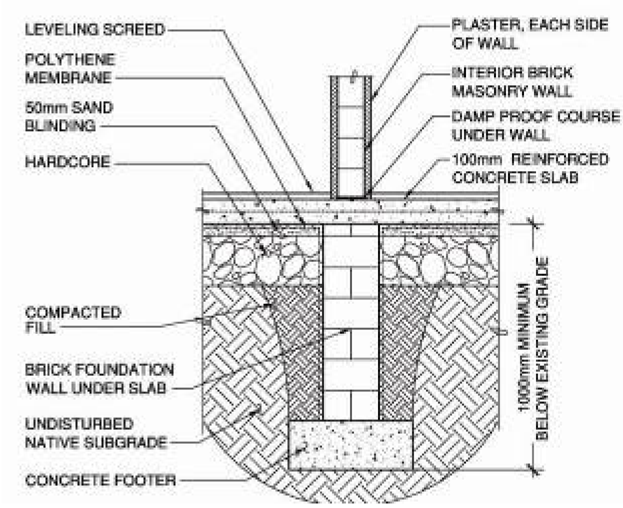

Figure 4.2
Recommended internal wall, foundation and floor detail

4.3 Thickened Slab Foundation

A thickened reinforced concrete slab foundation is seldom used in East Africa but is appropriate where there is consistent rock or sandy ground conditions as approved by the Structural Engineer.

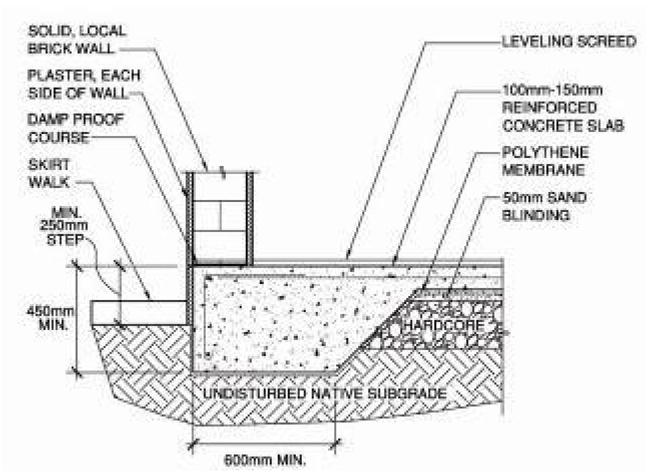

Figure 4.3
Thickened reinforced concrete slab foundation.

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4.4
Thickened Slab Foundation

Internal partition wall foundation for reinforced thickened concrete slab. See notes for 4.3 above. Confirm all foundation designs with the Structural Engineer.

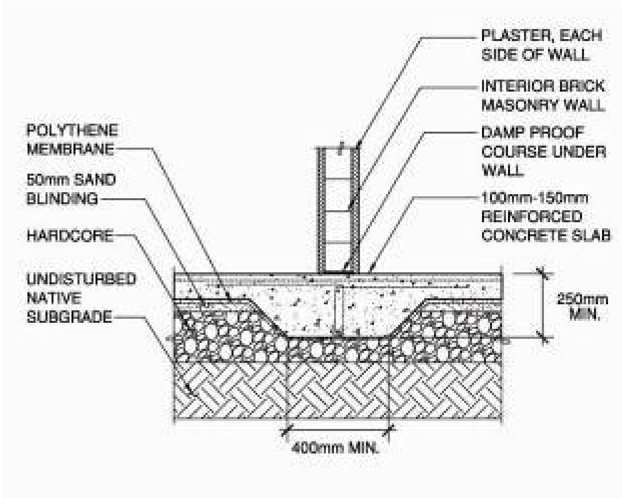

Figure 4.4
Thickened concrete slab foundation under internal partition wall

4.5
Intermediate Floor

There is a common method of forming a lightweight intermediate floor for multi story construction called a 'Maxpan' system. Maxpan involves the formation of a series of smaller beams spanning across the floor spaced apart with clay fired 'trays'.
Note: These systems are often installed badly resulting in the failure of multi story buildings. One Maxpan building collapse in January 2008 in Kampala killing 11 construction workers. See 3.8 for a discussion about multi-story construction.

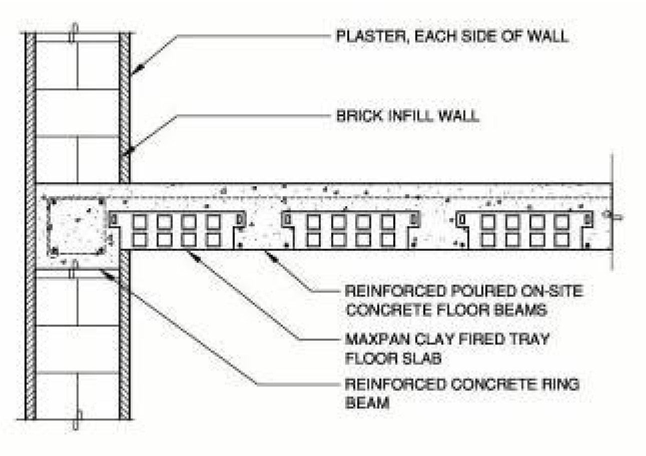

Figure 4.5
Diagram showing the use of a MAXPAN floor system.

4.6
Roof and Top of Wall section

Roofs are generally constructed using metal sheeting over steel or timber roof framing. A ring beam connects the columns together and the top plate sits on top of the ring beam. Roofs are not sealed and there are few flashings available. During storms water will inevitably progress in to the roof space but will normally dry off quickly provided there is sufficient ventilation.

- Metal roofing is recommended. Tile roofing is more expensive, requires more roofing framing and is dangerous in an earthquake.
- Softwood timber roof framing must be coated with a preservative treatment or used motor oil to prevent insect decay.

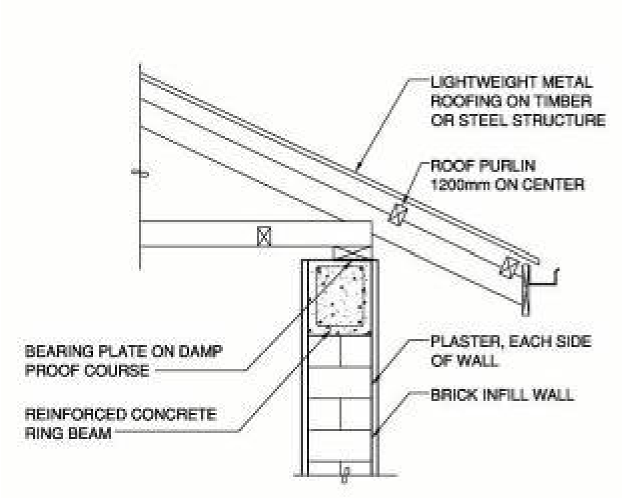

Figure 4.6
Recommended roof and exterior wall construction.

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4.7
Earth Stabilise Bricks

There are a number of types of Compressed Earth Blocks (CEB) used in East Africa. An evaluation of CEB is provided in Appendix H.

The main issues in using any type of CEB are durability and structural integrity. Unsupervised production of bricks will result in low quality, crumbly bricks that will deteriorate quickly.

- Supervision and quality control is imperative
- Suitable for small single story buildings only
- Large overhanging eaves or plastering to both interior and exterior are recommended
- Reinforced columns are essential

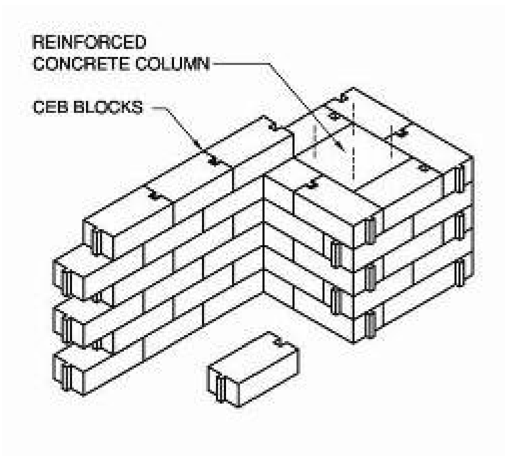

Figure 4.7
Compressed Earth Block construction.

4.8
Thatch Roofing

Thatch roofing is widely used in rural situations throughout East Africa. It is cost efficient and effective for sound and thermal insulation. In the cities it is often used for boutique restaurants and shops. The lifespan of an average thatch roof is 7-10 years if maintained properly.

Most local ministries prefer metal roofing as thatch roofing is associated with the village and backward development.

- Good for open air community structures
- Must be put in place by an experienced person
- Not recommended for structures that contain open fires
- Spraying for insects is required every 6 months - 1 year
- All timber has to be treated for termites

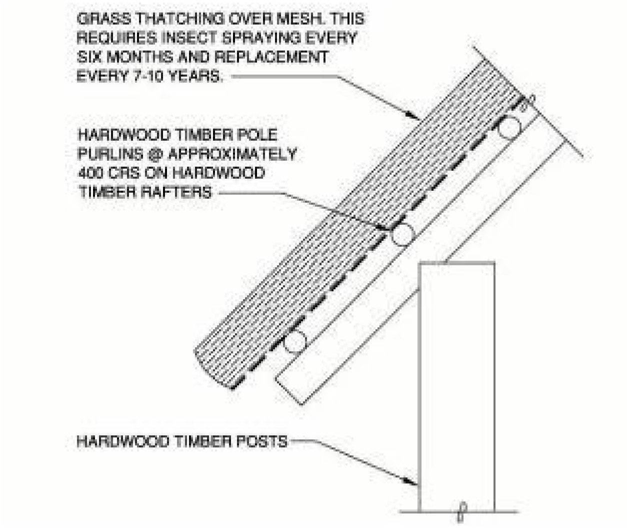

Figure 4.8
Thatch roof construction.

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5. Construction Overview

5.1
Construction workers
For the majority of small projects the construction workers hired will have only worked on small local building projects. They will be familiar with a range of standard ways of doing details and regardless of what is designed and shown on the drawings they will tend to keep to what they are used to. The only time this will be different is when a full time trained Construction Manager is on site.

5.2
Construction techniques
Look carefully at what is built locally and ask about anything that may stand out as different to what you are used to and ask why it has been done this way. Often there are very good reasons for what may be considered un-typical building practices.

5.3
Material Availability
If the site is situated near a major city with good vehicle access then most construction materials will be easily available. If the site is rural with bad road access then the range of materials available will be extremely limited. Research what materials are available locally and try to avoid relying on long distance transport of construction materials.

5.4
Construction Supervision
Where the construction is going to be supervised by a qualified western construction manager the design may be modified to allow for a more western method of building. This may involve detailed construction drawings showing complex material connections and weathering details.

5.5
Quality of workmanship
Most building projects do not meet high quality standards for basic construction and finishing. Therefore it is essential to keep details as simple as possible and not to set unrealistic expectations. Maintenance is not often a high priority (there is actually no word in the Lugandan language for maintenance) so low maintenance, durable materials are recommended.

5.6
Multi-storey construction
For any two-story buildings EMI EA recommends the use of a western construction company for the complete construction package. It is essential to have qualified construction management, administration and observation on a multi-story building project throughout the entire construction process.

6. Summary

- Study the existing environment and local building types
- Apply normal good design and environmental practice, being sensitive to site, climate, culture and construction industry practice.
- Review and revaluate all design assumptions
- Use local information and expertise

7. Reference Books

Metric Handbook; Third Edition; Architectural Press; Edited by David Littlefield, 2008
Hindrichs, Dirk U., ± 20°/40° latitude, Sustainable Building Design in Tropical and Subtropical Regions, Axel Menges, 2007

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Appendix A

LIST OF UGANDAN BUILDING CODES

NOTE THAT THESE CODES HAVE NOT YET BEEN APPROVED BY THE UGANDAN GOVERNMENT

Document Title	Document Subtitle
Standard Specifications for Building Works	-
Building Control Regulations	-
Structural Design Guideline Code	-
Sanitary Installation Regulations for Buildings	-
Regulations for Electrical Installation and Equipment In Buildings	-
Project Implementation Manual	-
Project Implementation Manual Vol. II Buildings	-
Bridge Design Manual	Road Design Manual Vol. IV
Drainage Design Manual	Road Design Manual Vol. II
Geometric Design Manual	Road Design Manual Vol. I
Pavement Design Manual	Road Design Manual Vol. III
Road Maintenance Management Manual	-
Road Maintenance Specifications	-
Standard Tender Documentation for Building Works	-
Standard Tender Documentations, Vol I - VII	-
Prequalification Documents for Consultancy Services	-
Request for Proposal - Bldgs	Consultancy Services of Buildings
Request for Proposal - Roads	Consultancy Services of Roads and Bridges
Request for Proposal for Consultancy Services	-

Reference

Ugandan Ministry of Lands, Housing and Urban Development, Building Regulations, 2005

Appendix B
SPACE GUIDELINES

The following space guidelines show indicative areas for the following spaces relating to building design in East Africa.

B.1
Schools

	Recommended	Minimum
Classrooms-individual seats	1.5m²/student	1.2m²/student
Classrooms-bench seats	1.2m²/student	1.0m²/student
Classrooms-informal seating	2.0m²/student	1.85m²/student
Distance between classroom buildings	5m	4m
Veranda to front of classrooms	2m	1m
Distance across courtyards	20m	14m
Wheelchair ramps to entrances	Slope 1:12	Slope 1:10
Wheelchair ramps	Slope 1:20	Slope 1:20
Ugandan government classroom size	40 students	6mx7.8m
Distance from classrooms to pit latrines	50m maximum	10m minimum

B.2
Offices

Directors/ Head teacher office	4mx4m	3mx4m
General administration offices	3mx2.4m	3mx2m
Single teacher offices	3mx2.4m	2mx2.4m
Double teacher offices	4mx4m	4mx3m

B.3
Churches (includes circulation and stage area)

Auditoriums-individual seats	1.0m²/seat	0.8m²/seat
Auditoriums-plastic garden chairs	1.2m²/seat	
Auditoriums-bench seats	0.8m²/seat	
Auditoriums-standing	0.6m²/student	

B.4
Medical Clinics

Reception & waiting	3mx4m	3mx3m
Examination rooms	3mx4m	3mx3m

Reference

Ugandan Ministry of Education and Sports,
Schools Facilities Grants for Primary Schools, Technical Handbook for District and Urban Councils, 2000
Uganda Ministry of Health, Guidelines for Public Practice of Registered Nurses and Allied Health Professionals, 2002

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Appendix C

READILY AVAILABLE MATERIALS IN EAST AFRICA

The following is a list of readily available materials in the main city centers in East Africa. Many materials become much more expensive if they require transport into rural areas. Use what is available locally where possible. Note that some sites will not have reasonable vehicle access and therefore require the use of locally found materials.

Material	Type	Uses	Notes & recommendations
Concrete		Floor slabs, columns, ring beams,	– Cement prices are extremely high and volatile and form the major cost of any building project. – Aggregate rock is often hand crushed and the size of the aggregate will generally be larger than specified. – Concrete vibration machines are uncommon and expensive. – Generally concrete will be mixed on site by hand. Pre-mixed concrete is rare.
Brick	Local clay fired	Non-structural only	– Quality varies widely and we recommend not using local clay fired bricks structurally. – The local kilns used to fire the bricks use a lot of timber or charcoal which is depleting East African forests.
Brick	Factory made	Structural	– Available in Rwanda and Uganda (Uganda Clays Ltd. Kajjansi, Uganda)
Hollow core Block	Factory made	Structural if reinforced	– Available in northern Tanzania, and becoming available in Uganda.
Timber Hardwood	Eucalyptus Grandis (Kalitunsi)	Small posts for fences	– Eucalyptus grandis is plantation grown for small exterior posts. It requires insect resistant treatment if in the ground.
	Mugavu Musizi	Doors, Windows, Roof trusses	– Termite resistant, requires seasoning – Is depleting the remnant of surviving forest in East Africa
	Mululu	Joinery	– Interior furniture
Timber Softwood	Pine	Roof trusses	– Must be treated with used motor oil or chemically treated to prevent insect and moisture failure
	Cyprus Pine	Roof trusses	– Has better resistance to termites than pine. but still requires treatment
Plywood	Hardwood or softwood	Ceiling linings	– Not recommended as may get water damaged
Metals	Steel	Roofing	– Must be galvanized or pre-painted in all situations. – Corrugated, super-V & faux tile profiles available.
	Steel	Structural members, security bars, gates	– Standard sizes available. – Steel workers can make almost anything
	Steel	Mesh, fencing	– Galvanized chain-link & wire mesh are available
	Zinc alloy	Roofing material	– Pre-finished coating on both sides – Corrugated and faux tile profiles available
Plaster		Exterior & interior finishing	– The most common method of exterior and interior finishing. – Plasterers are highly skilled.
Tiles	Ceramic	Interior finishing	– Commonly used on all floors and walls of bathrooms
	Clay	Roofing	– Commonly available in Uganda
Stone	Granite		– Seldom used
	Flat	Paving	– Decorative pavers are widely available & used for lining retaining walls, paving and decorative facing on walls
	Sandstone	Walls	– Uncommon except in Western Kenya and although beginning to be used in Eastern Uganda
	Aggregate	Concrete	– Mostly hand-crushed in local quarries
Gabion baskets	Wire mesh baskets with stones	Retaining walls	– Used in Rwanda

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Appendix D
CLASSROOM DESIGN

Recommendations for Classroom Design

Western classroom	Developing world classroom	Requirements	Recommendations
Textbooks, computers & projectors are used.	Teaching is done via rote memorization without the use of books.	Good visual and sound access to the teacher.	Proximity of the students to the teacher and board is essential.
20-30 students/ classroom	40-80 students/classroom	Design to Government regulations or ±40 students/ classroom	Design for 1.5m²/student
Good artificial light & electricity are available	No artificial light or electricity is available	Good natural lighting	Daylighting* Light colored reflective ceilings High ceilings High window head height
Low level windows for views for the children	Few windows with high level sills	Natural views to the outside	Large windows with low sills
Mechanical ventilation & fans control humidity & temperature & remove exhaust air	Natural ventilation only	Constant cross ventilation required in classrooms and corridors	Single loaded corridors Permanent vents above doors and windows Large operable windows**
Sound proof walls between classroom	Air gaps and direct sound transmission between classrooms	Ensure walls between classrooms extend up to the roof	Wing walls to exterior Acoustic separation of classrooms
Sound absorption to allow speech clarity within classrooms	Hard surfaces throughout the classroom	Add durable absorptive materials	Where cost allows provide a plastered ceiling
Sound insulation from external noise sources	No sound insulation from heavy rain noise	Provide insulation from rain noise	Provide external landscaping walls
Indoor dining and play areas provided	Local food prepared for younger children	Outdoor shaded areas for eating and playing	Open sided roofed structures for shaded play
A wide variety of outdoor play areas and outdoor seating	No play equipment Minimal outdoor seating	Provide outdoor covered spaces	Design some exterior shaded seating into the building

* Daylighting
Ceiling Height > Room Depth = greater daylight penetration
Raising the window head height = greater day light penetration and more even light distribution.

** Natural Ventilation and Airflow
Ventilation and Airflow are the primary contributors to the physical comfort (attentiveness & concentration) and health (attendance) of the student and teacher.
To create increased airflow through a room the outlet must be larger than the inlet.

Reference
Adapted from Learning Spaces #CH1T3; Presented by Tom Bastian; Architect; Engineering Ministries International

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Appendix E
CLIMATIC RESPONSIVE DESIGN

E.1 TROPICAL RAINFOREST CLIMATE

The key to design in a Tropical climate is the roof. Large roof overhangs shade the exterior walls, provide protection from driving rains, shade from the sun and allow large openings for day lighting, good ventilation and temperature control. Building materials must dry quickly.

Climate and Characteristics	Requirements	Design Response
Intense rain	Large roof	Large roof with overhanging eaves Design to capture rain water
High heat	Maximize ventilation	High ceilings Cross ventilation Isolate heat generators
High humidity	Maximize wind velocity	Ventilated roof
Solar heat gain	Minimize heat gain	Shade walls and windows using the roof Thin plan with E-W orientation Large windows and openings to north & south Minimize openings to east & west Highly reflective lightweight roof materials Environmental shading using trees
Low daily temperature variation	Low insulation requirements	High or low mass materials are appropriate
Strong sky glare	Maximize shading	Veranda or sun shading devices
Typical light winds	Wind capture/velocity	Single loaded configuration
Insects/termites	Insect protection	Termite resistant materials & building methods

E.2 ARID CLIMATE

The key to designing in an arid climate are the walls which provide protection from heat gain, intense glare and windblown dust. The building form also plays a role in shade creation as will plants and pools of water for evaporative cooling.

Climate and Characteristics	Requirements	Design Response
Very high solar heat gain	Heat reduction over air movement	Shaded courtyard form* E-W orientation High mass walls and roof
Reflected radiation from ground	Minimize Heat gain summer	Courtyard facing windows with minimal or no outside windows
Large daily & annual temperature variation	Utilize daily temperature variation for heating (winter)/Cooling (Summer) Minimize heat loss winter	Wall Roof Mass w/ large time-lag over insulation
Low humidity/dryness	Utilize low-humidity & humidity creation	Courtyard water feature or vegetation to enhance evaporative cooling Ducted wind capture
Sandy environment with dust storms	Dust barriers	Glare/Dust screening
Strong ground/building glare	Glare protection	Exterior walls

*Courtyard Form:
The height of courtyard should exceed any other dimension. Wind Catchers should be ducted thru a basement then to courtyard. Orient building to obtain maximum courtyard shading. Copy local wall and roof designs.

Reference

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Appendix F

SCHEDULES FROM THE UGANDAN BUILDING CODE

NOTE THAT THESE CODES HAVE NOT YET BEEN APPROVED BY THE UGANDAN GOVERNMENT

F.1
Eighth Schedule: Minimum Slope for Roofs **sub-article 3.2.6.7**

Roof Covering	Roof Structure	Roof Slope
Bitumen based /Other Approved Roofing Products	Concrete Slabs	1%
Cement / Clay / Metal Tiles	Concrete Slabs	10%
Cement / Clay / Metal Tiles	Structural Steel/ Timber Trusses	25%
Galvanized Steel / Other Approved Sheets	Structural Steel/ Timber Trusses	15%
Long span / Special Profiled Metal Sheets	Structural Steel/ Timber Trusses	5%

F.2
Twelfth Schedule: TOILETS & WASHBASINS FOR PERSONS WITH DISABILITIES ON WHEELCHAIRS sub-article 3.3.15.9

Number of Persons	Number of Sanitary Units
Up to 10	0
10-50	1
Over 50	2

F.3
Nineteenth Schedule: EXIT IN ESCAPE ROUTES **sub- article 3.4.6.20**

Population In Building	Exits
Up to 200	2
200-300	3
300-400	4
400-550	5
550-700	6
700-850	7
850-1000	8
1000-1500	9
1500-2000	10
Over 2000	10+1 for each 500 additional

F.4
Twenty Second Schedule: MINIMUM LATRINE ACCOMMODATION **sub-article 5.2.1.2 & 5.2.2.10**

FUNCTION	USERS	POPULATION	PROVISION OF LATRINES/WCs			
			Male			Female
			Without Urinal	With Urinal	Additional Urinals	
[SECONDARY] **SCHOOL OR COLLEGE**	**Staff**	1 – 15	-	1	-	1
		16 - 35	-	2	1	2
		36 - 60	-	3	2	4
	Boarding students	1 – 15	-	1	-	1
		16 - 30	-	2	1	2
		31 - 75	-	3	2	4
		76 - 100	-	6	4	8
		101 - 150	-	8	4	10
		Over 150	-	1 per 30	1 per 25	1 per 50
NURSERY	**Pupils**		1 per 15*	1 per 15*	1 per 15*	1 per15*
ELEMENTARY SCHOOL	**Boys**	1 - 25	2	2	1	-
		26 -50	3	2	2	-
		51 - 75	4	3	2	-
		76 – 100	5	4	3	-
		101 – 125	6	5	4	-
		126 – 150	8	6	4	-
		151 – 175	9	7	5	-
		176 – 200	10	8	5	-
		Over 200	1 per 30	1 per 30	1 per 50	-
	Girls	11 – 20	-	-	-	2
		21 – 40	-	-	-	2
		41 – 60	-	-	-	3
		61 – 80	-	-	-	4
		81 – 100	-	-	-	5
		101 – 120	-	-	-	6
		121 – 140	-	-	-	7
		141 – 160	-	-	-	8
		161 – 180	--	-	-	9
		181 – 200	-	-	-	10
		Over 200	-	-	-	1 per 30
OFFICE OR PUBLIC BUILDING	**Persons**	1 – 15	-	1	-	1
		16 – 35	-	2	-	2
		Over 35	-		1 per 75	
RESTAURANT	**Public, male**	1 – 50	-	1	--	1
		16 – 50	-	2	-	2
		Over 50	-	2	1 per 40	2
	Public, female	1 - 50	1	-	--	2
	Staff, male	1 – 15	-	1	--	-
		Over 15	-	-	1 per 75	-
	Staff, female	1 - 12	1	-	-	1
WAREHOUSE, WORKSHOPS AND OTHER WORKPLACES	**Male**	1 - 15	2	1	1	-
		16 – 35	3	1	2	-
	Female	1 – 12	-	-	-	1
		13 - 25	-	-	-	2

Reference
The following Schedules have been taken out of the Ugandan Building Code 2005
The rest of the Schedules can be found in
L:\DESIGN AIDS\BUILDING CODES - UGANDA\New codes updated\Building Control Regulations

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Appendix G
GUIDELIINES FOR CLINICS IN UGANDA

G.1
Day Care Clinics
Note that these are minimum standards for Day Care Clinics

Rooms (min 3)	Use	Min Furniture Required
Room 1	Reception & waiting	Benches/forms Table & chair for receptionist Reading materials
Room 2	Examination room	Chair & table for health worker Two chairs for patients Hanger/wall facilities i.e. curtains and screens Examination couch covered with mackintosh Adequate couch linen
Room 3	Treatment room	Treatment couch and chair Suitable lockable cupboard Adequate couch linen Separate bins for sharps A functional sterilizer, either autoclave or pressure cooker Appropriate waste bins with covers
General Requirements	Floor	Cemented, walls plastered and painted white. The roof shall be leak proof.
	Ventilation	Windows and vents shall together measure at least 30% of the floor area.
	Lighting	There shall be adequate lighting at all times the facility is open.
	Water & Washing facilities	Adequate clean water in both examination and treatment rooms, either from tap or a covered can with basin.
	Compound where present	Waste bins with covers for medical and non-medical waste Garbage pit measuring 1mx2mx2m A functional WC toilet/latrine Water drains shall be covered

G.2
Pharmacy
Note that these are minimum standards for a Pharmacy

Rooms (min 2)	Use	Size (min)	Min furniture required
Room 1	Shop Area Medicines outlet	3mx3m	3 chairs; 1 for staff, 2 for waiting patients Counter Shelves with sliding glass windows or covered with white transparent net A lockable cupboard
Room 2	Storage Area For keeping stocks not for immediate use	4mx3m	Shelves Two working stools Lockable drawers
General Requirements	Floor	Cemented, walls plastered and painted white. The roof shall be leak proof.	
	Ventilation	Windows and vents shall together measure at least 30% of the floor area.	
	Lighting	There shall be adequate lighting at all times the facility is open.	
	Water & Washing facilities	Adequate clean water in both examination and treatment rooms, either from tap or a covered can with basin.	
	Compound where present	Waste bins with covers for medical and non-medical waste Garbage pit measuring 1mx2mx2m A functional WC toilet/latrine Water drains shall be covered	
	Waste	There shall be adequate provision for safe disposal of pharmaceutical waste according to standard requirements and procedures prescribed by the NDA.	

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G.3
Basic medical Laboratory

Note that these are minimum standards for a Medical Laboratory

Rooms (min 3)	Use	Size (min)	Min furniture required
Room 1	Reception & Waiting	3mx3m	Refer Ministry of Health Guidelines for Private Practice for *Registered Nurses and Allied Heath Professionals; First Edition 2002* Section 6.4.4.9
Room 2	Specimen collection/storage, testing and washing-up of apparatus and main tests	4mx3m	Refer Ministry of Health Guidelines for Private Practice for *Registered Nurses and Allied Heath Professionals; First Edition 2002* Section 6.4.4.9
Room 3	A scheduled room and/ or toilet for taking specimens that need such facility		Refer Ministry of Health Guidelines for Private Practice for *Registered Nurses and Allied Heath Professionals; First Edition 2002* Section 6.4.4.9
Other requirements	Decontamination	There shall be provisions for decontamination of infectious Laboratory waste	
	Dangerous materials	Space and facilities for the safe handling and storage of inflammable and radioactive materials	
	Waste Disposal	There shall be adequate provisions for waste disposal, which must meet performance and pollution control requirements	
General Requirements	Floor	Cemented, walls plastered and painted white. The roof shall be leak proof.	
	Ventilation	Windows and vents shall together measure at least 30% of the floor area.	
	Lighting	There shall be adequate lighting at all times the facility is open.	
	Water & Washing facilities	Adequate clean water in both examination and treatment rooms, either from tap or a covered can with basin.	
	Compound where present	Waste bins with covers for medical and non-medical waste Garbage pit measuring 1mx2mx2m A functional WC toilet/latrine Water drains shall be covered	

G.4
Radiography Unit

Note that these are minimum standards for a Radiography Unit.

Rooms (min 3)	Use	Size (min)	Min furniture required
Room 1	Reception and Business Room	4mx4m	Table and a desk, chairs, a waiting bench, film viewer and shelves, textbooks. General reading materials.
Room 2	X-ray Room	3mx3m (4x4 if ultrasound)	X-ray machine, X-ray table, chest x-ray stand, cupboard, film identification marker (LR), film viewing screen, lead apron, sink.
Room 3	Dark Room	2mx3m	Processing tanks, safe light, cassette loading bench, film drier, name of printer, and shelves.
General Requirements	Walls	The walls of the dark room building shall be 9" or 15cm thick and made of concrete blocks.	
	Floor	Cemented, walls plastered and painted white. The roof shall be leak proof.	
	Ventilation	Windows and vents shall together measure at least 30% of the floor area.	
	Lighting	There shall be adequate light at all times the facility is open.	
	Water and Washing Facilities	Adequate clean water, either from a tap or can with a cover.	
	Compound where present	Waste bins with covers for medical and non-medical waste Garbage pit measuring 1mx2mx2m A functional WC toilet/latrine Water drains shall be covered	
	X-ray Room	X-ray room shall be located away from the patients waiting bay, if not, the door to the x-ray room shall be 2mm lead thickness equivalent. * Refer Ministry of Health Guidelines for Private Practice for *Registered Nurses and Allied Heath Professionals; First Edition 2002* Section 6.4.4.9 (Page 29)	

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G.5
Physiotherapy Unit

Note that these are minimum standards for a Physiotherapy Unit.

Rooms (min 2)	Use	Size (min)	Min furniture required
Room 1	Reception	3mx3m	Bench with backrest, table, and chair.
Room 2	Treatment Room	4mx3.5m	Two chairs, a desk, treatment table, curtains, and screen.
General Requirements	Floor	Cemented, walls plastered and painted white. The roof shall be leak proof.	
	Ventilation	Windows and vents shall together measure at least 30% of the floor area.	
	Lighting	There shall be adequate light at all times the facility is open.	
	Water and Washing Facilities	Adequate clean water, either from a tap or can with a cover.	
	Compound where present	Waste bins with covers for medical and non-medical waste Garbage pit measuring 1mx2mx2m A functional WC toilet/latrine Water drains shall be covered	

G.6
Health Unit for Nurses

Note that these are minimum standards for a Health Unit for Nurses.

Rooms (min 2)	Use	Size (min)	Min furniture required
Room 1	Reception	N/A	Benches, small table with reading materials.
Room 2	Examination and treatment	N/A	Refer Ministry of Health Guidelines for Private Practice for *Registered Nurses and Allied Heath Professionals; First Edition 2002* Section 6.4.4.9 (Page 38)
General Requirements			
	Floor	Cemented, walls plastered and painted white. The roof shall be leak proof.	
	Ventilation	Windows and vents shall together measure at least 30% of the floor area.	
	Lighting	There shall be adequate light at all times the facility is open.	
	Water and Washing Facilities	Adequate clean water, either from a tap or can with a cover.	
	Compound where present	Waste bins with covers for medical and non-medical waste Garbage pit measuring 1mx2mx2m A functional WC toilet/latrine Water drains shall be covered	

References
Uganda Ministry of Health, Guidelines for Public Practice of Registered Nurses and Allied Health Professionals, 2002

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Appendix H
EVALUATION OF COMPRESSED EARTH BLOCK

H.1 Introduction
Compressed Earth Blocks (CEB) are earth bricks compressed with either motorized hydraulic or hand-operated machines. Some blocks are simply made from soil and a small amount of water but most blocks commonly used in East Africa are 'stabilized' with the addition of cement. Earth building has a long history in Africa and CEB has been used in East Africa for the past 25 years.

H.2 Benefits
The advantages of CEB are that it uses locally found materials, it eliminates shipping cost, the blocks have a low moisture content, and the blocks are uniform thereby minimizing, if not eliminating the use of mortar and decreasing both the labor and materials costs. Construction is fast, minimal cement is used and the blocks produced are of comparable strength to locally fired brick but without the timber required and resultant pollution of kiln fired bricks. CEB machines can be used by supervised unskilled labor and can be transported via wheelbarrow or cart to remote locations.

H.3 Drawbacks
- The *quality* of the blocks is dependent on consistent quality control during the making of the blocks and throughout the construction process.
- *Structurally* although well made bricks provide good compressive strength they do not have any lateral stability.
- *Durability* will be a problem if the blocks are consistently exposed to wind and/or rain

H.4 Recommendations
- CEB are suitable for single story buildings only.
- Reinforced concrete columns are required for all CEB buildings in order to provide lateral stability during earthquakes.
- Quality control must be maintained throughout the entire manufacturing and construction process.
- Ring beams must be made from reinforced concrete and tied into the reinforced concrete columns.
- Soils must be tested as per machine manufacturers instructions to determine their suitability.
- Evaluate existing CEB buildings and contact the machine manufacturers for current design details and instructions.
- Large overhangs are recommended to protect the blocks from wind and rain.

H.5 Types of machines
The machines used are designed with simple levers that are easily manufactured in local machine shops. Several different machines are made in Africa; the two most commonly available machines in East Africa are discussed below.

H5.1 Interlocking Soil Stabilized Blocks (ISSB)
www.makiga.com

Machine Manufacturer*:* Makiga Engineering Services, Nairobi, Kenya

ISSB is a form of block where grooves and flanges fit together to allow the block to be laid in an interlocking method. Refer to **Figure 4.7.** The blocks can be curved (suitable for water tanks) or straight depending on the mold used. ISSB is made with a ratio of 1 part cement to 11 parts soil and the interlocking design reduces the requirement for mortar to every 4th course. The molded grooves allow quick construction, as blocks are self-aligning.
Although the interlocking block provides more lateral stability it is still not sufficient lateral support to keep the building standing during an earthquake. The designers of ISSB are currently developing a mold that allows reinforcing bars to be run from top to bottom. See recommendations above.

H5.2 Hydraform Hand Press (HP105)
Machine Manufacturer*:* Hydraform, South Africa
www.hydraform.com

Hydraform produce a variety of both mechanical and hand press machines. There are straight sided and interlocking block molds available. There is also an option of producing bricks with round holes in the center where reinforcing rods may be run from top to bottom and connected into the ring beam and foundations.

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Appendix I

ROLE OF VOLUNTEER ARCHITECT ON PROJECT TRIP

Pre-trip
Some pre-trip research is often useful to give an idea of the site:
- Check out the site on google-earth and print a copy to take on the trip www.googleearth.com
- Check out general climatic conditions to determine what building types may be suitable.

Useful items to bring:
-Calculator
-Fine drawing pencils
-Small roll of trace paper
-Colored drawing pens or pencils
-Scale rule (metric converter ruler if you are used to working in Imperial units)

During the trip

Day 1	The first day the role of the Architect is to assess the site and to take any notes applicable to the design while the Ministry describes their vision for the site.
Day 2	The Architect leads the programming meeting asking questions about the site, buildings and program as it relates to the vision of the Ministry. Design work can begin after this.
Day 3,4,5,6	Requires a series of meetings with the Ministry to present ideas for the site and buildings. Note that the sooner the Ministry has a chance to respond to new ideas the better. Do not leave major changes in planning till the final presentation.
Day of the final presentation	Co-ordinate the production of the final sketch drawings and present them to the Ministry. Allow an opportunity for the Ministry to respond and ask questions.
After the final presentation	Before leaving talk to the Project Leader about what their expectations are for what needs to be completed after the trip

The drawings required for the final presentation will vary from project to project but a general list of drawings prepared during the project trip is as follows:

- Existing site plan
- Proposed site plan- colored
- Floor plans for all first phase buildings
- Perspective sketches of individual buildings or groups of buildings

During the trip frequent communication is required between the Architect and the Civil Engineers in order to co-ordinate between the civil requirements and the architectural master plan.

After the trip
Each Project Leader will have different expectations for what is to be done by the Architect after the trip, discuss this with the Project Leader prior to returning home.

Useful Information

- All EMI drawings are done in Metric units. Millimeters are used for all architectural drawings.
- Some members of the Ministry and local community may never have seen a plan or any drawings before. It is often helpful to explain that it is a birds-eye view of the site or a cut through of the buildings and give time for this to be considered.
- The Ministry should be advised when their vision is totally inappropriate or un-buildable (always discuss this with the Project Leader first). Some common examples are:
  - A 5000 person church on a 1 acre site
  - Any building over one single story when there is no qualified Construction Manager employed
  - Moving huge amounts of earth in order to obtain flat areas of land e.g. a soccer/ football field on a steeply sloping site.

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