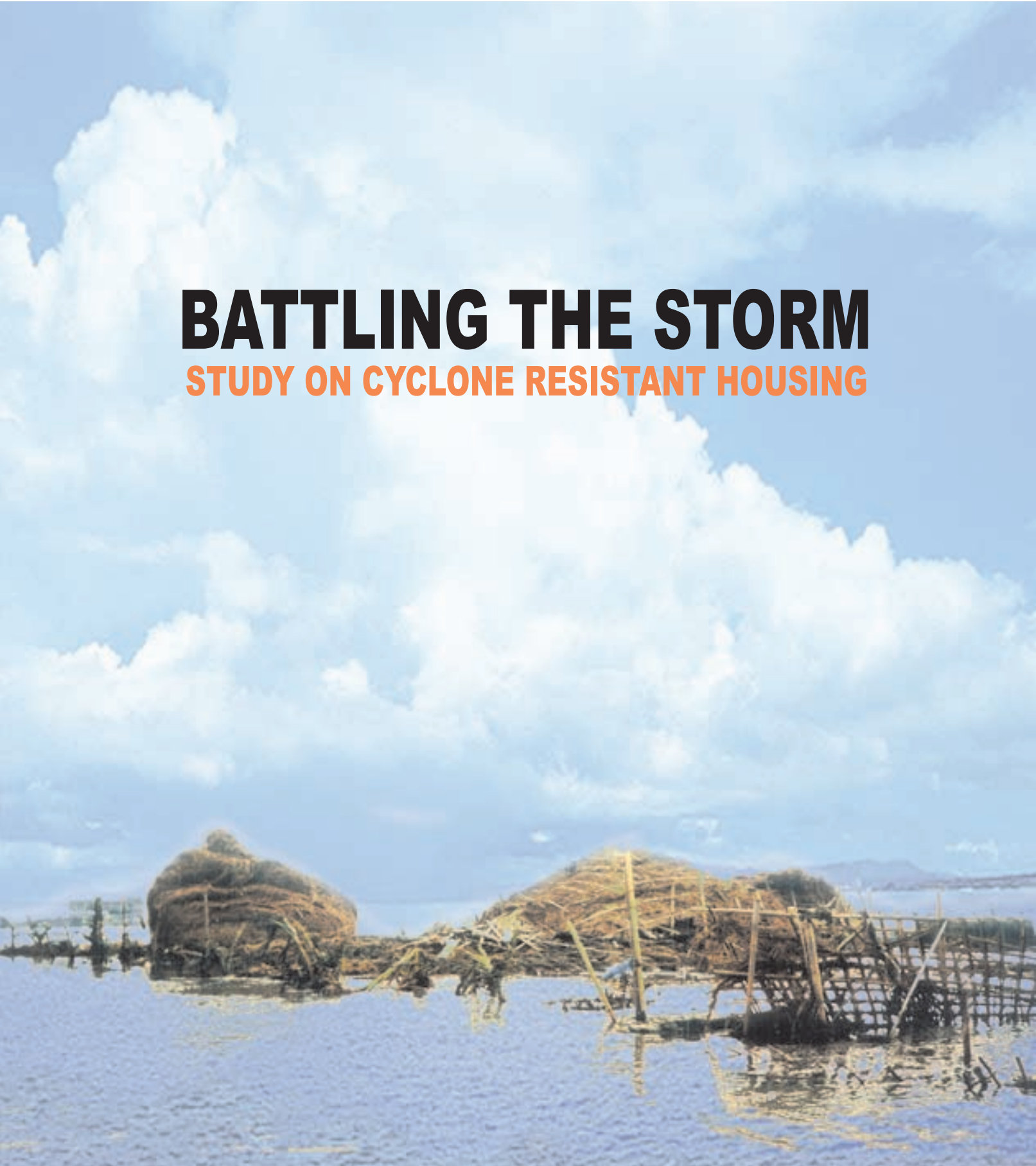
BATTLING THE STORM

STUDY ON CYCLONE RESISTANT HOUSING



COMMUNITY BASED DISASTER PREPAREDNESS PROGRAMME
BANGLADESH RED CRESCENT SOCIETY/GERMAN RED CROSS

BATTLING THE STORM

STUDY ON CYCLONE RESISTANT HOUSING

Author
Bashirul Haq
Principal Architect
Bashirul Haq and Associates Ltd.

In cooperation with
Dr. Purnima Chattopadhayay-Dutt
Delegate in Bangladesh
German Red Cross

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Author
Bashirul Haq
Principal Architect
Bashirul Haq and Associates Ltd.
35B/2 Indira Road, Dhaka-1215

In cooperation with
Dr. Purnima Chattopadhayay-Dutt
Delegate in Bangladesh
German Red Cross
C/o. Bangladesh Red Crescent Society
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Design, layout and typesetting by
Sk. Mahtab Ahmed
D-Graph Computer System
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PREFACE

Being the German Red Cross Delegate in Bangladesh, I also serve as an Advisor to the "Community Based Disaster Preparedness Programme" of the Bangladesh Red Crescent Society in Cox's Bazar, a coastal district frequently affected by tropical cyclones.

During the last decades, and specifically after the devastating cyclones of 1970 and 1991 this disaster-prone country has seen many interventions from outside in the field of disaster management and disaster prevention. With the aid of foreign technical assistance, cyclone shelters have been built, an early warning system for cyclones has been established, and relief has been given in form of food, clothing and housing.

But how did the people in the cyclone-prone areas deal with this disaster before and besides our intervention? Are they really just the passive victims, the vulnerable beneficiaries of relief, as we see them? Or do they, on the contrary, actively prepare themselves for the event of disaster? Are there any existing coping mechanisms, which we do not know of, but on which we could build our interventions in a more sustainable way?

We know that every cyclone destroys a considerable number of village houses, leading to an increased risk or injury, housing problems and - last not least - to the considerable financial burden of reconstructing the houses. Even with all the efforts of the donors, only a limited number of people can be provided with houses - which might not even meet their individual needs because of their uniform structure.

But if we can identify indigenous techniques of cyclone-strengthening of houses, and combine them with the findings of modern architectural technology, we might actually be able to contribute towards a mitigation of the destruction of houses - and of injuries and casualties due to collapsing of houses and loosening of tin roofs.

We cannot stop cyclones from coming. But we can try to strengthen the self-help capacity of people to cope with the disaster in a more sustainable fashion. Therefore, the study on cyclone-strengthening of existing houses, "Battling the Storm" has been initiated as a step in this direction.

I believe, Mr. Bashirul Haq and his colleagues deserve our gratitude for their considerable efforts, which included extended field visits, and they can be congratulated on their interesting findings.

My special thanks go to Major A. H. Quoreshi (Retd.), Secretary General and Mr. A. S. M. Akram, Deputy Secretary General of the Bangladesh Red Crescent Society, for their continuous support and untiring efforts to encourage self-help initiatives of the vulnerable communities in the cyclone-prone coastal belt.

Lastly, I am also indebted to my colleagues at the German Red Cross Secretariat General in Bonn, Germany, for providing me with inspiration and guidance regarding the publication of this study.

Dr. Purnima Chattopadhayay-Dutt
(German Red Cross Delegate in Bangladesh)

FOREWORD

The German Red Cross sponsored a study of traditionally built houses in some high risk zones of the cyclone in Cox's Bazar District. We were assisted by personnel of Community Based Disaster Preparedness Programme, (CBDPP) of the Bangladesh Red Crescent Society (BDRCS) at Cox's Bazar.

The survey was conducted by Bashirul Haq & Associates Ltd. and the people involved were :

Bashirul Haq	**Principal Architect : Bashirul Haq & Associates Ltd.**
Tawhid Amanullah	**Architect**
Monirul Islam	**Architect**
Tanzir Tuhin	**Student of Architecture, Bangladesh University of Engineering and Technology**
Ashrafuddin Bhuiyan	**Surveyor**

Mr. Mirza Nazrul Islam, Programme Co-ordinator, and other staff members of Community Based Disaster Preparedness Programme, Bangladesh Red Crescent Society , Cox's Bazar were very cooperative and helpful throughout the survey. Their active participation is highly appreciated. It made the survey team's work easier and more pleasant.

Our special thanks to Dr. Purnima Chattopadhayay-Dutt and Shafiquzaman Rabbani of German Red Cross for making this study possible with their generous help and active participation.

Our sincere thanks to those who generously allowed us to interview them and to photograph their houses, often without adequate prior warning.

An extensive physical survey of the selected houses was undertaken in order to record the structural components and activities of these houses. The survey also took note and documented the architectural and structural details, innovative use of materials, craftsmanship and technology intervention in the construction of these houses. Further, this report includes a case study of a house that survived the most severe cyclonic storm in 1994 in the Cox's Bazar area. The case study proves that a properly built house is able to withstand a severe cyclone.

The recommendations and guidelines for cyclone resistant houses are based on our survey and keep in mind architectural and design factors , as well as physical survey, social and environmental problems and the use of building materials.

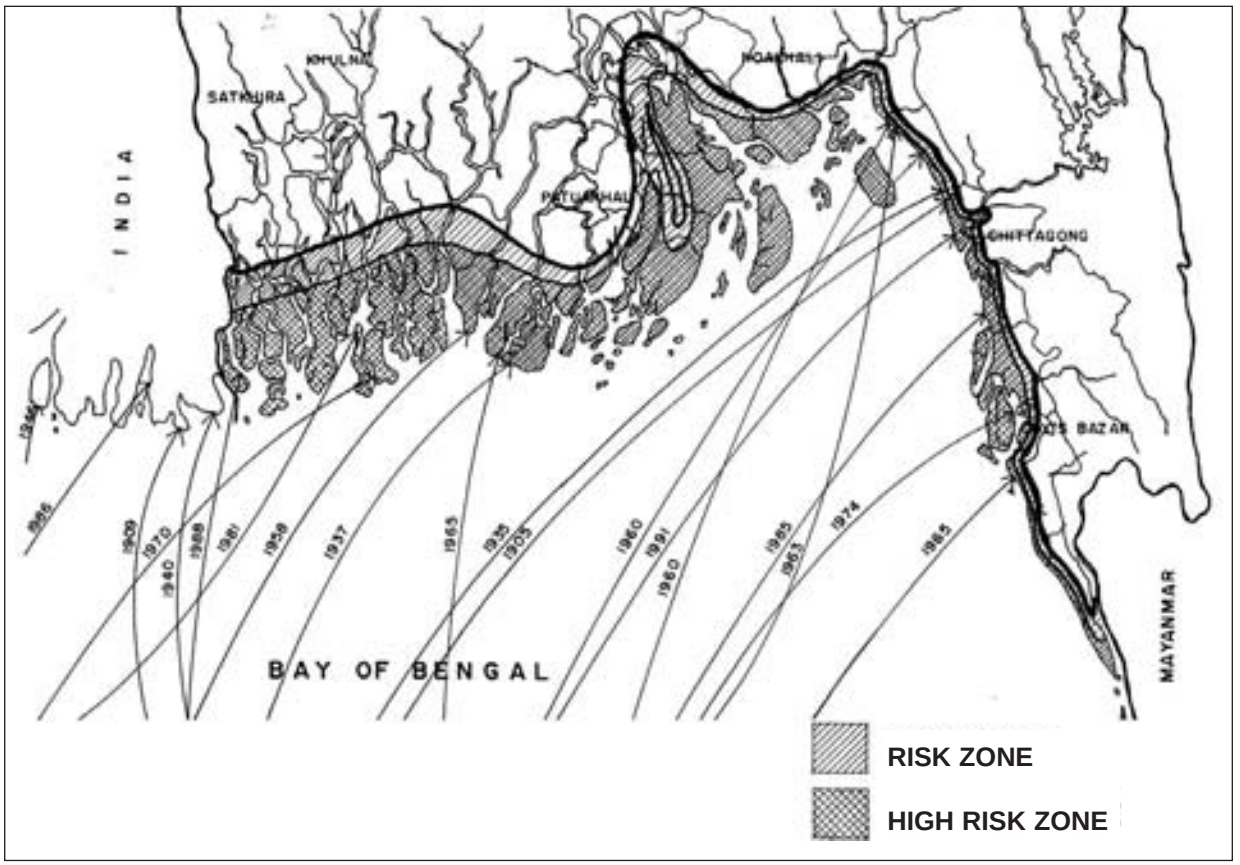
This survey has looked at existing houses and the process of building and maintenance of these houses in the face of frequent cyclonic storms and storm surges. Further, it has gathered information on shared knowledge and collective experiences of the people concerning all aspects of house building. We hope that in future this study will be of practical use to researchers as well as programmes working in the field of cyclone disaster preparedness.

Bashirul Haq
Principal Architect, Bashirul Haq & Associates Ltd.

1. INTRODUCTION

1.1 BACKGROUND

The coastal regions of Bangladesh are hit by cyclones regularly. The survey and study areas (except for Chandalipara,Teknaf) lie within the 'High Risk Zone' as identified in the report of the Multipurpose Cyclone Shelter Programme (Part IV, Volume IV), published by Bangladesh University of Engineering and Technology and Bangladesh Institute of Development Studies July, 1993 (See Map).



The country has evolved, in the face of repetitious calamities, a disaster preparedness programme. The major response to cyclones has been the building of cyclone shelters, which also double as community centers and schools. While these cyclone shelters have proved to be useful, they are more in the nature of disaster management, that is, they are measures that come in useful particularly in the event of a cyclone.

The approach of this study has been to look at existing houses and the process of building and maintaining these houses in the face of frequent cyclonic storms and storm surges, and gather information on shared knowledge and collective experiences of the people in all aspects of house building. The aim of this study is to find ways to make traditional structures more cyclone resistant and less prone to wind damage.

It is with this end in mind that the German Red Cross with the Bangladesh Red Crescent Society initiated this survey and study of traditionally built houses in cyclone risk areas.

1.2 LOCATION OF TARGET GROUPS

KEY MAP OF BANGLADESH

MAP OF
COX'S BAZAR DISTRICT

SURVEY AREA

A Dangorpara

B Chandalipara

C Nayapara

D Charpara

E Miajipara

F Majherpara

2. METHODS AND APPROACHES

2.1 GENERAL

Our 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. A direct involvement of the local people in problem identification was ensured, so that 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.

2.2 PARTICIPATORY METHODS, TECHNIQUES AND TOOLS

2.2.1 COLLECTION AND REVIEW OF SECONDARY SOURCES

These included

a) Mouza (smallest administrative unit of land and homestead holdings) maps and documents of the locations:

b) Upazila (Sub-district) maps of Teknaf, Moheshkhali and Chakoria and

c) District map of Cox's Bazar.

2.2.2 PREPARATION OF QUESTIONNAIRE, DIAGRAMS AND SCORING CARDS.

These were used to identify certain criteria, and were aimed at finding the following information:

Wealth ranking using house type and household furnishings as indicator (Annexure-I).

Identity of house owner (Annexure-II) and

Peoples perception of problems in housing (Annexure-III)

The preparation of diagram/scoring cards is shown in Annexure-IV.

2.3 SOCIAL MAPPING AND WEALTH RANKING

Social mapping was done by gathering a number of local people near an existing cyclone shelter, a non-governmental office or a village tea stall, involving them in identifying holding number and ownership of homesteads on the Mouza map. People's familiarity with Mouza maps was very interesting and their ability to identify holding number and ownership of homestead and agricultural land holding was also remarkable.

The process of social mapping enabled us to identify the social ranking of a selected number of households, based on our conversation and note taking during the survey.

The owners of households selected through the process of **SOCIAL MAPPING** were interviewed- using questionnaire 'Using House type and Household Furnishings as indicator'-in order to establish their wealth ranking. The wealth ranking categories were **VERY LOW, LOW AND MEDIUM.**

2.4 IDENTITY OF HOUSE OWNER

As poverty reduction was not the objective of determining the identity of the house owners, a simple questionnaire was formulated to find the identity of the selected house owners for cross references as an enabling measure to conduct the physical survey of their houses.

3. SOCIAL SURVEY

3.1 METHODS AND TOOLS FOR SOCIAL SURVEY

Questionnaires were used to ascertain wealth ranking and identity of house owners. Questionnaires were also used to identify People's perception of Problems in Housing ranked in order of importance.

Diagrams and scoring cards were used to identify collective experiences and options in the workability and preferences of wind breaks, distance of trees from houses, orientation and siting, shape of roof, causes of roof failure and types of openings and its vulnerability to cyclone. The survey was conducted in all six locations. Beans, seeds etc. were used as scoring devices on prepared diagrams. The ranking and scoring of responses of the people shown on the cards represent an average of all the respondents in six locations.

Local people were drawn together in a meeting in existing cyclone shelters, or in front of NGO offices or village stalls. By using a mouza map, we identified people's dwellings or homesteads. With the identity of the house owners established, we proceeded to rank the owners of homestead as very low, low & medium. After doing this we proceeded to our main task that is to evaluate people's perception of various problems related to housing.

3.1.1 PEOPLE'S PERCEPTION OF PROBLEMS IN HOUSING RANKED IN ORDER OF IMPORTANCE

Through random interviews and group discussions with people in the survey areas, we found that problems related to housing construction and maintenance are prevalent. These problems are excerberated during times of cyclone and tidal surge. The following table shows us what the people perceive as problems.

The survey has identified cyclone, cost of materials, cost of re-building, and lack of capital as the most important problems related to housing. Further, the survey revealed that tidal surge, finding a safe location for house building, availability of building materials, cost of labour and lack of technical knowledge are the next most important problems.

The respondents were spread over the six study and survey areas.

PEOPLE'S PERCEPTION REGARDING HOUSING PROBLEMS

Problem	NUMBER OF RESPONDENTS				
	Most Important	Next Most Important	Third	Fourth	Total No. of Respondent
Wind damage due to cyclone	62	10	0	0	72
Cost of re-building and re-constructing after a severe cyclone	56	11	3	2	72
Lack of capital	52	19	0	1	72
Cost of materials	39	29	3	1	72
Tidal Surge	24	48	0	0	72
Cost or lack of labour	11	42	16	3	72
Lack of technical knowledge	11	44	8	9	72
Availability of building materials	7	29	31	5	72
Finding safe location for house building	3	30	36	3	72
Availability of traditional builder	2	30	23	17	72

3.1.2 PEOPLE'S PERCEPTION OF PROBLEMS IN HOUSES IN TERMS SCORING AND RANKING USING DIAGRAM AND SCORING CARDS.

3.1.2.1 PEOPLE'S PERCEPTION OF SAFETY OF HOUSES FROM CYCLONE WITH OR WITHOUT WIND BREAKS.

The response was overwhelmingly in support of having windbreaks for protection against cyclone.

3.1.2.2 PEOPLE'S PERCEPTION OF SAFE DISTANCE OF TREES FROM HOUSES IN THE CYCLONE AFFECTED AREAS.

The majority of respondents were of the opinion of keeping a substantial distance of trees between 20 to 30 feet from houses.

3.1.2.3 PEOPLE'S PERCEPTION OF ORIENTATION AND SITING OF HOUSES.

Uniform agreement of the respondents was to orient houses width-wise towards windward direction.

3.1.2.4 PEOPLE'S PERCEPTION OF THE MAGNITUDE OF WIND LOADING AND WIND DAMAGE ON DIFFERENT ROOF SHAPES.

Uniform agreement of the respondents was for hip roof, indicating their collective experience that less damage is caused by cyclone to hip roof than to high gable roofs.

3.1.2.5 PEOPLE'S PERCEPTION OF OPENINGS IN HOUSES IN CYCLONE AFFECTED AREAS.

Most respondents where in favor of top hung windows, referring to this as being safer during cyclone.

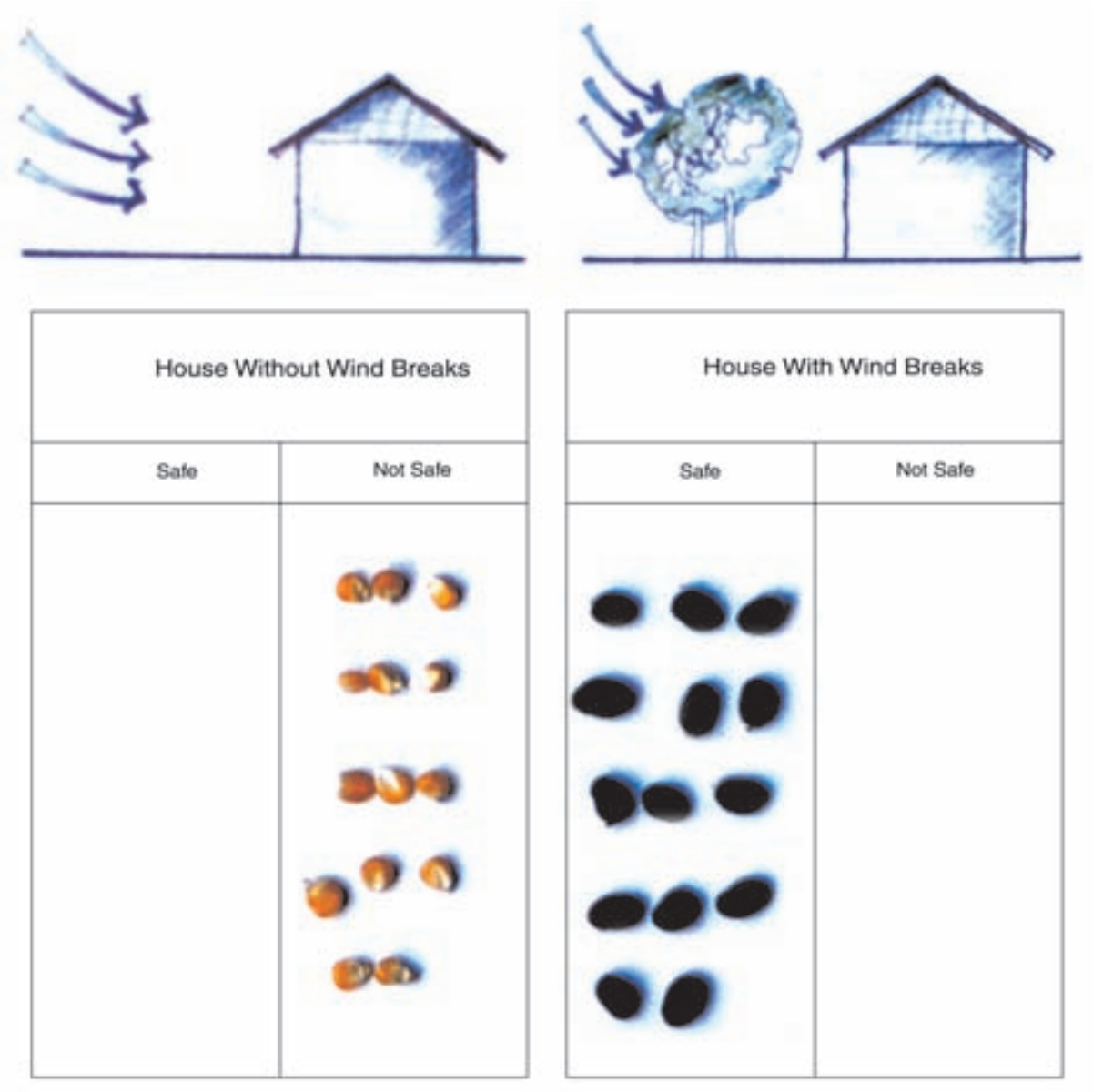
The respondents also felt that corner openings are not safe for the stability of the structures during cyclone.

3.1.2.6 PEOPLE'S PERCEPTION OF ROOF FAILURE BY CYCLONIC STORM.

A large number responded that faulty fixing details cause roof sheeting to get blown off, and can also cause lifting off of the roof.

An illustrated representation of our findings is given in the following pages.

3.1.2.1 PEOPLE'S PERCEPTION OF SAFETY OF HOUSES FROM CYCLONE WITH OR WITHOUT WIND BREAKS



SCORING AND RANKING

CARD NO : **01**

PLACE : Average ranking of all six sites.

COMMENTS : Response was overwhelmingly in support of having wind breaks for protection against cyclone

3.1.2.2 PEOPLE'S PERCEPTION OF SAFE DISTANCE OF TREES FROM HOUSES IN THE CYCLONE AFFECTED AREAS

Safe Distance			
10 Feet	15 Feet	20 Feet	30 Feet
			

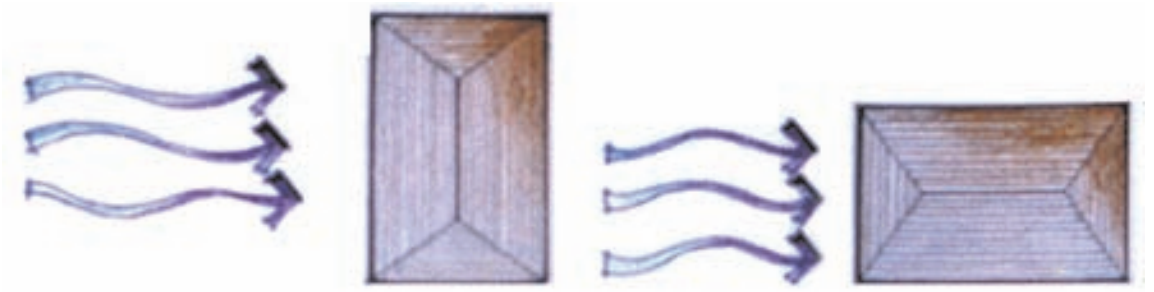
SCORING AND RANKING

CARD NO : **02**

PLACE : Average ranking of all six sites

COMMENTS : Majority respondents were of the opinion of keeping a substantial distance between 20 to 30 feet from houses

3.1.2.3 PEOPLE'S PERCEPTION OF ORIENTATION AND SITING OF HOUSES



Long Face Of Building Facing Wind Direction	
Traditionally Accepted	Traditionally Not Accepted

Shorter Face Of Building Facing Wind Direction	
Traditionally Accepted	Traditionally Not Accepted

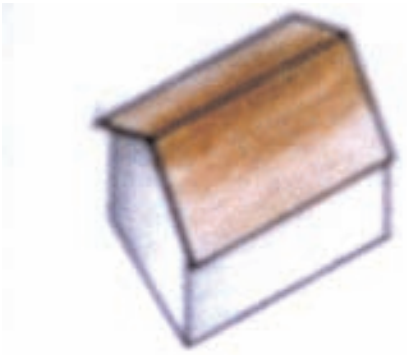
SCORING AND RANKING

CARD NO : **03**

PLACE : Average ranking of all six sites

COMMENTS : Response uniformly was to locate the houses width-wise towards windward direction

3.1.2.4 PEOPLE'S PERCEPTION OF THE MAGNITUDE OF WIND LOADING AND WIND DAMAGE ON DIFFERENT ROOF SHAPES



High Goble Roof	
Wind Resistant	Suffer Wind Damage

Hip Roof	
Wind Resistant	Suffer Wind Damage

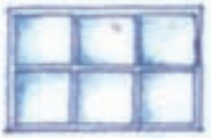
SCORING AND RANKING

CARD NO : **04**

PLACE : Average ranking of all six sites

COMMENTS: Response uniformly was for hip roof, indicating their collective experience that less damaged is caused by cyclone to hip roof.

3.1.2.5 PEOPLE'S PERCEPTION OF OPENINGS IN HOUSES IN CYCLONE AFFECTED AREAS

Type of opening	Safe	Not safe
 Side hung window		
 Top hung window		
 Window with large glass		
 Window with small glass		
 Door/window near the corner		

SCORING AND RANKING

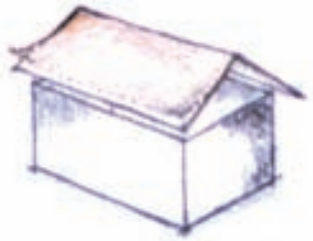
CARD NO : **05**

PLACE : Average ranking of all six sites

COMMENTS : Most respondents were in favour of top hung windows, referring to this as being safer during cyclone.

The respondents also felt that corner openings are not safe for the stability of the structures during cyclone.

3.1.2.6 PEOPLE'S PERCEPTION OF ROOF FAILURE BY CYCLONIC STORM

	COMMON TYPES OF ROOF FAILURE	
		
	ROOF SHEETING GETS BLOWN OFF	ROOF LIFTING OFF FROM THE SUPPORTING WALL
FAULTY FIXING DETAILS OF ROOF MEMBER TO WALL/COLUMN		
ROOF SHEETING NOT SECURED FIRMLY TO PURLIN		
OPENING CREATED BY BREAK DOWN OFF WALL, BRODEN WINDOW, DOOR ETC.		
EXTENDED ROOF OVER-HUNG		
COLUMN AND WALL FOUNDATION NOT FIRMLY ANCHORED TO THE GROUND		

SCORING AND RANKING

CARD NO : **06**

PLACE : Average ranking of all six sites

COMMENTS : Faulty fixing details of roof to wall and column.

A large number of people responded that faulty fixing details cause roof sheeting to get blown off . A sizeable number responded that it can also cause lifting off of the roof.

3.2 GRAPHICAL PRESENTATION OF SOCIAL SURVEY

3.2.1 GENERAL

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.

Selection of houses and their owners was an ongoing process, as we were very careful in selecting the house types in terms of standard of construction, use of materials, quality of finish and fabrication, orientation, roof shape and connection of structural members and structural system. The process of survey and note taking enabled us to select fairly representative examples of houses belonging to people of different wealth ranking in all six locations of our survey.

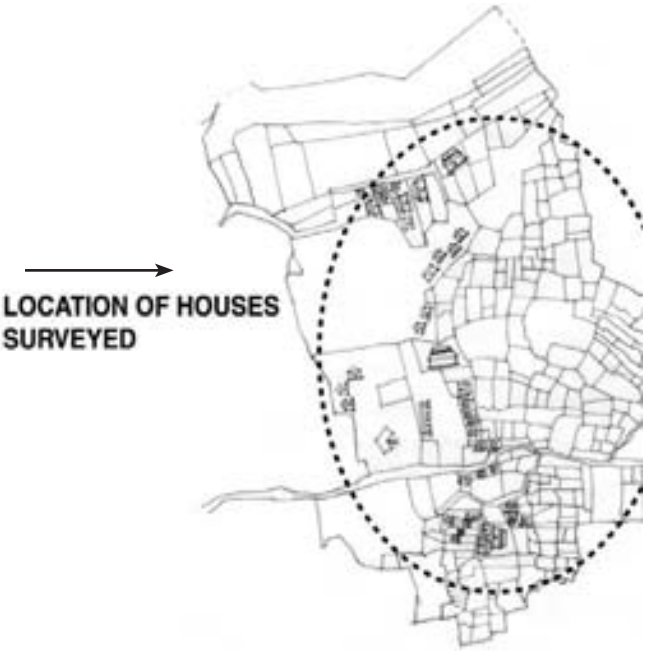
This part of the survey enabled us to have an understanding and a feel for the people, place and topology of houses.

3.2.2 LOCATIONS AND NAMES OF SELECTED HOUSE OWNERS

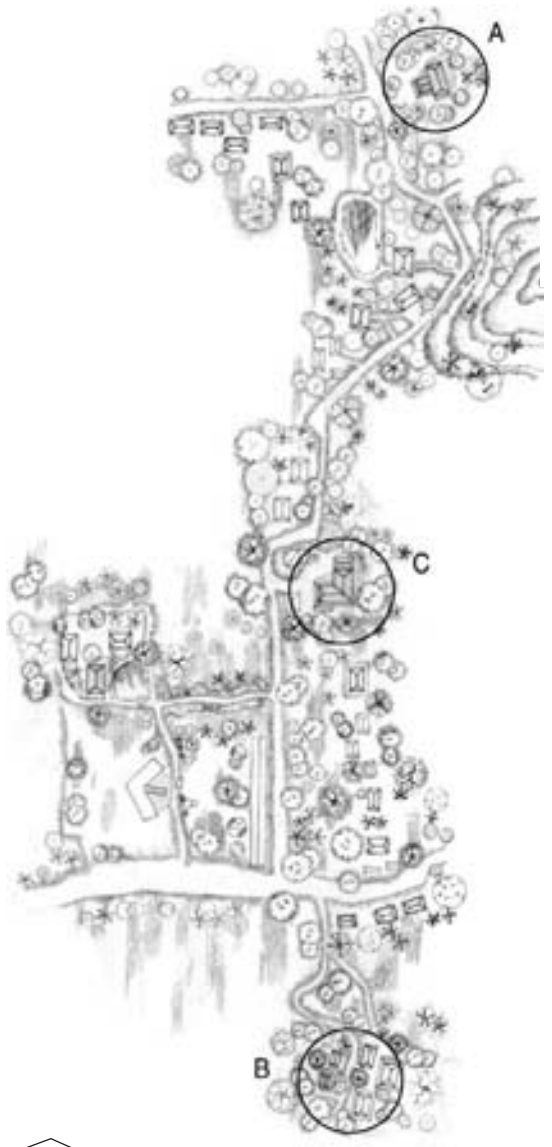
Location	Names of Selected House Owner's
3.2.2.1 DANGOR PARA	Abdul Jalil Imam Hossain Abdul Motaleb
3.2.2.2 CHANDALI PARA	Noor Ahmed Arjun Kumar Sheel Mahendra Kumar Sheel Satter Ali
3.2.2.3 NAYA PARA	Mohammad Hossain Mostafa Rahman Ishaque Sikder
3.2.2.4 CHAR PARA	Monir Ahmed Abu Bakkar Nurul Azim Nur Ahmad
3.2.2.5 MIAJI PARA	Abbas Ahmed Chowdhury Mukter Ahmed Zahir Ahamed Rashid Ahmad
3.2.2.6 MAJHER PARA	Mozaffar Ahmad Abdul Hamid Shamsul Alam Zahir Ahmad

3.2.2.1 DANGOR PARA
MOUZA SHAHPORDWIP

Social Mapping
Identity and Wealth Ranking
of House Owners



SOCIAL MAPPING



LOCATION MAP OF SELECTED HOUSES

IDENTITY AND WEALTH RANKING OF SELECTED HOUSE OWNERS

A

Head of Household	Abdul Jalil, Age 45
Spouse	2(Two), Age 35,30
Children	8 Male, Age between 20 to 10
	8 Female, Age between 18 to 5
Land Holding	6 acres
Wealth Ranking Level	Medium

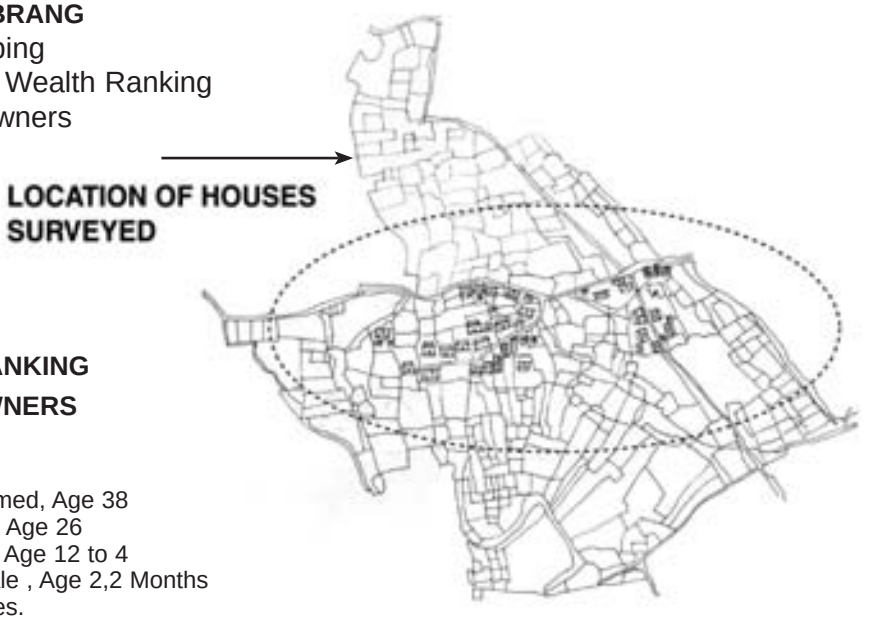
B

Head of Household	Imam Hussain, Age 65
Spouse	1(One), Age 45
Children	3 Male, Age between 16 to 7
	2 Female, Age 12 & 10
Land Holding	0.25 acres.
Wealth Ranking Level	Very Low.

C

Head of Household	Abdul Motaleb, Age 56
Spouse	2(Two), Age 40 & 30
Children	9 Male, Age between 20 to 6
	5 Female, Age 23 to 3
Land Holding	5 acres.
Wealth Ranking Level	Medium

3.2.2.2 **CHANDALI PARA**
MOUZA SABRANG
Social Mapping
Identity and Wealth Ranking
of House Owners



SOCIAL MAPPING

IDENTITY AND WEALTH RANKING OF SELECTED HOUSE OWNERS

A

Head of Household	Nur Ahmed, Age 38
Spouse	1(One), Age 26
Children	5 Male, Age 12 to 4
	2 Female , Age 2,2 Months
Land Holding	0.5 acres.
Wealth Ranking Level	Very Low

B

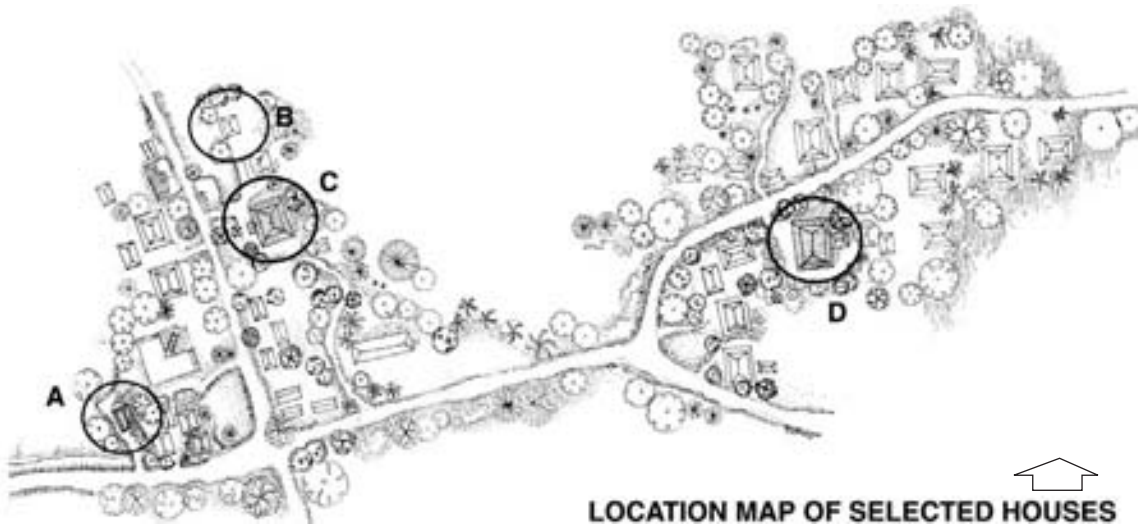
Head Of Household	Arjun Kumar Sheel, Age 30
Spouse	1(One) Age 25
Children	2 Male, Age 6,4
	2 Female, Age 9, 5 months.
Land Holding	0.5 acres
Wealth Ranking Level	Low

C.

Head Of Household	Mahendra Kumar Sheel, Age 65
Spouse	1(One), Age 55
Son	4 Male, Age 30 to 12
Daughter	3, Age 40 to 35
Land Holding	0.5 acres.
Wealth Ranking Level	Very Low

D

Head of Household	Satter Ali, Age 70
Spouse	1(One), Age 60
Son	2(Two), Age 35,25
Daughter- in-Law	1(One), Age 25
Grand Son	1(One), Age 6
Grand Daughter	1(One), Age 1
Land Holding	2.5 acres
Wealth Ranking Level	Medium



LOCATION MAP OF SELECTED HOUSES

3.2.2.3 NAYA PARA
MOUZA MATERBARI
Social Mapping
Identity and Wealth Ranking
of House Owners

IDENTITY AND WEALTH RANKING OF SELECTED HOUSE OWNERS

A

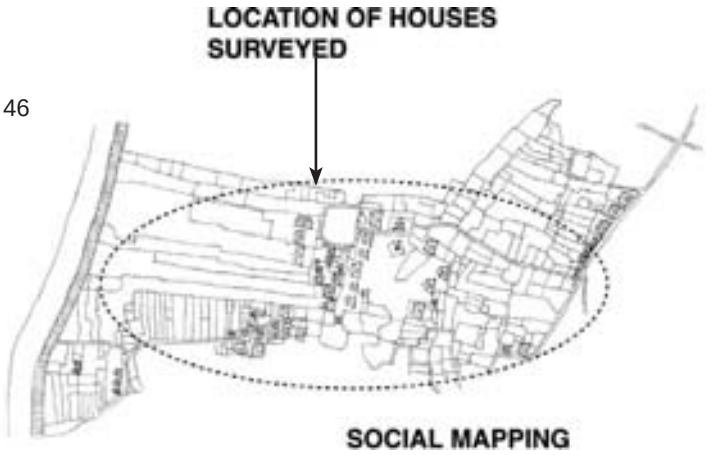
Head of Household	Mohammad Hossain, Age 46
Spouse	1(One), Age 30
Children	3 Male, Age 19 to 14
	3 Female, Age 11 to 2
Land Holding	5 acres.
Wealth Ranking Level	Low.

B

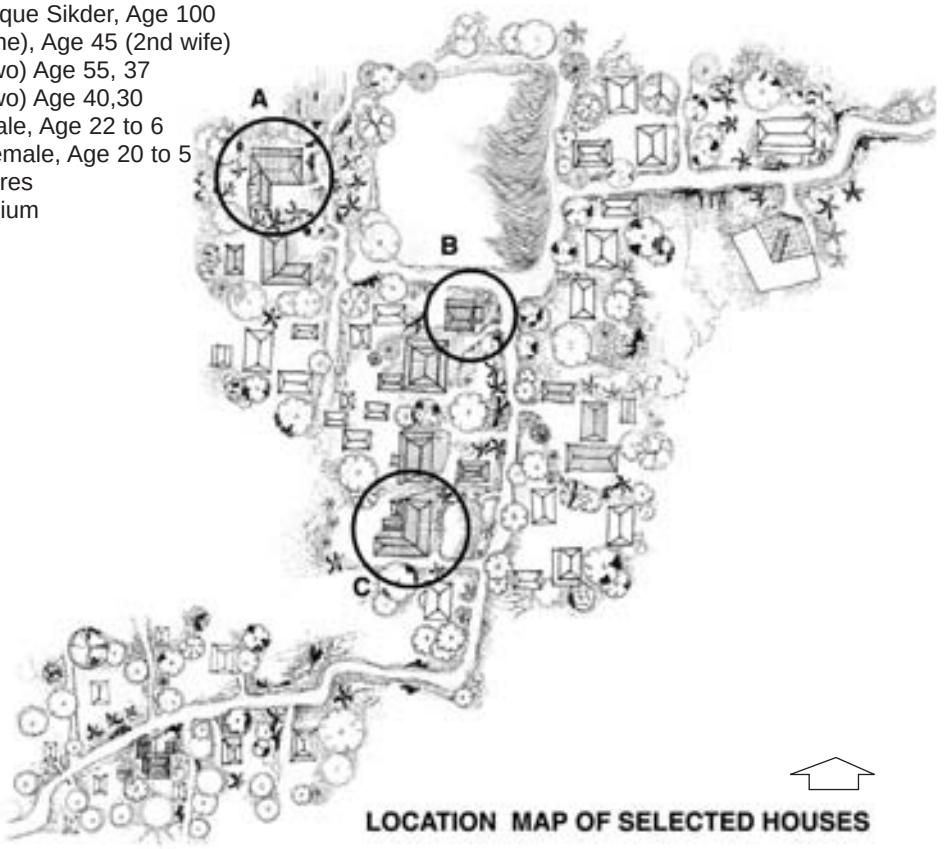
Head of Household	Mostafa Rahman, Age 32
Spouse	1(One) Age 22
Children	1 Male, Age 6 months
	2 Female, Age 4, 2
Sister-in-Law	1(One), Age 28
Father-in-Law	1(One, Age 65
Land Holding	0.5 acres.
Wealth Ranking Level	Very Low

C

Head of Household	Ishaque Sikder, Age 100
Spouse	1(One), Age 45 (2nd wife)
Son	2(Two) Age 55, 37
Daughter-in-Law	2(Two) Age 40,30
Grand Children	7 Male, Age 22 to 6
	2 Female, Age 20 to 5
Land Holding	6 acres
Wealth Ranking Level	Medium



SOCIAL MAPPING



LOCATION MAP OF SELECTED HOUSES

3.2.2.4 CHAR PARA
MOUZA GOROK GHATA
Social Mapping
Identity and Wealth Ranking
of House Owners

IDENTITY AND WEALTH RANKING OF SELECTED HOUSE OWNERS

A

Head of Household	Monir Ahmed,, Age 50
Spouse	1(One), Age 35
Children	1 Male, Age 5
	2 Female, Age 13, 10
Leading Holding	0.25 acres
Wealth Ranking Level	Very Low.

B

Head of Household	Abu Bakkar, Age 50
Spouse	1(One), Age 35
Children	1Male, Age 22
	3 Female, Age 20 to 8.
Land Holding	0.125 acres.
Wealth Ranking Level	Very Low.

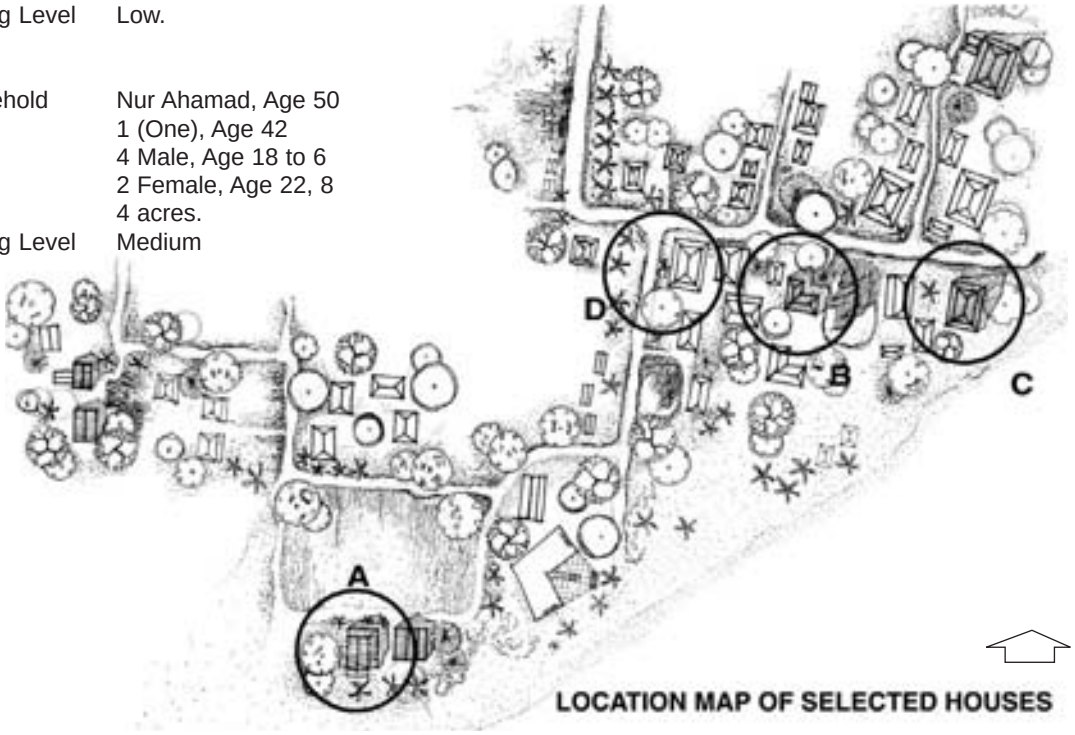
C

Head of Household	Nurul Azim, Age 35
Spouse	1(One), Age 28
Children	1 Male, Age 9
	2 Female, Age 5.1
Land Holding	0.25 acres.
Wealth Ranking Level	Low.

D

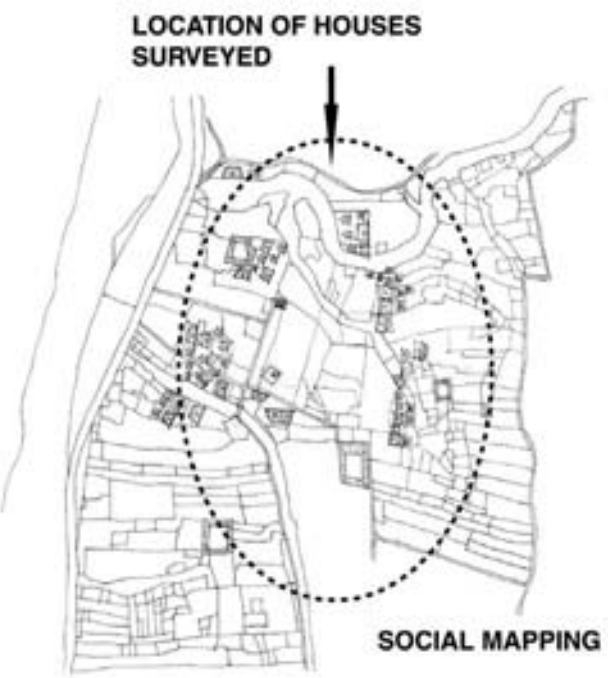
Head of Household	Nur Ahamad, Age 50
Spouse	1 (One), Age 42
Children	4 Male, Age 18 to 6
	2 Female, Age 22, 8
Land Holding	4 acres.
Wealth Ranking Level	Medium

SOCIAL MAPPING



LOCATION MAP OF SELECTED HOUSES

3.2.2.5 MIAJI PARA
MOUZA MOGNAMA
Social Mapping
Identity and Wealth Ranking
of House Owners



SOCIAL MAPPING

IDENTITY AND WEALTH RANKING OF SELECTED HOUSE OWNERS

A

Head of Household	Abbas Ahmed Chowdhury Age 55
Spouse	1(One), Age 50
Son	6, Age 35 to 20
Daughter	2 Age 33, 29
Land Holding	20 acres
Wealth Ranking Level	Above Ranking

B

Head of Household	Mukter Ahmed, age 60
Spouse	1(One), Age 45
Son	5 Age 30 to 7
Daughter	3 Age between 28 to 18
Brother	1 Age 40
Land Holding	2 acres
Wealth Ranking Level	Medium

C

Head of Household	Zahir Ahamed, Age 55
Spouse	1(One), Age 45
Son	7 Age between 30 to 8
Daughter	3 Age between 16 to 2
Land Holding	0.5 acres
Wealth Ranking Level	Low

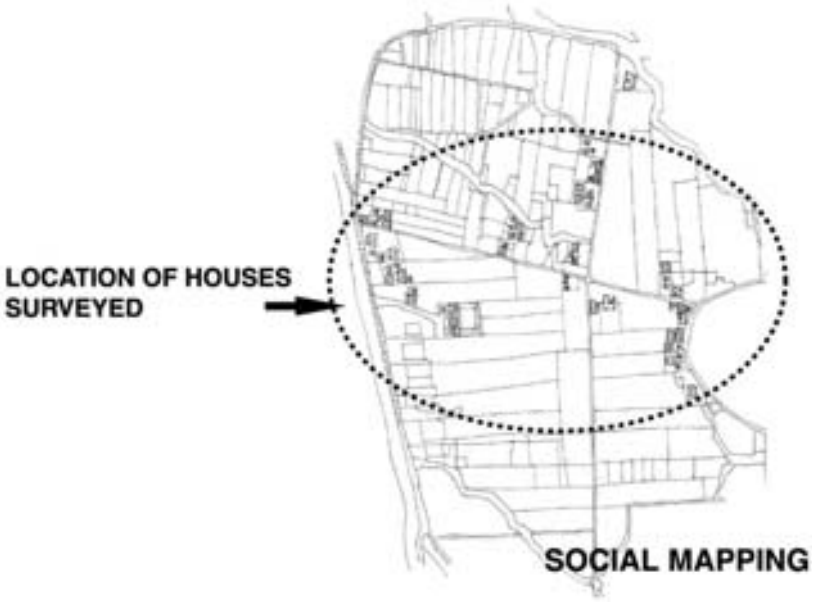
D

Head of Household	Md. Rashid Ahmad, Age 45
Spouse	1(One), Age 40
Son	1 Age 5
Daughter	5 Age between 25 to 8
Land Holding	0.25 acres
Wealth Ranking Level	Very Low

LOCATION MAP OF SELECTED HOUSES

3.2.2.6 MAJHER PARA MOUZA BADARK

Social Mapping
Identity and Wealth
of House Owners



**IDENTITY AND WEALTH RANK
OF SELECTED HOUSE OWNE**

A

Head of Household	Mozaffar Ahmad, Age 30
Spouse	1(One), Age 25
Children	1 Female, Age 5
Father	Age 80
Mother	Age 60
Sister	1 Age 20
Land Holding	1.5 acres
Wealth Ranking Level	Low

B

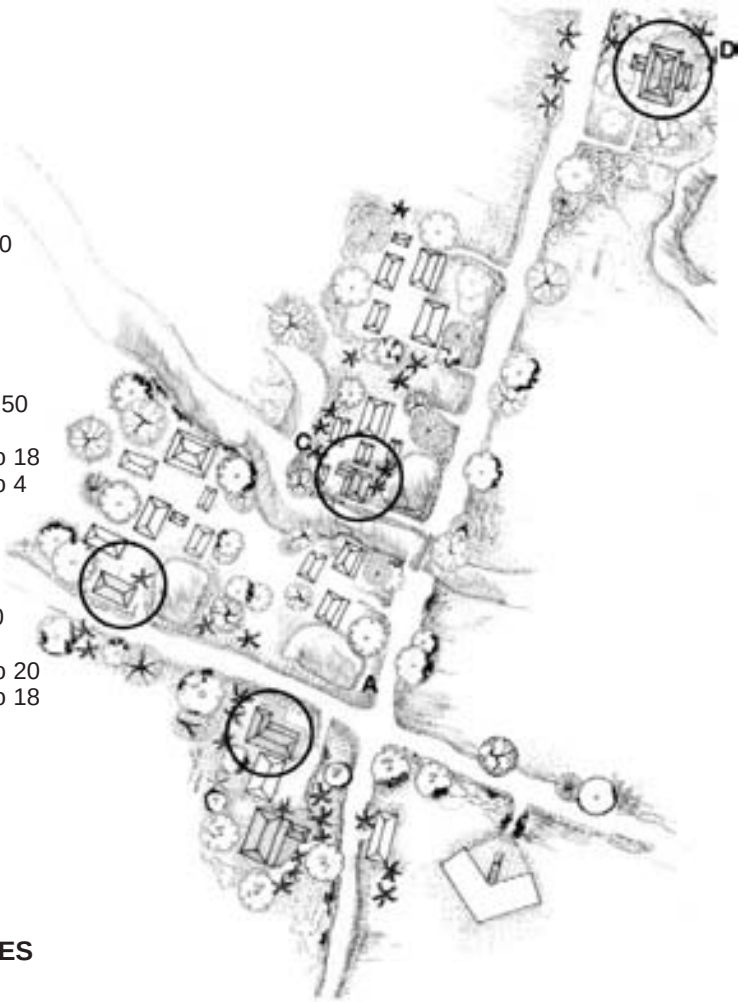
Head of Household	Abdul Hamid, Age 80
Spouse	1(One), Age 65
Land Holding	0.6 acres
Wealth Ranking Level	Very Low

C

Head of Household	Shamsul Alam, Age 50
Spouse	1(One), Age 40
Son	3 Age between 25 to 18
Daughter	4 Age between 20 to 4
Land Holding	No Land
Wealth Ranking Level	Very Low

D

Head of Household	Zahir Ahmad Age 60
Spouse	1(One), Age 56
Son	7 Age between 38 to 20
Daughter	3 Age between 30 to 18
Land Holding	2 acres
Wealth Ranking Level	Medium



LOCATION MAP OF SELECTED HOUSES

4. PHYSICAL SURVEY OF SELECTED HOUSES

4. 1 GENERAL

Monograph's of individual houses have been prepared through physical survey, measured drawings, sketches and photographs of selected houses in the following locations. 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.

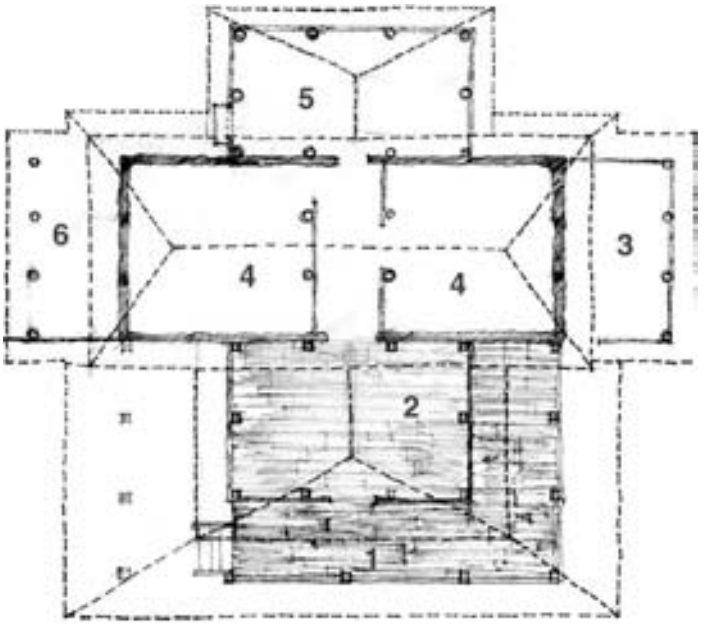
The house type of the survey area has evolved by taking into consideration harsh climate, cyclonic - storms, gusty wind accompanied by heavy rain. The traditional houses in these areas consist of a pashchati - a verandah type space enclosed with wall; and the ghar - the main house also enclosed with wall. The materials of the wall are mostly bamboo mat, wood plank, mud wall etc.

The roof shape of the ghar is invariably hip type, and there is always a separation between the roof of the 'ghar' and that of the 'pashchati'.

4.2 LOCATION	NAME OF HOUSE OWNERS
4.2.1 DANGOR PARA	**Abdul Jalil (A)** **Imam Hossain (B)** **Abdul Motaleb (C)**
4.2.2 CHANDALI PARA	**Nur Ahmed (A)** **Arjun Kumar Sheel (B)** **Mahendra Kumar Sheel (C)** **Satter Ali (D)**
4.2.3. NAYA PARA	**Mohammad Hossain (A)** **Mostafa Rahman (B)** **Ishaque Sikder (C)**
4.2.4 CHAR PARA	**Monir Ahmed (A)** **Abu Bakkar (B)** **Nurul Azim (C)** **Nur Ahmed (D)**
4.2.5 MIAJI PARA	**Abbas Ahmad Chowdhury (A)** **Mukter Ahmad (B)** **Zahir Ahmad (C)** **Rashid Ahmad (D)**
4.2.6 MAJHER PARA	**Mozaffar Ahmad (A)** **Abdul Hamid (B)** **Shamsul Alam (C)** **Zahir Ahmad (D)**

4.2.1 DANGOR PARA
House of Abdul Jalil (A)

SITE LOCATION



PLAN

Activities

Room Number	Description
1.	Pashchati (open)
2.	Living & Sleeping (public domain)
3.	Storage Area
4.	Sleeping Room
5.	Kitchen & Eating
6.	Shed for Livestock & Poultry

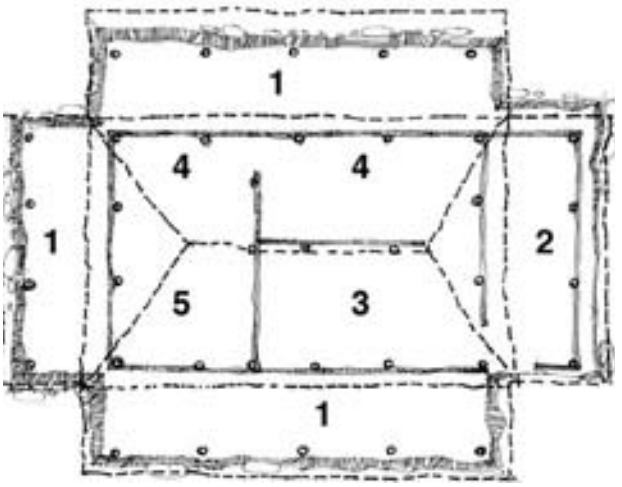
structure

Components		Materials
Vertical Support	:	Wood Pillar & Mud Wall
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Tin Roof
Wall	:	Bamboo, Wood & Mud Wall
Floor	:	Wood Plank & Mud Finish

FRONT VIEW

4.2.1 DANGOR PARA
House of Imam Hossain (B)

SITE LOCATION



PLAN

Activities

Room Number	Description
1.	Pashchati (open)
2.	Poultry.
3.	Living & Sleeping (public domain)
4.	Sleeping Room
5.	Kitchen & Eating

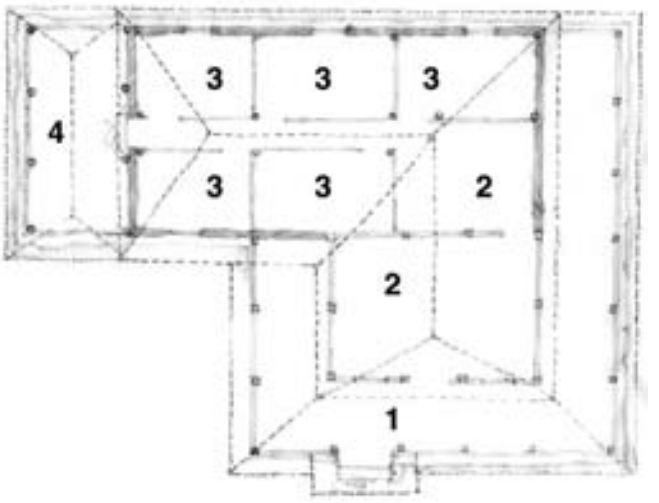
Structure

Components		Materials
Vertical Support	:	Bamboo Post
Roof Support & Roofing Material	:	Bamboo Joist, Purlin & Thatch Roof
Wall	:	Bamboo Woven Mat
Floor	:	Mud Finish

FRONT VIEW

4.2.1 DANGOR PARA
House of Abdul Motaleb (C)

SITE LOCATION



PLAN

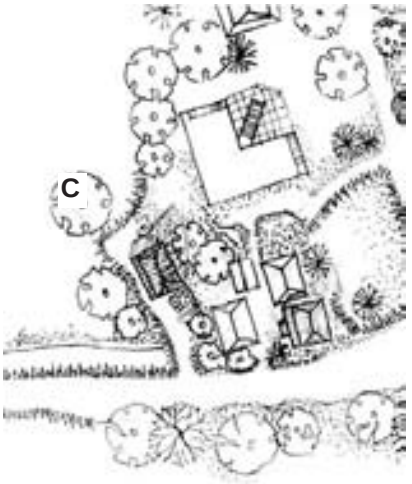
Activities Room Number	Description
1.	Pashchati (Open)
2.	Living & Sleeping (public domain)
3.	Sleeping Room
4.	Kitchen & Eating

Structure

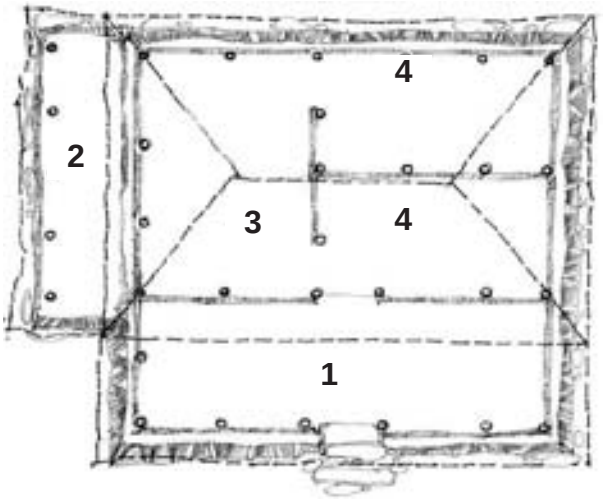
Components		Materials
Vertical Support	:	Wood Pillar & Brick Wall
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Tin Roof
Wall	:	Brick Wall,Plaster & Paint
Floor	:	Tinted Concrete Floor

FRONT VIEW

4.2.2 CHANDALI PARA
House of Nur Ahmed (A)



SITE LOCATION



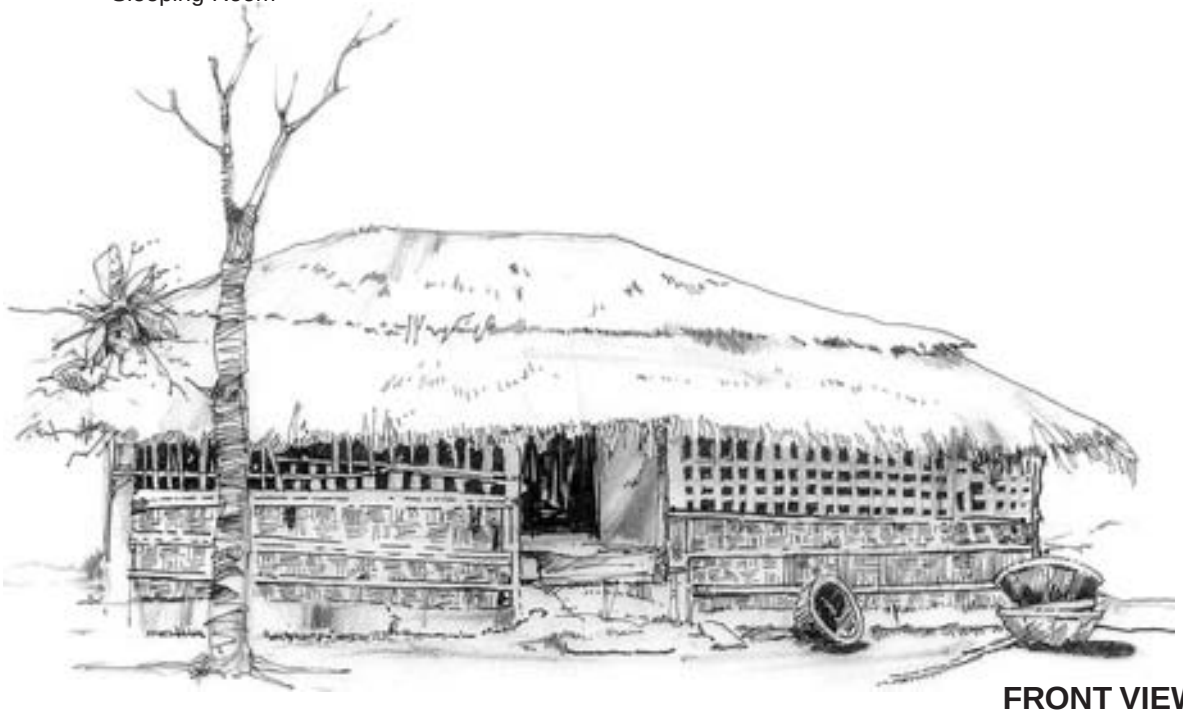
PLAN

Activities

Room Number	Description
1.	Pashchati (enclosed for living)
2.	Pashchati (open)
3.	Kitchen ,Eating & Sleeping Area
4.	Sleeping Room

Structure

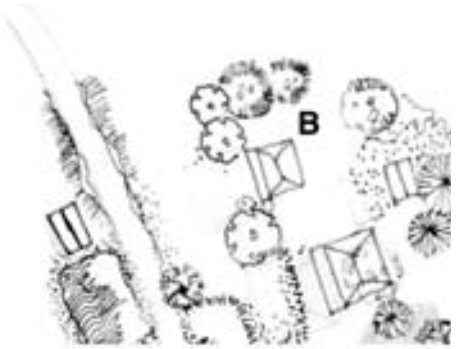
Components		Materials
Vertical Support	:	Bamboo Post
Roof Support & Roofing Material	:	Bamboo Joist, Purlin & Thatch Roof
Wall	:	Bamboo Woven Mat
Floor	:	Mud Finish



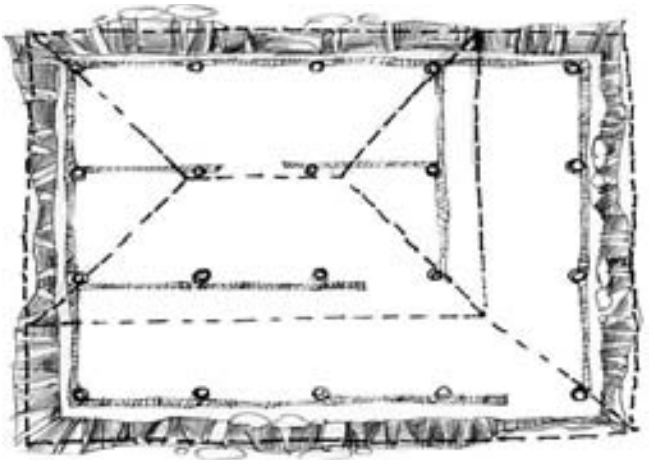
FRONT VIEW

4.2.2 CHANDALI PARA

House Of Arjun Kumar Sheel (B)



SITE LOCATION



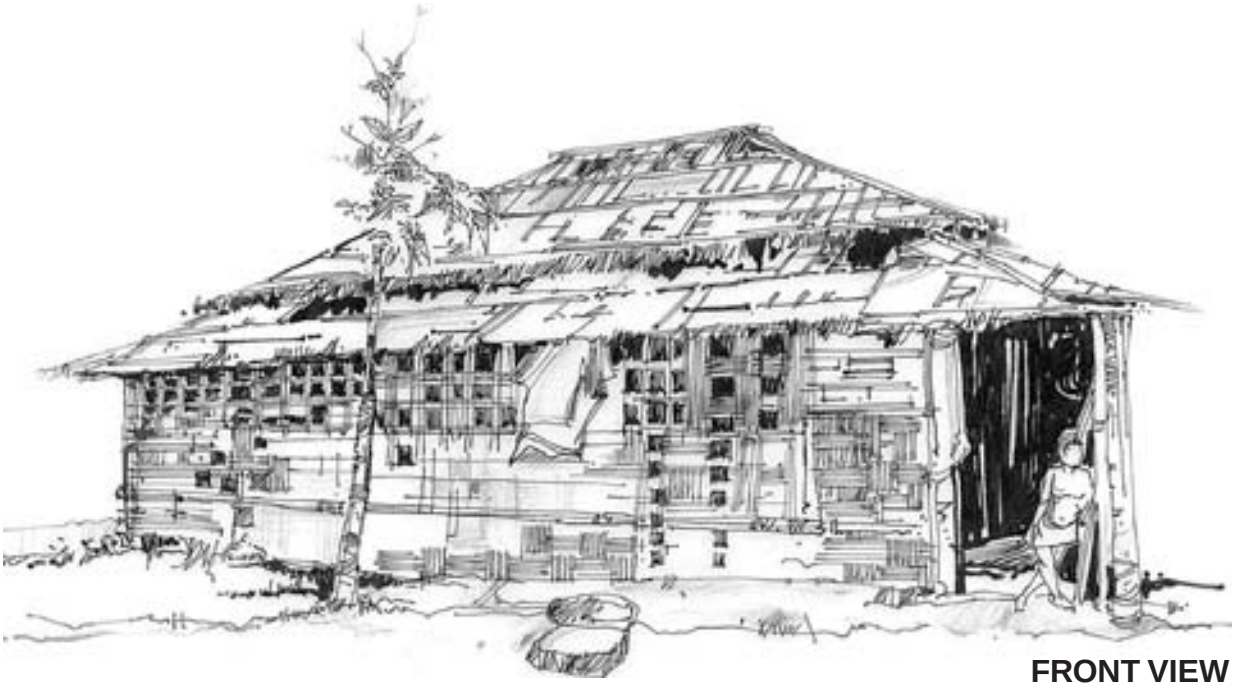
PLAN

Activities

Room Number	Description
1.	Pashchati (enclosed for living)
2.	Pashchati (open)
3.	Kitchen ,Eating & Sleeping Area
4.	Sleeping Room

Structure

Components		Materials
Vertical Support	:	Bamboo Post
Roof Support & Roofing Material	:	Bamboo Joist, Purlin & Thatch Roof
Wall	:	Bamboo Woven Mat
Floor	:	Mud Finish

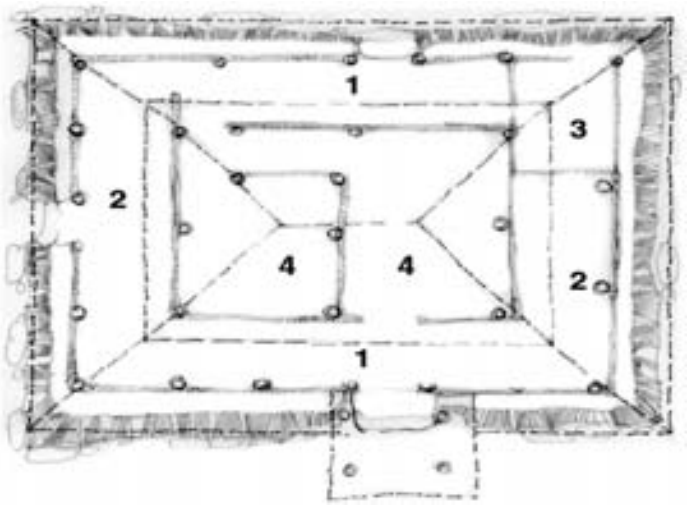


FRONT VIEW

4.2.2 CHANDALI PARA

House of Mahendra Kumar Sheel (C)

SITE LOCATION



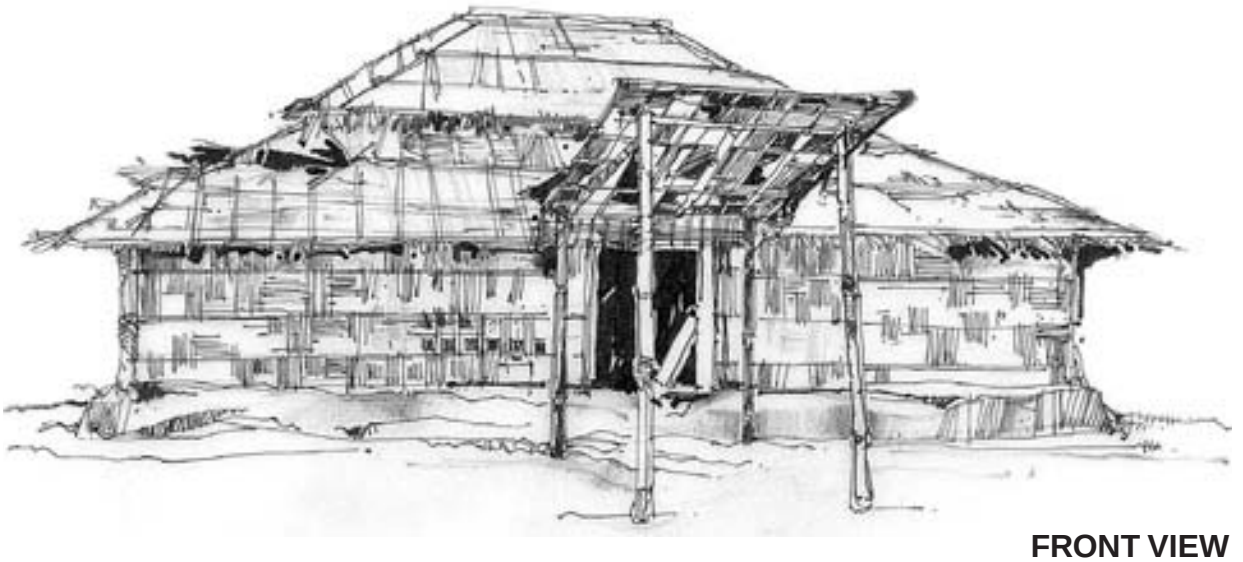
PLAN

Activities

Room Number	Description
1.	Pashchati (enclosed for living)
2.	Pashchati (enclosed for Kitchen, Eating)
3.	Poultry
4.	Sleeping Room

Structure

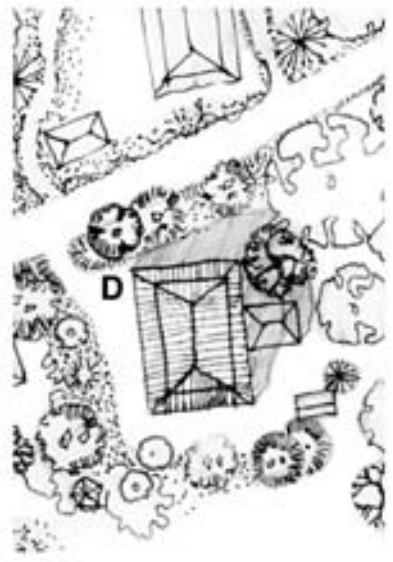
Components		Materials
Vertical Support	:	Bamboo Post
Roof Support & Roofing Material	:	Bamboo Joist, Purlin & Thatch Roof
Wall	:	Bamboo Woven Mat
Floor	:	Mud Finish



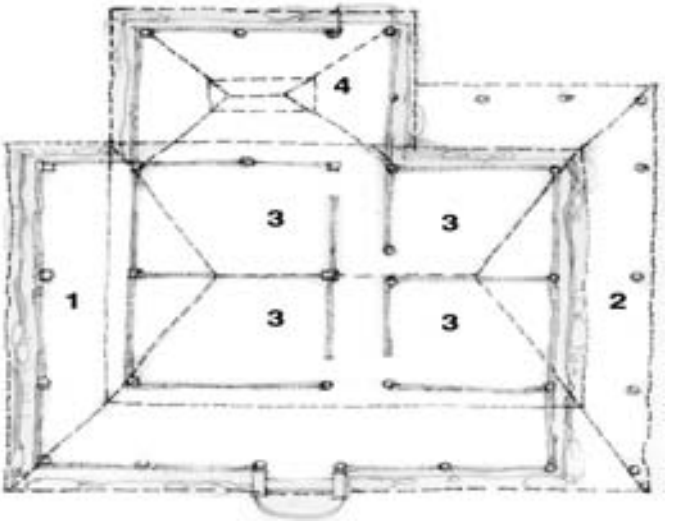
FRONT VIEW

4.2.2 CHANDALI PARA

House Of Satter Ali (D)



SITE LOCATION



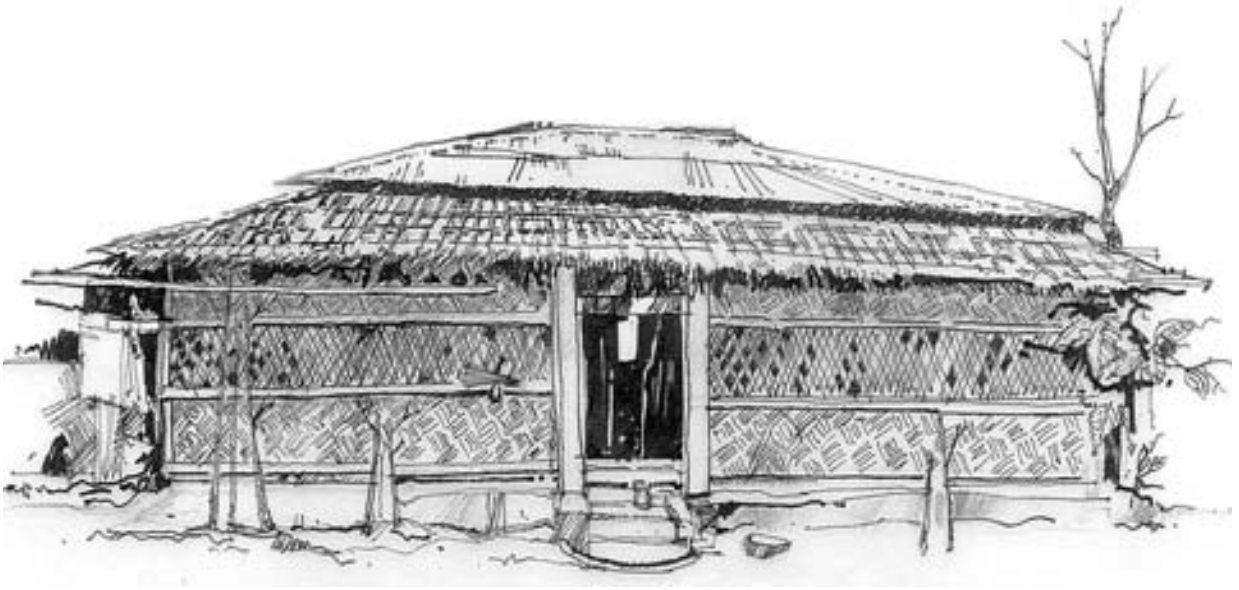
PLAN

Activities

Room Number	Description
1.	Pashchati (enclosed for living)
2.	Pashchati (open)
3.	Sleeping Room
4.	Kitchen & Eating

Structure

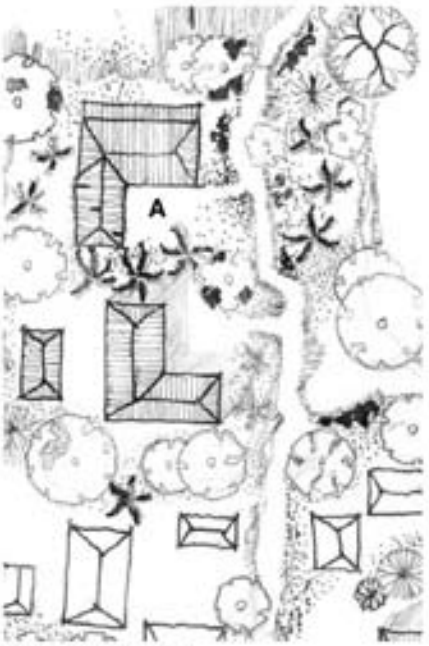
Components		Materials
Vertical Support	:	Wooden Post
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Tin Roof Over Ghar & Thatch Roof Over Pashchati
Wall	:	Well Crafted Bamboo Woven Mat
Floor	:	Mud Finish

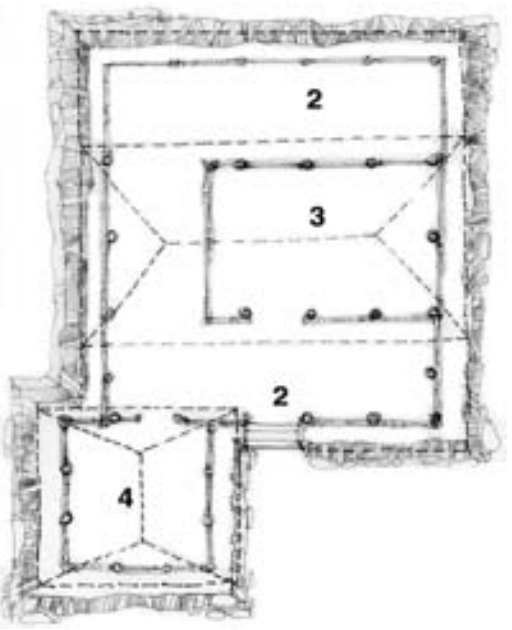


FRONT VIEW

4.2.3 NAYA PARA

House Of Mohammad Hossain (A)





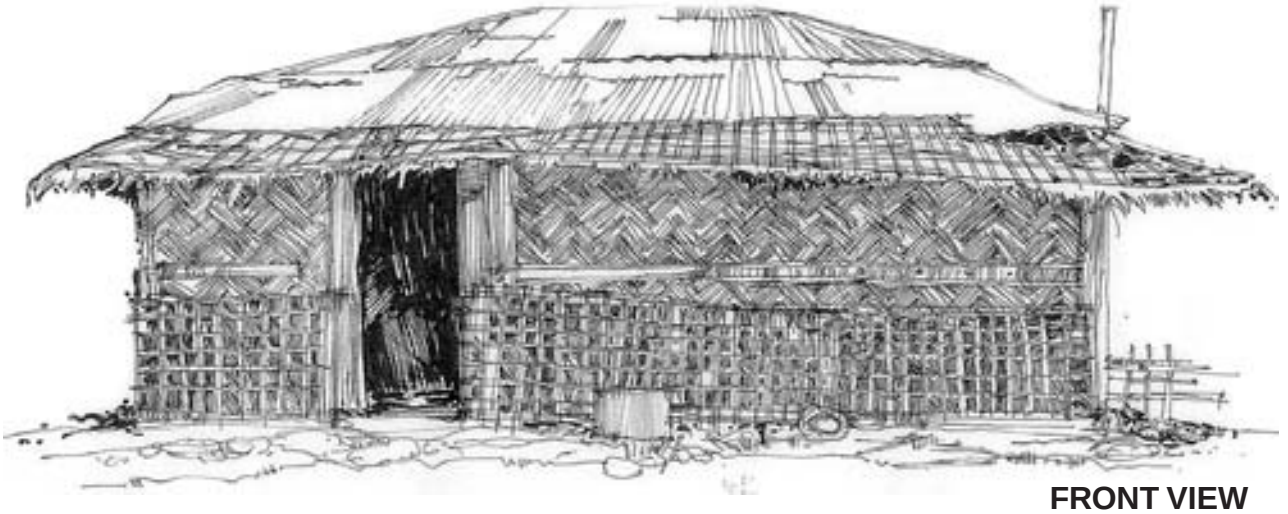
PLAN

Activities

Room Number	Description
1.	Pashchati (enclosed for living)
2.	Pashchati (enclosed)
3.	Sleeping Room
4.	Kitchen & Eating

Structure

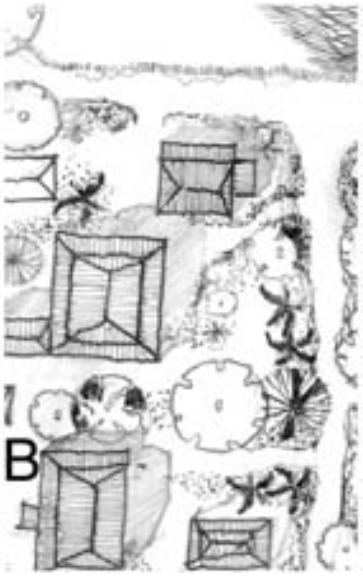
Components		Materials
Vertical Support	:	Wooden Post
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Tin Roof
Wall	:	Bamboo Woven Mat
Floor	:	Mud Finish

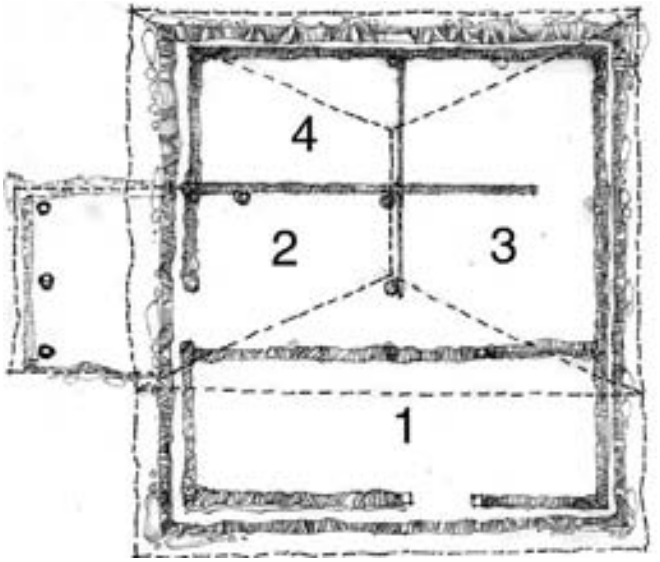


FRONT VIEW

4.2.3 NAYA PARA

House of Mostafa Rahman (B)





PLAN

SITE LOCATION

Activities Room Number	Description
1.	Sleeping room for Father-in-Law & Sister-in-Law
2.	Sleeping & Living
3.	Sleeping Room
4.	Kitchen

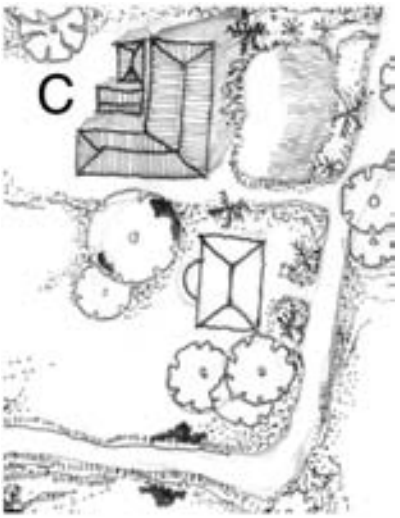
Structure

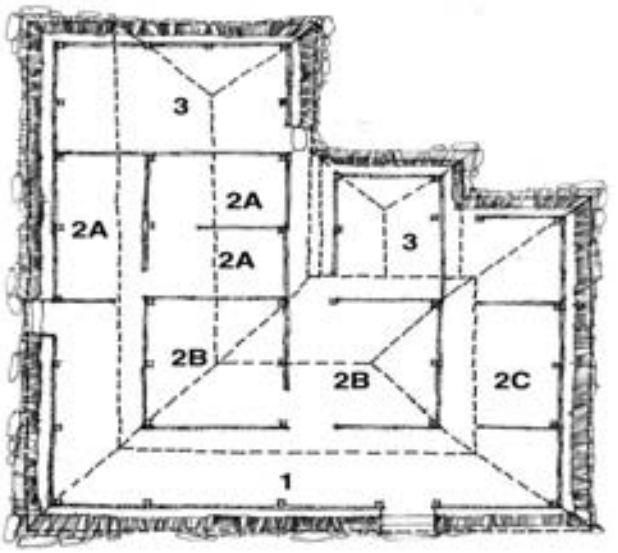
Components		Materials
Vertical Support	:	Bamboo Post & Mud Wall
Roof Support & Roofing Material	:	Bamboo / Wooden Joist & Purlin Thatch / Tin Roof
Wall	:	Mud Wall
Floor	:	Mud Finish

FRONT VIEW

4.2.3 NAYA PARA

House of Ishaque Sikder (C)





PLAN

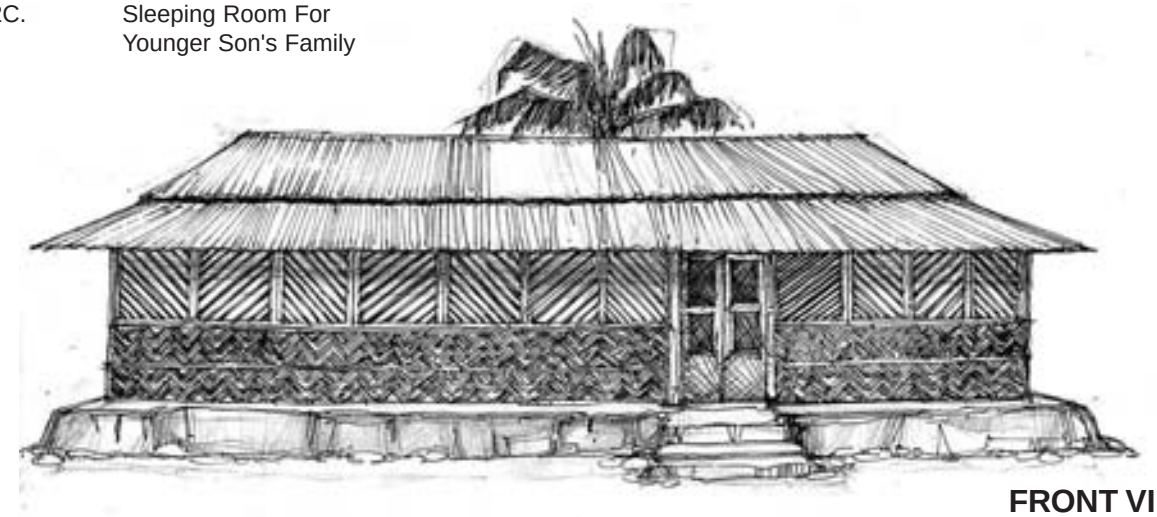
SITE LOCATION

Activities

Room Number	Description
1.	Pashchati (enclosed) Common Living & Sleeping Area
2A.	Sleeping Room For Parents
2B.	Sleeping Room For older Son's Family
2C.	Sleeping Room For Younger Son's Family

Structure

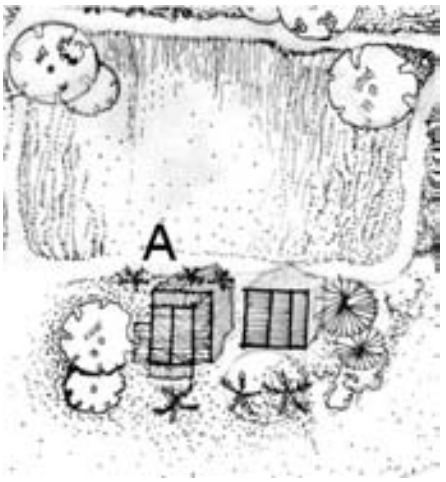
Components		Materials
Vertical Support	:	Wooden Post
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Tin Roof
Wall	:	Bamboo Woven Mat & Wooden Design Slats
Floor	:	Well Finished Mud Floor

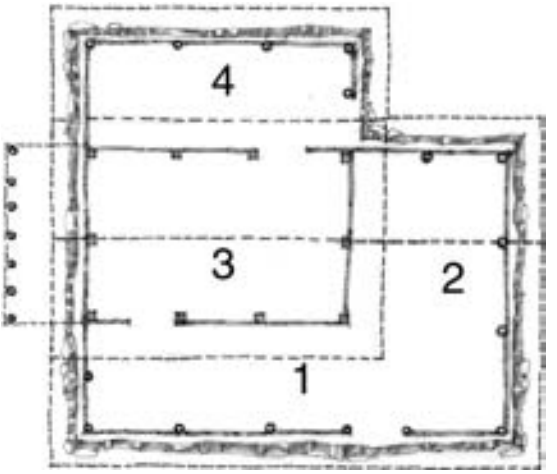


FRONT VIEW

4.2.4 CHAR PARA

House of Monir Ahmed (A)





PLAN

SITE LOCATION

Activities

Room Number	Description
1.	Pashchati (enclosed for Living)
2.	Pashchati (enclosed for Sleeping)
3.	Sleeping Room
4.	Kitchen & Eating Area

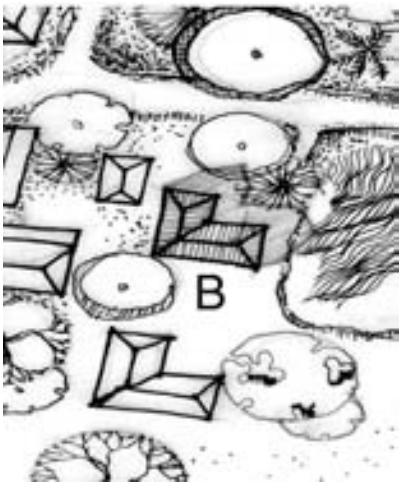
Structure

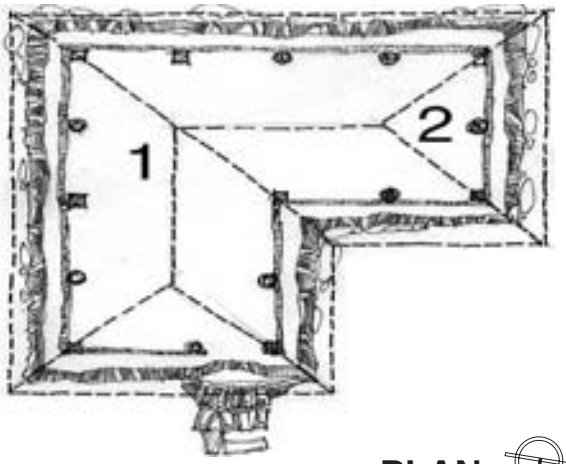
Components		Materials
Vertical Support	:	Bamboo Post
Roof Support & Roofing Material	:	Bamboo Joist, Purlin & Tin Roof
Wall	:	Bamboo Woven Mat
Floor	:	Well Finished Mud Floor

FRONT VIEW

4.2.4 CHAR PARA

House of Abu Bakkar (B)





PLAN

SITE LOCATION

Activities

Room Number	Description
1.	Sleeping Area
2.	Kitchen & Eating Area

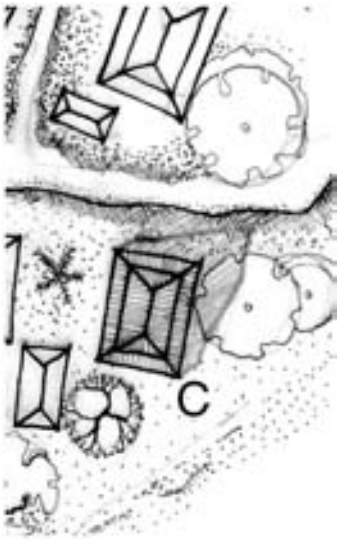
Structure

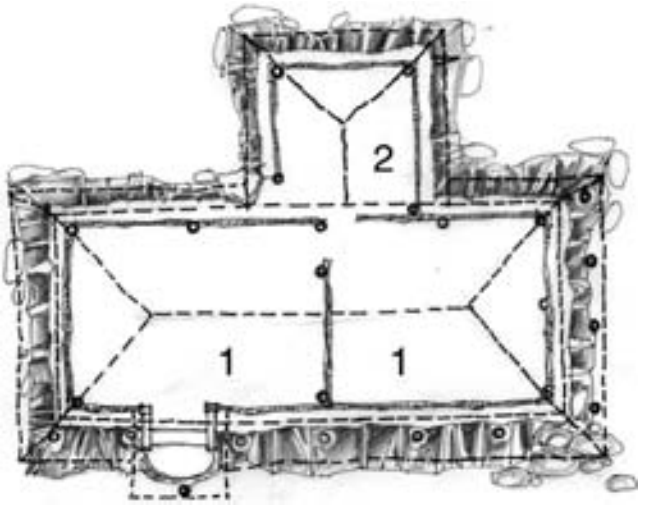
Components		Materials
Vertical Support	:	Bamboo Post
Roof Support & Roofing Material	:	Bamboo Joist, Purlin & Thatch Roof
Wall	:	Bamboo Woven Mat
Floor	:	Mud Finish

FRONT VIEW

4.2.4 CHAR PARA

House of Nurul Azim (C)





PLAN

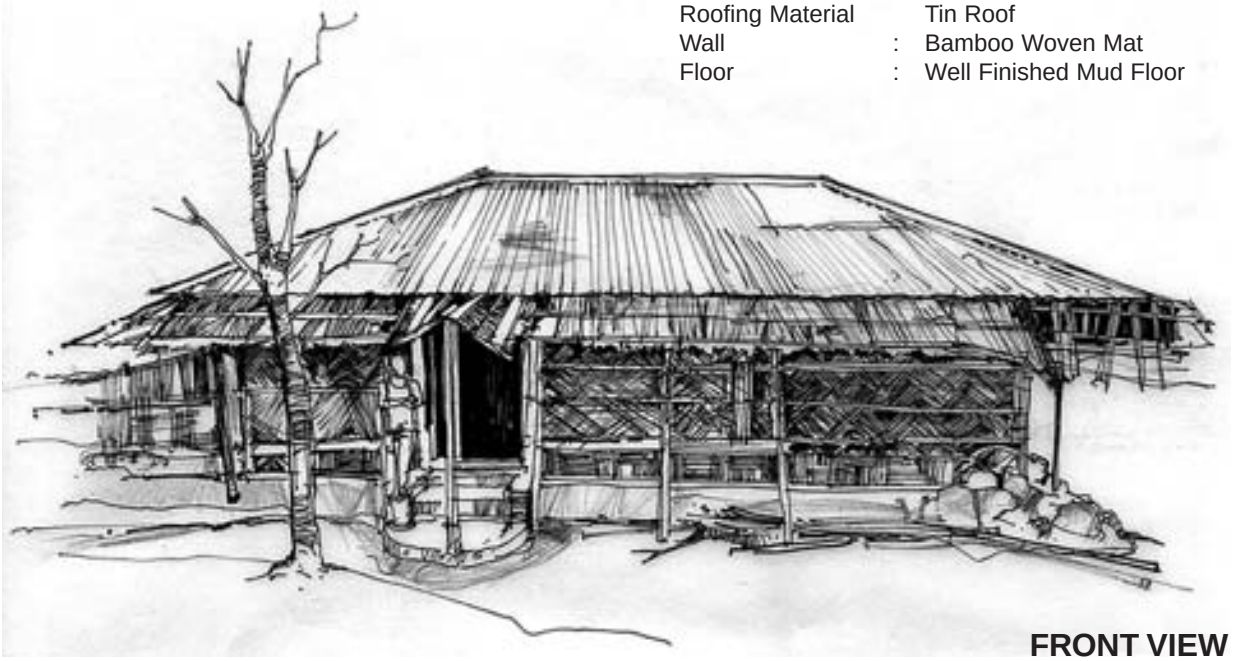
SITE LOCATION

Activities

Room Number	Description
1.	Sleeping Room
2.	Kitchen

Structure

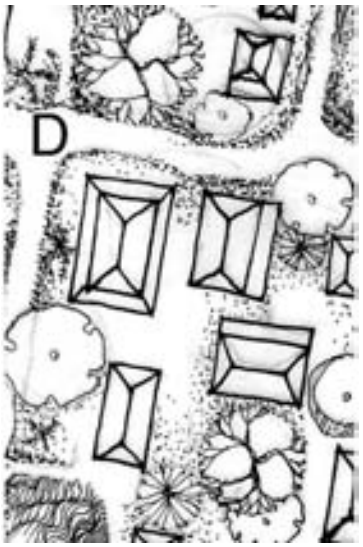
Components		Materials
Vertical Support	:	Wooden Post
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Tin Roof
Wall	:	Bamboo Woven Mat
Floor	:	Well Finished Mud Floor



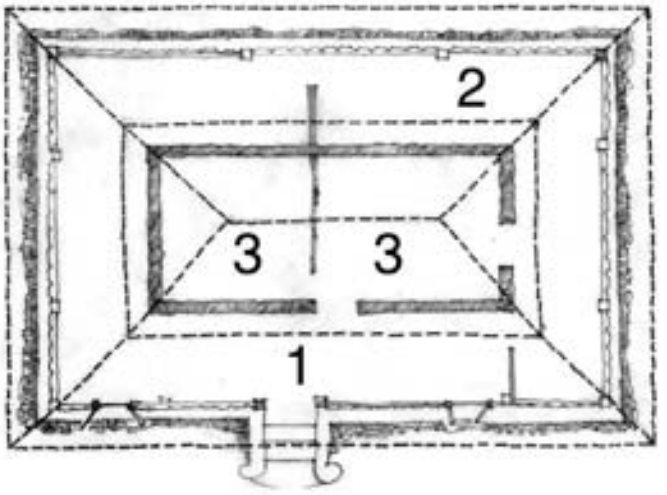
FRONT VIEW

4.2.4 CHAR PARA

House of Nur Ahmed (D)



SITE LOCATION



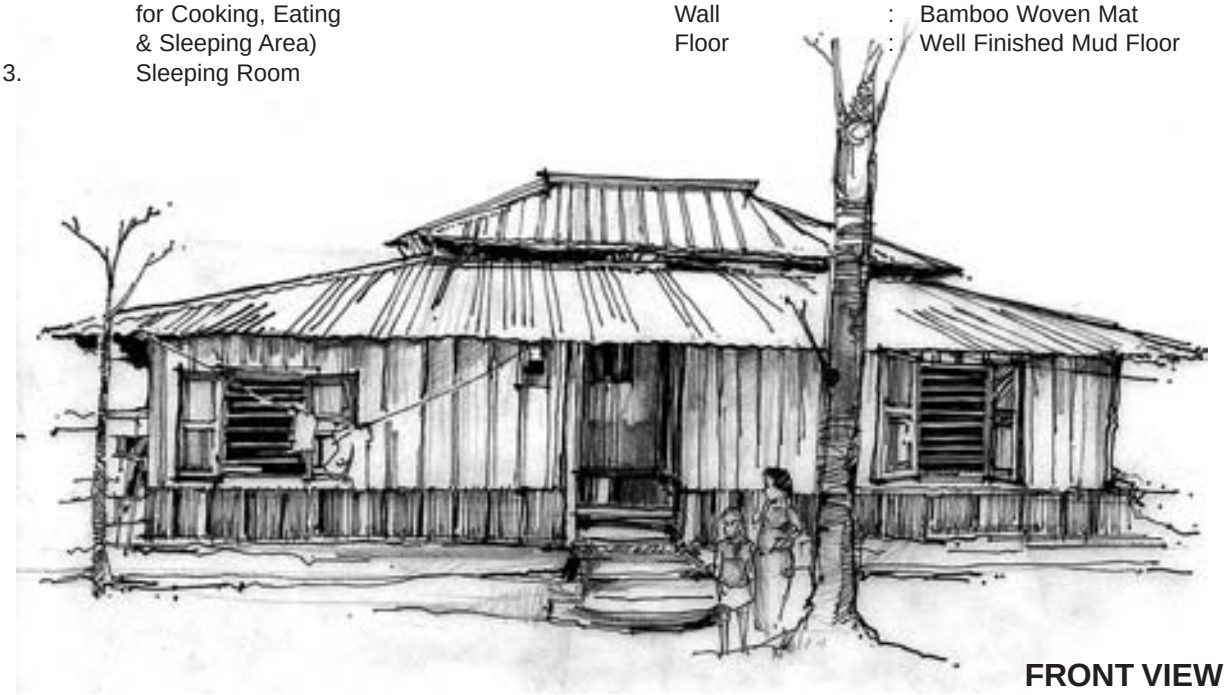
PLAN

Activities

Room Number	Description
1.	Pashchati (enclosed for Living)
2.	Pashchati (enclosed for Cooking, Eating & Sleeping Area)
3.	Sleeping Room

Structure

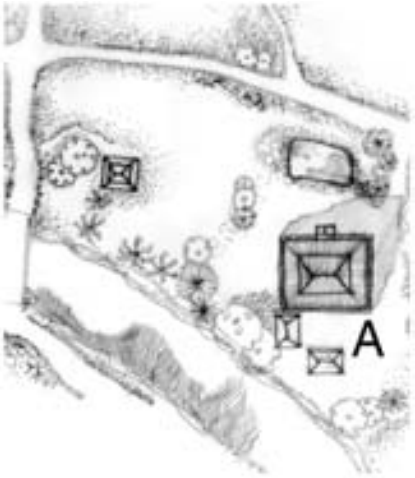
Components		Materials
Vertical Support	:	Wooden Post & Mud Wall
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Tin Roof
Wall	:	Bamboo Woven Mat
Floor	:	Well Finished Mud Floor

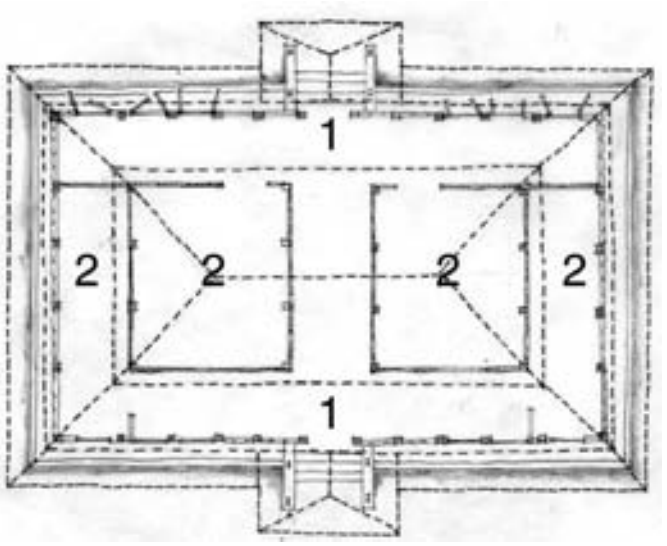


FRONT VIEW

4.2.5 MIAJI PARA

House of Abbas Ahmad Chowdhury (A)





PLAN

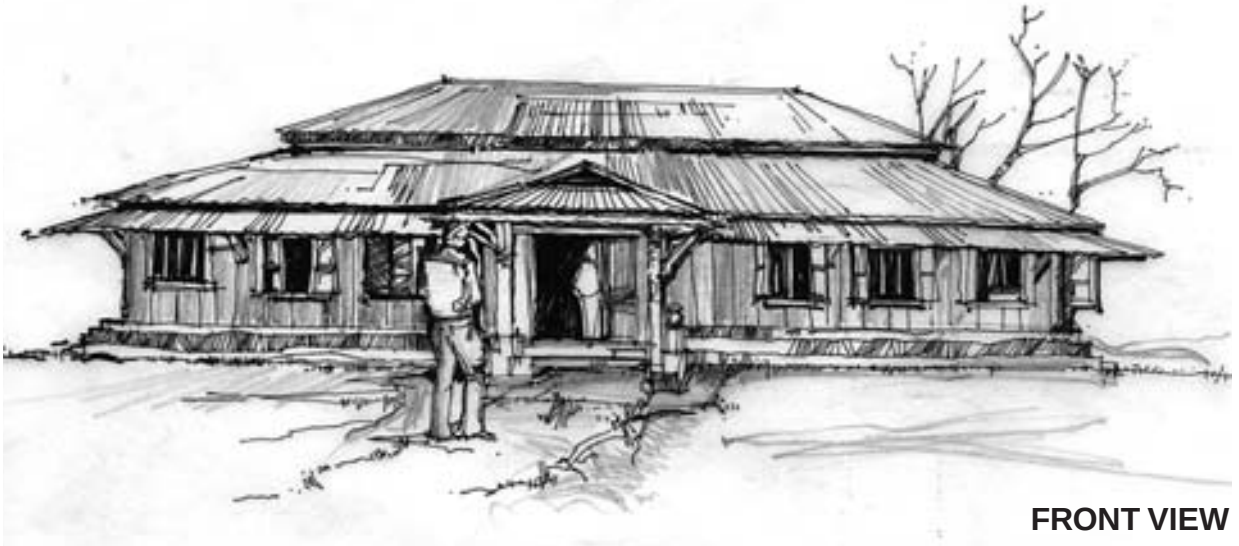
SITE LOCATION

Activities

Room Number	Description
1.	Pashchati (enclosed for Living & Sleeping) (Public Domain)
2.	Sleeping Room

Structure

Components		Materials
Vertical Support	:	Wooden Post
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Tin Roof
Wall	:	Bamboo Woven Mat
Floor	:	Well Finished Mud Floor

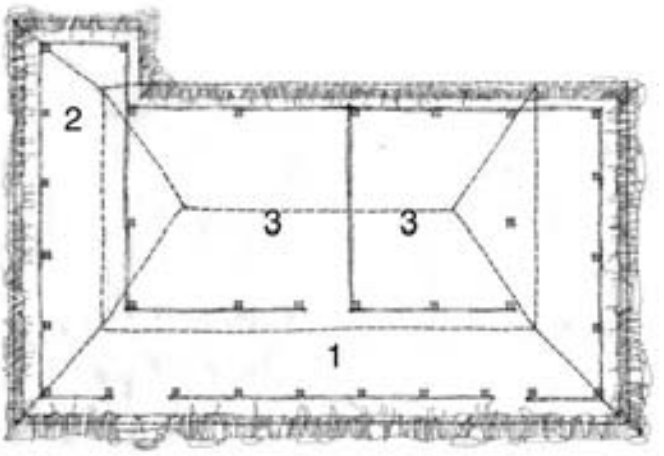


FRONT VIEW

4.2.5 MIAJI PARA

House of Mukter Ahmad (B)

SITE LOCATION



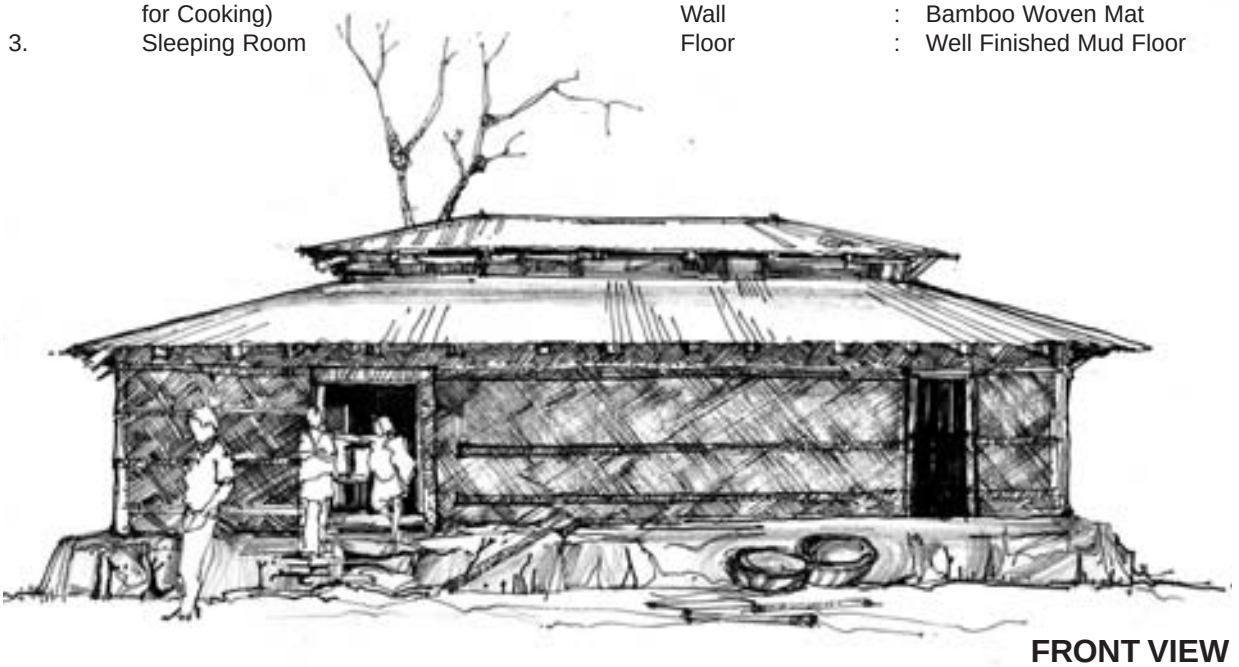
PLAN

Activities

Room Number	Description
1.	Pashchati (enclosed for Living)
2.	Pashchati (enclosed for Cooking)
3.	Sleeping Room

Structure

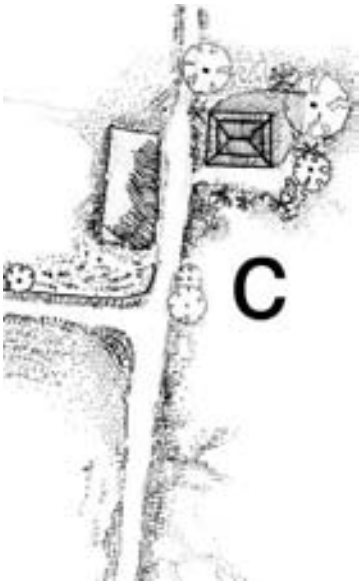
Components		Materials
Vertical Support	:	Pre-cast r.c.c. Post
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Tin Roof
Wall	:	Bamboo Woven Mat
Floor	:	Well Finished Mud Floor

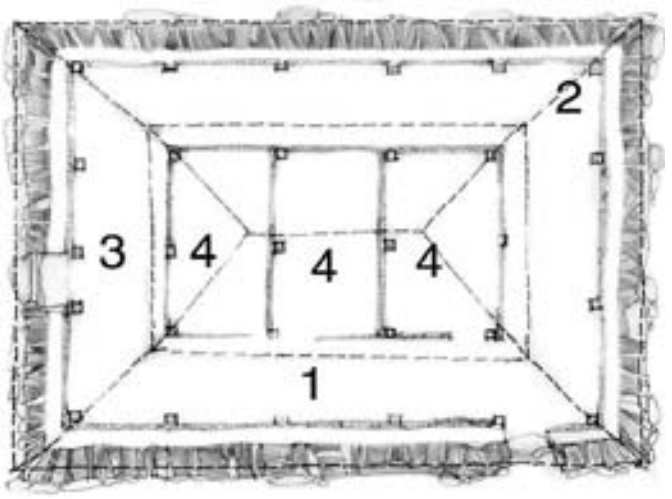


FRONT VIEW

4.2.5 MIAJI PARA

House of Zahir Ahmad (C)





SITE LOCATION

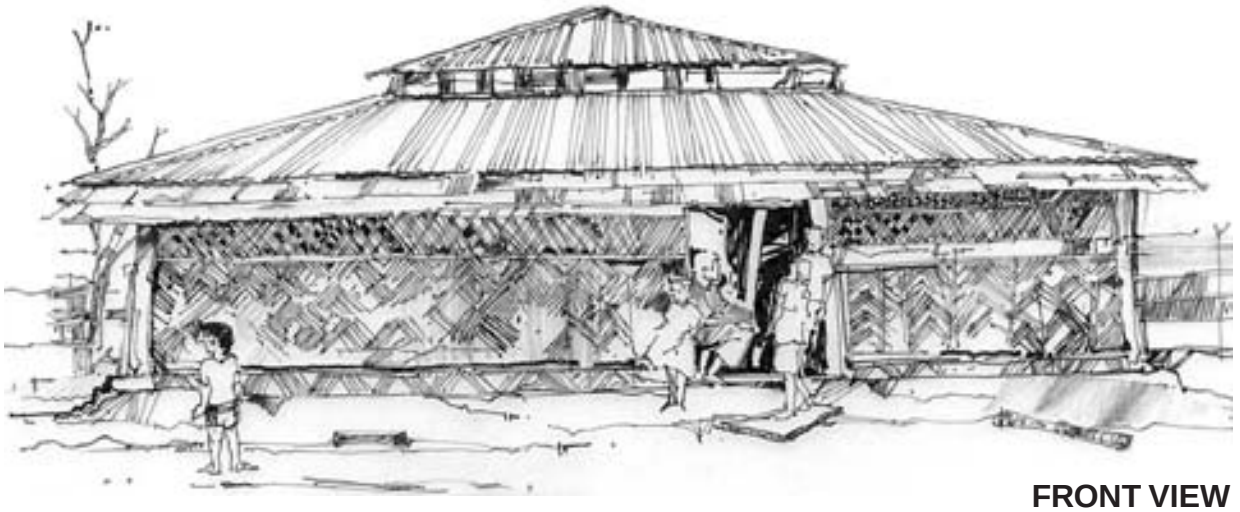
PLAN

Activities

Room Number	Description
1.	Pashchati (enclosed)
2.	Pashchati (enclosed For Cooking & Eating)
3.	Pashchati (enclosed For Living & Sleeping)
4.	Sleeping Room

Structure

Components		Materials
Vertical Support	:	Wooden Post
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Tin Roof
Wall	:	Bamboo Woven Mat
Floor	:	Well Finished Mud Floor

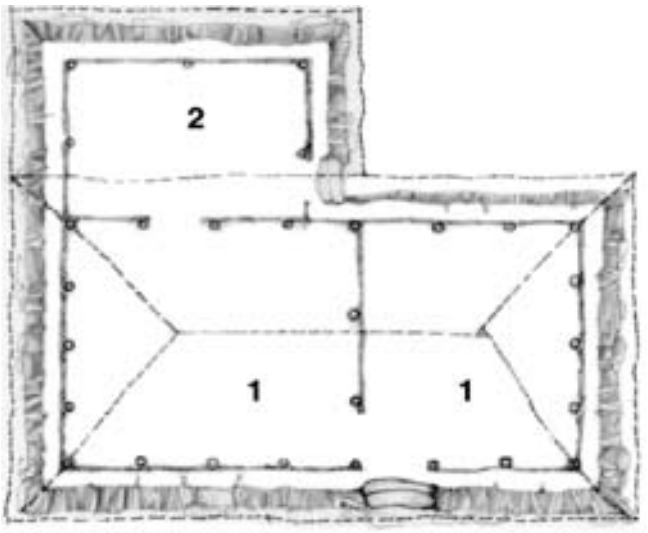


FRONT VIEW

4.2.5 MIAJI PARA

House of Rashid Ahmed (D)

SITE LOCATION



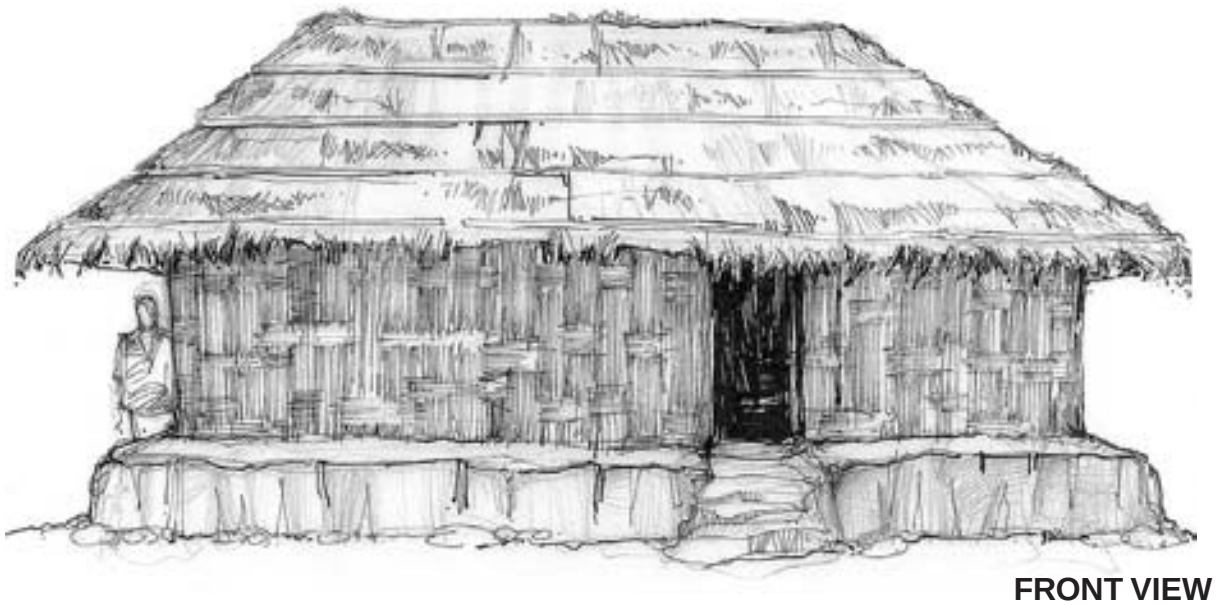
PLAN

Activities

Room Number	Description
1.	Sleeping Room
2.	Kitchen & Eating Area

Structure

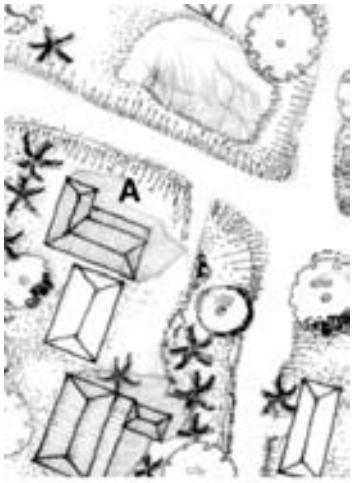
Components		Materials
Vertical Support	:	Bamboo Post
Roof Support & Roofing Material	:	Bamboo Joist, Purlin & Thatch Roof
Wall	:	Bamboo Woven Mat
Floor	:	Mud Finish



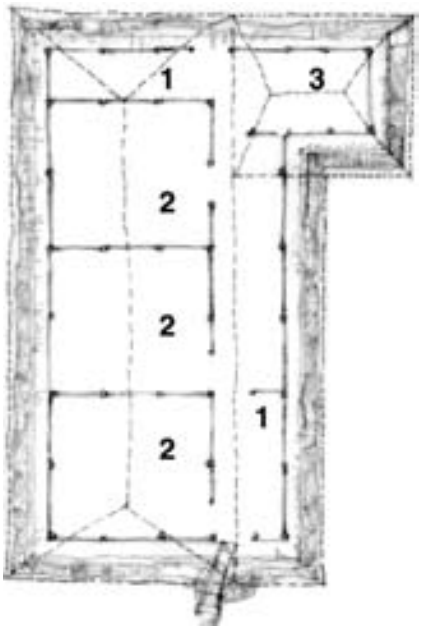
FRONT VIEW

4.2.6 MIAJI PARA

House of Mozaffar Ahmad (A)



SITE LOCATION



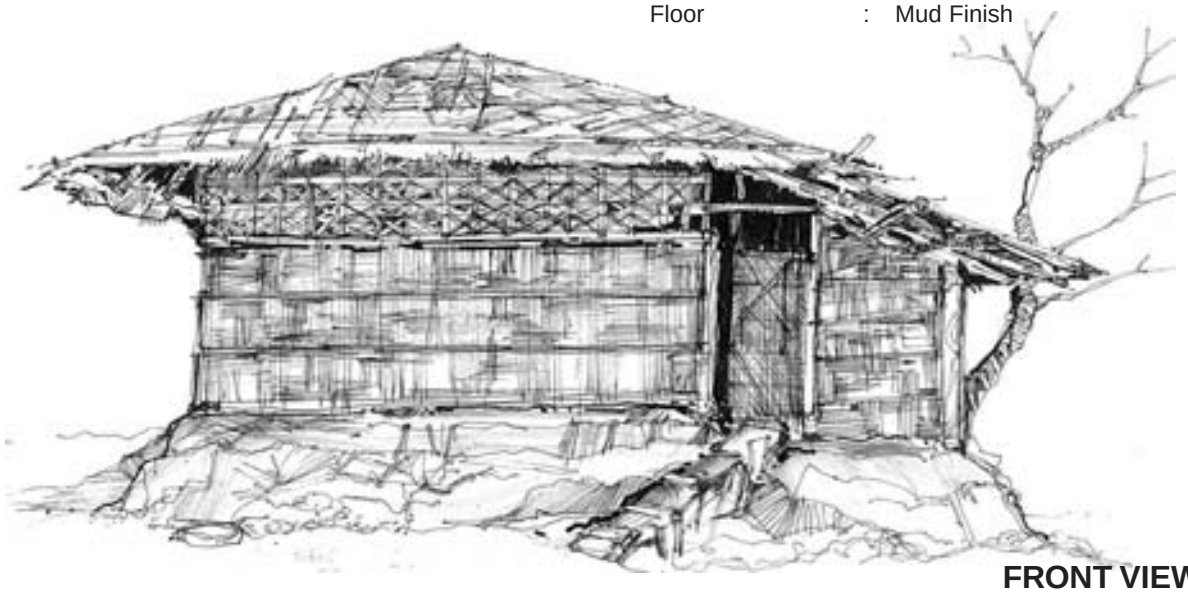
PLAN

Activities

Room Number	Description
1.	Pashchati (enclosed)
2.	Bed Room
3.	Kitchen & Eating

Structure

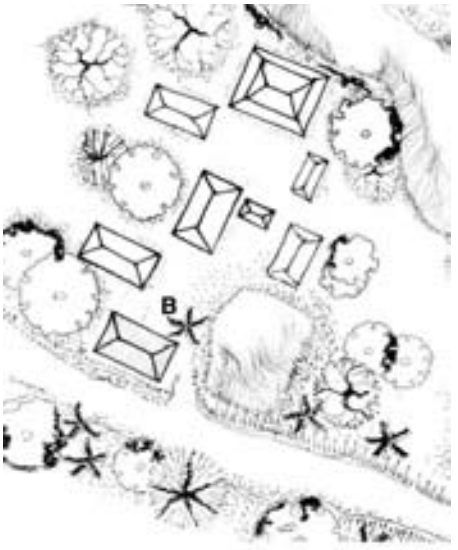
Components		Materials
Vertical Support	:	Bamboo Post
Roof Support & Roofing Material	:	Bamboo Joist, Purlin & Thatch Roof
Wall	:	Bamboo Woven Mat
Floor	:	Mud Finish



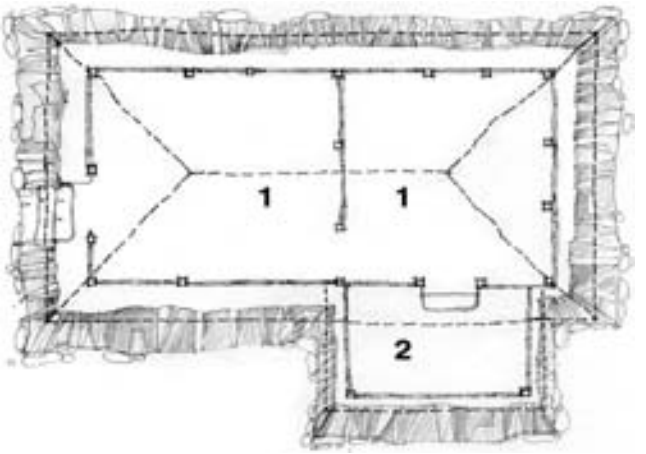
FRONT VIEW

4.2.6 MAJHER PARA

House of Abdul Hamid (B)



SITE LOCATION



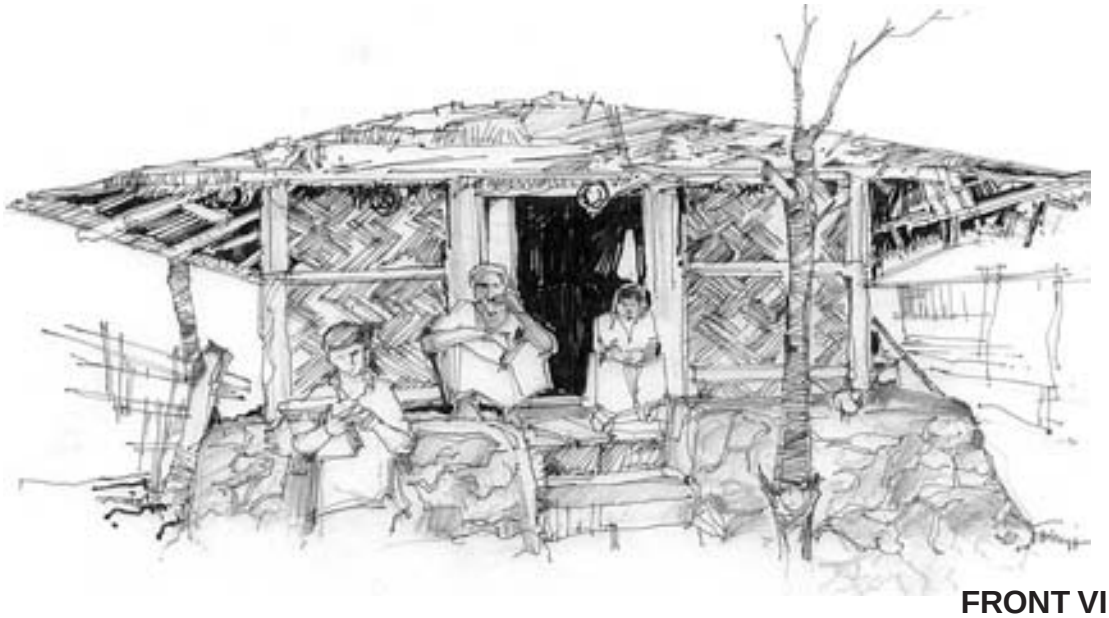
PLAN

Activities

Room Number	Description
1.	Sleeping Room
2.	Kitchen

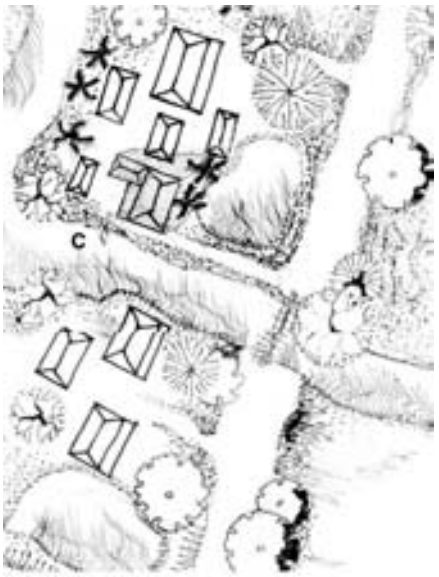
Structure

Components		Materials
Vertical Support	:	Wooden Post
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Thatch Roof / Asbestos Sheet
Wall	:	Bamboo Woven Mat
Floor	:	Mud Finish

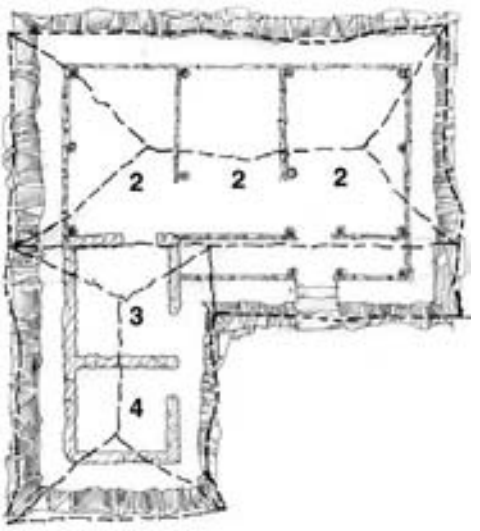


FRONT VIEW

4.2.6 MAJHER PARA
House of Shamsul Alam (C)



SITE LOCATION



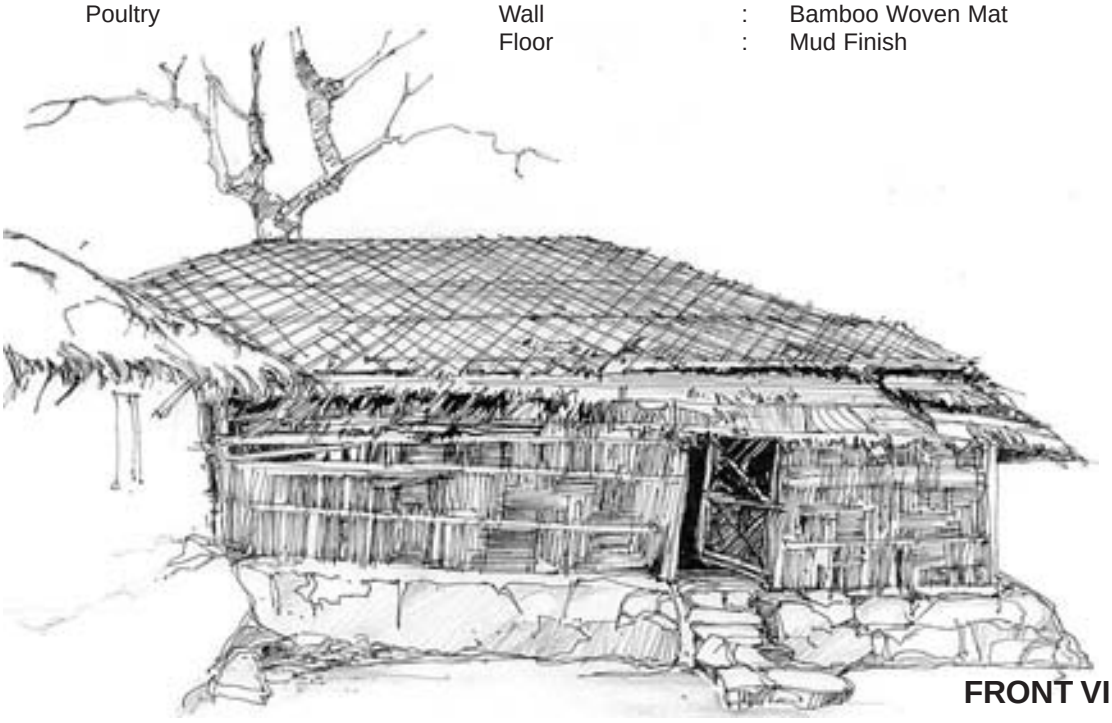
PLAN

Activities

Room	Description
Number	Pashchati (enclosed)
1.	Sleeping room
3.	Kitchen
4.	Poultry

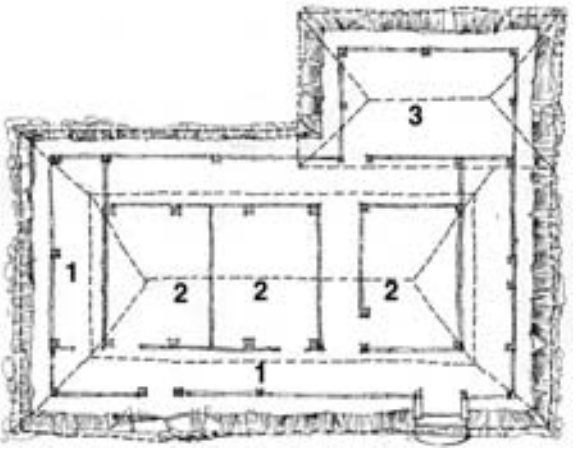
Structure

Components		Materials
Vertical Support	:	Bamboo Post & Mud Wall
Roof Support & Roofing Material	:	Bamboo Joist, Purlin & Thatch Roof
Wall	:	Bamboo Woven Mat
Floor	:	Mud Finish



FRONT VIEW

4.2.6 MAJHER PARA
HOUSE of Zahir Ahmed (D)



PLAN

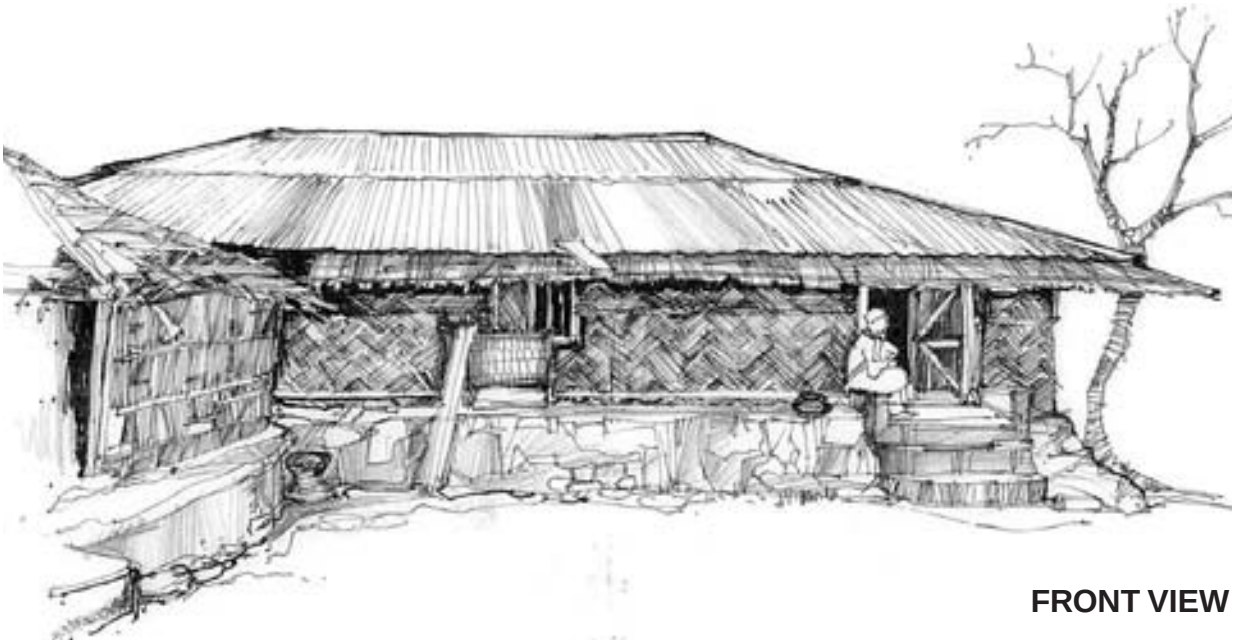
SITE LOCATION

Activities

Room Number	Description
1.	Pashchati (enclosed)
2.	Sleeping Room
3.	Room

Structure

Components		Materials
Vertical Support	:	Wooden & pre-cast r.c.c Post
Roof Support & Roofing Material	:	Wooden Joist, Purlin & Tin Roof
Wall	:	Bamboo Woven Mat
Floor	:	Well Finished Mud Floor



FRONT VIEW

5. ARCHITECTURAL AND STRUCTURAL DETAILS OF HOUSES

5.1 GENERAL

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 kinds of houses are vernacular, anonymous, spontaneous and rural. The builders show an admirable talent of blending their houses with the natural surroundings. The houses 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.

This section presents structural details of houses built with bamboo and wood. it is our understanding that materials alone do not make houses cyclone resistant rather, it is the manner in which these are used.

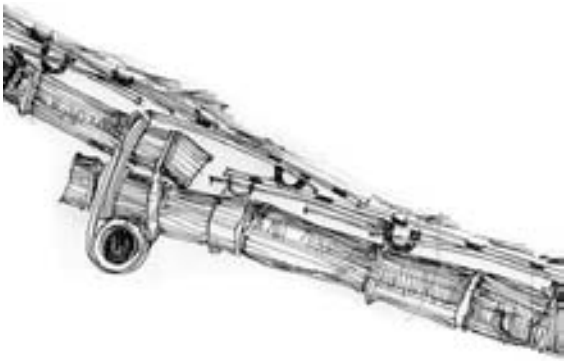
The details shown on the following pages show the manner of use by local builders. The competence of local builders is evident in their understanding and ability to identify certain structural features which are particularly susceptible to wind damage. These features are in the roof structures, extra 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.

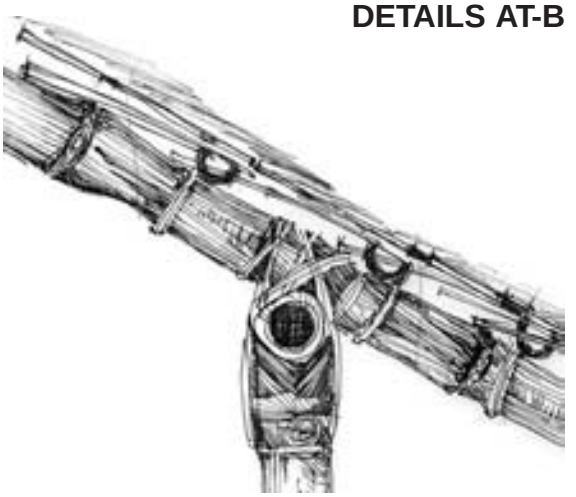
Another major weakness is the fast deterioration of traditional building materials like bamboo, as these are not protected against decay, fungi, termites and high humidity when in contact with the ground.

5.2 DETAILS OF BAMBOO STRUCTURE

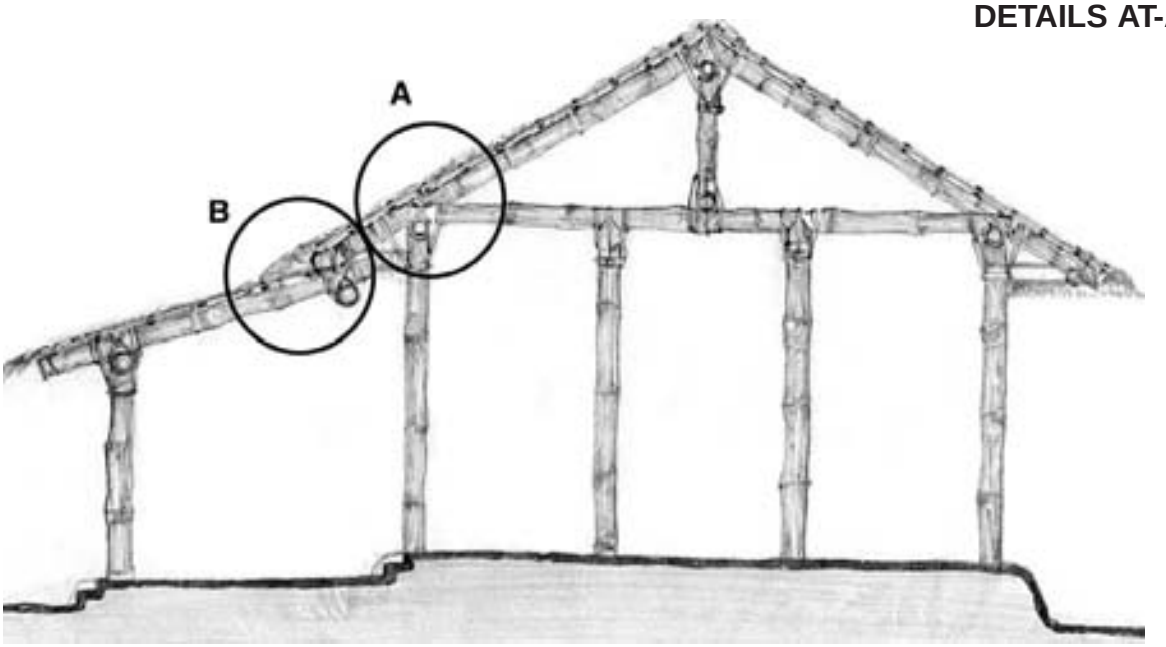
PERSPECTIVE VIEW OF ROOF CONNECTION
(between roof of 'ghar' &' pashchati')



DETAILS AT-B

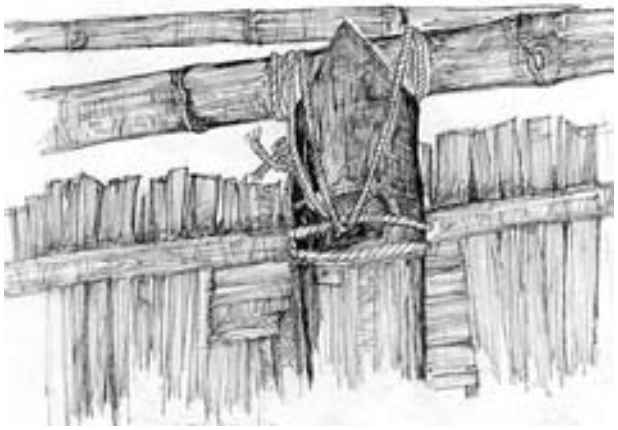


DETAILS AT-A



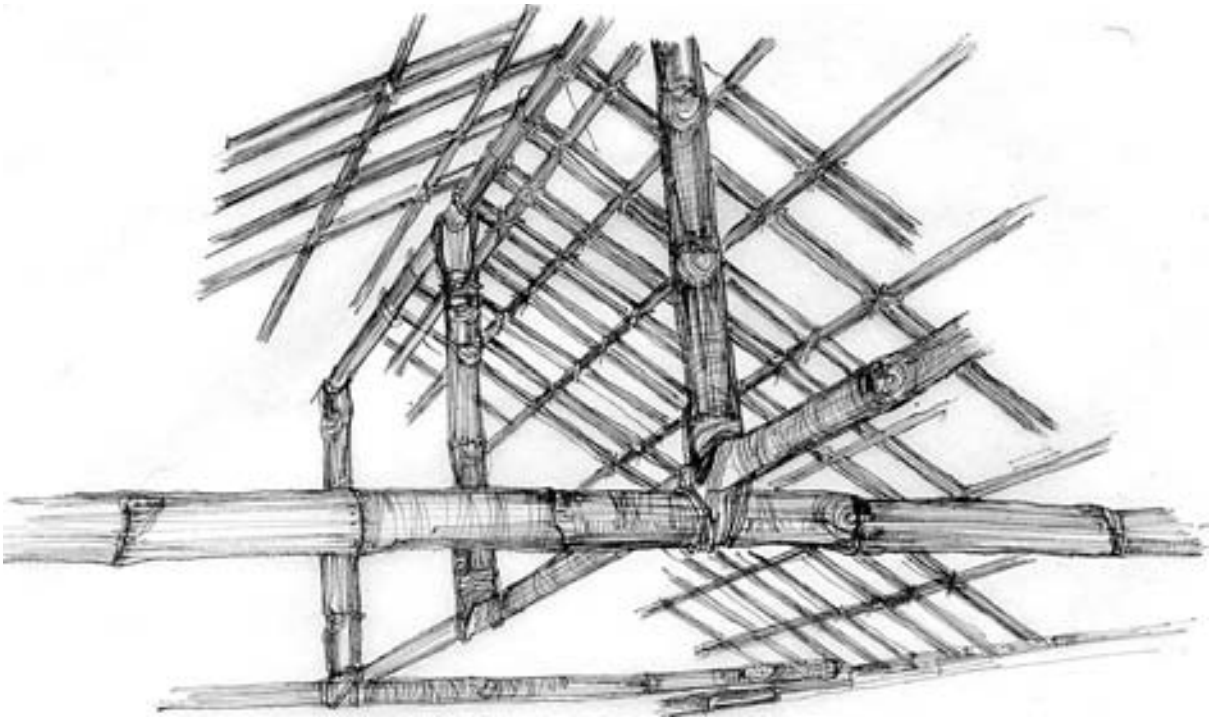
TRANSVERSE SECTION (section & details are not in scale)

5.2 DETAILS OF BAMBOO STRUCTURE



DETAILS OF VERTICAL SUPPORT

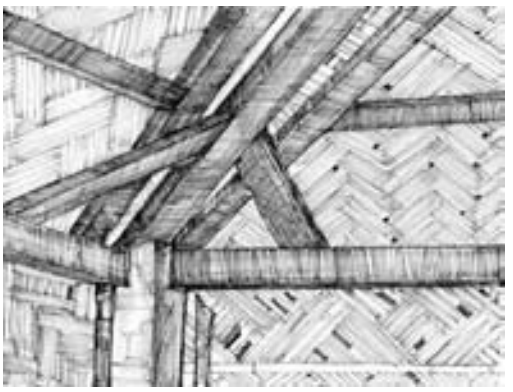
CORNER DETAILS OF RIDGE



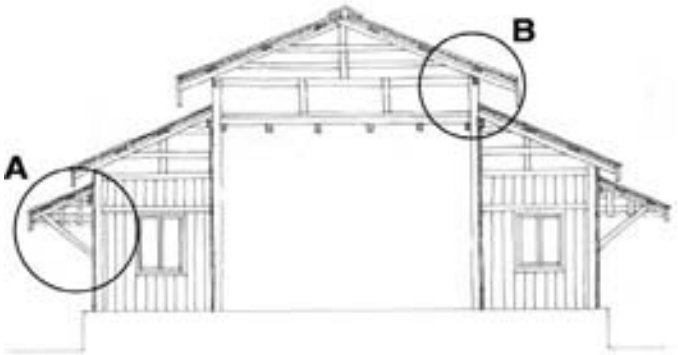
DETAIL PERSPECTIVE OF ROOF STRUCTURE

5.3 DETAILS OF WOODEN STRUCTURE

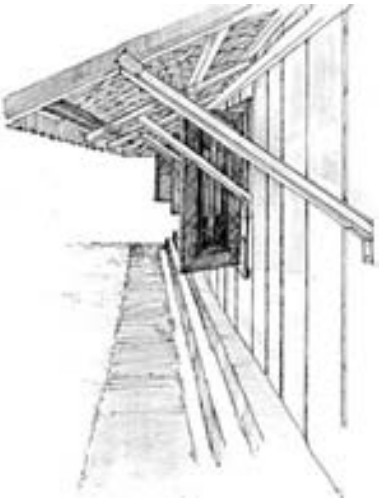
DETAILS AT B



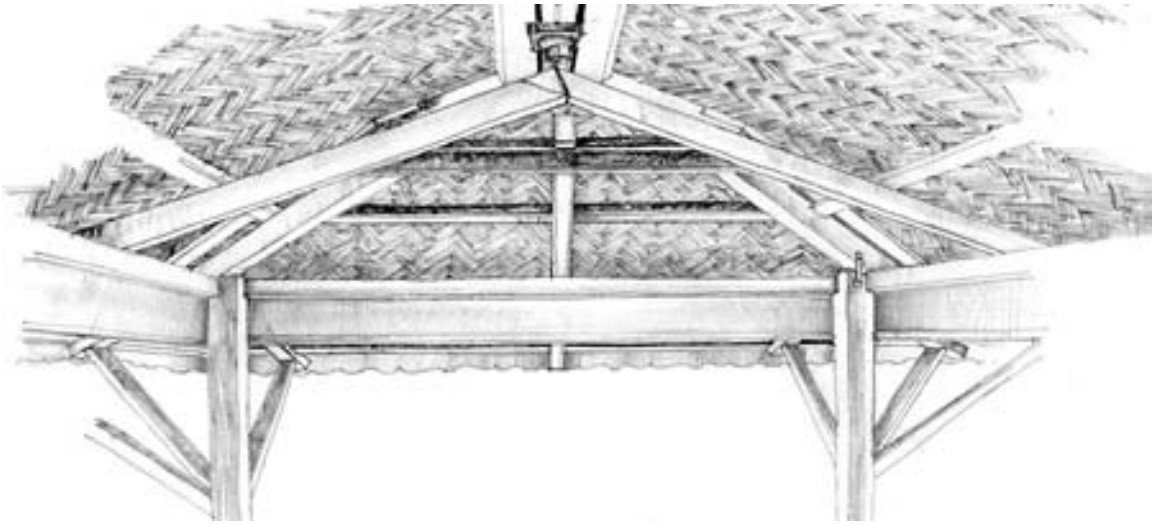
TYPICAL CORNER DETAILS



KEY SECTION



DETAIL PERSPECTIVE AT A



DETAILS OF ROOF AT ENTRANCE

6. TECHNOLOGY INTERVENTION IN HOUSE BUILDING

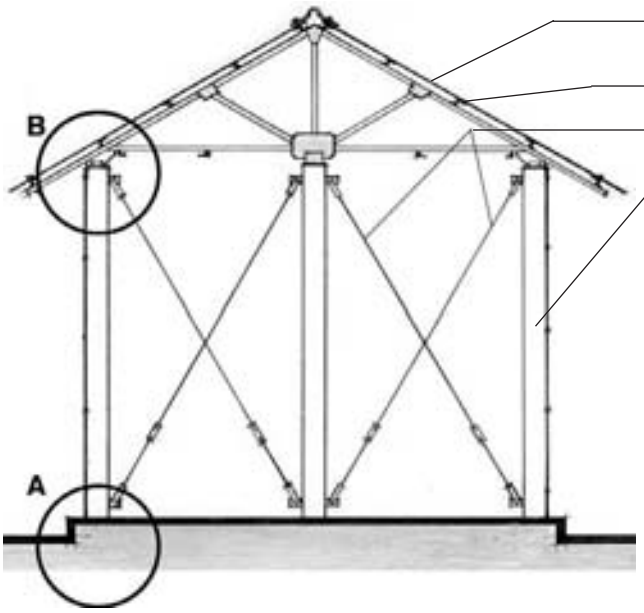
6.1 GENERAL

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.

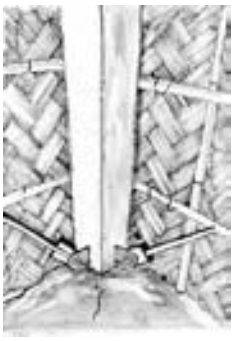
The technology intervention in house building at present is limited only to strengthening the structures for cyclone resistance by using pre-cast concrete post, steel truss and corner bracing. This house form disregards the traditional house topology, roof shape and life style of the local people.

6.2 SPECIFIC CASE OF TECHNOLOGY INTERVENTION

BDRCS with assistance from the International Federation of Red Cross and Red Crescent Societies has initiated design and building of a prototype House -"THE WIND RESISTANT HUT".



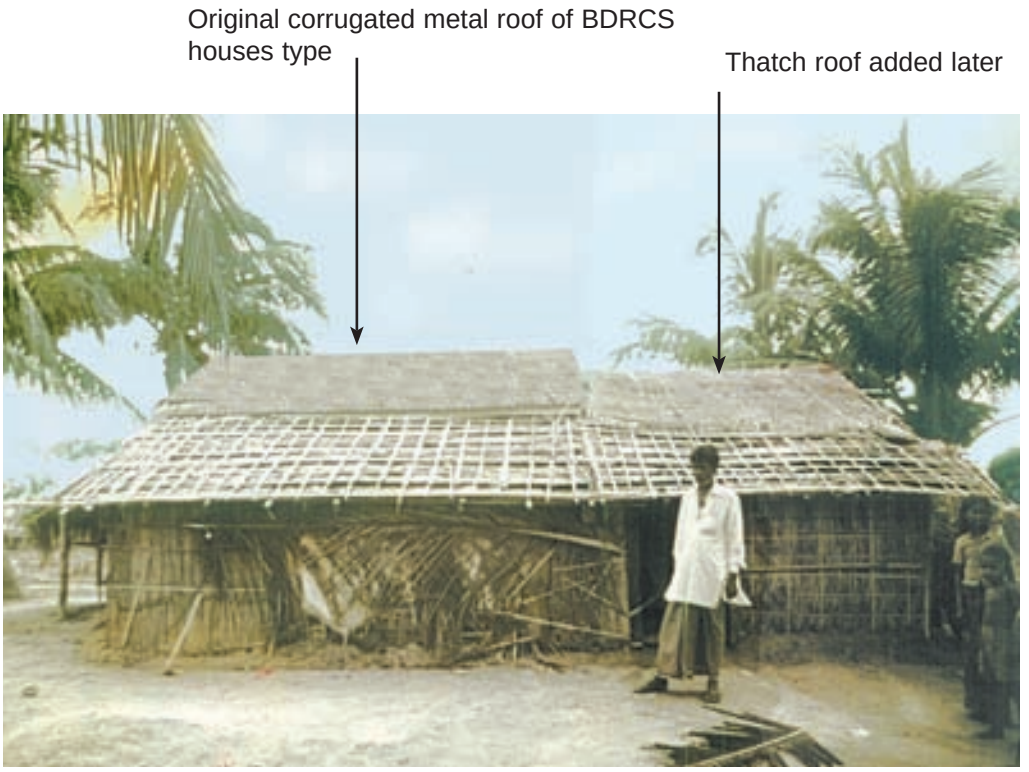
TRANSVERSE SECTION



DETAIL AT A

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. The problem 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 and low acceptance by the beneficiaries.

DETAIL AT B



TRANSFORMATION OF **THE WIND RESISTANT HUT**

Steel sections for fabrication of truss in marine weather require application of properly specified undercoat 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 vest record of resistance to wind loads. The recommended gable roof in cyclone affected areas is High Gable roof with pitch between 35˚ to 45˚. The roof shape of the BDRCS house type is gable roof with 27.5˚ pitch.

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 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.

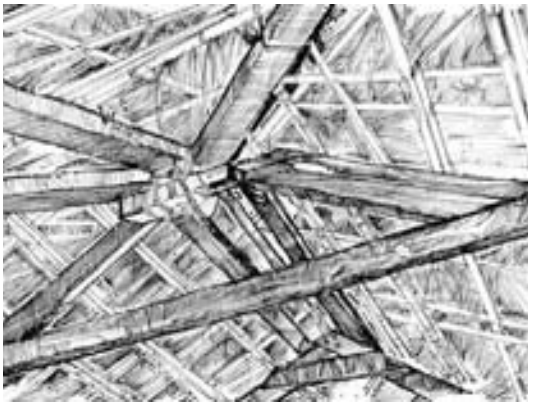
7. INNOVATIVE USE OF MATERIALS BY LOCAL BUILDERS

Building materials like pre-cast concrete post, nylon ropes, steel angle and steel sections for fixing and tying of different structural members are shown on this page.

These details show a keen understanding by the local builders in the use of heavier sections and materials for vertical support. This makes the traditional house stronger, thereby making it more resistant to wind pressure.

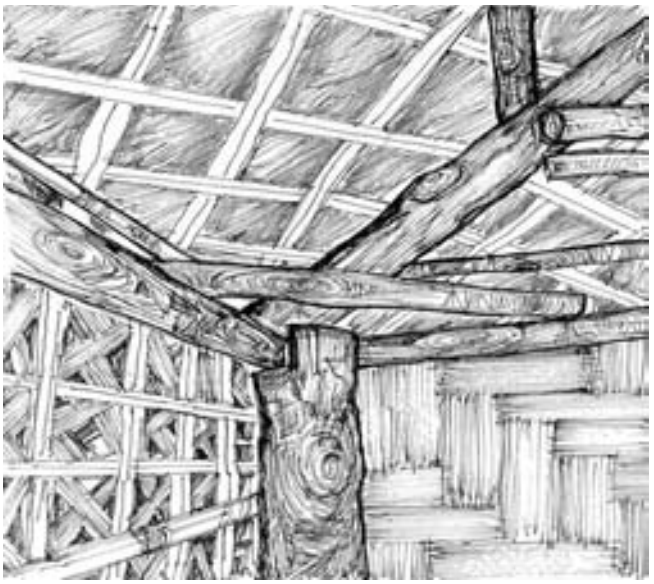
Further an awareness and understanding by local builders is also evident in the fixing details of roof structure to vertical column support, corner details and in the use of extra bracing at the ridge of hip roof, in order to make the house more cyclone resistant.

The local builder's use of stronger and durable materials like nylon rope for tying wood and bamboo sections for corner reinforcement of the house displays an understanding that many houses come apart at the corners as a result of pressure on two adjacent side walls of the houses during cyclone.



DETAILS OF RIDGE

USE OF PRE-CAST CONCRETE COLUMN



INNOVATIVE USE OF WOOD SECTIONS FOR CORNER DETAILS

USE OF NYLON ROPES FOR FIXING ROOF STRUCTURES TO COLUMN

8. BUILDING MATERIALS, CRAFTSMANSHIP AND DEVELOPMENT OF HOUSE TOPOLOGY

8.1 USE OF BUILDING MATERIALS

The materials, used in the houses are predominantly bamboo or wood for both 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 preservative. 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 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 through 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 annex building in Dangorpara, which had failed structurally during the cyclone in 1994.

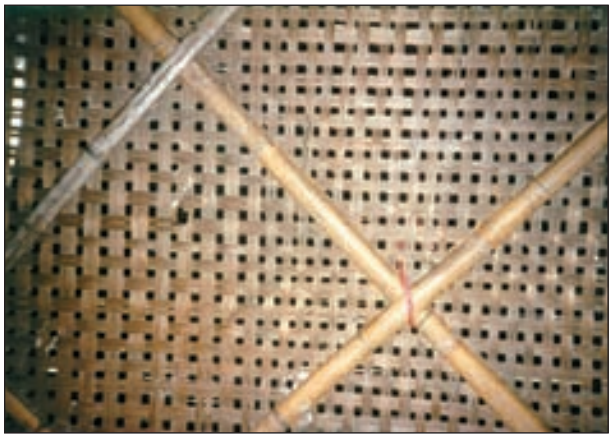
There are examples of innovative use of materials in some houses. The local builders have used a combination of wood, bamboo and pre-cast concrete post in some of these houses.

8.2 CRAFTSMANSHIP

In spite of problems in quality and use of materials we found a very high level of craftsmanship in bamboo and wood work. Some of these works are aesthetically appealing.

These are works produced by the spontaneous and continuing activity of people with a common heritage acting under a community of experience. We are loosing the art of doing these works but then the lesson to be derived from this need not be completely lost to us.

The lesson is to use modern technology in terms of better use of these materials that will last longer, requiring minimum maintenance. This will give confidence to people resulting in better care and better craftsmanship in the use of these materials.



8.3 DEVELOPMENT OF HOUSE TOPOLOGY

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.

9. CASE STUDY : HOUSE THAT SURVIVED THE LAST MOST SEVERE CYCLONE

House of Abdul Motaleb
Dangor para, Teknaf

The worst cyclone in the memory of local people of Dangorpara in recent times was in 1994. During the cyclone of 1994 the houses 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.

LOCATION OF ABDUL MOTALEB'S HOUSE

LOCATION OF CYCLONE SHELTER

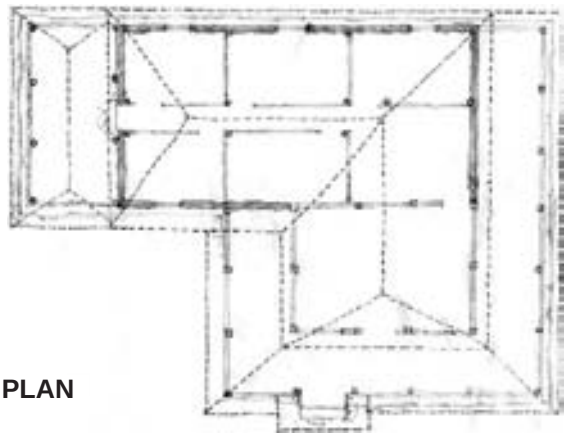
FRONT VIEW

Abdul Motaleb's house is located in an area surrounded by trees and other houses that act as wind breaks.

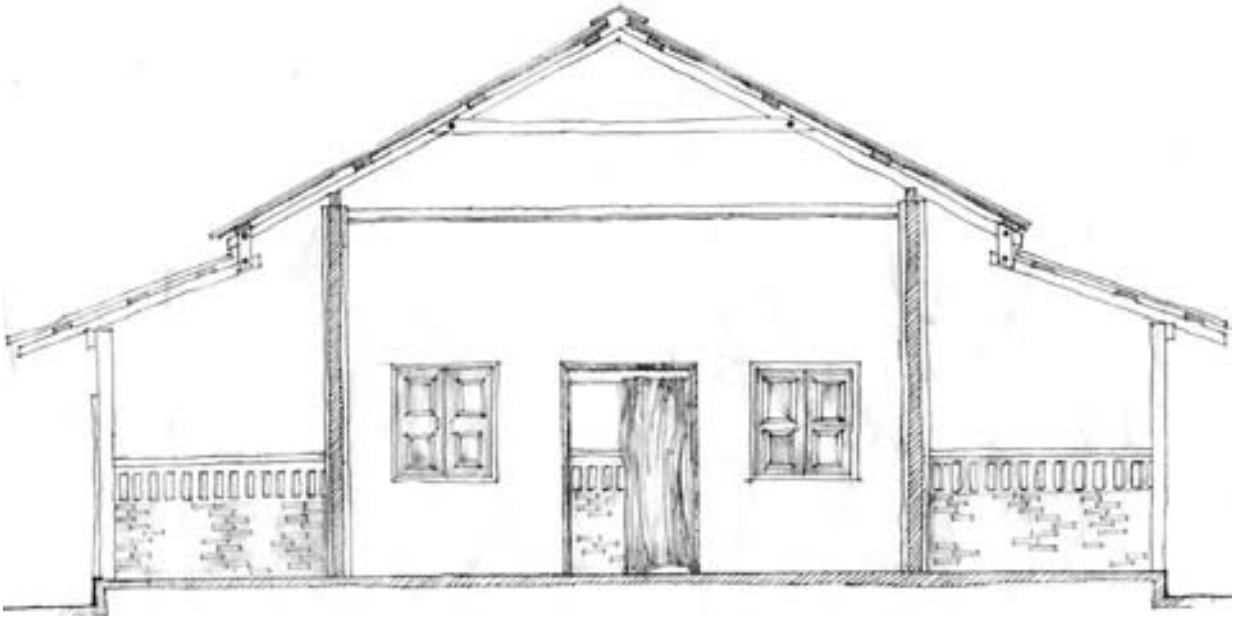
The roof supporting system is fabricated with wood sections of standard quality and size. High level of competence in joiner details, and the use of steel angles, bolts and screws for tying and fixing the different members of the roof structure and the vertical wooden post make the house very strong and cyclone resistant.

The house is selected as a case study because it is built with local building materials and by a local builder.

PERSPECTIVE VIEW OF PASHCHATI



PLAN



TRANSVERSE SECTION

10. RECOMMENDATIONS- GUIDELINES FOR CYCLONE RESISTANT HOUSES

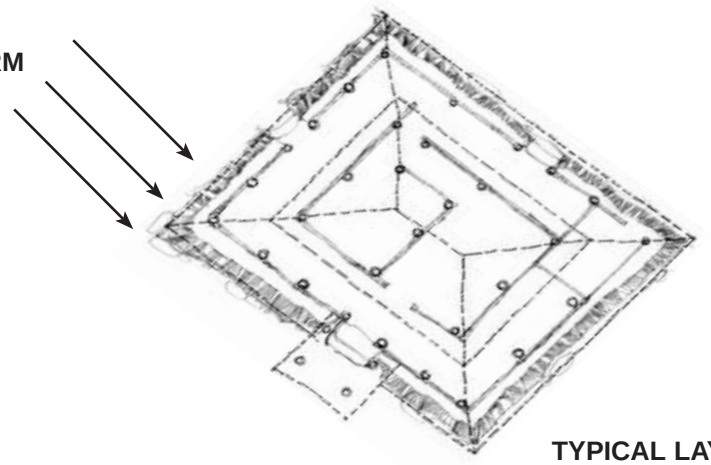
10.1 GENERAL

Recommendations and formulation of guidelines for cyclone resistant houses are based on evaluation and analysis of the SURVEY AND STUDY undertaken by us in six different locations in Cox's Bazar District; and our own input of architectural and design considerations, guidelines for bamboo preservative treatment plan for afforestation, structural details etc. A very important feature of these recommendations is that they are based on people's perception & their identification of problem & possible solutions.

10.2 ARCHITECTURAL AND DESIGN CONSIDERATIONS

10.2.1 LAY-OUT AND ORIENTATION

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

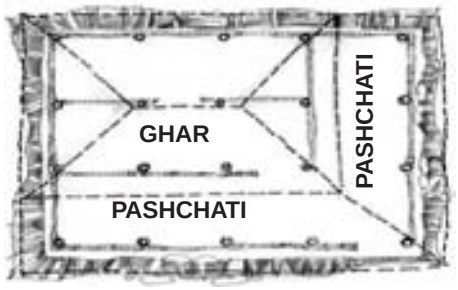


TYPICAL LAY -OUT

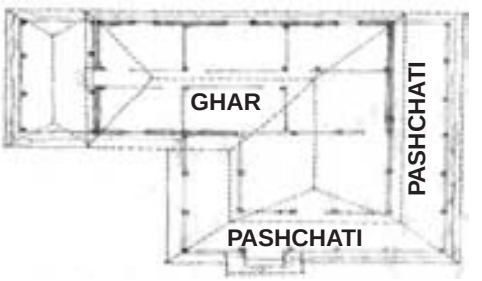
10.2.2 HOUSE TYPE

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.



PLAN :
HOUSE HAVING PASHCHATI ON 2-SIDES



PLAN :
HOUSE HAVING PASHCHATI
ON 3-SIDES

The shape of houses has evolved through considerations of family size, life style and the experience of recurring cyclonic storms. Further, cyclonic storms may have contributed to the people's perception of space and an understanding of its logic.

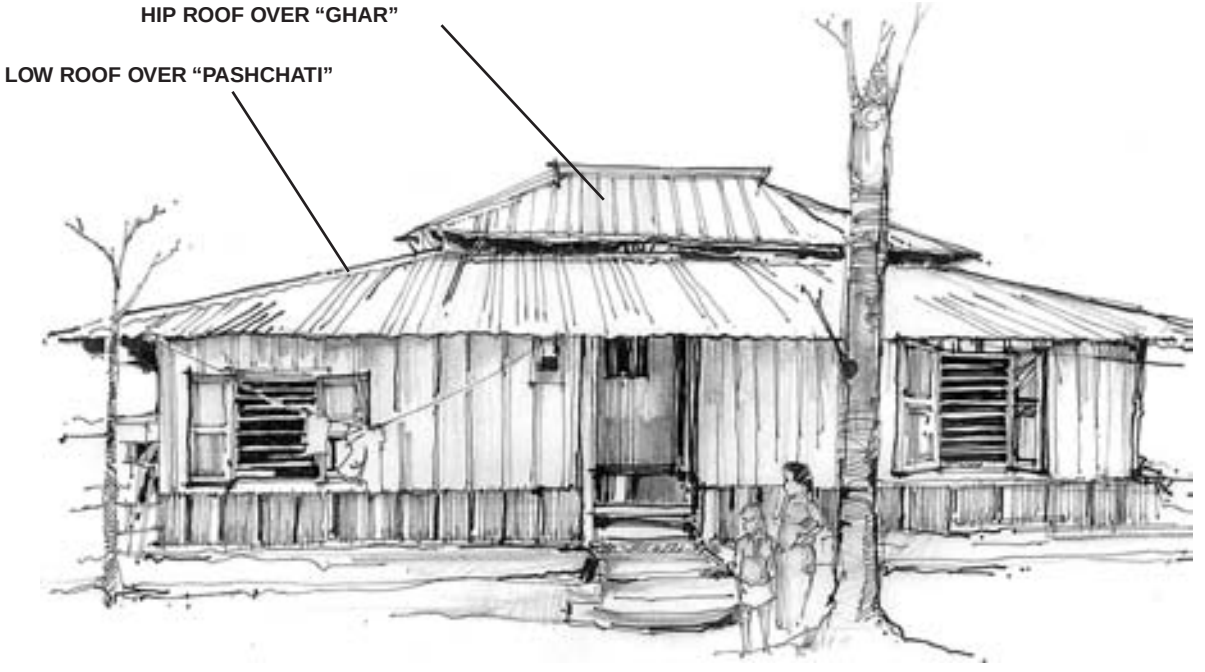
The typical house plan consists of a "ghar'' and "pashchati". In many houses the pashchati runs on all four sides of the "ghar''. There are houses with "pashchati" on 2 or 3 sides of the "ghar''. Whether the "pashchati" is on 2 or 3 sides of the "ghar", it is invariably facing the windward direction.

Cyclonic storms and high winds are the most obvious factors shaping the development of the form of these houses. In order to reduce the high pressure on the internal surfaces of the wall these houses are built with only one opening on the "pashchati". The pashchati wall works as a barrier and reduces water penetration into the ghar during high wind accompanied by rain.

10.2.3 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.

Magnitude of the wind loads on the structure influences the shape of the roof experiment and experience have shown that houses with hip roofs have the best record of resistance. During a cyclone a large pressure builds up under the overhang, and the pressure added to the suction on the upper roof may pry the roof away from walls and vertical support. These problems have been solved by traditional builders by keeping a minimum roof overhang in most houses, and by having a separation between roof over the 'pashchati' and the main roof of the 'ghar'.



10.3 SOCIAL AND ENVIRONMENTAL PROBLEMS OF HOUSING

10.3.1 SOCIAL 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.

Cost of re-building and repair after a severe cyclone was identified as a problem by 77% of the respondents.

Lack of capital was identified as a problem by 72% of the respondents.

Cost of materials was identified as a problem by 54% of the respondents.

As regards to cost and replacement of bamboo please refer to section 10.5

PRESERVATIVE TREATMENT FOR TRADITIONAL BUILDING MATERIALS-BAMBOO, WOOD, SUN-GRASS, ETC.

10.3.2 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) use 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 selected species of trees and location of plants.

10.3.2.1 PROGRAM FOR AFFORESTATION

The local people can be easily mobilized and plugged with the implementation of the Forestry Sector Master Plan for afforestation.

We are including excerpts from 'THE DEVELOPMENT PERSPECTIVES OF THE FORESTRY SECTOR MASTER PLAN', (See Annexure V & VI) Ministry of Environment and Forestry, Government of Bangladesh.

The Forestry Sector Master Plan is particularly relevant because of its stress on people oriented programs consisting of Environmental Management, Participatory Forestry, Wood Energy Conservation, Non-Wood Forest Product promotion and Bamboo Development.

The problems of planning and implementation of afforestation in our survey and study areas will be better understood if we study the Forestry Sector Master Plan.

10.4 WOOD AND BAMBOO USED IN INDIGENOUS HOUSES

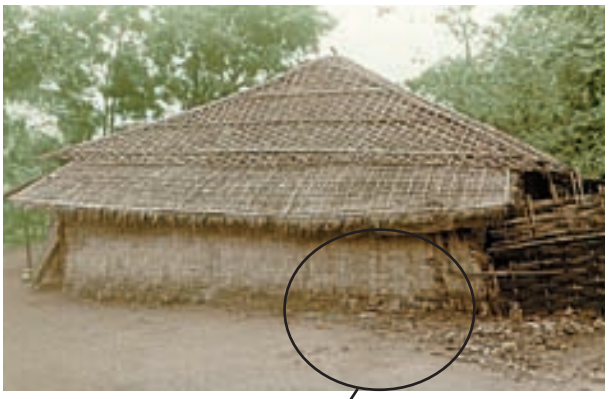
10.4.1 Bamboo And Wood Used In Local Houses

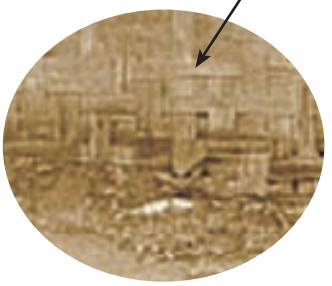
Wood and bamboo is extensively used in the construction of indigenous houses. The wood used in most houses are of very poor quality. This results in shrinkage, warpage, making these susceptible to fungal attack. Besides bamboo members should be treated with preservative to enhance their durability.

At present both wood and bamboo are used without treatment by appropriate preservative for protection against decay, insects, fungi, termite attack, marine environment and when these materials are in contact with moist ground.

There is a need for identifying experts to formulate proper selection of preservative and means of application depending on the properties, strength, appearance, classification etc., of wood and bamboo. The guidelines for bamboo preservative treatment is based on research done by **Bangladesh Forest Research Institute (BFRI).**

BAMBOO ROOF STRUCTURE



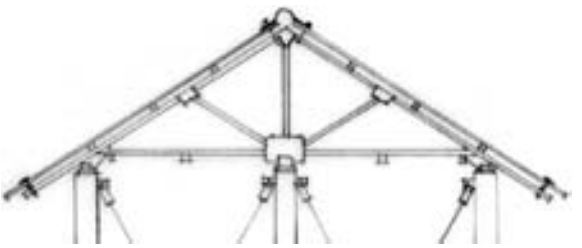


Example of decay

10.4.2 STEEL SECTIONS AND PRECAST CONCRETE MEMBERS USED IN LOCAL HOUSES STEEL SECTIONS USED IN LOCAL HOUSES.

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 one word application of specified undercoats.



STEEL ROOF STRUCTURE

Undercoats should be carefully selected for suitability in marine weather conditions. We are listing the chemical compositions of these undercoats below only as a reference.

Combination of an oleo-resinous medium and top quality non-setting red lead having high anti-corrosive property and durability.

The undercoat is based on high quality alkyd resins, iron oxide red and anti-corrosive pigment to withstand marine weather.

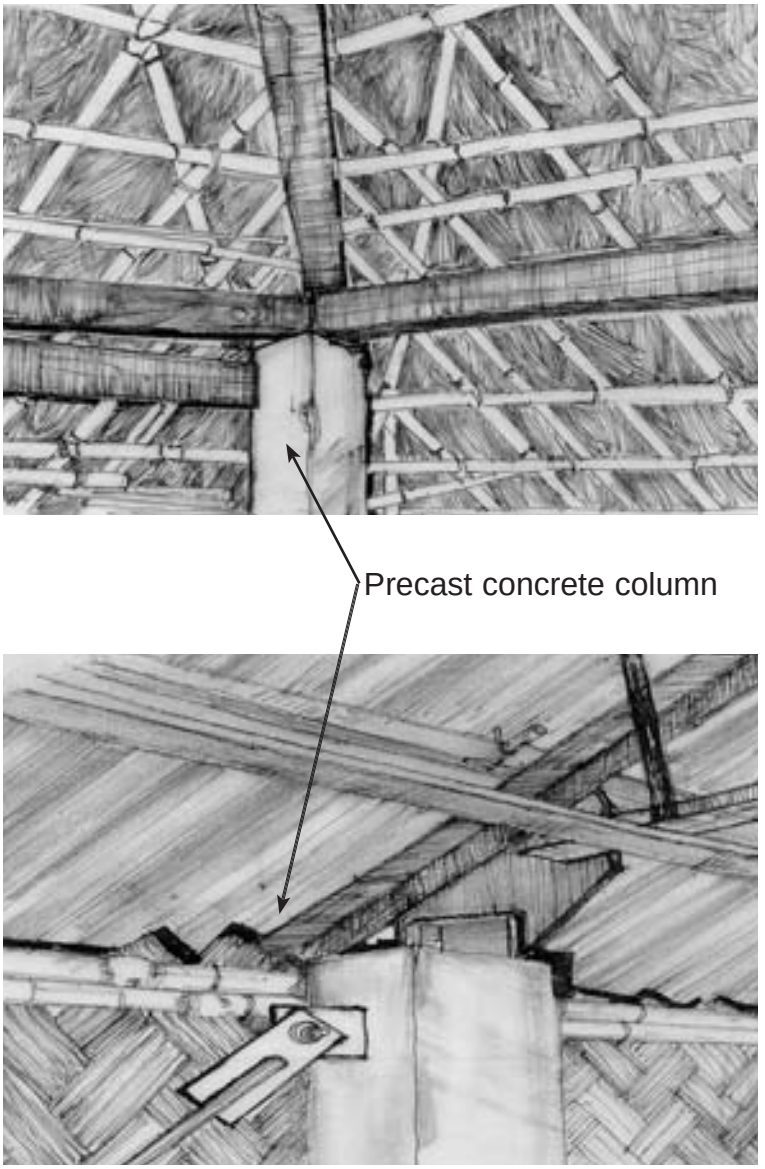
Two pack primer based on epoxy resin and rust inhibitive pigment. This undercoat has excellent corrosion and chemical resistance properties.

PRECAST CONCRETE USED IN LOCAL HOUSES

Precast concrete members have made inroads as a building material into the local houses 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 column sections as beams at roof level to support wood or bamboo rafters. The roof joist can also be of pre-cast concrete.



10.5 PRESERVATIVE TREATMENT OF TRADITIONAL BUILDING MATERIALS - Bamboo, Wood, Sun-Grass Etc.,

10.5.1 GENERAL

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 BRFI 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.

Hut built by BFRI at Chittagong - A pilot project using treated bamboo, wood, Sun-Grass etc.

10.5.2 PRESERVATIVE TREATMENT

Key characteristics of the technology application: The treatment is applied to bamboo splits either through soaking of preservative or to whole bamboo by displacing the sap with preservative.

Conventional Treatment: Conventionally bamboo is immersed into water immediately after cutting. This process dissolves the carbohydrates to reduce attack of the following steps.

Preparation of preservative.: CCB (Copper, sodium dichromate and boric acid) is a chemical preservative, and they are used in the following percentage.

Chemicals	Percentage
Copper Sulphate	4%
Sodium dichromate	4%
Boric acid	2%
Water	90%

The chemicals are available in powdered form under the trade name of Wolman CB. These chemicals, in small quantities, are not harmful for animals and human beings.

10.5.3 TREATMENT PROCEDURE

Bouchery Method

This method is effective only when freshly cut bamboos are used as the treatment is conducted in a low pressure to displace cell sap with preservative. The process consists of connecting the butt end of the bamboo to the pump (bouchery machine) with a rubber hose pipe. Bouchery machine contains the preservative. The displacement of the sap can be observed when a light coloured fluid is ejected on the other side of the bamboo sections. When the colour of the fluid deepens, it is an indication that the preservative have displaced the cell sap. In the absence of availability of pumps the butt end of the bamboo may be placed within the preservative solution in a slanted position using gravitational force to displace the sap from the bamboo cell.

Soaking Method

This method is used for the treatment of bamboo split, straw, coconut leaves etc., and less durable timber such as mango, rain tree, shimul, etc.

These materials are immersed in the preservative solution kept on a shallow container before treatment, it is essential that bamboo splits are soaked in water and then dried. The recommended period for keeping various building materials soak in the preservative are as follows:

Item	Time
Bamboo Splits	24 hours.
Sun-grass, Coconut leaves etc.	12 hours.
Timber	2-4 days.

The treated materials should be kept in the shade for the first 1-2 days and then in the sunshine for 3-4 days. This treatment is adaptable in any location because of minimum logistic problems in transport and technology transfer. The treatment process is time consuming and is effective only for freshly cut bamboos.

Larger amount of bamboo, cut earlier and having hardened sap should be pressure treated with preservative. There is a factory in Kalurghat called Rafique Industries, set up initially for pressure treatment of preservative for bamboo.

The process of preservative treatment of bamboo is a proven technology that has been able to increase the durability of service life of bamboo 3-4 times. There is a house built in 1983 entirely of bamboo at the premises of BFRI. This house after 15 years shows no sign of deterioration.

There is a large demand of bamboo in the rural areas for construction of houses and other uses. The demand is more than the supply pushing the price of bamboo very high. The use of treated bamboo, because of its enhanced durability, will greatly ease demand and stabilize the price of bamboo.

10.6 CONSTRUCTION TECHNIQUES, STRUCTURAL COMPONENTS AND DETAILS

10.6.1 GENERAL

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.

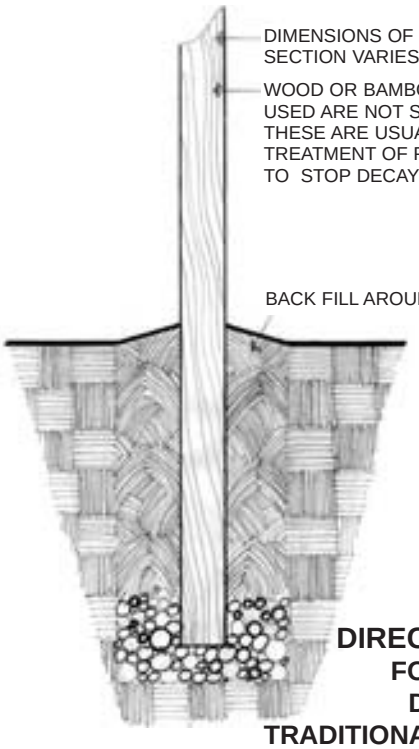
This section represents weaknesses of construction techniques, structural components and details in the manner in which the houses are built, and recommends solutions and guides to strengthen structural components and details for cyclone resistant houses.

Sequence of construction of a house consists of foundations, floor finishes, walls and openings, roofs structures and roof cladding.

The illustrated details are typical and not for constructing a particular house.

10.6.1.1 FOUNDATION DETAILS OF TRADITIONAL HOUSES

Wood, bamboo and pre-cast concrete posts are used for support of the houses in the areas of our survey and study. The weakest point identified in our survey in the traditional construction methods and techniques is anchorage of vertical supports to foundation system. This weakness is the main reason for strong winds to lift up the entire houses or blow it down. The typical foundation method used in the traditional houses is the direct burial of posts into the soil.



DIRECT BURIAL FOUNDATION DETAILS OF TRADITIONAL HOUSES

10.6.2 FOUNDATION OF TIMBER AND BAMBOO POSTS

Bamboo Posts

Bamboo should be selected on the basis of strength and appearance. It should be pressure treated with preservative. The section of the bamboo post should not be less than 125 mm in diameter. Corner posts should preferably be of higher diameter.

Recommendations and Guidelines

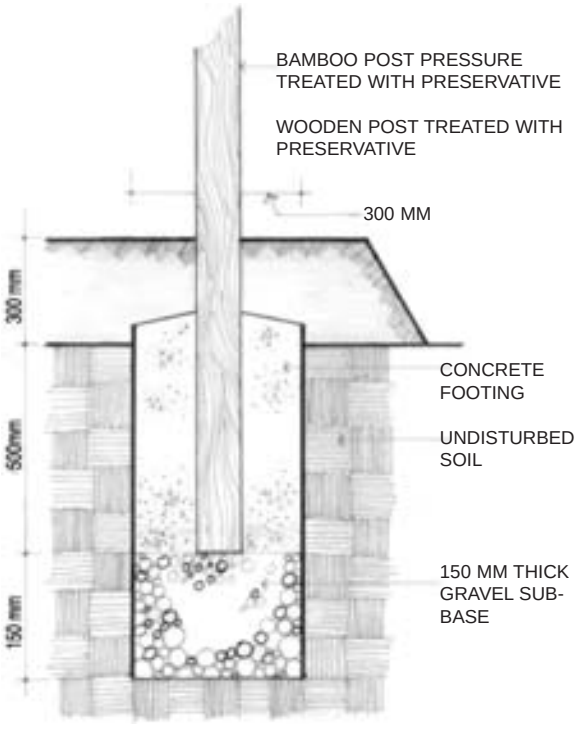
Bamboo should be selected on the basis of appearance and strength having an average diameter of 125 mm.
Bamboo should be treated with appropriate preservative.
Foundation in accordance with the details in "Typical Footing for Timber or Bamboo Post."

Timber Post

Timber for the post should be selected on the basis of strength and appearance. Timber posts should be well seasoned and treated with preservative. The section of sawn lumber size should be approximately 100x100 and form log approximately 150 mm diameter. Corner post should preferably be of higher sections.

Recommendations and Guidelines

Recommended section of sawn lumber 120x120m.
Recommended average diameter of log 150mm.
Lumber should be well seasoned and treated with preservative.
Foundation in accordance with the details in "Typical Footing for Timber or Bamboo Post"

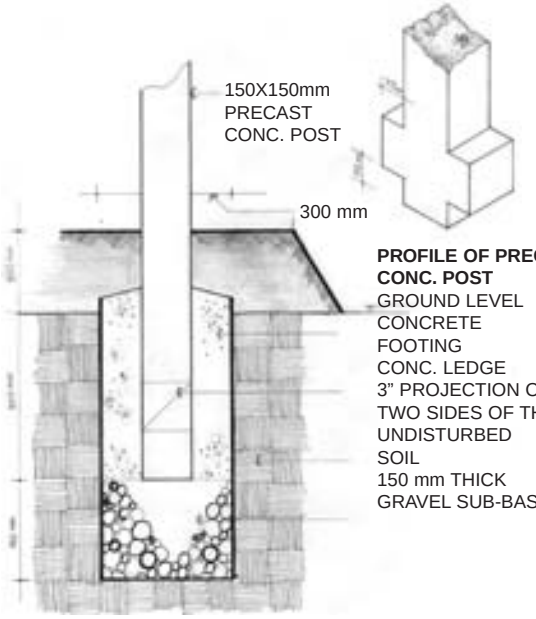


TYPICAL FOOTING FOR TIMBER OR BAMBOO POST

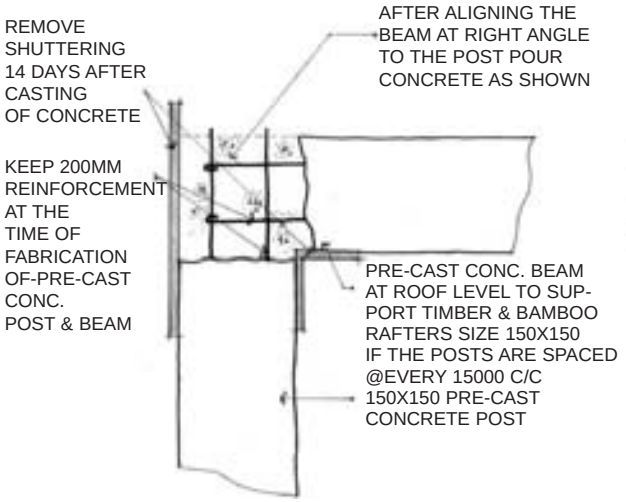
10.6.3 FOUNDATION OF PRE-CAST CONCRETE POSTS

Pre-cast concrete posts should be fabricated with quality control of materials and proper shuttering, fastener, ties, etc.

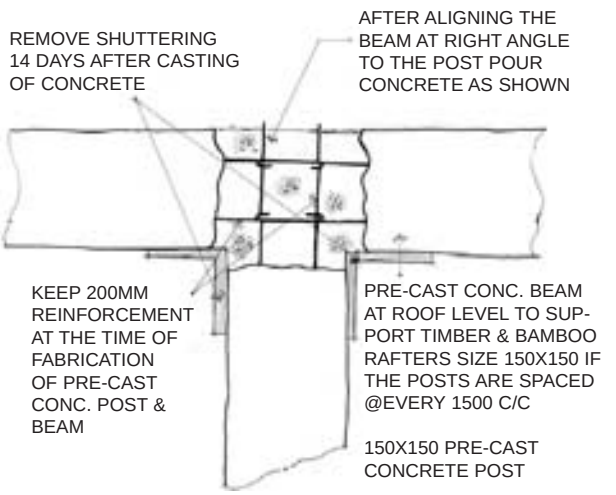
Should be embedded in the post at the time of fabrication. Keep provisions for ledges in the pre-cast concrete post.



TYPICAL FOOTING FOR PRE-CAST CONCRETE POST



CORNER DETAILS OF POST & BEAM



DETAILS OF POST & BEAM

Notes on Cement Concrete Foundation

Earth work in excavation should be carefully done for foundation without disturbing adjacent soil. Cement concrete work with cement, sand (local coarse sand of FM 1.5) and 3/4 down graded crushed stone chips or brick chips, (in accordance with the availability) in proportion of cement: sand : stone chip=1:2:4 (fc=2500 psi @ 28 days).

10.6.4 FLOOR FINISH

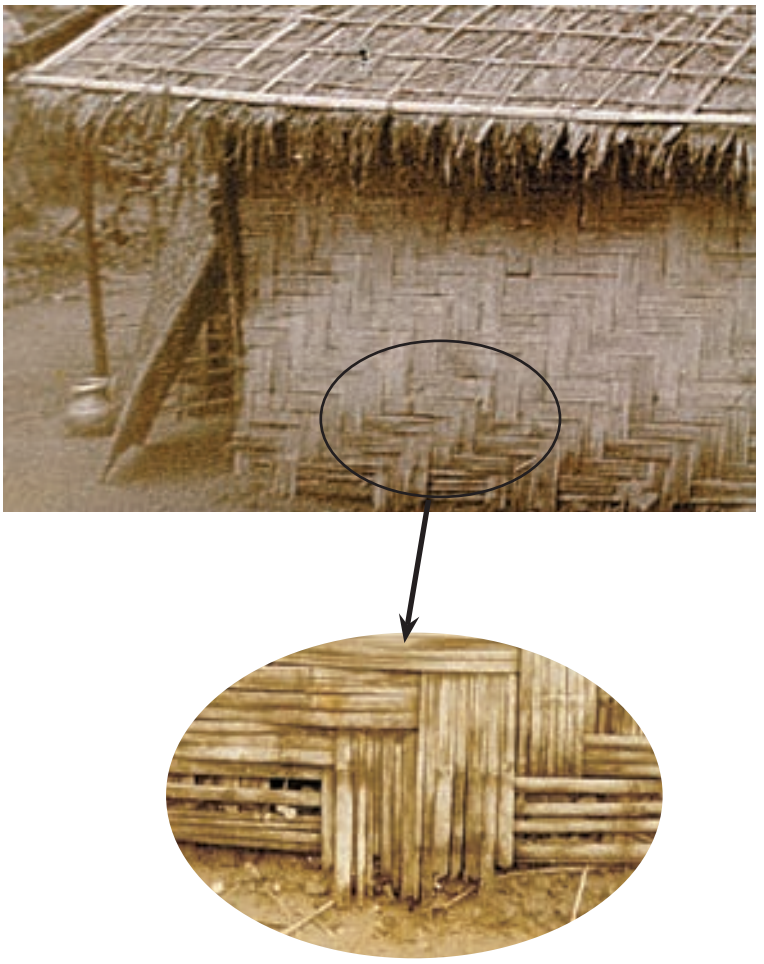
Most of the houses in our survey and study areas have mud floors. A few houses have concrete floor of natural cement or pigmented cement finish. Floor levels of many of these houses, particularly houses belonging to people of very low level of wealth ranking, are almost at natural ground level.

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.

Recommendations and Guide-lines.

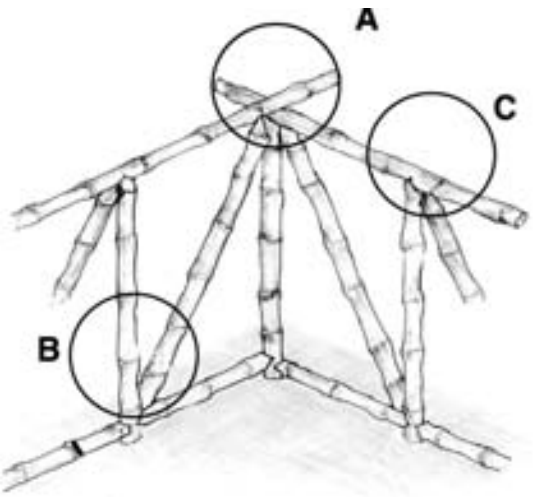
Floor height should be 450mm to 600mm from the natural ground level.

Regular maintenance of floor, particularly after every rainy season.

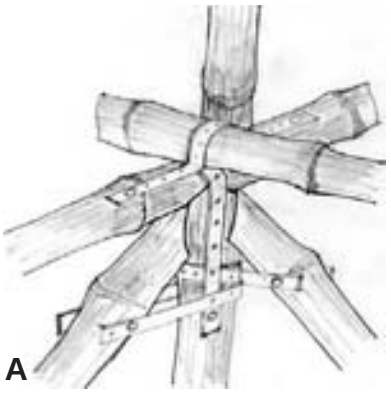


10.6.5 WALLS

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.



DETAILS OF CORNER BRACING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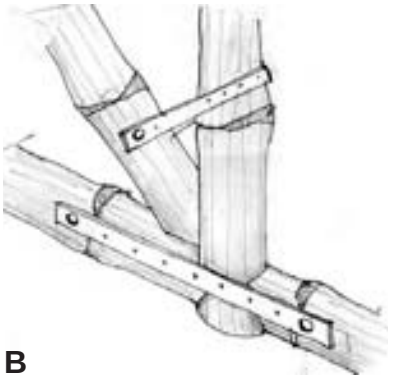
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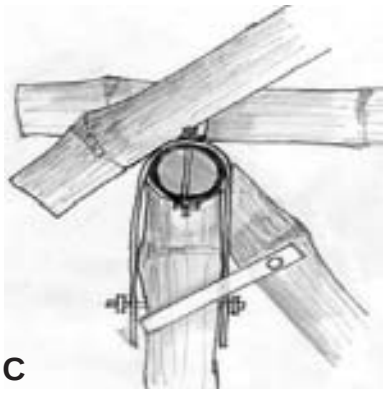
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Woven Bamboo Sheathing

Woven bamboo sheathing is the most commonly used wall in the ares of our survey and study.

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.

Timber Board Sheathing

A few houses in the areas of our survey and study have timber board sheathing walls. These walls are fixed to timber boards with nails and screws.

Recommendations and Guidelines

Lumber sections for post should be selected on the basis of appearance and strength

Use corner bracing.

10.6.6 OPENINGS

Houses built with bamboo sections have no window openings on the outside walls except one opening for entry to the house. There are houses where the upper parts of the bamboo wall are crafted with fine lattice work for ventilation.

Lack of openings of the woven bamboo mat wall in the traditional houses indicate the awareness of the local builder that openings significantly weaken the cyclone resistance capability of walls.

Openings in timber board sheathing wall can be framed easily by vertical timber posts, and horizontal timber sections.

Types of shutters are important for cyclone resistance of houses. Shutters hinged along the top of window frames are preferred as these will not suddenly open and let the wind in, thereby increasing the internal pressure to cause the roof to blow off or the walls to collapse.

Louvred shutters are recommended to provide security and ventilation at night. Special hardware should be used to close the louvres to block high wind penetrating inside.

10.6.7 ROOF STRUCTURE AND ROOF CLADDING

10.6.7 1 GENERAL

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 of most of the houses in our survey and study areas are built with bamboo.

10.6.7.2 ROOF STRUCTURE

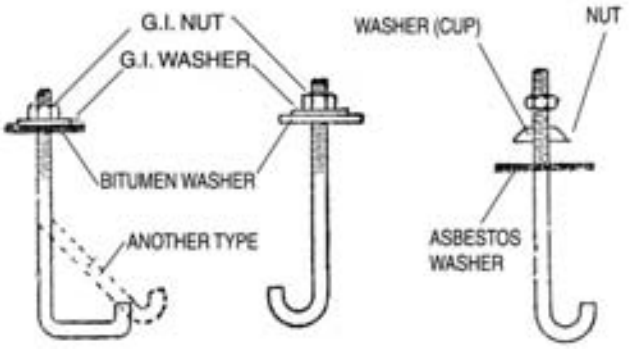
The roof structure consists of horizontal bamboo support members (beams) supported by bamboo posts. The bamboo beams support the rafters of split bamboo.

In the roof structure system, the most important connections are the connection between 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.



G.I. CRANK BOLT G.I. HOOK BOLT J HOOK

TYPICAL FORMS OF BOLTS & SCREWS USED FOR FIXING G.I. SHEETS

10.6.7.3 ROOF CLADDING

In addition to the roof structures, the thatch roof cladding must be able to transfer the wind loads to purlines. 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 purline. The sheets are fixed from the top of corrugation with screws, generally and G.I crank bolts with steel purlines. These screws are used with appropriate cup washer.

SUMMARY OF RECOMMENDATION REGARDING ROOF CLADDING AND OPENINGS

Fixing of purlines to rafters should be strengthened with metal straps or bolts with washer at ridges and eaves.

Purlins and slats should be well seasoned and pressure treated with preservative.

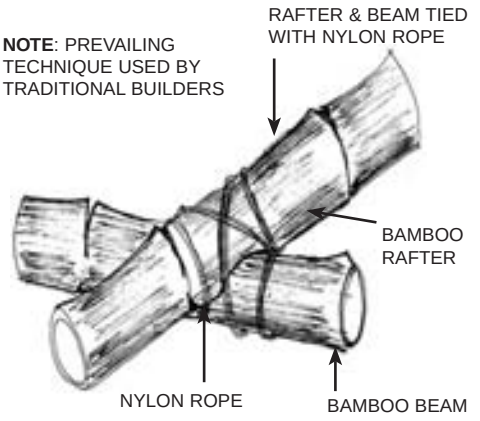
Openings should be framed by vertical posts and appropriate horizontal sections.

Shutters should be hung along the top frame of window openings.

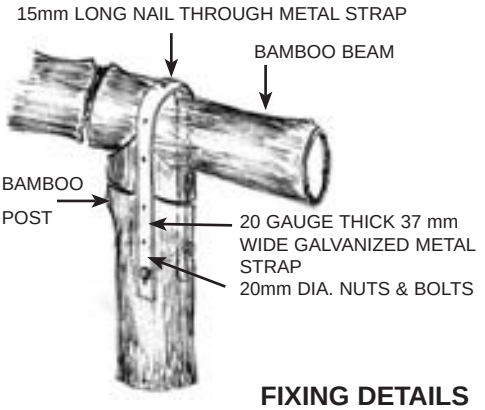
Factory finished metal sections of appropriate specifications may be used.

Glazing in windows should be avoided unless the sections are small.

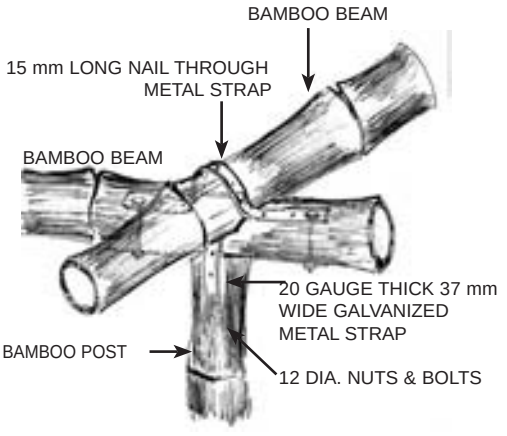
Louvre shutters should be designed with special hardware to block the wind inside during cyclone.



FIXING DETAILS
BETWEEN BEAM AND RAFTERS



FIXING DETAILS
BETWEEN POST & BEAM



FIXING DETAILS
BETWEEN POST, BEAM AND RAFTER

11. CONCLUSION

Disaster preparedness and planning in the past have been too dependent on massive financial, technical and infra-structural input by Government & NGO's. While such interventions are necessary, these steps must be accompanied by local people's participation as well as incorporating the age old wisdom of the people. This will have the double advantage of empowering the people, drawing them into plans which will no longer merely be injected from the outside, and will result in a more thought out, user and environment friendly response to extreme natural calamity.

However, it is important to note that traditional houses can only be cyclone resistant with a comprehensive approach for the implementation of all the recommendations in the guidelines for cyclone resistant houses. The critical aspects of the recommendations are a) solving the social and environmental problems of housing, b) technology input for improving and enhancing the durability of building material such as bamboo, and c) careful consideration of the recommendations outlined in construction techniques, structural components and details.

In short the cyclone resistant house is feasible with the simultaneous implementation of a community approved plan of tree plantation, preservative treatment of all components of building materials and following recommendations for technology input in construction techniques and structural components and details.

ANNEXURE

ANNEXURE I

WEALTH RANKING USING HOUSE TYPE AND HOUSEHOLD FURNISHINGS AS INDICATOR

INDICATOR	RANKING LEVEL		
	VERY LOW	LOW	MEDIUM
FLOOR FINISH	Mud floor	Well finished mud floor	Polished concrete cement floor or tinted concrete floor
WALL	Woven bamboo mat	Well crafted woven bamboo mat or corrugated sheeting	Brick wall and plaster
ROOF	Thatch roof Bamboo joist Split bamboo Purlins	Tin roof Wooden joist	Tin roof wooden Joist and false ceiling
WINDOWS	Split bamboo	Solid wood	Wood glass/louvres
TOILETS	Out door	Out door enclosed	Out door is one door enclosed with roof or indoor part of the house
KITCHEN	Out door open area	Out door with lean-to	Outdoor is one door enclosed with roof attached to the house
WATER SOURCE	Pond Community tubewell	Community tubewell	Own tubewell
LIGHTING	Small kerosene lamp	Hanging kerosene lamp	Electric bulb.
BEDDING	Mats on floor	Wooden bed (Chowki)	Wooden bed (Khat)

LOCATION :

NAME OF HOUSE OWNER : .....

ANNEXURE II

IDENTITY OF HOUSE OWNER

WEALTH RANKING: VERY LOW 0 | LOW 00 | MEDIUM 000

MOUZA :

VILL./PARA :

DAG NO. :

NAME OF HEAD OF HOUSEHOLD			AGE:
SPOUSE		NOS.	AGE:
GENDER	M	NOS.	AGE:
	F	NOS.	AGE:

LAND OWNERSHIP	HOMESTEAD	YES:	NO:
	LAND	ACRE	

RECIPIENT OF GRANT FOR HOUSE BUILDING / REPAIR

NAME OF AGENCY :

YEAR : | AMOUNT / MATERIALS :

MEMBER OF CO-OPERATIVE OR POVERTY ALLEVIATION PROGRAMMES

NAME OF ORGANIZATION:

YEAR OF JOINING: | POSITION:

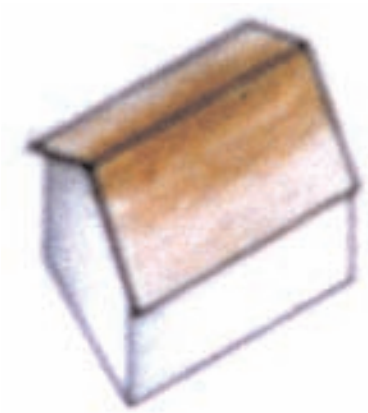
ANNEXURE III

People's Perception of Problems in Housing Ranked in order of Importance

NUMBER OF RESPONDENTS					
Problem	**Most Important**	**Next Most Important**	**Third**	**Fourth**	**Total Response**
Tidal surge					
Cyclone					
Finding safe location for house building					
Availability of building materials					
Cost of materials					
Cost or lack of labour					
Availability of traditional builder					
Lack of technical knowledge					
Cost of-re building and re-construction after a severe cyclone					
Lack of capital					

ANNEXURE IV

PEOPLE'S PERCEPTION OF THE MAGNITUDE OF WIND LOADING AND WIND DAMAGE ON DIFFERENT ROOF SHAPES



High Gable Roof	
Wind Resistant	**Suffer Wind Damage**

Hip Roof	
Wind Resistant	**Suffer Wind Damage**

SCORING AND RANKING

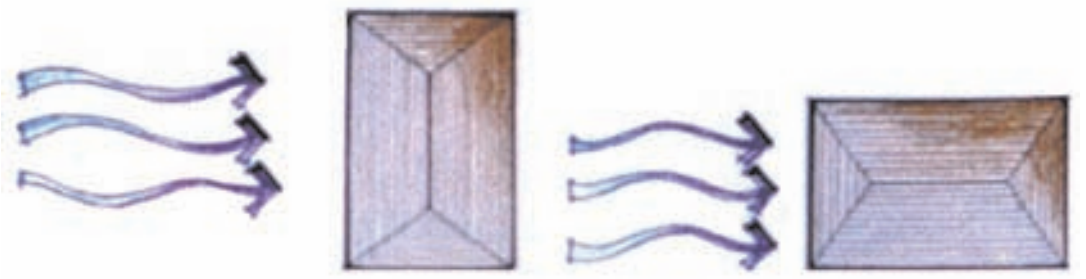
CARD NO:

PLACE:

COMMENTS:

ANNEXURE IV

PEOPLE'S PERCEPTION OF ORIENTATION AND SITING OF HOUSES.



Long Face of Building Facing Wind Direction		Shorter Face of Building Facing Wind Direction	
Traditionally Accepted	**Traditionally Not Accepted**	**Traditionally Accepted**	**Traditionally Not Accepted**

SCORING AND RANKING

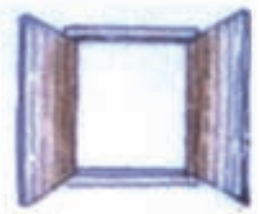
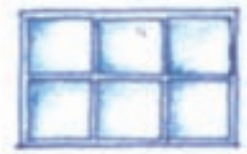
CARD NO :

PLACE :

COMMENTS :

ANNEXURE IV

PEOPLE'S PERCEPTION OF OPENINGS IN HOUSES IN CYCLONE AFFECTED AREAS

Type of opening	Safe	Not safe
 Side hung window		
 Top hung window		
 Window with large glass		
 Window with small glass		
 Door/window near the corner		

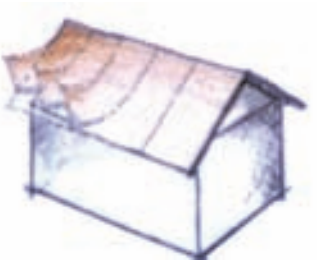
SCORING AND RANKING

CARD NO:
PLACE:

COMMENTS:

ANNEXURE IV

PEOPLE'S PERCEPTION OF ROOF FAILURE BY CYCLONIC STORM

CAUSES OF FAILURE	ROOF FAILURE COMMON TYPES OF ROOF	
		
	ROOF SHEETING GETS BLOWN OFF	ROOF LIFTING OFF FROM THE SUPPORTING WALL
FAULTY FIXING DETAILS OF ROOF MEMBER TO WALL / COLUMN		
ROOF SHEETING NOT SECURED FIRMLY TO PURLIN		
OPENING CREATED BY BREAK DOWN OFF WALL, BROKEN WINDOW, DOOR, ETC.		
EXTENDED ROOF OVER-HUNG		
COLUMN AND WALL FOUNDATION NOT FIRMLY ANCHORED TO THE GROUND		

SCORING AND RANKING

CARD NO:

PLACE:

COMMENTS:

ANNEXURE IV

PEOPLE'S PERCEPTION OF SAFETY OF HOUSES FROM CYCLONE WITH OR WITHOUT WIND BREAKS

House Without Breaks	
Safe	**Not Safe**

House With Breaks	
Safe	**Not Safe**

SCORING AND RANKING

CARD NO:

PLACE:

COMMENTS:

ANNEXURE IV

PEOPLE'S PERCEPTION OF SAFE DISTANCE OF TREES FROM HOUSES IN THE CYCLONE AFFECTED AREAS

Safe Distance			
10 Feet	15 Feet	20 Feet	30 Feet

SCORING AND RANKING

CARD NO:

PLACE:

COMMENTS:

ANNEXURE V

10.3.1 Statements of the National Forestry Policy (Excerpt)

Attempts will be made to bring about 20% of the country's land under the afforestation programme of the government and private sector by the year 2015 by accelerating the pace of the programme through the coordinated efforts of the government and NGOs and active participation of the people in order to achieve self-reliance in forest products and maintenance of ecological balance.

Because of limited amount of forest land, effective measures will be taken for afforestation in rural areas, in the newly accreted char in the coastal areas and in the denuded Unclassed State Forest areas of Chittagong Hill Tract and northern zone of the country including the Barind tract.

Private initiatives will be encouraged to implement programme of tree plantation and afforestation on fallow and hinter land, the banks of the ponds and homestead lands which are under private ownership. Technical and other support services will be extended for introducing agroforestry on privately owned fallow and hinter land to keep intact the production of grass and herb which is grown on government and privately owned forests and fallow lands.

Tree plantation on the courtyards of rural organization such as union parishad, school, eidgah, mosque-moktob, temple, club, orphanage home, madrassa etc. and other fallow lands around can be initiated. The government will encourage this type of initiative and extend technical and other supports.

Massive afforestation on either side of land surrounding road, rail, dam and khas tank through the partnership of the local people and the NGOs will be commended. Side by side, rubber plantation will be encouraged in all suitable areas of the country including Chittagong Hill Tract, Sylhet and Modhupur.

Massive afforestation on either side of land surrounding road, rail, dam and khas tank through the partnership of the local people and the NGOs will be commenced. Side by side, rubber plantation will be encouraged in all suitable areas of the country including Chittagong Hill Tract, Sylhet and Modhupur.

Special afforestation programs will be taken in every city of the country under the auspices of the government in order to prevent pollution of environment in the densely populated areas. Municipal, town and other relevant authorities will make concerted efforts in implementing this programme. Attempts will also be made to ensure tree plantation /afforestation while plans are made in respect of residential areas.

Massive afforestation programs in the denuded hilly areas of Unclassified State Forests areas of Rangamati, Khagrachari and Bandarban will be undertaken under the auspices of the government and private initiatives. The participation and rehabilitation of the local Jhum cultivator will be ensured while implementing this program. This will be done under the auspices of the Ministry of Land in cooperation with the local government by keeping the land ownership rights intact.

The priority protection areas are the habitats which encompass representative sample of flora and fauna in the core area of National Parks, Wildlife Sanctuaries and Game Reserves. Attempts will be made to increase the amount of this protected area by 10 per cent of the reserved forest land by the year 2015.

Multiple use of forest, water and fish of Sundarbans through sustained management will be ensured keeping the bio-environment of the area intact.

All state owned forests of natural origin and the plantations of the Hills and Sal forest will be used for producing forest resources keeping aside the areas earmarked for conserving soil and water resources, and maintaining the bio-diversity. Keeping in view the ecology, the management of forest lands will be brought under profit-oriented business.

ANNEXURE V

Inaccessible areas such as slopes of the hills, fragile watersheds, swamps, etc. will be identified and keep as protected forests.

The areas under the reserved forest which have been denuded or encroached, will be identified. Afforestation in these lands will be done through people's participation. In this regard, the use of agroforestry will be encouraged. NGOs will have opportunities to participate in this programme. Side by side, the land in Chittagong and Sylhet which were allocated to different persons and institutions for developing the tea gardens and still remain unutilised and uncultivated will be identified and used for tree plantation and afforestion.

Initiative will be taken to reduce wastage by using modern and appropriate technology at all stages of extraction and processing forest products.

Emphasis will be imparted on modernization of forest-based industries to ensure effective utilization of the forest raw materials.

Steps will be taken to bring state owned forest-based industries to competitive and profit-oriented management system under the free market economy.

Forest resource based labor intensive small and cottage scale industries will be encouraged in the rural areas. Rules and procedures regarding transportation of forest produce in the country will be simplified and made up to date.

Export of logs will remain banned given the scarcity of wood in the country. But processed forest products can be exported. Import policy on wood and wood-based products will be liberalized, but import tariffs, for the wood products which are abundant in the country, will be levied appropriately.

Because of the scarcity of forest land, state-owned reserved forest cannot be used for non-forest purposes without the permission of the Head of the Government.

A large number of tribal people live around a few forest zones. Since the ownership of land under their disposal is not determined, they grab the forest land at will. They will be imparted ownership of certain amount of land through the forest settlement process.

The rest of the forest land will be brought under permanent protection. Funds from different donors including International Aid Organizations will be used to promote private forestry organizations and tree farming, and for such programs like training, technical and financial support will be imparted at an increasing rate.

Women will be encouraged to participate in homestead and farm forest, and participatory afforestation programs.

Ecotourism, related to forest and wildlife, is recognized as forestry related activity, which will be promoted taking into consideration the carrying capacity of nature.

There will be massive campaigns through the government and non-government media for raising consciousences among the people regarding afforestation and conservation, and use of forest resources.

Encouragement will be extended to grow fruit trees for producing more fruits along with the production of timber, fuelwood and non-wood forest products under the afforestation programme.

Initiative will be taken to reduce wastage by increasing efficiency and modernizing the technology for extracting forest resources.

Forest Department will be strengthened in order to achieve the goal and objectives of National Forestry Policy. A new department called "Department of Social Forestry" will be established.

The implementation of National Forestry Policy will be supported by strengthening educational, training and research organizations. This will contribute to forestry sector development.

Laws, rules and regulations relating to the forestry sector will be amended and if necessary, new laws and rules will be promulgated in consonance with goals and objectives of National Forestry Policy.

ANNEXURE VI

10.3.2 BANGLADESH FORESTRY MASTER PLAN INVESTMENT PROGRAM SCENARIO (1995-2015)

PEOPLE -ORIENTED PROGRAMS

ITEM NO.	DESCRIPTION	PHYSICAL UNITS	PHYSICAL TARGET	ESTIMATED COST (Million Taka)
A.	***ENVIRONMENT MANAGEMENT***			
1.	*Institutional Strengthening and Support including Infrastructure, Equipment, Vehicles, and other support facilities.*		*TBD*	*750*
2.	*Training and Technology including transfer including of trainers, farmers and villagers, workshops and seminars*	*(ooo) persons*	*110*	*250*
3.	*Research and Development studies including inventories, surveys, studies, monitoring and evaluation.*	*TBD*	*TBD*	*200*
4.	*Consulting Services.*	*MPs*	*TBD*	*300*
5.	*Conservation comprising of:*			
	a. Herbarium and Botanical Garden	*Nos.*	*3*	
	b. Regional Nature Center	*Nos.*	*5*	
	c. National and Regional Zoo	*Nos.*	*3*	
	d. Natural History Museum	*Nos.*	*1*	
6.	*Protected Areas Expansion and Development, comprising of:*			
	a. Existing parks/Sanctuaries	*Nos.*	*1*	*50*
	b. Development of New Protected Areas	*Nos.*	*1*	*200*
	c. Rest Houses	*Nos.*	*20*	*20*
7.	*Community Based Resource Management*		*TBD*	*120*
	Sub-total: Environment Management			***1900***
B.	***PARTICIPATORY FORESTRY***			
1.	*Institutional Strengthening and Support including Infrastructure, Equipment, Vehicles, and other support facilities.*		*TBD*	*5000*
2.	*Training and Technology including transfer including overseas training, training of trainers, farmers and villagers,workshops and seminars.*	*Persons*	*600000*	*700*
3.	*Research and Development TBD studies including inventories, surveys, studies, monitoring and evaluation.*		*TBD*	*100*
4.	*Consulting Services*	*PMs*	*TBD*	*200*
5.	*Poverty Alleviation and Anti Encroachment activities.*			
	a. Agroforestry in Sal Forests	*Ha*	*25000*	*500*
	b. Wood lots on Sal Forest	*Ha*	*24000*	*600*
	c. Strip Plantations on other Government Land	*Kms*	*100000*	*2500*
	d. Private Homestead	*Ha*	*400000*	*2650*
	e. Private Fields	*Ha*	*40000*	*1000*
6.	*Bamboo Development*			
	a. Product Development and Improvement	*Ha*	*40000*	*500*
	b. Research, Development and studies	*TBD*	*TBD*	*300*
	Sub-total: Participatory Forestry			***14050***
	Sub-total: People-oriented Programs			***15950***

ANNEXURE VI..... cont.

ITEM NO.	DESCRIPTION	PHYSICAL UNITS	PHYSICAL TARGET	ESTIMATED COST (Million Taka)
A.	***ENTREPRENEUR-BASED INFRASTRUCTURE 1***			
1.	*Buildings / Construction including Engineering.*			
	a. Building/ Construction	*TBD*	*TBD*	*700*
	b. Vehicles, Equipment and Furniture	*TBD*	*TBD*	*1300*
B.	*Entrepreneur-based maintenance.*	*TBD*	*TBD*	*14000*
C.	*Industry Infrastructure*	*TBD*	*TBD*	*850*
D.	*Training/Technology Transfer*			
1.	*National including Field Staff, NGOs and Beneficiaries*	*TBD*	*TBD*	*600*
2.	*International including overseas Training, participation in Seminars and Workshops*	*TBD*	*TBD*	*400*
E	*Monitoring and Evaluation Studies*	*TBD*	*TBD*	*170*
F	*Consulting Services (Local and Int'l)*	*TBD*	*TBD*	*500*
G	*Institutional Changes/ Restructuring*	*TBD*	*TBD*	*150*
H	*Research and Development*			
1.	*Field Research Stations*	*TBD*	*TBD*	*260*
2.	*Laboratory Facilities*	*TBD*	*TBD*	*260*
3.	*Library Improvement*	*TBD*	*TBD*	*500*
4.	*Seed Improvement and Production*	*TBD*	*TBD*	*320*
5.	*Seed Storage facilities.*	*TBD*	*TBD*	*250*
6.	*Technology transfer including Research Networking*	*TBD*	*TBD*	*100*
7.	*Researchers / Scientists Training*	*TBD*	*TBD*	*300*
8.	*Research Programs Operations Cost.*	*TBD*	*TBD*	*260*
	Sub-total: Institutional Development			***4730***
IV.	***CONTINGENCIES GRAND TOTAL***			***80000***
PRODUCTION DIRECTED PROGRAMS				
A.	***FOREST PLANTATION DEVELOPMENT***			
1.	*Industrial Plantations*			
	a. Long Rotation Industrial	*Ha*	*125000*	*3500*
	b. Medium Rotation (Timber/Pole)	*Ha*	*160000*	*5500*
	c. Pulpwood	*Ha*	*50000*	*1200*
2.	*Soil Conservation and Watershed Protection*	*Ha*	*50000*	*1500*
3.	*Sal Forests Rehabilitation*			
	a. Natural Forest Enrichment	*Ha*	*25000*	*900*
	b. Replacement Plantations	*Ha*	*21000*	*750*
4.	*Parks and Sanctuaries Rehab.*	*Ha*	*13000*	*600*
5.	*Cyclone Protection and Coastal Afforestation*	*Ha*	*25000*	*750*
	Sub-total: Forest Plantations Development			
B.	***WOOD HARVESTING***			
1.	*Harvesting Equipment (3500 Cu.M./Yr.)*	*TBD*	*TBD*	*2500*
2.	*Training and Technology transfer including overseas Training & Study tours.*	*TBD*	*TBD*	*70*
3.	*Research, Training and Studies.*	*TBD*	*TBD*	*50*
4.	*Road Construction including new roads, access roads, and secondary roads.*	*Kms*	*12000*	*1580*
	Sub-total: Wood Harvesting			
C.	***INDUSTRY AND MANUFACTURING***			
1.	*Industry rationalization*	*Unit*	*600*	*10000*
	a. Newsprint	*ADT/Annum*	*50000*	*4700*
	b. Printing and Writing Paper	*ADT/Annum*	*50000*	*4000*
	c. Wrapping and Packaging	*ADT/Annum*	*4000*	*500*
	Sub-total : Industry and Manufacturing			***19200***
	Sub-total: Production Directed Programs			***38400***