Simple Action For the Environment (SAFE)
Registered under: Niraporth Bangladesh Songstha (Safe Bangladesh Organisation, SBO),
Sundarban Village, PO: Ramdubihat, Upuzila: Sadar Dinajpur.

Housing and Hazards
www.housingandhazards.org

Case study: construction of improved rural house in Dinajpur, Bangladesh

06 April 2011

Introduction

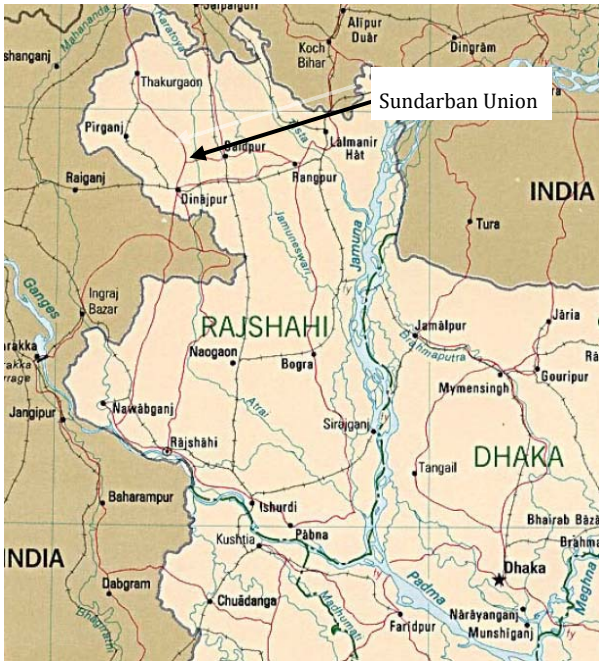
SAFE is a small NGO working in the Dinajpur district of Bangladesh to:

Reduce the vulnerability of low income households to environmental hazards such as flooding and strong winds.

We do this through promoting improved and appropriate house building techniques – using cheap, locally available materials, and environmental initiatives such as tree planting. With stronger houses that last longer, households in the long run save time and money and are less vulnerable to environmental hazards.

We aim to increase community self reliance by creating skilled and informed local builders, craftsmen and house owners. We do this through a programme of workshops, construction of demonstration houses and material subsidies.

This case study documents the construction of one such demonstration house which took place during March 2011. It has been undertaken with support from the Australian High Commission, British Women's Association and Housing and Hazards. It details our participatory approach and provides technical information about our techniques and the associated costs.



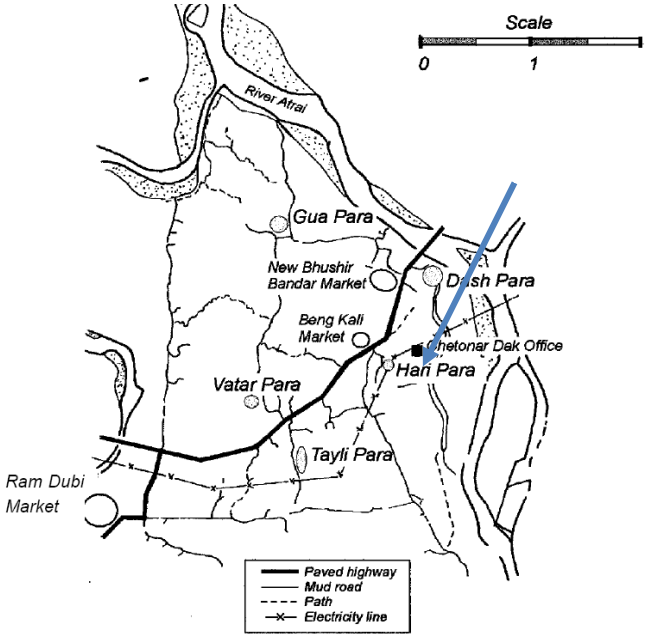
Northern Bangladesh

Participatory Approach

We recognise the importance of participation if our new techniques are going to be accepted and spread within the local population. This house has been built through a partnership between SAFE and the household. Both parties contributed labour and materials in an approximately 50/50 split. This split was agreed at the outset and a simple hand written contact outlining each party's responsibilities was signed.

The size and type (bamboo frame with mud plaster walls) of house was decided by the household based on available materials and space requirements. From this we constructed a scale model with the household and builders to ensure everyone understood the design.

The house included some new techniques and we made sure that the household and builders understood these fully. As part of this we organised a 2-day building-for-safety workshop for households in the local area, students and local builders. These workshops included practical demonstration of these new techniques.



Map of Sundarban Union showing location of demonstration house

Improved Construction Techniques

The house has been built with the household of Ranu and Gojen Chanda Roy near Hari para, Sundarban village, Dinajpur. The house is being built to replace the existing sleeping room which was in poor condition and too small owing to an extra family member having moved back to the house. The house comprises of 2 bedrooms and is of total dimensions 24ft by 8ft. The house is built on a mud plinth with no foundations (the existing ground being well consolidated), the structure is made from bamboo with 'wattle and daub' walls. The roof is of lean-to (*ekchala)* construction and made with bamboo frame and corrugated iron (CI) sheet. SAFE has used added several low cost improvements to this traditional house and these are as follows:

Foundation

The plinth was compacted in layers by hand. The plinth area and lower half of the walls are particularly at risk to damage by rain and two techniques were used to make the plinth

Workshop participants applying cement stabilised mud to walls

much more resistant to water. A capping layer, 2-3" thick, of cement stabilised mud was placed on the plinth. The mud was mixed with 5% cement[1,2] (refer to footnotes for more for more information on this technique). The plinth was finished with a cement and lime slurry (mixed in the proportions 1:1:6 lime : cement : water)[2], and coloured with a black oxide powder available at the local market.

Bamboo structure

Treatment with borax/boric acid solution

All bamboo used in the structure was treated with a solution of borax, boric acid and water. This solution penetrates the bamboo easily, reducing the level of sap in the bamboo and making it less likely to be damaged by insects. A Vertical Soak Diffusion technique was employed[3]: the bamboos are stacked vertically and the solution is poured inside from the top end (prior to this a hole was made in each diaphragm using a long metal rod, hammered into one end; the last diaphragm being left so that water would be contained within the culm).

The culms were left for 7 days, topping up daily as required. A concentration of 4% borax, 3% boric acid and 93% water by weight was used. The borax/boric acid solution can be reused up to 4 times so the most cost effective approach is to treat ¼ of the total bamboo at a time. If done in this way the total cost of the treatment is approximately 5% of the cost of the bamboo. Refer to section on costs below for more cost information.

The soaking period of 7 days is less than sometimes advised. It was judged that a period of time longer than this would result in a total soaking time (i.e 4 batches) that was so long as to be inappropriate for most rural households. The performance of the house over the next year will demonstrate whether this length of time was adequate.

Bamboo stacked for treatment

Topping up borax solution

[1] Iftekar, K.A. Handbook on Design and Construction of Housing for Flood-Prone Rural Areas of Bangladesh, ADPC 2005. Available at www.sheltercentre.org

[2] Norton, J. Building with Earth, A Handbook, Practical Action, 1997

[3] Vertical Soak Diffusion for Bamboo Preservation, Environmental Bamboo Foundation, 2003. www.bamboocentral.org

Concrete footing (kaatla) & bitumen

To prevent the part of the bamboo culm in the ground rotting, two techniques were used. 6no. posts were fixed to concrete footings or stumps (see sketch the final page). These form the foundation for the posts at the corners and the middle. These are the posts to which the cross bracing is fixed and are the most important for strength. The lower parts of the remaining posts were painted with bitumen. Refer to footnote 1 on previous page for more information on these techniques.

Bracing

Cross-bracing and plan-bracing were used too provide strength to sideways forces from high winds.

Stronger joints

The bamboo joints are fixed with nylon rope or wire. Bamboo nails are used at knee joints (see picture opposite). The cross-bracing is fixed with 6" steel nails (rather than bamboo nail) in pre-drilled holes and secured with nylon rope. This is because of the shear force on the nail due to the nature of this joint.

Design features

The cross wall dividing the two rooms is cross-braced.

Ventilation and lighting was improved by including small windows on all walls, and a small gap around the top of the walls.

The wattle and daub mud walls are places outside the bamboo frame and cross-bracing, protecting the structure from the rain. This is contrary to most local practice.

Walls

The walls are constructed with a wattle and daub technique. A bamboo 'lattice' is made by weaving strips of bamboo together and fixed to the outside of the frame. The lattice is raised off the floor by standing it on a row of bricks placed on the plinth. Mud is then

Corner joint at roof level with bamboo nail

applied in layers on both sides of the wall up to approx 2" thick, at a consistency where it can be squeezed between the lattice.

Three techniques have been used to improve the performance of the mud. On the lower half of the wall, cement stabilised mud (as for plinth capping, p3) has been used. This improves resistance to water and was not deemed necessary on the upper half of the walls as they are well protected from the rain by the overhanging roof. The mud used for the upper parts of the walls was mixed with rice straw to reduce cracking and help it bind to the lattice. Lastly a slurry of cement, lime and water (1:1:6) was painted over the lower half of the walls, again to improve resistant to water.

In this case, these 3 techniques have been used together for the purposes of testing new ideas - it is not necessary to use them all together in this way.

Testing cement stabilised mud

Roof

The roof is lean-to construction (*ekchala)*, made with a bamboo frame and CI sheet. The CI sheets are not fixed with roofing nails but with a local *sapra* technique which uses thin strips of bamboo, passed over and below alternate sheets, to secure them to the frame. In this way the sheets are not damaged by nails and can be easily resold.

Exposed parts of the roof frame were painted with bitumen and fixings made with galvanised wire.

A layer of bamboo matting has been placed directly below the CI sheet roof to provide some insulation from the heat.

Due to the small overhang of this roof, extra protection is needed for the walls. On one side of the house, a veranda has been built and on the other three sides small side roofs (see picture opposite) will be constructed.


Example of side roof (from different house)

For more information contact:

Azit Roy, T: +880 (0)1726 007 343, E: azit_sorkar@yahoo.com
John Arnold, T: +880 (0)1753 858 660 E: johnarnold700@yahoo.co.uk

In the UK:

Robert Hodgson (Housing and Hazards), T: +44 (0)1884 821239
R.L.P.Hodgson@exeter.ac.uk

House owner Gojen Roy

Compacting the plinth (taken from different house)

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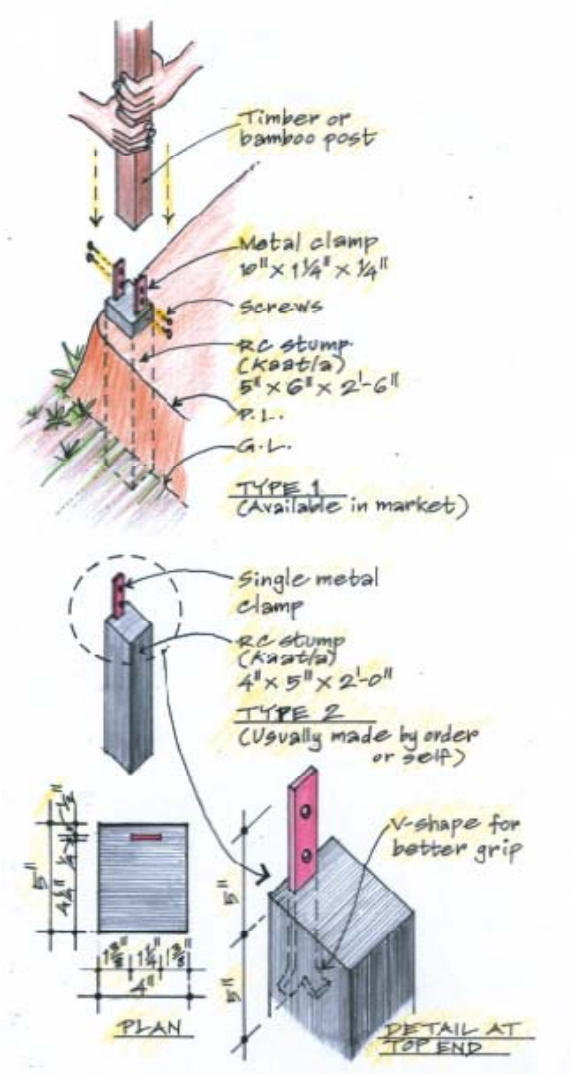

Concrete footing (*kaatla*), *taken from handbook for floodprone construction in Bangladesh, see footnote 1*

Cost breakdown for SAFE demonstration house - Ranu and Gojen's house

09th April 2011/JA

Notes

- Cost only includes material and labour costs. Tools for work not included
- Extra material or labour cost mean the costs associated with the improved building techniques
- Costs include materials and labour supplied by household in kind, e.g labour, recycled CI sheet
- The house comprises of 2 bedrooms and is of total dimensions 24ft by 8ft. The foundation is a mud plinth, the structure is made from bamboo with 'wattle and daub' infill walls. The roof is of lean-to (ekchala) construction and made with bamboo frame and Corrugated Iron (CI) sheet.
- Exchange rate at time of writing exchange rate approx. 1 GBP = 105Tk

				Material cost (Tk)		Labour cost (Tk)	
Item	**Quantity**	**Unit**	**Rate**	**Orignal cost**	**SAFE improve-ments**	**Original cost**	**SAFE improve-ments**
Foundation - plinth							
Cement for stabilisation of capping layer	50	kg			370		
Labour cost for carrying mud into place	5	man days	@370Tk/50kg		750		
Labour cost for compacting plinth	2	man days	@150Tk/day		300		
Labour cost for crushing mud in preparation for stabilsation	5	man days	@150Tk/day		750		
Treatment of bamboo							
Average amount of solution required per length bamboo	0.49	litres/ft bamboo					
Total length of bamboo used for structure (excluding wall lattice)	537	ft					
Assume reuse solution 4 times and treat 1/4 bamboo in 4 batches							
Total solution required for 1 batch	66	L					
Cost of borax	70	Tk/kg					
Cost of boric acid	80	Tk/kg					
Cost of 1L solution @ 4:3:93 borax:boric acid:water by weight	5	Tk					
Cost of total solution required.					344		
Labour for treating process	6	man days	@150Tk/day				900
Concrete footing (*kaatla)*							
Materials for 6no. footings (concrete and metal clamp)		Tk			537		
Labour for making footings	1	man days	@200Tk/day				100
Coating posts with bitumen							
Bitumen (alcatra), 5L	5	kg	@60Tk/kg		300		
Labour for painting	1	man day	@150Tk/day				150
Frame							
Bamboo for frame, walls and roof	42	culms	@130ea	5070	390		
GI wire	1	kg	@80/kg		40		
Nylon rope	2	kg	@80/kg		120		
Walls							
Cement for stabilisation	100	kg	@370Tk/50kg		740		
Labour cost for crushing mud in preparation for stabilsation	10	man days	@100Tk/day				1000
NOTE: Labour cost for preparing cement stabilised mud is similar as trad-							
-itional method plaster therefore not included as extra							
Lime for slurry					80		
Bricks under the perimeter fo wall			@4Tk ea.		350		
Roof							
Cost of CI sheet (approx size: 10'x2.5')	13	no.	@490ea	6370			
Bamboo matting used for insulation under the CI sheet	1	piece		1500			
Finishes							
1no. timber shuttered window and 1no. timber door and frame				1500			
Total costs				14440	5071	10600	2150

Cost summary				
Labour cost for SAFE	6750	Tk	@150Tk/day	
Labour cost (in kind) by household	6000	Tk	@150Tk/day	
Total labour cost	12750	Tk		
material cost without SAFE improvements	14440	Tk		
Total cost of SAFE improvements	5071	Tk	26%	of total material cost
Total cost (materials only)	19511	Tk		
Total cost (labour + materials)				
Total cost without SAFE improvements	25040			
Total cost of SAFE improvements	7221			
Total cost (labour + materials)	32261		22%	of total cost