Building Safer Houses in Rural Bangladesh

Salek M. Seraj and K. Iftekhar Ahmed

A safe house that safeguards its inhabitants from the destructive effects of natural elements is a basic human right. Substantial research has been carried out worldwide on developing hazard-resistant housing, yet millions of people in countries such as Bangladesh still remain at the mercy of natural hazards. It is not the lack of available solutions, but poverty that creates this vulnerability. What would be classified as a hazard in an affluent country, assumes form as a disaster here.

Bangladesh University of Engineering and Technology (BUET) and the University of Exeter, U.K., have been collaborating through a DFID-funded higher education link to conduct practical research into affordable technologies that could help those in need of safer homes. This includes laboratory and field studies to develop improved understanding of natural and local building materials, behaviour of non-engineered rural construction, process of low-income home procurement, socio-economic aspects of low-income housing and participatory dissemination methods. It was also attempted to raise awareness of such issues among professionals and decision-makers through international seminars and national workshops. This book is a direct outcome of this link and its subject matter is derived from the experience gathered through the link. The underlying notion is that to be effective, technological improvements must be appropriate, accessible, available and, above all, affordable.

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1. Context of Housing and Hazards

1.1 Introduction

The context of housing in Bangladesh is shaped by the interaction between people and nature, where nature is beneficial but also presents hazards. Indeed, natural hazards (and also man-made ones) are an integral part of life in Bangladesh, all the more so because a hazard only results in a disaster only if people are vulnerable, this is to say: HAZARD + VULNERABILITY = DISASTER. The poverty of the majority of the people places them in a vulnerable position where they are unable to cope with the frequent hazards that they face – thus disasters making the headlines.

What constitutes the nature of the housing of this majority? This is the main question which this chapter seeks to address. Perhaps what sets the tone is the fact that most of the existing housing and houses which are going to be built in the next few decades are likely to be non-engineered. This form of housing is clearly vulnerable to various hazards and thus arises the importance of addressing the need to reduce this vulnerability, in other words, "building for safety"; this is a basic principle behind the deliberations of this book, hence this introductory chapter begins with a general review of this principle. This is supplemented by highlights of some of the key issues facing building for safety programmes.

Following an overview of general principles in this chapter, some selected aspects are then presented to compose a larger picture of the housing context. Firstly, the housing characteristics and conditions of low-income groups are delineated through the findings of a demographic survey. This shows that although both rural and urban housing are vulnerable to hazards, the urban situation is certainly more precarious. Notwithstanding that, because of the preponderance of rural housing, secondly, it has been chosen to discuss some of its main characteristics. A wide array of rural house types, construction methods and building materials are described.
here. Thirdly, an important user-group – women – is dealt with, where the significance of their contribution to housing is underscored. Similar to selecting women as a specifically important and representative group relating to housing, the most widely used house building material in Bangladesh – bamboo – is also discussed. The report here of diminishing bamboo supply reflects the broader scenario of an overall reduction in the resource base of natural building materials, posing a serious constraint on building adequate and safe houses, and augmenting hazard-vulnerability. Finally, as an example of unique context within Bangladesh, the housing of ethnic communities in the Chittagong Hill Tracts is described.

1.2 Design, Construction and Building for Safety

From time immemorial, natural disasters have been causing the loss of millions of lives and resulting in colossal damage to the economy. In fact, the terms "natural hazard" and "natural disaster" were used almost synonymously. During the last few years, a clear distinction has gradually emerged between the two. A natural hazard is a "natural phenomenon or a combination of phenomena which threaten people or physical assets" while "a natural disaster is an event, sudden or progressive, which impacts with such severity that the affected community has to respond by exceptional measures" (Carter, 1991). Whereas it is extremely difficult to reduce natural hazards, developments in science and technology have now made it possible to reduce natural disasters, i.e. the impacts of natural hazards. This realisation is reflected in the change in nomenclature of the global efforts now underway to mitigate natural disasters. Originally it was named IDHR (International Decade for Hazard Reduction) when it was first proposed in 1984, but, later on, when it was adopted by the UN General Assembly in 1987, its name was changed to the IDNDR (International Decade for Natural Disaster Reduction).

The housing situation in Bangladesh is extremely poor. According to the 1991 housing census, the backlog in housing was 3.1 million units, composed of 2.15 million units in rural areas and 0.95 million units in urban areas. By the year 2000, the housing shortage is likely to exceed 5 million (GOB, 1996). If we take into account the replacement needs of the rudimentary thatched houses, the target will be much more. About 90% of dwellings in rural areas and about 60% in urban areas are non-durable, which implies that even if they are not subjected to extreme natural hazards, they would have to be replaced within 10-15 years.
Although natural hazards affect developed as well as developing countries, there is a difference in their impact. In the developed countries, improved mitigation measures have resulted in a dramatic reduction in the loss of human lives. For example, a magnitude 7 earthquake in a developing country may result in thousands of deaths, but an earthquake of similar magnitude in a developed country (e.g. California in USA) may kill only a few persons. However, the overall loss to the economy is much higher in the case of developed countries. For example, in 1992, Hurricane Andrew caused an estimated loss of US$ 15.5 billion in Florida and the Great Hanshin earthquake in Kobe in 1995 resulted in an estimated loss of US$ 75 billion to physical assets (about 1.6% of GDP).

We have been fortunate that no major earthquake has affected Bangladesh during the last 78 years. The last major earthquake which had its epicentre within Bangladesh was the 1918 Srimongal earthquake which caused a lot of destruction in the Srimongal area and damaged houses as far away as Kishoregonj. A review of the damage statistics of the 1897 Great Indian earthquake shows that most of the brick masonry buildings in Dhaka collapsed or sustained major damage. The effect of a similar earthquake on the city (with a population 65 times more than in 1897), which has a large number of 3-5 storey brick masonry buildings with very little seismic resistance, would be catastrophic now. Moreover, many of these are on fills, with a possibility of ground failure during earthquakes. The traditional light-weight low-rise buildings in the north east part of the country (timber frame with thin bamboo mat walling) had excellent earthquake resistance, but these are unfortunately being replaced by multi-storied brick masonry with reinforced concrete (RC) floors and roofs which are extremely vulnerable to earthquake damage.

1.2.1 Types of Natural Hazards

The various types of natural hazards may be classified as follows:

**Atmospheric Hazards**
- Tropical cyclones
- Storm surges
- Extra tropical cyclones
- Tornadoes/Thunderstorms
- River floods
- Droughts
Geological Hazards
- Earthquakes
- Tsunamis
- Volcanic eruptions
- Landslides
- Snow avalanches

Other Hazards
- River erosion
- Wildfires
- Locust infestation

It is estimated that about 3 million people around the world have lost their lives during the last 20 years due to natural disasters and around 1 billion people have been affected. The total damage during the period is estimated to be US$ 200 billion. Although all sectors of the economy are affected by natural disasters, destruction of infrastructure constitutes one of the major components of this loss.

1.2.2 Natural Hazards in Bangladesh

Bangladesh is one of the most disaster-prone countries in the world. The major natural hazards which affect housing in Bangladesh are as follows:

- Earthquakes
- Tornadoes/Thunderstorms
- Tropical Cyclones and Storm Surges
- River Floods
- River Erosion

1.2.3 Impacts of Natural Hazards on Housing

The effects and consequences of some of the major natural hazards on housing are shown in Table 1.1.

1.2.4 Review of Present Situation in Bangladesh

Until recently the question of housing for the rural poor has received little attention from national decision-makers. There is currently a shortfall of 3.5 million units of adequate accommodation in Bangladesh. The study titled "Bangladesh 2020 - A Long-Run Perspective Study" (World Bank-BCAS, 1998) has projected a national population of 170 million by the year 2020 (medium growth scenario), of which 110 million will be living in rural communities; so the existing problem of rural housing is likely to increase greatly if it is not addressed as a matter of urgency.
World Bank economists use three economic indicators when assessing individual poverty levels; one of those is the material used in constructing the person's house roof. Figure 1.1 shows the present situation in Bangladesh.

Thus, more than half the buildings of Bangladesh have roofs of natural organic materials. These have a short lifespan of typically less than 5 years, so natural decay is often enough to destroy them without including the hazards. Therefore, low-cost improvements that increase longevity will have a very significant role in developing rural resilience to natural hazards.

1.2.5 Government Policy

A National Housing Policy was approved by the government in 1993 with the prime objective of ensuring housing for all strata of society including the disadvantaged and shelterless poor. However, little action has been initiated to follow-up the above policy objectives. The current five year plan (1997-2002) has been recently approved by the government and includes considerable emphasis on rural housing (GOB, 1997), using inexpensive, affordable materials allied to soft loans for low-income households. For this purpose, a special fund would be created by the government. In vulnerable coastal areas additional grants will help local bodies to further reduce costs to the homeowner. This policy appears to reflect a significant shift of emphasis toward the rural poor. Its implementation could make a major impact on poverty alleviation.

1.2.6 Engineered Housing

Buildings which are designed by competent engineers and supervised by them during construction are termed "engineered buildings". The design is governed by building codes which specify the loads, the design methodology and the details to be followed to enable the structure to resist the effects of natural hazards. In Bangladesh, efforts were initiated in 1973 to analyse the hazards due to extreme winds (Choudhury, 1974) and in 1979, to prepare an outline of a
Code for Seismic Resistant Design (GSB, 1979) but it is only recently that a comprehensive National Building Code has been formulated (BNBC, 1993). The Code includes a wind speed map, seismic zoning map and a table giving the storm surge heights at different locations. The use of these values and the provisions of the Code should lead to construction of buildings which provide adequate safety against natural hazards. The Code also includes detailed recommendations for strengthening masonry buildings against earthquakes by providing horizontal as well as vertical reinforcement.

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Effects</th>
<th>Impact on Housing</th>
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<tbody>
<tr>
<td>Flood (can be caused by unusually intense rainfall or by changes to earth's surface, such as deforestation upstream)</td>
<td>Inundation</td>
<td>Damage to human settlements: walls may collapse, foundations may fail. Forces evacuation</td>
</tr>
<tr>
<td>Tropical cyclone, Tornado, Thunderstorm</td>
<td>High winds</td>
<td>Damage to buildings and other man-made structures: roofs blown away, collapse of walls &amp; frames. Collapse of foundation</td>
</tr>
<tr>
<td>Storm surge</td>
<td>Inundation and wave action</td>
<td>Collapse of walls due to inundation; foundation failure; collapse of walls and roof due to wave action</td>
</tr>
<tr>
<td>Earthquake</td>
<td>Tremors (ground shaking)</td>
<td>Damage to buildings, buildings, particularly unreinforced brick masonry and mud-walled housing.</td>
</tr>
<tr>
<td></td>
<td>Liquefaction</td>
<td>Buildings surface sink into soil</td>
</tr>
<tr>
<td></td>
<td>Ground failure (horizontal displacement)</td>
<td>Damages buildings on the rupture lines</td>
</tr>
<tr>
<td>River erosion</td>
<td>Loss of ground support</td>
<td>Collapse of foundation</td>
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Table 1.1: Effects of Major Natural Hazards on Housing

1.2.7 Non-Engineered Housing

Most of the existing housing and houses which are going to be built in the next few decades are likely to be non-engineered, i.e. they would not have the benefit of being designed and supervised by engineers. Most likely, these are going to be designed and built by owners. These are the
houses which are the most vulnerable to natural hazards. Our efforts should, therefore, be directed towards reducing the vulnerability of these non-engineered constructions. Fortunately, during the last few years, a number of projects have been undertaken in different parts of the world aimed at developing techniques for reducing the vulnerability of non-engineered construction against extreme winds and earthquakes (NBS, 1977 and IAEE, 1981).

These studies have identified the following four factors which have a strong influence on the vulnerability of housing:

- Siting
- Design
- Construction Methods
- Materials

Taking all these into consideration, simple guidelines have been proposed for use by non-technical people and are presented in an illustrated booklet titled "43 Rules - How Houses Can Better Resist High Wind" (NBS, 1977). The International Association of Earthquake Engineering has prepared a manual for earthquake-resistant non-engineered construction (IAEE, 1981). By following these guidelines, it should be possible to reduce significantly the damage to housing due to natural causes, leading to a reduction in the loss of human lives and property.

The guidelines mentioned above have been available for quite a number of years. A question may naturally be asked: "Why are these not being followed in practice?". The answer is that the fruits of R&D are not being transferred into the field. As mentioned earlier, most of our houses are designed and built by owners or artisans who do not have access to these booklets. Obviously, there is a necessity for bridging this gap by transferring technology to the people, mostly living in the rural areas, who are actually involved in non-engineered construction. The lessons learnt from "agricultural extension services" may be used in this effort.

The following are some of the steps which may be used:

- Translating the guidelines into Bangla, including some modifications to reflect the conditions in Bangladesh.
- Training of trainers may be arranged by BUET and HBRI
in association with NGOs involved in housing and banks providing micro-credit for housing (e.g. Grameen Bank).

iii Training programmes for artisans (masons, carpenters and other building-related technicians). These may be organised by NGOs.

iv Use of mass media (e.g. TV) to demonstrate good practices.

Experience of other countries shows that post disaster reconstruction provides an excellent opportunity for introducing improvements in housing technology. The experience of Tonga may be cited, where, following the 1985 typhoon, a few thousand houses were built using the help of BRE (Building Research Establishment), UK. This has resulted in a dramatic improvement in the building practices in the island.

1.2.8 Housing in Flood-Prone Areas

The obvious measure which may be adopted for flood-prone areas is to raise the floor level above the level of flood-water. This may be achieved by:

a. raising the level of ground on which the building rests
b. building on stilts
c. floating house with floor level rising along with the flood water

The first solution is very common in our rural areas where individual houses, clusters of houses or a whole village may be raised above the flood level by earth filling. However, adoption of this solution throughout the whole of the flood-prone areas does not appear feasible under the prevailing socio-economic conditions. Buildings on stilts are quite
common in the coastal areas as well as along the river banks or roadside ditches (Figure 1.3). The major problem is that, unless properly braced, the unsupported lengths of columns may be excessive, leading to reduced resistance to lateral loads due to wind or earthquake. Floating houses supported on half-cylindrical ferrocement pontoons have been developed in Thailand but appear to be an expensive solution.

Houses on reinforced concrete stilts have been used in areas subjected to storm surge (e.g. Urir Char). However, the cost of Tk. 1 lac for a single room (around 3m x 3m) is beyond the means of most families. A model house on stilts is shown in Figure 1.4. The use of precast prestressed space frames may lead to a reduction in the cost. Moreover, a structure which can be dismantled and re-erected at a new site would enable its use in areas subjected to erosion.

Mitigation techniques to reduce the vulnerability of housing to natural hazards can be incorporated most economically and effectively during construction. However, there is a large stock of existing housing which has already been built without adequate protection against natural hazards. Techniques for retrofitting have been developed, particularly for brick masonry and mud-wall housing. These include adding a ferrocement veneer, vertical corner reinforcement embedded in mortar, introducing tie beams and adding buttresses (IAEE, 1981).

Mud walled construction remains common in North Bengal where houses made in this way are vulnerable to the high seismic risk there. There is still work needed in this area.

Mud construction is typically vulnerable also to erosion by both rainfall and flooding. The addition of a straw binder
helps to increase resistance and, in the 1960s, the well-known Egyptian architect, Hassan Fathy, experimented with stabilising mud bricks with straw. A series of tests was carried out at Central Building Research Institute, Roorkee, India, to find out the efficacy of different treatments to increase the durability of mud walls subjected to rain. Treating the surface of wall with asphalt-kerosene mixture was found to be effective. In 1979 a BUET research project followed up CBRI’s lead and concluded that spraying mixture of equal parts of kerosene and asphalt at a rate of 740 grams per square metre onto the mud surface provides optimum stabilisation. The cost of that measure would be a mere 28 Taka per 10 sq. m. of wall area.

Bamboo frames are often damaged by the poor quality of the jointing arrangements. Considerable work has been done in the Philippines to develop more rigid joints; that experience should be incorporated into Bangladeshi programmes.

The fire resistance and water-proofing of thatch can both be improved by spraying appropriate chemicals onto the completed roof. Research will show us the most cost-effective and appropriate treatments for improving thatch performance and reducing the serious fire-hazard they present.

Many NGOs have developed improved model houses. After a tornado devastated villages in Shaturia (west of Dhaka), Enfants du Monde (EDM) set up a programme to distribute their model houses freely to poor beneficiaries. However, when subsequently surveys were carried out to determine
programme impacts, it was found that almost all the distributed houses had been sold by the poor people to relatively well-off people to realise the considerable capital that they represented. This trend has been found by many other similar programmes and reinforces the need for home improvements to be affordable within the means of the owner.

There are particular problems to be overcome in the surge-prone areas where cyclones can generate wind-speeds up to 250 kph and surge waves of 6m or more. Stilted house may be appropriate here, although until now no such solution has found much acceptance. One of the reasons is the relatively high cost (around US$2,500 for one room (floor area 18 sq.m.) on stilts. Another problem occurs in river bank areas where land may be eroded away at any time and demountable houses will be needed. There are thus several particular cases to be considered.

1.2.13 The Way Forward

The 1996 International Workshop on Housing and Hazards generated important recommendations. In particular, the following points should be prioritised:

- Full scale tests on various house-types to enable the preparation of design and detailing guidelines;
- Estimation of costs of improvements;
- Preparation of manuals - these should be written in simple language with pictorial instructions;
- Develop a training programme with workshops for all levels of involvement in the house-building process, including engineers, technicians, craftsmen and owners, with particular emphasis on women;
- Draw appropriate lessons from dissemination successes in other fields such as oral rehydration therapy and agricultural extension;
- Involve NGOs and the mass media such as radio and TV in the dissemination process.

Although Bangladesh is among the most disaster-prone countries in the world, its national efforts have not been significant. A large volume of literature exists. What is now required is a concerted effort to transfer the know-how to people who are actually involved in the design and construction of housing.

1.3 Some Key Issues in Building for Safety

Statistics show that the numbers of people affected by disaster is growing annually by 6%. However, the impacts of a disaster will vary according to the circumstances of the
community affected. For example, in 1993 both Latur (India) and Los Angeles (USA) were struck by earthquakes of magnitude 6.5 (Richter). 8,240 died in Latur while the death toll in Los Angeles was a relatively low 60.

The lesson from the earthquake in Kobe makes another point: this event killed 5,466 and caused damage totalling $100bn. This is an illustration of the way in which property losses are escalating alarmingly. These issues were addressed in the 1996 INDNR theme “Cities at risk”.

Much of the death toll from earthquakes results from collapsing masonry and buildings. The reality is that these deaths primarily occur in the dwellings of low-income families. Since such families are normally well below the threshold of engineered structures built by qualified builders, there is a clear need for more community-based training programmes in hazard-resistant housing. The various issues surrounding vulnerability must be examined to determine any social, cultural or maybe political reasons for unsafe practices.

1.3.1 Risk Assessment

In assessing the risks affecting them, a community will need to consider three elements:

1. What preparedness measures are in place or can be developed. Have they the necessary knowledge, resources and authority to put them in place? Who will take responsibility?
2. Are there ways of reducing the risk by, for example, moving homes out of flood-prone areas (or above them on mud platforms) or mitigating winds by the use of wind breaks.
3. Can realistic warnings be issued that will enable the most vulnerable to take effective action before a disaster to mitigate its likely effects.

Building stronger houses is one way of reducing the risks created by a hazard. Building for safety includes better basic construction and the retrofitting of existing structures with strengthening elements.

1.3.2 Building for Safety

The objective of a Building for Safety programme should be to promote community self-reliance and to create a culture of safety. There is no need to make major changes in building technology; indeed this should be resisted, since Bangladesh
and many other hazard-prone countries are littered with failed projects that attempted fundamental changes.

Rather than physical changes in technology, the objective should be to create a team of experienced local builders and craftsmen. Supply of components and materials should be associated with advice and explanation of their uses and benefits so that the culture of safety is built up gradually.

This process should focus on and involve the most vulnerable social groups.

### 1.3.3 Effective Training

Figure 1.5 illustrates diagrammatically the importance of increasing participation of a participant in effective learning.

This diagram highlights the fact that effective learning must be based on direct experience. Therefore, trainees need to avoid class-room based theoretical training approaches. Students retain more of the message for longer by active involvement, ideally including repetition of activities.

Training needs to include everyone - the building users as well as the builders. Conducting building for safety training programmes provides opportunities for incorporating a range of other skill training.

By linking Building for Safety programmes with income generation activities it is possible to enable participants to generate the funds necessary for improving their homes. This has been done, for example, in Anhai Province in China.

### 1.3.4 Community Based Programmes

Although the risks from earthquakes are not so severe in Bangladesh as those from floods or cyclones, it is still vital to design and construct safer dwellings for poor families. Probably the only way to do this is through community training.
The best time to introduce safe building training is after a disaster as part of the reconstruction process. This time presents a unique window of opportunity. Probably the next best time to introduce improvements will be when new dwellings are being built. However, the most difficult thing will probably be to address the need to make existing buildings safe. This is expensive and socially disruptive as well as often technically difficult.

To be effective, training needs to be experiential - where advice is given on the job - rather than in a passive class room situation. Community-based training in building safety is best organised in conjunction with other opportunities for developments in leadership, skills, local preparedness planning and income generation as new skills in building can be marketted and general community development is seen as a positive outcome of the process (Figure 1.6).

Here, it has been challenged that the most effective way to build houses for low-income families in hazard-prone areas is by using building contractors. Building for Safety community-based programmes may take longer than those undertaken by large building firms and they may be less tidy. Also, opposition may be expected from vested interests in modern technology, such as contractors. However, community programmes offer significant benefits, in terms of social gains, which decision-makers should consider very carefully.
1.4 Low-Income Housing Pattern

Low-income urban and rural communities are the primary victims of natural hazards here in Bangladesh, as in other developing regions. Therefore, investigations have to be made to understand the process that creates this state of vulnerability of the low-income community and its influence on the housing pattern of these people.

1.4.1 Method of Study

The study aims at investigating the process leading to the vulnerable housing pattern of low-income rural and urban communities. The study, therefore, is based on relevant data collected through a field questionnaire survey.

1.4.2 Questionnaire

In preparing the questionnaire the following things were considered: (i) the difficulty of the field questionnaire survey exercise, (ii) length of the questionnaire, (iii) simplicity of the questions asked, and (iv) the circumstances in which the questionnaire would be completed. A typical questionnaire sheet (translated from Bangla) used during the field survey is presented in Table 1.2. Questions were asked regarding the respondent’s profession, place of residence, housing type, rent/ownership status, length of stay, number of family members, experience of hazards, reason for living in a hazardous house, efforts to improve housing safety, whether benefited by any government/official help, daily income and age.

<table>
<thead>
<tr>
<th>Table 1.2: Questionnaire Sheet</th>
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<tbody>
<tr>
<td>Survey area (to be completed by the surveyor):</td>
</tr>
<tr>
<td>Person surveyed is Male/Female (to be completed by the surveyor):</td>
</tr>
<tr>
<td>Survey Questions:</td>
</tr>
<tr>
<td>1. What do you do for a living?</td>
</tr>
<tr>
<td>(Permanent/Temporary job, Professional/Casual labour, type and duration of work)</td>
</tr>
<tr>
<td>2. Where do you live?</td>
</tr>
<tr>
<td>3. What type of house do you live in?</td>
</tr>
<tr>
<td>4. Are you Tenant/Owner of the dwelling place?</td>
</tr>
<tr>
<td>5. How long have you been living in this house?</td>
</tr>
<tr>
<td>6. How many persons are living with you?</td>
</tr>
<tr>
<td>7. Is your house safe from flood and storm? What type of difficulties have you faced so far?</td>
</tr>
<tr>
<td>8. If it is not safe, why do you live in this house?</td>
</tr>
<tr>
<td>9. How did you rent/build this house?</td>
</tr>
<tr>
<td>10. Have you ever asked the owner of the house to make it strong?</td>
</tr>
<tr>
<td>Why didn't you strengthen it yourself?</td>
</tr>
<tr>
<td>11. Does any leader or officer ask you about your welfare?</td>
</tr>
<tr>
<td>12. How much do you earn daily?</td>
</tr>
<tr>
<td>13. Your age, please.</td>
</tr>
</tbody>
</table>
While the ultimate target was to cover a few regional cities of Bangladesh and a number of rural regions in different corners of the country, due to financial and time constraints, the areas covered were the Dhaka City area and rural areas including Char Hijli, Char Motto, Gopalpur, Dashara, Bhabanipur, Malancha and Bolta of Manikgonj district. However, cross-section of most of the low-income target groups has been covered in the questionnaire survey.

A total of 198 low-income persons have been interviewed with only about ten percent female respondents; one can well understand the difficulty of interviewing women in this conservative society. The respondents’ age distribution has been presented as a frequency histogram in Figure 1.7(a). It can be observed that the majority of respondents are in the 30-40 years age band. The number of family members of the respondents has been presented in another histogram in Figure 1.7(b). This reflects the well-known low acceptance of population control measure among this group. It can be seen that the majority of the families are of 5-7 members. Having this sort of family size and an average daily income
as shown in Figure 1.8 as a frequency histogram, one can easily imagine the financial hardship of these low-income communities. For the majority of families the average daily income is in the range of Taka 50 to 100 and for the rural subjects it is only about Taka 50. It is understandable that with such a low income level, it would be difficult to save much for housing cost/improvement after meeting other household costs.

The occupation of respondents is shown in Figure 1.9. Here it can be seen that the majority of respondents are rickshaw-pullers and hawkers with a considerable proportion of daily labourers. Other groups covered are earthworkers, small shopkeepers, servants/maids, street children and sweepers.

1.4.5 Housing Pattern

The analysis of survey data shows that about 90% of the low-income respondents live in rented accommodation, while only 12%, especially in rural areas, own their accommodation. This reflects that the low-income urban community is mainly composed of a migrant population. The respondents were also asked about their duration of stay at their present places and this is presented as a frequency histogram in Figure 1.10. It can be observed that more than three fourths of the respondents were living for less than five years at their present address. The subjects were also asked about the hazards they had faced in their houses. Almost all the respondents admitted that they have faced one or more hazards. The types of housing hazards experienced by the respondents are presented in a frequency histogram in Figure 1.11. It can be observed that majority of these poor people suffered from floods, rainwater logging and leaking of rainwater through roofs. A water-logged low income settlement is shown in Figure 1.12. A considerable portion also suffered from cyclonic storms while only a few suffered from fire hazard. The types of housing for low income people are presented in a frequency histogram in Figure 1.13. Here it can be seen that only a few live in brick-built pucca houses, especially, domestic workers/maids; most of the respondents live in sapra type unsafe houses made of bamboo, polythene, thatch/leaves and occasionally having metal roofs. When asked why they had chosen such places of accommodation, more than half answered that they have no other places to go to or to take, indirectly reflecting their financial and social vulnerability. But a considerable proportion (about 30%)
blamed their financial hardship for choosing their unsafe and cheap accommodation. About 10% of the respondents answered that they lived there as these were their familiar places.

![Histogram of Daily Income of the Respondents](image)

![Occupations of the Respondents](image)

*Note: Rpuller means rickshaw-puller; Dlabor means day-basis labourer*

The respondents were also questioned whether they had asked their landlords to make their house safer; only about 23% percent answered in the affirmative. The rest were either afraid or did not bother to ask. But the rural community with dweller-ownership invariably blamed their financial hardship for not having improved their houses which normally were constructed by them with partial involvement of local artisans. They admitted that they solely depended on the artisans for any sort of safer construction technique. However, the group in urban areas which had solicited the landlords, did not achieve any better housing condition other than experiencing
the red-eye of the landlords or their hoodlums. The majority of the subjects opined that they were almost bound to accept what their landlord/employer offered them; this also reflects that the low-cost houses, especially in Dhaka, were not enough in number to meet the growing demand of migrants. When asked whether any political, community or government members have inquired about their well-being, only about 5% answered in the affirmative. A portion of the respondents also admitted the occasional armed threat in their neighborhood to establish the sheer authority of landlords.

Figure 1.10: Frequency Histogram of Duration of Stay at the Respondents' Present Dwelling

Figure 1.11: Frequency of Types of Experienced Housing Hazards

1.4.6 Implications It has been found that the factors influencing the low-income housing pattern were: ownership of the land/house; government/community regulation scheme; duration of stay at
a certain place; income level; familiarity with a certain area; and work requirements. This study has revealed that there is a serious lack both in the people’s attitude and in commitments from political/community/government side for ensuring reduced hazards in the house. In addition, government level inspectory regulation is necessary to ensure minimum level of safety in low-income housing. In rural areas, where a significant portion of low-income people own their dwellings, they can be benefited by local artisans well-trained in the low-cost safer house building techniques. With an average daily income of only Taka 50, they need a government/non-government organization-managed housing finance scheme in order to improve their financial capability for safer housing. Also, a campaign to increase the safety awareness of these low-income communities will go a long way towards the target of reduced hazards in their housing.

Figure 1.12: A Water-Logged Low-Income Settlement

Figure 1.13: Types of Housing of the Respondents

Note: BB means bamboo, PL means polythene, L roof means roof made of leaves/thatch
Housing is a more complex commodity than most people realise. Safety and comfort are still the basic essentials for housing. Housing is a composite social entity. There are single family houses, duplexes, apartments, row houses, permanent, semi-permanent and temporary houses. A housing environment can be an index of the social health, happiness, social justice and dignity of the inhabitants. Housing has multifaceted economic and social characteristics and it also has social benefits. Housing can contribute to community development by improving equity and efficiency in society. Income earning opportunities can be improved by locating low-income housing areas near employment concentrations.

About 80% people of Bangladesh live in rural settlements and 86% of the dwelling units are located in rural areas (GOB, 1993). There has, however, been very little public sector involvement in rural housing. There is virtually no land use plan for the rural areas of the country, which comprise about 85 percent of the total land area. The present facilities in respect to housing and physical infrastructures are very inadequate in the rural regions of Bangladesh (GOB, 1997). Traditionally, rural housing has been taken care of by the villagers themselves. The government could not make any significant contribution in this respect except from the distribution of some building materials, as relief measures in areas ravaged by natural calamities, such as flood and cyclone (Hasan, 1991; 1998).

Because of the subsistence nature of the economy, 85% of the dwelling units in the rural areas are in the form of shelters, which do not provide adequate protection from wind, rain and flood. Presently, there is only one tube-well for every 105 persons to supply drinking water in the rural areas. The sanitation coverage in the rural areas is only 36 per cent of the population (GOB, 1997). Due to the natural process of wear and tear, lack of repair, and due to the poverty of the rural population, rural housing conditions have deteriorated seriously. At present, about 30% of the rural families do not have their own homestead. They live in 'Ijmali' (shared properties), mortgaged or rented homesteads. The majority of the houses in rural areas are built inadequately in terms of structural qualities (GOB, 1993). The housing shortage in the rural areas is increasing rapidly, and it is projected that this shortage might exceed 5 million units by now, if the current trend continues (GOB, 1997).
1.5.2 Some Important Characteristics

In rural Bangladesh housing processes are more vernacular in nature which evolved through ages. Housing types developed in the rural areas in relation to the physical environment, socio-economic and cultural development. The cultural change which followed the Industrial Revolution in most developing countries has had little impact on the traditional way of life; thus little impact on the housing processes in the developing world. Only recently, an accelerating growth of population in a number of developing countries has brought about a change in some of the associations of the functional characteristics of housing for accommodating more population in limited housing space inherited through generations. An example of such a change of this type is the use of courtyard in rural farm houses which was formerly an essential part of these houses for its manifold uses (e.g. for better air circulation, recreation and for household and other farm related functions). The courtyard has functional utility for husking of cereals, drying of jute fibers, clothes, etc. This space is gradually being decreased by the construction of new housing units and many of the post-harvest operations are being performed now in mills or even on the roadside.

1.5.3 Design Process

Physical control is quite apparent in the housing processes in rural areas. Land level is one of the major criteria in selecting housing site. Bangladesh is predominantly a flood plain/delta terrain. For this reason, a major part of the high lands are preferred for building a house. Where high lands are not available or scarce, as in the Haor areas, houses are built on artificially raised ground. Moreover, the availability of housing materials and their regional differences have an impact on housing construction and design. Climatic impact characterizes the roofing design of rural houses. Pitched roof is the common design to drain off rainfall quickly.

Social and economic determinants of the housing processes encompass a number of factors, such as the income, status and size of the family in the household. Besides, a number of cultural practices influence the design and form of a house, particularly, the orientation or location of individual housing units. For example, sleeping units in the households are generally made south-facing by both Muslims and Hindus (two major religious groups of Bangladesh), while kitchens are normally constructed west-facing. The Hindus have the
tradition to build cattle sheds and latrines away from the housing complex. However, in some parts this practice is also common among the Muslims. The salient features of a typical rural house is shown in Figure 1.14.

![Figure 1.14: Salient Features of a Typical Rural House](image)

### 1.5.4 Housing Layout

The house is the symbol of position and status among the rural inhabitants of Bangladesh. Thus housing design varies according to socio-economic status of the household. But this might not be the rule, since often the houses are generally inherited and their structure and design tend to be the reflection of aspiration and status of the ancestors. Nevertheless, large farmers usually possess a more elaborate housing structure than those economically less well off.
A house in rural Bangladesh may consist of one or more rooms, depending mainly on the socio-economic status of the owner. Rooms are different in sizes and shapes, though rectangular is the common shape. Housing units /rooms are constructed around a rectangular or square courtyard (Figure 1.15). In order to get rid of smells, it is regarded sanitary to build the cowshed and latrine away from the main housing area to one corner of the housing perimeter. Kitchens, normally smaller in size, are built separately. In dry seasons and among the poorer families, cooking is usually done in the courtyard and the space is rarely roofed. Kitchen, cowshed, poultry pen and latrine are less emphasized in the total housing layout, as are reflected in their inherent designs and locations. These are usually built of inferior materials and are also poorly constructed.

![Figure 1.15: A Typical Courtyard Layout of a Rural Homestead](image)

In some parts, as in northern and mid-western Bangladesh, the houses in rural areas traditionally have inner and outer courtyards. This practice exists in favour of the farmhouse operations. Since such households belong normally to large farmers, they compose a self-reliant functional entity. But more recently, as a result of the pressure of population on land as well as the development of community and village-based
commerce and agricultural services, this tradition is gradually eroding. In some parts of the country, especially in the south, a pond is an essential part of the house and has manifold uses. A house is surrounded by perennial trees giving protection from sun, storms and cyclones and they also offer some degree of privacy. A house often has a boundary wall to ensure privacy of the inmates, which is normally made of bamboo, palm leaves, straw or corrugated iron sheets, etc. depending on the social and economic status of the owner. In some areas, as in northwestern Bangladesh, rooms are built around a courtyard instead of a wall for maintaining privacy for the household. A typical rural homestead is shown in Figure 1.16.

Figure 1.16: Salient Features of a Typical Rural Homestead
1.5.5 House Form

The form of a house manifests the complex interaction of many factors, which is revealed in variations of the construction designs. The family owning a house made of corrugated iron sheets (CI sheets) is very common in rural areas. There are variations in the design and size of CI sheets. Shape of the roof is related to the status and wealth of the family (Figure 1.17). Roofs with fours facets of CI sheets, chouchala (four pitched) and with two facets, dochala (gabled), show two major variations in the design and indicate the position of the farmer in the rural society. The high roofed chouchala with an attached verandah is aesthetically more attractive than a same sized dochala house. The rooms in these houses have high windows. The plinth of these types of houses are sometimes made of cement. Two-storied houses built with CI sheet built house, although very rare, are highly prestigious in rural areas. Such houses, which are made of mud/CI sheets, are owned mainly by affluent farmers and households.

Figure 1.17: Typical Roof Forms of Rural Houses

1.5.6 Amenities and Services

Amenities and services such as water supply, latrine, sewerage, drainage, electricity, etc., do not seem to have priority in the housing structure in rural Bangladesh. Natural sources of water are still vital in rural livelihood, but other sources, such as tubewell and dugwell, are gradually being considered important nowadays. About 54 percent of the households use a pond as
general source of water followed by tube well (21 percent). Drinking water is mainly fetched from tube-well (53 percent) followed by pond (21 percent). About one-third of the rural houses do not have any arrangement for latrine. Most houses do not have any drainage facilities (GOB, 1997).

**1.5.7 Construction Materials and Technology**

Houses in rural areas are mainly made of locally available indigenous materials such as bamboo, straw, grass, jute sticks, *golpata* (palm fronds), mud and CI sheet. The wall is made of straw, jute stick, bamboo, mud and CI sheets, while thatch or CI sheet roofing, and sometimes roofing with tiles is used, as in some parts of Rajshahi, Kushtia, Bogra and Jessore. Bamboo is widely used as a common house building material. CI sheets and thatch/leaves (like golpata) roofing is found in majority of houses in rural Bangladesh. In most cases the floor is made of mud (i.e., *kutcha*). Cemented floor, brick built wall and concrete roofing (i.e., *pucca*) used to be rare in the rural areas of the country. However, pucca buildings are increasingly becoming common in many villages of Bangladesh. Previously, the houses of the big landowners and the former zamindars (landlords) were mainly included in this group. Brick built mosques or temples are not uncommon in the country. About 35 percent of roofs of rural houses are built of strong materials which range from cement and mortars to CI sheet and wood, and only 13 percent of the walls of the housing units are made of permanent and semi-permanent materials, such as CI sheet and cement/brick. A large proportion of dwelling structures in the rural areas is temporary in nature; this type of construction is called 'kutcha'; it accounts for about 80 percent of the total rural houses. The physical conditions of most of these may be described as moderate to poor (GOB, 1997).

It has been observed that straw and bamboo are the most commonly used building materials in the construction of housing in rural areas of the country. These are used as the chief construction materials for walls. Straw, and bamboo form the main housing materials for the construction of both wall and roof. In Pabna and Sirajganj districts CI sheet is mainly used for construction of walls. In Dhaka District, the use of cement and brick is quite common as materials used for both walls and roofs, perhaps due to the nearness to the capital city and also to relatively better economic condition of the inhabitants as a result of the degree of urban exposure.
Cement and brick walled house is also prevalent in the border regions of Jessore district, which may be due to long settlement traditions adjacent to old human habitats near to West Bengal. In this area, mud-walled and tiled-roof houses with spacious courtyards are also quite common.

Mud/kutch brick is commonly used in the walls of the houses in some parts of north Bengal where the elevation is above flood level and the soil has the right characteristics for brick-making. Similar houses are also prevalent in Kushtia District where the house are built with high plinth and spacious verandah and have an inner courtyard to accommodate storage units. Tiles are predominantly used for roofing of houses in Naogaon district and also in western areas. CI sheet forms the common material of houses in southern Bangladesh (Hasan, 1999).

The above description portrays only the key characteristics of building materials in rural Bangladesh, and some exceptions are not unlikely. However, the generalised picture of the materials used for housing can be broadly classified under: (a) kutch, (b) semi-pucca, (c) pucca. It should be noted that the pattern obtained through the categorization of rural dwellings into these three main classes closely follow those obtained earlier.

1.5.8 Rural House Types

In the plain lands of Bangladesh, although there is more similarity than difference in geographic conditions, there are some variations in housing characteristics. Houses are often constructed of organic materials and have varying sizes and shapes. The majority of these houses is temporary in nature. In the rural areas of Bangladesh, the following types of houses are commonly found in different parts of the country (Hasan, 1999).

1.5.9 Bamboo Walled Houses

In some areas in the eastern and northern part of Bangladesh, the houses are mainly bamboo walled, with thatched curved roof built on high plinths (Figure 1.18). Shapes are predominantly oblong.

A small verandah with wood or bamboo support is the common design. Plaited bamboo plastered with a thick layer of mud is often used for walls for house construction in southwestern and northern parts of Bangladesh. The same type of housing style is also common in the islands and in the coastal regions of Chittagong. In the latter case, the only difference is found in the roofing design, which is usually
constructed as double facet and the main roof is separated from that of the verandah. The houses are mostly one and a half storied in height. In the rural areas, in and around Dhaka, Narayanganj, Chandpur and Pabna, bamboo walled houses with CI sheet roofing are quite common.

The northwestern regions of Bangladesh have a distinctive characteristic of mud-walled housing. Oblong shaped mud walled houses with thatch and tile roof are common in Bogra, Pabna, Khushtia and Jessore. In Chapai Nawabgangj, the roof of a mud walled house is moulded by brick dust mixed in with lime, which is peculiar to this area. In the region from Bogra to Kushtia, mud-walled houses with CI sheet roofing are another common type. Relatively taller mud-walled houses of about 15 feet high are found along the southwest border of Bangladesh. Bamboo fenced outer boundary walls of houses is the characteristic housing feature of the region between Darshana and Jessore. Above flood level land, relatively less rainfall and dry climate, and the lateritic soil are the main reasons for the development of mud walled housing structure in these regions.

Mud-walled houses with two to three level roofs are common in Chittagong region. A two-storeyed mud-walled house is shown in Figure 1.19. The walls are made of sun-dried mud of one to two feet thickness. The heights of these houses can vary: one type is about ten feet high, and the others are around double its height. The roofs of the house are thatched, tiled or made of CI sheet.

A relatively small population group of Bangladesh build timber houses. In the Mogh communities of Cox's Bazar, Teknaf and Moheshkhali, timber houses represent a different
cultural heritage with distinctive architectural tradition. The houses are normally built on a wooden platform above the ground, to keep away poisonous snakes and ferocious animals. The reasons for this may lie in the existence of forests in surrounding regions, which are infested with wild animals and reptiles. These forests also provide ample timber for house construction. The space beneath the platform allows free airflow, and is also used for various household purposes. The houses are generally painted black, and have woodcarvings on cornices and doors (Figure 1.20).

Figure 1.19: Two-Storeyed Mud-Walled House

1.5.12 Timber and Brick Houses

In the eastern part of Sylhet, often the floor, bottom section of walls and the plinth are made of brick, and the rest of the wall is made of reed or bamboo matting, plastered with cement or mud on both sides. These houses have timber frames and columns. The roof is normally made of CI sheet or straw. Figure 1.21 shows a timber and brick house.

Figure 1.20: Timber House
1.5.13 Corrugated Iron (CI) Sheet Houses

In regions, especially in the north-eastern part where rainfall is very high, houses with CI sheet roofing are very common. Figure 1.22 shows a CI sheet house. The development of this house may have its origin in the British colonial past, when such houses were built in tea plantations and for administrative headquarters. These houses also provide effective protection against heavy tropical rain, and the sheets are damp-proof, light, and durable.

In north-eastern Bangladesh, particularly in Sylhet, houses have boundary walls made of CI sheet or bricks. Some of the boundary walls are colorful and have high gates, which are considered prestigious in this region. Often the owners of these houses reside abroad, mainly in the UK.

In the southwestern part of Bangladesh; in Faridpur, Madaripur, Barisal, Patuakhali and Bhola, CI sheet houses are also...
common, where sheets are used both for roofing and wall construction. In central Bangladesh, such as in Dhaka, Comilla and Mymensingh, CI sheet is mainly used for the roof, while mud or mud blocks are used for walls (Figure 1.23). In the southern part of Khulna, especially in the Sundarban region, golpata (palm fronds) is commonly used as a roofing material for bamboo walled houses.

Figure 1.23: House with Mud Walls and CI Sheet Roof

1.5.14 Thatch/Straw Houses

In the Haor basin and in areas along major rivers of Bangladesh, organic building materials such as reeds, long grass, thatch, and jute sticks are widely used for roofing and wall construction. This is mainly because reeds and long grasses are abundantly available in char areas and on riverbanks. Moreover, these areas are often flood-prone and subject to various hazards and risks like river bank erosion, which forces people to use cheap materials for house building. Figure 1.24 shows a typical thatched house. In relatively flood free areas, such as in Bogra and Tangail district, temporary roofing materials like thatch or long grass are used upon mud walls.

1.5.15 Indigenous Practices in Rural Housing

In rural areas of Bangladesh, the housing processes are vernacular in nature, which evolved through ages. These housing processes manifest the agrarian economy of the country, and have developed in relation to its physical and cultural set up. Rural houses are generally constructed of locally available indigenous materials, and these are characteristically less variable. The majority of rural houses are apparently temporary in nature, particularly with respect to the materials used for their construction (Hasan, 1999).
Vernacular building forms are well developed in rural Bangladesh, but these are undergoing rapid changes because of industrialized building materials. The use of corrugated iron (CI) sheets has become quite popular and widespread, and the production and use of traditional building materials is diminishing consequently (Ahmed, 1994). Vernacular architecture in rural Bangladesh has evolved corresponding to its main physiographic regions. A number of techniques for house building using indigenous materials exist in the country. The layering technique involves building with large earth blocks or sun-dried bricks. There is another commonly used technique, which is plastering bamboo mat walls with mud. This method adds sturdiness to the otherwise flimsy though highly developed bamboo construction techniques (Ahmed, 1994).

As discussed, different kinds of indigenous practices are found for house construction in rural areas of Bangladesh. In the northwestern region, particularly in the Barinda highland, houses are often made of mud and earth. At first, mud is collected and kept in a mound and wetted regularly by pouring water. The people themselves soften the mud by pressing it with feet. In the end, the softened mud is placed at different layers for building the walls of houses. In some areas, particularly in the southwestern region, construction of houses with sundari tree as support material and golpata as shading material is very common. At first, the frame of the house is made using sundari planks or poles of different thickness. Outside cover is then attached to this frame. The choice of building materials for this depends upon
affordability. Some people use galvanised iron (GI) sheet, some use thatch, and some use bamboo mat or wood. Often the bottom portion of the walls is constructed of 5-inch thick brick walls (sometimes the entire walls). For rural housing, the common practice in most areas of Bangladesh is to use a bamboo frame. Bamboo poles are first dug deep into the ground and then fixed strongly by compressing earth around the bottom of each pole. Then transverse bamboo rafters are tied to the vertical poles. These are tied either by steel wire or rope. Finally, the frame for the roof is made. In the end, different kinds of materials are used for covering the frame. For example, CI sheet can be used for both walls and roof. Bamboo mat for walls and CI sheet for roof. Alternatively, bamboo mat for walls and either straw, grass or thatch can be used for roof. A number of indigenous construction techniques are also found in the rural areas of the country. Phasing construction over a period of time is very common. Often the walls and frame of the house are constructed in one season or year, and the roof is made in another year or season. Upgrading or extension of the house over time is another common practice. Often thatch roof is replaced by CI sheet roof when households have enough money at hand. For rural houses, the common practice is to build a one-room house first. Then incremental additions are made to the house: e.g., a few more rooms, a verandah, a permanent kitchen, or better quality windows are added. However, the toilet is generally placed a little away from the main house. Attached toilet is still very uncommon in the rural areas of Bangladesh. In rural areas, most of the houses are placed around a courtyard. This inner court provides light, ventilation, seating and cooking area and a private space for family members. This is a very vernacular, fundamental and indigenous concept of house building in the country, and has been practiced in Bangladesh from generation to generation.

1.5.16 Prospects

Housing processes in the rural areas of Bangladesh are more vernacular in nature than in the cities. They have evolved over a long period. Houses are often constructed of organic materials and have varying sizes and shapes. In some areas in the eastern and northern part of Bangladesh, the houses are mainly bamboo walled with thatched curved roof built on high plinths. The north-western regions of Bangladesh have distinctive characteristics of mud-walled houses. A relatively
small population group of Bangladesh build timber houses. In north-eastern Bangladesh, particularly in the Sylhet region, houses have roofs and walls made of CI sheets or bricks. In the southern part of Khulna, especially in the Sundarban region, golpata is commonly used as a roofing material for bamboo walled houses.

In Bangladesh, very little government attention is given to rural housing except for a few NGO assisted houses. Still the housing situation in the rural areas of Bangladesh is by far better than in the urban slums and squatter settlements. One important reason can be that rural householders are generally the owners of their homes. Therefore, they try to maintain and clean their houses as much as possible within their affordable limits. But in urban slums and squatter settlements, occupants have very few rights on the houses where they live. Unfortunately, in recent times, there is a phenomenon of rural slum formation in many areas of Bangladesh. Increasing population density, lack of space for house construction, dwindling land-to-man ratio, and persistent poverty are the main causes for such development. The government could come forward to provide land (particularly khas land) to these rural slum dwellers, especially for house building.

In most cases, rural people know better how to build their houses, when to build, and what materials to use than professional builders or engineers. They have a keen sense of resource management for house building within their meager means, which calculative and strategic planning may not be able to work out. This is basically by virtue of their indigenous knowledge passed on to them from generation to generation. Therefore, professional planners, architects and engineers could learn from them. What is necessary is to provide rural people with adequate finance, building materials, technical know-how, information and infrastructural support. For example, most of the rural areas of Bangladesh are beyond the electricity and telecommunication coverage of the country. Provision of infrastructure including transport networks, water supply, electricity and telecommunications facilities would definitely increase the quality of life of rural people. Finally, financial assistance (either in the form of credit or grants) would eventually enable rural people to build safe and permanent houses according to their own needs and resources.
1.6 Role of Women in Rural Housing

In Bangladesh women represent about half of the total population. Various indicators reveal that the status of women is lower than that of men. Traditional socio-cultural practices limit their opportunities in education, skill development, employment and participation in the national development process. Their literacy rate is 38.1% and life expectancy is 58.1 years. There are also sharp differences between boys and girls, women and men, in the national status (BBS, 1993).

Women's participation in the development process is a common phenomenon all over the world. They play an important role in each sector of national activity. Rural women are mostly engaged in their household work, especially in house management. They are also involved in housing development such as construction, repair, etc.

In the study area (Gonali village, Khulna), most of the houses were kutcha and constructed with mud, straw, golpata (kind of palm leaf available in the Sundarbans), etc, which need regular repair and maintenance. Rural women play a vital role in this respect. They collect local building materials and build, repair or maintain their own houses with the help of family members (Figures 1.25 and 1.26). But their contributions of time and labour generally tend to be undervalued. This study has investigated the contribution of women in rural housing development and the causes of their involvement in this field.

1.6.1 Objectives of the Study

Women constitute a power by both their direct and indirect involvement in development work. They also participate for the development of their own dwelling units. The potential of women in this field should be better understood and their increasing roles in this field should be clearly identified by this study.
The specific objectives of this study are:

I. To explore women’s contribution to rural housing development
II. To find out the causes of their involvement
III. To search the problems faced by women during construction, repair and maintenance of their houses.

1.6.2 Methodology

The study is based on fieldwork in Gonali village in Dumuria Thana, Khulna. Gonali is a Muslim-Hindu village and male-female ratio 1.219 (national figure is 1.04). Data has been collected from observation and in most cases collected through a structured questionnaire. Out of 295 households (BBS, 1991), 112 households were taken as samples, about 38% of total households. The sample consisted of 50% Hindu and 50% Muslim households.

Status of Education: Obviously, education has empowered women in various stages of housing development activities such as the plan, foundation, construction materials, etc. of the houses. In the study area, it is seen that 20.69% of the women were literate and 24.14% were non-literate. Table 1.3 shows that women were less educated than men. The involvement of women was found to decrease in housing development activities with the increase of educational status.
Table 1.3: Level of Education

<table>
<thead>
<tr>
<th>Sex</th>
<th>Frequency</th>
<th>Literate</th>
<th>%</th>
<th>non-literate</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>283(54.95)</td>
<td>158</td>
<td>36.32</td>
<td>82</td>
<td>18.85</td>
<td>240(55.17)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>232(45.05)</td>
<td>90</td>
<td>20.69</td>
<td>105</td>
<td>24.14</td>
<td>195(44.83)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>515(100.0)</td>
<td>248</td>
<td>57.01</td>
<td>187</td>
<td>42.99</td>
<td>435(100.0)</td>
<td></td>
</tr>
</tbody>
</table>

Monthly Income: Table 1.4 reveals that 9% women had no income and were completely dependent on men. Most of these women had some sources of income. The majority (58%) earned Tk100 – 500 and only 2.5% earned Tk 1000 – 3000 per month. They estimated that they sold their vegetables, eggs, milk, etc., and earned small sums of money. But the lion's share was spent on house construction, repair and maintenance. Some of the women who earn more than Tk 1000 had taken loans from NGOs. So it can be said that if loan programmes are implemented by the GOs and NGOs, then the income level of women increases. Consequently they will be able to follow an important role in rural housing development. Although some women were empowered by loans in the study area, the overall income level of women was unsatisfactory.

Table 1.4: Monthly Income of the Female Members

<table>
<thead>
<tr>
<th>Monthly income range (Tk)</th>
<th>No. of households</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>No income</td>
<td>10</td>
<td>8.93</td>
</tr>
<tr>
<td>Less than Tk 100</td>
<td>23</td>
<td>20.54</td>
</tr>
<tr>
<td>100 – 300</td>
<td>28</td>
<td>24.99</td>
</tr>
<tr>
<td>301 – 500</td>
<td>37</td>
<td>33.04</td>
</tr>
<tr>
<td>501 – 1000</td>
<td>10</td>
<td>8.93</td>
</tr>
<tr>
<td>1001 – 2000</td>
<td>3</td>
<td>2.68</td>
</tr>
<tr>
<td>2001 – 3000</td>
<td>1</td>
<td>0.98</td>
</tr>
<tr>
<td>3000 +</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>112</td>
<td>100.0</td>
</tr>
</tbody>
</table>

In addition to construction, women have involvement in house repair and maintenance activities. They have the duty of protecting houses from various natural disasters such as rain, cyclone, tornado, water logging, etc. Along with men, they contribute in keeping the house clean, thus protecting the houses from becoming dilapidated. In this village 30.9% male and 65.9% female were engaged in construction, repair and maintenance activities. This shows the great helping hand of women in maintaining the houses. Table 1.5 shows that children
also sometimes help in various stages of housing development activities. So women's involvement is clearly significant in housing development as well as in rural economic development.

<table>
<thead>
<tr>
<th>Types of Work</th>
<th>Average interval (days)</th>
<th>Involvement of the family members</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male(%)</td>
<td>Female(%)</td>
</tr>
<tr>
<td>Construction</td>
<td>74</td>
<td>59(20.3)</td>
<td>44(15.2)</td>
</tr>
<tr>
<td>Repair</td>
<td>23</td>
<td>21(7.2)</td>
<td>52(17.9)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>10</td>
<td>10(3.4)</td>
<td>95(32.8)</td>
</tr>
<tr>
<td>Total</td>
<td>107</td>
<td>90(30.9)</td>
<td>191(65.9)</td>
</tr>
</tbody>
</table>

There are various types of work in which women are engaged such as soil carrying, mixing, layering, polishing, foundation, etc. (Table 1.6). In the study area, the women were engaged 4.2 hours per day, i.e. 17.5% of a day. For earth works (soil carrying, mixing and foundation preparation) about 23% women were involved. For polishing and structure preparation 25% and 20% women were involved respectively. In fact, they mainly spent their time in maintenance activities like floor polishing and mud collection. If a woman's participation of each day is converted to monetary value (i.e. wage rates), then women can save Tk 36.75 (considering Tk 70 for 8 hours) per day, obviously an illustrative contribution of rural women.

<table>
<thead>
<tr>
<th>Participants</th>
<th>Types of work</th>
<th>Average working hour per day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Earth works(%)</td>
<td>Floor polishing(%)</td>
</tr>
<tr>
<td>Housewives</td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td>Others female members</td>
<td>06</td>
<td>03</td>
</tr>
<tr>
<td>Others</td>
<td>02</td>
<td>01</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>26</td>
</tr>
</tbody>
</table>

Funding is an important aspect of housing development. In the study area, the major sources of funds (45.53%) constitute family savings and only 2.68% have taken NGO loans for construction, repair and maintenance of their houses. Table 1.7 shows that 21.43% and 30.36 % respondents have built or repaired their houses with the help of relatives and personal savings respectively. Table 1.7 also indicates that the government's involvement in rural housing development is almost nil, as indicated in the National Housing Policy (GOB, 1993) and Fifth Five Year Plan (1997-2002) of GOB (1997).
Construction, repair and maintenance of houses are tedious tasks. In the study area, 18.75% women considered it as physical suffering. The majority of the respondents (33.93%) identified excess rain as a major problem, because most of the walls were constructed with mud. About 11% claimed that the natural courses of Beel Dakatia (a large natural water body), blocked by human action, results in inundation as a common phenomena in the study area, especially in the rainy season. Table 1.6 also shows that women face financial problems (28.57%) for the construction, repair and maintenance of their houses. So, this indicates again the need of involvement of GOs and NGOs for financial and technical support for better participation of women in rural housing development.

Table 1.7: Sources of Funds and Types of Problems Faced by Women

<table>
<thead>
<tr>
<th>Sources of fund</th>
<th>Frequency</th>
<th>%</th>
<th>Types of problem faced</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banks</td>
<td>-</td>
<td>-</td>
<td>Salt problem</td>
<td>09</td>
<td>8.04</td>
</tr>
<tr>
<td>NGOs</td>
<td>03</td>
<td>21.68</td>
<td>Excess rainfall</td>
<td>38</td>
<td>33.93</td>
</tr>
<tr>
<td>Relatives</td>
<td>24</td>
<td>21.43</td>
<td>Financial problem</td>
<td>32</td>
<td>28.57</td>
</tr>
<tr>
<td>Personal savings</td>
<td>34</td>
<td>30.36</td>
<td>Physical suffering</td>
<td>21</td>
<td>18.75</td>
</tr>
<tr>
<td>Family savings</td>
<td>51</td>
<td>45.53</td>
<td>Others</td>
<td>12</td>
<td>10.71</td>
</tr>
<tr>
<td>Total</td>
<td>112</td>
<td>100.0</td>
<td>Total</td>
<td>112</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Without the contribution of women, the entire infrastructure of rural society would collapse. If women obtain equal rights they too can participate positively along with men for rural housing development and also play a critical role in the national economy of Bangladesh. The study findings proved that women contribute money and physical labour during the period of construction, repair and maintenance. However their contributions are not recognized by society. Their contribution in rural housing development is appreciated in terms of money (average Tk 36.75 daily). Without the contribution of women, most of the dwellings would fall into miserable condition. It is essential to empower women through some income-generating activities by the government and NGOs.
Bamboo cultivation is significantly important for rural housing in Bangladesh because bamboo is the most widely used natural building material. In the 1991 census it was found that bamboo was used in walls of more than 56% of housing throughout Bangladesh and even more in rural areas: nearly 60%. More than 47% and more than 51% of roofs of housing throughout Bangladesh and in rural areas respectively used bamboo (BBS, 1993).

Bamboo is an easily transportable building material (Hodgson and Carter, 1999) and is used for making numerous items and implements for regular use. It may be noted that there are more than 70 items that can be made with bamboo, which are not only linked to housing but to various different items catering to people’s needs (Choudhury, 1984) and which provide a livelihood to many people in rural areas (Figure 1.27). Some of its uses in buildings other than directly as a building material are scaffolding, shuttering and ladders for various construction works (SKAT, 1991), Figure 1.28. Bamboo rhizomes are used as fuel in brick kilns (Abedin and Quddus, 1990; Johnson and Ritchie, 1993). Small rural bridges are commonly made of bamboo and it is also the main raw material for paper and pulp factories (Choudhury, 1984; SKAT, 1991). It can nevertheless be accepted that one of the vital uses of bamboo is for construction and that it is the most commonly used building material in rural housing of Bangladesh. A rural house built of bamboo is shown in Figure 1.29.

Figure 1.27: Bamboo Artisans at Work
Bamboo is a distinctive and important plant in the ecosystem and economy of Bangladesh. There is however evidence showing diminishing supply of bamboo in Bangladesh and an accompanying steep increase in price. Yet bamboo is an important natural resource and widely utilised for making numerous articles for daily use. Bamboo is used as a building material in more than 60% of houses in Bangladesh and especially in rural areas its use is significant. Studies in the field of low-income housing show that the phenomenon of declining supply and increasing price of bamboo has a two-pronged effect on low-income communities (Ahmed, 1998). For households that can afford it, the alternative is to opt for building materials such as CI (corrugated iron) sheet, RC posts and brick. These products have adverse environmental impact during their production and embedded energy cost in transport, and whether they are environmentally appropriate as building materials can be questioned. On the other hand poor households are unable to afford even bamboo to maintain their houses regularly. A bamboo house requires frequent maintenance, failing which a household is compelled to live in a weakened and hazardous structure. The alternative is to build with weaker, smaller and cheaper pieces of bamboo or other more flimsy materials, thus representing a decline in quality of housing of the poor. Recent studies show that in Bangladesh "extreme" compared to "moderate" poverty is reducing more slowly, indicating growing inequality (DFID, 2002); the qualitative difference in housing between that of the "moderate" and "extreme" poor resulting from diminishing bamboo resources is illustrative of this increasing inequality.
As most of the rural population is poor and live below the poverty line, it is important to develop low-cost and affordable building materials for rural housing. If the cost of building materials is too high, it presents tremendous difficulty for low-income villagers to afford and build houses. Additionally, frequent natural disasters compound the problem greatly. About a few decades earlier most rural homesteads had a small bamboo garden (bash jhar) in the backyard (Figure 1.30). At that time the population of Bangladesh was lesser and there was enough space for most households to have a little bamboo garden growing without much attention or nurturing. Over time with high population growth, cultivable land in Bangladesh has become scarcer. On the other hand, bamboo continues to play a vital role as a building material and also for many other purposes, and there is still high demand for it. However, there has been very little serious initiative to improve bamboo cultivation processes in this context of demand and scarcity.

Wells et al. (1994) have documented the increasing scarcity and resulting rise in the price of bamboo in Bangladesh. This has also been widely observed by various experts (Abedin and Quuddus, 1990; Boa and Rahman, 1987; Choudhury, 1984; Dunham, 1992; Dunham, 1991; Haque, 1986; Johnson and Ritchie, 1993; SKAT, 1991). The price of bamboo and timber has almost tripled in the decade 1980-90 at a greater rate than inflation (SKAT, 1991) (Figure 1.31). More recent figures show that the price of a bamboo pole has increased further from Tk 80
in 1990 to Tk 100 in 1997 to Tk 120 in 2001. This price increase reflects the supply constraint, which is also evident from the greater distances travelled by traders for village bamboo supplies (Abedin and Quddus 1990; Johnson and Ritchie 1993) (Figure 1.32), and from the lesser number of bamboo traders, harvest of immature poles, smuggling in from India and illegal appropriation from state forests (SKAT 1991).

Various factors are causing this scarcity. Population increase is attributed to as the obviously main reason (Abedin and Quddus, 1990; Choudhury, 1984; Johnson and Ritchie, 1993; Dunham, 1992; Dunham, 1991; SKAT, 1991), but other factors are also responsible. Poor management of bamboo resources, both in villages and forests, has led to declining production. It appears that while there is increased demand for bamboo, there is lack of management skills in the villages (Abedin and Quddus, 1990). For example, new poles are harvested from the edge of clumps, leaving old poles at the centre. These are then prone to disease that eventually affects the whole bash jhar (Johnson and Ritchie, 1993). In fact, the disease, bamboo blight, is common in Bangladesh (less common in other bamboo-producing countries) and due to poor management it has reduced bamboo supply greatly (Boa and Rahman, 1987). This does not imply that villagers are completely negligent about their bamboo plantations; they do apply simple management techniques. However, the increased demand and poverty leads to over-harvesting and cutting immature bamboo, adding to the scarcity and increasing the chance of disease (Johnson and Ritchie, 1993). This is a vicious cycle: more demand leads to over-harvesting, which then leads to scarcity and further
pressure of demand. Not only in villages, but also in forests, bamboo is declining by about 3% per year (Wells et al., 1994; Johnson and Ritchie, 1993). Combined with over-exploitation and encroachment of agriculture due to increased population, poor management is also responsible (Johnson and Ritchie). The lack of management is compounded by over-harvesting of easily accessible areas of the forests, while remote areas are left alone (Choudhury, 1984), thus affecting the overall stock.

![Figure 1.31: Increase in Bamboo Price in Dhaka, 1980-90](Source: SKAT, 1991)

The principal effect of bamboo scarcity on households with lower income is that they use inferior quality and lesser quantity of bamboo for building houses. Because of this, such houses require frequent repair and maintenance. Additionally, because such houses tend to be flimsy and not durable, it presents a safety hazard for their occupants (Ahmed, 1999).

![Figure 1.32: Bamboo is Transported Over Long Distances](Source: SKAT, 1991)
1.7.2 Redressing Bamboo Scarcity

Two main remedial measures to prevent decline of bamboo supply have been suggested. Firstly, a chemical treatment of bamboo to prolong its life and thus reduce pressure on existing stock has been suggested (Dunham, 1991; Dunham, 1992; Proshika, 1993). Application in Bangladesh has so far been piece-meal and safety issues related to toxicity of chemicals have not been addressed adequately. Secondly, the regeneration of bamboo supply through improved cultivation and management has been proposed (Farrelly, 1996). There are many afforestation and social forestry programmes in Bangladesh, but none particularly address bamboo cultivation. Inadequate disease prevention and mismanagement of existing resources contribute further to decline in stock. There thus seems to be potential for introducing hazard-free bamboo treatment as a sustainable process for the utilisation and consumption of the resource within the framework of a wider initiative for its improved and sustainable regeneration, production and management. Various livelihoods are linked to bamboo and an initiative for bamboo regeneration would also regenerate these livelihoods.

During the Housing & Hazards International Workshop in 1999 at BUET, Dhaka, recommendations were formulated for research into the regeneration and improvement of supplies of natural building materials. Research into socio-economic factors was another major recommendation of the H&H workshop. These two recommendations inspired one of the authors to conduct research on bamboo cultivation. The methodology followed was Participatory Action Research (PAR), emphasising the importance of involving the end-user in the research. This research was a learning-by-doing type, where the principal research investigator, a rural inhabitant himself was the end-user. The research was primarily concerned with socio-economic factors, such as awareness building and motivation of rural people for improved bamboo cultivation rather than purely technical matters.

1.7.3 Bamboo Research – Stage 1

At the end of February 1999, through consultation with villagers, a local person who knows how to cultivate bamboo with his indigenous knowledge was identified and consulted. At the outset, the villager cut a little piece of bamboo (2 feet high) from an existing bamboo garden. Then the root, called guri in Bangla, was planted by the edge of a pond for two months. The guri was planted there because the environment of that place is the best for growing new bamboo shoots. The shoots are called gei in Bangla. In April the gei was
transplanted into the bamboo garden by digging a hole of 3 inches by 3 inches. The depth of the hole was one and a half feet. After transplanting the gei, necessary organic (mainly cow dung) and also some chemical fertiliser was mixed into the soil. The little bamboo (gei) was watered until the peak rainy season at the end of August. There were now more geis in the bamboo. Once more shoots start coming out from the bamboo, it starts growing longer and longer. One of this newly grown bamboo plants will produce more bamboo in the coming years. In 3-5 years, one of the grown plants would produce about 30 new bamboo plants around it (Rasul 2000).

1.7.4 Bamboo Research—Follow-up

During the first phase of the research the geis were not planted in an organised manner because it was the first such experiment. The principal researcher did not have much prior experience on cultivating bamboo and had to begin almost from scratch; thus quick and good results could not be expected. Additionally, the monitoring method was not formulated earlier: the geis’ growth needs to be measured every two months and the thickness attained in different parts of the pole (base, stem and tip) should be recorded, as well as the amount of fertiliser used for each gei per week.

Beginning in April 2002, this time a piece of raised land, measuring 20 feet by 20 feet (400 square feet) was selected adjacent to the existing bamboo garden. Figure 1.33 shows the bamboo plantation pattern adopted during the course of the research. After acquiring this land, it was dug up to a depth of 1.5 feet. After digging, the research investigator added 40 kilograms of cow dung and 10 kilograms of fertiliser or mati shar (consisting of TSP, urea, etc). The soil was thus fixed with these fertilisers. Four pieces of bamboo, each about 2 feet long, were buried into the soil for 15 days by the side of a pond where it was a bit moist. The land was divided into quadrants, each quadrant measuring 10 feet by 10 feet, and the four bamboos were transplanted with each bamboo at the centre of each quadrant at a distance of 10 feet from each other. These were watered throughout the whole month of June 2002, 27 times in 30 days. At the time of writing this paper in July 2002, the planted bamboos had started growing and the leaves and shoots were beginning to come out. One gei was observed and more was to come. It is important to remember that during the dry season, the plants need to be watered more intensively. Each bamboo
plant should be given 1-2 kilograms urea fertiliser in addition to regular watering. The harvest from each individual bamboo is expected to be 30 poles in 3 years. This method produces more harvest than traditional bamboo production techniques and by separating the stands reduces risk of bamboo blight.

Raising awareness of bamboo cultivation is very important for rural housing in Bangladesh. The cultivation process is very simple indeed. It can be done easily in villages and the rural people of Bangladesh can be benefited by efforts for promoting improved bamboo cultivation. Economic benefit, access to bamboo as a building material and opportunity for generating local employment would be possible if such bamboo cultivation initiatives are taken. There is a need to establish bamboo farms to demonstrate the potential of improved and sustainable bamboo production and to address the environmental implications of the decline of this local resource. Other than improved bamboo farming, some of the main activities of these farms could be researched, such as the development of bamboo cultivation and propagation methods, bamboo treatment with adequate safety measures and the production and marketing of treated bamboo building products (furniture, household and agricultural implements and handicrafts). Such a farm founded on the principle of sustainable production of bamboo should allow for generating sustainable livelihoods for local cultivators, artisans, manufacturers and entrepreneurs. It could work as a model of how bamboo can fit into the rural environment and serve a variety of domestic and community needs of a village. The bamboo farm could also work as an educational centre for documentation, research, exhibition and dissemination.
The Chittagong Hill Tracts (CHT) is renowned for its indigenous culture, which enriches the cultural diversity of Bangladesh. It is the native land of 20 different ethnic groups. This region also has natural diversity consisting of hills, forests, water bodies and wildlife. Housing is an important component of the culture of CHT ethnic groups, which is remarkably unique in this area. Their housing pattern is different from that of the mainstream (Bangalee) culture in terms of design, technology and building materials. As with other components of their culture, for centuries CHT ethnic people have been fostering this housing pattern traditionally. House or habitation is the core element in ethnic society. It maintains the relation between the border of culture and nature and plays a significant role in knitting the foundation of culture. The house acts as the base from which CHT ethnic groups act upon nature. It is the labour space of CHT ethnic culture. Through living in a house, members of the ethnic community adapt to nature and cope with the inimical environment. To understand the adaptation and coping strategies of CHT ethnic people, their housing pattern has to be studied. This section focuses on three issues - understanding the pattern of ethnic housing, assessing the relation between housing pattern and ecological system, and analysing resistance capacity and adaptive value of ethnic houses in hazards, disasters and other inimical situations.

1.8.1 Socio-Cultural Aspects of the Ethnic Population

This section is based on an anthropological study of nine small and big ethnic groups in Bandarban district of the CHT. These groups are - Marma, Murang, Bowm, Lusai, Tongchoinga, Tripura, Kheang, Khumi and Chakma. During the 16th century the ancestors of CHT ethnic groups first settled in this area (Hossain, 1993). Some anthropologists termed them as 'Mongoloid' people (Resely, 1891). Their social structure is patriarchal and patrilineal, although women play a major role in the household and economy. They believe that supernatural power creates them. Diversified religious customs exist in their community. Most of them are nature worshippers and animist, observed more than a century ago - "They worship the terrestrial elements and have vague and undefined ideas of some divine power which overshadows all" (Lewin, 1869). Some are Buddhists. Recently a few of the ethnic people have converted to Christianity. Although the hilly terrain is not favourable for agricultural activity, the people nevertheless have to subsist on agriculture by terracing and tilling the hillsides, since other
economic activities are not well-developed. On the flattened, terraced surface of the hills and also on gentle slopes, shifting cultivation is carried out, locally known as jhum. This is the main subsistence system of CHT ethnic society. Interpersonal relations, social institutions and customs relating to gender, family and clan have been developed on the basis of kinship and lineage system. Para (hamlet) is the intermediary administrative unit that consists of 10-50 households and led by a chief named Karbari. The para maintains the relation among individuals, families and institutions of the state. In the revenue system, para is under the mouza (neighbourhood) which is controlled by a 'Headman'. All Headmen are controlled by the circle chief named Raja (Monarch). Karbari, Headman and Raja are hereditary appointed posts. Every single group possesses an individual mother tongue, art and literature, mostly in verbal and folk forms.

1.8.2 Worldview, Rituals and Housing

Ethnic people view their world through beliefs on supernatural beings such as deb (god), debi (goddess) and debota (deity). Some deities control everything of their life including household and household-based activities. It is believed that these deities had roles in constructing houses in the prehistoric age. Even now, these beings are active within their household life. Existing pattern of their houses is believed to have been firstly introduced by these deities, mentioned in their text. They relate all things of their life with the divine. The profane life of ethnic people is in two worlds - para and hilly forests. Divine beings create these worlds. House is the 'core' of the para-centric world. Some deities are believed to stay in the para and are responsible for protecting the para or houses from attack of evil beings.

In the ethnic groups, it is clearly manifested as Haviland (2000) suggests: "Rituals is the means through which persons relate to the sacred; it is religion in action." Certain individuals are specially involved and active in dealing with the above mentioned deities and spirits through ritual activities. The majority of these rituals are either exercised in houses or household-orientated. One of the objectives of exercising these rituals is to activate the above spirits or deities for protecting households from attack by wildlife, calamities or hazards. Totems are used for denoting animal or plant apical ancestors of a clan. Ethnic people display totems in their houses. This has two objectives - firstly, to express their clan identity and secondly, to protect them and their houses from evil beings.
1.8.3 Land System

In the CHT area, land consists of forests, uneven hills and water bodies including natural fountains, canals, etc. Ethnic people use the land for jhum (shifting) cultivation, house settlement, gardening, etc. The Bangladesh government owns the land of this area. The chief of Bomang circle Raja is responsible for collecting land revenue on behalf of the state through the Headman and Karbari. Every couple is entitled to use 2-4 acres for jhum cultivation and has to pay Taka 5 as jhum kar (revenue).

1.8.4 Settlement and Housing Pattern

Due to their kin-based society, ethnic people follow a lineage system in knitting the family and constructing habitation. The members of one or two individual clans settle in each para. Clan indicates the unilineal descent group based on stipulated descent (Kottak, 2000). Their houses are internalised in the para. A para consists of 10-50 households or families. There are two types of families - nuclear (consisting of parents and children) and extended (including three or more generations).

The settlement pattern of this region is influenced by its topography. Since the CHT is sparsely populated, settlements tend to be scattered. Although settlements can be seen on top of hills, on slopes or in the valleys, ethnic people prefer to establish a para at the hilltop in deep forest having adjacent area of water bodies. Forming a para on the hilltop in forests is supported by their divine texts. This type of para is characterised as agglomerated habitation (Baqee, 1998), shown in Figure 1.34.

Because of the uneven terrain, houses are raised on bamboo or wooden posts to site them on the hilly terrain. Every family generally owns one house. The floor of the house is on a raised wooden or bamboo platform generally built at about 1.5-4.5 metres height from the ground (see Figure 1.35). These houses are locally known as machang ghor or tong ghor. The CHT ethnic people have used this type of house for centuries, in harmony with their ecology. Each house is divided into two main parts - balcony and inner portion. The typically long open balconies serve as a social area and also to carry out activities such as weaving with handloom. As per function, the inner portion is divided into several rooms that also vary from community to community, shown in Figure 1.36. It can be seen that ethnic houses often consist of up to 10 rooms. Each room is used for a specific purpose. In some cases, houses are divided by bamboo partitions into rooms when members of the extended family get married and require their own private space. For
example, if there are three married members in a family then there would be four rooms. Unmarried members or guests use the outermost room, which is also used for sitting or cooking (Shafi, 1997). The house is accessed by a wooden or bamboo ladder which leads on to the wide raised platform. The open space under the platform is used for rearing poultry, goats or pigs.

Figure 1.34:
Mapping of Para Prepared with an Ethnic Community
As suggested by Handwerker (1981), technology "...is the realm of culture that most importantly defines the conditions to which individuals and social units adapt. Technologies link individuals and social units to the physical environment, and individuals and social units are linked to technologies through the activities... These activities constitute the functional niches of a technological system....". In the CHT ethnic communities, house building technology is a traditional system existing from generation to generation through verbal and practical transmission. Building technology includes three major aspects - knowledge, technicians and elements-tools. It is a 'science' of the community.

As with other aspects of their culture, ethnic people acquire knowledge on house building from their social institutions. They believe that many years ago the progenitors of their society took shelter on a hilltop in deep forest. They learn from this belief how to build houses. There is no professional group for constructing houses. They build their houses themselves. Various kinds of choppers are the main tool for constructing houses. Other than that they use spade, machete, axe, hammer, etc. For the main elements of the houses, ethnic people use the following raw materials, which are available locally:

- Wood and bamboo for making platform, walls and posts;
- Leaves of bamboo, wooden shingles, a kind of tall grass and hill reeds for roofing and thatching;
- Cane and rattan for binding.
Figure 1.36: Layout of Ethnic Houses (Machang Ghor)

a) Marma Group  b) Murong Group  c) Tripura Group  d) Chakma Group
1.8.6 Aesthetics

Aesthetics is a specialisation of ethnic houses. In the anthropological sense, it pertains to "appreciation of the qualities perceived in works of arts; the mind and emotion in relation to a sense of beauty" (Kottak, 2000). On the basis of this viewpoint of beauty the aesthetic aspects of ethnic houses can be described from three different angles, described as follows:

- **Combination of elements**: Several elements of houses at different points are framed with each other in rhythmic form. Posts, platform, roofing, hedge, etc. are made with elements where there is no maladjustment in their combination. Thus, externally, this projects harmony.

- **Artistic works in wood and bamboo**: Ethnic people sketch and cut the figures of birds, domestic animals, wildlife, flowers, trees, fountains, hills, etc. on the front side of houses, specially on windows or door frames and hedges of houses.

- **Demonstrating 'beautiful' things**: To make houses beautiful, dwellers display different types of apical of animal, trees and flowers with houses. After hunting, they make these with head, horn and skin of wildlife - tiger, dog, cow, snake, etc. Expressing the clan identity of house dwellers is another objective of displaying apical.

1.8.7 Usage of House

Mentioned earlier, the profane world of ethnic people is in two-life types - firstly 'para'-centric inner life and secondly hill/forest orientated outer life. In the inner life, almost all daily activities are performed within the area of houses. The house is used by its dwellers in ethnic communities for various purposes. During the whole period of the life of a person the house is widely used. The house area is used for resting, sleeping, enjoying conjugal life, guest entertainment, seating, cooking, preserving water, storing belongings, cleansing, perambulation, crop processing, husking, child caring, storing fuel wood, nursing and treating patients, etc.

The house is important as a post-marital residence. In CHT ethnic community two types of post-marital residence exist - uxorilocality (residence with wife's relatives after marriage) and virilocality (residence with husband's relatives). Practice of the first type is minor and temporary.

1.8.8 Adaptive Value

Adaptation indicates the process by which organisms cope with environmental stresses. Ethnic people cope with and adapt to the environment that is made of hills, trees, natural calamities, wildlife, etc. through their pattern of houses. For centuries they...
CONTEXT OF HOUSING AND HAZARDS

have lived in machang ghor. Basically houses are the only shelter and ecological niche in their community. Due to the natural condition of their environment, ethnic people have to maintain close and balanced relations with the environment for survival, development and continuing the complete life system including houses and settlement.

In the CHT locality, ecosystem is developed by balancing the relationship between natural elements (hills, plants, forests, wildlife, fountain, rivers, etc.) and cultural traits. Housing settlement is one of the components of the ecosystem. Settlements and existing ecosystems are not threatening to each other. Ethnic people have their own indigenous technologies to build their houses within the given environment. They use locally available natural resources as raw materials for housing. They do not damage nature in collecting and utilising raw materials. Their lineage and kin-based habitation and housing are favourable for their subsistence system and modes of production. Ethnic houses have resistance capacity to protect the dwellers from hazards and natural disasters such as storms, floods, attack of wild animals, fire, etc. and have adaptive value to face any inimical situation. For example, ethnic people use bamboo leaves for roofing because they do not catch fire easily. This pattern of housing and habitation has adaptive value for survival and development of ethnic groups within a certain environmental and ecological niche.

Building machang houses on bamboo or wooden stilts is a traditional practice of the CHT ethnic communities. A reason is that the machang helps to protect them from attack of wildlife and snakes, and is suitable for coping with the environment and natural hazards; it gives protection from heat, cold and water run-off from the hillsides. It allows privacy and thus provides opportunity for enjoying family life.

1.8.9 Other Housing Typologies

Other than indigenous ethnic communities, there are also some Bengali settlers in the CHT with different housing typologies. Stilted machang houses are uncommon among this group and houses are instead built on mud plinths as done typically in the plains. Nonetheless, the use of local resources such as bamboo and mud creates buildings with regional character. An example of adaptation to local environment is found in houses built on hilly slopes that have large pitched roofs with very low eaves almost reaching the ground,
somewhat similar to a tent (Figure 1.37). This is done so as to resist strong winds on the exposed hillsides. These houses are very large with several rooms accommodating joint families, representing a cultural expression of joint family living patterns.

1.8.10 Importance of Ethnic Housing

In the developing national context of Bangladesh, CHT ethnic housing is one of the major cultural resources, which is in endangered situation. The influx of mainstream Bengali settlers is a source of conflict. This population group is traditionally not adapted to living in a hilly area and consequently hampering the balance with nature and the ecosystem so characteristic of the ethnic people. Deforestation of the wooded hills and over-exploitation of natural resources is rampant in many parts of the CHT.

The continuity of ethnic housing, an important component of ethnic culture, would ensure the cultural diversity and heritage of Bangladesh. Not only that, but ethnic houses contain the quality of sustainability due to the appropriate use of local resources for building and adaptation to the environment. As a representation of cultural diversity, the ethnic housing pattern of CHT should be studied widely; this could provide inputs into programmes for sustainable and environment-friendly housing.
Figure 1.37: House of a Bangalee Settler in the CHT (continued from page 62)
2. Building Technologies for Hazard Resistant Housing

2.1 Introduction A great part of the material in this book has resulted from studies and work carried out under a higher educational link between two engineering schools, one at BUET (Bangladesh University of Engineering and Technology) and the other at the University of Exeter, UK. Because of this, the emphasis has been on developing and promoting building technologies for hazard-resistant housing. Nonetheless, the underlying concern has been that the technologies should be appropriate, affordable and achievable in rural circumstances, a reason for subsequently conducting field-level grassroots studies to test in reality the applicability of the results of the laboratory studies. A large amount of technical studies have been carried out, so it was essential that some of the main findings find their way into this chapter.

This chapter begins with a description of mud stabilisation and bamboo structure tests at BUET. The results of the mud stabilisation tests were also utilised in the field. The effect of strong wind on housing is an important factor in building hazard-resistant housing and reducing vulnerability, and a large part of this chapter is devoted to the topic. Firstly, two main aspects are covered: a) experiences of multipurpose cyclone shelters and b) technologies for improvement of wind-resistance of traditional housing. Secondly, results of wind tunnel tests on the behaviour of model rural houses under different wind conditions conducted mainly at the University of Exeter are presented. These provide useful guidelines for stronger construction details, planting vegetation and other such hazard-resistance measures to safeguard rural houses against strong wind. An inventory of post-disaster housing types provided by organisations
in Bangladesh, some of which incorporate hazard-resistant technologies, is then included to indicate the state of the practice beyond the confines of the BUET-Exeter studies. The final section attempts to gel together the lessons offered by the technical studies by relating them to economic, social, environmental and other multidimensional aspects.

2.2 Hazard Resistant Rural Houses

Natural disasters, particularly extreme winds and floods, have been causing huge loss of lives and properties every year in Bangladesh. Most of the Bangladeshi population lives in rural areas where the construction of residential houses follows a traditional way in which houses are mainly constructed with thatches, bamboo, etc., with untreated earth base having minimum or no foundation. In most cases, these structures have almost no lateral load resistance mechanism. During floods, rural houses go under water causing severe damage to their bases. During wind events, the frames of rural houses undergo partial or total collapse as they have little or no lateral load resistance. Here some treatments and techniques are proposed for the improvement of rural house bases, and the vulnerability of rural houses to failure due to cyclic moderate wind loading is shown.

2.2.1 Development of Durable Plinth

During floods, many house bases go under water for a certain period. After the recession of flood-water, it is usually found that most of the bases are either washed away or have been damaged to a considerable extent. Development of water-resistant mud-concrete is essential to making house bases more durable.

The bases of the rural vernacular houses are made from soil in the traditional way. Loose soil is heaped at the location where the base is to be prepared. Water is added to make mud and it is positioned in the periphery of the base area like a boundary wall of height about 60-120 cm. Within this boundary the rest of the soil is dumped and mixed with water to prepare mud. Then the mud is heaped and compacted up to the desired height of the plinth.

Since the plinth is a very important part of the house, it should withstand the effects of flood. The first part of the investigation included determination of the properties of soil mixed in the laboratory with some additive or cementitious materials. This mixture has been termed here as mud-concrete.
In this study, rice husk (RH), rice husk ash (RHA) and cement (C) were used to make the mud-concrete.

The cementing materials were mixed with the soil in different proportions then water was added to prepare the mud. The net weight of the soil and the cementing material in each of the cases was fixed at 68 kg. The percentage of the ingredients RH, RHA or C was fixed at 5% by weight. To make the mixture to a desired consistency, water (4000 cc) was added to make the mud-concrete. The sample was then put in the wooden mould of size 81 cm x 35 cm x 15 cm (Figure 2.1) to make a continuous soil bed of size 75 cm x 30 cm x 15 cm in five layers (Serajuddin, M., 1980). In each layer, 25 nos. of blows were given with a 11.3 kg hammer from 15 cm height. After four days it was cut into ten pieces to have cubes of size 15 cm x 15 cm x 15 cm each. The compressive strengths of the samples with different combinations are given in Table 2.1. Mud Cement blocks of various sizes were also prepared in cube moulds (Figure 2.2). These were dried and tested under water for more than two months (Figure 2.3) and the blocks remained in intact condition.

<table>
<thead>
<tr>
<th>Combination</th>
<th>Cross-Sectional area (cm²)</th>
<th>Height (cm)</th>
<th>Max Load (kg)</th>
<th>Compressive strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>224.5</td>
<td>15.2</td>
<td>3810</td>
<td>1.70</td>
</tr>
<tr>
<td>Soil + HRA</td>
<td>217</td>
<td>15.2</td>
<td>3991</td>
<td>1.81</td>
</tr>
<tr>
<td>Soil + C</td>
<td>220</td>
<td>15.2</td>
<td>3129</td>
<td>1.41</td>
</tr>
</tbody>
</table>

Table 2.1: Compressive Strength of the Mud-Concrete

Figure 2.1: Preparation of Mud-Concrete, (a) Mould, (b) Hammer
The dry samples of different combinations (soil, soil+RH, soil+RHA, soil+C) were placed on a tray and kept under water for ten days to get an idea about the effect of flood on the bases of rural houses. When the tray along with the samples was taken out of water after ten days, it was observed that all other samples except the cement-mixed soil washed away. It appears that although the compressive strength of cement mixed soil (soil+C) is not the best of all the mud-concretes, it produces a better plinth to withstand the effects of flood. The effect of the percentage of cement and also the use of jute-fibre, straw, etc. as cementing materials in the mud-concrete is yet to be investigated.
2.2.2 Common Failure Modes and their Prevention

The authors made visits to several villages with a view to studying the framing as well as base preparation techniques and it was found that the techniques are more or less similar. Bamboo columns are traditionally being used as the main supporting members. The columns are embedded directly into the ground, which tend to decay in contact with sub-soil water. In most places, sub-soil insect attack on bamboo columns forces the house owners to replace the columns frequently. Poor households are unable to afford and replace bamboo in necessity, which leaves their houses weak and vulnerable to moderate wind. Reinforced cement concrete pillars can be considered as a great innovation for this problem; but the poor rural people often cannot afford them.

Instead of replacing bamboo columns with reinforced cement concrete pillars, their performance with respect to sub-soil water or insect attack at their base can be improved by using concrete blocks with a hole at the center for insertion of the bamboo column. Before insertion, the end of the post can be coated with a layer of bitumen for further protection from water or insects. A less expensive and simpler method would be to burn the lower part of a bamboo column until its surface color becomes black and then to coat it with motor oil as shown in Figure 2.4. Scorching dries the bamboo out completely and depletes internal cellulose from which insects derive nourishment, thus retarding insect attack. When scorching bamboo, caution needs to be exerted that it does not burn all the way through (Figure 2.5). Coating it with oil prevents further access by insects and additionally protects from sub-soil water. Instead of motor oil, bitumen can be used where available. Motor oil, an industrial by-product, is generally less expensive than bitumen, but bitumen performs better. A summary of bamboo treatment is shown in Figure 2.6.

The lifting of the leeward roof slope of rural houses is another very common problem in Bangladesh. The total wind force on the roof depends on the difference of pressure between the outer and inner faces. Any open doors, windows or ventilators on the windward side of a house can increase air pressure inside the building and this also increases the loading on those points of the roof and walls that are subjected to the external suction. Openings at positions that are experiencing external suction will also reduce the pressure significantly inside the house and thus reduces the risk of lifting the roof off the house. Use of jute ropes or special
Figure 2.4: Coating Bamboo with Bitumen

Figure 2.5: Scorching Bamboo
type of rope, locally called *sutli*, to fasten the joint where horizontal and vertical members meet, aggravates the problem as the jute ropes rot and become weak within a very short period of time and thus the vulnerability of roof to lifting increases. With a view to strengthening the joint, several cores of iron wire can be twisted together and the roof frame can be tied down to the top wall beam and column as shown in Figure 2.7 and Figure 2.8.

![Figure 2.6: Treatment of Bamboo Column, (a) Scorching the Bamboo, (b) Covering with Motor Oil, (c) Soaking in Bitumen, (d) Placing the Column in Position](image)

2.2.3 Properties of Bamboo as a Framing Material

Generally three types of bamboo are available in Bangladesh. They are locally called *mahal* or *talla*, *ora* and *barak*. Among them barak is relatively thick-walled and widely used as column and beam which are locally named *khuti* and *paire/dhynna* (the beam along the long side or the beam along the short side), respectively. Other types of bamboo are usually thin-walled and are split and woven into a variety of stiff mats that are used as walls and sometimes as roof cladding.

To determine the strength characteristics of bamboo, compression tests have been performed on bamboo specimens of length 20-25 cm and full sized bamboo of length 150-152 cm (Figure 2.9a). For tensile strength, the bamboo was split and a reduced section was prepared as shown in Figure 2.9b. Compression test results of both types of bamboo specimen and the tensile strength characteristics of bamboo are given in Tables 2.2, 2.3 and 2.4 respectively.
Figure 2.7: Connection of House Frames, (a) Three-Dimensional View (b) Top Plan of a Joint

Figure 2.8: View of a Frame Connection

Figure 2.9: Specimens prepared for Testing, (a) Full-Sized Compression Test Specimen, (b) Tensile Test Specimen
Buckling failure was observed for the full-sized specimen (Figure. 2.10) and the buckling strength was found to be 0.56 times the compressive strength of the shorter bamboo specimen. On the other hand, it is seen that bamboo is very strong in tension and the tensile strength is about 4.4 times of the compressive strength of a full-sized bamboo specimen. Unless it becomes weak due to insect attack or by rotting, bamboo was found to be safe to withstand the stresses caused by moderate wind-induced lateral load.

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Length (cm)</th>
<th>Outer dia. (mm)</th>
<th>Thickness (mm)</th>
<th>Ultimate load (kg)</th>
<th>Compressive strength (N/mm²)</th>
<th>Average strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21</td>
<td>58</td>
<td>15</td>
<td>8934</td>
<td>43.3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>21</td>
<td>58</td>
<td>15</td>
<td>9524</td>
<td>46.1</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td>60</td>
<td>16</td>
<td>10431</td>
<td>46.3</td>
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<td>4</td>
<td>19</td>
<td>69</td>
<td>16</td>
<td>12472</td>
<td>45.9</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>23</td>
<td>74</td>
<td>18</td>
<td>12698</td>
<td>39.3</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>22</td>
<td>65</td>
<td>16</td>
<td>12472</td>
<td>49.7</td>
<td></td>
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</tbody>
</table>

Table 2.2: Compression Test Results of Bamboo (Barak) Specimen

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Length (cm)</th>
<th>Outer dia. (mm)</th>
<th>Thickness (mm)</th>
<th>Ultimate load (kg)</th>
<th>Compressive strength (N/mm²)</th>
<th>Average strength (N/mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>152</td>
<td>59</td>
<td>11.5</td>
<td>4535</td>
<td>25.9</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>152</td>
<td>63</td>
<td>13.5</td>
<td>4580</td>
<td>21.4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>150</td>
<td>58</td>
<td>11</td>
<td>4807</td>
<td>29.0</td>
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</tbody>
</table>

Table 2.3: Compression Test Results of Full Size Bamboo (Barak)

<table>
<thead>
<tr>
<th>Specimen Number</th>
<th>Section (mm)</th>
<th>Ultimate load (kg) (N/mm²)</th>
<th>Tensile strength (N/mm²)</th>
<th>Average strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15 x 13</td>
<td>1814</td>
<td>91.3</td>
<td>112.5</td>
</tr>
<tr>
<td>2</td>
<td>18 x 10</td>
<td>2403</td>
<td>131.0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>17 x 10</td>
<td>2041</td>
<td>117.8</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>16.5 x 10.8</td>
<td>1995</td>
<td>109.8</td>
<td></td>
</tr>
</tbody>
</table>

In order to understand the wind resistance potential of a rural hut under cyclic moderate wind loads, a full-scale model hut was tested under two cycles static load. Although the science of theoretical fluid mechanics is well developed and computational methods are experiencing rapid growth, it remains necessary to perform physical experiments to gain insights into many fluid flow effects. It is necessary for the houses subjected to wind loads to be sufficiently strong to perform adequately from a structural safety and serviceability viewpoint. From dimensional analysis, it has been shown (Simiu et al. 1986) that the similarity
requirements between the model and the prototype are exactly satisfied when and only when the two systems have exactly the same scaling. From this standpoint, full-scale model produces the best possible result. On the other hand, the natural wind is turbulent, and the phenomena that takes place in the boundary layer of wind is highly dependent on the nature of this boundary layer. Due to the physical limitations in simulating the natural wind in the experiment, static load was applied instead.

Figure 2.10: Testing of Full-Sized Bamboo Specimen

An experimental set-up is shown in Figure 2.11. Static load was applied uniformly to the frame of the house through a loading jack, plan view of which is shown in Figure 2.12. The deflections of the house frame caused by static lateral loads were measured by a theodolite. During application of the first cycle of loads, some small cracks were observed on the base soil adjacent to the bamboo columns and no repairs were made before the second cycle of loading. This has been done to simulate the phenomena of frequent storms of moderate speed that do not actually cause total collapse of the house. It is observed from Figure 2.13 that deflections during the second phase of loading are larger than that of the first cycle. This observation can easily be extended to the fact that the house will collapse under cyclic moderate wind loading if remedial
measures are not taken in between. The remedial measures might be to strengthen the loose soil adjacent to the column base by hammering and/or to provide lateral support to the main frame of the house on the leeward side of the house.

![Figure 2.11: Test Set-Up of Full-Scale Rural House Under Lateral Load](image)

![Figure 2.12: Plan View of House Under Test](image)

Traditional rural housing is very light and fragile, and has the simplest form consisting of a skeleton of bamboo framing formed by four corner poles framed by four struts in the horizontal plane at a height of 1.5-2.0 meters from the plinth level. Anwar (1996) has analysed such a basic frame as shown in Figure 2.14 with different kinds of wind braces and has shown that the lateral and
torsional stiffness of the basic frame can be increased by more than 100 times by using vertical cross-bracing along the four sides of the house. The effect of lateral bracing on the lateral load resistance of the full-scale model is still under investigation.

**Figure 2.13: Behaviour of House Frame under Cyclic Loading**

An experimental investigation has been carried out to understand the effects of flood on the plinth soil and to clarify the vulnerability of rural houses to cyclic wind loading. Based on the experimental results, the use of cement-soil mixture with 5-8% cement by weight has been suggested to prepare the plinth of houses of flood-prone areas. Remedial measures have been advised which will create a strong safeguard against the repeatedly occurring moderate storms.

Future investigation is to be continued with changing the percentage of cement in the mud-concrete, instead using 5-8% by weight. In field conditions mixing may also be done by volume; understandably, the percentages may not be that accurate, but it would allow convenience of application. Effect of different kinds of lateral bracing on the lateral load resistance potential of the full-scale house frame is still under investigation.
2.3 Cyclone-Resistant Domestic Construction

The Multipurpose Cyclone Shelter Project (MPCSP), financed by UNDP and the World Bank and undertaken in 1992/3 (BUET/BIDS, 1993), was a detailed study with the objective to provide cyclone shelters for refuge for the population of 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 houses of pucca (durable) 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.

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 kutcha construction for dwellings, therefore, relates to their far greater number and to a prevailing context of poverty.

The ADB Report of the Housing Sector Institutional Strengthening Project (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 kutcha construction (non-masonry, bamboo, reeds, jutesticks, etc.).
- 23% of urban and more than 40% of rural dwellings are of temporary construction (lesser quality than kutch). 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 kutch dwellings being regarded as substandard and requiring replacement with pucca construction. In that case, annual construction of 2,167,000 dwellings would be needed, including replacement of all "substandard" dwellings over a seven year period (Halcrow Fox, 1993). 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.

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 place, 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.

2.3.1 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 for it 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 focused 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 or were insufficiently maintained.

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.

<table>
<thead>
<tr>
<th>Hazard Class</th>
<th>Depth of water (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>below 0.5</td>
</tr>
<tr>
<td>2</td>
<td>0.5-1.0</td>
</tr>
<tr>
<td>3</td>
<td>1.0-1.5</td>
</tr>
<tr>
<td>4</td>
<td>1.5-2.0</td>
</tr>
<tr>
<td>5</td>
<td>Greater than 2.0</td>
</tr>
</tbody>
</table>
2.3.3 Wind Risk Areas

Wind alone will be the prevailing hazard in areas inland from those affected by storm surges. 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 kutcha and pucca dwellings as refuge during floods (designs should allow for this)
- reduction of the recurrent costs of dwelling maintenance
- reconstruction/replacement, enabling more people to stay safely in their own homes which will relieve overcrowding in safe-haven structures. This has been noted in the past as contributing to reluctance to use such shelters.

2.3.4 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 (e.g., 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.

2.3.5 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:

<table>
<thead>
<tr>
<th>Floor</th>
<th>Frame</th>
<th>Walls</th>
<th>Roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mud plinth</td>
<td>Bamboo pole</td>
<td>Woven bamboo</td>
<td>Thatch</td>
</tr>
<tr>
<td>Raised timber</td>
<td>Jute poles</td>
<td>Mud</td>
<td>CGI sheet</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CGI sheet</td>
</tr>
</tbody>
</table>

2.3.6 Siting and 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.

2.3.7 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.

2.3.8 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.

2.3.9 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
- Limit the areas of window openings in relation to walls.

2.3.10 Roof
The roof is usually either thatch or cgi sheet.

Proposed improvements are:
- increase the pitches of roofs to 30 to 40 degrees;
- encourage the use of hipped roofs;
- tie down thatch;
- use more frequent, improved fixings for cgi sheet; and
- use methods for the permanent or temporary tying down of entire roofs (e.g., on receipt of cyclone warnings).

2.3.11 Survival of Cyclone-Resistant Kutchta Construction
It is necessary to establish the extent to which improved kutchta construction has survived in cyclones and reasons why traditional construction has failed. Case studies from the field are required. 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.
2.3.12 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.

2.3.13 Improved Pucca Construction

Construction in pucca (permanent) materials such as brickwork and concrete block offers further important opportunities for improved domestic construction. 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 as 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.

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 for 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 (Figure 2.15). Reinforced concrete "nucleus houses", built by the PWD (government's Public Works Department) 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.

Figure 2.15: Polythene Sheet Used in Roof Mat Sandwich
The cost of the proposed improvements to a kutcha 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 const-ruction by-pass
the real need which is for improved traditional construction.

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;
- the services of the mass media such as radio, television
  and cinema may be used for dissemination purposes.
- 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 NGO and others in community development programmes. All these activities should be either continuous or repeated annually.

2.3.16 Future Directions

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 kutcha and pucca materials and methods;
- repeated annually or designed to be continuous.

Again, the present imbalance of funding in favour of pucca construction requires redressing to concentrate more on kutcha 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 kutcha construction are also required; finally long-term programmes, say of 25 years, are expected to be needed for effective promulgation, demonstration and absorption.
Bangladesh is prone to disasters such as flood, tropical cyclone, storm surge, tornados, river bank erosion, earthquake and arsenic. The country is particularly vulnerable to some of the world’s strongest tropical cyclones. Death and loss of property from these cyclones are the highest in the world. Most government or external initiatives have traditionally paid little attention to addressing the underlying causes of vulnerability caused by cyclonic storm. Mostly management practice and modes of implementation are undertaken without due consideration to community dynamics, perceptions and priorities. Questions arise as to: a) how the affected people deal with disasters; b) whether these people are just passive victims and vulnerable beneficiaries of relief; and c) the existence of coping mechanisms developed historically by the people on which interventions can be planned for more sustainable disaster management.

The following two projects, built in the cyclone affected areas of Cox’s Bazar, are discussed here:

a) COMMUNITY-BASED MULTIPURPOSE CYCLONE SHELTERS by the Development Association for Self Reliance, Communication and Health (DASCOH).

b) BATTLING THE STORM: A STUDY ON CYCLONE RESISTANT HOUSING by Community-based Disaster Preparedness Programme, Bangladesh Red Crescent Society / German Red Cross.

Process oriented establishment of Community Based Multipurpose Cyclone Shelters (CMCS) were implemented by DASCOH. At the outset DASCOH identified the problems associated with the planning, construction, usage and management of cyclone shelters. DASCOH from the beginning prepared an organisational system to overcome these problems.

Communities were selected on their firm commitments in ensuring their willingness to donate sizeable land to construct the shelter. After selection of the intervention areas, the disaster preparedness needs of the community were assessed through Participatory Rural Appraisal (PRA) exercises. Through these exercises the community recognised the need and importance to organise into
committees to decide on this usage, management, shelter construction and to collaborate with outside technical assistance in the planning, construction and management of cyclone shelters.

DASCOH undertook a feasibility study by engaging a Swiss engineer for the project. The engineer undertook a survey and assessment of existing and planned cyclone shelters. The final assessment adjusted the shelters by Prism Bangladesh to be the most appropriate design as it was considered harmonious, original and well suited for the project areas selected by DASCOH. Bashirul Haq & Associates Ltd, designer of the shelters built by Prism Bangladesh (Figure 2.16) was chosen to to prepare the architectural designs for DASCOH’s project (Figure 2.17).

The requirements of the shelter were:

1) School having 5 class rooms
2) Separate areas for men and women, when used as a shelter during cyclone
3) Separate toilets for men and women
4) Drinking water inside the building
5) Hand pump to be operated at the first floor
6) Shelter requiring least maintenance
7) Building design should generate a sense of pride in the community.
2.4.2 Cyclone Resistant Housing

It is common knowledge that cyclone destroys a considerable number of houses in the affected areas. Further, this leads to increased risk of injury and the burden of reconstruction of houses. Combined efforts of Bangladesh and donor agencies to provide pucca houses that are cyclone resistant, at present, is financially prohibitive. Alternatively, indigenous technology and shared knowledge of the communities in home building, which has been effective in cyclone resistance and in combining local knowledge with easily applicable intervention of appropriate technology could be identified. This might contribute towards a mitigation of the destruction of houses. With this objective German Red Cross initiated a survey and study.

The survey was based on the premise that problems in housing should not be defined by experts only, but should be based on dialogue with local people of the target areas. Direct involvement of the local people in problem identification was ensured, so local perceptions, attitudes, values, shared knowledge, etc. could be taken into account.

The ideas (or methods) were: (a) to learn directly and by face-to-face encounters with local people, in order to incorporate technical know-how, as well as to learn about physical and social conditions; (b) to learn by listening to, and seeking from local people, their concerns and priorities about housing related problems; and (c) to use participatory assessment methods and activities for creating dialogues with local people for the collection of relevant information.

Participatory methods, techniques and tools included: 1) the collection and review of secondary sources (this included collection of mouza, upazilla and district maps); and 2) the preparation of a questionnaire, diagrams and scoring cards. These tools were used to ascertain wealth ranking and identity of house owners in order to prepare social mapping. Scoring cards were used in the survey to identify options, work ability and people’s perceptions of safety, orientation, distance of the trees from the houses and structural weaknesses in traditional houses.

2.4.3 Graphical Presentation of Social Survey

This part of the survey was a graphical presentation of social mapping, location of selected houses and the identity and wealth ranking of selected house owners. The drawings were prepared
with the help of the existing mouza maps of the study area. It allowed obtaining an understanding of the people, place and typology of houses (Figure 2.18).

2.4.3.1 Physical Survey of Selected Houses
Monographs of individual houses have been prepared through physical survey, measured drawings, sketches and photographs (see Figure 2.19. Each house was identified by its owner. The houses were chosen on the basis of findings of the survey, social mapping, wealth ranking and identity of house owners.

2.4.3.2 Architectural and Structural Details of Houses
The houses surveyed can be termed indigenous houses. The term describes the art of building by anonymous local builders. The accent is on community enterprise in building produced by the spontaneous and continuing activity of people with a common heritage. Other terms used for these kind of houses are vernacular, spontaneous and rural. The
builders show an admirable talent for blending the houses with the natural surroundings. The house plan, roof shape and orientation have developed in response to the climate, topography and available building materials of the area. The manner in which these materials are used and the development of structural features by the traditional builders to withstand harsh climatic conditions is surprising, as if the builders have anticipated systematic developments in building science.

![Figure 2.19: An Example from the Physical Surveys of Houses](image)

Materials alone do not make houses cyclone resistant, rather it is the manner in which these are used. The competence of local builders is evident in their understanding and ability to identify certain structural features which are particularly susceptible to wind damage. These features are in the roof structures, extra support of the roof ridge, the tie between roof structures and vertical support, and the need for extra ties for extended roof overhangs. Further, the awareness of builders of the need for strengthening traditionally built structures is evident when we look at their use of metal strap between wooden post and joist and the use of strong and durable nylon rope for tying bamboo sections.

The main weakness of many of these houses is the fact that the foundation is not firmly anchored to the ground. This causes houses to be lifted up or blown away by cyclones. Another major weakness is the fast deterioration of traditional building materials like bamboo, as these are not protected against decay, fungi, termites and high humidity when in contact with the ground.
2.4.3.3 Technology Intervention in House Building

A sizeable number of local people are unable to undertake safer construction of their houses for lack of capital and high cost of building materials; they cannot afford the cost of re-building after severe damage due to cyclone. This is reflected in the survey of people's perception of the most important problems in housing. The technology intervention in house building at present is limited only to strengthening the structures for cyclone resistance by using pre-cast concrete post, steel truss and corner bracing. This house form disregards the traditional house typology, roof shape and lifestyle of the local people, which is the cause of rejection of the prototype houses introduced by several organisations.

2.4.4 Specific Case of Technology Intervention

BDRCS with assistance from the International Federation of Red Cross and Red Crescent Societies initiated the design and building of a prototype house: "The Wind Resistant Hut". The structure of this house type has pre-cast concrete columns for vertical support, steel truss for roof support and steel rod for bracing between columns. Bamboo mat is used as wall. Problems with this house type arise not with the details of anchoring to foundation and jointing details of truss to vertical post, but the use of steel sections for fabrication of truss, roof shape and most importantly in the lukewarm response in acceptance by the beneficiary (Figure 2.20).

2.4.4.1 Transformation of the Wind Resistant Hut

Steel sections for fabrication of truss in marine weather require application of properly specified paint and regular maintenance. Fabricated steel sections as building materials are inherently more complicated for repair and maintenance, particularly in a low technology area where people depend on local expertise and locally available materials. Experiments have shown that houses with hip roofs have the best record of resistance to wind loads. The roof shape of the BDRCS house type is gable roof with 27.5° pitch, where the recommended gable roof in cyclone affected areas is 'high gable' roof with pitch between 35° to 45°. The traditional houses in these areas have a room surrounded by pashchati (verandah). The roof shape of the roof over the room is invariably hipped and the pashchati roof is separated from the hipped roof. Because of this separation, pashchati roof usually
suffers wind damage without affecting the roof of the ghar. The *pashchati* area, beside creating extra space for entertaining guests, eating, cooking, sleeping, etc., also acts as a barrier during cyclones accompanied by heavy rain. Further, its low roof creates a sense of protection and privacy.

The photograph of the house in Figure 2.21 shows the transformation of a BDRCS initiated house type. The roof of the BDRCS house type is visible within the present house form shaped by addition and alteration in order to suit the lifestyle of the beneficiary living on Moheshkhali island.

*Figure 2.20: BDRCS 'Wind Resistant Hut'*

*Figure 2.21: House at Charpara, Moheshkhali*
2.4.5. Building Materials

The materials used in the houses are predominantly bamboo or wood for vertical support, joist and truss for roof support. Walls are either of bamboo mats or wood planks. Bamboo is used in houses that belong to households with low economic ranking, and wood is used in houses belonging to those of moderate level ranking. Technology intervention in house building has introduced steel and pre-cast concrete sections into a few houses. Use of bamboo as a building material requires a high level of maintenance or frequent replacement because they are of poor quality and not treated with preservatives. As such, the material is not protected against decay, fungi, termites, marine bore attack and high humidity when in contact with the ground. Decay, fungi and termite attack are less visible in houses built with wood sections. This may be due to better maintenance and use of good quality and appropriate species of wood that is safe from termite and marine bore attack.

The steel sections used in some of the houses were already rusting. Steel used in the marine area requires special undercoats and regular maintenance, as observed in shelters built in St. Martin's Island, where steel windows have rusted badly over the years due to lack of proper undercoat paint and maintenance.

Pre-cast concrete pillars were used for vertical support in some houses. Quality control of materials and fabrication of pre-cast concrete pillars are important for strength. During the survey a number of broken and twisted concrete posts were observed in one location, which had failed structurally during the cyclone of 1994. There are examples of innovative use of materials in some houses, such as the use of a combination of wood, bamboo and pre-cast concrete posts.

2.4.6 House Typology

Cyclonic storm and high wind seems the most obvious factor in the development of the form and shape of these houses. The magnitude of wind loads on the structure influences the roof shape. Experience and experiment have shown that houses with hip roofs have the best record of resistance. During a cyclone, large pressure builds up under the overhang, and this pressure added to the suction on the upper roof can pry it away from the walls. This problem has been solved by keeping a minimum roof overhang in most houses and a separation between the roof over pashchati from the main roof of the house.
In order to reduce high pressure on the internal surfaces of the wall, the indigenous houses are built with only one opening, which can be securely closed at the time of cyclone. The wall around the pashchati, particularly in the case of bamboo mat wall, helps in reducing water penetration affecting the ghar during gusty wind accompanied by heavy rain. The main cause of wind damage on the houses, particularly houses built with bamboo sections, is the insufficient weight of these houses when they are subjected to external pressure and suction on the walls during cyclone. This can be rectified or even avoided by improving the anchoring of the vertical support firmly to the foundation. The case study that follows shows how indigenous housing can be modified to withstand harsh climatic conditions.

2.4.7 Case Study: House that Survived

The worst cyclone in the memory of local people of one of the study areas in recent times was in 1994. During this cyclone the house belonging to a wealthy person became a shelter for hundreds of women and children of the surrounding areas, because local people felt confident that the house would withstand the cyclone as it had withstood previous cyclones. It has been observed in the cyclone affected areas that there is less likelihood of a house being damaged or destroyed if the roof structure of the house is strong and secured to the vertical support system which is firmly anchored to the foundation.

This house was located in an area surrounded by trees and other houses that act as wind breaks. The roof supporting system was fabricated with wood sections of standard quality and size. High level of competence in joinery details, and the use of steel angles, bolts and screws for tying and fixing the different members of the roof structure and the vertical wooden posts made the house very strong and cyclone resistant. The house was selected as a case study because it was built with local building materials and by a local builder.

2.4.8 Preservative Treatment of Traditional Building Materials

Surveys and interviews were conducted in order to obtain information on locally available methods, availability of expertise and, above all, effectiveness of preservative treatment. Technology availability and its effectiveness for improving and enhancing durability, particularly of bamboo, is a very important aspect of the recommendations of this study.
This technology could be potentially significant, looking at the use of untreated bamboo in houses of the survey areas. The durability of untreated bamboo is only 2-3 years, as bamboo is constantly subjected to attack by insects, fungi, termite and when in contact with moist ground. Experts from the Bangladesh Forest Research Institute (BFRI) and Bangladesh Agricultural Research Council (BARC) were interviewed, and information, literature, etc. on the preservative treatment technology developed by BFRI were collected.

BFRI built a house using treated bamboo, wood, sun-grass, etc. in 1983. This house demonstrates the effectiveness of the need and the critical aspect of the preservative treatment. There was no sign of decay or attack by fungi, insects and termites on the treated building materials even after all these years.

2.4.9 Construction Techniques, Structural Components and Details

The purpose of recommendations on construction techniques, structural components and details is to create an understanding and awareness among local people, organizations involved in house building and local builders to improve cyclone resistance of traditional houses. The survey and study have already identified weak points in design considerations, social and environmental problems, building materials, architectural and structural details of houses. Here the weaknesses of construction techniques, structural components and details in the manner in which the houses are built are presented, and solutions and guidelines to strengthen structural components and details for cyclone resistant houses are suggested. Sequence of construction of a house consists of foundations, floor finishes, walls and openings, roof structures and roof cladding. The illustrated details are typical and not for constructing a particular proto-type house.

2.4.10 Guidelines for Cyclone Resistant Houses

2.4.10.1 Layout and Orientation

In most cases, the layout and orientation of traditional houses are in such a manner so that the shorter face of the house is towards the windward direction of the cyclone.

2.4.10.2 House Plan

The best plan shape is a square or a rectangle for wind resistance. The traditional houses in these areas are mostly rectangular with length and width ratio within 2:1. It may be mentioned here that length to width ratio up to 3:1 is generally recommended for cyclone resistant houses.
2.4.10.3 House Roof Shape
The traditional houses have hip roof over the ghar and a very low roof over the pashchati which is separated from the hip roof. Experience has shown that this type of roof has the best record of resistance during cyclone (Figure 2.22).

![Hip roof over ghar and low roof over Pashchati](image)

Figure 2.22: Roofing of Traditional House

2.4.11 Social, Economic and Environmental Considerations

2.4.11.1 Socio-Economic Problems
People’s perception of problems in housing have been gathered through the survey conducted in six different locations in Cox’s Bazar District. The problems identified in order of importance are: cost of re-building and repair after a severe cyclone, lack of capital, cost of materials and lack of technical knowledge of building construction.

2.4.11.2 Environmental Problems
It was possible to identify through people’s participation the environmental problems related to housing. These problems are: a) cyclone, b) tidal surge, c) finding safe location for house building, d) plantation of trees as wind breaks to reduce the impact of cyclone on houses, and e) distance of trees from houses.

A proper plan for plantation of trees helps reduce the impact of both cyclone and tidal surge. Tree plantation should be undertaken by participation of local people for appropriate selection and location of trees and plants.

2.4.12 Indigenous Building Materials

2.4.12.1 Bamboo and Wood
Wood and bamboo is extensively used in construction of indigenous houses. Wood used in most houses is of very poor quality. This results in shrinkage and warpage, causing susceptibility to fungal attack. Besides, bamboo members should be treated with preservatives to enhance their durability. At present both wood and bamboo are used without treatment by appropriate preservatives.
Steel sections have been introduced through technology intervention in a few houses for fabrication of truss and strengthening of structural members for tying and fixing. When steel sections are used in marine and salty atmosphere, there is need for ensuring quality control of materials, proper surface preparation and application of specified undercoats. Undercoats should be carefully selected for suitability in marine weather.

Precast concrete members have made inroads as a building material into the local house building trade. The members are primarily used as vertical support. Problems at present consist in quality control of materials and methods of fabrication. Besides, there are no well thought out tying and fixing details incorporated during fabrication of the pre-cast post. It is possible to use pre-cast sections as beams to support wood or bamboo rafters. The roof joist can also be of pre-cast concrete.

Bamboo and wood sections should be selected on the basis of appearance and strength. Bamboo should be treated with appropriate preservatives. The foundation should be in accordance with the details in Figure 2.23 in order to improve anchoring of the vertical support firmly to the ground, giving sufficient stability to the house.

Figure 2.23: Typical Footing for Timber or Bamboo Post

Most of the houses had mud floors, but a few had concrete floors. Floor levels of many of these houses, particularly houses belonging to people of very low economic level, were almost at the ground level. The woven bamboo mat walls in
these houses were buried into the soil presumably to prevent entry of frogs, snails, insects, reptiles, etc. into the houses. These walls deteriorate very fast due to constant contact with the moist ground and being subjected to fungi, termite and insect attack (Figure 2.24).

![Figure 2.24: Walls Deteriorating in Contact with the Ground](image)

**2.4.16 Walls**

Wind is resisted by woven bamboo or timber board sheathing and vertical supports. Diagonal bracing should be used to strengthen the walls, and to reduce the chances of corner failure due to unequal pressures on two side walls during cyclones (Figure 2.25). For construction techniques and details, the expertise of local builders for spacing of vertical bamboo posts and fixing and tying of woven bamboo sheathing to posts can be relied upon.

![Figure 2.25: Corner Bracing](image)
If the roof structure is secured firmly to the vertical support system there is little likelihood that the house would be damaged by cyclone. Recommendations should focus on bamboo and thatch as building materials for roof structures and roof cladding. The reason is that bamboo is the most extensively used building material. The roof structure of most of the houses in the study areas were built with bamboo.

2.4.17 Roof Structure and Cladding

2.4.17.1 Roof Structure
The roof structure consisted of horizontal bamboo support members (beams) supported by bamboo posts. The bamboo beams supported rafters of split bamboo. In the roof structure system, the most important connections were that between beams and vertical support and between rafters and beams. In order to make houses cyclone resistant, these connections should be strong to withstand the powerful upward force of the cyclone (Figure 2.26). Metal straps, commonly known as 'hurricane straps', may be used in the connections, particularly between post and beam. Local technology for connection details between beam and rafter is by tying the rafter firmly to the beam by nylon rope after cutting a notch in the rafter. In a better constructed structure, the notch in the rafter is securely fitted to the beam, maintaining the required slope. In terms of cyclone resistance the use of 20 gauge galvanised metal straps, nails, nuts and bolts along with the use of local materials such as nylon rope can be recommended (Figure 2.27, Figure 2.28).

2.4.17.2 Roof Cladding
In addition to the roof structure, the thatch roof cladding must be able to transfer wind loads to purlins. The eaves and the ridges of the roof are particularly susceptible to wind pressure during cyclone. Purlins, therefore, are important structural members of the roof structural system. Local builders use lattice bamboo slats having gaps of 200mm to 250mm between two slats. The latticed slats are fixed to purlins to protect the thatch roof from uplift during cyclones. The existing construction technique of roof cladding is well thought out, and in most cases, built well.
2.4.17.3 Fixing of C.I. Sheet Roofing
Spacing of purlins and the length of C.I. sheets should be adjusted so that the joints of the sheets fall on a purlin. The sheets are fixed from the top of corrugation with screws. Generally cotch screws are used with wood purlins and galvanised metal crank bolts with steel purlins. These screws are used with appropriate cup washers.

2.4.18 Construction Technologies for Wind Resistance
Observations made on Bangladesh's southeast coast suggest that cyclone resistance can be enhanced in traditional buildings by using a combination of architectural and innovative construction technologies.
Construction features that enhance wind resistance include:

1. A square floor plan
2. Hipped roof design
3. Additional support for the roof ridge
4. Use of appropriate preservative treatments to prolong lives of bamboo and thatch elements
5. Use of concrete footings for posts
6. Use of metal straps to fix bamboo joints rigidly

The Bangladesh Forest Research Institute built a house using these and other methods which has lasted very well, demonstrating the efficacy of these methods.
2.5 Effect of Wind on Rural Housing

Experimental investigation has been carried out in a wind tunnel on three different types of models of rural Bangladeshi houses. Tests were conducted by placing models of houses at different horizontal angles on a sliding platform and subjecting it to wind flow of different speeds and measuring the total thrust on the model produced by the wind. The tests were carried out to study the effect of different conditions of door and window openings, effect of the presence of verandah and the behaviour of the models in presence of different types of windbreaks. The study reveals that at high wind speed keeping the doors and windows closed or open does not produce significantly different results. The presence of verandah increases wind thrust on two types of model but decreased the thrust on the third type. It has been found that due to the occurrence of wind jetting, the effectiveness of trees as windbreaks is reduced. Solid wall type windbreak has been found to be most effective in reducing the wind thrust on models. These findings could contribute towards improvement of skill and practices of construction of wind-resistant rural houses in Bangladesh.

Recurrent occurrence of strong cyclones and loss of lives and property in the southern part, as well as other regions of Bangladesh, is well known. Construction of a number of cyclone shelters and coordinated cyclone alert system is in effect in these areas, and these measures are somewhat successful in preventing loss of human lives and livestock. Apart from this, no measure is taken to reduce loss of the household properties. The majority of people in this area belongs to the poorest section of society whose standard of living is far below even the limit of poverty. Local people without any formal engineering knowledge build the large majority of houses in these areas. According to a report (Lewis and Chisholm, 1996), about half of these houses is temporary in nature. These can seldom survive against even moderate intensity of storm. The houses are built of the cheapest construction materials like bamboo poles, woven bamboo, mud and thatch. Almost every year these have to be rebuilt after devastation by storms. When the long-term effect is considered, these houses turn out to be costly as a result of rebuilding them almost every year. It is thus felt that there is a strong need of more engineering knowledge to improve the construction quality of the dwellings in these storm-prone areas.
Within the framework of local construction practices, wind resistance properties of rural vernacular houses may be improved if some engineering judgements are applied on the basis of their behavior under wind. Such types of houses in the rural areas of Bangladesh are not covered in any design codes. Although there are some studies (Anwar, 1996) on improving the lateral load resistance characteristics of such rural houses, apparently no scientific database on the behaviour of these specific types of houses during strong wind is available. With the objective of understanding the behaviour of rural vernacular houses in Bangladesh, a series of wind tunnel tests on scaled down models has been performed in the recent past by a number of researchers. Ansary et al. (1999) and Ansary et al. (2000) performed an extensive study on the wind pressure distribution around a 1:20-scale model of a rural house. It was performed under various conditions of incident wind angles, roof pitch, presence of openings, etc. It revealed that pitch angle between 25°-40° was better against wind resistance. The pressure distribution measured at some critical locations has enabled identifying the most vulnerable points in a rural house structure. Roy et al. (2000a, 2000b) conducted another extensive study on models, including studying the failure characteristics of the model bamboo framework under various structural configurations. This study supported the fact that introduction of some sort of bracing system to the common bamboo frame structure significantly improves its resistance against wind forces.

The research presented here is a sequel to the above mentioned studies. A series of investigations have been undertaken to study the behaviour of different roof patterns, the effect of having an open verandah and effectiveness of different types of windbreaks.

2.5.1 Experimental Setup and Description of Models

Experiments were conducted in a wind tunnel at the School of Engineering, University of Exeter, UK. The wind tunnel is an open circuit type and has a working section 500mm high, 750mm wide and 1500mm long. The maximum wind speed of the tunnel is 35 metre/second. The wind tunnel is shown in Figure 2.29.
Figure 2.29: Wind Tunnel used in the Study

Figure 2.30: Type of Models under Study

Figure 2.31: Typical Dimensions of the Model (shown with the Do-chala Type)
Three types of roof patterns were studied as shown in Figure 2.30:

Ek-chala or Chapra: The roof of this type of house consists of a singly sloped roof made of thatch or C.I. sheet. This type of roof is common among the poorest people. The pitch angle for the experiment was chosen as 10 degrees.

2. Do-chala: This is a typical house with pitched roof as shown in Figure 2.31. The slope of the roof is in two opposite directions. The pitch angle for this type of roof was chosen as 30 degrees.

3. Chou-chala: This is another type of typical house with pitched roof in which the slope of the roof is in all four directions. The pitch angle was chosen as 30 degrees, similar to the Do-chala type.

The models used in the present study are approximately at 1:50 scale of typical rural houses of Bangladesh. Each type of model was studied with a verandah, as well as without a verandah.

2.5.2 Description of Windbreaks

The effect of the presence of different kinds of barriers was also studied. Three types of barriers against the wind were considered:

1. Solid wall: Although construction of a solid wall around a house is not common in Bangladesh, it was included in the study for academic interest. The height of the wall was approximately 30mm.

2. Hedge: This is a more common type of barrier surrounding the houses. Properly planted and supported hedges can provide significant barrier against wind. The height of the hedge was approximately 35mm.

3. Tree: Trees provide good protection against wind. But there is no quantitative assessment on how much the level of protection is. The level of protection offered by trees was investigated. In this study, the height of trees was approximately twice the height of the models.
2.5.3 Measurement of Wind Force

In previous studies, the effect of wind was studied by measuring pressure at different locations. Although such measurements are useful in understanding the local characteristics of wind pressure distribution, such measurements do not give an idea of the total thrust on the model generated by the wind. Calculation of the total wind thrust from pressure distribution only at certain locations is difficult. Estimation of such kind of quantities is important in assessing the relative behavior of different kinds of roof patterns with or without the presence of verandah, the influence of windbreaks, etc. Thus, in this study was decided to measure the total wind thrust on the model instead of measuring pressure at different locations. This was done by placing the model on a movable sliding platform and connecting the platform to a spring fitted LVDT. A picture of the test arrangement is shown in Figure 2.32. The LVDT was, in turn, connected to a computer-controlled data logging system. The spring fitted LVDT was calibrated so that the displacement data signal sent to the data logger could be converted to force data by the controlling PC based on the stiffness of the spring. The whole arrangement was shielded by placing paper boards at the level of the platform, so that when the model was placed on the platform, the wind produced thrust only on the model, but not on the platform. Thus the platform slid due to wind thrust produced on the model only. This is shown in the Figure 2.33 (a,b and c).

Figure 2.32: The Arrangement of Sliding Platform, LVDT, etc.
2.5.4 Measurement of Wind Speed
A Pitot tube connected to a calibrated electronic micro-
manometer measured the wind speed. The calibration was
done by comparing the pressure measurements of the micro-
manometer and the same from an inclined water column.

2.5.5 Boundary Conditions
The pattern of wind flow during an actual storm is quite
different from that of a wind tunnel. Proper simulation of a
storm requires that both the model and the flow be
geometrically, aerodynamically and thermally similar. The
conditions existing in a wind tunnel may be different from
those that exist in a real storm. The results of wind tunnel
tests must be interpreted in the context of these limitations. It
is generally understood that, despite the differences, tests
using a wind tunnel enables us to gain a fairly good idea about
the behavior of real structures subjected to a real storm.

2.5.6 Experimental Results
Experimental investigation was carried out to study the effect
of different parameters, such as the effect of wind incident
angles, effect of presence of verandah, effect of keeping the
doors and windows open or closed, etc. In the following sub
sections, these matters are discussed in more details. A picture
of the Chou-chala model (with verandah) under test is shown
in Figure 2.34.

2.5.6.1 Effect of Wind Incident Angle
The effect of wind incident angle was studied for all model
types. The test was performed by positioning the models on
the sliding platform at different angles at an interval of 30
degrees and then subjecting it to different wind speeds.
Recognizing the symmetry, the study was performed for
angles of 0 to 180 degrees. Here, 0 degrees incident angle
means wind hitting directly the front side (the side with door)
of the models. The test was carried out for different conditions
of door and window openings.
Figure 2.35 shows the behaviour of the Do-chala model. It was observed that at low wind speed, the model catches more wind for incident angle of 90° when the doors and windows are all open. When the openings are fully or partially closed, the maximum thrust occurs at an angle of about 30 degrees. However, for higher wind speeds as shown in Figure 2.35c, the maximum thrust occurs at an incident angle of 30 degrees when the openings are fully or partially closed.

Figure 2.36 shows the results for Chou-chala model. It was observed that for all-closed or all-open conditions of the openings the behaviour is similar. Maximum thrust occurs at an angle of approximately 30 degrees while the minimum force develops at the incident angle of 90 degrees for all magnitudes of wind speeds. In general, the all-closed condition of openings produces smaller thrust than the all-open condition, as seen in Figure 2.36.

Figure 2.37 depicts the behavior of the Chapra model. Unlike the previous two cases, this model developed maximum thrust at 0 degrees incident angle of wind. However, similar to Chou chala model, minimum thrust is produced at 90 degrees angle.
2.5.6.2 Effect of Presence of Verandah

The effects of the presence of a verandah are shown in Figures 2.38, 2.39 and 2.40, for the models of Do-chala, Chou-chala
and Chapra, respectively. For the Do-chala model the presence of verandah produces more wind thrust for all values of wind incident angles and the increase in the wind thrust is higher between incident angles of 0 to 90 degrees. For the Chou-chala model wind thrust increases for wind incident angles from 0 to 75 degrees and from 120 to 180 degrees, while the thrust decreases for incident angles between 75 to 120 degrees. However, the overall change in the thrust due to the presence of verandah is not as significant as that of the Do-chala model. The effect of presence of verandah is quite significant for the Chapra model. It can be observed from Figure 2.40 that the presence of verandah actually lowers wind thrust for wind incident angles of 0 degrees to about 45 degrees, after which the thrust is higher for angles up to 90 degrees. Afterwards, the difference in conditions between 'with verandah' and 'without verandah' diminishes.

Figure 2.38: Wind Force on Do-chala Model in Presence of Verandah without Windbreaks (windows closed)

Figure 2.39: Wind Force on Chou-chala Model in Presence of Verandah without Windbreaks (windows closed)

Figure 2.40: Wind Force on Chapra Model in Presence of Verandah without Windbreaks (windows closed)
Since wind can hit a house from any angle in a real life storm, it is important to study the maximum thrust produced by wind. Figure 2.41 compares the maximum thrust produced on the models. It was observed that the presence of a verandah increases the wind thrust for Do-chala and Chou-chala by about 10%, while for Chapra, the addition of a verandah actually lowers the thrust by the same amount. The overall magnitude of wind thrust is lowest for Chou-chala and highest for Do-chala.

2.5.6.3 Effect of Windbreaks
Windbreaks such as trees have been long regarded as an effective measure to protect a house from storms. However, it appears that there is not sufficient data to assess the effectiveness of such windbreaks in protecting typical Bangladeshi rural houses against cyclonic wind. Tests were carried out to investigate the effectiveness of three different types of windbreaks - trees, hedges and solid wall. The experiment was carried out with the Chapra model. Models of trees and other barriers were placed across the wind at a distance approximately equal to four times the height of the model. Figure 2.42 shows the Chapra model with a row of trees barrier.

![Figure 2.41: Effect of the Presence of Verandah on the Maximum Wind Thrust on Model at 30 m/sec Wind](image)

![Figure 2.42: A Chapra Model under Study with Tree Barrier](image)
Experimental results from testing the Chapra model with the different kinds of barrier are shown in Figures 2.43 and 2.44. Figure 2.43 shows the effect of gradual increase of wind force on the model. It was observed that the solid type windbreak is most effective in shielding the model from wind. Next to solid wall was the hedge type barrier in terms of effectiveness in shielding the model and the tree type barrier was found to be the least effective of all. This finding is interesting since it has been long regarded that trees are effective in shielding houses from wind. A comparative representation of the maximum wind force developed at 25m/sec wind in the presence of different kind of windbreaks is shown in Figure 2.44. It was seen that a tree barrier can reduce the wind thrust by about 39%, the hedge type barrier can reduce it by about 54% and the solid wall type barrier was effective in reducing the thrust by 86%. This phenomenon may be explained by the fact that in the case of solid wall (see Figure 2.45), the wind flow is fully deflected upward and the flow passes over the model, creating a static zone beneath. In such a situation, only a small amount of force is produced on the model, due probably to local turbulence.

The behaviour of the hedge type barrier is similar to that of the solid wall. However, a hedge is not fully opaque to wind. The presence of small openings causes a portion of the flow to pass through the hedge; this flow is able to hit the house directly, producing some thrust.
The least effectiveness of tree barrier among the three types studied can be attributed to the fact that in the case of trees, wind jetting occurs beneath the trees. Due to the presence of large openings beneath the trees, wind can easily pass through and hit the model, which reduces their effectiveness. This result reveals that large trees like mango or jackfruit trees may be less effective than they were thought to be, unless they are accompanied by dense bushes that would be able to prevent wind jetting beneath the trees.

![Figure 2.45: Wind Flow Patterns for Different Types of Wind Breaks](image)

2.5.7 Summary

Study in the Wind Tunnel

Of the three types of model studied, the Chou-chala appeared to be the safest type. Thrust was maximum on the Do-chala type. Study of the effect of presence of openings reveals that at low wind speed a closed condition produces less thrust than open conditions, but at high wind speed, the conditions of opening do not have much influence on the maximum thrust. It was found that the presence of a verandah increases the vulnerability of the Do-chala and Chou-chala type, while in the case of the Chapra, the presence of a verandah actually lowered the thrust. In studying the effect of different types of windbreaks it was found that due to the occurrence of wind jetting, trees may not be as effective as they were thought to be. Hedges were found to be relatively more effective if they can be made to sustain the wind. Of all the windbreaks, solid wall type was found to be the most effective in shielding the model.
2.6 Selection of Post-Disaster Shelter

Bangladesh is faced with the perennial problem of floods and cyclones occurring every year. The existing housing for the majority of the population, particularly in rural areas, is very weak and incapable of resisting the extreme loads generated during these natural calamities. The large-scale destruction of housing during these natural events demands major efforts for providing emergency shelter to the affected people. Assistance in providing post-disaster shelter is, therefore, one of the major concerns of the government. A large number of Government Agencies and Non-Governmental Organizations (NGOs) of Bangladesh are involved in providing post-disaster assistance which includes materials for temporary shelters.

Agencies involved in post-disaster relief operation would naturally like to utilise their limited resources in the best possible way. The various shelter options and technologies available in Bangladesh differ in cost, durability as well as quality of services provided by them. Bangladesh University of Engineering and Technology (BUET) was entrusted by the Aid Management Office of the British High Commission, Dhaka, to develop guidelines for selecting an appropriate shelter from among a wide range of alternatives. BUET organised a series of workshops entitled "Post-Disaster Shelter Options" in 1994-1995, where the participants came from various national and international organizations involved in post-disaster management across the country, as well as from academia. During the course of the workshops, various facts, figures and experiences concerning shelter options following a disaster were collected. BUET developed a methodology for evaluating the different shelter options, where a Value for Money (VfM) index was calculated for all the options in a rational and simple manner. During the workshop deliberations, BUET showed the use of the method with data collected from the participants. The objective of this section is to present this methodology, which can be used by organisations involved in providing shelter to poor communities in the aftermath of natural disasters. Numerical results are also presented to demonstrate the application of the method.

Various shelter types have been used in post-disaster emergency situations in Bangladesh. Some of them were meant to provide basic emergency short-term shelter and are
weak in terms of strength and stability. Yet they were considered as viable choices and have been used extensively because of their low cost, easy handling and ease of fabrication. Other shelter options are stronger and more durable; however, they naturally require more investment. It is necessary to weigh the relative advantages and cost of different options available for making the appropriate choice with available resources.

During the course of the workshops, thirteen shelter options (S1 through S13), presented below, were identified as choices which could be provided after a disaster.

2.6.1 Plastic Sheet-Bamboo (Shelter Option S1)

In this structure, the roof and side-walls are made of plastic sheeting tied to a bamboo framework with wire or rope (Figure 2.46). Bamboo poles are used as column supports. This shelter has the advantages of being the cheapest shelter, easy to handle (light-weight, easy storage and transportation), with salinity resistance and flexible applications. Superior quality plastic sheeting can subsequently be used to waterproof the roof of a thatch-bamboo house. Disadvantages include transparency (lack of privacy), susceptibility to fire hazard, heat increase in hot weather, inadequate protection against further storms due to lack of strength and short life (damage due to ultraviolet sunlight). Plastic sheets are produced locally; however, superior plastic sheets may have to be imported.

2.6.2 Canvas Tarpaulin (Shelter Option S2)

Only jute/cotton canvas tarpaulins are delivered. Beneficiaries scavenge bamboo poles or tree branches to make a frame to which the canvas is tied with wire or rope. In comparison to plastic sheeting, tarpaulins are more expensive, more comfortable and provide privacy. Although they are about twice as heavy as plastic sheeting, they still have the advantage of easy handling (storage and transportation). Canvas tarpaulins can be numbered and tracked, which is preferable from a management point of view. Canvas is produced locally by a small number of industries that may not be able to meet the large demand in the event of a major disaster. Tarpaulins are not available in the sub-national markets. Disadvantages include: incompleteness, requiring additional framework, which causes deforestation at user localities; high fire risk; vulnerability to insects and rodents during storage
and use; inadequate strength against strong storms; short life, due to ultraviolet sunlight causing deterioration if the tarpaulins are continuously wet; and susceptibility to tearing.

Figure 2.46: Plastic Sheet-Bamboo Shelter

2.6.3 Permatent Shelter (Shelter Option S3)

The Permatent is a complete one family emergency shelter and only needs simple digging tools for its erection. It is manufactured in the UK, but there are plans to make it also in Bangladesh. Each Permatent unit consists of three steel trapezoidal profiled sheets, 1.1 m wide and 0.55 mm thick, which are crimp-curved and when interlocked together form a free standing shell type structure (Figure 2.47). The steel is hot-dip galvanised, primed and has a durable polyester coating applied to both surfaces. All steel sheets are marked for tracking convenience. The two endwalls are made of polythene backed jute canvas, one has a window and the other has a door. The floor space is about 14 square metres.

The Permatent has a projected minimum life of about 20 years and can be put to multiple use as temporary shelters for 15 to 20 times. Advantages of such a system include completeness of structure that is easy to erect, high strength capable of resisting strong winds, maintenance free, fire resistant and easily repairable, polyester coating reflecting solar heat keeping interior cooler than other similar forms of roofing, multiple use if retrieved, and re-use later as a roofing unit for low-cost housing. Demerits are its high initial cost disallowing free distribution, large sheets being somewhat awkward to handle and transport, heat gain in hot weather, and problems of socio-cultural acceptability of this new structural form.
2.7.4 Canvas Tents (Shelter Option S4)

Canvas tents are distributed complete with poles, ropes, etc. They are more acceptable to the people as they are commonly used by settlement officers, scouts or armed forces. They are complete shelter options. The relative merits and demerits of use of canvas material have been discussed earlier. If imported, their price may be much higher compared to locally produced tents. This type of shelter option is generally suitable for short term use.

Figure 2.47: Permanent Shelter

2.6.5 C.I. Sheet-Bamboo (Shelter Option S5)

In this option, a complete package of materials is supplied for the erection of a low-cost house with corrugated iron (C.I.) sheet roof with wooden or bamboo roof support and bamboo poles, and with bamboo mat side walls. Figure 2.48 shows a photograph of C.I. sheet-bamboo shelter. Advantages include ability to store and transport easily, availability in local market, strength and durability, locally repairable, familiarity to people, fire resistance and re-usability. When new, the galvanising reflects the sun's heat, which, however, begins to rust after a few months. Disadvantages include: requirement of additional tools for erection; danger of C.I. sheets fixed insecurely being flown away during storms; susceptibility to damage in saline conditions; and heat gain in hot weather. C.I. sheets are not normally marked by numbers and cannot be tracked. The critical element in such housing would be to provide proper securing mechanism of the C.I. sheet with the structural framework.
This shelter option consists of a thatch roof supported on a bamboo frame and bamboo poles with bamboo mat walls. Fig. 2.49 shows a photograph of thatch-bamboo shelter. The thatch roof should preferably contain polythene sheet between layers of thatch for waterproofing. This type of house would be very inexpensive, but would have the disadvantage of being relatively weak against strong winds and having a shorter life. The materials used are also vulnerable to fire.

This shelter option would be similar to option S5 with the main difference of having reinforced concrete (RC) or prestressed concrete (PC) columns in addition to bamboo poles (Figure 2.50). Naturally such a house would be much stronger and resistant to winds. The pillars and poles may be embedded below the ground level. The roof support system is wooden. A house of 3 metres by 5 metres may have 6 RC columns with footing in addition to bamboo posts and have bamboo wall matting, wooden roof support and C.I. sheet roof. This option would naturally be more expensive, requiring longer erection time and skilled labour.

This shelter consists of a demountable prefabricated prestressed concrete house model (MARC, 1994) developed under a UNCHS-funded project by Multi-disciplinary Action Research Centre (MARC). The manufacturer claims it to be sufficiently strong against cyclonic storms with speed up to 230 kmph. This long-term shelter would naturally be an expensive option and require skilled labour.
Under severe circumstances, only plastic or polythene sheets may be distributed. The users gather bamboos, poles and branches to make a framework to which the sheet is fixed with rope or wire, if available. Relative merits and demerits of plastic sheeting have already been discussed. A major disadvantage of not providing framework material is that deforestation may occur locally.
2.6.10 C.I. Sheet only (Shelter Option S10)  
C.I. sheets may be distributed alone without supplying materials for the framework of the shelter. The beneficiaries may prop the C.I. sheets on the ground leaning together to form a tent-like structure. Alternatively, they may collect bamboo or branches to make a framework and fix C.I. sheets as the roof using wire, ropes and nails. They themselves have to provide materials such as bamboo mats for the side walls. The merits and demerits of using C.I. sheet have been discussed earlier. Figure 2.51 shows houses made entirely of C.I. sheet.

Figure 2.51: C.I Sheet House

2.6.11 C.I. Sheet-Steel Truss (Shelter Option S11)  
This shelter is similar to option S7 with the difference of having a stronger and more durable roof support system consisting of steel truss instead of having a wooden roof support system.

2.6.12 LGED Model 10A (Shelter Option S12)  
This is a long-lasting shelter option developed by the Local Government Engineering Division (LGED) of Bangladesh. The house consists of RC pillars, ferro-cement slabs for roofing on RC frame support system and bamboo mat walls (Figure 2.52). This would require skilled labour for erection.

2.6.13 LGED Model 10E (Shelter Option S13)  
Another shelter option has been developed by the LGED and consists of steel angles as the support system for both the columns and the roof. The walls are bamboo matting and C.I. sheet is used as roofing.

2.6.14 Governing Factors  
In developing a methodology for comparison among different shelter options, the different parameters are first identified. Factors to be considered in evaluating the Value for Money (VfM) indicator for each shelter option include the quality factors and the cost factor, described below.
2.6.15 Quality Factor

The quality or benefit factors are the factors which the donor organisation, providing emergency shelters to disaster affected people is looking for when deciding to provide the shelter. Eleven quality factors for assessing emergency shelter options are found to be important:

1. Mobilisation time (includes procurement time plus transport time to disaster site)
2. Ease of storage
3. Possibility of re-use and multiple-use
4. Time and ease of erection (whether tools or special skill are required)
5. Structural strength and stability (resistance to high winds; normally emergency shelters are stored in a place safe from surges or flood after the hazard has passed)
6. Health and safety of occupants (environmental protection, fire resistance, etc.)
7. Social acceptability (privacy, comfort, etc.)
8. Completeness of shelter
9. Durability (life of shelter)
10. Ease of administration (to prevent misuse and misappropriation of funds and resources)
11. Environmental impact

2.6.16 Cost Factor

The cost factor is the cost per square foot of usable space inside the shelter, taking into consideration its use for one disaster cycle only. This includes the following costs:

(i) Material cost
(ii) Labour cost
(iii) Transport cost  
(iv) Administration cost  
(v) Storage cost

All available sources of information should be investigated to get a realistic estimate of the cost which for the same shelter option is likely to vary considerably. It is quite obvious that transport costs, storage, etc. would be dependent on factors such as location, locality, nature of disaster, etc.

2.6.17 Methodology for Evaluating Options

This is a new methodology which integrates all pertinent factors into a single Value for Money (VfM) index. It is based on a methodology developed for overall technology assessment by Sharif and Sundararajan (1983). Their method, however, appears to be too rigorous and intricate for general use by disaster managers. The method suggested here is more simplified, yet rationally takes into account the interplay of all factors.

The different steps to be followed in the proposed methodology are described below. Numerical data received from the workshop participants, including two reports by MARC (1994) and EDM (1994), are used in the demonstration of the method. Ranking of the different shelter options based on Value for Money is then presented. It should be noted that this ranking cannot be used directly, since limited data was available.

2.6.18 Weightage of Quality Factors

The weightage, in other words the relative importance index, for the different quality factors, needs to be established. The weightage reflects how important these factors are in meeting the objectives of the post-disaster shelter from the donor's point of view. The following procedure is recommended for the determination of weightage. First determine which factor is of the least importance. Put a score of 1 (one) for the least important factor. Now compare the other factors with this factor. If the other factor is equally important, put 1 for that factor also. If not, put a score to the other factor on a scale of 3 to 9 following the general guidelines given in Table 2.5.

The weightage (Wi) of the eleven quality factors is taken as the mean value of the data received from the workshop participants, as shown in Table 2.6. The maximum and minimum values received are also presented to give an indication of variation of participant response.
Table 2.5: Guidelines for Determining Weightage (Scale of 1 to 9) (Scores of 2, 4, 6, 8 may be given if deemed appropriate)

2.6.19 Relative Quality Scoring

Each of the shelter options is now given a relative Quality Score (Qi) in a scale of 1 through 9, when considering each of the eleven quality factors. Each row of Table 2.7 presents a relative scoring of the various shelter options when considering a particular quality factor. For the eleven quality factors, there are eleven sets of guidelines for scoring, listed in Table 2.8. Table 2.7 represents the average value of scores that were received from the workshop participants. The variation is not presented here, but it needs to be noted that significant variation can exist due to lack of knowledge about the different shelter options. The response received had also large variations for some cases and it is considered best to use the average value.

<table>
<thead>
<tr>
<th>Quality Factor (Q.F.)</th>
<th>Mean (Wi)</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mobilisation time</td>
<td>8.5</td>
<td>9.0</td>
<td>7.0</td>
</tr>
<tr>
<td>2 Ease of storage</td>
<td>6.5</td>
<td>7.0</td>
<td>5.0</td>
</tr>
<tr>
<td>3 Reuse/multiuse</td>
<td>6.5</td>
<td>7.0</td>
<td>5.0</td>
</tr>
<tr>
<td>4 Erection</td>
<td>7.3</td>
<td>8.0</td>
<td>7.0</td>
</tr>
<tr>
<td>5 Strength/stability</td>
<td>5.8</td>
<td>7.0</td>
<td>5.0</td>
</tr>
<tr>
<td>6 Health/safety</td>
<td>4.8</td>
<td>9.0</td>
<td>2.0</td>
</tr>
<tr>
<td>7 Social acceptability</td>
<td>4.3</td>
<td>8.0</td>
<td>1.0</td>
</tr>
<tr>
<td>8 Completeness</td>
<td>6.3</td>
<td>7.0</td>
<td>5.0</td>
</tr>
<tr>
<td>9 Durability</td>
<td>6.0</td>
<td>7.0</td>
<td>5.0</td>
</tr>
<tr>
<td>10 Administration ease</td>
<td>7.3</td>
<td>8.0</td>
<td>7.0</td>
</tr>
<tr>
<td>11 Environmental impact</td>
<td>5.5</td>
<td>8.0</td>
<td>3.0</td>
</tr>
</tbody>
</table>
2.6.20 Value for Money (VfM)

The proposed methodology is based on the rational determination of a Value for Money (VfM) index for each shelter option. The "Value" is a measure of the overall quality of the option, while the "Money" stands for its cost. Based on available resources and VfM index, the donor can choose the appropriate shelter.

The "Value" of a particular shelter option is a complex combination of the different quality factors, some of which may be partially overlapping. A simple and rational method to obtain the Value would be:

\[
\text{Total Value} = \sum_{i=1}^{11} W_i Q_i
\]

The "Value" for a particular shelter option is thus determined by multiplying the different quality scores by their corresponding weightages (Table 2.6) and adding them up, as shown in Table 2.7. This Table (bottom row) also includes the total cost per square foot of usable area for each shelter option. The "Value for Money" index (VfM) is obtained by dividing the "Value" by the "Cost".

\[
\text{VfM} = \frac{\text{Total Value}}{\text{Total Cost per sq.ft. of usable space}}
\]

2.6.21 Ranking of Shelter Options

Table 2.9 gives the VfM index and relative ranking of all shelter options, based on data in Table 2.7. The option with the highest VfM score will naturally be the best choice to the post-disaster shelter donor agency.

It should be noted that the VfM value for shelters may change for different disasters, regions, time periods, market situations, etc. The relative ranking of various shelter options in Table 2.9 are based on the assumption that the materials used for making the shelters are not re-used.

If it is possible to retrieve shelter materials or recover its cost from the disaster affected people at the end of the crisis, for shelters with durable components, the possibility of re-use in future post-disaster situations becomes possible. Re-use is considered for some shelter options, as described in Table 2.10. Due to re-use, the cost factor decreases (compare with Table 2.9) and the VfM index increases. Table 2.10 presents the new ranking for this case. Whether the shelter materials are at all retrievable from the poor people needs to be verified in the field before considering re-use.
## Table 2.7: Relative Quality Scoring of Shelter Options

<table>
<thead>
<tr>
<th>QUALITY FACTORS</th>
<th>Wi</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
<th>S7</th>
<th>S8</th>
<th>S9</th>
<th>S10</th>
<th>S11</th>
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<tbody>
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<td>Ease of storage</td>
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<td>6.7</td>
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<td>6.7</td>
<td>6.3</td>
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<td>7.3</td>
<td>6.0</td>
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<td>3.3</td>
</tr>
<tr>
<td>Reuse/multiuse</td>
<td>6.5</td>
<td>6.3</td>
<td>6.0</td>
<td>4.0</td>
<td>4.7</td>
<td>7.0</td>
<td>4.3</td>
<td>6.7</td>
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<td>7.7</td>
</tr>
<tr>
<td>Erection</td>
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<td>8.0</td>
<td>7.0</td>
<td>7.7</td>
<td>7.7</td>
<td>6.0</td>
<td>5.7</td>
<td>4.3</td>
<td>1.0</td>
<td>6.3</td>
<td>5.7</td>
<td>7.0</td>
<td>2.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Strength/stability</td>
<td>5.8</td>
<td>2.0</td>
<td>3.0</td>
<td>7.0</td>
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<td>5.3</td>
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<tr>
<td>Health/safety</td>
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<td>6.3</td>
<td>7.0</td>
<td>5.0</td>
<td>7.0</td>
<td>7.3</td>
<td>6.3</td>
<td>6.7</td>
<td>6.7</td>
<td>5.0</td>
<td>4.7</td>
<td>4.7</td>
<td>6.0</td>
<td>6.7</td>
<td>6.7</td>
</tr>
<tr>
<td>Durability</td>
<td>6.0</td>
<td>2.3</td>
<td>4.0</td>
<td>7.3</td>
<td>4.0</td>
<td>5.7</td>
<td>4.0</td>
<td>7.3</td>
<td>9.0</td>
<td>2.3</td>
<td>6.0</td>
<td>7.3</td>
<td>7.7</td>
<td>8.0</td>
</tr>
<tr>
<td>Administration</td>
<td>7.3</td>
<td>5.7</td>
<td>7.0</td>
<td>6.0</td>
<td>7.3</td>
<td>5.0</td>
<td>5.3</td>
<td>5.0</td>
<td>2.7</td>
<td>8.0</td>
<td>6.7</td>
<td>6.3</td>
<td>2.7</td>
<td>3.7</td>
</tr>
<tr>
<td>Environmental impact</td>
<td>5.5</td>
<td>2.3</td>
<td>4.3</td>
<td>6.7</td>
<td>6.0</td>
<td>6.7</td>
<td>7.3</td>
<td>4.7</td>
<td>7.7</td>
<td>3.0</td>
<td>4.7</td>
<td>6.3</td>
<td>7.3</td>
<td>7.3</td>
</tr>
<tr>
<td><strong>TOTAL VALUE SCORE</strong></td>
<td>357.3</td>
<td>342.7</td>
<td>413.5</td>
<td>411.5</td>
<td>412.0</td>
<td>355.4</td>
<td>398.1</td>
<td>353.7</td>
<td>310.7</td>
<td>404.3</td>
<td>437.6</td>
<td>321.4</td>
<td>408.2</td>
<td></td>
</tr>
<tr>
<td>Cost, Taka/sqft (US$/sqft)</td>
<td>34 (0.75)</td>
<td>30 (0.66)</td>
<td>100 (2.22)</td>
<td>44 (0.98)</td>
<td>70 (1.56)</td>
<td>38 (0.84)</td>
<td>94 (2.09)</td>
<td>300 (6.66)</td>
<td>25 (0.56)</td>
<td>35 (0.78)</td>
<td>80 (0.78)</td>
<td>156 (3.47)</td>
<td>115 (2.56)</td>
<td></td>
</tr>
<tr>
<td>QUALITY FACTORS</td>
<td>Weightage</td>
<td>Mobilisation time</td>
<td>Ease of storage</td>
<td>Reuse/multiuse</td>
<td>Erection</td>
<td>Strength/stability</td>
<td>Health/safety</td>
<td>Social acceptability</td>
<td>Completeness</td>
<td>Durability</td>
<td>Administration</td>
<td>Environmental impact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
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<td>------------</td>
<td>------------------</td>
<td>----------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>&lt; 1 day to mobilise</td>
<td>Easy</td>
<td>Always reused</td>
<td>&lt;1 day to erect</td>
<td>Stable under extreme hazards</td>
<td>Ensures health &amp; safety under all situations</td>
<td>Totally acceptable</td>
<td>Shelter provided is complete</td>
<td>Shelter life&gt; 20yrs</td>
<td>5 yrs</td>
<td>Perfectly manageable</td>
<td>No impact on environment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>15 days</td>
<td>Sometimes reused</td>
<td>Average</td>
<td>10 days</td>
<td>Stable under normal conditions</td>
<td>Ensures health &amp; safety under normal conditions</td>
<td>Acceptable with reservations</td>
<td>Requires some additional material by user</td>
<td>5 yrs</td>
<td></td>
<td></td>
<td>Average adverse impact</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>&lt;45 days</td>
<td>Never reused</td>
<td>Difficult</td>
<td>&lt;30 days</td>
<td>Weak</td>
<td>Always unsafe for occupants</td>
<td>Local people totally reject the option</td>
<td>Requires maximam extra material by user</td>
<td>&lt; 0.5 yrs</td>
<td></td>
<td></td>
<td>High adverse impact on environment</td>
<td></td>
</tr>
</tbody>
</table>
Table 2.9: VfM Score and Ranking of Shelter Options
(Not Considering Re-Use of Shelter Materials)

2.6.22 Discussion of Results

The data that forms the basis of the results presented here are drawn from the response of workshop participants and reports presented at the workshop (MARC, 1994; EDM, 1994). The outcome of this study cannot be directly applied as limited response was received from the participants of the workshop. More extensive data is required for obtaining reliable VfM values that can be used.

The Value for Money (VfM) considered here is the value for the donor or aid-giving agencies' money. The unit costs (Taka per sq.ft. of usable space) are considered for short term use for one cycle of disaster only, which is one year. Practical experience of NGOs and relief organizations working in Bangladesh indicate that most or all shelters are non-retrievable after distribution in a disaster. However, reuse and multi-use of shelter/shelter material by end users may still be considered an important shelter quality or attribute from the donor's point of view. The results are likely to be sensitive to changes in geographical location (with probable changes in transportation facilities and market facilities), type of disaster (flood or cyclone), etc.
<table>
<thead>
<tr>
<th>Code</th>
<th>Shelter Option</th>
<th>Total Value</th>
<th>Possibility of Re-use</th>
<th>Cost (Tk/Sft.)</th>
<th>VfM</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Plastic Sheet-Bamboo</td>
<td>357</td>
<td>No re-use likely</td>
<td>34</td>
<td>10.5</td>
<td>7</td>
</tr>
<tr>
<td>S2</td>
<td>Canvas Tarpaulin</td>
<td>383</td>
<td>Second use of one third inputs</td>
<td>25</td>
<td>15.3</td>
<td>2</td>
</tr>
<tr>
<td>S3</td>
<td>Permatent</td>
<td>414</td>
<td>Four re-use of four fifth inputs</td>
<td>36</td>
<td>11.5</td>
<td>4</td>
</tr>
<tr>
<td>S4</td>
<td>Canvas Tents</td>
<td>412</td>
<td>Second use of one third input</td>
<td>36.5</td>
<td>11.3</td>
<td>5</td>
</tr>
<tr>
<td>S5</td>
<td>C.I. Sheet-Bamboo</td>
<td>412</td>
<td>Two re-use of half inputs</td>
<td>47</td>
<td>8.8</td>
<td>9</td>
</tr>
<tr>
<td>S6</td>
<td>Thatch-Bamboo</td>
<td>355</td>
<td>No re-use likely</td>
<td>38</td>
<td>9.3</td>
<td>8</td>
</tr>
<tr>
<td>S7</td>
<td>C.I. Sheet-Wood-Bamboo-RC/PC columns</td>
<td>398</td>
<td>Two re-use of half inputs</td>
<td>70</td>
<td>5.7</td>
<td>10</td>
</tr>
<tr>
<td>S8</td>
<td>All PC Dryland Model</td>
<td>354</td>
<td>No re-use, likely to be permanent</td>
<td>300</td>
<td>1.2</td>
<td>13</td>
</tr>
<tr>
<td>S9</td>
<td>Plastic Sheet only</td>
<td>311</td>
<td>No re-use likely</td>
<td>25</td>
<td>12.4</td>
<td>3</td>
</tr>
<tr>
<td>S10</td>
<td>C.I. Sheet only</td>
<td>404</td>
<td>Two re-use of</td>
<td>23</td>
<td>17.6</td>
<td>1</td>
</tr>
<tr>
<td>S11</td>
<td>C.I. Sheet-Steel Truss</td>
<td>438</td>
<td>The re-use of three-fourth inputs</td>
<td>40</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>S12</td>
<td>LGED Model 10A(PC-PC)</td>
<td>321</td>
<td>No re-use, likely to be permanent</td>
<td>156</td>
<td>2.1</td>
<td>12</td>
</tr>
<tr>
<td>S13</td>
<td>LGED Model 10E (C.I. Sheet-Steel Angle)</td>
<td>408</td>
<td>Two re-use of three-fourth inputs</td>
<td>86.6</td>
<td>47</td>
<td>11</td>
</tr>
</tbody>
</table>

*Table 2.10: VfM Score and Ranking of Shelter Options (Considering Re-Use of Shelter Materials)*
Both the weightage of quality factors (Table 2.6) and relative quality scoring of shelter options against each of these factors (Table 2.7) were obtained as a mean of scores provided by the workshop participants. Their response showed a large difference in perception among different donor agencies with regard to some of the factors: Health/Safety, Social Acceptability, Completeness and Environmental Impact. Regarding the other quality factors there is great similarity in view regarding their importance. If the sample size was large, statistical measures such as standard deviation and confidence levels would provide a valuable guide to the reliability of the scores obtained. As the sample size was very small such statistical analysis would not be of significance and hence was not carried out. A practically acceptable result can only be obtained after statistically evaluating responses received from a large group of participants.

2.6.23 Value for Money Index

Relief and rehabilitation programs for disaster affected communities, following floods and cyclones, have a regular occurrence in Bangladesh. The donor or aid giving agency, in the absence of an accepted analysis procedure, is often faced with the difficult problem of selecting a particular shelter from among a wide variety of shelter options available. A simple methodology has been proposed here for the rational determination of a Value for Money (VfM) index for each shelter option. Evaluation of VfM is done from the relief manager or donor’s point of view, keeping cost and quality of the shelter option as separate factors. The donors or disaster managers can use this index to judiciously select the shelter. The cost, hence the VfM index, for the same option may vary depending on factors such as geographical location, local market conditions, type of disaster, etc. The cost corresponds to use of shelters for short term (one year) only. If a particular shelter can be retrieved and re-used in future needs, the cost would be reduced accordingly. This, however, needs to be verified in practice. The purpose of presenting numerical results is to give an illustration of how to apply this methodology and to present a rough representation of whatever limited data that was received. It is recommended that in practice extensive data be collected in order to obtain a reliable assessment of the VfM index for the shelter options.
2.7 Improving Rural Housing In Bangladesh

The social, geographical and climatic factors which make Bangladesh’s housing stock especially vulnerable to natural hazards are well-known. Those factors bear disproportionately on the homes of the poor and a major re-evaluation is needed at both Government and NGO levels to develop an overall strategy for improvements of rural housing.

This section deals specifically with issues pertaining to the improvement of kutcha housing (that is, houses made from bamboo, thatch and mud in which most of the population lives).

2.7.1 Population Increase

At more than 800 persons/km², Bangladesh’s population density is among the highest in the world. Between the Census of 1991 and 1997, the country’s population increased by almost 11 million, according to one estimate (BBS, 1991). That rate of increase by itself requires construction of 2.2 million homes annually of which 84% (1.8m) will be in rural areas.

As the population increases, so people are increasingly forced to live in low-lying areas vulnerable to floods and cyclones. At present, there are no major changes expected in the socio-economic profile of the country in which 75% are employed in agriculture producing 40% of the Gross National Product. Therefore, this state of vulnerability may be expected to persist for the foreseeable future (25 years).

2.7.2 Ratio of Kutcha to Pucca Construction

In 1960 it was estimated that 90% of houses in Bangladesh were rural and of kutcha construction (bamboo, thatch and mud). At that time the ratio represented 8.2 million dwellings. By 1993 the rural housing stock represented 83% of the country’s total and 75% of those were of kutcha or sub-kutcha (temporary) construction. It might be noted that the rise in urban construction probably includes a significant quantity of temporary slum dwellings and could reflect a deterioration in overall housing stock.

Projecting those figures in association with the population increase shows that the actual number of kutcha and temporary housing constructions will continue to increase for some time, even though these construction types may decline as a percentage (Figure 2.53).

2.7.3 Forces of Nature

The tropical monsoon climate gives between 55 inches of rain in the central border area and 200 inches in the northeast, of which 80% falls between late May and early October. The rain is often accompanied by severe wind-storms.
Figure 2.53: Projection of House Numbers

Figure 2.54 illustrates the effects on housing of some of the more severe natural events to have struck Bangladesh in recent years. It may be noted that, generally, more damage is caused by flooding than by wind. Flooding can occur twice during a year. Winds (cyclones and tornadoes) may cause very intense damage over their relatively narrow paths, but the major devastation in such cases results from the associated storm surges which can be up to 10 metres in height, evident from the 1991 cyclone.

To put these figures in context, the 1970 cyclone killed 300,000 and the 1974 floods affected up to 36 million people over an area of 87,000 square kilometres.

As well as the physical destruction of houses, flooding saturates the ground, reducing foundation stability, erodes river banks and redeposits silt and sand, affecting agriculture and reconstruction activities. Prolonged periods of flooding may thus affect *pucca* buildings as badly as *kutcha* ones.

Other natural hazards which affect Bangladesh, although not so significantly as flood and wind, include:

- Earthquakes: potentially serious, indicated in several recent tremors;
- Fire, especially in densely packed urban areas;
- Hail stones: golf-ball sized hail stones have been known to cause severe damage.

In the face of such a range of hazards, it must be accepted that it will be impossible to make a house of natural materials that can completely withstand all these.

2.7.4 Regional Vulnerabilities

Different areas are subject to differing intensities of hazards. This means that there is not one ideal solution to improving *kutcha* housing that can be applied in all places.
However, it may be possible to transfer technologies from one place to other suitable locations. For example, the steeply curved thatched roofs used in high rainfall areas are very strong in relation to vertical loads and could be encouraged elsewhere.

Figure 2.54: Houses Damaged or Destroyed by Natural Events, 1970-78

Four broad classifications of hazard can be identified. These classifications may, in time, be subject to clarification or refinement:

1. Subject to heavy rainfall with seasonal ground run-off;
2. Heavy rain with rising water and flash floods;
3. Heavy rain, flash floods, cyclones, tornadoes and "Nor'westers";
4. Heavy rain, floods, cyclones, tornadoes, "Nor'westers" and storm surge.

2.7.5 Economic Forces

Landlessness (75% of the rural population are functionally landless) and poverty force many people to migrate in search of income; the result is often movement to lower, more vulnerable ground in the chars and shifting deltaic areas. The existing distribution of power, income and assets is a major component of that vulnerability, reinforcing the benefits of the power system for those already in control. Major changes to the processes that create vulnerability need to be addressed (Blaikie et al., 1994).

Any building programme would have additional benefits in creating local employment and demand for locally produced materials. The increased confidence of
rural communities as their housing stock improves should result in less mobility of families and create sociological continuity.

2.7.6 Disaster Preparedness Provisions

In areas most affected by extremes of climate, the creation of additional pucca housing can be seen as provision of communal safe havens. In such places, improved kutcha housing may have only limited benefit. Perhaps the “improvement” (say, a steel post) may be all that remains after the disaster. This could prove lifesaving if designed as an anchorage point or it might serve to identify the house location after the flood.

An important flood mitigation measure for kutcha housing is to raise the structure on a mound (killa) or stilts. Roads could be widened to provide stronger embankments and raised areas for the construction of houses. This would be more cost effective than constructing many individual killas, and the raised areas created could more easily be stabilised and protected by shelter belts of bamboos and trees. Such vegetation would also provide sustainable supplies of building materials.

2.7.7 Appropriateness of Improvements

Any suggestions for improvements to kutcha housing must take into account the appropriateness of the materials and respect for the local vernacular building types. Factors which influence the appropriateness of the material include:

1. Affordability/cost
2. Practicality of use
3. Availability
4. Transportability/location
5. National/international and donor culture

Respect for the cultural aspects of building needs to recognise:

1. Location
2. People and their experiences
3. Traditional materials and methods
4. Sociological aspects
5. Historical factors
6. Differences between rural and village/city dwellings.
2.7.8 The Emergency Period

Analysis of data available after the 1970 cyclone/surge wave showed that 83% of post-disaster shelter reconstruction were provided from within the affected populations. Outside assistance from the Government and NGOs accounted for only 17% of the new/repaired dwelling provision.

Within 2 days of the cyclone, people were rebuilding their homes. However, the emergency aid system was only just getting into action, hampered as it was by the damage to transport and communications networks.

It is inappropriate to try to introduce housing improvements in this emergency recovery period. Studies show that the ability to regenerate income is more a priority than shelter. Improved building methods take time to introduce and few can spare that time, even if the aid system has access. Improvements must be considered later. Unfortunately, by the time it is appropriate to consider building improvements, most agencies will have expended their housing budgets and have no reserve for improving what they have already done. Thus the status quo remains.

2.7.9 Dissemination of Knowledge

Dissemination of information on improved building methods must take place at three basic levels:

1. Between multi-disciplinary groups and international agencies;
2. Between key players within Bangladesh; and
3. Within rural communities.

Given that 75% of rural workers are functionally landless, that adult literacy is 35% or less of the population, that 8 out of 10 live below the poverty level and that 45% of the population is under 15 years of age, the keys to developing building for safety programmes will include:

1. Training of educators;
2. Development of appropriate methods; and
3. Practical (financial) support for programmes.

The last point above is important. Although improved building brings tangible results, lack of finance will often be
an inhibiting factor and, for most rural families, income generation and improved health are generally higher priorities (Blaikie et al., 1994; Hodgson and Whaites, 1993). It is not practical to enforce a recommendation or legislation that causes home-owners to spend an additional 5% on their homes, even if it were clearly for their betterment and safety. However, there is equally little chance of meaningful improvement without some form of government supplement and corresponding monitoring of the policy.

The following examples illustrate some of the problems encountered with technical transfer programmes in Bangladesh.

Example 1: Polythene sheet
Oxfam's experience and research during the 1970s showed that ultra-violet light degrades clear polythene into a brittle, non-waterproof material. The sheeting, when used for roofing, also causes increases in internal condensation with potential health risks. Nonetheless, there has been a limited transfer of this technology, originally used for emergency shelters, with local families copying the "sandwich" technique in their own, non aid-provided homes (Figure 2.55).

![Figure 2.55: Polythene Sheet Roofing](image)

This example shows that improvements can be taken up that have been demonstrated locally, that are available and affordable and that have been proven against the weather elements. However, people will usually wait to see how the new material performs in comparison with their existing structure before deciding to use it themselves. In other words, any building development must be tested in many
places to ensure rapid acceptance and hence ready availability of the materials.

Such demonstration buildings need to be placed in accessible village locations to ensure maximum exposure to the population and to remove any psychological barriers that might be created by an isolated scientific test. Follow-up studies will need to ensure that good ideas are not lost in cases where poor buildings may be overwhelmed by disaster; there will be a tendency for onlookers to tar the whole structure with the same brush - "all useless".

Example 2: Protecting looms
Many home-made wooden looms, used in cottage industries, have their feet resting on brick or stone (Figure 2.56). Experience shows that this reduces the risk of rot and termite attack and the precaution is used widely throughout Bangladesh. Strangely, the adoption of this technology in buildings is a leap of transfer that is not often made naturally. Interestingly, one of the innovations proposed by participants at the H&H workshops in North Bengal was to do just this. It is not clear why the technique is not widely used.

Example 3: Raised grain stores
Grain stores are commonly raised above ground level and strengthened with cross-bracings (Figure 2.57). These techniques are not often adopted by villagers when building their own dwellings. This raises several questions as to why this might be the case:
1. Who introduced these techniques originally, and when?
2. Could it be that the original builders understood the principles and died before passing on their knowledge?
3. Is the low literacy rate a factor in the failure to transmit principles?
4. Do people place more value on their food stores (and contents) than they do on dwellings that have always been temporal in the face of ravages of nature?

Problems of technology transfer and retention are exacerbated by the frequency of natural disasters, the casualty rates and the low life expectancy (51 years).

Quite a while ago, the idea was put forward that the life of bamboo in contact with the ground could be prolonged by charring the ends and treatment with bitumen (or used motor-oil). This was proposed after discussions with rural housebuilders. Work is still needed, twenty five years later, to demonstrate scientifically the extent to which this does improve bamboo life. The effects of different types of oil also remains to be tested. Clearly, there is still much research to be done.

2.7.10 Timescale for Change

In other fields of development, such as agriculture, medicine, literacy, healthcare and family planning, changes have occurred over periods of 25 to 30 years in small incremental stages. One major step in the development of community health has been the introduction of village-level para-medics to disseminate essential primary health information.

If a parallel can be drawn between building for safety and community health, then it would be logical to introduce “para-
architects” who would be local people given basic training to disseminate simple construction improvements in their neighbourhoods. Such para-architects would be the basic agents for change over a 20 to 25 year period. The approach must aim for consistency and an appropriate scale of activity over that period.

In parallel with the field dissemination, scientific exploration of construction principles needs to be undertaken. Research into fast-growing varieties of bamboo and other materials appropriate to the soils of Bangladesh would also be beneficial.

2.7.11 Funding

All these suggestions, including a resource base and training centre, will require funding. However, the scale of the funding should be seen in the context of the damage caused to the national infrastructure and economy by natural disasters.

Currently, most of the resources applied to buildings are being put into pucca structures which account for only 16% of the housing stock. While these can and do provide safe havens in times of disaster, the wide distribution of the population and their reluctance to leave their home until the last minute makes this role one of only marginal value.

As a simple example, if just 1% of the damage caused by the 1974 floods had been saved, then the cost of reconstruction would have been reduced by $5.79 million (equivalent to over $20m today). Since nearly a third of the damage was to domestic housing, improved building technologies could save the nation considerable sums. Better housing also protects property so the savings might be greater in practice.

External aid to Bangladesh amounts to 5% of the GNP (and totalled $1,386m in 1993). 95% of the country’s development programmes are financed from abroad. The National debt stood at $16.6bn in 1994 (New Internationalist, 1997-8). It could be argued that a small percentage of these sums put into improvements to kutcha housing could improve the lives of the 84% of the population who live in them and might free up expenditure for other development activities.

2.7.12 Proposed Strategy

It is possible to introduce improved technologies into the annual house-building/maintenance cycle using indigenous materials and techniques and available funding.

The dwelling is a costly family asset. Repairs to kutcha buildings are needed frequently, but are cheaper than the
initial cost of a pucca house. The main housebuilding season occurs after planting, so there is little surplus cash in the home. Income generation is a higher priority than shelter after a disaster, so house repairs are put off. Most people therefore cannot afford even simple improvements which might protect their main asset.

The costs of improvement amount to between 5% and 8% of the basic new house cost (Carter, 1997). A basic house can cost around Tk 2000 so the improved model will cost Tk 2160. Improvements are more cheaply included in new construction than in repair programmes and should be seen as offset by long-term benefits.

Appropriate improvements would include:

- Lower parts of posts charred and bitumenised;
- Wall and roof-frames cross-braced;
- Wire lashings at roof/wall/post junctions;
- Roof support frame strengthened;
- Roof strengthened;
- Lower parts of bamboo mat walls treated;
- Mud plinth stabilisation.

Possible sources for funds include:

- Government: within change of policy towards rural housing;
- NGOs: on-going programmes;
- Disaster relief funds: within rehabilitation programmes;
- House owners: own funds for new houses;
- Bank/co-op loans: Local banking and micro-credit facilities.

2.7.13 Proposed Alternative Housing Programme

New housing programmes should be designed as a mix of improved *kutcha* and a small proportion of *pucca* homes which act as safe havens. Rather than building 50 *pucca* homes, the same funds might provide 100 improved *kutcha* dwellings plus 10 *pucca* ones and improvements to ancillary structures, such as kitchens and tubewells, to create general improvements in environmental conditions within the community. This would benefit a much larger number of people, but could generate disputes as to who would get the *pucca* homes and what arrangements would be made for their use in emergencies.
Table 2.11: Comparative Costs in Taka (Note that land costs are not included)

<table>
<thead>
<tr>
<th>Element</th>
<th>All pucca house 50 Pucca homes</th>
<th>Proposed alternative 100 kutcha, 10 Pucca+ ancillary structures</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHBRI model concrete house.</td>
<td>50 X Tk16,000 = 800,000</td>
<td>10 X 16,000</td>
</tr>
<tr>
<td>Improved kutcha houses.</td>
<td></td>
<td>100 X 2,160 = 216,000</td>
</tr>
<tr>
<td>Improve existing dwellings.</td>
<td>TOTAL, Tk.</td>
<td>600 X 200 = 120,000</td>
</tr>
<tr>
<td>Provide educational materials.</td>
<td></td>
<td>82,500</td>
</tr>
<tr>
<td>Employ workers 10 weeks@Tk 45/ day.</td>
<td></td>
<td>30 X 2,250 = 67,500</td>
</tr>
<tr>
<td>Leaving balance for: Community preparedness/flood markers/etc.</td>
<td>30,000</td>
<td></td>
</tr>
<tr>
<td>Raising tubewells above flood level.</td>
<td></td>
<td>20,000</td>
</tr>
<tr>
<td>Planting bamboo as windbreaks, etc.</td>
<td></td>
<td>24,000</td>
</tr>
<tr>
<td>Investing in microcredit fund for building contingency.</td>
<td>70,000</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10,000</td>
</tr>
</tbody>
</table>

The total cost of such a project would be Tk 800,000. This illustrates how it is possible, within the cost of 50 pucca houses, to provide new improved homes for 110 families and to upgrade a further 600 homes. Thus, up to 14 times the number of families would benefit. The community could be involved in its own disaster preparedness and substantial employment could be generated. Clearly, other mixes of activities in the alternative proposal are possible and may be appropriate, depending on local circumstances.

The benefits could be spread even more widely by providing some of the funding on a credit basis. This could help to transfer ownership to the community and the revolving fund would be seen as a way of sustaining further improvements for others.
Since no major changes can be predicted in the national economy, and, hence, the ratio of pucca-to-kutcha housing might remain the same over the coming 25 years, it can be argued that current funding and energy being spent on pucca housing improvements is inappropriate in terms of rural/urban housing ratios.

If improvements to the rural housing stock amounting to 8% of the initial construction cost (an additional Tk 160 per house) could reduce disaster damage by 1%, then Tk 75 - 90 crore could be saved during major events.

Over 1.8 million new rural homes are needed each year just to cover the population increase; concerted action is needed now to ensure that these dwellings are safe and affordable. Past experience has mostly been of measures which have been too little, too late and not sufficiently scientifically founded. Housing must be raised as a national priority concern.

As an old African proverb says, “It’s better to light a candle than to curse the darkness.”
3. Implementing Hazard-Resistant Housing

3.1 Introduction

The description in the previous chapters of the hazard-prone housing context in Bangladesh and the development of hazard-resistant construction technologies allows discussing in this chapter examples of putting into practice technology in context. Implementing hazard-resistant housing or building for safety programmes presents challenges often not foreseen in technical or other studies. Field experience itself presents opportunity for generating and gaining context-specific knowledge that can inform research and practice. However, the basis of this knowledge stream needs scrutiny; hence in this chapter, project and concept reviews are included alongside reports of implemented projects.

Implementation of hazard-resistant housing usually incurs extra cost, however small that might be. Because of this, especially in the low-income context, people are often unwilling or even unable to make the extra investment to safeguard their houses against hazards. Therefore, creating access to financing is a prerequisite for implementation of building for safety programmes. This chapter, therefore, begins with some concepts on affordable financing for hazard-resistant housing based on local needs and housing patterns. Then follows a review of low-income housing projects implemented by community development organisations. This shows the tremendous challenges confronted and limitations experienced in the field by implementing agencies. Another review follows next, on the participatory workshop process followed in action-research projects associated with the BUET-Exeter link. Once again, the limitations experienced in the field by such projects is pointed out, especially the lack of continuity beyond project tenure confines; but also it is evident is that this approach has more potential to empower communities to reduce their vulnerability than offered by current projects of most organisations. Case studies of two grassroots action-research projects, in Dinajpur and Gopalganj, are then presented.
Reading the preceding reviews, one is now able to objectively examine the findings of these two projects. As a final cautionary note, the last part of this chapter includes a review of current ‘participatory’ practice, a reminder that community participation in building for safety programmes, though much talked about, is not easy and requires genuine effort.

3.2 Affordable Financing for Housing

Extensive damages are caused to housing in Bangladesh by natural hazards, such as floods. Damages are mainly attributed to building materials used for construction. Houses are generally made of bamboo, thatch and mud – making them extremely vulnerable to floods. Anything more durable than bamboo and thatch are beyond the affordability of most rural residents. It is assumed that improved quality and the condition of housing can significantly cut down damages caused to housing. To be specific, the quality of houses can be improved through better design and use of more permanent building materials, which will consequently lead to lower damages. But this improvement involves increasing cost to housing and in this case affordability is the first barrier to quality housing.

Questions that immediately arise in this connection concern how to increase affordability so that people can make gradual improvements to housing. Is it not possible for them to construct permanent housing at one go? Is it possible to bring down construction cost to a level, so that an increasing number of people can be brought under the fold of hazard-safe housing? Is it possible for the government to play a pioneering role in providing hazard-safe housing to people who would otherwise remain without it?

In the context of the questions posed above, the aspects of affordability and finances, and the possibility of increasing access to improved housing are explored by considering the points below:

- Making housing improvement cost affordable to the rural people.
- Lowering the cost of construction to bring hazard safe housing within the reach of the general mass of rural people.
- Making finance available to the rural people so that they can make successive improvements to their houses.
- Creating financing institutions for extending monetary help to people.
- Providing hazard safe housing through government initiatives.
3.2.1 Affordable Improvements to Housing

It is assumed that improved housing design and use of more durable materials can significantly lower the extent of damages caused to housing. It has been found that with a little more than Tk 500 than the usual cost of a conventional rural house significant changes can be made and consequently bring down the extent of cost of damage. A loan of about Tk 600 is what a poor rural family might need in the first stage of graduation to improved housing. Since the general rural population is poor, even this small amount of loan is not available from friends, neighbours or relatives. In this regard, financing institutions can lend a helping hand to the rural poor in order to graduate to hazard-safe housing.

Stilt houses in flood-prone areas can be further improved by starting with reinforced concrete (RCC) pillars and maybe beams in the first phase. In the next phase, the split bamboo matting can be replaced with brick walls. In another phase the roof can be replaced with permanent materials such as RCC. The Institution of Engineers has developed the idea of thin shells for low-cost houses. The idea of thin shell can be adapted for roofing of stilt houses. Gradually more rooms can be added to the houses as affordability increases.

3.2.2 Lowering the Cost of Building Materials

In the initial stage of house building most people are constrained to use temporary materials of bamboo and thatch because of their economic condition. With improved economic condition and increasing affordability, and with some help from financing institutions, the quality of housing can gradually and surely be improved.

The technical difficulties of building houses with permanent materials are that these techniques with materials such as brick and concrete are unknown to most rural residents. The other problem is that the price of such permanent materials and the cost of construction tends to be expensive and beyond the means of most people. In such cases prefabricated building materials can partly provide a solution to building improved and hazard-safe houses.

The industry of prefabricated building materials can provide job opportunities to the rural people and at the same time produce affordable home building materials. Prefabricated materials such as pillars, beams, roofs, doors and windows, which are easy to construct and easy to transport, can be produced by such industries. This type of industry can have a positive impact on the natural
environment. The quality of prefabricated building materials has to be strictly enforced, otherwise people’s life would be again at risk. Prefabricated building materials could be bought in instalments, expanding further the affordability of people.

3.2.3 Making Finances Available to People with Low Affordability

What the rural people need is a small amount of money at varying times. But there are no public sector institutions in the rural areas that might help people finance and improve housing. On the other hand the economic condition of the general rural people is not so satisfactory that they can lend money to other people. The role of Grameen Bank (Figure 3.1) and a few NGOs (like Proshika, BRAC, etc.) are very laudable, but the coverage of banks and the NGOs is small compared to the number of people that require financial and material assistance. Thus there is an urgent need to set up institutions that will provide home building and home-improvement loans to rural people.

About 96 million people live in the rural areas of Bangladesh. The coverage of the Grameen Bank and NGOs like BRAC, Proshika, etc. is about 25% of the target group. It is plainly evident that the majority of people are left out. In this context the government has to intervene to enable people to build hazard-safe housing.

Most of the formal financing institutions are located in urban centers and they hardly extend loans for house building to the general people. The House Building Finance Corporation is the only public sector finance institution in
Bangladesh and its service is limited to urban residents only. There is an immediate need to create a Rural House Building Finance Corporation to provide housing loans to residents of the countryside.

Considering the number of people that require finances for building hazard-safe homes, hazard prone areas need to be identified and categorised according to the intensity of hazard experienced by specific areas, such as extreme, moderate or low hazard-prone areas.

The government cannot provide finance to all areas at once. The lending program has to initially start with areas that are extremely hazard-prone and subsequently to other less hazard prone areas. Alternatively two divisions can be created within the financing institutions to cater for extremely hazard prone areas and for areas that are less hazard-prone.

Innovative ideas can be taken up to increase funds of the financing institutions. This may be done through, say, sale of lottery tickets. This will create interest and awareness about the financing institution, as well as provide funds for the institution to function. The sale of lottery tickets by Red Cross, BIRDEM (Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorder), etc. is quite popular with the people. The institution can also act like a bank. People can deposit money with the financing institution and account-holders given preference in getting loans.

3.2.5 Providing Hazard Safe Housing through Government Initiatives

In the above sections, possibilities of increasing the affordability of the rural people to improve housing through financial and material assistance have been discussed. The following section discusses an alternative for improving the housing situation in hazard-prone areas of Bangladesh.

The government is constructing cyclone shelters from its own fund and with the help of foreign aid. The Red Crescent Society along with other agencies is providing finances to such ventures. These shelters are built for one or a few villages or communities. Village people go these shelters during cyclones. They provide safety to 200 people or about 40-50 families (Figure 3.2). The shelters not only provide temporary accommodation, but they are very helpful when disasters strike. However, the efficiency of these shelters is hampered due to various reasons. They are located 2 to 2.5 km away from human habitation. Therefore, villagers are reluctant to abandon their houses and stay there until the last moment. Sometimes it is too
late to reach the safety of these shelters. Additionally, some shelters have become dens for anti-social activities, and some have their lost doors and windows. The government must ensure the maintenance and efficiency of these shelters.

Shelters, accommodating 200 to 250 people, require Tk 4-5 million to build. Therefore about Tk 0.1 million are spent for every family consisting of an average of five members. If the government spends this amount (0.1 million Taka) for each family to construct a cyclone-safe house, which would also be flood-safe, people could stay inside their houses with their belongings and livestock when disaster strikes. The government could build a permanent, hazard-safe stilt house for every family. Equipped with basic amenities, these houses would be safe and comfortable for the rural people. The rooftops of these houses could be designed to harvest rainwater during crisis.

3.2.6 Making Solutions Effective

It is generally seen that people do not want to leave their home during floods until the situation becomes too critical for safety. They want to stay in their own house and protect whatever belongings they have. If they abandon their homes their belongings would be lost. In this case, solutions to providing hazard safe houses by improving conventional houses has been suggested. Also possibilities are being explored for increasing the affordability of people by lowering the cost of house building components by prefabricating them or by providing safe houses through government initiative. If any solutions are to be effective, the government and concerned agencies must be aware and committed to provide hazard-safe housing for the rural people.
It is frequently heard that Bangladesh is "nothing but an amalgamation of 68,000 villages". However, despite major allocations for rural development in national planning and policy making, the actual implications of this statement is rarely understood. People in rural areas are often relatively more deprived than in cities, and are vulnerable to poverty, natural calamities and social insecurity. To improve their housing conditions, the primary task is to reduce their vulnerability. Throughout the world, millions of helpless people are living at vulnerable locations in great insecurity.

... the number of the world’s poorest rural people who are forced to live where the environment causes insecurity because of soil erosion, the threat of landslip or flooding and other environmental hazards ... is about 371 million.”
(New Internationalist, 1996)

This figure is certainly increasing. Rural communities have evolved their own coping mechanisms to resist these natural hazards. This section discusses organisational initiatives for providing housing to rural communities, especially to those that have lost their houses due to natural calamities such as riverbank erosion, floods and cyclones.

3.3.1 The Present Scenario

The Government, international organisations and NGOs have been working for quite a while now ‘to give’ shelter to the victims of natural disaster. So far the approach to solve the problem has been quick and efficient, but also usually superficial. Quite often such efforts pay more heed to the official agenda of the organisations than to actual needs of the people. Several NGOs offer housing loans to the rural poor in Bangladesh. The National Housing Trust (NHT) of the government has begun working on collaborative projects with some NGOs to provide housing on credit. This is certainly a worthy initiative and these efforts have to be commended for some of their achievements. However, on initial observation of some of these projects, it appears that community or household participation is lacking or very minimal, and a paternalistic attitude seems to prevail among related policy makers and staff. There is hardly any recognition in these quarters that low-income communities have a reservoir of locally relevant resources that might contribute to the house building process. The entire process, including beneficiary selection, site location, choice of materials and house
construction is decided at the bureaucratic level and people using
the house and loan are excluded from this process. It frequently
happens that they are not happy with the house they are living in,
they do not like the surroundings and they are even mistrustful
of the house cost they are required to repay. It is indeed alarming
that the government has already invested large sums of money
on these projects and is planning a very extensive programme
based along the lines of present projects. A number of projects
were visited and several NGO staff members and beneficiaries
were interviewed, the primary basis of this section.

3.3.2 Purpose of the Study

The study of housing conditions created by various agencies
should be viewed as the beginning of a development process
situated within a framework of a larger institutional initiative.

It helps establishing the need for:
• independent evaluation
• public discussion
• review and analysis
• alternative ways of working with people

The purpose of this study is to introduce a way forward
from the present stagnation in plans and actions for rural
housing settlements. Both NGOs and government organisations
have demonstrated good intentions of helping the landless rural
community. However, so far the translation of these intentions
reflects self-advertisement and propaganda, clearly apparent
from their imposing methods, such as compelling people to live
in pre-determined model houses and thus providing a
superficial quick-fix to very deep-rooted problems.

It appears unknown that both the housing process and the
house product itself are important issues for improving or
creating a good housing condition; prevalent emphasis is only
on the product. Successful examples of low-income settlement
schemes are found elsewhere, including in neighbouring South
Asian countries, where situations are similar to Bangladesh.
Incremental housing development, self-selection processes and
working with the community are some of the approaches that
have proven effective, albeit with regard to context. These ways
have been implemented and evaluated, then improved upon to
move further. Development agencies in Bangladesh need to
step forward to improve their housing support process by
improving their mind-set, ideas and formulas for development
with quick-and-easy solutions, such as building row houses
with army and navy personnel, imposing model houses and
stigmatising these new rural communities from improving their
lot further. It should be remembered that a house is principally
a means to improve living conditions, not an end in itself.

3.3.3 Proshika Palli: A Case Study

The National Housing Trust (NHT) of the Bangladesh
government has developed a financing network with several
NGOs to deliver housing programs to homeless people,
especially to victims of natural disasters. Proshika, one of the
well-established local NGOs, is part of this network. Proshika
was established in 1988 with the purpose of working in different
fields of community development. Under its housing program
Proshika had built 30,506 houses for low-income people. They
had established 37 resettlement villages, named Proshika Pallis
for river erosion victims, at 23 locations in 15 districts. The total
number of houses built in these resettlement villages is 1,370.
However, this large intervention must be evaluated in terms of its
impact and contribution, not only in terms of the number of
houses built. Proshika Pallis in Bashail and Diabari in Manikgonj
district and also a site at Teota in the same district where a new
settlement is planned to be built were studied. This study is based
on field investigations, meetings and interviews with Proshika
and other NGO staff members, villagers and project beneficiaries.
Comparisons are also drawn with other planned and unplanned
settlements visited in the course of this study.

3.3.4 Beneficiary Selection

Proshika Pallis are established for riverbank erosion victims.
Beneficiaries are supposed to be selected from existing
Proshika members. However, this is not always followed and
people not involved with the organisation are selected in many
cases. There is anecdotal evidence that beneficiaries are
selected after building houses and then compelled to become
organisation members. The common selection criterion was that
beneficiaries were at a vulnerable state, living on erosion-prone
riverbanks. They had lost not only their houses but also their
belongings, hence their economic base was destroyed. Many
families lived in makeshift plastic huts or under the open sky.
Proshika has been able to reach these poorest (or most helpless)
people of this society. They were landless, homeless, hazard-
stricken and distressed people. It would have been difficult for
them, perhaps impossible for many, to resettle themselves. It
was also possible that the loss of agricultural land, their source
of production, would have led them to migrate to urban centres
and live as squatters. Thus, by settling them in re-settlement
IMPLEMENTING HAZARD-RESISTANT HOUSING

villages Proshika is reducing such possibility of rural-urban migration. Compared to other organisations such as BRAC which help only existing landowners to improve their houses, Proshika can claim some success in this regard.

3.3.5 Site Selection and Location

If available, Proshika tries to build settlements on government owned (khaas) land. The Assistant Commissioner of Land allots land on the basis of applications or acquires new land if necessary. Otherwise, the organization looks for suitable land and buys it for the beneficiary group. In most cases, it becomes necessary to develop ‘uninhabitable’ sites. Road connections into settlements are usually incorporated later.

3.3.5.1 Land Value

In Diabari, the site is by the main road and Proshika staff claim that land price is high. Surprisingly, knowing this, in nearby Teota a large plot of agricultural land (paddy field) has already been bought for establishing a re-settlement village. Since good price was offered, the landowner was tempted to sell his agricultural land. Here arises the problem with repayment of such expensive land. Eventually the extra cost of land is transferred to the loan to be repaid by beneficiaries.

3.3.5.2 Preparation of Land

Before establishing a settlement it is essential to prepare the land. When land is raised for this purpose by bringing soil from another place, it should be left to settle properly for a certain period (6 months - 1 year). The soil must settle first before structures are built on it. Otherwise the soil settles and the house sinks gradually. This problem prevails seriously in the case of Diabari Proshika Palli. The soil is still settling and inhabitants need to regularly raise house plinths and repair them. Sufficient time and care is not given to site-preparation, causing a problem to the residents.

3.3.5.3 Existing Resources

Trees, pond, roads etc. are the valuable resources of a site and the aim should be to make the best use of these resources. In the Bashail project it was found that the existing resources of the site, which was an orchard originally, were ignored and destroyed. All the trees of the site were cut down to build houses. Such an insensitive approach towards site planning cannot be encouraged (Figure. 3.3).
The background of the beneficiaries shows that they used to depend mainly upon agricultural land and rivers for their main sources of income. Most of them were farmers or fisherfolk by profession. When resettled in a new place, they suddenly found themselves jobless. In terms of proximity to employment opportunities, none of the sites visited is ideally situated. Again, the prosperity of these settlements depends on residents having
a wide range of economic opportunities. Proshika, although promising various economic programs to help residents build strong local economies, eventually did not follow that through. According to expert opinion, 'It has been established that monthly payments to repay the loan by a household should be between 15% to 20% of its monthly family income' (Anzorena 1997). Due to the lack of employment opportunity and the lack of income-generating activities, beneficiaries of Proshika Palli are compelled to repay a big amount of loan which hardly matches their income.

Very few policy guidelines are there for physical planning of these settlements. It seems true that 'inappropriate personnel without relevant experience' (Ahmed, 1999) usually plan these settlement villages. The framework of ideas behind these housing schemes does not take into account the actual users. The entire process is decided at the bureaucratic level and people availing themselves of the housing loan are excluded from this process and thus they are compelled to live in an alien environment that is imposed upon them. Several other studies of completed projects (Bhatt, 1986) have identified the following problems that are inherent in such a design approach:

Figure 3.5: The Narrow Streets in Rainy Season Become Muddy. Proshika Palli in Bashail, Manikgonj
The bias of economics in planning typically discounts the social aspects of design.

2. During project planning incorrect assumptions are made concerning family size, income and plot sizes.
3. Projects lack variety of plot sizes to cater to diverse needs of different households.
4. Projects do not attempt to provide multi-family plots.
5. They follow a blind plot allocation process.
6. Projects lack quality and variety of open spaces.

The spatial needs of low-income households are not uniform, but vary considerably from one household to another. These variations depend on several factors such as: the size and structure of the family; occupations; if the family engages in some economic activity at home or not; whether they maintain animals at home or not, and so on (Pandya, 1988). While visiting Proshika Pallis the authors found that very little attention is paid to these factors. An average family size of five members is assumed (which is obviously not correct in many cases) and a pre-designed housing unit is thus inappropriate. Plots of the same size (each 2 to 4 decimals) are allotted to beneficiaries and the allocation process does not allow the users to select the location or size of their plot. Without being responsive to the social, religious and family needs of its occupants, such housing schemes cannot be successful. Similar assertion have been made by Bhatt et al. (1990).

For any housing design approach to be successful, it is essential that it goes beyond mere economic factors, considers social and cultural aspects, and responds to the lifestyle of the people who will live in it.

Being responsive to these aspects requires the users’ involvement in the whole process of physical planning. They will select their own plot and determine its size according to their family size and affordability, construct their own houses and decide what the materials would be and thus make such expensive projects successful. Users’ participation in all steps of planning is essential.

3.3.7.1 House Placement on the Site

Simply sub-dividing land and then building houses, as generally practised, is not adequate in planning low-income settlements. “The arrangement of houses on the site is another matter that requires competent physical planning and design
skills" (Ahmed, 1999). Planned settlements visited by the authors, like the Proshika Pallis, and also the Asrayon Prokalpa and Adarsha Gram (the government's resettlement villages for the landless) and cluster villages of the Grameen Bank also have serious shortcomings in this regard.

Proshika usually arranges the houses in rows around a pond, which is dug to collect soil for the preparation of land, for raising plinths, etc. In Diabari, where 44 families are rehabilitated, the pond is too deep and since a comfortable slope is not maintained, the pond may prove hazardous (Figure 3.4). Least attention is paid to the orientation of the houses. All the houses of Bashail Proshika Palli are orientated along the east-west direction and therefore fail to benefit from the prevailing southern breeze. The narrow lane between two rows of houses is rather tight and causes various problems of privacy and movement which becomes very difficult in the rainy season (Figure 3.5). On the other hand, though different from Proshika, yet not very inspiring, is the planning approach found in Asrayon Prokalpo (Figure 3.6). The same regimental barrack type planning is practised there.

![Figure 3.6: Barrack Type Asrayon Prokalpa](image)

### 3.3.7.2 Plot Size

The most critical aspect of these Proshika villages is the inadequate size of homestead land. Each beneficiary has only about 3 decimals of land, inclusive of 1.5 decimals of pond area. No doubt, the place is too inadequate for maintaining a reasonable degree of privacy. There are direct and indirect effects of inadequate land. The direct effects are that it provides no space for vegetation, domestic animals, household activities (e.g., crop drying), socialisation, playing, etc. There is also no
scope for future extension. The indirect effects are lack of identity and privacy. Such inadequate land creates plot-minded or territorial mentality. Comparatively in Adarsha Gram and Asrayon Prokalpo, beneficiaries are more satisfied having 8 decimals of homestead land with a better environment there, in spite of poor physical planning principles. The allotted land allows for a frontyard and backyard in each house, where additional ancillary buildings or extensions can be built. Most beneficiaries have carried out substantial additions and extensions because of the availability of space. It can be expected that these projects would perform better over the long term, as Ahmed (1999) suggested: "if provided with the right amount of space and other necessary facilities, low income communities are able to maximise the potential of a site, incrementally transforming it to suit their needs."

The authenticity of this remark is found during the visit in Adarsha Gram project at Boutoli in Gopalganj district. It was established 15 years ago (Figure 3.7). A somewhat strong community feeling is sensed there and the rigidity of planned settlements, like Proshika Palli and Asrayon Prokalpa, is merely seen. However, the question arises: though adequate homestead land is an advantage for households, is it sufficient to obviate other drawbacks of planning? One should not negate the necessity of careful physical planning and user participation in the housing process.

3.3.7.3 Kitchens - Tradition and Demand
In Bangladesh, kitchens are traditionally built in the yards and a distance is maintained from the main house to keep away smell,
heat and smoke. The lifestyle of rural people, the way they cook and the stoves they generally use lead them to this type of planning. It was found that most of these factors are totally ignored in the Proshika settlements. Kitchens are built attached to the house and present great problems to residents. The smoke from the kitchens blowing into the houses is a constant source of discomfort. Therefore, most households have added a separate kitchen and use the attached kitchens for other functions such as a storeroom or extra bedroom (Figure 3.8). The already small individual plots and consequently the whole site thus gets more congested. On the other hand, in the Adarsha Grams and Asrayon projects there is sufficient land for beneficiaries to utilise for their needs in ways they choose.

3.3.7.4 Water and Sanitation

Basic infrastructural services such as water and sanitation are basic requirements for making a settlement habitable. In a planned settlement, it is possible to cater to these requirements during planning. Still, “water supply in planned settlements presents a fundamental problem” (Ahmed, 1999) and also the same situation exists for sanitation. The absence of proper planning aggravates this.

In the Proshika villages, tubewells are installed usually in the ratio of 20 households to one tubewell. In Diabari, two tubewells serve 44 families in the settlement and similarly 59 families of Bashail Proshika Palli are being served by three tubewells. Because of the need for sharing, tubewells are placed outside, with no particular household responsible for vigilance and maintenance. Two aspects are important to make these water sources more workable: the number and location of the tubewells. It was found that the number of tubewells was inadequate in these settlements. To have fewer than 20 households sharing the tubewell, where it would be shared with a small group of neighbours, might prove more workable. A group might consist of 10 households or less. In the Asrayon Prokalpo, 10 families share one tubewell and this presents a somewhat better situation. Moreover, an appropriate location of the tubewell might reduce some of the problems as suggested by Bhatt et al. (1984): "An ideal location for a stand-pipe [i.e., tubewell] is within a square in a cluster of few houses. The washing related functions blend well with other activities of the square."

No definite thought is given to in the placement of tubewells in Proshika settlements. They are located randomly at any available corner or by the road. For some families, this
water source is at an inconvenient distance. The potential of a
shared tubewell to develop as a square or community space is
unrealised.

Sanitation is another problem. “Not only in planned
settlements, but in general where agencies had provided
sanitary pit latrines...the latrines were generally not
operational” (Ahmed, 1999). As in Proshika villages, the
quality of latrines are poor and break easily. These are not
sufficiently deep as only three instead of five concrete rings
are provided for lining the edge of the pit. In Diabari, five
months after establishing the village, very few families were
found using their latrines. Beneficiaries were expected to
build screens around the latrines, but very few of them had
done that.

Both in Diabari and Bashail, serious complaints exist
regarding the location of latrines. They are too close to the
house and, as eventually they become dirty, they become a
constant source of discomfort for the residents (Figure 3.9).
Beneficiaries suggest one common toilet instead, at a
convenient distance from the house, for a number of families.
In other Proshika villages built later, this idea of common
toilet has been implemented and thus arises the issue of user
participation. If the users were asked at an early stage, this
problem might not have arisen. The time has come to ask
whether it is right to use these people as laboratory guinea-
pigs. Is there enough time and money for experimenting with
these people's lives? Is it ethically right?

During the visit to the Adarsha Gram project in Gopalganj
district, not a single family was found to re-install their
latrines when the first one (given by the government 15 years
ago) was filled up or broken. This indicates the residents' 
reluctance to use sanitary latrines and their poor affordability.
Therefore, not considering the present only, but forecasting
the future is also another job of a planner. Keeping all these
things in mind, proper sanitation should be planned.

3.3.8 House
Construction

When a person builds a house, a sense of possession and
responsibility develops. Selecting a building material, buying
it, designing the space according to requirements, doing the
construction work and thus having a house for the family is a
useful experience. It allows residents to take their own
decisions and feel that they own the houses and the
maintenance of the houses is their responsibility.
However, the process followed by development agencies is quite different. They do not want to give any credit to beneficiaries, except in the case of the failure of the project. Not only in Proshika Palli, but also in other planned settlements established so far like Adarsha Gram, Asrayon Prokalpa, cluster villages of Grameen Bank, this paternalistic attitude is prevailing. For the beneficiaries, it is too hard to be satisfied with a finished product, especially when it is a house to live in.
Naturally, they have serious complaints regarding the building material, cost to be repaid, etc. People working in this field must realise that the process is more important than the product. The process internationally endorsed now is the self-help process. The concept of self-help housing includes the complete cycle of design, formulation and execution of a housing and habitat production process by the users. For example, the alliance of SPARC/ NSDF/ MM in India that claims themselves as "Community based, community led, community initiated and community focused organisation" have through their works:

- Shown to the government that if they give land to poor people they can build cheaper and better houses for themselves.
- Increased the skills and capabilities of community groups to build houses themselves and each project is a training process that will help more people to try this possibility. (Anzorena, 1998; Anzorena, 1999).

The residents of Proshika Palli expressed a similar desire and claimed that they could have built better houses spending less money. Similarly, in Asrayon Prokalpa, army personnel, without any participation of beneficiaries, build barrack houses. During planning these settlements, the conventional approach described by Gunaratna (1991) in Sri Lanka is also followed here: "... local vernacular traditions of house-building in their variety and richness should be suppressed and supplanted by modern housing conformation to some Westernised ‘urban’ official standards."

No option is offered to the people, they find no scope to utilise their knowledge and are living in these settlements with great dissatisfaction. If the beneficiaries get involved at the construction phase, they become trained in building houses and may contribute with innovative input.

3.3.9 Building Materials

Regarding building materials, Proshika is trying to be innovative and especially responsive towards climate and environment. Chemically treated bamboo and MCR (Micro Concrete Roofing) tiles are introduced in the Proshika settlements. Surprisingly, this is done without even asking the residents and they are not at all aware about the positive or negative aspects of these materials.
3.3.9.1 Chemically Treated Bamboo

One of the main problems in chemical bamboo treatment is that the chemical compound used is toxic and is hazardous. Awareness-formation and strict vigilance is essential for this material so that it does not become a source of hazard to human health and safety. However, safety regulations seem lacking in Proshika villages. From meetings and conversations with the beneficiaries, it is found that, despite the durability of treated bamboo, it is still less desired than CI sheet. In status or re-sale value, it cannot compete with CI sheet.

3.3.9.2 MCR Tile

For roofing, MCR tile is promoted as an alternative to CI sheet. Some of the main advantages in comparison to CI sheet, suggested by its promoters, are its better thermal qualities, the use of local materials whereas CI sheet is imported, and small-scale labour-intensive production with potential for generating local employment instead of centralised factory manufacture (Parry Associates, undated). Still, successful dissemination of this material will be possible only where a significant cost advantage can be established. It was found by Ahmed (1999) that the cheaper variety of MCR tile is 24% less expensive than CI sheet, not enough for a significant cost advantage. Moreover, all the beneficiaries of Proshika settlements denounced it as fragile and undesirable. Since there is no local supply of MCR tile and skilled workers, beneficiaries cannot repair or replace the tiles. They complain that it is difficult and laborious to dismantle and a market for resale does not exist. Nonetheless, the residents mentioned some plus-points of MCR tiled houses: cooler and more comfortable than CI sheet and generally do not tend to lift off during storms like CI sheet, since the tiles are tied to the roof frame. Yet, provided with the choice, they would have certainly opted for CI sheet. It is their desires and needs that should have been considered.

3.3.9.3 MS Angle Roof Frame

MS angle roof frame is another option adopted by Proshika. At only about 5-10% less expensive than timber, this might not offer much cost advantage. Nonetheless, an MS angle frame, painted for rust protection may serve much longer than timber or bamboo. By avoiding direct contact with water, durability can be increased. The beneficiaries are apparently satisfied with this roofing frame, though lack of replicability
and cost are still obstacles to its widespread adoption. Such framing is also used by other organisations such as Caritas, BRAC and in the Asrayon Prokalpa. If widely used, hopefully it may reduce pressure on declining organic resources.

3.3.10 Maintenance

As mentioned by Hodgson and Seraj (2000): “Not all damage results from specific hazards. ...Poor maintenance commonly contributes to house damage...” Generally, people prefer to use such materials in construction that need less maintenance and repairing. That is one of the main reasons why rural people opt for CI sheet. Uncommon and unfamiliar materials made the beneficiaries of Proshika settlements uncertain about the future of these materials, especially about the MCR tiled roofs. In this climatic context, algae and moss tends to form on these tiles. Though it is claimed that it is possible to maintain them and keep them clean, the residents need to climb on the roofs to do so, hard to be done without damaging the tiles. Hazards associated with negligence and poor maintenance must be avoided.

3.3.11 The Way Forward

- The need to be independent both in policy and in people’s actual independence

In order to make improvement in the field of low-income housing, a new more people-centred approach would have to be followed. This approach may be hard to implement because of self-interest and lack of understanding of the situation by development agencies. Additionally, in general professionals and academics do not have the necessary orientation to contribute significantly; indeed they are like outsiders in their own society, stated quite directly by Rahman (1993):

“We the intellectuals of Bangladesh, trained in a colonial environment, with colonial attitudes and aspiration are educated to form and to join a class of our own, aspiring for recognition by the international brotherhood of intellectuals, but alien from our own society, ignorant of the social life and the conditions in the countryside and of the mind, the spirit of the potentials of the man in rural Bangladesh.”

A better approach in policy-making would be context-specific and there should be independence in thinking and judgement. At present agencies imitate Western methods of physical planning and build prototype design solutions: monotonous, basic model houses to create a Western-biased
‘modern’ housing system in a sort of blindfolded way, and this is then described as progress and development.

- **Learning from the present lack**

Unless attitudes change towards development, the situation will remain stagnant. The rural community will remain unsatisfied with anything they receive from agencies, if their problems, opinions and decisions are not taken into account seriously. The changing attitude shown by a ‘support-based system’ instead of ‘provider-based deliveries’ has helped the Million Houses Programme in Sri Lanka to become a success (Gunaratna, 1991).

On the other hand what happens here, described accurately once again by Rahman (1993) is:

> The vast majority of the people classified as ‘poor’, are objects of pity, paternalistic intervention and assistance. Many of these people under the blinding light of compassionate observation which was flashed upon them, have internalised this negative self-image ... Perceiving themselves as ‘inferior’, sought to be developed by the sheer power of ‘development’ effort which has often uprooted vast masses of people from their traditional life, to become inferior citizens in alien environments itself has concentrated power.

This clearly undermines the inner resources people have that could contribute towards social improvement. By cultivating a sense of inferiority and obliterating the self-value of low-income communities and individuals, the possibility for developing independence and resourcefulness is lost. Hence a problem is created, which if not addressed will continue to make the ‘poor’ dependent on others.

- **Willingness for improvement**

The so-called educated policy makers are pursuing the same mentality of dependency. The image of poverty is the license for personal development. Bangladesh as a whole is defined as a ‘poor’ country, overlooking the unexplored rich qualities in rural Bangladesh. Because of the poverty in the minds of policy-makers, the whole country has become dependent on top-down deliveries. The ‘poor’ policy-makers have miles to go before they understand and appreciate the real rural Bangladesh.
3.4 The Housing and Hazards Workshop Process

The Housing & Hazards Group (H&H) piloted a series of Building for Safety workshops during its first field study in 1997 (Carter, 1997) (Figure 3.10). The study was conducted in Sundarban Union, Dinajpur District, in cooperation with Chetonar Dak, a small village-based non-governmental organisation. The workshops aimed to reduce poor people’s vulnerability to disaster by motivating them to improve the hazard-resistance of their homes. This section presents an assessment of the impacts of that first study and indicates possible ways ahead for the workshop process.

![Workshop in Progress in Sundarban Village](Figure 3.10: Workshop in Progress in Sundarban Village)

The H&H workshop approach was developed to support low-income communities’ own strategies for survival in hazard-prone Bangladesh. It is intended to be flexible so as to accommodate localised and personal circumstances. The workshops provided a mechanism through which H&H worked with villagers to find ways of strengthening their homes using affordable and locally appropriate ideas. Participants worked through a series of discussions and practical exercises under the guidance of local facilitators to examine their local building methods and materials. From their analyses of the causes of vulnerability they derived “best practice” building techniques which would strengthen their homes and reduce the damage resulting from natural hazards. This process resulted in marginal cost improvements which would make more resilient homes affordable within the villagers’ means and circumstances.
The participants have been slow to act. The impact assessment survey, conducted during December 1998, revealed that the rate of implementation of workshop ideas by participants has been disconcertingly low. A number of issues need to be addressed if the workshops are to achieve their objective of reducing hazard vulnerability in the community.

Firstly, a greater understanding of poverty is required. The study has suggestions for ways of negotiating a way forward within a resource-scarce environment. Implementation of building improvements is impeded by causes of inertia other than poverty alone. To overcome these, activities must be sustained beyond the workshops themselves.

3.4.1 Poverty: A Persistent Bar in the Path of Progress

There is a slowness to act upon building needs in general. Many of the workshop participants commented that building is undertaken only when it becomes more than necessary. As one respondent said: “house improvements or repairs are not necessary unless our houses have been damaged or worn out.” Given this prevalent attitude, it was not surprising to find that people had not taken action to make their homes more hazard resistant before disaster struck.

Although it was not as devastating there as in other parts of Bangladesh, the 1998 flood was unusually severe for Dinajpur district. The impact was felt by workshop participants, one half of whom reported damage to their buildings. Yet, despite the participant’s comments reported above, slowness to act has continued even after the disaster: the majority of participants have not yet made any repairs to their homes, even four months after the event.

Once the floods and rainy season have passed, people can usually expect that significant rain will not come again until the following year’s rains. This could explain why some people feel in no hurry to make repairs, especially on buildings considered less essential than the main living/sleeping house. However, in some cases even those important buildings remain unrepaired. An example is that of one participant who is now living with his family in their small kitchen house. He lives a hand-to-mouth existence and has been unable to find the money to rebuild his living house destroyed by the floods. The winter in northwest Bangladesh which follows the rainy season is a bitterly cold experience, especially for those without decent shelter. It is
not for lack of suffering that this participant, like others similarly placed, has not been spurred into action. The reason is poverty.

An essential part of H&H’s future research must be to investigate more closely the reasons why people do not progress quickly with building. This is an important key to understanding why so many participants are not taking the further step of making the kinds of improvements advocated by the H&H workshops. Of those few who have started some remedial construction, only a couple of participants have used one or two of the workshop ideas. One participant explained: “It is hard for us to rebuild after the floods because there is not enough money. Therefore, people can rebuild only in a poor way - repairing enough just so that we can get by.”

Even one of the workshop demonstrators, although well disposed towards H&H ideas, struggled to implement them when building his own house. The main dwelling unit of his homestead had fallen down; being a day-labourer, he was building the new home bit by bit as money came in. Meanwhile, he and his wife were sleeping outside and winter was advancing. On days when he had enough money, he would stretch it to use H&H ideas such as painting bamboo pillars with tar to ward off insects and rot. When money was short, he put in posts without treatment. The need to complete the house so that he and his wife could sleep in warmth and security was a greater force than any thoughts of waiting for a few days to accumulate the funds to make the house more durable.

Being aware of these economic pressures facing families after disaster, H&H had expressly sought to encourage participants to make housing improvements long before hazards strike. However, the survey suggests that only the better-off could respond to this encouragement. The few cases where participants had enthusiastically put several workshop ideas into practice were new building projects and not responses to hazard damage or dilapidation. Typically, those participants had ready cash available at the time of building - enough to afford the extra cost and even to employ builders.

Perhaps it can be said that none used as many H&H ideas as the demonstration building (Figure 3.11) which was constructed at the end of the workshops. The survey also indicated a reason for this. When asked whether poor people
would be willing to spend the little extra needed to make their homes strong "like the demonstration building", only one gave an unequivocal 'yes'. The majority said that the extra materials required (i.e., a few bricks, C.I. sheet, bamboo, wheat straw thatch, a small quantity of tar and a handful of nails) would be too expensive for poor people. The demonstration house was described by one person as being "like a rich person's bedroom". Another described it as being "equivalent to four houses built in the general way". The demonstration building is relatively large (18'x12') because it was intended for communal use as a sewing training centre. This seems to account for participants' views that its cost would be beyond the means of a poor family, even though the workshops emphasised a budgeting exercise in which the marginal cost of the improvements was clearly seen to be a mere 8%. This attempt to demonstrate long term gains by spending a little extra initially seems to have been unsuccessful.

Figure 3.11: H&H Demonstration Building in Dinajpur

Most rural families have a fragile economy. Daily income varies with the seasons, weather, health and many other factors. Today's income can be as unpredictable as tomorrow's, never mind next month or next year. All income is immediately accounted for several times over by competing daily needs, and 'marginal costs' or 'long-term benefits' have little relevance. Even a workshop facilitator explained that in pondering the rebuilding of his kitchen, he and his wife are already arguing over how they can afford the time away from earning to do the building. Money for 'extras' is beyond the point.
This points to a need for better understanding of rural economies, the dynamics of household resource management in a resource-scarce environment and of how hazard-resistant building can negotiate a way forward within these constraints.

Common responses by aid projects to economic obstacles are either to offer credit or to provide some form of material assistance. However, pilot project participants mostly expressed dislike of credit as a possible solution. A few of them agreed that loans may be appropriate for business activities where profits can be used to repay capital and interest; the majority said that credit for housing is bad because poor people cannot afford credit for items which do not make money. The common sense in this attitude is difficult to dispute and it seems more appropriate to explore savings rather than credit as an economic approach.

3.4.2 Help with Building Materials: Contradiction or Complement to the H&H Approach?

Provision of building materials appears to be a departure from the H&H commitment to self-help solutions. Moreover, past failures of material distribution programmes have provided graphic warnings of the problems to be surmounted in avoiding a dependency culture. It is now seen as good practice in many sectors that beneficiaries should bear some of the costs of the ‘aid’. However, with so many development initiatives now demanding contributions, the poor are sandwiched between the competing demands of essential facilities such as water, education, health care, sanitation and shelter.

Although each aid initiative sets its costs within the beneficiary’s ability to pay, the cumulative effect is that even the marginal costs of H&H improvements lie beyond the means of the poorest sector of the community. Given the pressures on family incomes that have been seen in Sundarban, perhaps some kind of material assistance for hazard-resistant housing may prove worthy of consideration. Some people also remarked that organisations which conduct motivational programmes exhorting people to implement ideas but which do not fund the advocated actions, lack credibility.

Several people offered carefully considered opinions about what more could be done to help people make their homes more hazard-resistant. They called for very specific help with building materials which would be tailored to facilitate implementation of particular H&H ideas. Suggestions included:
Provision of good quality wire for making bamboo joints and for the kata process (cutting mud walls to control cracking);
2. Tar and brushes for treatment of bamboo poles;
3. Rice-husks for mud wall building;
4. Bricks and cement for forming the dhari (outer part of the mud plinth)
5. Loan of compaction rammers for building more robust mud plinths.

Participants were also keenly aware of the pitfalls of material provision and of how pressure on daily incomes could lead to misappropriation of resources intended for housing improvements. An essential recommendation came out of their comments: Specifications for assistance should be made so that it will not be tempting for poor people to sell the designated materials and so that materials (or quantities thereof) should not be too attractive to a market of marginally better-off people in the surrounding community. This recommendation can be met by keeping the distribution of materials tightly matched to the implementation of workshop-sanctioned improvements and activities.

The success of a materials provision programme such as this will hinge on one crucial factor: the presence of a field worker who can procure and distribute the materials justly. The H&H programmes initially relied on a local partner to host the workshops and later to conduct the follow-up activities. However, it turned out that the H&H objectives for the use of the resources did not tally with those of the local partner. This indicates a need for independent field staff who would ensure that assistance could be specifically tailored to the needs of the target (neediest) beneficiaries. Such field workers, responsible to H&H, would also provide the basis of effective monitoring and accountability structures.

Recognising that participants would need to draw support and inspiration from one another as they started to put workshop ideas into practice, the first H&H project arranged for follow-up activities during the ensuing building season. The local NGO partner agreed to host further workshops; a song team was commissioned to publicise the work; tar would be provided for bamboo treatment and advice would be given by the workshop facilitators. However, as no single person was made responsible for the coordination of this activity, the plans were slowly
forgotten. Without someone to nurture the process of hazard mitigation stimulated by the workshops, it could not survive.

It had been hoped that the participants themselves would be the sources of a spread of enthusiasm for H&H ideas. This had been discussed and agreed with the participants at the end of the workshops. However, of those who could recall making this commitment, nearly all had to admit that they had not put it into practice. They commented that as their houses had not fallen down they had not had to rebuild and so had not been in a position to spread the building for safety messages. Several respondents called for a community-based motivator. They explained this need with comments such as: "I'm only a little person - people don't listen to me." There is clearly a lack of personal confidence among the poorer people which inhibits them from taking the sort of leading role envisaged.

The second study has also found a lack of confidence about certain ideas which had been explored during the workshops. Without reinforcement of the original messages, participants were beginning to get muddled about what ideas had been covered. Many could remember that particular methods had been discussed, but could not recall the 'nuts and bolts' details that would enable them to use the techniques to good effect. This vagueness would also reduce confidence in implementation of ideas.

This all points to a need for a follow-up worker who would keep ideas fresh in the minds of participants and would stimulate the spread of building for safety practices to other members of the community. Appropriate activities for such a worker might include:

- Answering questions on practical implementation of workshop ideas;
- Finding out and attending when people are doing building work;
- Inviting neighbours to observe implementation of ideas and to lead discussion;
- Organising follow-up meetings;
- Involving participants in motivational work;
- Coordinating song team and jatra (drama) performances which raise awareness of the issues;
- Organising demonstration building exhibitions.

The list of potential follow-up activities is as long as the imagination can stretch.
3.4.4 The Role of Women in Home-Building and Maintenance

The first study targeted female as well as male participants, recognising that both are involved in the building process. In practice, the division of activities traditionally has men undertaking tool-based work such as site preparation, preparation of materials and roof construction. Bamboo wall construction requires the use of tools and is thus done by men; mud walling is much more a hands-and-feet activity and is often done by women.

However, once the building is completed, the woman of the house plays a much more significant role in maintaining the buildings, particularly those built of mud (Figure 3.12). The effects of rain, floods and even daily wear and tear all result in a continual erosion of the structure. The methods of construction used also contribute to a lack of long-term resistance to those hazards and the workshops suggested appropriate ways of reducing cracking in mud walls.

Two neighbours present an example of the importance of maintenance and of the woman’s role:

In home A, the women follow traditional practice, polishing the walls and plinth of the house weekly with mud paste or with water. Each month, they undertake more substantial plastering. As a result of this attention, the 26 year old house appears almost new.
The neighbouring house of family B, only 15 years old, shows substantial decay in several places. Family B is much poorer than family A and both male and female members of the family must spend the day working away from the house. Therefore, the women are unavailable to keep the house in good repair and the building is less able to resist any hazards which may occur.

This traditional role of women in keeping building exteriors crack-free is very important in reducing penetration of rain and insects. However, it appears that such maintenance is in fact undertaken more for aesthetic reasons than for structural ones. This suggests that future workshops should emphasise the long-term benefits of mud maintenance and incorporate ways of making this possible. It also points to a need to consider how public demonstration buildings, which do not get such regular attention, will be able to demonstrate the durability of improved mud walls.

The gender division of labour based on tool use is not hard and fast. In many aspects of life women can be seen using tools too, for example, harvesting crops, tilling the land and making bamboo baskets, as well as in the kitchen. When there is work to be done, women will get on and do it, tradition notwithstanding. However, when a male arrives on the scene, with time, rather than tools, in his hands, the confidence of the women who had been getting along the job often seems to evaporate, with the tools being handed over to the men to finish the task. Confidence and opportunity are, of course, fundamental factors which influence women's liberty and decision-making.

In particular circumstances, tradition can be bypassed, even during house-building. To give an example: Two young women had built their parental home, in its entirety by themselves. Their father is paralysed and their elderly mother works all day in the fields to earn 20 taka for their rice. The girls had been given sanctuary by a small organisation for abandoned women where they learned handicrafts and skills which developed their self-confidence. Having saved money from their handicrafts, they returned home to build the family house and provide a more secure situation for the whole family. The important stimulus was the confidence acquired through mastery of new skills plus the accompanying income.
Those parents were lucky in their children. Many households headed by elderly widows have to rely on costly professional builders for home construction. The 1997 workshops included two examples of this. In both cases, it was the young daughters who attended, but it appears that the girls, aged 15 and 16, were too young to take part in subsequent building work or to influence decisions about it. In neither case were the improved technologies implemented. These are among the poorest households in the village and can ill-afford the expense of the builders who were needed to reconstruct after storm damage. Such households should be the main focus for building for safety programmes and would benefit particularly from the work of a confidence-building motivator.

It must also be recognised that female participants are not as immediately empowered to make decisions about building (or most other things) as are their men-folk. In a resource-scarce environment, family differences over major expenditures can be a source of great tension. While the man can follow the patriarchal norm and make his own decisions, the woman has much greater difficulty in persuading her husband to use extra money for implementing ideas which she has learned from a workshop. This problem might be avoided if husbands and wives were to attend the workshops together, with the result that there would be a better likelihood of getting the full family’s support for H&H ideas. Working together, a husband and wife could be a good resource team for an H&H field worker to use in motivation work in the villages. An advantage in many areas is that whilst the husband can work with the men of the para, the wife can have access into the homes and courtyards of neighbours that her husband would not.

Decisions about the methods of construction used for different houses within the family homestead can also impact adversely on women. The living/sleeping house is usually the best built and maintained. By comparison, the kitchen, in which the woman spends much of her time, is typically the least well-built of the houses. Therefore, the survey found, the kitchen is one of the first buildings to suffer damage during hazard events. As a result, working in the cold and rain makes the woman more vulnerable to sickness, further adding to her workload. Participants’ stories of their suffering in the 1998 flood included problems associated with cooking and eating.
as an important theme. This is an aspect worthy of more consideration in future workshop programmes; before that can happen, a closer study is needed of peoples’ attitudes to kitchens.

“Distressed sales” (where materials such as C.I. sheet are resold to realise capital) can adversely affect the women and children who are left exposed in the home (Sorrill, 1998). The decision to resell C.I. sheeting is commonly made by the male of a household following spending controlled by the same male. In many cases, the men spend much of their time working or living away from the building in question while their women and children remain to occupy a house exposed in security and environmental terms. People are often very concerned about personal security and violent robbery. For example, one family building their home explained that the house would have no windows because violent individuals could easily enter through such openings. Part removal of a C.I. sheet roof creates additional (but often unrecognised) hazards of dislodged and flying sheets in high winds. These negative aspects of distressed sales might be emphasised during the workshops.

From the above it is clear that there are many aspects of the relationship between women and housing that should shape the development of the H&H workshop approach. It is worth noting that the workshops themselves provide a very good action-research opportunity for investigating women’s issues and perspectives. To do this will require the development of focus discussions in both the mens’ and womens’ workshops which approach housing in a way that is sensitive to the different gender perspectives.

3.4.5 Realising Potential

The first H&H pilot study sought to initiate a ‘process’ of growing attention to self-help improved housing within the community. Having revisited that aim during the second evaluation study, it can now be seen that the sustaining of this process will require more than just the initial workshops. The following auxiliary inputs need to be considered:

- Specific types of assistance with materials, closely associated with the workshop technologies;
- Field workers to facilitate the workshops and maintain subsequent momentum;
- Careful preliminary negotiations should be conducted with the community concerned, to:
implementing hazard-resistant housing

establish programme objectives;
develop understanding of the social, economic and materials constraints prevalent in that community;
arrive at a mutually agreed plan of action in which the motivators work alongside community based organisations to bring about reductions in hazard vulnerability.
consider the long-term implications of replicating and sustaining the programme.

Incorporation of these additional measures will require coordination, the training of staff and the creation of administrative structures if the workshop process is to be replicated widely. In return, the process gives a unique close acquaintance with vulnerable communities and a valuable action-research opportunity. The workshops provide the opportunity to draw on information about local situations in terms of community experience of hazards, vernacular housing, building methodologies and local constraints on good building practice. These data are needed by organisations interested in addressing vulnerability reduction and will also be vital in directing future research and development activities.

The H&H pilot study clearly pointed to the necessity of having a long-term view and strategy for continuity beyond initial programme input. Local capacity building, continuity of contact between programme facilitators and the community and flexibility for adaptation of programme to changing needs and circumstances of the community over time are important to consider if the programme is to have a long term positive impact for the community. An organisational set-up, at least for an initial period for 5-10 years, would definitely be necessary. Once local capacity is built, the organisation might become absorbed within the community and there would be less need for facilitation by people from outside.

With such support, a community-driven approach can begin to empower communities to overcome the difficulties which impede self-help housing action. It also has the potential to make significant contributions to the strategies of development organisations working towards a Bangladesh less vulnerable to the effects of hazards.
3.5 Implementing Building for Safety in Dinajpur

Despite large expenditures on designing and constructing improved technologies for low-cost house construction, most rural people in Bangladesh live in traditional houses which are vulnerable to natural hazards, as experienced in this tropical region. Unless the low-cost house is provided to them, or credit is available, the poorest families cannot afford even the cheapest imported technology. For such people, help in identifying improvements that make their homes safer, but not significantly more expensive, is needed. Providing improved replacement houses after a disaster has not proved either timely or cost effective in terms of increasing the resilience of the most vulnerable groups to future disasters (Hodgson, 1995).

This section describes a programme to characterise the building types and construction processes in a village in northern Bangladesh. The programme aimed to identify the resources (financial, physical and skills) available in the community and to explore how those resources are applied to house building. The objective was to raise awareness among houseowners of the cost-benefits to be derived from safer building techniques, as well as the physical protection which better houses give.

3.5.1 Location and Geography

Sundarban village sits astride the main highway, midway between Dinajpur and Saidpur (Figure 3.13). The River Atrai forms the eastern boundary of the predominantly agricultural village. With a population of 7,000 (1991 census) covering an area of 10.4 sq.km, Sundarban is the largest village in the Union which also bears the name. Literacy rates in 1991 were 34% (male aged more than 7) and 14% for women. The inadequate facilities for education prompted the establishment of a local NGO, Chetonar Dak, in 1991 to organise non-formal education programmes.

The village lies on the edge of the piedmont plains in the northwestern corner of the country. This relatively raised area is not normally known for flooding and is away from the main cyclone affected areas around the Bay of Bengal. Therefore, it does not have much history of international emergency relief aid, nor, until recently, any aid at all. However, since 1991 it has been struck by several major floods (1991, 1998) and two tornadoes (1995 and 1996) which have all been devastating locally.
This makes the village appropriate for study as it is possible to investigate indigenous solutions to the problems of natural hazards. Also, there is a variety of building types and materials which enables comparison of a large range of options.

3.5.2 Programme Rationale

Illiterate daily labourers seldom have time to access vital information, even if they could read it. This programme provided a volunteer to act as a catalyst for change to encourage enquiry into traditional techniques and promote discussion of appropriate technology improvements. Involvement of the community artisans at all levels is essential, necessitating a working knowledge of the Bangla language.

The field programme started in September 1996 and continued until May 1997 following the suggestions included in communicating Building for Safety by Dudley and Haaland (1993). Work to date has included wider investigation of construction in Bangladesh and mapping construction types within the village. A start has been made on identifying appropriate media for the dissemination of information.
3.5.3 Dissemination Path

The diagram in Figure 3.14 outlines the various routes through which safe building information can be disseminated from a specialist organisation such as the H&H Group to householders within the paras (sub-villages). One objective of this study was to identify which dissemination route would be most effective in Bangladesh.

3.5.4 Village Survey

The Sundarban project started with a survey of present building practice in the village. Using the Thana map as a basis, the paras which together form the village unit have been identified and located. (See Figure 3.15). The physical mapping activities helped to introduce the field worker to residents of all parts of the village and to start gathering anecdotal information. It also provided opportunities to record the common building types and technologies now in use.

Some houses were numbered, apparently as a result of the 1991 census. However, not all retained their numbers and the system used does not seem to have been systematic, so it has not been used for sampling purposes. Instead, as an initial approach, three paras with the following different social characteristics had been selected for more detailed studies.
Dash Para  Fishermen/Hindu area
Large para
Frequently flooded (near river)
Mainly mud construction

Hari/Roshini Para  Poor Hindu area
Bamboo used widely

Vatar Para  Agricultural Muslim area
Mainly mud construction

When completed, the study looked at all aspects of house construction practice. The following comments on roof construction and performance have been made by respondents to the initial survey:

Frame: Framing is almost exclusively made of bamboo. Figure 3.17 shows typical details for a pitched thatched roof and for a "flat" corrugated iron (CI) roof.
**CI sheet**: Locally made sheet is thin and weak, giving poor thermal insulation. However, CI sheet is associated with longevity and wealth and so is desirable. CI sheets are usually laid flat without nailing to maintain better resale values. Ahmed (1994) emphasised the importance of CI sheeting as an investment. Some good hipped roofs have been seen.

**Thatch**: The following four varieties are used in Sundarban:

- *Chon* grass lasts five or six years, but is expensive. It used to be popular, but as there is no food crop associated with its production, it is not grown much now. One *chon* grass field has been seen in Sundarban, but its owner has not yet been traced or interviewed.

- Rice straw is used abundantly although it lasts only one year (Figure 3.16). The house-building season comes just after the main harvest and many people use the straw to rethatch annually. Apart from the rapid deterioration, rice straw appears to be a good thatching material according to the criteria of thatch experts (Hall, 1988). However, it has many other uses as fodder and fuel.

- Wheat straw is available after the winter harvest and is another popular thatching material. It can last two years and the stiff straight stems give a distinctive layered appearance to roofs.

- Sugar cane cover is available from nearby plantations. This broad leaf is harder to lay, but will last three or four years, so its use is becoming more widespread as thatchers become accustomed to it.

**Clay tiles**: Tiles are still in use on some roofs. Tile production has traditionally been a Hindu craft and continued
in this predominantly Hindu community until recently. Tiles are more durable than other roof coverings but their heavy weight soon distorts a typical bamboo frame.

The following anecdote illustrates how traditional materials can last, given the correct conditions. As reflected by its name, which means "beautiful forest", Sundarban village was, a generation or so ago, largely covered by...
bamboo jungle. In 1972-3 quantities of this mature bamboo were used to reconstruct houses destroyed during the Liberation War (1971). One of those houses was destroyed by flooding in 1995 and the bamboo beams were found to be as sound as when they were installed some 23 years previously. Modern bamboos are felled before they reach full size, which does not apparently allow them to attain this degree of longevity. This experience suggests that allowing bamboos to grow for a longer period may result in more durable construction.

3.5.6 Target Group for Dissemination

There are some professional house builders in Sundarban. However, most low-income houses are built by their owners, often with professional assistance with the roof construction. It appears that men generally do the main construction while women become responsible for maintenance. The survey will be extended to consider the options open to households headed by women. Therefore, dissemination must reach virtually every household in order to be fully effective. To do this required an extensive PLA (Participatory Learning and Action) approach which had been started through the initial survey.

3.5.7 Key Messages

The underlying messages which need to precede any technical innovations are:

a. When building your house consider the hazards in the light of previous experience - will it be strong enough?

b. Extra initial expenditure on hazard resistance could save a lot of money later on.

Some experiences of dissemination media are give below.

3.5.7.1 Visual

The set of drawings developed as a teaching aid by Chisholm (1979) has been introduced during the informal survey work. Initial results suggest that while the drawings are adequately detailed line drawings and are understood by people, the text and the drawings need to be read together. This is a drawback when communicating with those who are functionally illiterate (still the majority in rural Bangladesh). In general, while the messages contained in these drawings cover much of the basic technologies which are needed (treatment of bamboo against deterioration, bracing structures, tying with wire instead of string), some of the texts are ambiguous. Proposals which affect the function of a building, such as relocating the
doorway, will not be readily accepted and will need further discussion in the village. Thus, these materials do not stand alone and must be used to support training seminars.

3.5.7.2 Audio
The basic key messages outlined above lend themselves to dissemination via cultural routes. Village functions often include musical recitations and a start has been made by composing a suitable song containing the 'Housing & Hazards' messages. This route of dissemination might be seen as raising awareness among the audience and rendering individuals more receptive to subsequent formal training.

3.5.8 Recapping the Sundarban Experience

Stronger homes can protect livelihoods as well as lives. A participatory survey described above, identified the common building materials in use and obtained the views of a cross-section of professional and self-help builders regarding building safer and stronger homes.

The factors which govern the choices of building materials open to rural low-income families are discussed. Those factors include tradition, building function, material cost, availability and access to skills. Suggestions are made concerning incorporation of such factors in the design of housing programmes in rural areas.

Natural hazards such as earthquakes, winds and floods kill hundreds of thousands of people annually and destroy the property of many survivors. A stronger, safer built environment can thus protect both lives and livelihoods (Hodgson, 1995). There has been a lot of research into low-cost housing technology over the past few decades, but still the technologies are not widely used. The Housing and Hazards (H&H) Group was set up to explore solutions to the difficult problem of communicating affordable building technologies in rural areas.

The first H&H studies have been made in Dinajpur District in the village of Sundarban. The preceding sections described the context of the studies in Sundarban village, which has a population of 7,000 (1991 Census) and covers an area of 10.4 sq km. It is planned that experiences from the Sundarban projects will guide affordable housing programmes elsewhere in Bangladesh and other countries. Carter (1997) has given a detailed account of the first H&H project and has presented the findings of surveys of house geometries and materials used in the study village. The second study is described in section 3.4.
This section summarises the observations of these studies and discusses the factors which guide individual homeowners’ choices of house form and building material.

54 houses were surveyed in 5 paras at different locations around the village. There was a surprising variation in architecture and methodologies used, even within this fairly small area (Figure 3.18). Figure 3.19 shows graphically the materials used for walling and those used for roofing. Broadly, about half the houses had layered mud walls and just over half had some form of thatch. However, the combinations were not predictable, so there are at least four common combinations with subsets of each, depending on which of the four styles of thatching had been used, on the techniques used for bamboo construction and so on.

In plan, the single-roomed houses conformed closely to a length/breadth ratio of about 1.6. However, individual structures ranged in length from 3.2 metres to 5.5 metres. Multiple-roomed houses were similar in width to the single rooms but longer. One aspect in which there was little variation was that of orientation; typical village homes are arranged around a square courtyard and almost all dwelling houses face south.

The houses surveyed were all relatively young with nearly half being less than 5 years old. Only one exceeded 20 years. This finding probably reflects the poor durability of most untreated kutcha building materials as much as it does the problems of exposure to natural hazards. It should be noted that flooding and high winds do occur in this area and regularly destroy dwellings, although the exposure is lower than in the coastal belt.
It can be argued that the range of structural forms described above represents generations of experience of living in Bangladesh’s hazard prone environment. Houses destroyed by cyclones or floods are rapidly rebuilt (as seen in October 1998). Why change tradition?

The main reason why the coping mechanisms of previous generations are not now so effective is that pressure on the production potential of the land has caused the price of basic materials to rise faster than other prices. Ahmed (1999) illustrated this for the example of bamboo. Thus, each disaster reduces a family’s capital and increases its vulnerability to future hazards. Increasing the resilience of the home could help to stem or to reverse that trend.

In fact, one of Carter’s findings was that innovative householders do experiment with modified techniques and with modern materials, but in Sundarban there was no mechanism for sharing experiences in such a way that others might also benefit. Hodgson and Carter (1998) have described the participatory workshops which Carter developed to assist in spreading indigenous knowledge more widely throughout the village.

As noted above, the cost factor is becoming increasingly significant to low-income households. Kutcha housing encompasses a broad range of costs. Whilst a small mud
walled house with thatched roof could be built for as little as Tk 1,500 (with significant labour input from the householders), a similarly sized bamboo frame and mono-pitch iron sheet (sapra) roof costs around Tk 5,000 to Tk 7,000 to build complete. This is a large sum for a daily labourer earning, say, 30 or 40 taka per day.

Many models of low-cost housing have been proposed. Some were summarised in presentations at the first Housing and Hazards Workshop in 1996. Islam (1996), for example, quotes typical costs in the range Tk 15,000 to Tk 24,000 (that is, Tk 1,400 to Tk 2,000 per square metre). While these model houses undoubtedly have an important part to play in developing housing for the rural poor, they do not address the needs of a large population of very low-income households for whom barely sustaining themselves from day to day is a struggle.

The contribution, in labour terms, that householders are able to put in themselves is also an important factor. In Bangladesh the workload of a daily labourer or small householder is highly seasonal. It is well known that the majority of house building occurs during periods where there is little demand for agricultural labourers. During this time the opportunity of working on one's own house is available since the householder would most likely be otherwise unemployed. If low-cost housing can be built by the householders themselves, then they have the option to save money in this way.

Carter (1997) reported that a range of important strengthening techniques can be incorporated into a kutcha house for an increase in cost of only about 8%. The challenge is to develop appropriate techniques and better methods for communicating them to the people who could benefit from the knowledge.

One approach taken in the first pilot project was to ask participants to calculate the costs of different roof constructions over a long period. As shown in Figure 3.20, it is possible to calculate that an expensive chou-chala (hipped) CI sheet roof could be cheaper over 25 years (since it is more or less maintenance-free) than the cost of replacing a cheap thatched roof every two to three years. Generating this type of awareness is a big challenge for rural programmes.
If people can afford the transport, they can opt for more durable mud walling. One interesting example given by Carter (1997) was of a rickshaw puller. This is a normally poorly rewarded occupation and yet the respondent could afford mud walls because, to him, the transport was free. Any neighbour would have to buy his services!

The cheapest cost for which a house could typically be built is Tk 1,500 to Tk 2,000 for a mud house with a thatched roof. To achieve this the householder would need to build the house himself and only buy materials and hire labour for the roof.

Mud is commonly applied to the wall by hand. This encourages the use of mud of a fairly weak, wet consistency with consequent problems of shrinkage as the wall dries. The poorly compacted material is also easily burrowed by rats and termites.

The combination of mud and thatch was recognised by participants in the Sundarban workshops as providing an even internal environment throughout the year: cool in hot weather and warm in cold weather.

3.5.12 Brick

Brick construction is normally beyond the means of low-income households in the study area. One exception is the area nearby a brick-making field which has long since become abandoned. Many old bricks remain scattered around, which are collected by house-builders as they are
salvaged and eventually used. One can imagine that the amount of time taken to find enough bricks of sufficient quality to build a wall would make such a task attractive only to families who lived in the immediate vicinity and could find a few bricks here and there in their spare time. This accounts for the small proportion of brick dwellings recorded by Carter’s survey.

3.5.13 Bamboo

Bamboo is a cheap and easily transportable building material. Houses made of bamboo can be extended easily when more money is available later and so it is the choice of those on the lowest incomes. However, the poorest people can afford only the thinnest bamboo which may last only one or two years. Poor quality bamboo framing is liable to be associated with walls made of bamboo-mat or jute-stick panels, which not only have poor durability, but also give limited protection against the monsoon rains.

However, whilst a mud house takes 3 to 4 months to build if built properly, a bamboo house can be built in a much shorter time. In an extreme case, a young man who needed a house before he could marry built one in 5 days using a bamboo frame and prefabricated bamboo matting bought at a market in town. This could be an important advantage in some circumstances.

People are well aware of the limitations of bamboo, particularly in respect to insect attack and its poor resistance to rotting (Figure 3.21). A common form of seasoning is to immerse bamboo culms in ponds for a period of 2 to 3 weeks. This results in dilution of the contained sap and reduces future insect attack, but the precise benefits have not been quantified.

Examination of old houses by Carter (1997) found that the bamboo stems embedded in some had lasted for over 20 years without significant deterioration. This led to some thought as to whether modern practice provides an inferior material. Currently, bamboo is normally cropped after about five years’ growth. Proximity to rice paddies results in bamboo growths being enhanced by the artificial fertilisers used there; this may, at first, appear an attractive by-product of modern agriculture, but rapid growth usually results in a less dense, weaker material. These effects have not been investigated in depth; further studies into such hidden by-products of the current emphasis on food production are urgently needed.

Bamboo splits easily and is therefore difficult to joint by normal carpentry methods. Nails do not hold tension for long
before pulling from the culm. Frame joints are therefore commonly held together using jute cord or other natural binders which decay rapidly. Creepers may be used in forest areas, but are not seen in Sundarban village. Hasan (1985) has recorded the typical framing details of village houses.

Timber is normally too expensive to feature in *kutcha* houses. Very few low-income households will have access to cheap supplies; even timber which grows on their land must be put through the expensive processes of seasoning and sawing to make usable sections.

Four different types of thatch are used in Dinajpur District. Traditionally, chon grass was used for its low cost, straight stems and relative longevity. However, this material was not cultivated for any other reason, and, since the 'green revolution', the sites where it grew have been put to rice cultivation. It is now very hard to obtain.

Rice straw is the most readily available thatching material, but the rapid-growth of high-yield rice varieties means that much of the straw available now is of very poor quality and rethatching is needed at one to two-year intervals.

Wheat is also commonly grown in the district. Wheat straw is widely used elsewhere in the world for thatching (Hall, 1998). The stems are straight and provide improved resistance.
to rainwater penetration, compared with rice straw. However, it is not available until quite late in the house building season which deters many from using wheat straw, even in this area. Even more durable and almost as popular as wheat is the use of outer leaves, or covers, of sugar-cane. The large plantations of sugar-cane in Dinajpur District produce covers almost as a by-product. It is more difficult (and hence costly) to use as thatch, but it can give twice the life-span of the other materials.

3.5.16 Corrugated Iron Sheet

Corrugated iron (CI) sheet roofs are widely prized for their longevity. They also act as important repositories of savings in that sheets can be resold in future times of hardship and replaced with cheaper thatch. The most common type of CI sheet construction among low-income households in Sundarban village is the sapra roof. Nearly 40% of the houses inspected had these, in which the CI sheets are fixed between two frames of bamboo and mounted in a single slope at a shallow angle. Pitched roofs of this type of construction are built North East India, but so far not in North Bengal. An important factor in this construction is that the sheets are not nailed or damaged in any way; this enables them to retain their value as a hedge against hardship for much longer. It also makes them more vulnerable to removal by strong winds.

The breakdown in cost of a house of this type (sapra) is quite revealing. Typically, 20% of the cost is bamboo, 60% is CI sheet, 5% other materials and the remaining 15% is taken with labour costs. This type of construction is popular largely because it uses the minimum amount of CI sheet possible. Even so, over half the cost is taken up by purchase of this expensive commodity.

3.5.17 Incremental Construction

Because of the high cost of house building, an incremental approach is often adopted. Many householders with sapra roofs express the hope to one day be able to afford the additional CI sheet to convert the roof into a hipped structure which is both more durable and of a form which is traditionally more respectable. Houses are often built with it in mind to include additional features at a later stage when funds allow. For example, it is possible to convert a verandah from thatch to CI sheet or to add thatched covers around the perimeter of a mud walled house to protect it from the direct impact of rain. One householder had struck a bargain on a pile of bricks. Although not enough to build a house, he saw it as a worthwhile investment and expected to buy the remaining
bricks required in a few years’ time. The adaptability of kutcha housing cannot be more vividly illustrated than one example of two brothers who initially shared a large single-roomed mud walled house. As their families grew they wished to move into separate rooms. Being some distance from suitable mud, they knocked down their existing house, reconstituted the mud and with it built a new two-roomed house.

3.5.18 Homestead Form

No overview of rural housing in Bangladesh (or anywhere else) would be complete without consideration of the organisation of the homestead around the house. Hasan (1985) comments that “traditional attitudes towards different domestic activities still dictate the space organisation of a rural house”, although he does acknowledge that population pressure was already changing those traditional attitudes. The extent of the typical rural family group was reducing as children were being forced to move away to urban homes.

Nonetheless, the needs for privacy, secure compounds for agricultural activities and for housing junior family members still today dictate a courtyard-centred homestead with various buildings around the perimeter. Thus, many houses still develop linearly, one room at a time as the needs grow, and the rectangular single room with a central door and length to breadth ratio of 1:6 remains the basic unit of kutcha housing.

3.5.19 The Housing Process

The factors governing choice of building materials are diverse and lead to a large variety of building forms even within a very small area. Although the choice is largely cost driven, there are social and geographical factors which cannot be easily quantified. Even the cost of materials and construction vary from family to family depending upon their location, assets, expertise and available time.

Developing low cost housing for Bangladesh should not be seen as a project to design a low cost house. It should be seen as a process which enables householders to make more informed choices and to share housing knowledge and expertise within their communities.

For that process to be effective, the programme must incorporate professional technical expertise in a readily understandable form and in such a way that villagers can quickly obtain appropriate answers to sometimes complex technical questions. This will require multi-disciplinary coordination across the boundaries of technology, sociology, and economic and anthropology fields.
This Participatory Action Research (PAR) project was carried out under the Higher Educational Link on Hazard-Resistant Housing between BUET and the University of Exeter, UK. The project was concerned with developing methods for improving houses and reducing vulnerability to hazards of low-income communities in a flood-prone rural area in Gopalganj district, Bangladesh, with the view that they may also find application in other flood-prone regions.

Technological innovation was linked to a participatory research process based on mutual decisions of the research team and villagers. It was attempted to develop a process for interaction of formally trained building professionals and rural householders/builders for building stronger and safer houses. It is believed that the results of the research might prove useful in other areas and in organisational housing programmes, and, therefore, beyond the confines of the project, effort for dissemination is being continued. In the same way, periodic monitoring of the performance of the project is being carried out.

Floods constitute a serious hazard in Bangladesh, particularly for low-income communities. In this context, there is a need for developing methods for improving performance of rural housing in floods. There are hardly any field-based studies on this subject in Bangladesh; even in such a comprehensive compilation as the Grameen Trust's Website on Flood 1998 (Grameen Trust, 1998), references to housing show numerical information on devastation and damage to housing, but no reference to building safer houses. To address this need, this project was conceived for developing 'building-for-safety' (BFS) options for flood-prone areas, defined as "construction technologies for building stronger and safer houses by strengthening parts of a building which are particularly weak with regard to specific natural hazards" (IT Publications, 1994). These options were intended to be context specific and adaptable in terms of income, household needs, location, etc.

The concept of Participatory Action Research (PAR) used in this project bears some discussion here (Figure 3.22). It is an all-inclusive approach involving various stakeholders in the process of developing news ideas and action agendas for problem-solving or improving a particular situation (in this case, house building technology development for flood-resistance). This approach attempts to accommodate multiple perspectives and viewpoints from both within the community...
and outside in a non-hierarchical way. It was adopted here after observing the prevalent mismatch between the objectives of organisationally based low-income housing programmes and local and/or community needs and aspirations (Ahmed, 1999).

The driving force behind this process of technology development is a synthesis of professional/academic and local/indigenous knowledge through participatory consultation indicating directions for replication, assessment of local adoption, appropriateness and dissemination methods. Emphasis is placed on creation of technological choices or, as in this project, developing options for building safer houses – this is a democratic characteristic of the concept. Emphasis is placed on the process of technology development, that is, using a 'model process', instead of sole preoccupation with the 'product' aspect represented by the conventional approach of developing 'model houses' or prototypes.

Dissemination of the ideas developed in the project is of paramount importance: for the last few decades various supposedly low-cost, appropriate building technologies have been developed by organisations and at educational institutions, but most of them have yet to see widespread application. For this purpose, communication between a variety of actors is necessary, requiring specific methods, tools, knowledge, experience, attitude and behaviour. The participatory concept has been widely discussed and promoted (see for example Chambers, 1997; Rahman, 1993; Slocum et al., 1995), but has found very limited application in the field of low-income housing in Bangladesh, an important reason for its application in this project.

3.6.2 Methodology

Because this was an action research project, most activities were carried out in the field, with a small proportion of the work being done in Dhaka, such as compiling reports, accounts, etc. The main stages of the project were as follows:

**Stage 1: Reconnaissance.** Visiting the project area to become familiar with the context and to document local characteristics, housing patterns and building methods. Some of the main activities during this stage included:

- **Area and Community Profile:** Studying the salient characteristics of a low-lying settlement and its lower caste Hindu inhabitants.
- **Housing Map and Household Information:** Preparing a map of the settlement and collecting demographic and housing
related information of the twenty seven households living in the settlement.

- Data Collection & Documentation: A large volume of data was amassed during reconnaissance and later stages. This included information on local housing patterns and building methods, preparing building materials inventories, sketches and drawings, and extensive photographic documentation.

Stage 2: Workshops. Workshops were held to brainstorm ideas for improving rural houses and to thereby develop locally relevant BFS options. Specific types of construction and possible improvements for the base (including posts), walls and roof of rural houses were discussed and developed. Two workshops were held in the village - one for women and the other for men. Primarily, the main parts of buildings were
discussed in focus groups with 5-8 persons per group and in open discussions. This included:

(a) Base, including plinth and posts, (b) Walls and (c) Roof

These discussions focused on construction methods for each part with regard to:

(a) Merits and demerits, (b) Preferences, (c) Costs, (b) Possibilities for improvement

The workshop findings allowed developing BFS options for improvement of the base, walls and roof of rural houses. Participatory dialogue between the research team and villagers was the basis for developing these options. Cost was an important factor because these options, although increasing costs somewhat, were to be modest and affordable for low-income households, allowing savings from reduced maintenance over the long term.

Stage 3: Demonstration and Dissemination. This was perhaps the most important stage of the project. Two households in separate, but nearby, villages volunteered applying some of the BFS options developed at the workshops to reconstruct their houses (DH1 and DH2). These were built as demonstration houses to study the BFS options and to disseminate the results of the research (Figure 3.23). Instead of building a demonstration 'model' house, it was chosen to incorporate building-for-safety options in the reconstruction of existing houses. The houses were built in separate villages for wider impact. The idea was to demonstrate possibilities for improving a rural house by incorporating some significant changes. The demonstration houses were results of contributions, material and otherwise of both the research team and villagers, built by mutual participation. A children’s song team was trained to sing and disseminate the ideas developed in this project. A 25-minute documentary film has been made to serve as a dissemination tool. Dissemination is an on-going activity extending beyond the confines of this project. The project results have been and are going to be presented at a number of conferences, seminars and other such fora, and also perhaps more pertinently, at village workshops in other regions.
Figure 3.23: Plan and Section of a Demonstration House (DH1)
3.6.3 Building-for-Safety (BFS) Options used in Demonstration Houses

Because the development and application of BFS options were central to the project, they are described in some detail below.

3.6.3.1 Cement Stabilised Mud Plinth

Results of laboratory studies of stabilised mud carried out under the BUET-Exeter link were applied in the field. Model stabilised plinths were made on site to confirm strength and water-resistance tests before actual construction. The existing mud plinths of the demonstration houses were levelled and prepared for a cover of 3-4 inches of cement stabilised earth. Soil was obtained from the sites. Cement was bought from Gopaldurg town and transported by tricycle vans. Because the earth had a high clay content, upon advice from a geologist in Dhaka, it was decided to add 20% sand and 8% cement by volume to stabilise the earth. Earth was dried, broken down and screened before being mixed dry with sand and cement, after which water was added to make a paste-like mix. This mix was used for stabilising the plinth, mixing small batches at a time, layering it by hand and then tamping for compaction. The completed plinth was cured by water for a week. In addition to resistance to erosion by water, other advantages of a stabilised plinth, observed by villagers, are a dry and clean surface, reduced infestation by rats and insects and security from burglary. Long-term durability is as yet unknown because there are no examples of stabilised mud plinths in that region. Thus these demonstration houses should allow gaining first-hand knowledge in this regard by monitoring over the long term.
3.6.3.2 Hollow Concrete Stump (Katla)
Local concrete stumps to protect the lower part of bamboo/timber posts (katla) were improvised and designed partially hollow (Figure 3.24). This reduced the cost; an extra katla could be obtained from materials savings of cement, sand and aggregate from 10 hollow katlas; i.e., 10% cost savings. A hollow katla filled with sand/earth before placing it in position is as strong and sturdy for its purpose as a solid one. Because here katlas were placed into a stabilised mud plinth, they were wrapped with polythene sheets for easy removal if necessary later. Hollow katlas were produced as follows: polythene sheets were spread on the ground and a 2-sided wooden shuttering placed. For each katla, at one end a 16-18 inch long 3/8 inch MS flat bar clamp and in the other a 2 inch diameter (outer) PVC pipe lubricated with sump oil were placed in position according to dimensions specified in the design. Casting was then done with a 1:4:4 (cement:sand:aggregate – 3/4 inch brick chips) mix to make 4 inch x 5 inch x 2 ft katlas. One hour after casting, the PVC pipe was slowly drawn out, leaving a part of the katla hollow. At least 10 days curing was necessary. For efficient use of wooden shutters, better cost-effectiveness and production, it is advantageous to produce a number of katlas together. For each demonstration house more than 20 katlas were produced over two days. To prevent rust, the clamps were painted with molten bitumen.

3.6.3.3 Bamboo Treatment
Local bamboo treatment methods were followed to encourage their practice. Bamboo poles were bought and soaked in a nearby waterbody, a local practice of flushing out the inside sap to make the bamboo unattractive to insects. However, at present, villagers often do not follow this practice. In this project this practice was encouraged: bamboo was bought a few weeks in advance and soaked in water before using. Bamboo was not locally available, it had to be bought from a weekly market in town and transported to the site by tricycle vans, adding to the cost. In the demonstration houses, bamboo posts were supported on katlas and painted with bitumen about 1.5 ft from the bottom. This is expected to extend the life of the posts; an unprotected bamboo post dug into the ground lasts only for about 2 years, requiring frequent replacing. For households unable to maintain bamboo posts, this can mean living in a hazardous house. Bamboo has become expensive and scarce, and extending its useful life as
IMPLEMENTING HAZARD-RESISTANT HOUSING

a building material can mean cost savings and reduced vulnerability of low-income households.

3.6.3.4 Painting Walls with Bitumen
Painting the lower part of walls with bitumen for protection against rainwater splashing and water from the ground is a local practice and was encouraged in this project for wider use. A small amount (less than 1 kg) of bitumen was needed for painting an 8-12 inch band around the lower perimeter of the walls. For example, in DH1, 2 kg bitumen was bought from the town market and used for painting walls, katla clamps, rainwater gutter brackets and bamboo posts.

3.6.3.5 Cross-Bracing
Cross-bracing of the bamboo wall frame structure with split bamboo poles is common to some extent in the area. This increases the resistance of the house structure to strong wind. Cross-bracing was used in the demonstration houses with the view to encouraging this practice.

3.6.3.6 Rainwater Gutter
Rainwater falling from roof eaves and damaging the plinth, walls and ground around the house was a common problem. A simple rainwater gutter was devised with a 3 inch diameter split PVC pipe and MS flat bar brackets (at about 3 ft. intervals) (Figure 3.25). The gutter sloped to the sides, thus draining away rainwater to the corners and from there to the back of the house. Since the demonstration houses were gabled, in each house two gutters, one at each eave, were provided. The brackets were made by local blacksmiths according to the design developed by the research team and villagers. They were painted with molten bitumen for rust-prevention and attached by screws to bamboo roof purlins. There was an example of a house in the village which had a metal sheet gutter, which suggests that a less expensive and more durable gutter such as that used in the demonstration houses might be adopted locally.

3.6.4 Monitoring
In addition to periodic monitoring, about six months after constructing the demonstration houses, after the rainy season, an independent evaluation of the project was carried out (Figure 3.26). The results of this report are presented in summarised form below.
3.6.4.1 Demonstration House Condition

After visiting and examining simply by touch and hitting with hand, the stabilised earth plinths seemed to be in good condition compared to ordinary earth plinths in terms of both dryness and hardness (Figure 3.27). No coating had been needed since construction. Some cracks were found on the plinth and were independently repaired by the household female members using the same mixture (cement, sand and soil). Rats and insects were unable to affect the stabilised plinth, which was highlighted positively by the household and other community members.

As the soil of the locality was clayey, the team had to mix a higher percentage of cement and sand to get desired performance,
compared to other regions with more sandy soil as evidenced in the BUET lab tests. The plinth dimensions of DH2 are 21 feet long, 18 feet wide and 1 foot high. In order to provide a 3-inch cement stabilised earth (cement: sand: soil = 0.75:1:8) covering of the top and sides of the plinth, 11 bags cement were required. The demonstration house owners and the community appreciated the stabilisation technique, but they were not yet prepared to pay for it. So it appears necessary to reduce the construction cost of the improved plinth.

Figure 3.27: In the House Next to DH2 (left) the Plinth is Getting Damaged and the Owner had Covered it with Polythene Sheets to Prevent Further Damage; In Comparison DH2 (right) is in Much Better Condition

The hollow concrete stumps (katlas) have succeeded efficiently in giving protection to the bitumen-coated bamboo posts. Bamboo cross-bracing has successfully increased the stability and durability of the house walls. The introduction of rainwater gutter was an effective and appropriate technology in this research project. The DH2 household and their neighbours collect and use rainwater falling from the gutter, but the DH-1 household has chosen not to, indicating the need for follow-up motivational activity.

3.6.4.2 Local Perception and Future Prospects
Residents of the demonstration houses were happy with their houses. But neighbouring people were not convinced to build their houses using the BFS options without any financial support. This is mainly due to their poor economic condition. Lack of motivation in this respect and the relief mentality of the local people seem to be the main causes for not accepting the new technology. A social factor was also responsible for the community choosing not to replicate the demonstrated technologies. Women are solely involved in plinth
maintenance, but men control household expenditure. Because the men are not very concerned with the women's labour, they do not feel the necessity of an improved plinth that would save this labour. A man in the village where DH2 was built has expressed interest in building his house using the BFS options. This is a positive sign. Perhaps in the future, if any NGO or social organisation makes arrangements for financial support, people might be more interested. This suggests the importance of disseminating the ideas developed in this project among community development agencies which would be better placed to implement them.

3.6.4.3 Vulnerability Reduction
The aforementioned technologies that were employed in the demonstration houses have succeeded in reducing the vulnerability of their inhabitants. There was a clear difference between the condition of the demonstration houses compared to that of other houses in the village. The rainwater gutters were successful in preventing erosion of the earthen plinths. It was clearly visible that the stabilised plinths of both the demonstration houses were of superior resistance to the monsoon rains and floods. The plinths of neighbouring houses were crumbling without regular maintenance, whereas those of the demonstration houses had only sustained very minor cracks. Both the families of DH1 and DH2 had repaired the cracks with the same cement reinforced earth mixture and no further damage occurred. Even though the construction cost was a little more than the average local house, due to reduced maintenance as a direct result of better water resistance, the demonstration houses were financially more effective in the long term. A combination of the local social mentality and individual financial implications has restricted the local replication of these technologies. However, if financial assistance were offered, then many people would not hesitate at the opportunity to mitigate their homestead against floods. If the local people's vulnerability to floods, which they have to endure on an annual basis, is reduced, then the floods will not have such a catastrophic effect, loss of assets will be reduced, and the standard of living and quality of life of the rural poor will develop greatly.

3.6.5 Observations
Vulnerability to hazards is directly proportional to a household's economic position: for a low-income household even a strong gust of wind can spell trouble. Hence this project
attempted to strengthen various parts of a rural house that are susceptible to damage by not only floods, but also by other hazards such as rain and wind. Not only large disasters, but regular hazards such as deterioration and weakening of house structures by insect attack, dampness and rainwater contributes to a household’s vulnerability, especially when incomes only permit less durable building materials. The BFS options were developed with regard to this aspect of vulnerability.

The BFS options used in this project were context-specific. There are also useful lessons for wider relevance, but principally, projects of this type would have to be based on context-specific studies because of regional variability and diversity of building methods, materials, resources, etc. For example, in Gopalgonj, because of the high clay content in the local earth, up to 9% cement and 20% sand had to be added. But less than 100 kilometres north in Manikganj district, also a flood-prone area, it was found that the local earth could be stabilised by adding only 5% cement.

This project was concerned with housing in flood-prone areas and not about developing a ‘flood-resistant’ house prototype. The options developed are not expected to provide complete resistance, which would be much too expensive for low-income communities. Rather, the purpose has been to develop ideas for minimising vulnerability that would be affordable and achievable in their circumstances. Strengthening a house does, however, increase the cost (about 15-20% if all the options developed in this project are used), which is potentially discouraging for low-income households, as indicated by the independent monitoring presented above. To balance this extra cost to some extent, cost-reducing options such as hollow katlas, were developed. A number of options were developed for a range of household incomes: households would subscribe to more options, according to affordability and prioritise them according to their own needs.

This project’s objective was to conduct action research as part of an educational link programme without scope for direct continuity beyond the confines of the project. However, in order to sustain and promote the ideas of this project, an organisational set-up would be necessary to continue work on developing better housing for low-income communities as long-term action, once again suggested by the independent monitoring. This project could serve as a basis for establishing such a set-up, a reason for continuing dissemination activities.
3.7 Review of Participatory Practice

The concept of community or user participation in development programmes, particularly for the poor, has become widespread and now most international funding organisations attempt to highlight its importance in their programmes. Rahnema (1992) has chronicled the increasing popularity of participatory development, showing how this concept with its initial quasi-radical overtone has eventually been co-opted into mainstream development discourse. The term ‘participation’ has received tremendous attention since the 1970s and various proponents have postulated a variety of analytical conceptualisations and operational definitions.

While often used in political propaganda and in manipulative schemes to advance vested interests (of which there are many examples), participation is commonly advocated as a theoretical construct [with practical applications, characterised by Participatory Action Research (PAR)] for changing structural conditions within society which prevent self-actualisation and poverty alleviation of under-privileged individuals and communities (for example, see Chambers, 1997; Rahman, 1993). It is also common to define it more narrowly as simply involving beneficiaries in development projects. (See Fuglesang and Chandler, 1993; Oakley, et al., 1991). Touching on its more sinister applications, Hamdi has written about the spectrum of conceptual divergences regarding participation:

"The best processes of community participation ensure that everyone involved has a stake in the outcome and that therefore they have some measure of control over it. The best processes ensure that all concerned will share the responsibilities, profits, and risks of what they will decide to do. ... The worst processes are tokenism. These are plans devised by a dominant group legislated to seek the opinion of others, who consult these others on issues that are preselected and may have little or no relevance to those invited to comment. In between, where most projects fall, are various shades of community participation... " (Hamdi, 1991)

These divergences occur because of the wholesale acceptance of the participatory concept by a variety of actors within the development establishment; its exclusion may even suggest anathema towards current development practice and
It is interesting that despite their diversity in conceptual and programme orientations, most development organisations based in the West claim to endorse participatory practice in some form or the other. There are bound to be varying interpretations and different levels of performance in application, and even misuse, when there is such widespread endorsement of a concept. Without considering the implications of participation in practice, it has become conventional for most development project documents to contain references to it. How it is practised, or whether it is practised at all, remains a different matter.

3.7.1 Participation in the Bangladeshi Context

To comply with stipulations of Western funding organisations, in Bangladesh there is also widespread reference to and claim of participation in local project documents. For example, projects of the government's Adarsha Gram Programme (AGP) for housing and resettlement of the landless are built by contractors based on centralised standard design decisions and there is no participation of beneficiaries; sometimes beneficiaries are even chosen after houses have been built. Yet an AGP annual report states: "... the Adarsha Gram Project now includes components such as landuse planning, people’s participation ..." (Bangladesh Ministry of Land, 1995). Conversely, as pointed out by an observer: "The financing memorandum and the [AG] project proforma stipulate that the construction of houses has to be done by the settlers themselves. But, in fact, this has been done by contractors" (Hye, 1996). Many such examples can be cited.

If the AGP programme is compared to the example in Figure 3.28, it can be seen that in the latter there was at least an attempt at participation, albeit with poor results, whereas in the former there was only a token reference to it. In these examples organisations tended to act in response to their own perception of a community ‘need’, without considering community ‘aspirations’. Need can perhaps be fulfilled without participation, but not aspirations. The example below shows a common pattern: the grid was a result of self-interest of both parties, replacing aspirations with perceived need. What is tacitly common between both examples is that people in a context of poverty and vulnerability generally tend to agree with how a commodity, such as housing, is provided by organisations. Even when a poor person articulates the importance of participation, it is often framed with reference to its benefit to
the organisation, not to the beneficiary: "If we were allowed to build our own houses, there would be no risk of blaming the government," said Rohima Khatun, an AGP beneficiary (Ahmed, 1999). On the other hand, a prominent AGP staff member believed that it was better to involve beneficiaries in project implementation because this led to more beneficiary satisfaction with the houses provided. However, in reality there was usually only one pre-implementation meeting with beneficiaries, which the same staff member thought made the projects sufficiently participatory.

In India, new villages were planned after the Maharashtra earthquake of 1993. The planners wanted a grid layout for the new villages. Given a choice between a grid and cluster layout, people opted for the grid. The planners said that the decision was participatory. Eventually it emerged that several factors had combined to induce choice of the grid layout: the planners had loaded their description in favour of the grid; older people did not fully understand the choice; young men said that the grid was modern, and ridiculed the older people for their doubts; the grid was known to be what the outsiders wanted to provide; and people believed they would get housing quicker if they agreed to the grid, since some other villages had already been constructed on those lines.

The displaced people, concerned with self-esteem, not fully understanding and feeling unable to change things, had acquiesced and said they wanted what they thought they were supposed to want and would be able to get. It seems that the planners had ventriloquised.

Often, in cases where there is participation, such as the Grameen Bank's micro-credit programme, it is used more as a clever arrangement for better cost-recovery and programme efficiency (Rahnema, 1992) than for advancing human rights and liberating people's creative energy, fundamental premises of the concept (for example Rahman, 1993). Thus it is not surprising to find that in the field of low-income housing in Bangladesh there is very limited evidence of actual practice of participation by community development organisations (Ahmed, 1999). Indeed, despite its widespread endorsement, this appears to be the case with the development field in general in Bangladesh, pointed out in an UNDP report, echoing the authors' observations:
"Usually policy decisions at the national level are based on judgements of the top level planners, politicians, bureaucrats and powerful lobbies of industry and agriculture. They talk about the poor, make decisions about their problems and priorities and allocate resources. The voice of the poor as a stakeholder in the development process is neither heard nor desired to be heard. Poverty increases and many poor groups become increasingly isolated from the mainstream of development." (UNDP, 1996)

3.7.2 Participation. An Exogenous Concept?

The fact that the participatory concept developed and became accepted in developed countries as a policy for intervention in poorer societies, perhaps an outcome of their earlier consolidation of democracy-orientated institutions, is less mentioned in literature or by its advocates; it is founded on liberal ethics and conscience about social justice, the roots of Western democracy, acting as a grand narrative. In that sense, paradoxically, it also represents one-way, vertical flow of knowledge from the epicentres of development theory in developed countries, almost similar to notions of North-to-South resource/skill transfer characterising development thinking before the participatory concept was advanced as an alternative (Chambers, 1997; Rahnema, 1992; Tripura, 2000).

This is evident from the fact that it is uncommon to find examples of its indigenous promotion in developing countries as a community development policy independent of sanction or support from developed country funding bodies. One is led to reflect seriously upon Lerner’s assertion made more than three decades ago: "traditional society is non-participant, while modern society is ‘distinctly ... participant’" (Lerner, 1958). However, this picture of traditional society as an isolated closed system can be questioned in the present context. Such insular societies are indeed few now when West and East, North and South, rural and urban, and rich and poor are all entangled in a global web spun by the all-pervading cash economy of a single monetary system of subversion of previous modalities of exchange. Lerner’s studies actually pointed out that traditional society was beginning to "pass," perhaps an oblique premonition of present-day globalisation and of the development fiasco, the forces of which had already set in motion, during the time of his publication, the then recent formation of the World Bank, IMF and the UN.
Yet, if the case of Bangladesh is considered, it is clear that its social structure is comprised of powerful hierarchies of income, age, gender, ethnicity, etc. - often a reflection of regional traditions, ideals of democracy and equal opportunities. At the same time, lip-service is given through political propaganda. Thus, the concept of participation of poor communities in their own development appears incongruous in the context of the Bangladeshi social structure; it perhaps undermines the basis of this structure.

Hence there appears to be an impasse: conventional top-down development projects are not able to meet local needs at the micro-level, hence the promotion and co-option of participatory development, often at odds with local tradition. Participation then appears as an exogenously-contrived action mode that seeks to promote endogenous autonomy; thus participatory development appears to be an oxymoron. However, informed by an Oriental philosophical perspective, some thinkers now embrace paradoxes instead of decrying them in an Occidental positivist vein, and co-existence between apparent polarities is accepted as an essentially human condition (Sillitoe, 2000), thus presenting scope for revision and re-interpretation of contradictions.

The tradition versus participation impasse can be reviewed further by considering that in the Bangladeshi context specifically, exogenously-driven change was present throughout history: socio-cultural cross-fertilisation over the ages, which is still continuing, is endemic, often belied by the apparent timelessness of the relatively less-affected Bangladeshi rural setting, the icon of Bangladeshi tradition [for example, while identifying ‘timelessless’ as a characteristic of Bangladeshi villages, Ashraf (1997) has chronicled the diversity of external influences over time that have shaped religious, aristocratic and public buildings in this region]. Thus if local tradition is not static, then it is only natural that widely popular concepts such as participation transcend national and cultural boundaries. In this light, the participatory concept deserves reassessment in terms of its relevance to local context.

In Bangladesh, as in many other parts of the world, there is the necessity for context-specific social development in education, health and related spheres, perhaps primarily at the grassroots level, and the need for reducing vulnerability to
environmental and human-induced hazards (which seem to be on the increase), so that low-income communities are not further marginalised and deprived of their rights and of their share of national resources in a context of globalisation and consequent, often irrevocable, economic transition. There is a developmental role for the state and civil bodies in these regards, which remains nebulous and without clear direction in Bangladesh.

Anti-development notions expressed by authors such as Escobar (1995) and Rahnema and Bawtree (1997) can only be accepted in the case of projects affecting communities and households negatively, because of the lack of, or minimal, or inappropriate local consultation. As a forthcoming publication suggests through a variety of examples, participatory practice does have many pitfalls, but it still offers methodological and other advantages if its limitations and the context of application is understood well (Cooke and Kothari, 2001).

Despite its exogenous roots, the participatory concept does hold some water: the state, its institutions and civil society have a responsibility towards improving the lot of its citizens and common sense suggests that it is better to involve them in action towards their own development instead of bypassing them. However, without major structural changes in the nature of formal institutions and their relationships to poor communities, the notion of participation may remain simply rhetoric and an impasse would persist. Hierarchical arrangements and attitudes, although reflecting local tradition, need to be questioned, especially when they conflict with collective benefit. If tradition is viewed as a flexible entity continuously moulded and redefined over time, perhaps there is then space for incremental change and growth in human potential by participation in action and change that has collective relevance to society at large.

### 3.7.4 A Case for Participation

The arguments against participatory practice are built largely upon cases such as those cited above, perhaps because they are preponderant in the development landscape. The criticism arises mainly because participation was not an integral aspect of these projects, but more of a corollary in response to established ethos of current practice. The grinding axe is not directed against core human values such as "attention, sensitivity, goodness or compassion" or acts such as "learning, relaxing and listening" (Rahnema, 1992), which are central to
the participatory concept. Thus the criticism is not against participation per se, but against current bad practice. Indeed, even ardent critics such as Rahnema (1992) have suggested re-defining participation in an alternative vein beyond co-option by vested interests, encompassing human values that contribute towards realising social, community and personal development. In such a definition then, the core human values inherent in the concept of participation would be central and integral, beyond concerns for programme and resource efficiency.

3.7.5 Search for New Directions

Given the above framework, it is obvious that new directions in development practice regarding the place of participation within it are needed. By shedding its old skin, how can the current serpent of participation metamorphose into a genuinely humane being? Perhaps this metamorphosis begins with inquiry and reflection to enable action to inform the search for new directions. Two inter-related streams of inquiry, conceptual and pragmatic, might allow translation of thought into action; mediation between these two realms would then have to be forged. To simplify for the sake of initiating the search for new directions, the two streams of inquiry can be encapsulated thus:

1. Is there a place for basic human values, immeasurable, yet inherent in the participatory concept, such as compassion, sharing, learning from others and respecting their viewpoints and dignity however marginal they might be, and accommodating in action multiple perspectives of all stakeholders?

2. What is the role of the professional in the context of social development to which he or she is expected to contribute? Is this contribution to be made by respecting local traditions of hierarchy or by accepting exogenous concepts that apparently contradict such traditions? Can there be a blend of these two, which might perhaps indicate the way forward?

The scenario suggested by these questions is one of reconstruction: trekking through a war-ravaged landscape and salvaging tiny gems inlaid in mangled armour and undamaged pieces of the war detritus, it might be possible to create with them new implements for rebuilding the landscape as one of long-lasting peace. Not to give participation a new lease of life, but to give it new life.
4. Dissemination of Building for Safety Messages

4.1 Introduction

The previous chapters summarise work done recently in Bangladesh to increase the resilience of low-income housing to natural hazards. Although similar work has been done in many places around the world over the past 50 years, almost 20% of the world's population still lives in insecure housing. There has clearly been a failure to communicate essential building for safety messages to the people who need them most. It is important to consider for whom those messages are targeted.

The largest target group needs little explanation: it is those 20% of the world who stand to gain most from better technology and who commonly build their own houses with little or no training. However, to help those on low incomes achieve their ambitions for better homes, the messages must be disseminated throughout a network of persons, professionals, legislators and institutions who either practice or could support the building for safety process.

4.1.1 Non-Governmental Organisations (NGOs)

In the past, most shelter programmes have concentrated on provision of new, improved 'low-cost' houses to selected beneficiaries. Typically, beneficiaries would have no influence over either the selection process or design of the house and consequently the design was inappropriate. Often, in these programmes houses went to households that were not among the most needy.

Over the years, participatory approaches have helped to refine the targeting of benefits and to allow beneficiaries to give more input into the design process. However, the use and effectiveness of 'participation' remains variable in distribution and quality, and most programmes still give it little more than lip service.

4.1.2 National Legislators

It is axiomatic in most administrations that laws are made to preserve the status quo. Any progressive legislation tends to
be drafted from the perspective of the educated urban elites who commonly comprise legislative bodies. The rural poor have little power; in the absence of knowledge of crucial policy issues, legislation often favours the more politically conscious upper classes.

It is, therefore, important to inform urban decision-makers of building for safety issues and to encourage a more pragmatic approach to solving the problems resulting from poor housing. The corollary is the rural people need to be motivated and to become aware of what, at least in democratic states, they may reasonably expect in the way of institutional support as they struggle with their environment.

**4.1.3 Technical Professionals**

Technicians are trained to seek and implement technical solutions to problems. They commonly view the solutions to strengthening low-income housing as trivial and not worth considering. If they do consider the options, they are amazed that such simple solutions have not previously been implemented. There is a big challenge to face in making technical professionals aware of the socio-economic and other constraints that prevent the poorest households from building hazard-resistant homes. In the longer term, this could be addressed through including training on appropriate technology within the educational curricula for young professionals.

**4.1.4 Local Government Administrators**

Local service providers can play a big role in demonstrating good practice and providing advice as part of a support network. Commonly, local administrators build schools, clinics, community and administrative infrastructure. The buildings needed for these functions provide opportunities to demonstrate building for safety techniques. As awareness of building for safety develops, local administrations could, and should, create educational resources and a technical advice service to ensure that standards for workmanship and design are established and improved with time. This type of support is now commonplace in developed economies, but in Bangladesh, the prevailing tendency to avoid official regulations would have to be taken into account.

**4.2 Educating Decision-Makers and Technical Personnel**

Publications, such as this one, have an important role in disseminating awareness of building for safety issues and in establishing standards. However, the target audience for each publication needs to be considered carefully and its style and content adjusted accordingly.
Generally, publications in English, or in another international language, can be appreciated only by educated elites and professionals. Publications that are intended to be used at the field level might need to be translated into an appropriate regional tongue. Even then, they might not be accessible to the owner-builder in a country such as Bangladesh where the adult literacy rate is only about 30%.

The higher education link programme between Bangladesh University of Engineering and Technology (BUET) and the University of Exeter, UK has sought to influence decision-makers through a series of international seminars and associated books and published proceedings. These have raised some awareness at the national level in Bangladesh, but so far have had less impact at the grassroots level.

Figure 4.1 shows the covers of books of the proceedings titled "Village Infrastructure to Cope with the Environment" (Seraj et al., 2000a), "Affordable Village Building Technologies" (Seraj et al., 2000b), "Implementing Hazard-Resistant Housing" (Hodgson, et al., 1999), and the book titled "Communicating Housing Technologies in Low Income Areas" (Hodgson and Seraj, 2000). Although the target group of these published materials is the educated section of the population, the main concepts and technological solutions discussed in these books may very well be extended to the grassroots level in Bangladesh by suitably translating extracts into Bengali. The book by Hodgson and Seraj (2000) is different from the proceedings because it is intended to provide tertiary level lecturers with resource material for presentation, outlining the parameters which govern technology transfer at the grassroots. Again, few mainstream engineering courses can afford the time to devote to this subject; it is expected that the materials produced might be found useful when delivered as part of general or introductory courses to undergraduates students of building related fields in developing countries.

4.3 Graphical Representation of Technical Concepts

Since drawings and photographs communicate more effectively than written documents and research articles in a non-literate context, it is quite important to produce appropriate dissemination techniques which utilise visual messages.
Figure 4.1: Covers of the Books Produced Under the BUET-Exeter Link
Colourful leaflets embodying building for safety messages may play a vital role in bringing simple technological solutions to the doorstep of the users. Such an attempt was undertaken by Seraj and Hodgson (2000a) by printing nine colour leaflets, showing and explaining ideas which could be used for making a rural non-engineered house stronger. In Figure 4.2, these leaflets have been reproduced in grey-scale. Here, the top portion depicts the house design improvement technique, and the lower part shows the corresponding inappropriate design and construction method to be avoided in practice. These leaflets, although drawn in the context of Bangladesh, could be equally relevant in other hazard-prone areas.
Painting bottom of the post is most important

To slow down the decay of the bamboo post treat them with burning and paint with alcatra or soak them in oil as shown on Leaflet 2. The decay is worst near ground so at least treat the bottom 1m before putting the pole into the ground. Make sure that at least 200 mm of the treated pole remains above ground so that ants and rain water cannot affect it. The poles should be repainted every year for the longest life.

This is only one way of making your house stronger. Other leaflets show more ideas which may also be used.
Without protection, rot and insects can easily destroy bamboo posts and the house will fall down. To protect the bamboos, scorch them over a fire to drive out the sap. Insects eat sap so they will not like the pole so much after that. Then you can either paint the bamboo with alcatra or soak it in old engine oil for 24 hours. The bamboo should be repainted every year for longest life.

This is only one way of making your house stronger. Other leaflets show more ideas which may also be used.
DIAGONAL BRACINGS MAKE YOUR HOUSE STRONGER

You can make your house frame many times stronger by adding diagonal pieces of bamboo in the walls and at corners. This is most important in the end walls. This stops the house from falling over when the wind blows or when the posts have rotted. Bamboos split in half can be used for this. The small extra cost is soon balanced by savings in costs of rebuilding the house.

_This is only one way of making your house stronger. Other leaflets show more ideas which may also be used._
TIE THE JOINTS WITH WIRE TO STRENGTHEN

Jute or grass ropes stretch and break easily, allowing your house form to come apart. The house corners are most important. When these break, the roof may easily be blown away. To strengthen the corners, use several pieces of G.I. wire twisted together to tie the walls and roof. This will help to keep the house still and the other ropes will last longer, too. If possible tie all joints with wire.

*This is only one way of making your house stronger. Other leaflets show more ideas which may also be used.*
RAISING THE FLOOR ABOVE THE FLOOD

Make sure that your house plinth is high enough to make your floor above expected flood level. You can mark flood levels on trees to remind you. If your house is in a place where floods happen often then you can make the mud stronger in several ways (see Leaflet 9).

This is only one way of making your house stronger. Other leaflets show more ideas which may also be used.
USE TREES TO REDUCE THE WIND STRENGTH

The wind can more easily destroy your house if it is in an open place. You can protect your house by planting trees nearby.

This is only one way of making your house stronger. Other leaflets show more ideas which may also be used.
A SMALL WINDOW IN THE BACK OF YOUR HOUSE MAY REDUCE THE CHANCE OF YOUR ROOF GETTING LIFTED IN WIND

Without the window, the wind can make pressure inside the house and blow away the roof.

This is only one way of making your house stronger. Other leaflets show more ideas which may also be used.
If the houses in a village are put in straight, parallel rows, the wind is forced between them and its speed becomes greater. It is, thus, better to make houses in compounds with trees between to avoid this problem.

This is only one way of making your house stronger. Other leaflets show more ideas which may also be used.
Plinths of mud walls are often weak because they crack and the cracks allow water to enter and soften the mud. You can strengthen mud walls and plinths in several different ways:

- Use less water in the mud. There will be less cracking.
- Add rice husk or chopped straw. The fibres will reduce the cracks and strengthen the mud.
- Add up to one part of cement to every 25 parts of mud to make the mud resistant to floods.

Other ways are being investigated.

This is only one way of making your house stronger. Other leaflets show more ideas which may also be used.
In rural Bangladesh, village song teams often perform at weddings and other social gatherings. The skills of those singers may be utilised effectively for disseminating information related to various development issues.

Seraj and Hodgson (2000b) implemented the idea of technological information dissemination by producing a 17-minute, professionally created, video presentation containing three baul songs explaining building for safety ideas. Figure 4.3 shows the baul song team performing in a village. The lyrics of these songs are given in Figure 4.4.
Figure 4.4 Lyrics in Bangla of the Baul Songs in the Dissemination Video Produced Under the BUET-Exeter Link
Secure shelter which protects the family against its environment is universally recognised as a basic right for all. Despite decades of research, many millions of low income families remain at the mercy of winds, floods, earthquakes and other natural forces. Nowhere is this more so than in Bangladesh.

In this situation, it is important to find ways to communicate technical knowledge to the grassroots where it is needed most, and the Baul Song Video is an attempt to do so. 'Bauls' are traditional village singers that communicate spiritual and other messages to a large rural audience. This tradition was utilised to disseminate building for safety messages.

In the songs of the Baul Song Video, printed in Bangla above, several methods for making stronger rural houses have been suggested. It is anticipated that the proposed hazard-resistant technologies are appropriate, affordable and implementable by rural Bangladeshi homeowners and craftpersons who are predominantly poor. The small extra cost that some of these techniques may involve is expected to be balanced by saving in costs of rebuilding the house. The Video is the product of a Higher Education Link between the Bangladesh University of Engineering & Technology and the Housing & Hazards Group based at the University of Exeter, UK.
4.3.3 Calendar and Pocket Calendars

People often tend to forget the miseries of past hazards. Therefore it is important to remind people of information related to affordable, appropriate and implementable hazard-resistant house building solutions. One of the ways of reminding people regularly is by means of yearly wall and pocket calendars. Figure 4.5 shows a page of a calendar for year 2001. This calendar showed both Bengali and English months for wider acceptability. Figure 4.6 shows pockets calendars for the year 2003 having four different messages for building safer non-engineered houses.

Figure 4.5: English-Bengali Wall Calendar Produced as Dissemination Material
Figure 4.6: Pocket Calendars Each with a Building for Safety Message
4.3.4 Website  

In this age of increased information and communication networks, the internet plays a vital role in disseminating information across the globe. The website www.HazardResistantHousing.com (see Figure 4.7 for a view of the homepage) has been launched to facilitate networking and to assist people in other hazard-prone areas. The website contains information pertaining to hazard-resistant construction and strengthening of non-engineered structures.

![Figure: 4.7 Page from the Website www. HazardResistantHousing.com](image)

4.3.5: Mass Media  

The newspaper, radio, television and other arms of the mass media may be utilised effectively for communicating and disseminating building for safety messages. Among several other exposures to the mass media, the UK-based BBC Radio 4 produced a program titled CONNECT: The House on the Rock on November 13, 2002. In this program the presenter discussed with BUET and Exeter academics what science and engineering could offer people whose houses are built in hazardous regions. Apart from producing this informative program, BBC Radio 4 displayed relevant information and images on its website (see Figure 4.8).
There’s no place like home. But millions of people around the world live in the almost certain knowledge that theirs will be destroyed at an unknown time in the future by a natural hazard. Extreme events such as cyclones, floods, earthquakes and fires leave hundreds of millions of people homeless every year. Many of the climatic events are increasing in frequency and population growth coupled with migration towards coastal economic centres is causing many more people to become vulnerable. In this episode of Connect Quentin Cooper asks what science and engineering can offer people whose houses are built in some of the most hazardous places on earth.

4.3.6 Training Programmes

Training programmes targeted specifically for organisations and persons active in the field serve as an effective vehicle for disseminating research findings so that they find their way into practice. Academics from BUET and Exeter University have been running training workshops to build capacity of staff members of grassroots-based organisations and to thus extend knowledge beyond the confines of their premises. A workshop series, consisting of three workshops, was run in Dhaka during 2000. Two of the workshops were held in collaboration with important Bangladeshi organisations - the Grameen Bank and Proshika. Great interest was expressed by many people from a variety of organisations and important links were made. This was carried over to a capacity building workshop for grassroots workers in a rural area of Dinajpur district, resulting in a stabilised mud-walled village house built by using ideas developed at BUET and Exeter.
building workshops have also been run for BRAC (Bangladesh Rural Advancement Committee) staff members, which have resulted in workshop participants implementing building for safety methods in houses built through their programmes in northern Bangladesh. In the rural workshops, 'hands-on' construction sessions on stabilised mud construction and bamboo/thatch treatment were an essential ingredient, allowing office-based staff members to gain understanding on the application of these methods in actual conditions (Figure 4.9).
It is very important to keep a detailed record of all technological achievements and failures in order to contribute to future work and to avoid repetition. In addition to serving as a record, all the publications and other products described above were also produced as dissemination materials, to serve as useful documentation for future reference. Visual documentation is particularly effective for record-keeping, dissemination and as educational resources, such as the videos (Figure 4.10) produced by Amanat (2002) on Wind Tunnel Tests and by Ahmed (2002) on Participatory Action Research. These materials are expected to have long-term educational and practical value for future researchers and end-users.

Figure 4.10: Video Documentation Produced Under the BUET-Exeter Link

4.4 Guidelines for Dissemination of Research Findings

Lack of dissemination of potentially effective technologies is a problem. Technologies designed by professionals or in research institutions, quite often technically sound and tested rigorously may result in cost effectiveness if implemented. However, comparatively few have achieved widespread impact and social acceptance. There is little detailed research on aspects of social success or post-project performance. For example, in Bangladesh mud houses are greatly susceptible to hazards such as floods, particularly in areas with unexpected floods, such as in the southwestern region in year 2000, where many mud houses collapsed or were severely damaged. Building with cement/lime stabilised earth may help to overcome this collapse. The national House Building and
Research Institute (HBRI) has undertaken extensive research into improvements to mud structures, but very few examples of application in the field or dissemination of research findings exist.

There are tremendous challenges involved in research dissemination and is a field demanding greater attention and more extensive study. Yet some simple and basic guidelines can be suggested here:

- Any increase in cost, even slight, meets resistance from poor communities who survive on subsistence incomes. Technologies clearly have to be combined with access to funds. The Grameen Bank's rural housing programme demonstrates the potential for such a course.

- Poor communities, especially those in vulnerable situations and exposed to hazards, are reluctant to take risks with new and unfamiliar technologies. Therefore, demonstration through pilot projects is needed. New technologies used in institutional or community buildings often convince local communities of their merits. In a housing project in Zambia, for instance, it was initially conceived that machine-pressed stabilised earth blocks were for use for house building, and blocks were made available to project beneficiaries. However, they did not prefer the blocks, which were then used in building a school. This highlighted their effectiveness and attractiveness; local households then began using them for their houses (Goethert, 1990).

- Rural development programmers run by agencies need to be supplemented by research institutions, leading to a two way process. Feedback from the field enhances the work of research institutions and field-based agencies benefit from the expertise of research institutions.

- Agencies working in the field need to connect to relevant existing bodies of information. For example, improved construction technology with bamboo and mud developed in Central America and India could have relevance to Bangladesh. International linkage may have much to offer.

- Support to extension workers through manuals, books and instruction sheets on construction methods prepared by professionals or academics may be useful. Such literature should be prepared in local language, with culturally comprehended pictorial matter for effective
communication. Mass or popular media may also utilise these methods. Documents in a technical language that confines it to experts is not useful; they have to be translated into simple, easily comprehensible form for rural populations.

- Post-project evaluation with surveys of user needs is a necessary component of applied research and also provides an opportunity to assess receptiveness of communities to new technologies. This would encourage community participation and assist in understanding the potential for acceptability at the community level.

- Dealing with natural hazards is linked to a wider set of social, cultural, economic and environmental issues; technological innovation has to be understood with respect to these. Technologies that appear sound are useful only if they able to reach the community and contribute to aspirations that the community has.
Building Safer Houses in Rural Bangladesh

Salek M. Seraj and K. Iftekhar Ahmed
Contents

Preface 01

Foreword 04

1. Context of Housing and Hazards 06

1.1 Introduction 06

1.2 Design, Construction and Building for Safety 07

1.2.1 Types of Natural Hazards 08
1.2.2 Natural Hazards in Bangladesh 09
1.2.3 Impacts of Hazards on Housing 09
1.2.4 Review of Present Situation in Bangladesh 09
1.2.5 Government Policy 10
1.2.6 Engineered Housing 10
1.2.7 Non-Engineered Housing 11
1.2.8 Housing in Flood-Prone Areas 13
1.2.9 Post-Construction Repair and Retrofitting 14
1.2.10 Mud-Walling Technologies: Some Notes 14
1.2.11 Bamboo and Thatch 15
1.2.12 Improved Structures 15
1.2.13 The Way Forward 16

1.3 Some Key Issues in Building for Safety 16

1.3.1 Risk Assessment 17
1.3.2 Building for Safety 17
1.3.3 Effective Training 18
1.3.4 Community Based Programmes 18

1.4 Low-Income Housing Pattern 20

1.4.1 Method of Study 20
1.4.2 Questionnaire 20
1.4.3 Data Collection Area 21
1.4.4 Analysis 21
1.4.5 Housing Pattern 22
1.4.6 Implications 24

5 Rural Housing Typology, Construction Technology and Indigenous Practices
1.5.1 Rural Housing in Bangladesh 26
1.5.2 Some Important Characteristics 27
1.5.3 Design Process 27
1.5.4 Housing Layout 28
1.5.5 House Form 31
1.5.6 Amenities and Services 31
1.5.7 Construction Materials and Technology 32
1.5.8 Rural House Types 33
1.5.9 Bamboo Walled Houses 33
1.5.10 Mud Walled Houses 34
1.5.11 Timber Houses 34
1.5.12 Timber and Brick Houses 35
1.5.13 Corrugated Iron (CI) Sheet Houses 36
1.5.14 Thatch/Straw Houses 37
1.5.15 Indigenous Practices in Rural Housing 37
1.5.16 Prospects 39

6 Role of Women in Rural Housing
1.6.1 Objectives of the Study 41
1.6.2 Methodology 42
1.6.3 Analysis of Findings of the Study 42
1.6.4 Interval and Involvement of Family Members in Construction, Repair and Maintenance 43
1.6.5 Sources of Funds and Types of Problems Faced by Women During Construction, Repair and Maintenance 44
1.6.6 Women's Contribution 45

1.7 Bamboo Cultivation and Rural Housing
1.7.1 Scarcity of Bamboo 47
1.7.2 Redressing Bamboo Scarcity 51
1.7.3 Bamboo Research—Stage 1 51
1.7.4 Bamboo Research—Follow-up 52
1.7.5 Need for Initiatives 53
## CONTENTS

### 1.8 Ethnic Housing Pattern in the Chittagong Hill Tracts

1.8.1 Socio-Cultural Aspects of the Ethnic Population 54  
1.8.2 Worldview, Rituals and Housing 55  
1.8.3 Land System 56  
1.8.4 Settlement and Housing Pattern 56  
1.8.5 Building Technology 58  
1.8.6 Aesthetics 60  
1.8.7 Usage of House 60  
1.8.8 Adaptive Value 60  
1.8.9 Other Housing Typologies 61  
1.8.10 Importance of Ethnic Housing 62

### 2. Building Technologies for Hazard Resistant Housing

2. Introduction 64

2.2 Hazard Resistant Rural Houses

2.2.1 Development of Durable Plinth 65  
2.2.2 Common Failure Modes and their Prevention 68  
2.2.3 Properties of Bamboo as a Framing Material 70  
2.2.4 Full Frame under Cyclic Lateral Load 72  
2.2.5 Future Directions 75

2.3 Cyclone-Resistant Domestic Construction

2.3.1 Improved Domestic Construction for Cyclone Resistance 77  
2.3.2 Hazard Class 78  
2.3.3 Wind Risk Areas 79  
2.3.4 CGI Roofing 79  
2.3.5 Improved Traditional Construction 80  
2.3.6 Siting and Layout 80  
2.3.7 Plinth 80  
2.3.8 Frame 81  
2.3.9 Walls and Openings 81  
2.3.10 Roof 81  
2.3.11 Survival of Cyclone-Resistant Kutchta Construction 81  
2.3.12 Tree Planting 82  
2.3.13 Improved Pucca Construction 82
2.3.14 Implementing Improved Domestic Construction 84
2.3.15 Promulgating Improved Construction Technology 84
2.3.16 Future Directions 85

2.4 Building Design for Disaster Management 86
2.4.1 Community-Based Multipurpose Cyclone Shelters 86
  2.4.1.1 Organisational System 86
2.4.2 Cyclone Resistant Housing 88
2.4.3 Graphical Presentation of Social Survey 88
  2.4.3.1 Physical Survey of Selected Houses 89
  2.4.3.2 Architectural and Structural Details of Houses 89
  2.4.3.3 Technology Intervention in House Building 91
2.4.4 Specific Case of Technology Intervention 91
  2.4.4.1 Transformation of the Wind Resistant Hut 91
2.4.5 Building Materials 93
2.4.6 House Typology 93
2.4.7 Case Study: House that Survived 94
2.4.8 Preservative Treatment of Traditional Building Materials 94
2.4.9 Construction Techniques, Structural Components and Details 95
2.4.10 Guidelines for Cyclone Resistant Houses 95
  2.4.10.1 Layout and Orientation 95
  2.4.10.2 House Plan 95
  2.4.10.3 House Roof Shape 95
2.4.11 Social, Economical and Environmental Considerations 96
  2.4.11.1 Socio-Economic Problems 96
  2.4.11.2 Environmental Problems 96
2.4.12 Indigenous Building Materials 96
  2.4.12.1 Bamboo and Wood 96
2.4.13 Steel Sections and Pre-Cast Concrete Members 97
2.4.14 Foundations 97
2.4.15 Flooring 97
2.4.16 Walls 98
2.4.17 Roof Structure and Cladding 99
### 2.4.17 Roof Structure
- 2.4.17.1 Roof Structure 99
- 2.4.17.2 Roof Cladding 99
- 2.4.17.3 Fixing of C.I. Sheet Roofing 99

### 2.4.18 Construction Technologies for Wind Resistance 100

### 2.5 Effect of Wind on Rural Housing 102
- 2.5.1 Experimental Setup and Description of Models 103
- 2.5.2 Description of Windbreaks 105
- 2.5.3 Measurement of Wind Force 106
- 2.5.4 Measurement of Wind Speed 107
- 2.5.5 Boundary Conditions 107
- 2.5.6 Experimental Results 107
  - 2.5.6.1 Effect of Wind Incident Angle 107
  - 2.5.6.2 Effect of Presence of Verandah 109
  - 2.5.6.3 Effect of Windbreaks 111
- 2.5.7 Summary Study in the Wind Tunnel 113

### 2.6 Selection of Post-Disaster Shelter 114
- 2.6.1 Plastic Sheet-Bamboo (Shelter Option S1) 115
- 2.6.2 Canvas Tarpaulin (Shelter Option S2) 115
- 2.6.3 Permatent Shelter (Shelter Option S3) 116
- 2.6.4 Canvas Tents (Shelter Option S4) 117
- 2.6.5 C.I. Sheet-Bamboo (Shelter Option S5) 117
- 2.6.6 Thatch Bamboo (Shelter Option S6) 118
- 2.6.7 C.I. Sheet Wood-Bamboo-RC/PC Columns (Shelter Option S7) 118
- 2.6.8 All PC Dryland Model (Shelter Option S8) 118
- 2.6.9 Plastic Sheet only (Shelter Option S9) 119
- 2.6.10 C.I. Sheet only (Shelter Option S10) 120
- 2.6.11 C.I. Sheet-Steel Truss (Shelter Option S11) 120
- 2.6.12 LGED Model 10A (Shelter Option S12) 120
- 2.6.13 LGED Model 10E (Shelter Option S13) 120
- 2.6.14 Governing Factors 120
- 2.6.15 Quality Factor 121
- 2.6.16 Cost Factor 121
- 2.6.17 Methodology for Evaluating Options 122
- 2.6.18 Weightage of Quality Factors 122
- 2.6.19 Relative Quality Scoring 123
- 2.6.20 Value for Money (VfM) 124
- 2.6.21 Ranking of Shelter Options 124
2.6.22 Discussion of Results 127
2.6.23 Value for Money Index 129

2.7 Improving Rural Housing In Bangladesh 130
2.7.1 Population Increase 130
2.7.2 Ratio of Kutcha to Pucca Construction 130
2.7.3 Forces of Nature 130
2.7.4 Regional Vulnerabilities 131
2.7.5 Economic Forces 132
2.7.6 Disaster Preparedness Provisions 133
2.7.7 Appropriateness of Improvements 133
2.7.8 The Emergency Period 134
2.7.9 Dissemination of Knowledge 134
2.7.10 Timescale for Change 137
2.7.11 Funding 138
2.7.12 Proposed Strategy 138
2.7.13 Proposed Alternative Housing Programme 139
2.7.14 Need for Change 141

3. Implementing Hazard-Resistant Housing 142

3. Introduction 142

3.2 Affordable Financing for Housing 143
3.2.1 Affordable Improvements to Housing 144
3.2.2 Lowering the Cost of Building Materials 144
3.2.3 Making Finances Available to People with Low Affordability 145
3.2.4 Creating Financing Institutions for the Rural Population 145
3.2.5 Providing Hazard Safe Housing through Government Initiatives 146
3.2.6 Making Solutions Effective 147

3.3 Rural Housing Initiatives by Development Agencies 148
3.3.1 The Present Scenario 148
3.3.2 Purpose of the Study 149
3.3.3 Proshika Palli: A Case Study 150
3.3.4 Beneficiary Selection 150
3.3.5 Site Selection and Location 151
3.3.5.1 Land Value 151
3.3.5.2 Preparation of Land 151
## CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3.5.3</td>
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### 3.4 The Housing and Hazards Workshop Process

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### 3.5 Implementing Building for Safety in Dinajpur

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<td>3.5.13</td>
</tr>
<tr>
<td>3.5.14</td>
</tr>
<tr>
<td>3.5.15</td>
</tr>
</tbody>
</table>
3.5.16 Corrugated Iron Sheet 190
3.5.17 Incremental Construction 190
3.5.18 Homestead Form 191
3.5.19 The Housing Process 191

3.6 Implementing Building for Safety in Gopalganj 192
3.6.1 Conceptual Framework 192
3.6.2 Methodology 193
3.6.3 Building-for-Safety (BFS) Options used in Demonstration Houses 197
   3.6.3.1 Cement Stabilised Mud Plinth 197
   3.6.3.2 Hollow Concrete Stump (Katla) 198
   3.6.3.3 Bamboo Treatment 198
   3.6.3.4 Painting Walls with Bitumen 199
   3.6.3.5 Cross-Bracing 199
   3.6.3.6 Rainwater Gutter 199
3.6.4 Monitoring 199
   3.6.4.1 Demonstration House Condition 200
   3.6.4.2 Local Perception and Future Prospects 201
   3.6.4.3 Vulnerability Reduction 202
3.6.5 Observations 202

3.7 Review of Participatory Practice 204
3.7.1 Participation in the Bangladeshi Context 205
3.7.2 Participation: An Exogenous Concept? 207
3.7.3 Context-Specific Participatory Development 208
3.7.4 A Case for Participation 209
3.7.5 Search for New Directions 210

4. Dissemination of Building for Safety Messages 211

4.1 Introduction 211
   4.1.1 Non-Governmental Organisations (NGOs) 211
   4.1.2 National Legislators 211
   4.1.3 Technical Professionals 212
   4.1.4 Local Government Administrators 212

4.2 Educating Decision-Makers and Technical Personnel 212
4.3 Graphical Representation of Technical Concepts
   4.3.1 Leaflet Series  215
   4.3.2 Baul Song Team and Video  225
   4.3.3 Calendar and Pocket Calendars  228
   4.3.4 Website  230
   4.3.5 Mass Media  230
   4.3.6 Training Programmes  231
   4.3.7 Long-Term Impact  232

4.4 Guidelines for Dissemination of Research Findings

References
A safe, sound and healthy house, which safeguards its inhabitants from the adverse effects of natural forces and calamities, is recognised universally as a basic human right. During the last few decades, substantial amount of research has been carried out on developing hazard-resistant housing. Despite these earnest efforts, millions of low-income families, especially in developing countries such as Bangladesh, still remain at the mercy of cyclones, floods, earthquakes and other natural hazards. It is not the lack of available technological or engineering solutions, but the sheer absence or lack of affordability of the poverty stricken majority of the population that make them vulnerable to natural hazards, which they encounter almost on a regular basis. Consequently, what would otherwise have been termed as a hazard in a developed scenario, reaches the news-stands as disasters in an underdeveloped context. As a matter of fact, as with cyclones, floods and earthquakes, poverty is also a disaster in the developing world.

Bangladesh University of Engineering and Technology (BUET) and the University of Exeter, U.K., have been informally collaborating since 1996 to conduct practical research into affordable technologies that could help those most in need of secure homes. Between 1998 and 2002, the UK Department for International Development (DFID) funded various activities of the higher education link (HEL) established between these two institutions. The partnership has supported laboratory and field studies, resulting in improved understanding of natural and local building materials, behaviour of non-engineered rural construction, process of low-income home procurement, and socio-economic aspects of low-income housing. During the course of this collaboration, it was attempted to raise awareness of housing issues among professionals and decision-makers through international seminars and national workshops. Participatory dissemination techniques have also been developed,
which are appropriate for rural communicators and can be utilised at village level workshops.

The book Building Safer Houses in Rural Bangladesh is a direct outcome of the DFID funded link, which had the same title. It addresses various housing issues with the understanding that to be effective, technological improvements must be appropriate, accessible, available and, above all, affordable. This book has been divided into four chapters entitled ‘Context of Housing and Hazards’, ‘Building Technologies for Hazard Resistant Housing’, ‘Implementing Hazard Resistant Housing’, and ‘Dissemination of Building for Safety Messages’, which as the titles suggest, cover the salient aspects of the subject.

While drafting the book, the authors have extracted liberally from the papers of various researchers that were included in one or more of the three conference proceedings edited and published under the BUET-Exeter link. The authors of this book gratefully acknowledge the contributions of co-writers of various sections, whose research endeavours and fruitful discussions during the writing of this book, helped in shaping this edition. The co-writers of various sections of this book, shown in parentheses after their names, are as follows: J. R. Choudhury (1.2); I. Davis (1.3); M. Hossain (1.4); M. Hasan, M. S. Ullah and C. D. Gomes (1.5); M. A. Alam and M. Hasan (1.6); I. Rasul (1.7); Z. Islam, N. Akter, M. Z. Hossain and N. Akter (1.8); U. K. Roy, P. S. Roy, M. S. Alam and S. Saha (2.2); J. Lewis and M. P. Chisholm (2.3); B. Haq (2.4); K. M. Amanat and R. L. P. Hodgson (2.5); T. M. Al-Hussaini, M. K. Islam, A. M. M. Safiullah and J. R. Choudhury (2.6); M. P. Chisholm (2.7); R. Hafiz (3.2); Y. Ara and R. Kabir (3.3); S. A. M. Magne (3.4); R. L. P. Hodgson and M. L. Carter (3.5); K. H. Kabir (3.7); R. L. P. Hodgson (4.1).

The authors are indebted to Dr. R. L. P. Hodgson of the University of Exeter, who jointly coordinated the HEL along with Dr. S. M. Seraj of BUET. Dr. Hodgson was very active in various stages of the HEL and also authored and co-edited various publications that resulted during the HEL. Dr. Hodgson also acted as an inspiration towards writing this book. Prof. J. R. Choudhury, Vice-Chancellor of BRAC University and an international expert on hazard-resistant design, guided the authors in the right direction and was always a source of encouragement. Prof. Choudhury’s contribution is gratefully acknowledged. The past Vice-Chancellors of BUET, Prof. Iqbal Mahmud and Prof. Nooruddin Ahmed supported and personally patronised the link activities. We thank them very much for their
highly positive role. The present Vice-Chancellor of BUET, Prof. Md. Alee Murtuza has also been very supportive and has inspired the authors with his foreword to this book. We highly appreciate his gesture. The authors are indebted to many colleagues, who throughout the years have encouraged them in conducting research on building safer houses, as well as in writing this book. Among many, mention must be made to Professors S. Ahmad, M. S. Z. Bosunia, A. M. Hoque, M. F. Ahmed, A. M. M. Safiullah, M. H. Ali, M. A. Rouf, M. M. Hoque, Sk. S. Ali, M. M. Rahman, I. Ahmed, K. Enam, F. H. Mallick, Dr. M. A. Ali and Mr. M. Z. Islam. Lastly, the authors wish to express their appreciation to Ms. Tayyeba Nasir and Ms. Sangeeta Barua of the British Council, Dhaka for sincerely taking care of the administrative details of the link between BUET and Exeter, and to Mr. Ariful Rahman and his team at Progressive Printers for patiently and painstakingly accommodating the publication process and for the quality of printing of this volume. Most of the existing housing and the majority of the houses which are going to be built in the near and distant future in the developing world are likely to be non-engineered. Spiralling house rebuilding costs as well as the poverty trap are expected to dominate the housing scenario of the predominantly poor millions of people around the world. The present endeavour cannot, perhaps, even touch the tip of the iceberg. The authors would be happy as long as this book keeps the vision of building safer houses alive, which may trigger small, but meaningful changes. Although this book has been written in the context of Bangladesh, it is expected that its contents should be relevant in other hazard-prone areas of the world.

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Foreword

As I write this foreword, more than one billion people of the world continue to live in a state of severe poverty, at a level where they are unable to meet their basic needs of food, clothing, shelter, education, health care, clean water and sanitation. Even though it is widely accepted that only through fulfilling these basic human needs, the security of an individual can be ensured, apparently most of our efforts continue to respond to emergencies with short-term humanitarian assistance. The most logical question that needs to be asked and answered honestly is also the question that is being pushed under the rug: Which is of greater importance to humanity – crisis management or long-term poverty alleviation?

The need for a protected shelter cannot be overemphasised. Good housing conditions are usually considered as preconditions for health and well-being. Family and culture are nourished upon the safety of a house – people habitually call this their home. Unfortunately, a very large number of people of this world are denied a secure home due to poverty, natural calamities and human conflicts. Nowhere is this truer than in the so-called developing countries of the world. Although the new millennium of globalisation is opening up new doors of opportunity to the privileged few of the world, unfortunately most poor people are either remaining poor or becoming poorer, and in many cases, totally destitute. As a result, millions of low-income families remain at the mercy of winds, floods, earthquakes, fires and other natural and human-induced hazards. The story is almost the same everywhere. Proper housing which is strong enough to counter the effects of natural forces remain beyond the economic capacity of the poor. Available technological solutions are expensive and often incomprehensible to ordinary people. What can be deemed essential is to ensure grassroots participation and empowerment, local capacity-building and adoption of concerted poverty reduction strategies, thereby achieving better knowledge
and understanding of local context and promoting an enabling macro-economic and political environment. This is a tall order: easier said than implemented.

In their book Building Safer Houses in Rural Bangladesh, Professor Dr. Salek Seraj and Dr. Iftekhar Ahmed have gone into details of the precarious housing situation that exists in rural Bangladesh and have suggested appropriate and affordable ideas that could perhaps bring positive change within this existing situation. This book is a valuable compilation relevant to the situation of the hazard-vulnerable population of rural Bangladesh. Founded on a thorough treatise of the context, locally appropriate concepts for building hazard-resistant housing and methods for their implementation and dissemination have been elaborated upon. This book starts with an in-depth description of the context of housing and hazards. It is, indeed, a valuable compilation of relevant information, subsequently allowing to suggest in the book locally appropriate technological concepts for building hazard-resistant housing for the disadvantaged section of the community, as well as methods for their implementation in the field. At the end, suitable dissemination techniques have been elaborated upon. I am confident that the contents of this book will inspire further studies in this field. I certainly feel that the ideas described in this volume can be suitably adapted in other parts of the world. I hope this book will be a valuable source of information and contribute towards bringing improvements to the housing situation of the poor.

Professor Dr. Md. Alee Murtuza
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Dhaka, April 2004
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