

## **CYCLONE-RESISTANT DOMESTIC CONSTRUCTION IN BANGLADESH**

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### **Introduction**

The Multipurpose Cyclone Shelter Project (MPCSP) : MPCSP, financed by UNDP and the World Bank and undertaken in 1992/3 (BUET/BIDS, 1993) was a detailed study with the objective of the provision of cyclone shelters to provide refuge for the population of the cyclone-prone areas of Bangladesh. Subsequently, an interim Study Project has been undertaken to assess the feasibility of a construction programme and to ultimately prepare contract documentation. This subsequent study has adopted the sub-title of the Cyclone-Risk Area Development Project.

In its consideration of domestic dwellings, the MPCSP Report "Master Plan" (BUET/BIDS, 1993) made reference to those of pucca construction in recognising that private residences play a significant role as safe havens (shelters) in cyclones and that strongly built pucca private residences with two or more stories saved many lives in the April 1991 cyclone.

The Master Plan includes discussion of settlement patterns and of a survey for the preparation of an inventory of one-storied private buildings for conversion to provide more secure refuge in cyclones. It does not include reference to the quality, poor or otherwise, of which the majority of rural dwellings are constructed.

Kutchha and pucca dwellings : More than eighty percent of the population of Bangladesh is classified as rural, according to the 1991 Census. Although the number of pucca constructions increased by several hundred percent during the ten years 1981-91, the national average proportion of pucca buildings to total household numbers is still only 2.18% (BBS, undated). Thus, more than nine million houses, occupied by over 90% of households, are of less than pucca construction. The need for improved kutchha construction for dwellings therefore relates to their far greater number and to a prevailing context of poverty.

The need for housing provision : The ADB Report of the Housing Sector Institutional Strengthening Project (HSISP, Halcrow Fox, 1993) reviews the involvement of NGO and aid programmes in these contexts. It includes an assessment of the performance, strategies and institutions of the urban and rural housing sector, particularly the provision of shelter and services to low-income

households, noting that :

- 82% of dwellings in Bangladesh are in rural areas,
- 75% of rural dwellings are of kutchha construction (non-masonry - bamboo, woven bamboo, etc.), and
- 23% of urban and more than 40% of rural dwellings are of temporary construction (lesser quality than kutchha).

These data reflect the prevailing poverty of rural populations in a context of floods and tropical cyclones. Also, most low income households lack fresh water, sanitation, cooking facilities and energy supply. However, in contrast to urban residents, up to 95% of rural people, including those classed as "landless", may own at least the land on which their dwelling is located.

Rural housing need is assessed on the basis of kutchha dwellings being regarded as substandard and requiring replacement with pucca construction. In that case, the HSISP Report estimates that annual construction of 2,167,000 dwellings would be needed, including replacement all "substandard" dwellings over a seven year period. The Government of Bangladesh has accepted that it does not have the resources for such an enormous undertaking and is therefore adopting an enabling approach for the provision of improved housing within a national housing policy.

Evidence from the field : This suggests that in cyclone-prone areas there is a socially perceived need for improved construction of dwellings and that assistance to build stronger homes would be appropriate. "Community houses" might also be built in pucca construction to serve say 50 households in places where other forms of cyclone shelter are remote. Such community houses could be used normally as residential accommodation for a teacher; the land would be donated and the building maintained by the community.

Field sources have also commented that the dangers of flying roof sheets discourage people from leaving dwellings to go to shelters. In 1991 three people were killed in this way at Bakerganj; as the embankment was not overtopped at this position, they would probably have survived the cyclone otherwise. Improved construction would reduce this risk and at the same time make it less dangerous to stay at home.

Improvements in housing standards must be undertaken in conjunction with development of sea and river embankments and increased understanding of the impacts of storm surge flooding.

## Improved domestic construction for cyclone resistance

Pucca materials (brick, block work and corrugated galvanised iron (cgi) sheet) have been in use for so long that it is often difficult to make a useful technical distinction between "traditional" and "non-traditional" construction. Kutcha and pucca combine in the form of semi-pucca buildings and cgi sheets are used in all forms of buildings and for many purposes (walls, roof, water channels, fencing, etc.).

Traditional construction takes forms reflecting cultural expressions as well as expediency. It is used by the majority of rural dwellers, both landowning and landless. While there is room for improved cyclone resistance in pucca construction, the need is much greater among the millions of people dependent upon traditional materials and construction methods.

Previous initiatives to improve domestic construction in Bangladesh have mostly focussed on the use of non-traditional materials such as reinforced concrete or steel framing. This implies an inadequacy of traditional materials whereas the real need is instead to improve traditional construction methods.

Cyclone-resistant traditional building technologies have been largely neglected for the following reasons :

- The major cause of damage and death in cyclones has been the accompanying storm surge; non-pucca construction has been swept away regardless of its quality
- Embankments have largely failed to protect homes either because they did not exist (1970) or were insufficiently maintained, and
- There is a tendency to spend as little as possible on domestic construction since the investment is likely to be washed away in the next storm surge.

## Hazard class

Five hazard classes have been proposed by the Cyclone Resistant Infrastructure Development Project. These identify depths of potential inundation by storm surges as follows:

Hazard Class	Depth of water (m)
1	below 0.5
2	0.5-1.0
3	1.0-1.5
4	1.5-2.0
5	Greater than 2.0

## Wind risk areas

Wind alone will be the prevailing hazard in areas inland from those affected by storm surges.

## Appropriateness of Improved Domestic Construction

As improved domestic construction can be made to withstand flooding of up to one metre and high winds, it is appropriate to consider this approach in

- areas of Hazard Class 2 (below 1.0m)
- areas of wind risk alone

Within these areas, improved construction could make possible :

- continued occupation of homes during cyclones;
- reduction in need for safe-havens;
- avoidance of dangers between homes and safe-havens;
- reduction of time away from home and attendant risk of theft;
- Greater ability to use roofs of both kutchra and pucca dwellings as refuge during floods (designs should allow for this)
- reduction of the recurrent costs of dwelling reconstruction/replacement, enabling more people to stay safely in their own homes will relieve overcrowding in safe-haven structures. This has been noted in the past as contributing to reluctance to use such shelters.

## CGI roofing

CGI (Corrugated Galvanised Iron) sheet has been used in the construction of domestic buildings for more than 150 years. It is used successfully in cyclone resistant construction elsewhere in the world (eg. Lewis, 1991). It is becoming widely used in Bangladesh because of its convenience, as an expression of comparative wealth and because it is often distributed as a relief or reconstruction material after cyclones and floods.

Less constructively, cgi is recognised as having a long-term resale value. The sheets are liable to be redistributed among family members in the case of the owner's death or sold to relieve financial hardship. Either of these situations can thus initiate deconstruction of the dwelling and substitution with a material of lesser quality (though possibly one with less dangerous properties).

The distribution of roof sheeting for commercial or relief purposes

should not occur without accompanying advice on cyclone-resistant fixing techniques. It is essential to improve fixing techniques for cgi and other metal, plastic or fibre-glass sheets to reduce damage from detached roofs and to protect the occupants.

### Improved traditional construction

To be widely adopted, any modifications to traditional construction must be assessed for cultural as well as socio-economic acceptability. The wider contexts of population migration (both long-term and seasonal), flooding and cyclone-risk reduction, land tenure, credit access and development policies are all relevant to successful implementation.

Subject to regional availability, traditional materials are typically used as follows :

Floor	Frame	Walls	Roof
Mud plinth	Bamboo pole	Woven bamboo	Thatch
Raised timber	Jute poles	Mud	CGI sheet
		CGI sheet	

### Siting & layout

The siting of the scattered settlements of rural Bangladesh characteristically takes advantage of the slightest variations in ground levels. Trees (where existing) and buildings should be inter-related so as to protect each other.

Clustering helps to protect from normal winds and weather as well as from cyclones in a way that linear layouts do not. It also allows greater privacy with freedom of movement, especially for women. Supervision of children and animals is easier and security against looters (a particular requirement of relocated communities) is improved. For all these reasons, land allocated to housing projects should be sufficient to allow clustered layouts.

### Plinth

Extreme care and attention is usually given to construction of the raised floor or plinth which is often the only remaining trace of a building after a flood. This can be constructed in excess of half a metre in height and thus protect the rest of the structure in Hazard Class 1 areas.

Improved plinth construction measures include better integration of the frame posts and improvements to the flood resistance of plinths in areas of sandy soils.

### **Frame**

This is usually of muli or talla species of bamboo, possibly with jute poles for lighter members. Frame elements are commonly lashed together with jute rope.

Proposed improvements are :

- treatment of bamboo against insect attack;
- Treatment of poles against rot in the ground;
- better anchoring of poles into the ground
- inclusion of cross-bracing, and
- substituting galvanised wire binding for jute rope.

### **Walls and openings**

Walls are typically panels of split and woven bamboo or similar materials or cgi sheets. Wall panels commence within the mud plinth.

Proposed improvements are :

- Place the door in the centre of the wall
- Add a small window in the rear wall
- To limit the areas of window openings in relation to walls.

### **Roof**

The roof is usually either thatch or cgi sheet.

Proposed improvements are :

- increasing the pitches of roofs to 30 to 40 degrees;
- encouraging the use of hipped roofs;
- tying down thatch;
- more frequent, improved fixings for cgi sheet, and
- methods for the permanent or temporary tying down of entire roofs (eg. on receipt of cyclone warnings)

### **Survival of cyclone-resistant kutcha construction**

It is necessary to establish the extent to which improved kutcha construction has survived in cyclones and reasons why traditional construction has failed. Case studies from the field are required.

### **Storage of belongings**

Traditionally, family belongings are stored by burial in the mud plinth of the house. This could be allowed for in construction of the plinth by, for example, incorporating a concrete box. Cyclone-resistant construction offers alternative options for domestic storage within the roof structure.

### **Tree planting**

Afforestation is referred to in the MPCS "Master Plan" as traditional accompaniment to dwellings in coastal areas, as it is throughout Bangladesh.

Trees provide :

- wind break
- impediment to waves and surge
- anchorage for people and dwellings
- high level platform bases
- ground stabilisation

Tree planting programmes on killas and embankments should be extended to settlements throughout the risk areas and planting materials made available for the purpose.

### **Improved pucca construction**

Construction in pucca, or permanent, materials such as brickwork and concrete block work offers further important opportunities for improved domestic construction. Very many more advisory studies have been undertaken for pucca construction than for traditional construction. This probably reflects an assumption that pucca construction is a prerequisite for cyclone and flood-resistance as well the affinity of Dhaka-based or overseas donors for pucca rather than traditional methods.

It should be remembered that pucca construction requires improved building techniques to use its more permanent materials to their fullest advantage. Social and economic investment in the perceived security of pucca construction may otherwise result in greater, not lesser, losses.

Possible improvements in pucca construction include :

- the use of concrete in foundations and improved anchoring techniques
- the use of sawn timber and galvanised steel straps to tie roof structure members to each other and to walls
- improved fixings for roof sheets
- the provision of external timber window shutters.



### **Non-traditional construction**

An influx of non-traditional construction forms occurred after the 1970 cyclone and the War of Liberation in 1971. Projects proliferated to create flood- or cyclone-resistant domestic construction, for "nucleus houses", steel-framed dwellings or those with concrete posts and beams. Many initiatives were the results of alien preconceptions of need and usefulness originating outside Bangladesh. Few of the products were sustainable either as dwellings or as projects and were easily superseded as development assistance shifted to other priorities.

Successful technology transfer requires that the new technique be seen to serve a specific issue, to be of clear advantage, to follow traditional social and cultural forms and to be of low cost. One successful example was the introduction during the 1970s of polythene sheet used in bamboo mat "sandwiches" for roofing. Reinforced concrete "nucleus houses", built by the PWD at Urir Char, filled a specific need for "sentry" houses for guards who could prevent looting while others went to shelters. Unfortunately, poor site selection has sometimes negated the benefits as whole buildings have been swept away.

### **Implementing improved domestic construction**

The cost of the proposed improvements to a kutchha bamboo dwelling would be of the order of 5% of its total cost and the same might be expected for upgrading a pucca construction. It is interesting to note that a study in Comilla in 1977 found that although the home represented 10% of its assets, the typical family spent only 2% of its income on maintenance.

Both Government and non-governmental agencies have provided various types of assistance with rural housing. These programmes, including loans for construction, house repair projects and construction of new buildings, have not always managed to target those rural landless households in most need. In any case, exercises in non-traditional construction by-pass the real need which is for improved traditional construction.

### **Promulgating improved construction technology**

Traditional construction is undertaken by self-builders, possibly with help from neighbours and friends (other self-builders). This artisanal building is an aspect of local knowledge and is not in the purview of construction professionals or commercial contractors. Therefore, ways must be found to reach self-builders using methods more appropriate to this audience than conventional sources of information on construction technology.

Methods for technical improvement should be considered in their cultural, social, economic and practical contexts, including, for example :



- training programmes for non-governmental organisations (ngos) engaged in housing construction, repair and loan programmes so that their activities could be accompanied by the promulgation of improved traditional construction techniques;
- promulgation by ngos would be through community groups and community development activities;
- additional public information programmes should be mounted to spread information through newspapers and local news sheets;
- demonstration projects with technical assistance in the field.

These activities would require the preparation of guidelines, leaflets and notices in Bangla and with graphic illustrations for distribution as public information programmes in advance of each cyclone season. Additional information leaflets should be prepared for promulgation through purveyors of construction materials, especially of corrugated roof sheets.

A series of participatory demonstration projects should be mounted to show the importance of house siting, juxtaposition and form and how various materials should be selected, treated, joined and maintained. These would provide the visual material for the preparation of videos to be used by ngos and others in community development programmes.

All these activities should be either continuous or repeated annually.

## Conclusions

Dwellings incorporating improved cyclone and storm-resistant construction are an important component of cyclone-resistant infrastructure development.

Improved domestic construction can be capable of resisting flooding of up to half a metre (Hazard Class 1) and cyclone winds of inland force.

Improved techniques for the fixing of corrugated galvanised iron roof sheets are required urgently.

Programmes for improved domestic construction should be considered in their cultural, social, economic and practical contexts. Such programmes should be :

- inclusive of tree planting;
- inclusive of both kutchha and pucca materials and methods
- repeated annually or designed to be continuous.

### Points for further study

- The present imbalance of funding in favour of pucca construction requires redressing to concentrate more on kutchha types;
- Roof construction must take into account its significance as shelter in times of flooding;
- The relationship between dwelling maintenance and cyclone damage needs to be addressed through training and information programmes;
- Post-cyclone field surveys of the modes of structural failure of kutchha construction are required;
- Long-term programmes, say 25 years, are needed for effective promulgation, demonstration and absorption.

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