Malawi Shelter Cluster
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Coordinating Humanitarian Shelter

Malawi Shelter Cluster
Technical Working Group
for
Promoting Safer Building Practices
in Malawi

a collaboration with the Global Shelter Cluster Working Group on "Promoting Safer Building Practices" and partners of the GCRF research project

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Agenda:

1. Introduction and recap of last meetings findings and conclusions

2. walls, colums, beams, (loadbearing structures) weaknesses and stronger solutions
- analysis of solutions proposed in the safer house construction guidance
- experiences and potential solutions from the field

3. Materials? What environmentally friendly „green" materials to promote?

4. How to rate and select the alternative Solutions identified
- proposed matrix

5. AOB, suggestions for way forward

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Recap: Identified weaknesses and failure mechanisms:

	House element (categorg) (these elements should be used as guideline, use only the relevant ones or add other not mentioned; delete what is not applicable)	Description of element (as observed)	Failure mechanism (if not built well)	Strength of the Element (if built well)	Element Importance ranking[1]	Possible solution	Solution ranking[2]	Comment	Possible solution	Solution ranking[2]	Comment	Are EIC material already available?
1	Foundation(DPM, Plinth wall, plastering with water dehydrating agent)	**Most houses do not have the foundations and few which have they make it shallow and others they just make a header course and start wall construction**	The building lacks stability as it stands on a top soil which is not stable and well compacted and. This also exposes the superstructure wall to running water risking the wall to soaking	The house with foundation stands firm on a stable ground making it stronger against running water	8	provide a compacted embarkment around the wall	12	can be done by owner	construct a deep and raised foundation	11	The action needs more bricks but the purpose it serves is very essential	
2	Structure (column, beam, load bearing walls, lintel, wallplate,etc.)	**Most of the houses do not have wall plates fixed this affects the even distribution of roofing load to the bricks on the superstructure walls**	In case of failure of a brick/block point loaded with the roofing wall the failure is not controlled as it passes to the next brick with extra force	Roofing load is evenly distributed to bricks	8	Insert the plated by lifting the roof and tie it to the wall with tie wire or ropes of relatively high tensile strength	10	Lifting the roof may need more man power	Fix wall plates and tie them to the wall with a galvanized tie wire	11	Cost for purchasing galvanized tie wire may e hard for the villagers to manage	
3	Structure (column, beam, load bearing walls, lintel, wallplate,etc.)	**Most houses use timber pole posts and they are usually not treated for termites.**	Timber post poles are attacked by **termites** hence weakened and fail to support the roofing.	Posts help to support the roof	8	Treat timber posts for termites and have regular checks if attacked by termites	10	Termicides might not be affordable	If possible consider constructing masonry columns	10	Exposure to rains may damage the column if done by adobe bricks and mud mortar	
4	Structure (column, beam, load bearing walls, lintel, wallplate,etc.)	**Usually they use thin timber poles for lintels where there are no door frames and where there are door frames they don't put lintels. Mostly not treated and not strong**	Small timber easily eaten by **termites** and are not strong enough to support the roofing load, they break resulting into a roofing failure.	The bricks load effect on top of door opening is taken care by the lintel	8	Insert strong poles, lintel, with a proper thickness	10	The insertion process may cause a structural failure to the wall	Fix the lintel to bear the brick load	12	Its relatively easy to afford	
5	Roof structure and strap	Quality of the thatch is also an issue as most thatched houses they use the grass with a lot of debris hence decomposes faster than expected. some don't tie the thatched grass making it prone to wind	The roof doesn't get off the water quickly hence getting into the grass casing decomposition.	Clean grass makes the roof to have a long life since there are no decomposing	8	At least clean the grass that will be on top	11	Marrying the two can be a challenge sometimes	Clean the grass before using it for thatch	11	(applies only for thatch roof) A lot of grass will be needed to satisfy the need	
6	**Foundation(DPM, Plinth wall, plastering with water dehydrating agent)**	**Plinth wall with a compacted space protects the foundation wall from getting wet.**	**A well compacted volume of filled material between foundation and plinth wall blocks the running water to soak the foundation wall**	**A dry foundation is stronger to bear the superstructure loading effect.**	7	Construct a plinth wall around the foundation to avoid water getting closer to the foundation and where the foundation is low consider an	11	Providing an embarkments is the easiest thing that only needs man power	Raise the foundation and construct a plinth wall around it	10	Molding of bricks for the plinth wall demands an extra labour	
7	**Structure (column, beam, load bearing walls, lintel, wallplate,etc.)**	**Some houses have a one-brick thick load bearings walls**	**The wall is overloaded with the roofing risking human life and property damage due to structural failure**	**A thick wall support the load better and provides much comfort inside the**	7	provide supporting posts to take the roofing load	10	It depend with the availability of poles in the area	Construct a double-brick thick wall or use the bricks of a good thickness	10	The shelter consumes more bricks and mortar to construct double-brick thick wall	
8	**Foundation(DPM, Plinth wall, plastering with water dehydrating agent)**	**Damp proof membrane protects the wall from the capillary action**	**Incase of the foundation getting wet the moisture is blocked to get into the superstructure wall**	**The wall is kept dry all the time making it strong**	7	Construct a plinth wall to avoid water getting closer to the foundation and drain water away from the structure quickly	11	The suggested solution can reduce the magnitude of the effect	sensitize the importance of putting a membrane/plastic sheet before starting construction of the superstructure wall	9	The cost attached to it may not be affordable to everyone	

Wall starting on a header course on the ground

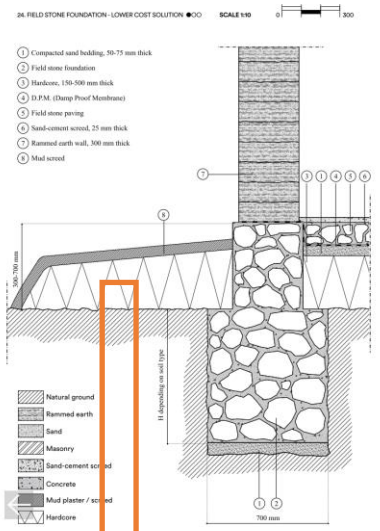
Side Gable CGI covered (burnt brick) Design – lintel failing due to heavy brick loading and lengthy span

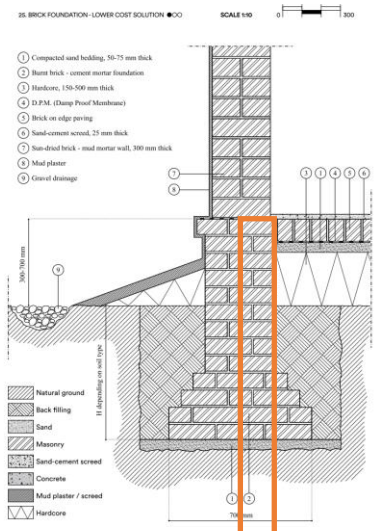
Missing wall plate for even distribution of load on the wall

Recap: foundations

Foundation solutions from safer housing guidance:

- Rubble (field stone) masonry
- Burnt brick with cement mortar





Low cost alternative foundation elements

- Damp proof membrane
- Raised plinth, ideally protected with bricks and/or plaster

Verandas (*khonde*) and other exterior covered spaces where many daily life activities take place as these shadowed spaces are very comfortable in hot days. House in Penganga, Ntcheu. © Jon Twingi

Plastic membrane protecting the wall from humidity in Masako, Dowa (bottom). © Jon Twingi

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Identified weak elements for loadbearing structures:

Walls with insufficient thickness and an important height are dangerous in the events of a disaster as they are not stable enough. CC - Ignasio Ngoma

Unsupported masonry gables tend to fail in the out-of-plane direction in the event of an earthquake. This house's gable fell after the Karonga earthquake in 2009. © Sonia Molina

Missing wall plate for even distribution of load on the wall

Raising dampness creates unhealthy living conditions inside the houses due to moisture. © Sonia Molina

Side Gable CGI covered (burnt brick) Design – lintel failing due to heavy brick loading and lengthy span

When wooden poles are in direct contact with the ground and are not regularly treated or replaced, they are vulnerable to rising damp and decomposition. Veranda in Lifidzi, Salima. © Jon Twingi

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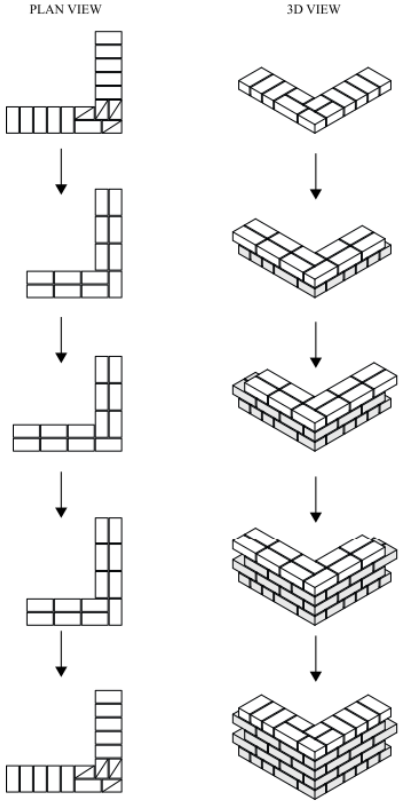
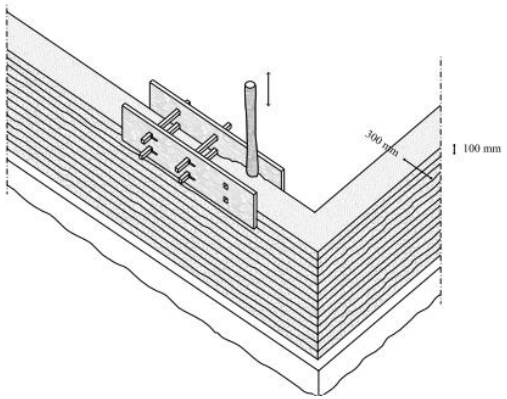
wall solutions from safer housing guidance:



33a. RAMMED EARTH WALL - LOWER COST SOLUTION ●○○



5.2.2. Rammed earth walls

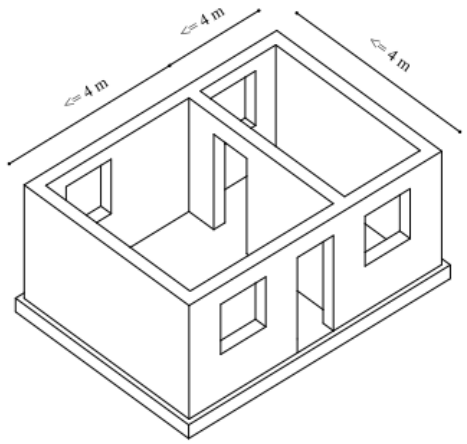
The rammed earth wall height should be less than 8 – 10 times its thickness. Considering a 2,5 m high wall from slab on grade to roof connection, the minimum allowed thickness is 300 mm.
The unsupported length of a rammed earth wall between cross walls should not exceed 13 – 14 times its thickness. Therefore, for a 300 mm thick wall, the maximum distance between cross walls should not exceed 4 meters.
During the building process, each compacted layer should not exceed 100 mm.
The best way to ensure the monolithic structure of the rammed walls is to pour a sufficient quantity of water at the sub-joints every 100 mm.
Bamboo canes can be used as internal (within the wall) vertical reinforcement, placed every 400 – 800 mm. The reinforcement must be attached to the foundation and connected to the ring beam (if present) at the top of the wall.

32. MAXIMUM DISTANCE BETWEEN WALLS - LOWER COST SOLUTION ●○○

5.2.1. Sun-dried brick - adobe - walls

A typical size of 290 – 300 mm long by 140 – 145 mm wide by 90 – 100 mm high is recommended for sun-dried (adobe) bricks.
The sun-dried bricks (adobe) wall height should be less than 8 – 10 times its thickness. Considering a 2.5 m high wall from slab on grade to roof connection, the minimum allowed thickness is 300 mm. Therefore, all structural walls must be one-brick walls. Half-brick walls should not be allowed.
All the walls should be well tied up with each other, so the building can act as a box during earthquake vibration. In order to obtain an effective box-like action, the maximum unsupported length of wall between cross walls must be limited. The unsupported length of an adobe wall between cross walls should not exceed 13 – 14 times its thickness. Therefore, for a 300 mm thick wall, the maximum distance between cross walls should not exceed 4 meters.

28. MAXIMUM DISTANCE BETWEEN WALLS - LOWER COST SOLUTION ●○○



5.2.4. SSB – Stabilised Soil Block – walls

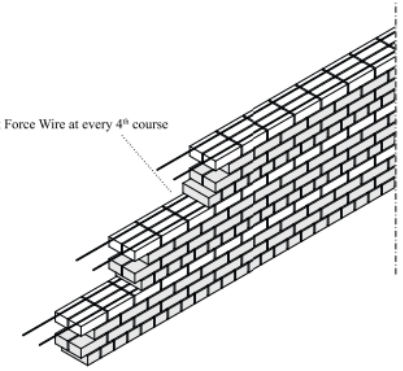
If all SSB walls are provided with a ring beam that ties them together, the height of a SSB wall should be less than 18 times its thickness. Considering a 2,5 m high wall from slab on grade to roof connection, the minimum allowed thickness will be 140 mm. Therefore, a half-block wall (140 mm thick) is sufficient to carry the vertical and lateral loads.
In order to obtain an effective box-like behaviour, the unsupported length of a SSB wall (140 mm thick) between cross walls should not exceed 25 times the wall thickness. Therefore, for a 140 mm thick wall, the maximum distance between cross walls should not exceed 3.5 meters.

41. MAXIMUM DISTANCE BETWEEN WALLS - HIGHER COST SOLUTION ●●●

Horizontal reinforcement - enhancement of seismic response

Horizontal joint reinforcement built into the walls improves the seismic resistance of the masonry. The horizontal joint reinforcement should consist of Brick Force Wire at every 4th course.

38. ONE BRICK WALL - HORIZONTAL REINFORCEMENT - HIGHER COST SOLUTION ●●●



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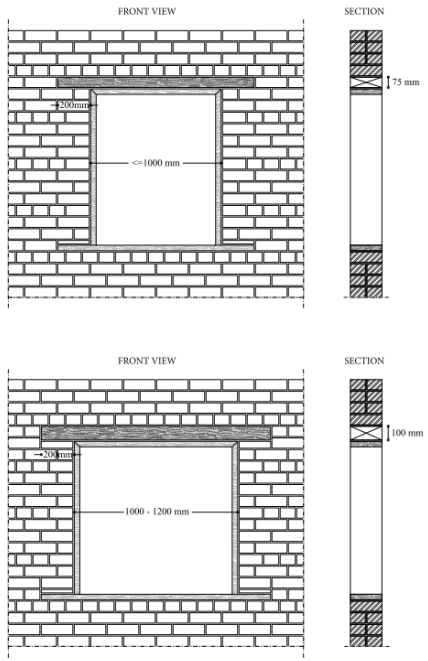
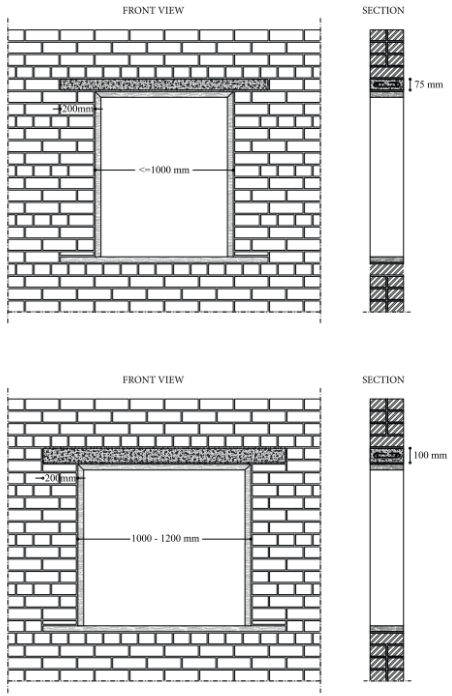
Lintels and beams from safer housing guidance:

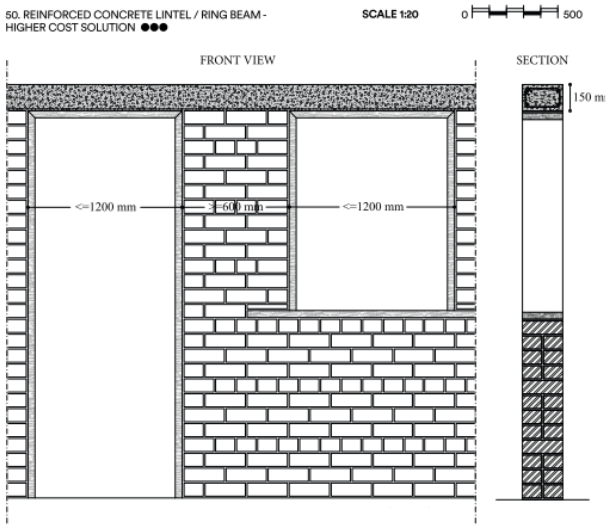
Timber lintel:



Concrete lintel:



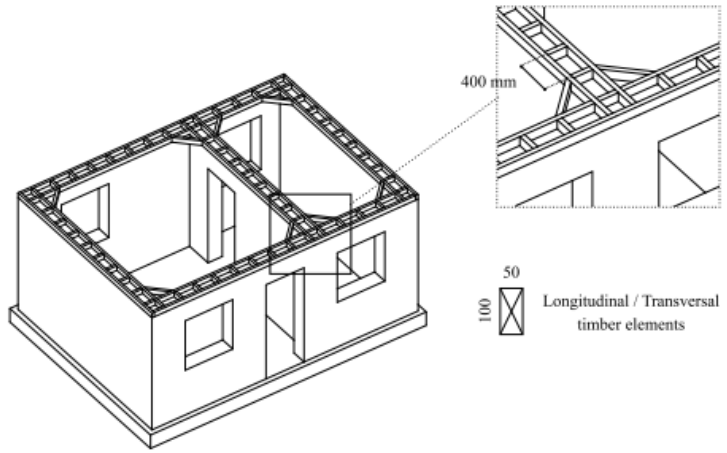
Reinforced concrete ringbeam:



5.4.2. Timber/wooden ring beam

As an alternative to reinforced concrete, the ring beam can be timber (treated against termites, pine tree is recommended) or wood (blue gum is recommended). This solution is recommended for buildings characterised by poor mechanical properties of the masonry (adobe and rammed earth walls).
The timber ring beam should be built using two longitudinal timber members (base = 50 mm; thickness = 100 mm) placed in parallel, with halved joints at corners and junctions of the walls. Transverse pieces (50 x100 mm section) should be placed at 400 mm distance.
The wooden ring beam should be built using two longitudinal wooden members (diameter ≥ 80 mm) placed in parallel, with halved joints at corners and junctions of the walls. Transverse pieces (diameter ≥ 80 mm) should be placed at 400 mm distance.
All the joints must be nailed together and firmly tied to the walls with galvanised steel wire: at least 2 wrappings will be required for every transverse piece (400 mm) around no less than 600 mm of masonry.

53. TIMBER RING BEAM - MEDIUM COST SOLUTION ●●○



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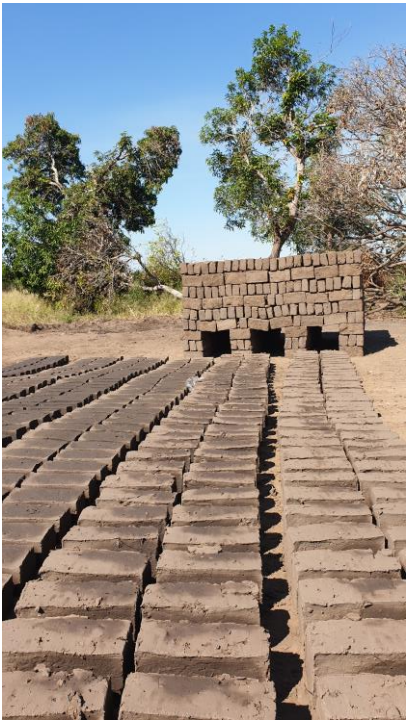
What environmentally friendly „green" materials to promote?

Adobe, Wood ?, Burnt brick?, Stone, Stabilized compressed earth blocks?, Concrete blocks?... Steel??






How to rank the different solutions in terms of safety, affordability, technical skills, material availability, etc.?

	Very low cost		low cost		medium cost		High cost		Very high cost	
Foundation	Technical affordability	(range 1 to 5)	Technical affordability	(range 1 to 5)	Technical affordability	(range 1 to 5)	Technical affordability	(range 1 to 5)	Technical affordability	(range 1 to 5)
	Mitigation measures		Mitigation measures		Mitigation measures		Mitigation measures		Mitigation measures	
	Technical relevance	(range 1 to 5)	Technical relevance	(range 1 to 5)	Technical relevance	(range 1 to 5)	Technical relevance	(range 1 to 5)	Technical relevance	(range 1 to 5)
	Mitigation measures		Mitigation measures		Mitigation measures		Mitigation measures		Mitigation measures	
	Social impact	(range 1 to 5)	Social impact	(range 1 to 5)	Social impact	(range 1 to 5)	Social impact	(range 1 to 5)	Social impact	(range 1 to 5)
	Mitigation measures		Mitigation measures		Mitigation measures		Mitigation measures		Mitigation measures	
	Environmental impact	(range 1 to 5)	Environmental impact	(range 1 to 5)	Environmental impact	(range 1 to 5)	Environmental impact	(range 1 to 5)	Environmental impact	(range 1 to 5)
	Mitigation measures		Mitigation measures		Mitigation measures		Mitigation measures		Mitigation measures	
	Cultural impact	(range 1 to 5)	Cultural impact	(range 1 to 5)	Cultural impact	(range 1 to 5)	Cultural impact	(range 1 to 5)	Cultural impact	(range 1 to 5)
	Mitigation measures		Mitigation measures		Mitigation measures		Mitigation measures		Mitigation measures	