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DISASTER MANAGEMENT IN BANGLADESH: AN ARCHITECT'S INVOLVEMENT

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Introduction

Bangladesh is prone to Disasters like Flood, Tropical cyclone, Storm surge, Tornado, River bank erosion, Earthquake and Arsenic. The country is particularly vulnerable to approximately 95% of the world's 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. The management practice and modes of implementation are undertaken without due considerations to community dynamics, perceptions and priorities. Questions are being raised for in-depth probe as to a) how do the affected people deal with disasters, b) whether these people are just passive victims, and vulnerable beneficiaries of relief, c) the existence of coping mechanisms, developed historically by the people, on which interventions for disaster management can be planned for a more sustainable management of disaster. This paper includes the following 2 (Two) projects, built in the cyclone affected areas of Cox's Bazar.

COMMUNITY BASED MULTIPURPOSE CYCLONE SHELTERS by Development Association For Self Reliance, Communication and Health (DASCOH).

BATTLING THE STORM- STUDY ON CYCLONE RESISTANT HOUSING by Community Based Disaster Preparedness Programme, Bangladesh Red Crescent Society / German Red Cross. Published by German Red Cross (A Registered Project of the world exposition, Germany)

COMMUNITY BASED MULTIPURPOSE CYCLONE SHELTERS. 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 Organisation System in order to overcome these problems.

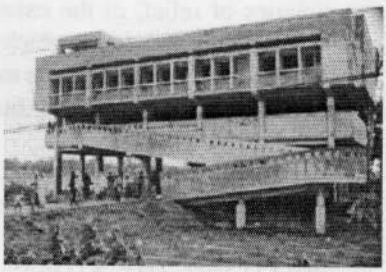
Organisation System Of DASCOH

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 was 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 CMCS's.

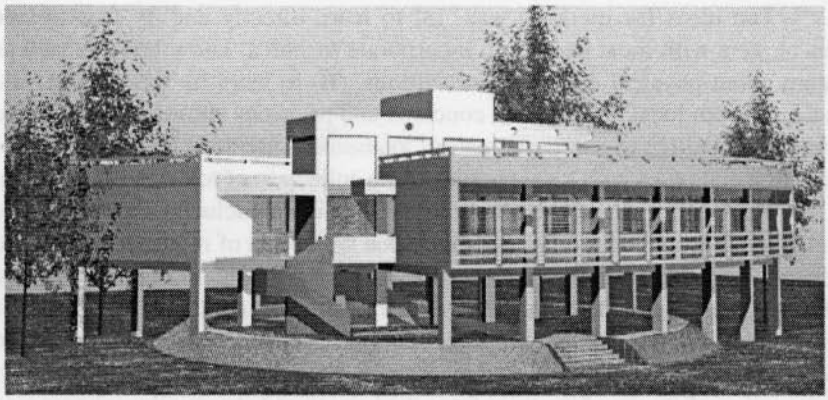
DASCOH undertook a feasibility study by engaging a Swiss engineer for the project. The engineer undertook a survey and assessment of existing and planned cyclone shelters.The final assessment adjusted the shelters by Prism Bangladesh to be the most appropriate design as it was considered harmonious, original and well suited for the project areas selected by DASCOH. Our firm (Bashirul Haq & Associates Ltd.) designer of the shelters built by Prism Bangladesh, was chosen to be the architect for DASCOH's project. The requirements of the shelter are stated below

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.



Community Development Center and Cyclone Shelter Prism, Bangladesh

The architectural programme and the imagery of the boat left in my unconscious from the memory of having seen boat building activities in the vicinity of the selected sites together evolved into an architectural solution presented below.



Cyclone Shelter For Development Association For Self-reliance, Communication & (DASCOH), Bangladesh

BATTLING THE STORM STUDY ON CYCLONE RESISTANT HOUSING

It is common knowledge that cyclone destroys a considerable number of houses in the cyclone 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. Alternately, if we could identify indigenous technology, shared knowledge of the communities in home building which has been effective in cyclone resistance and combining local knowledge with easily applicable intervention o f appropriate technology might be able, in our view, to contribute towards a mitigation of the destruction of houses. With this objective German Red Cross initiated a survey and study through us which resulted into a published report titled BATTLING THE STORM- STUDY ON CYCLONE RESISTANT HOUSING. This study was conducted in six different locations of Cox's Bazar at Dangorpara, Chandalipara, Nayapara, Miajipara and Majherpara.

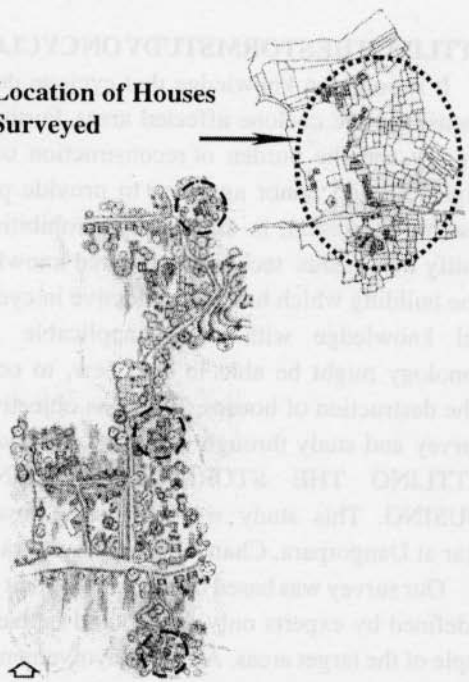
Our survey was based on the premise that problems in housing should not be defined by experts only, but should be based on the dialogue with local people of the target areas. A direct involvement of the local people in problem identification was ensured, so local perceptions, attitude, values, shared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

The ideas (or method) was (a) to learn directly and by face-to-face encounters with local people, to incorporate technical know-how, as well as 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 collection and review of secondary sources (this included collection of mouza, upazilla and district maps). Preparation of questionnaire, Diagrams and Scoring Cards. These tools were used to ascertain wealth ranking and identity of house owners in order to prepare social mapping. We used scoring cards in our survey to identify options, work ability and preferences of people's perceptions in safety, orientation, distance of the trees from the houses and structural weaknesses in the traditional houses.

GRAPHICAL PRESENTATION OF SOCIAL SURVEY

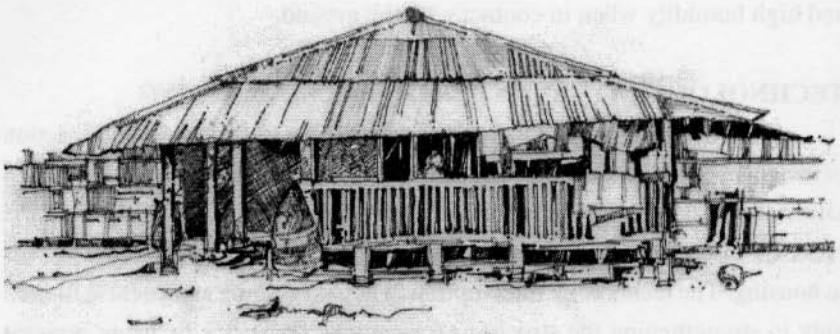
This part of the survey is a graphical presentation of social mapping, location of selected houses and the identity and wealth ranking of selected house owners. The drawings were prepared with the help of the existing Mouza maps of the study area. This part of the survey enabled us to have an understanding and a feel for the people, place and typology of houses. Presentation of social mapping and location map of selected houses is an example of the Graphical Presentation Of Social Survey at Dangorpara.



Location Map of Selected House

PHYSICAL SURVEY OF SELECTED HOUSES

Monographs of individual houses have been prepared through physical survey, measured drawings, sketches and photographs. Each house has been identified by its owner. The houses were chosen on the basis of findings during the process of survey and preparation of social mapping, wealth ranking and identity of house owners. Presentation below is an example of the Physical Survey of the House belonging to Abdul Jalil at Dangorpara.



ARCHITECTURAL AND STRUCTURAL DETAILS OF HOUSES

The houses we surveyed may 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 a people with a common heritage. Other terms used for these kind of houses are vernacular, anonymous, spontaneous and rural. The builders show an admirable talent of blending the houses with the natural surroundings. The house plan, roof shape and orientation have developed in response to the harsh 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. It is our understanding that 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 ridge of roof, tie between roof structures to vertical support, and the need for extra tie for extended roof overhang. Further, the awareness of builders of the need of

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.

TECHNOLOGY INTERVENTION IN HOUSE BUILDING

A sizeable number of local people are unable to undertake construction of their houses for lack of capital and high cost of building materials; and cannot afford the cost of re-building after a 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 life style of the local people, and this is the cause of rejection by local people of the proto type house that BDRCS introduced in the Cox's Bazar area.

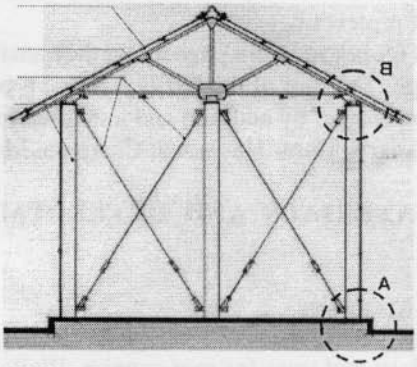
Specific Case Of Technology Intervention

BDRCS with assistance from the International Federation of Red Cross and Red Crescent Societies initiated design and building of a prototype house THE WIND RESISTANT HUT

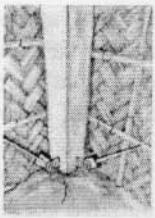
The structure of this house type has pre-cast concrete columns for vertical support, steel truss for roof support and steel rod for bracing between columns, Bamboo mat is used as wall. Problems with this house type is not with the details of anchoring to foundation and jointing details of truss to vertical post, but the use of steel sections for fabrication of truss, roof shape and most importantly the lukewarm response in acceptance by the beneficiary.

CORRUGATED GALVANIZED
SHEET ROFF

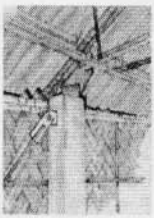
METAL TRUSS
METAL TIE
PRE-CAST CONC, POST



TRANSVERSE SECTION



DETAIL AT A



DETAIL AT B

Transformation Of The Wind Resistant Hut Of BDRCS

Steel sections for fabrication of truss in marine weather require application of properly specified under-coat 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^{O} pitch, where as the recommended gable roof in cyclone affected areas is High Gable roof with pitch between 35^{O} to 45^{O}.The traditional houses in these areas have a 'ghar' surrounded by 'pashchati'. The roof shape of the 'ghar' invariably is hip roof, and the 'pashchati' roof is separated from the

Original corrugated metal roof
of BDRCS'S house type.

Thatch roof added later.

HOUSE OF MONIR HPSSAIN
AT CHAR PARA, MOHESHKHALI

hip roof; and because of this separation, roof of pashchati usually suffers wind damage without affecting the roof of the 'ghar'. Pashchati area, beside creating extra space for entertaining of guest eating, cooking sleeping etc., also acts as a barrier during cyclone accompanied by heavy rain. Further, its low roof creates a sense of protection.

The photograph of the house on this page 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 life style of the beneficiary, Munir Hussain at Charpara, Moheshkhali.

BUILDING MATERIALS AND DEVELOPMENT OF HOUSE TYPOLOGY

Use Of 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 very low or low level of wealth ranking, and wood is used in houses belonging to people of medium level wealth ranking. Technology intervention in house building has introduced steel and pre-cast concrete sections into a few houses in these areas. Use of bamboo as a building material requires a high level of maintenance or frequent replacement because these 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 maybe 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 are already rusting. Steel used in the marine area requires special undercoats and regular maintenance, as we had observed in shelters built in St. Martin's Island, where steel windows have rusted though the years and have almost disappeared due to lack of proper undercoat and maintenance. The pre-cast concrete pillars are used for vertical support in some houses. Quality control of materials and fabrication of the pre-cast concrete pillars are important for strength. During our survey we observed a number of broken and twisted concrete posts in Abdul Jalil's annexe building in Dangorpara, which had failed structurally during the cyclone in 1994. There are examples of innovative use of materials in some houses, like use of a combination of wood, bamboo and pre-cast concrete post in house building.

DEVELOPMENT OF HOUSE TYPOLOGY

Cyclonic storm and high wind seems the most obvious factor in the

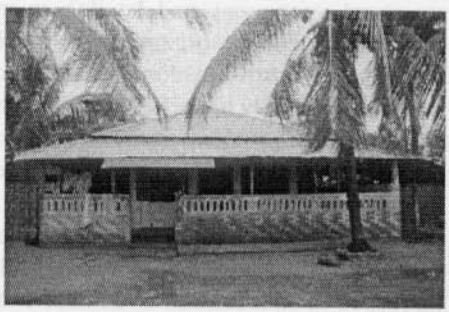
development of the form and shape of these houses. Magnitude of the wind loads on the structure influences the shape of the roof. Experience and experiment have shown that houses with hip roofs have the best record of resistance. During cyclone a large pressure builds up under the overhang, and the pressure added to the suction on the upper roof can pry the roof 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 'ghar'.

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 insufficient weight of these houses when they are subjected to external pressure and suction on the walls during cyclone. This can be improved or even avoided by improving anchoring of vertical support firmly to the foundation. The case study that follows shows how indigenous housing can be modified to withstand harsh climatic conditions.

CASE STUDY : HOUSE THAT SURVIVED THE LAST MOST SEVERE CYCLONE

The worst cyclone in the memory of local people of Dangorpara in recent times was in 1994. During the cyclone of 1994 the house belonging to Abdul Motaleb became a shelter for hundreds of women and children of the surrounding areas, because the 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.

Abdul Motaleb's house is located in an area surrounded by trees and other houses that act as wind breaks. The roof supporting system is fabricated with wood sections of standard quality and size.



ABDUL MOTALEB'S HOUSE

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 post make the house very strong and cyclone resistant. The house is selected as a case study because it is built with local building materials and by a local builder.

PRESERVATIVE TREATMENT OF TRADITIONAL BUILDING MATERIALS - Bamboo, Wood, Sungrass Etc,.

Survey and interviews were conducted by us in order to get information on locally available methods, availability of expertise and above all effectiveness of preservative treatment. Technology availability and its effectiveness for improving and enhancing the durability of use, particularly of bamboo is a very important aspect of the recommendations of the study.

Application of this technology is significant, if we look at the use of untreated bamboo in the houses of our 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. We interviewed experts in Bangladesh Forest Research Institute (BFRI) and Bangladesh Agricultural Research Council (BARC), and gathered information, booklets etc, on the technology developed by BFRI for preservative treatment.

BFRI built a hut using treated bamboo, wood, sun-grass, etc, in 1983. This hut convinced us of 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 building materials of the hut.

CONSTRUCTION TECHNIQUES, STRUCTURAL COMPONENTS AND DETAILS

The purpose of the guide and recommendations on construction techniques, structural components and details is to create an understanding and awareness among local people, organizations involved in house building and the 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, physical and social survey of built houses and architectural and structural details of houses. This section presents weaknesses of construction techniques, structural components and details in the manner in which the houses are built, and recommends solutions and guides to strengthen structural components and details for cyclone resistant houses. 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 house.

RECOMMENDATIONS - GUIDELINES FOR CYCLONE RESISTANT HOUSES ARCHITECTURAL AND DESIGN CONSIDERATIONS

Lay-out And Orientation

Lay-out and orientation of traditional houses, in most cases, the house is orientated in a manner so that the shorter face of the house is towards the windward direction of the cyclone.

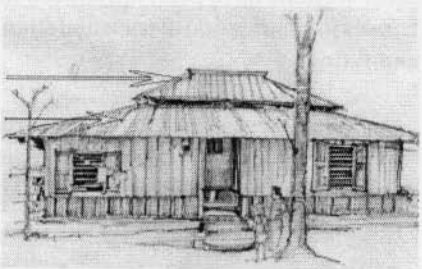
House Plan

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 recommended for cyclone resistant houses.

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 records of resistance during cyclone.



HIP ROOF OVER GHAR
LOW ROOF OVER 'PASHCHATI'

SOCIAL ECONOMICAL AND ENVIRONMENTAL CONSIDERATIONS

Social And Economic Problems

People's perception of problems in housing have been gathered through the survey conducted by us in six different locations of 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.

Environmental Problems

We were able 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.

We believe that a well thought out plan of plantation of trees help reduce the impact of both cyclone and tidal surge. Tree plantation should be undertaken by involving participation of local people in order to select species of trees and location of plants.

COMMENTS ON MATERIALS USED IN INDIGENOUS HOUSES

Bamboo And Wood

Wood and bamboo is extensively used in the construction of indigenous houses. The wood used in most houses are of very poor quality. This results in shrinkage, warpage, making these susceptible 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 for protection against decay, insects, fungi, termite attack, and when in contact with moist ground.

Steel Sections And Pre-cast Concrete Members

Steel Sections

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 salt atmosphere, there is a need for ensuring quality control of materials, proper surface preparation and application of specified under coats. Undercoats Should Be Carefully Selected For Suitability In Marine Weather.

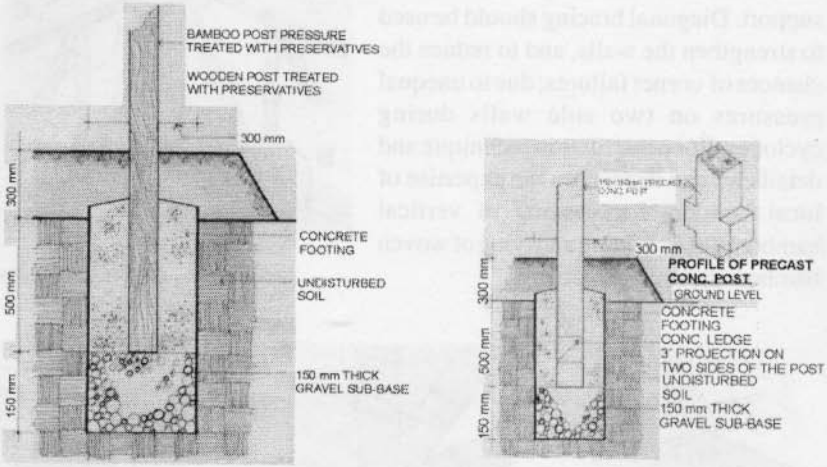
Precast Concrete Sections

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, are 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.

FOUNDATIONS

Bamboo and Wood sections should be selected on the basis of appearance and strength. Bamboo should be treated with appropriate preservatives.

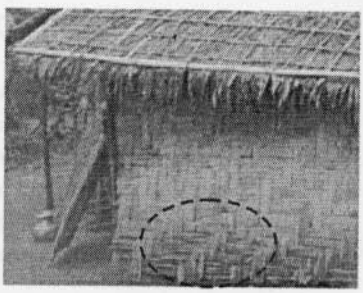
Foundation in accordance with the details in 'Typical Footing For Timber Or Bamboo Post' in order to improve anchoring of the vertical support firmly to the ground giving sufficient weight to the houses.

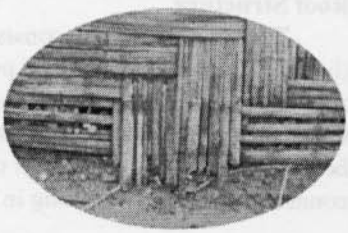


TYPICAL FOOTING FOR TIMBER OR BAMBOO POST

FLOOR FINISH

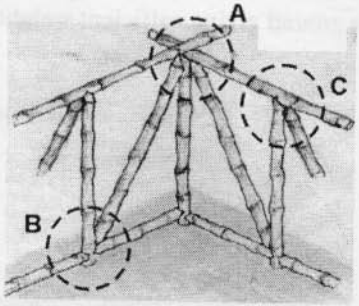
Most of the houses in our survey and study areas have mud floors. A few houses have concrete floor of natural cement or pigmented cement finish . Floor levels of many of these houses, particularly houses belonging to people of very low level of wealth ranking, are almost at natural ground level. The woven bamboo mat walls in these houses are 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 moist ground and being subjected to fungi, termite and insect attack.



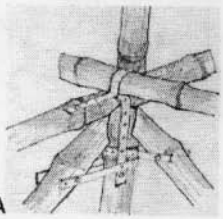


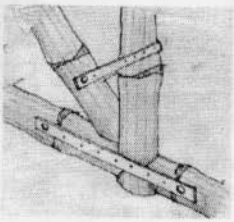
WALLS

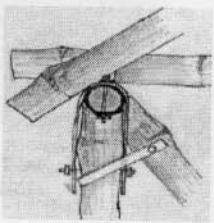
The wind is resisted by woven bamboo or timber board sheathing and vertical support. Diagonal bracing should be used to strengthen the walls, and to reduce the chances of corner failures; due to unequal pressures on two side walls during cyclones. For construction technique and details we can depend on the expertise of local builders for spacing of vertical bamboo post and fixing and tying of woven bamboo sheathing to post.



CORNER BRACING







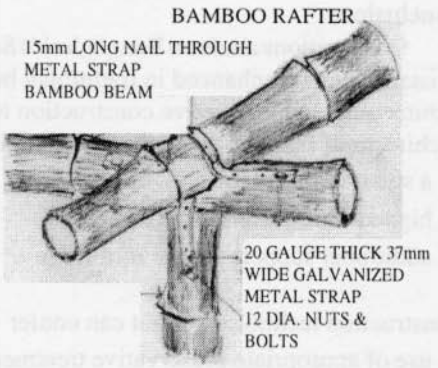
ROOF STRUCTURE AND ROOF CLADDING

Study and observations have shown that if the roof structure is secured firmly to the vertical support system there is little likelihood that the house will be damaged by cyclone. The recommendations focus on bamboo and thatch as building materials for roof structures and roof cladding. The reason for this is that bamboo is the most extensively used building material. The roof structure of most of the houses in our survey and study areas are built with bamboo.

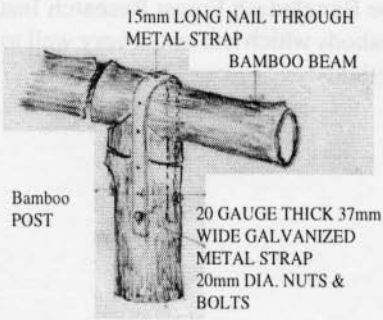
Roof Structure

The roof structure consists of horizontal bamboo support members (beams) supported by bamboo posts. The bamboo beams support the rafters of split bamboo. In the roof structure system, the most important connections are the connection be etween beams and vertical support and the connection between rafters and beams. In order to make houses cyclone resistant, these connections should be strong in order to withstand the strong upward force of

the cyclone. Metal straps, commonly known as hurricane straps in hurricane prone countries, may be used in the connections, particularly for connections between post and beam. The local technology for connection details between beam and rafter is done by tying the rafter firmly to the beam by nylon rope after cutting a notch or 'housing' in the rafter and in a better constructed structure the notch in the rafter is securely fitted to the beam maintaining the required slope at the same time. In terms of cyclone resistance we recommend the use of 20 gauge galvanized metal strap, nails, nuts and bolts along with the use of traditional materials like nylon rope etc.



FIXING DETAILS
BETWEEN POST, BEAM & RAFTER



Roof Cladding

In addition to the roof structures, the thatch roof cladding must be able to transfer the wind loads to purlins. Study and research have shown that the eaves and the ridges of the roof are particularly susceptible to wind load during cyclone. Purlins, therefore, are important structural members of the roof structural system. The 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 due to cyclone. The existing construction technique of roof cladding is well thought out and in most cases built well.

Fixing Of Corrugated G.i. Sheet Roofing

Spacings of purlins and the length of G.I.sheets should be worked out and 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 G.I. crank bolts with steel purlins. These screws are used with appropriate cup washers.

Conclusions

Observations made on Bangladesh's South East coast suggest that cyclone resistance can be enhanced in traditional buildings by using a combination of architectural and innovative construction technologies.
Architectural features that enhance wind resistance include:

- a square floor plan
- hipped roof design
- additional support for the roof ridge

Construction technologies that can confer wind resistance include:

- use of appropriate preservative treatments to prolong lives of bamboo and thatch elements
- use of concrete footings for posts
- 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 to convince us of the effectiveness of these methods