

BARAPUKURIA COALMINE VILLAGE

By

Emerald Upoma Baidya

I.D. No.: 08108013

Seminar II

Submitted in partial fulfillment of the requirements

For the degree of Bachelor of Architecture

Department of Architecture

BRAC University

Spring, 2013

ACKNOWLEDGEMENT

At first, I would like to thank my thesis studio teachers; Imon Chowdhuree, Abul Fazal Mahmudun Nobi, Shakil Ahmed Shimul and Nandini Awal to help me with their wise guidance and patience throughout the semester to carry out a successful thesis project.

I would like to mention special gratitude to Khondaker Hasibul Kabir who has been an inspiration for me, especially in choosing the project topic and and of course a vital source of advice and help later on in the development phase of the design project.

My sincere thanks to other teachers and seniors of the Architecture Department of BRAC University and University of Asia Pacific who have helped me with their advice.

I would like to thank my friends and juniors who have relentlessly given their support; emotionally and physically.

And last but not the least, endless thanks to my family without whom I could not be able to achieve this.

TABLE OF CONTENTS

Abstract 4

CHAPTER 01 Introduction 5

 1.1 Project Brief 5

 1.2 Project Rationale 5

 1.3 Project Background 6

CHAPTER 02 Site Analysis 10

 2.1 Site Appraisal 10

 2.2 Photographs 14

 2.3 SWOT Analysis..... 15

CHAPTER 03 Literature Review 16

 3.1 Introduction 16

 3.2 Vernacular Architecture..... 17

 3.3 Indegeneous material and technology 29

 3.4 Cultural sustainability 45

CHAPTER 04 Case studies 52

 4.1 Introduction 52

 4.2 Incremental housing at Belapur..... 53

 4.3 New Gournna 59

 4.4 Community based habitat in Jogenbabur math, Dinajpur 66

 4.5 Disaster resilient habitat at shatkhira Dinajpur 71

CHAPTER 05 Program development 76

CHAPTER 06 Design Development 77

ABSTRACT

"Barapukuria Coalmine Village" is a low-rise housing project for the employees of the Barapukuria Coalmine Company. A study trip to the villages of north-Bengal made me observant about how the rural vernacular of Bangladesh is undergoing a drastic change since the past several decades and inspired me design a "village" as my thesis project.

The project site is in Barapukuria, Dinajpur in a village called Dhulauldal. The site, in which the mild nature is the force to play with, became a vital component from which the master plan of the project developed. The project is like a journey which started with a goal to achieve a comprehension of the morphology of the rural vernacular, from a small living unit to the pattern in which the paddy fields, forests, little villages are composed to create the unique artwork of nature.

The design focus of the master plan was to compose the elements in such a way that the spaces are demarked yet integrated into one another and over-all creates a flow which opens towards the existing stream, at the same time, the existing forest penetrates in the site and merges with the landscape of the site.

The concept of the unit design was to create an unit surrounding a court as a heart of the household, this pattern of the unit then duplicate and change to create patterns for the clusters to present the users with different yet interesting levels of open spaces.

CHAPTER 01

INTRODUCTION

1.1 Project Brief

Project Name: Barapukuria Coalmine Village

Site: Barapukuria, Dinajpur.

Site Area: 30 acre.

Client: Barapukuria Coal Mining Company Limited, Barapukuria, Dinajpur.

Cost of the Project: BDT 190,530,0000.

1.2 Project Rationale

The inspiration for choosing this project is the achievement of a comprehension about the vernacular architecture of rural Bangladesh through designing a habitat in a rural setting. This would test the claim that with the use of indigenous materials and techniques, developed for meeting the needs of modern life, the cultural identity at a rural vernacular context which seems to be losing with increasing popularity of industrial building materials; could be sustained and protected. This would not be simply a nostalgia for the past but with an objective to create a sustainable society, a society which is culturally sustainable, meets its own economic and social needs and cares for environment along the way.

This project is significant because it allows architectural intervention in rural area at the vernacular level. History of architectural evolution in this region tells us stories only about religious and public buildings and modern architectural interventions are mostly seen in the urban areas. The aspiration of dwellers in Bengali villages is shaped by the effect of urbanization, for example, they are more willing to make a brick house when they have enough money but not enthusiastic enough to repair or develop their mud homesteads with available materials, although they might know the building techniques or have knowledge about building materials. The preservation and development of the essence of vernacular architecture of rural Bangladesh is also equally important.

A project like this is thus an opportunity to discourage thoughtless imitation of urban architecture in rural neighborhoods and might work as an effort to achieve cultural sustainability from the core of rural.

1.3 Project Background

The economic development of Bangladesh presently depends on the discovery and proper utilization of its indigenous energy resources. Natural gas is currently the only indigenous non-renewable primary energy resource of the country, which is being produced and consumed in significant quantities. Gas, the main source of commercial energy and plays an active role towards economic growth of the country. Natural gas now accounts for about 70% of the country's commercial energy supply.

The Government of Bangladesh is endeavoring to develop alternative sources of indigenous commercial energy to reduce the growing pressure on natural gas resources and reliance on imported energy. Recent reserve estimation, current consumption rates and future daily requirement projection scenarios suggest that the known recoverable reserves will be exhausted very soon. To meet the current energy demand Coal may play a vital role.

The Barapukuria coal field extends over an area approx. 6.68 sq km with calculated deposit of 390 million MT. Depth of deposit varies from 118-509m. Most of the produced coal is consumed at the nearby 250MW thermal power plant and the rest amount by the brick manufacturers. BCMCL (Barapukuria Coal Mining Company Limited) is planning to extract 8 slices of coal from its 36m thick coal seam VI. Each slice is approximately 3m height.

Discovery	Geological Survey of Bangladesh (GSB) discovered the Coal Basin in 1985
Techno Feasibility Study	M/S Wardell Armstrong, UK with the assistance of Overseas Development Administration (ODA), UK conducted the Feasibility Study and Submitted report to petrobangla in May 1991.
Findings of Techno Feasibility Study	
Coal Basin Area	668 hectare (6.68 Sq.km.)
Coal Reserve	390 Million Tones
Depth of Coal	118-509 meter
Central Area of the Basin	300 hectare
Northern Coal Deposit	281 hectare (Open window area)
Southern Coal Deposit	87 hectare (Shallow Depth area)
Mine Redesign Activity	Mine Redesign Activity Approved on 23 July 2000.
Development Work recommenced on	
1st Amendment of the Contract October 2000	19 October 2002
2nd Amendment of the Contract	23 March 2005
Acceptance Test Run of Longwall and Development Sysytem	Acceptance Test Run of four Roadheader system and two long wall faces (1101 & 1110), out of 15 designed longwall faces was completed in 29 May 2005.

Table 1: Basic Information regarding BCMCL coal mining (<http://www.bcmcl.org.bd/>)

After feasibility study carried by UK based consultancy firm Wardell Armstrong in 1987-90, underground mining method was recommended for operation. As per recommendation the mine is designed for underground operation and currently operated in central area, the deepest part of the mine. A separate study is undertaken by Petrobangla to determine whether open pit mining is feasible in other part of Barapukuria Coal basin.

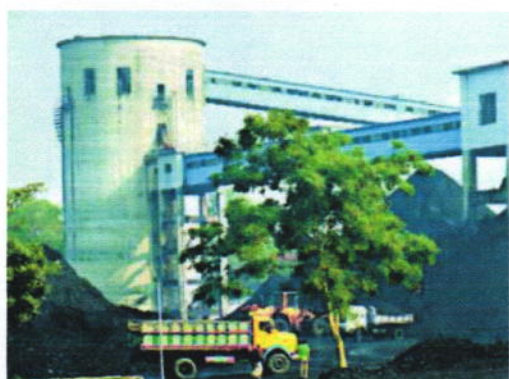


Figure 2 : Industrial activities at BCMCL
(<http://www.bcmcl.org.bd/>)



Figure 1: Coal found at Barapukuria Coal Mine
(<http://www.bcmcl.org.bd/>)



Figure 3: Industrial and office zone of BCMCL (<http://www.bcmcl.org.bd/>)

As per the thumb rule of subsidence approximately 60-70% of the mining height may be subsided over time. The surface of the mine causes damage to houses, structures, roads, trees and cultivable land which will ultimately turn into a vast water land /lake.

The total amount of reserve estimated approximately 3300 million MT which is equivalent to 77TCF natural gas. The entire coal fields are located in densely populated agricultural land. At present there is no specific law for acquisition of coal bearing strata. Subsidence is a common phenomenon in underground coal mining. It may be observed immediately after mining and continued over time period.

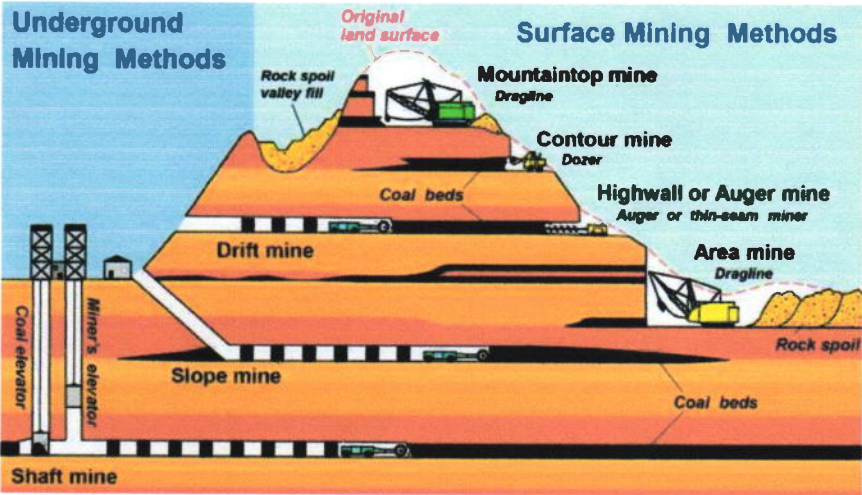


Figure 4: Illustration showing different Coal mining methods (Kentucky Geological Survey, 2012)

As per the thumb rule of subsidence approximately 60-70% of the mining height may be subsided over time. The surface of the mine causes damage to houses, structures, roads, trees and cultivable land which will ultimately turn into a vast water land /lake.

(Nurujjaman, 2013)

CHAPTER 02

SITE ANAYSIS

2.1 SITE APPRAISAL

2.1.2 Location

The 30 acre site is in Himaidpur union of Parbatipur thana, Dinajpur district. It is presently an agricultural land divided into plots owned by public owners and the Coalmine company is in the process of buying the plots to realize the rehabilitation project.



Figure 5: Location of Dinajpur (Baidya, 2013)

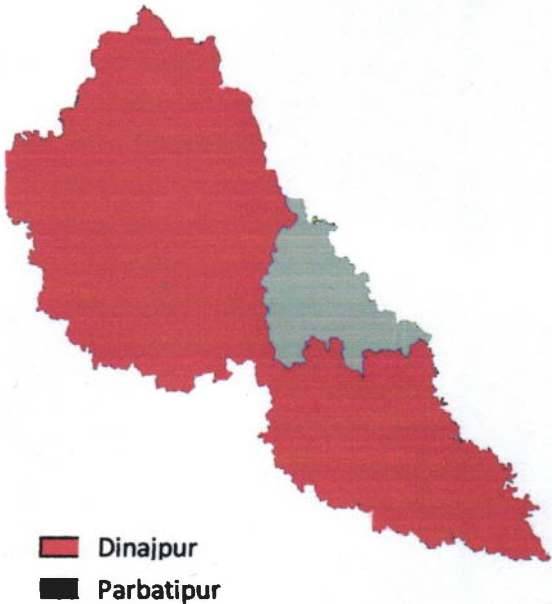


Figure 6: Location of Parbatipur (Baidya, 2013)

Barapukuria area is situated at about 50 km southeast from the district headquarters Dinajpur. Parbatipur, the Thana headquarters and a railway junction, is only 12 km north of Barapukuria. The nearest railway station, Phulbari, is only 6 km southwest from this area. The domestic airport at Saidpur is located at about 40 km east of Dinajpur, which is connected by a metalled road with Phulbari. The Parbatipur-Santahar Broad gauge railway line is only 25m away from the western boundary of Coal Mine.



Figure 7: The Coal mine area

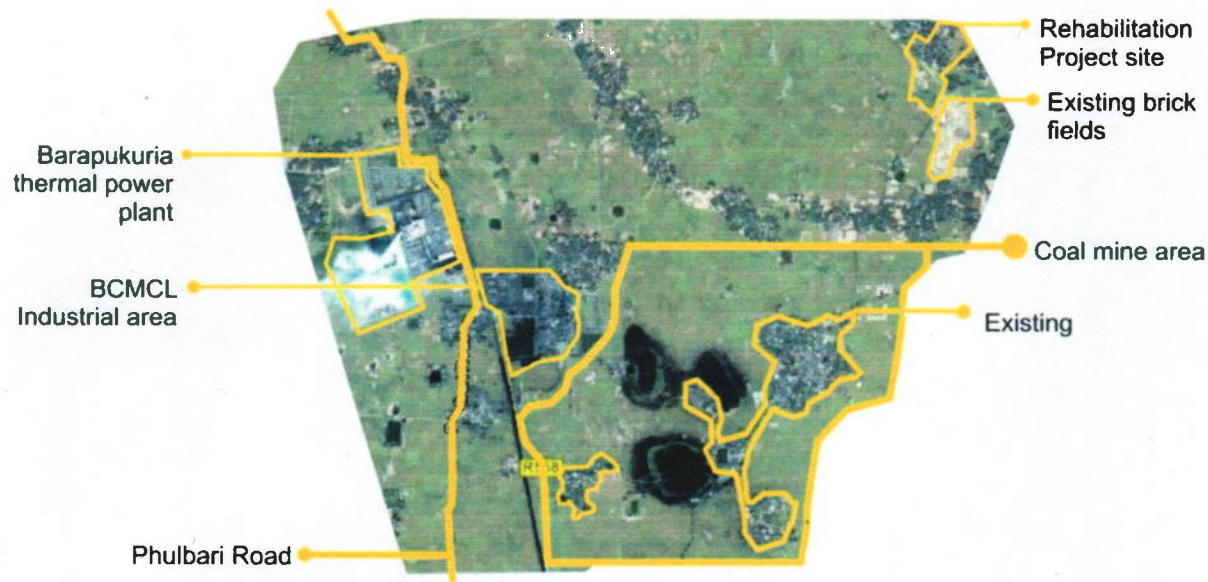


Figure 8: The Project site with the context

2.2.2 Landmarks

- 1. Phulbari thermal power station
- 2. Barapukuria Coal Mine Industrial Zone
- 2. Brick fields

2.2 ENVIRONMENTAL CONSIDERATION

2.2.1 Climate

The site area experiences a hot, wet and humid tropical climate. Under the Köppen climate classification, This area has a tropical wet and dry climate. The area has a distinct monsoonal season, with an annual average temperature of 25 °C (77 °F) and monthly means varying between 18 °C (64 °F) in January and 29 °C (84 °F) in August.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C (°F)	24 (76)	27 (80)	31 (87)	32 (89)	33 (91)	31 (88)	32 (90)	31 (88)	31 (87)	31 (87)	28 (83)	25 (77)	29 (85)
Average low °C (°F)	14 (58)	17 (63)	22 (72)	25 (77)	26 (79)	27 (81)	27 (81)	27 (81)	27 (80)	25 (77)	21 (69)	16 (61)	23 (73)

Table 2: Climate data of Dinajpur . (Source :www.wikipedia.com)

2.3 SITE AND SURROUNDING PLAN

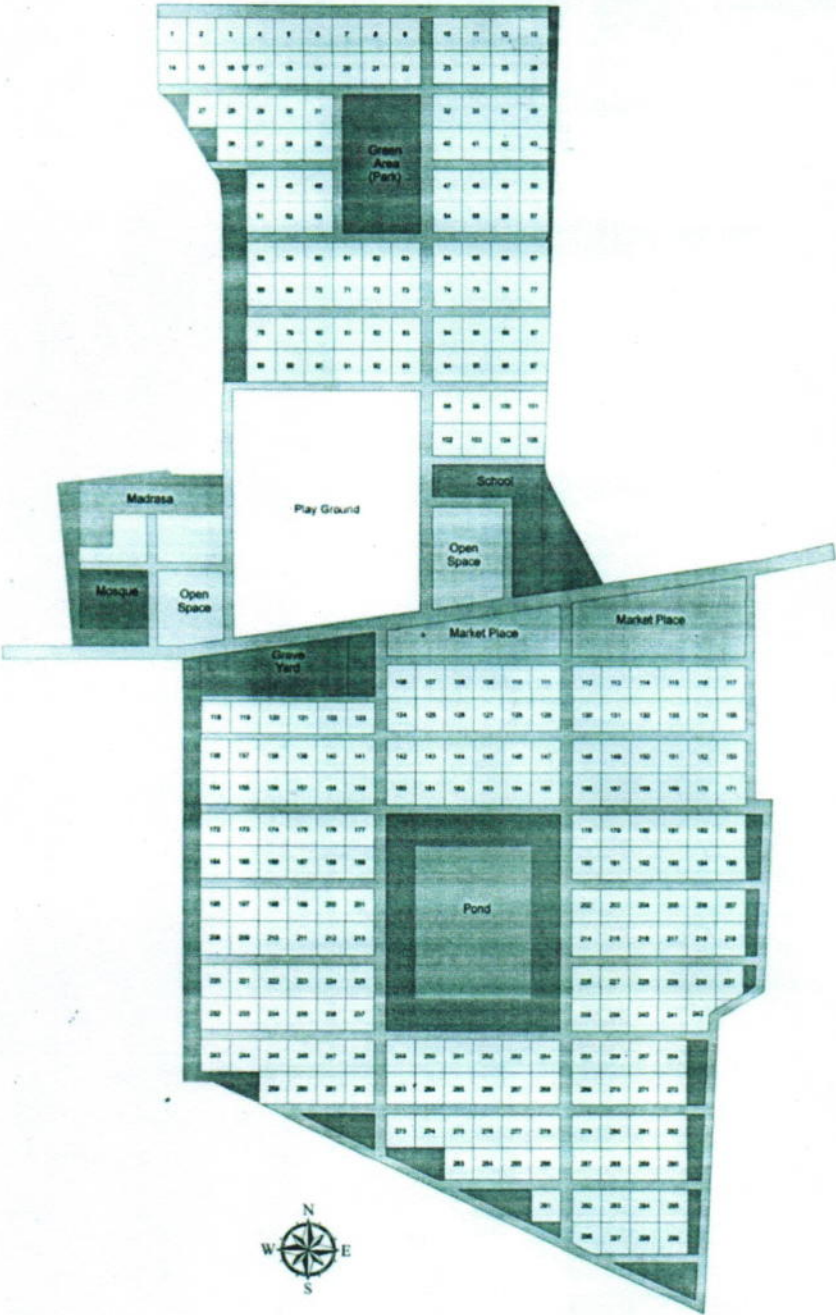


Figure 9 : Master plan proposed by BCMCL (Nurujjaman, 2013)

2.4 PHOTOGRAPHS



Figure 10: Panoramic image of the site (Baidya, 2013)



Figure 11: Panoramic image of the site (Baidya, 2013)



Figure 12: Existing Brick field nearby the site (Baidya, 2013)

2.5 TOPOGRAPHY

34 meters elevated above the sea level, the land of this area is alluvial plain.

2.6 SWOT ANALYSIS

Strengths:

1. The main strength for building a habitat in this area is its topography. Because the land is plain high land, flooding is rare.
2. A planned road network is already existing, this will help the new habitants to commute easily to and from the Phulbari and Parbatipur city center.

Weakness:

1. However, the roads are not yet built properly and not good enough for motor vehicles.

Opportunities:

1. Existing vegetation would contribute in creating a good habitable area for the new settlement.

Threats:

1. Existing brick fields in the area might pose threat to living condition in the site by creating air pollution.

CHAPTER 03

LITERATURE REVIEW

3.1 INTRODUCTION

This objective of this project is to claim that by the use of indigenous material and technology in the practice of architecture in the context of building rural shelters would vitally contribute in achieving cultural sustainability.

This chapter discusses about the main ideas related to the project and studies the theories and principles developed by expert professionals (architects, engineers, researchers etc.) that are vital for comprehension of the needs of a housing project of a low-income rural society.

1. Vernacular architecture:
 - Definition and significance of vernacular architecture.
 - Vernacular architecture of Bangladesh.
2. Indigenous materials and technology
 - Definition and significance of Indigenous materials and technology.
 - Scopes and development of local material and technology.
 - Scopes and development of local material and technology in Bangladesh.
3. Cultural sustainability
 - Definition and significance of culture and heritage.
 - Sustainability and cultural sustainability.
4. Charles Correa's ideas and principles about low income housing
5. Hasan Fathy's Ideas and principles of architecture.

3.2 VERNACULAR ARCHITECTURE

3.2.1 Definition of vernacular architecture

The word "Vernacular" comes from Verna; meaning "native slave" or "home-born slave". The word probably is derived from an older Etruscan word.

In architecture, it refers to that type of architecture which is indigenous to a specific time or place (not imported or copied from elsewhere).

Another etymology can be derived from the Latin word "*vernaculus*", which means native. Architecture is vernacular when it exhibits all of its criteria related to the native context in the sense that it can only be acceptable and recognizable within any particular society by applying some particular technology, materials, social rules and systems.



Figure 13: A Toda hut at India



Fig. 14: A traditional Indonesian house



Figure 15: A typical Serbian rural hut



Fig. 16: African hut at Cameroon

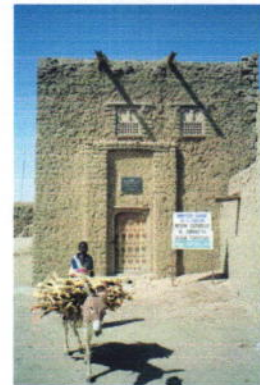


Figure 17: A house in Timbuktu

Vernacular architecture is a term used to categorize methods of construction which use locally available resources and traditions to address local needs.

Vernacular architecture tends to evolve over time to reflect the environmental, cultural and historical context in which it exists.

Frank Lloyd Wright described vernacular architecture as; "Folk building growing in response to actual needs, fitted into environment by people who knew no better than to fit them with native feeling". He also suggested that, "it is a primitive form of design, lacking intelligent thought", but "it is worth studying than all the highly self-conscious academic attempts".

Vernacular architecture is sometimes synonymous with Primitive architecture, Indigenous architecture, Anonymous architecture, "Architecture without architects".

A conventional definition of architecture usually doesn't accept 'vernacular architecture' as 'architecture'. "Architecture is the art, profession or science of designing and constructing buildings, certainly covers the constructions existed from the time of hunters and food collectors- if not from the early time of mere gatherers- to the present" (Turan, 1990). This definition of architecture attempts to recognize the shelters/and dwellings of general people as architecture, From these understanding one cannot exclude the vernacular houses from the domain of architecture.

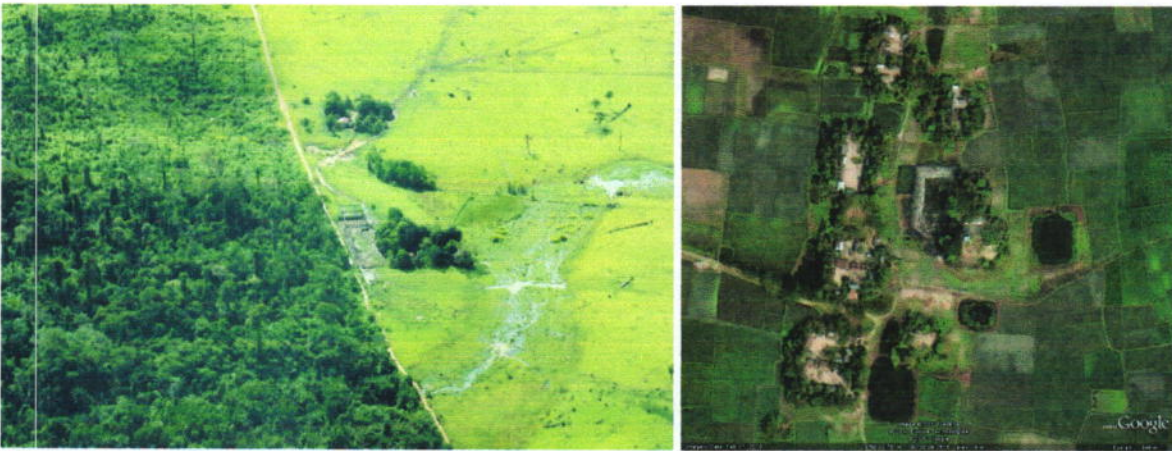


Figure 18, 25: Patterns of rural homesteads at rural countryside

"Vernacular architecture comprises the dwellings and all other buildings of the people. Related to their environmental context and available resources, they are customarily owner or community -built, utilizing traditional technologies. All forms of vernacular architecture are built to meet specific needs, accommodating values, economies and ways of living of the living of the cultures that produces them." (Oliver, 1997).

"Vernacular architecture generally embodies community values, and less evidently, may symbolize concepts of cosmos, or acts as an analogue for the abstraction of belief. Thus even a simple dwelling may reflect both the material and spiritual worlds of it builders and occupiers." (Oliver, 1997).

3.2.1 Vernacular architecture in Bangladesh

A traditional rural 'Bengali House' is an inheritance from the past, exists in the present and has a potential for the future. The traditional house in its basic form is a cluster of small 'shelters' or huts around a central courtyard called the 'Uthan'. The individual house may constitute the following categories:

1. the outer house (Out house or Baithak ghar)

2. The inner house (dwelling unit or Ghar)
3. The kitchen
4. The cattle-shed

Larger houses may also include the following:

5. the store house (fuel storage, granary)
6. the rice- husking shed or 'dheki-ghar'

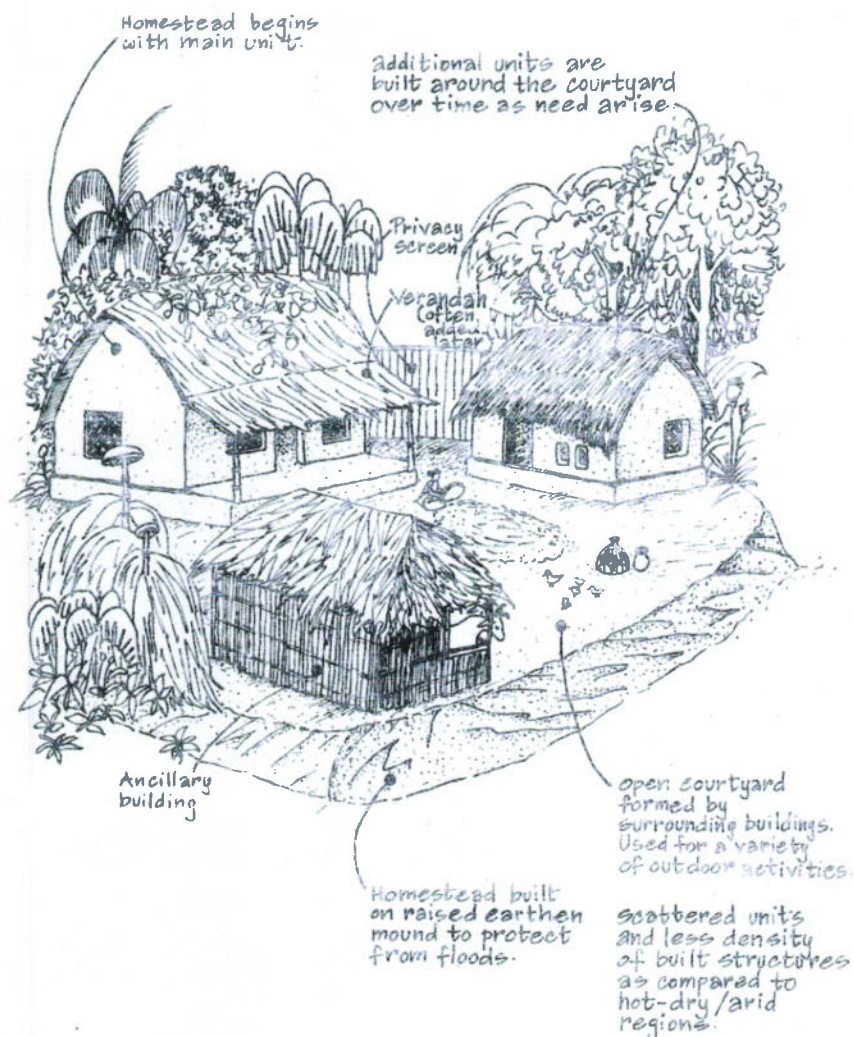


Figure 19: A typical homestead showing salient features (Ahmed, 1994)

The huts are usually single roomed, detached and loosely spaced around the central court. An extensive landscaping is done to define the house in the larger landscaping and the surrounding environment. The latrine and bath are never considered as parts of the main structures and are always kept at a distance. The combination of all the huts is called a 'Bari' or the 'House'. The courtyard or "Uthan" serves to maintain both unity and individual identity of the families in the house. (Hasan, 1985)

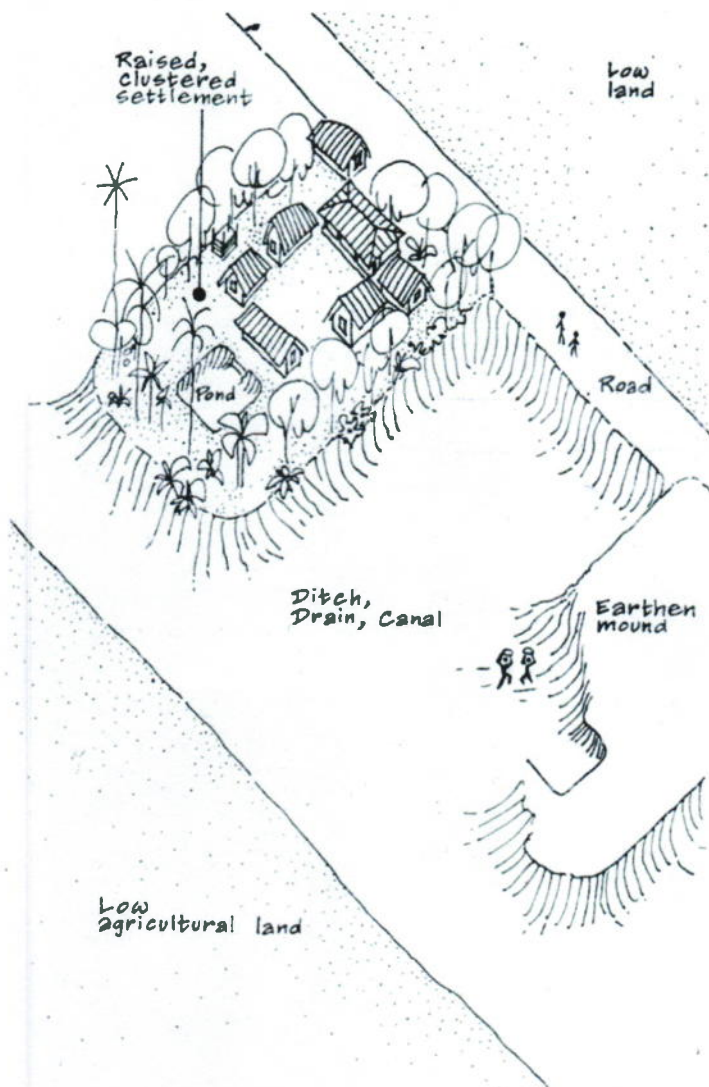


Figure 20: A typical settlement pattern in Bangladesh (Ahmed, 1994)

By creating a land (or a 'mound') for the 'house' the act of homesteading starts. The land for the homestead is raised above the flood plains demarcating it from the surrounding agricultural land. The shape, size and height of the 'mound' varies from place to place. After raising of the land for the proposed homestead, various shelters, huts and open spaces are organized on it and gradually the 'house' takes its shape. (Hasan, 1985)

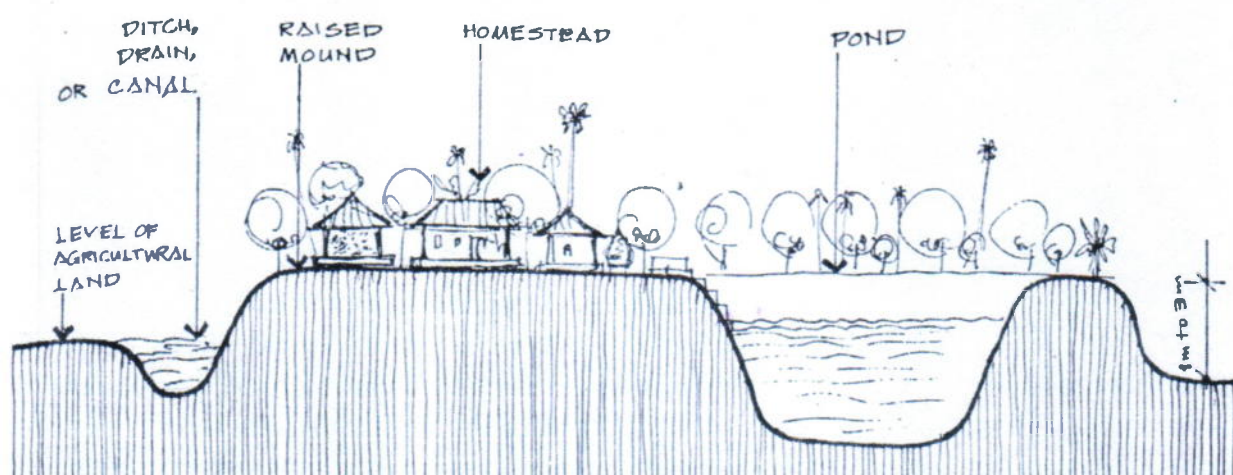


Figure 21: A section showing the preparation and formation of the land for a homestead (Hasan, 1985)

3.2.1.1 The significance of culture and the house form

All the arrangements and uses are structured in the house by the local perception of privacy. which defines appropriately and dictates necessary measures to secure the space and the result is the inner house and outer house. Perception of privacy in every culture is performed in their own way, which is again at least partly affected by the position of women in that particular culture. In Bengali culture, 'Privacy' is achieved is achieved through visual perception and male/female separation. Visual privacy is achieved by using physical devices, which includes organization and orientation of shelters, partition between the inner and outer house, indirect entry to the inner house and so on. All these have made the traditional houseform of rural Bangladesh "Introvert type". The domestic privacy is concerned with regard to male and female rather than family and nonfamily. The conceptual image of male and female role in the house

divides their respective spatial and temporal domain of influence. Male and female have their respective, definite functions and roles to perform with regard to the house. 'Inner house' corresponds to the 'female domain' and the 'outer house' corresponds to the 'male domain'.

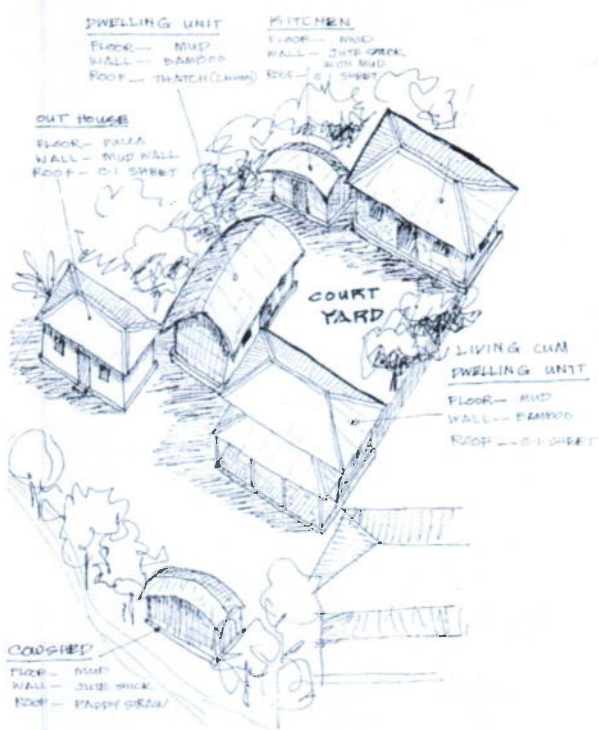


Figure 22: A case study at Joydevpur (Hasan, 1985)

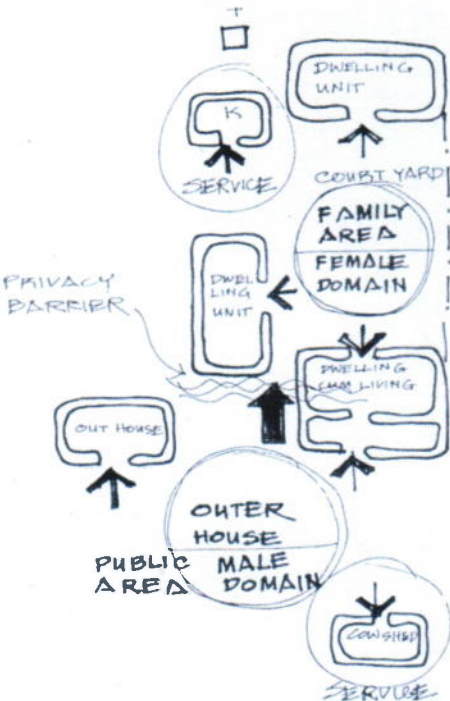


Figure 23: Analysis of spaces of the homestead (Hasan, 1985)

3.2.1.2 The significance of religion and the house form

The characteristics of a traditional rural 'Bengali house' is firmly based on the religious convictions and the cultural identities of the rural populace. The population of Bangladesh consists of two main religion groups- the Muslims and the Hindus. The Muslims constitute more than 80% of the total population.

The Muslim house structures are normally laid out following the cardinal direction so that it is convenient to establish the direction of 'kiblah' of the prayer. The direction of the 'kiblah' also determines the orientation of the sleeping mats and the toilets which in turn affects the organization of the spaces and their use.

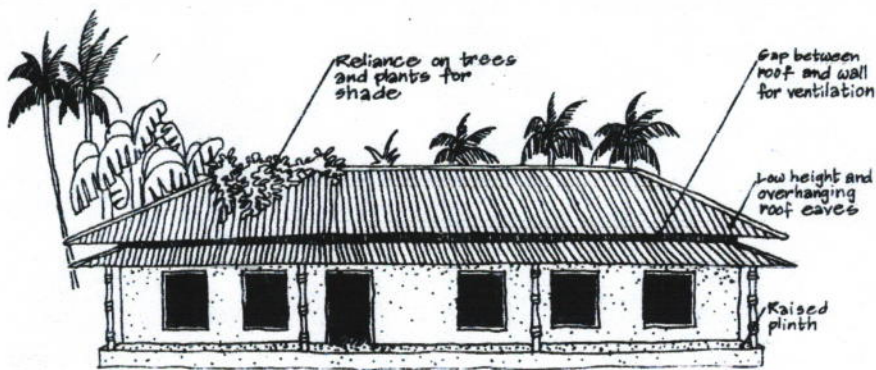
The Hindu homesteads do not exhibit any such concern for the cardinal directions in particular, although the East is considered a sacred direction because the sun rises in the east.

The Muslims do not identify particular places of ritual purity within the house or homestead. The Hindu homesteads, on the other hand, are organized on the basis of particular places of ritual purity- both indoor and outdoor. Thus , a corner of the indoor courtyard is marked place of ritual purity- the 'Tulsi tala' with an alter.

3.2.1.2 The significance of climate and the house form

The predominant characteristics of the climate of Bangladesh are high solar radiation and heavy annual rainfall. In such warm humid climate thermal comfort in the built environment is extremely important from rain and wetness is of high concern in the design and construction of the house structures.

The traditional house structure is rectangular in plan with the length varying from 4.5m to 7.5m and the width varying 3. to 4.5m normally. It is built on ground with the floor of the plinth raised about .3m to 1.2m from the ground level in order to safeguard it from the temporary water logging of the site or heavy surface run off due to torrential downpour.



Front View

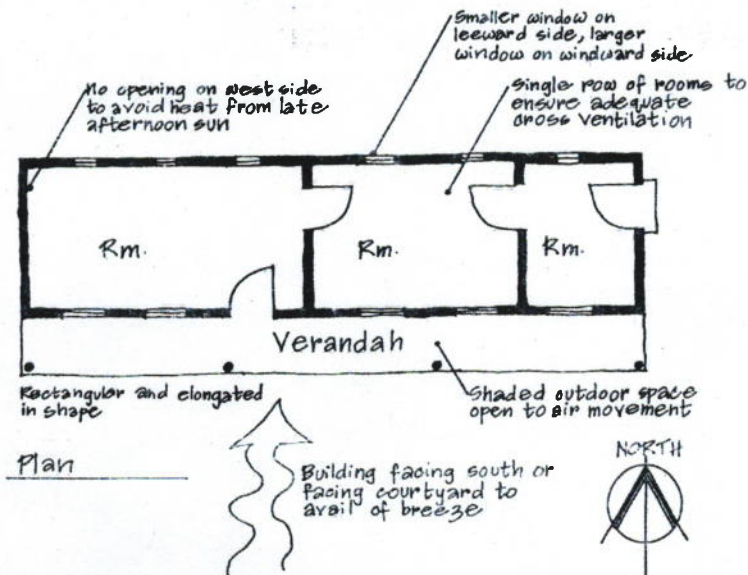


Figure 24: An analysis of the relationship of climate and rural vernacular house form (Ahmed K. I., 1994)

3.2.1.3 The traditional house structures: types, materials and construction methods

Rural Bangladesh offers an interesting variety in traditional house types in terms of floor, wall and roof. In terms of floors, they are single storied and double storied, although single storied structure is the most common all over Bangladesh. In terms of roof shape, houses are single pitched (ek chala), double pitched (do chala), hipped (char-chala), double hipped (aat chala) and semicircular type. Traditional houses are commonly recognized as 'Mud house' (irrespective of roof type), 'Thatch house', 'Tin house' or 'Tile house'. (Hasan, 1985)

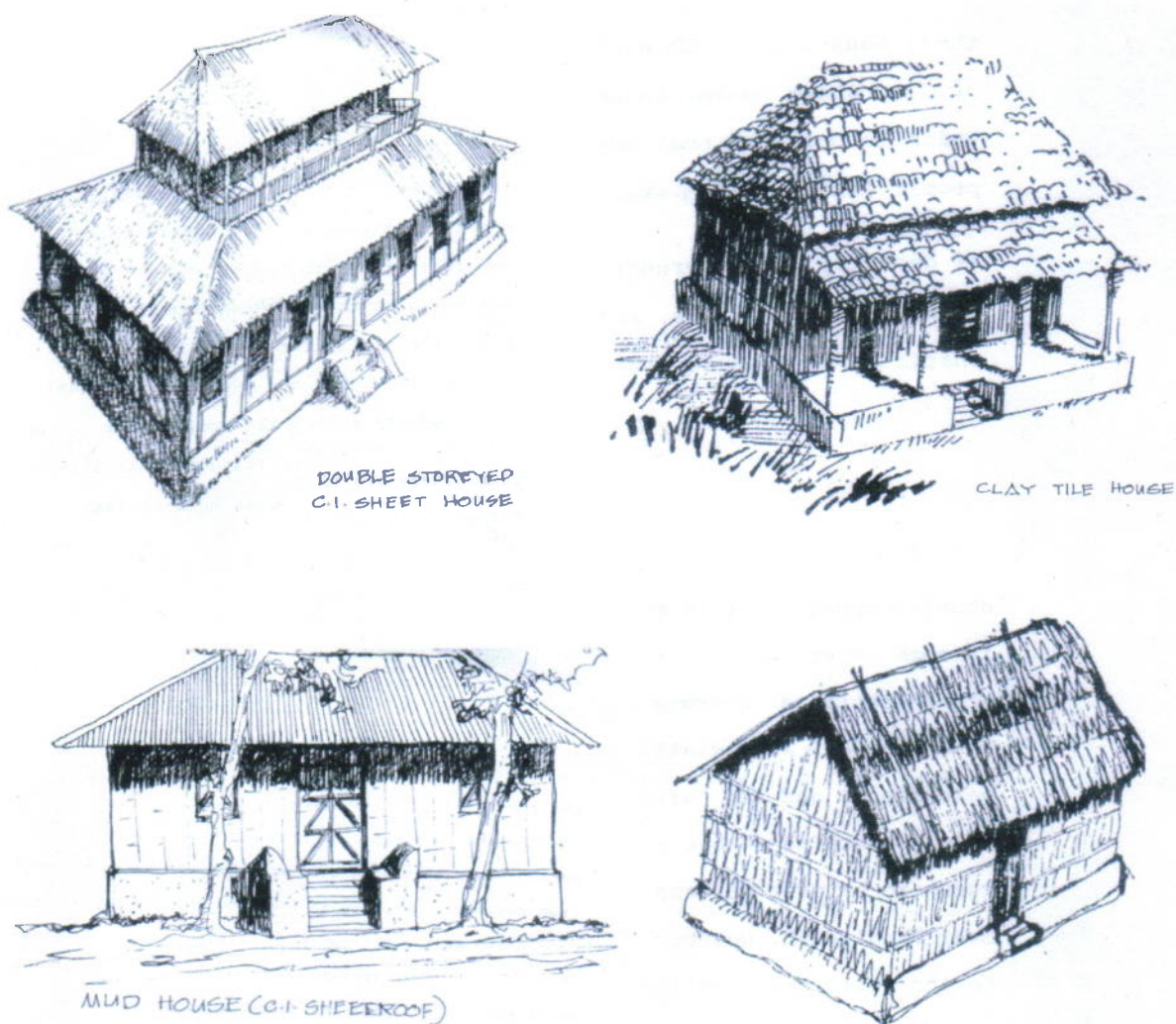


Figure 25: Study of different types of rural houses (Hasan, 1985)

3.2.2 Increasing popularity of industrial building materials

In Bangladesh factory-made, imported building products are rapidly becoming more and more popular since the past decade. The traditional, more natural building materials are gradually being replaced by others that are more dependent on technology and an affluent economy. Popular opinion perceives such materials as being more progressive and modern; local administrations largely support this view. Whatever the cause of this transformation may be, the long term effect are often detrimental to society and the environment, leading to a loss identity for the culture that is now experiencing a transformation. (Ahmed, 1994)

3.2.2.1 Use of C.I. sheets

In the past, majority of rural buildings were made of earth, but since the past decade, industrialized building products, mainly corrugated iron sheets (mainly known as "tin sheets"), are rapidly replacing the traditional building materials. Originally indigenous rural buildings in Bangladesh (and still in many areas) roofs constructed of various types of thatch. These types of roofs require frequent maintenance in the rainy climate, and are thus perceived to be poor in quality. Most of the thatched roofed houses now belong to the poorer segments of the rural population. The more affluent construct the roofs of ancillary buildings out of thatch, while the roofs of dwelling units were in former times constructed of more durable fired clay tiles, and are now being constructed of C.I. sheets.

Before independence from British colonial rule, roofing tile production was operated by a class of Hindu potters. After independence, due to the partition of India into Muslim Pakistan and Hindu India, there followed a mass migration of Hindus from Bangladesh to neighboring India. Much of the art of clay tile production disappeared from Bangladesh at that time. It is in this juncture of time that the advent of C.I. sheet roofing took place, was marketed successfully and thereby gained popularity. While C.I. sheet roofing may be a symbol of permanence for the rural affluent, for most of the rural poor it is yet, to a large extent, an inaccessible building material in terms of cost. The resources required for the production of C.I. sheets are not available in Bangladesh, and therefore C.I. sheets are imported. or the raw materials and then sheets are produced locally.

Apart from their thermal disadvantage, C.I sheet roofs are noisy during rainy periods, which are frequent in Bangladesh. The use of sound dampening layers or false ceilings may reduce noise, but this would automatically increase costs of labour, construction and materials.

The thermal disadvantage of C.I sheets is a serious problem, especially in a hot-humid climate like that of Bangladesh. They heat up very fast and also cool down fast. When a shiny C.I. sheet is installed, it reflects a portion of the short wave solar radiation, and allows the majority of the remaining radiation to pass through to the interior of the building. In this process the short wave radiation is converted to long wave radiation, and as the absorptivity of the C.I. sheet for long wave radiation is low, the interior of the building consequently becomes hot. The small portion of

radiation absorbed cannot be emitted easily and therefore causes the sheet to heat up. When C.I. sheets age and acquire layers of rust on their surface, they become darker in color and consequently reflect even less radiation than the shiny sheets, and absorb and emit more radiation.

In humid areas the diurnal temperature variation is not great, and the high insulation value of thick earth walls characteristic of hot-arid areas is not an important requirement. However, thin earth walls provide the necessary balance between the exterior and interior temperature. C.I. sheets with their lack of insulative quality do not provide the necessary balance and on hot days allow the interior to heat up rapidly, and on cold days allow the interior to heat up rapidly, and on cold days also allow it to cool down rapidly.

There is a need for the development of a suitable roofing material for rural Bangladesh. The production of fired clay roofing tiles should be revived if possible, because it utilizes the locally available material, earth, and also because its production generates employment. This, of course, entails a new initiative and may be difficult to realize. The production of fired clay tiles is an energy-intensive process, therefore availability of fuel has to be assessed, along with its potential for generating a labor-intensive process.

Thatching is certainly a practice rooted in locally available resources and skills, and has been adapted to the climate. In spite of this rationale of its use, it presents several problems, the main one being that it is a system using perishable materials and hence requires frequent maintenance and replacement. Also in the tropical climate of Bangladesh, thatch is a nesting ground for harmful insects.

3.3 INDIGENOUS MATERIAL AND TECHNOLOGY

This thesis claims that the increased use of indigenous material in building shelters will contribute in achieving sustainability, especially cultural sustainability by protecting our cultural identity. However, meeting modern needs of a community by architecture needs careful study and application of modern materials and technology.

3.3.1 Definition and significance of indigenous materials

Indigenous materials are generally considered to be materials which are produced in the same bioregion or regional ecosystem where they will be used, although some practitioners consider materials to be indigenous only if they are available on the same site where they will be used.

There is no clear answer to the question of whether the use of indigenous materials is more sustainable than current patterns of material use. The importance of context is paramount in deciding the answer to this question, particularly in terms of the existence of infrastructure for harvest or transportation. What can be clearly stated, however, is that it is more sustainable to use materials which:

- 1) have the lowest possible life cycle consumption of matter and energy
- 2) have minimal net negative impacts to the natural environment
- 3) maintain some reasonable level of human satisfaction

In general, using indigenous materials reduces the quantity of resources expended on transportation costs. By reducing the scope of harvesting and processing and transferring responsibility from the corporation to the individual, the use of indigenous materials may reduce the net level of negative environmental impact, and may increase the net level of human satisfaction by empowering people to provide building materials for themselves. As such, the use of indigenous materials may be more sustainable than using other commercially produced materials. However, in some cases commercially produced materials may prove to be more energy efficient over the whole product life cycle in the intended context of use, may require less investment in new harvesting infrastructure, or may simply be much more highly preferred by humans. In these cases, the commercial materials may be more sustainable than their indigenous counterparts.

3.3.2 Scopes and development of local material and technology

Auroville has highly advanced the development of local materials and technology, especially building with earth. Some technologies that are concerned to this project is discussed below:

CSEB (Compressed Stabilized Earth Block): The first attempts for compressed earth blocks were tried in the early days of the 19th century in Europe. The architect François Cointereaux precast small blocks of rammed earth and he used hand rammers to compress the humid soil into a small wooden mould held with the feet.

The first steel manual press which has been produced in the world in the 1950's was the Cinvaram. It was the result of a research programme for a social housing in Colombia to improve the hand moulded & sun dried brick (adobe). This press could get regular blocks in shape and size, denser, stronger and more water resistant than the common adobe. Since then many more types of machines were designed and many laboratories got specialised and skilled to identify the soils for buildings. Many countries in Africa as well as South America, India and South Asia have been using a lot this technique.

The soil, raw or stabilized, for a compressed earth block is slightly moistened, poured into a steel press (with or without stabiliser) and then compressed either with a manual or motorized press. CEB can be compressed in many different shapes and sizes. For example, the Auram press 3000 proposes 18 types of moulds for producing about 70 different blocks.

Compressed earth blocks can be stabilised or not. But most of the times, they are stabilised with cement or lime. Therefore, we prefer today to call them Compressed Stabilised Earth Blocks (CSEB).

The input of soil stabilization allowed people to build higher with thinner walls, which have a much better compressive strength and water resistance. With cement stabilization, the blocks must be cured for four weeks after manufacturing. After this, they can dry freely and be used like common bricks with a soil cement stabilized mortar. (http://www.earth-auroville.com/compressed_stabilised_earth_block_en.php)



Figure 26: Wall of CSEB

INITIAL EMBODIED ENERGY PER M ³ OF WALL	POLLUTION EMISSION (Kg of CO ₂) PER M ³ OF WALL
CSEB wall = 631 MJ / m ³ Kiln Fired Brick (KFB) = 2,356 MJ / m ³ Country Fired Brick (CFB) = 6,358 MJ / m ³	CSEB wall = 56.79 Kg / m ³ Kiln Fired Brick (KFB) = 230.06 Kg / m ³ Country Fired Brick (CFB) = 547.30 Kg / m ³

Figure 27: comparison of energy consumption and pollution emssion between CSEB and brick

ADVANTAGES OF CSEB

• A local material Ideally, the production is made on the site itself or in the nearby area. Thus, it will save the transportation, fuel, time and money. • A bio-degradable material Well-designed CSEB houses can withstand, with a minimum of maintenance, heavy rains, snowfall or frost without being damaged. The strength and durability has been proven since half a century. But let's imagine a building fallen down and that a jungle grows on it: the bio-chemicals contained in the humus of the topsoil will destroy the soil cement mix in 10 or 20 years... And CSEB will come back to our Mother Earth!	• Energy efficiency and eco friendliness Requiring only a little stabilizer the energy consumption in a m³ can be from 5 to 15 times less than a m³ of fired bricks. The pollution emission will also be 2.4 to 7.8 times less than fired bricks. • Cost efficiency Produced locally, with a natural resource and semi skilled labour, almost without transport, it will be definitely cost effective! More or less according to each context and to ones knowledge! • An adapted material Being produced locally it is easily adapted to the various needs: technical, social, cultural habits.	• Market opportunity According to the local context (materials, labour, equipment, etc.) the final price will vary, but in most of the cases it will be cheaper than fired bricks. • Reducing imports Produced locally by semi skilled people, no need import from far away expensive materials or transport over long distances heavy and costly building materials. • Flexible production scale Equipment for CSEB is available from manual to motorized tools ranging from village to semi industry scale. The selection of the equipment is crucial, but once done properly, it will be easy to use the most adapted equipment for each
---	---	--

• Limiting deforestation Firewood is not needed to produce CSEB. It will save the forests, which are being depleted quickly in the world, due to short view developments and the mismanagement of resources. • Management of resources Each quarry should be planned for various utilisations: water harvesting pond, wastewater treatment, reservoirs, landscaping, etc. It is crucial to be aware of this point: very profitable if well managed, but disastrous if unplanned!	• A transferable technology It is a simple technology requiring semi skills, easy to get. Simple villagers will be able to learn how to do it in few weeks. Efficient training centre will transfer the technology in a week time. • A job creation opportunity CSEB allow unskilled and unemployed people to learn a skill, get a job and rise in the social values	case. • Social acceptance Demonstrated, since long, CSEB can adapt itself to various needs: from poor income to well off people or governments. Its quality, regularity and style allow a wide range of final house products. To facilitate this acceptance, banish from your language “stabilized mud blocks”, for speaking of CSEB as the latter reports R & D done for half a century when mud blocks referred, in the mind of most people, as poor building material
---	---	--

SOME LIMITATIONS OF CSEB

• Proper soil identification is required or unavailability of soil. • Unawareness of the need to manage resources. • Ignorance of the basics for production & use. • Wide spans, high & long building are difficult to do.	• Low technical performances compared to concrete. • Untrained teams producing bad quality products. • Over-stabilization through fear or ignorance, implying outrageous	• Under-stabilization resulting in low quality products. • Bad quality or un-adapted production equipment. • Low social acceptance due to counter examples (By unskilled people, or bad soil & equipment).
---	--	--

Figure 28: Discussion about CESB as a building material. (http://www.earth-auroville.com/compressed_stabilised_earth_block_en.php)

3.3.3 Scopes and development of local material and technology in Bangladesh

Several architects, engineers and researchers from home and abroad has been involved with building practices in rural areas. Some of these initiatives are projects designed to rehabilitate a disaster affected community, and some are small scale projects for testing new techniques and materials. This portion of the paper discusses about the technical aspects of such innovations and practices.

3.3.3.1 Appropriate construction techniques (Ahmed K. I., 2005)

List of construction to develop appropriate design using local materials

PLINTH	POST	WALLS	ROOFING
Cement Stabilization	Coating Lower End	Detachable Lower Panel	Chemical Treatment of Thatch
Brick Perimeter Wall	R.C. Post	Painting with Bitumen	Wind-Resistant Roofing
Brick and Concrete	Internodal Injection Method	Protective Lower Panel	Rainwater Gutter
	Hot and Cold Method	Rain Protector (<i>Bhelki</i>)	Ferrocement
	Hollow Concrete Stump	Chemical Treatment of Bamboo Mat Walls Dip Diffusion Method	Metal Roof Structure
	Hollow Cylindrical R.C. Post	Cross-Bracing	Timber
	Metal Post	Basic Guidelines for Wattle and Daub Construction	
	Timber	Double Layer Framework with Earth Infill	
	Stilts	Cement Stabilization	
	Soaking Bamboo in Water	Compressed Earth Blocks	
	Clump Curing of Bamboo	Rammed Earth	
	Bamboo Seasoning	Ferrocement	
	Chemical Preservative CCA	Timber	
	Chemical Preservative CCB		
	Chemical Preservative Oils		

Techniques for making a more stable plinth:

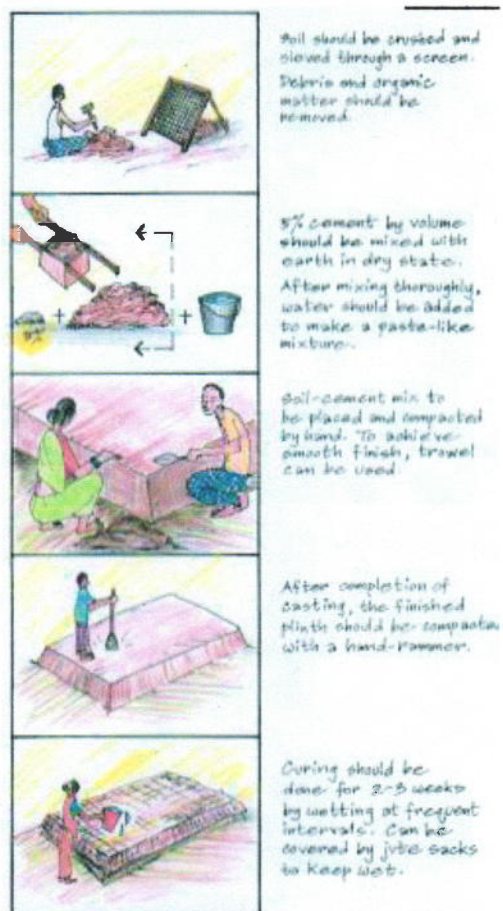
Cement Stabilization:

- Stabilization of the typical earthen plinth can be carried out with a mixture of earth and cement.

- The proportion of cement to be added depends on the nature of the soil which can easily be tested on site.
- For soil with more than 40% sandy-silty particles, 5% cement additive is adequate. For soil with less sandy content, sand has to be added to raise the content above 40% and may require a somewhat higher proportion of cement additive.
- Test blocks should be made on site to determine the suitability and proportions of the mixture, keeping in mind the above point.
- Soil should be crushed and sieved into a fine form and cement in the right proportion to be added in dry state.



- Moistened with water and should be immediately used. Wet mixture left unused for too long becomes unusable as it begins to set and harden.
- Stabilization works best together with compaction. Can be cast and compacted by hand and finished with a trowel.
- For further compaction, a simple hand rammer or wooden battens can be used.
- At least 3 weeks curing by water should be done. Can be covered by jute sacks to keep moist and water poured at regular intervals to avoid drying.
- Capping the plinth with cement stabilized earth is cheaper, easier to construct and maintain.
- Complete stabilized earth plinth is more expensive and harder to construct, but the results are more durable.



Techniques for treatments of posts:

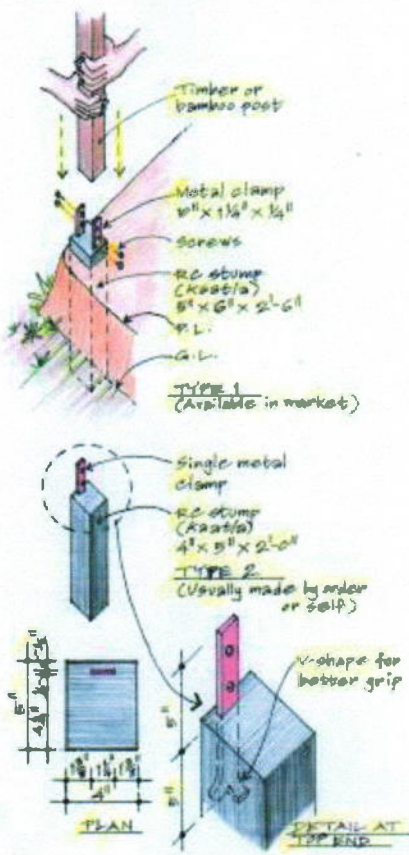
Coating Lower End:

- Cheapest method for protecting from dampness lower end of bamboo/ timber posts typically embedded into the ground.
- Local method known by most villagers, but not widely practiced, and thus requires promotion.
- Molten bitumen, Mobil or sump oil, or a combination of these can be used.
- Should paint the lower end with brush or cloth and continue coating above plinth level according to last flood level.
- Provides mainly damp-proofing, does not prevent much insect or fungal attack.
- Extends life of bamboo post by a couple of years or so.
- For chemical preservative treatment of bamboo posts.



Concrete Stump (Kaatla):

- Local method for protecting the base of bamboo/ timber posts by supporting on concrete stumps embedded into the plinth or ground and connecting them by MS (mild steel) clamps.
- Locally known as kaatla or shiri.
- Possible to reduce cost by 10% by making the kaatla partially hollow. Space can be filled with sand/ earth before placing in the ground and strength is not compromised.
- Greatest advantage is reduction of recurrent expenditure on replacing bamboo posts; a bamboo post protected from the ground by kaatla lasts five years or longer, representing more than double lifespan.
- For a bamboo post supported on kaatla, it is better to paint lower end with bitumen for additional damp proofing.
- Termite shield made of polythene or metal can be used in the space between bottom of post and above kaatla top.
- Polythene sheets to be spread on the ground and a 4-sided wooden shuttering placed according to kaatla dimensions, given below.
- For each kaatla, at one end a 10-12 inch long $\frac{1}{4}$ inch thick MS flat bar to be placed in position so that after casting it is embedded by 4-6 inch into the kaatla.
- The bar should have two / 8 inch holes towards the upper end to insert screws for attaching the post, thus serving as a clamp.

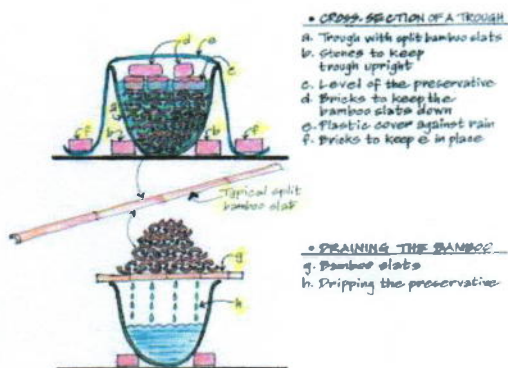


- Casting is to be done with a 1:4:4 (cement : sand : aggregate – $\frac{1}{2}$ inch brick chips) mix to make 5 inch x 4 inch x 2 feet kaatla.
- At least 3 weeks curing by water is necessary.
- To prevent rust, the MS clamps can be painted with molten bitumen.
- For efficient use of wooden shutters, better cost-effectiveness and production, it is advantageous to produce a number of kaatlas together.

Chemical Treatment of Bamboo Mat Walls:

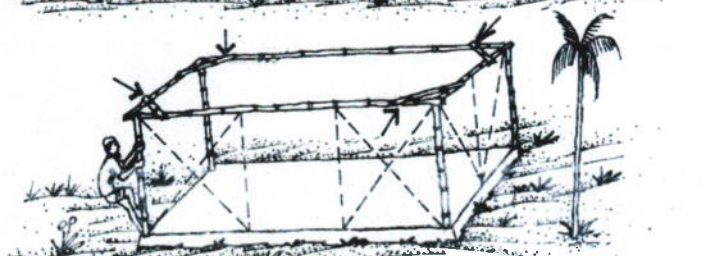
- Simple chemical preservative treatment methods for increasing the longevity of organic materials have been developed a long time ago.
- Increases cost by 20-25%, but can increase longevity by more than three or four times. If untreated, bamboo mat walls do not last more than 4-5 years in outdoor conditions, but after treatment lasts for 15-20 years.

- The chemicals are not harmful if proper precautions are maintained.
- For chemical preservative treatment of bamboo battens and mats, the simplest method is to build a tank made of bricks and concrete, or at cheaper cost, lining an excavation in the ground with polythene sheet, or cutting a cylindrical metal container (e.g. oil drum) into half and welding them end-to-end (for other methods, see section 3.4).
- A typical preservative can be prepared to be mixed in the tank in the following proportions: Copper Sulphate 4%, Sodium Dichromate 4%, Boric Acid 2%, Water 90% = TOTAL 100%.
- The materials should preferably be freshly harvested, but dry ones can also be treated.
- Bamboo battens and mats are to be first soaked in water for at least 24 hours and then dried.
- They are then to be immersed completely in the chemical preservative solution for 24 hours.
- After soaking, the materials are to be raised above the tank and supported on bamboo poles or timber battens so that excess chemicals can drip back into the tank and can be re-used.
- Then they are to be dried in an open shaded space for 1-2 days and then in sunshine for 3-4 days.
- Gloves or polythene bag covers to be worn to protect hands from chemicals during the treatment process.



Cross-Bracing:

- To increase stability and wind resistance of the structural frame of bamboo-framed houses, cross bracing with split bamboo sections should be done.
- If a house become weakened, cross-bracing helps to keep the structure stable.
- Split bamboo sections used for cross-bracing should be treated with chemical preservatives so
- that they do not decay easily and lose their strength.
- Instead of jute or coir rope, nylon rope or good quality galvanized wire should be used for tying the elements of the structural frame.



FIX BAMBOOS ACROSS THE TOP OF EACH CORNER
 প্রতি কোণায় কোণাকুলি করে বাঁক লাগান



এই রকম দুর্ঘটনা ঘটনা উচিত না

THIS TYPE OF ACCIDENT
 NEED NOT HAPPEN



INSERT SPLIT BAMBOOS
 BETWEEN THE POSTS

খুঁচির মাঝে কোণাকুলি করে বাঁক লাগান

Earth construction:

Limitations:

- 1 Despite the wetness of the Bangladeshi context, earthen walled houses are prevalent in many areas.
- Mostly monolithic type wall construction, but also wattle-and-daub type in some areas.
- 1 Most such areas are relatively elevated, but in recent years have experienced unprecedented
- floods, resulting in widespread collapse of houses with earthen plinths and monolithic walls.

Causes of Limitations:

- Water is the greatest enemy of earthen houses.
- Effect of Flood: Flood water affects the typical earthen plinth, thus weakening the base of walls.
- Combined with capillary rise of water into the walls, this can result in collapse of the entire house.
- Effect of Rain: Driving rain, especially in houses without sufficiently extended roof eaves, can damage earthen walls severely.
- High Maintenance Requirement: Earthen plinth and walls require regular maintenance, often plastered every week, especially during the wet season. Since household women do this work, it is unaccounted labor and places an extra demand on women who are often overburdened with domestic tasks.
- Vermin Infestation: Various insects, including worms, termites and ants, and also rodents and birds tend to burrow into earthen walls and establish their habitats. This can weaken earthen plinths and walls substantially.

Basic Guidelines for Wattle and Daub Construction:

- The framework should include structural posts (bamboo, timber or reinforced concrete) to support the roof.
- The frame should have cross-bracing to increase its sturdiness.
- In the case of bamboo framework, substantial horizontal members made of larger split bamboo sections or two sections tied together should be used at 3 feet intervals to reduce the size of panels to be filled in with smaller split bamboo sections and earth. This bears the weight of the earth plaster adequately, which can otherwise cause frame distortion and make the plaster fall off.
- Bamboo or timber slats, battens and posts used for the framework should be treated against decay and insect attack (refer to sections 2.3.2 and 3.4).
- Earth used for plastering should be stabilized with cement .

- Instead of jute or coconut coir rope, good quality galvanized wire or nylon rope should be used for tying together the elements of the framework.
- Wattle and daub walls should be built on a solid plinth, at the least of stabilized earthen capping.

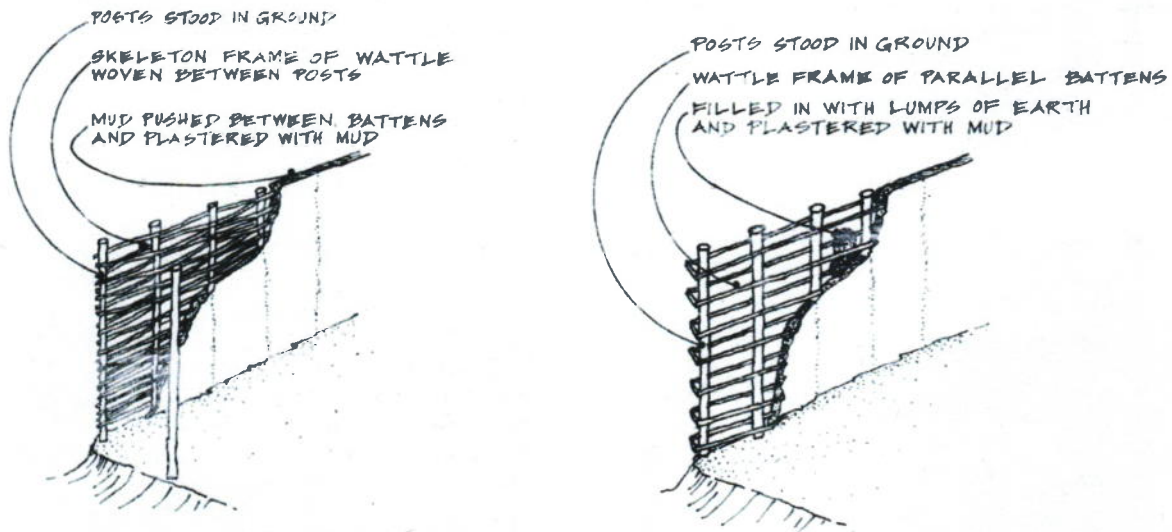


Figure 29, Figure 30: Wattle and daub wall detail (Ahmed K. I., 2005)

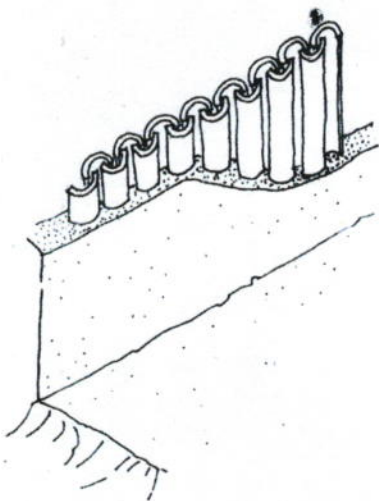
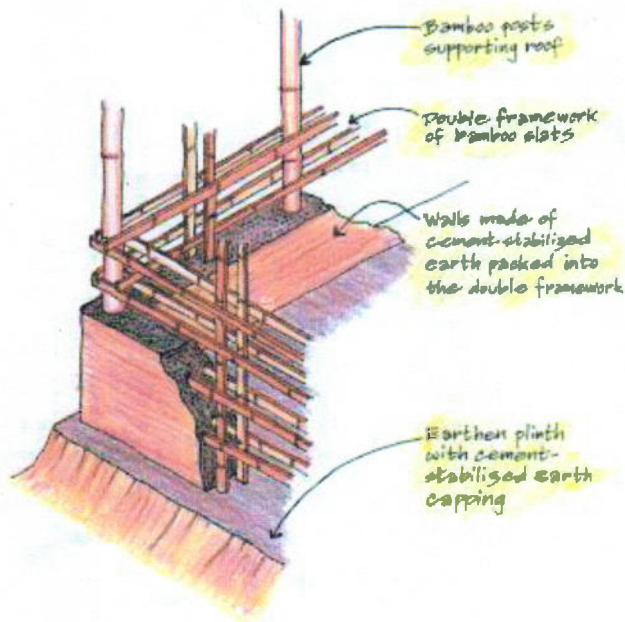


Figure 31: Ekra wall detail (Ahmed K. I., 1994)

Double Layer Framework with Earth Infill:

- Improved and stronger variation of wattle and daub where earth is packed in between two retaining frameworks.
- Load-bearing structure of bamboo or timber posts to support the roof should be built on a solid plinth (at least of stabilized earth capping).
- Horizontal and diagonal bamboo slats should then be nailed on either side of the posts.
- Spacing of vertical posts depends on width of bamboo slats: 1½ inch slats require posts at 1 foot center to center with 2½- 4 inch gaps between the slats; for stronger slats of 3-4 inch, posts can be at 2½- 3 feet distance.
- The space between the frameworks should then be filled with earth (preferably cement stabilized) by hand in lumps and packed down tightly so that it pushes out between the slats.
- Walls should generally be around 6-8 inch thick.
- Small brick chips and/or gravel can also be included into the earth mixture.
- The surface may or may not be plastered. If plastered, stabilized earth mixture of the same proportion as the wall material, but wetter, should be used.
- Instead of jute or coconut coir rope, good quality galvanized wire or nylon rope should be used for tying together the elements of the framework.
- Because the slats are close to the wall surface, they can be replaced when damaged without having to dismantle the wall.



Stabilization with Cement:

- Mixing a small amount of ordinary Portland cement to earth greatly increases its resistance to water. This process is known as stabilization.
- Lime can also be used, but requires more quality control, therefore it has been chosen here to recommend cement, which is now widely available in most areas.
- Together with the addition of cement, stabilization works best if the earth is also compacted.

Soil Selection:

- Cement stabilization is suitable for soil that has low clay content, that is, it should be composed of larger sandy particles.
- Soil with less than 40% sand content cannot be satisfactorily compacted and stabilized. With such soil, sand has to be added until its composition is suitably modified.
- Soil with more than 40% sand content can generally be stabilized with 5% cement by volume.

Stabilized earth construction methods:

Stabilized earth can be used in wattle and daub construction and other earth construction methods such as the traditional hand-compacted layering method. The results of these methods can be improved in terms of water resistance by cement stabilization, following the basic principles of preparation. However, to achieve better compaction and hence better water resistance, the methods discussed below are more suitable.

Compressed Earth Blocks:

- There are a variety of presses for producing compressed earth blocks ranging from manual to motorized ones, but these are mostly uncommon in Bangladesh. Therefore the most suitable method would be to use a simple wooden brick mold operated by hand pressure, which is widely available for brick production.
- Necessary soil selection and identification should be carried out. If the soil has less than 40% sand, extra sand should be added. The soil should be finely crushed, if necessary using a sieve, removing all debris and organic materials from it.
- 5% cement by volume to be added to the processed soil, using a typical 1 cubic foot wooden box. Mixing should be done in dry state and the mix then slightly moistened, taking care not to add too much water.
- Small batches of mix should be prepared and each batch used up within 15-20 minutes to make blocks using the brick mold.
- The blocks should be stored in shade or under cover and moistened frequently for curing at least for two weeks.
- When laying the blocks, mortar of the same mix as used in the block should be used, but using more water. A small amount of lime can be added to prevent shrinkage cracks.

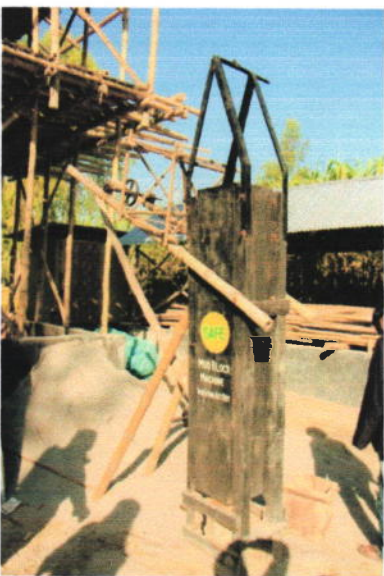


Figure 33: Earth block machine developed by researcher Azit Roy, Dinajpur



Figure 32: A house made by earth blocks

3.4 CULTURAL SUSTAINIBILITY

3.4.1 Significance of culture and ethnicity

To understand how architecture could hold our culture, it is required to understand what is culture and its significance in the development of human societies.

Culture can be defined as "the totality of knowledge, skills, rules, standards, prohibitions, strategies, beliefs, ideas, values, and myths passed from generation to generation and reproduced in each individual, that control the existence of the society and maintain psychological and social complexity" (E. Morin, 1999:26).

"Culture constitutes a fundamental dimension of the development process and helps to strengthen the independence, sovereignty and identity of nations. Growth has frequently been conceived in quantitative terms, without taking into account its necessary qualitative dimension, namely the satisfaction of man's spiritual and cultural aspirations. The aim of genuine development is the continuing well-being and fulfillment of each and every individual". Anchored in a social process entailing self-awareness, evaluation, comparison and contextualization culture confers people sense of identity and recognition, whether at an individual or group level. The several levels of construction and confirmation follow multi scale issues that extend from the micro-local (house, quarter) to the global one (worldwide) of varying relevance. Boundaries are drawn on the basis of all implying a classificatory system and consequently a negotiation or an enactment of power: geographical units, civilizing attributes, biological shapes, socioeconomic positions, etc. In this connection, diversity and complexity are reflections of the subject positions and the doable variations procured by the historical circumstances or the collective memory.

Ethnicity is one of the many ways in which people identify themselves (family, community, nation, class, occupation, gender, age, etc.) but it is distinct from the others because has the potential to become radical, totalizing, the central basis of identity. It is a mode of action and representation, the mark through which an "ethnic group put its imprint on forms, values, and rhythms" (A. Leroi-Gourhan, 1965:91). Because of it is believed as genetically given and unchangeable, ethnicity is a founding structure of social differentiation and recognition, as well as of discrimination in such cases. As result, culture denotes the means by which people make meaning, sustain their self-definition and interrelate social liaisons.

Culture denotes the means by which people make meaning, sustain their self-definition and interrelate social liaisons. It is what enables a community to carry out plans for living together in order to respond to common ambitions and fillings of belonging. Of course, it could give rise to the involvement of full human potential resources in terms of self-expression, creativity and innovation in social, political, economic and ecological development.

Other definitions of culture provide clues as to the types of material possessions (art works, homes, clothing); the ideas, values, and attitudes (language, worshipping nature, tribal ceremonies); and the activities (dancing, music, hunting) that further explain what culture means.

3.4.2 Sustainability and Cultural Sustainability

Sustainability can be defined as the ability to meet current environmental/ecological, economic, social, and cultural needs without jeopardizing the ability of future generations to meet their needs.

Adding culture to the already widely accepted three pillars of sustainability--social, environmental, and economic—is important for society to address because the addition of a fourth pillar to represent culture creates a holistic approach to sustainability.

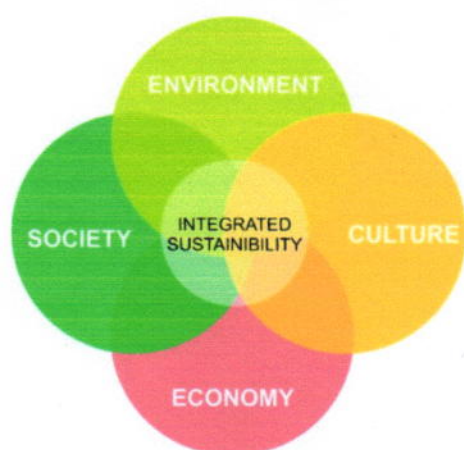


Figure 34: The circles of sustainability (Baidya, 2013)

Economic sustainability is concerned with "actions and issues that affect how people and organizations meet their basic needs, evolve and define economic success and growth."

Environmental sustainability attempts to minimize the use of nonrenewable resources and energy consumption, eliminate waste to land fill, etc. It is concerned with “actions and issues that affect natural systems, including climate change, preservation, carbon footprint, and restoration of natural resources” (Werbach).

Social sustainability focuses on meeting all, or as many of a community's needs as possible, such as appropriate facilities for the elderly, children and cultural groups. It is concerned with “actions and issues that affect all aspects of society, including poverty, violence, injustice, education, healthcare, safe housing, labor, and human rights” (Werbach).

Cultural sustainability is concerned with “actions and issues that affect how communities manifest identity, preserve and cultivate traditions, and develop belief systems and commonly accepted values” (Werbach).

Cultural sustainability examines ways to enhance our cultural identity and sense of place through heritage, shared spaces, public art, social capital, educational opportunities, and public policies in ways that promote environmental, economic, and social sustainability.

Cultural heritage connects people to a place that symbolizes the identity and values that provide a sense of belonging on personal and community levels, and the continuance of that heritage is what cultural sustainability is about. As people strive to maintain their sense of self and place, decisions and actions relating to sustainability need to take into account a community's cultural capital.

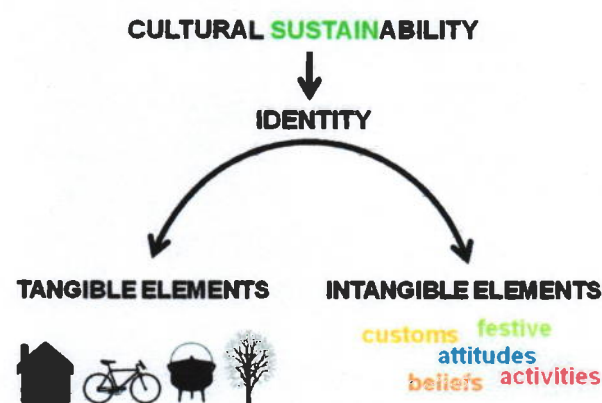


Figure 35: A conceptual diagram showing explaining cultural sustainability (Baidya,2013)

In "Integrating Environmental and Cultural Sustainability for Heritage Properties," authors Powter and Ross, who are both conservation architects, state, "The definition of cultural sustainability continues to evolve, yet explicit reference to heritage conservation (or historic preservation) is often overlooked or applied simplistically". A building's cultural value is also known as cultural capital which encompasses tangible forms of culture such as places, arts, and artifacts.

When preserving cultural capital for contemporary and future use, communities are protecting their cultural identities, both tangible and intangible.

Cultural sustainability must not focus on tangibles over intangibles so that communities can retain a holistic sense of place and identity. Intellectual and spiritual experiences are just as important to one's sense of well-being as heritage buildings and art.

Cultural sustainability involves efforts to preserve the tangible and intangible cultural elements of society in ways that promote economic sustainability. According to UNESCO's website, the definition of intangible culture "includes oral traditions, performing arts, social practices, rituals, festive events, knowledge and practices concerning nature and the universe or the knowledge and skills to produce traditional crafts" (2012).

Cultural sustainability projects benefit the environment through the preservation of cultural capital such as buildings, like the mills, that retain a community's heritage. Cultural capital can be produced or preserved with environmentally friendly materials, taking into account the concerns that environmentalists and ecologists have toward endangered species.

Our sense of place – in addition to childhood experiences and historical and cultural contexts – influences how we perceive, experience, and value the natural world and ultimately, influences all our entire belief systems. Practical applications of cultural sustainability can minimize the use of natural capital through resource management; improve tangible social capital such as public facilities and infrastructure; and strengthen economic capital through fair trade and getting more out of renewable resources.

There is more to sustainability than environmental practices, economic growth, and equitable social services. Sustainability also includes a community's values and cultural heritage. A paradigm shift in the worldview toward sustainability needs to include discussions about cultural sustainability in ways that do not damage our ecosystem, environment, and social well-being.

Sustainability efforts that once were characterized by environmental, social, and economic discussions, now see the inclusion of culture in the discussions as a holistic benefit to communities through the development of a sense of place.

3.5 CHARLES CORREA'S IDEAS AND PRINCIPLES OF HOUSING

According to Charles Correa, living in an Asian city involves much more than the use of a small room. Such a cell is only one element in a whole system of spaces people need in order to live. This system is generally hierarchal consisting of four major elements:

- Space needed by the family for exclusively private use such as cooking and sleeping.
- Areas of intimate contact i.e. the front doorstep where children play, people meet their neighbors.
- Neighbourhood places e.g. the city watertap where you become part of your community.
- The principle open space used by the whole community.

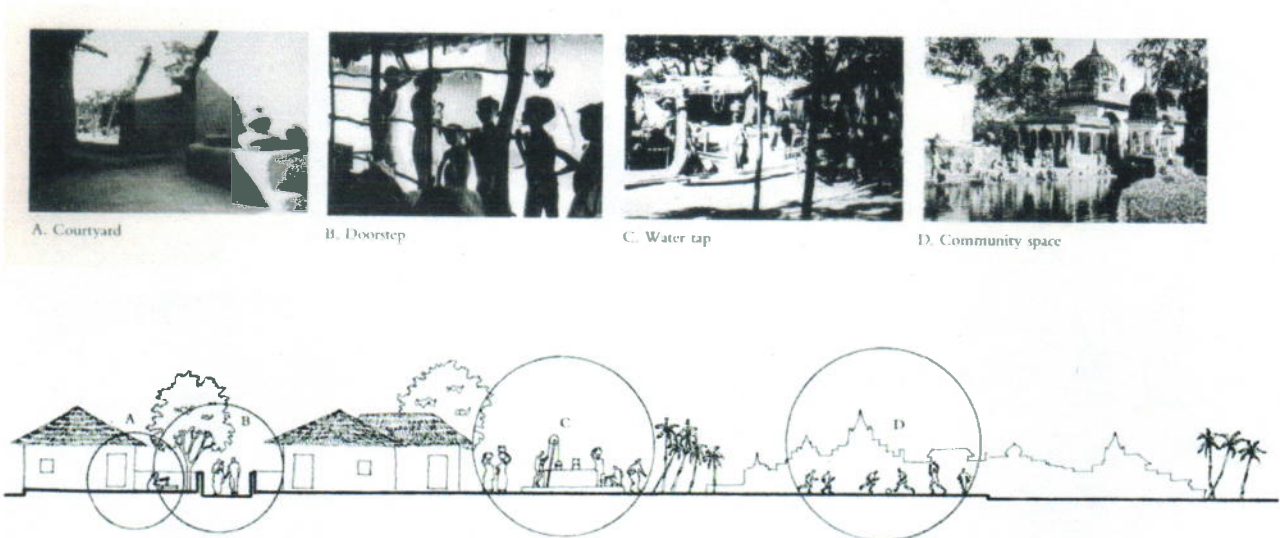


Figure 36: Hierarchy of spaces (Correa, 1987)

The most important characteristic of the system is that each element can consist of either covered or open-to-sky space which is of crucial significance to Asian countries, since almost all of them are located in warm climates where a number of essential activities take place outdoors.

In a warm humid place 75% of essential functions can occur in a private courtyard for at least 70% of the year.

3.6 HASAN FATHY'S IDEAS AND PRINCIPLES OF ARCHITECTURE

There may be said to be six general principles which guided Hassan Fathy throughout his career:

1. his belief in the primacy of human values in architecture;
2. the importance of a universal rather than a limited approach;
3. the use of appropriate technology
4. the need for socially oriented, co-operative construction techniques
5. the essential role of tradition
6. the re-establishment of national cultural pride through the act of building

The first of these, Fathy's fundamental humanism, has anticipated many concerns about the destruction of the environment. He sat himself apart from the majority of practitioners of his time by rejecting the temptation to reduce the users of buildings to anonymous ciphers, and he was able to proclaim proudly the vital importance of each individual regardless of social or economic status.

The second principle, that of universality, shows a keen awareness of theology, philosophy, history, sociology, science and physics, as well as music, literature, art and dance. He consistently dealt with all the influences on his work in a non-judgmental way. In searching for the sources of Islamic architecture, for instance, he did not limit himself within borders, but had a wider perspective. While the material he chose and the spaces he evolved had deep spiritual, psychological and cultural associations within his own country, they also have the power to evoke a much wider response. His voracious curiosity was fed by extensive travel, which gave him a cosmopolitan, rather than a provincial view of the world around him.

The third general principle of Fathy's work, was his belief in the need for appropriate technology in architecture. For Fathy, technology must be applied in a way appropriate to both its users and its context, and be controlled by what he once described as 'the innate knowledge that comes directly from the emotions without study or analysis, or from what psychology calls the

subconscious.' He constantly appealed to all architects to temper scientific methods with a sensitivity for human needs. Through technology, he felt that architecture could become a true arbiter between the highest achievements of human intelligence and the natural world, to the mutual benefit of both.

The fourth principle that is consistent in Fathy's work is his belief in the idea of co-operative building, or what is called 'self-help'. Having originally put this idea into practice in the construction of the village of New Gourma nearly fifty years ago, he was finally to see it accepted in principle throughout the world.

Fathy encouraged a deeper respect for the use of tradition in architecture, noting that the word itself comes from Latin *tradere*, to carry forward or to transfer, and thus implies the cyclical renewal of life. He defined tradition as 'the social analogy of personal habit' and he thought, every architect should develop a heightened awareness of such habits, and to incorporate them sympathetically into each design. For Fathy the rediscovery of traditional form also involved the search for a missing link in a cultural chain that had been cut by the intrusion of the industrial age, especially in his own country.

The sixth principle of Fathy's work is his determined attempt to reawaken a sense of cultural pride among his countrymen, and to make them aware of their architectural heritage. In their rush towards what is euphemistically called progress, many developing countries have sought to eradicate architecture of the past.. One of Fathy's major contributions has been his effectiveness in warning others of the consequences.

CHAPTER 04

CASE STUDIES

4.1 INTRODUCTION

The case studies are selected with a focus to comprehend the factors which makes a low-income habitat more socially sustainable. A socially sustainable community-

- express a sense of **identity** through heritage, art and culture
- enjoy a sense of **belonging**

Sensitive use of indigenous building materials, creation of interactive spaces and community participation in building can play significant role to achieve cultural identity and sense of belonging through architecture. It has been widely accepted by policy makers and commentators, funding bodies and NGOs that the key to performance in low-cost housing projects in developing countries lies in community participation.

On the basis of the level of participation of the beneficiary group or the community in comparison to the architects, engineers, planners and funding organizations (government, NGO, private companies etc.), low-income community housings designed by architects can be of 3/4 types and are shown by diagrams below:

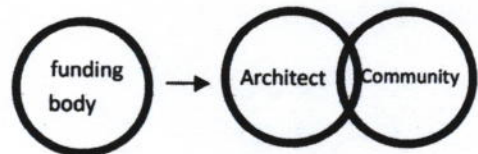
1. Amount of community participation: limited.

Community is merely **informed or manipulated** and might be able to make later changes. Eg.: Incremental housing at Belapur.



2. Amount of community participation: moderate.

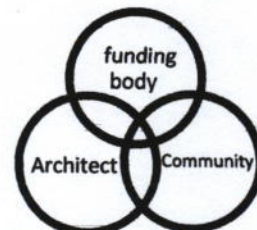
Community takes part in construction of houses. Eg.: New Gourma Village



3. Amount of community participation: intense.

Community takes part in making design decisions, their aspirations are more likely to be reflected and sense of belonging will be stronger.

Eg.: Community based Low Cost Housing at Jogen babur math, Dinajpur, Disaster Resilient Habitat at Sathkhira.



4.2 INCREMENTAL HOUSING AT BELAPUR

This Project by Architect Charles Correa, located on six hectares of land about 2km of the city centre of New Bombay, attempts to demonstrate how high densities (500 persons per hectare, including open spaces, school etc) can be easily achieved within the context of a low-rise typology.

The site plan is generated by a hierarchy of community spaces, starting with a small shared courtyard 8mx8m around which seven houses are grouped, Each of these houses is on its own piece of land, so that the families can have the crucial advantage of open-to -sky spaces (to augment the covered areas). Furthermore, they do not share any party-walls with their neighbors- which makes these houses truly incremental, since each family can extend their own house independently.

These house cover almost the entire social spectrum from squatter families to the upper income brackets-yet, in order to maintain the fundamental principal of equity, the sites themselves vary in size only marginally (from 45 sqm to 70 sqm), The form and plan of these houses are very simple, so that they can be built and extended by horizontal masons and craftsmen- thus generating employment in the Bazaar Sector of the urban community (i.e. exactly where they needed for the urban migrants).



Figure 38: Looking out to shared courtyard



Figure 37: A general view of the housing with the low-lying hills in the background

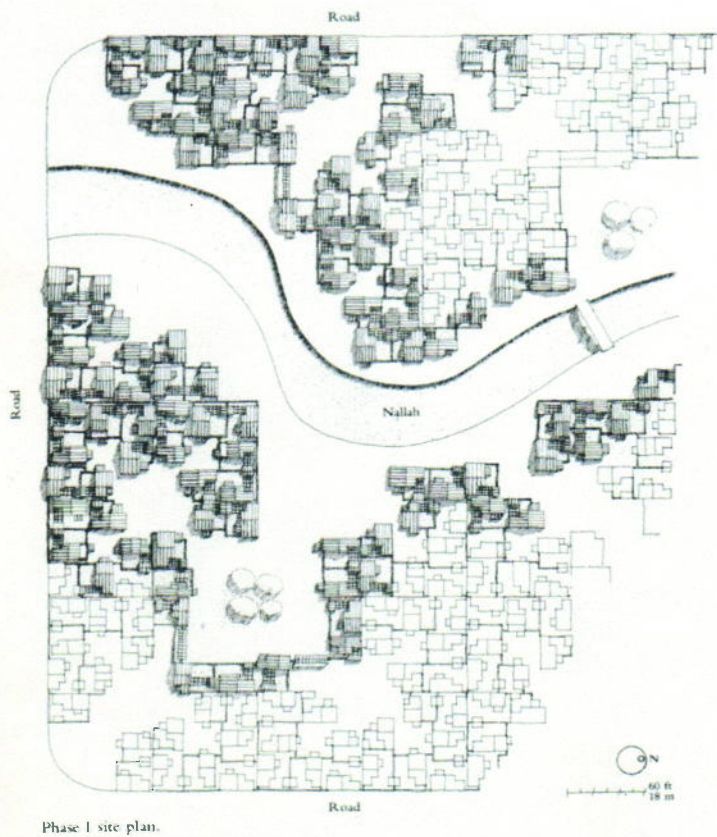


Figure 39: Master plan of Phase 1 (Correa, 1987)

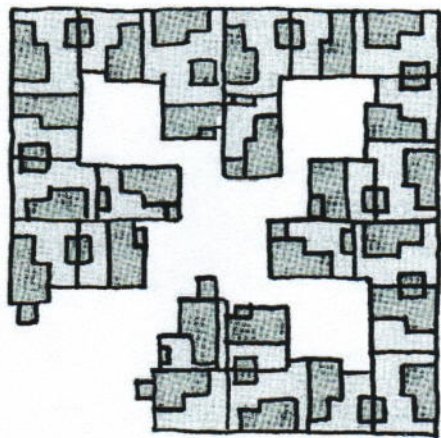


Figure 41: Built and open space relationship of a cluster(Correa, 1987)

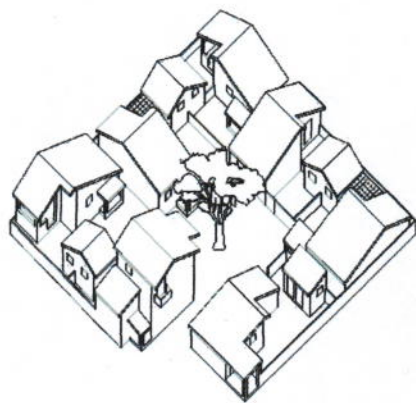


Figure 40: Axonometric drawing of a cluster (Correa, 1987)

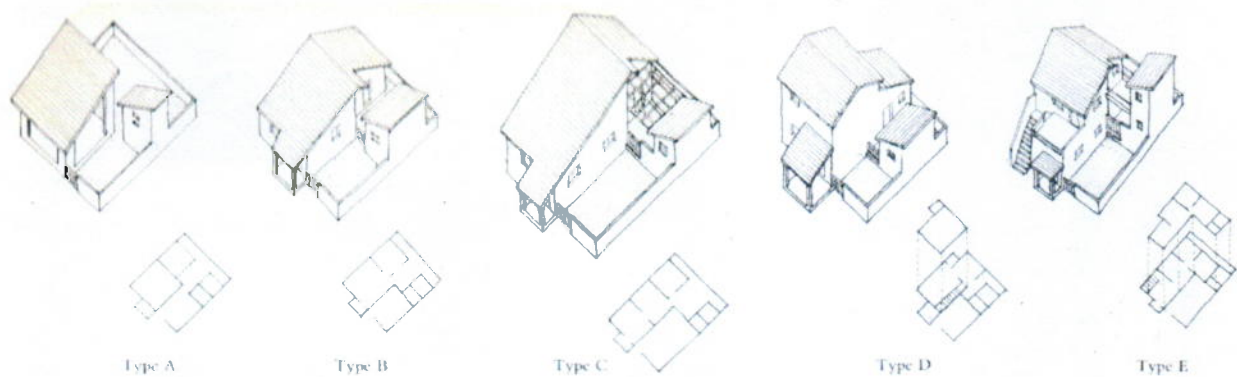


Figure 42: Different unit types for designed for families with varied affordability (Correa, 1987)

The project uses one overriding principle: each unit is on its own individual site to allow for expansion. The low-rise high-density scheme utilizes a cluster arrangement around small community spaces. At the smaller scale, seven units are grouped around an intimate courtyard of about 8x8 meters. Three of the clusters combine to form a larger module of 21 houses surrounding an open space of 12x12 meters. Three such modules interlock to define the next scale of community space- approximately 20x20 meters. The spatial hierarchy continues until the neighborhood spaces are formed where schools and other public-use facilities are located.

The whole is arranged so that the neighborhood spaces open to a small stream which runs through the center of the site (which drains the surface water during the monsoon rains) and overlook the hills behind. Along a diagonal running through the site is the proposed bazaar.

The house themselves are planned with toilets located in pairs, to save on plumbing and sanitation costs. For each plot the main structure of the house can abut the boundary on two clearly specified edges in a pattern that ensures that it will be free-standing in respect to its neighbors. No windows are allowed on these walls in order to protect the privacy of all concerned. The houses are structurally simple and can be built and altered by local masons with the participation of the inhabitants themselves.

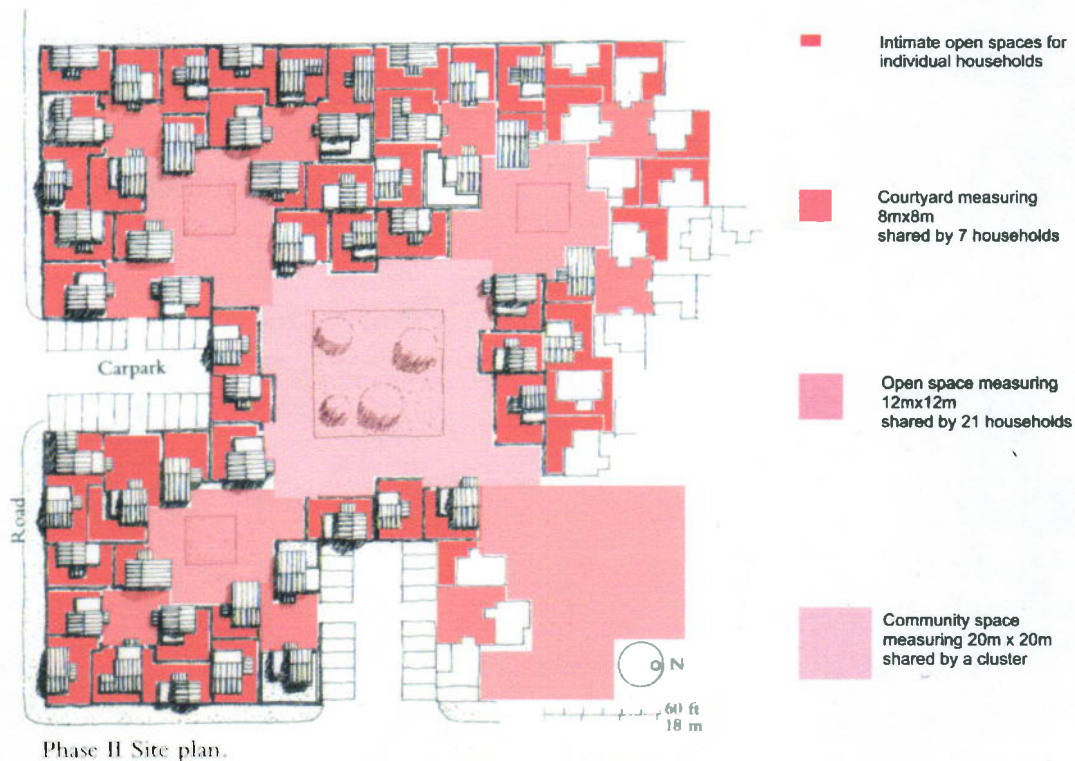


Figure 43: Analysis of the hierarchy of open spaces in the planning (Baidya, 2013)

Belapur makes a statement which combines those principles Correa believes to be most important in housing, namely: Equity, Incrementality, Pluralism, having Open-to-Sky spaces and Disaggregation of spaces to allow for participation in forming one's own environment, and to facilitate income generating activities. As such it is a robust architecturally- designed solution for lower and middle income housing.



Figure 44: A cluster, showing individual houses although sanitary facilities abut along the same walls



Figure 45: The human scale allows for community interaction



Figure 46: A view of houses

4.2.1 Later changes in Belapur housing

Belapur housing has changed with time, whether or not the changes made by the inhabitants added to the scheme's vigour is to be judged. Most of the houses have been remodeled or destroyed and rebuilt. According to a study carried out in 2008 by two bloggers Rahul Srivastava and Matias Echanova, some inhabitants said some aspects of the design were impractical (e.g. the toilets were detached from the house). Some clusters of houses became mini-gated-communities while others became mini-slums. No one was in charge of maintaining the common open spaces at the center of each cluster of houses, so maintaining and cleaning of those spaces became a problem. These spaces do not fall under any jurisdiction; not private nor public. Perhaps, the dispute between neighbors is a part of the pluralistic designs of creating a community. However, according to the two visitors, these were not much serious problem and the community people managed to solve them themselves. The Belapur housing is one of the few architect designed housings allowed people to modify their houses freely, whether with a paintbrush or mortar. (Srivastava, 2008)



Figure 47: Belapur Housing in 2008; after many modification and changes adapted by the inhabitants. (Srivastava, 2008)

4.3 NEW GOURNA

The village of New Gourna, which was partially built between 1945 and 1948, is possibly the most well known of all of Fathy's projects because of the international popularity of his book, "Architecture for the Poor", published nearly twenty years after the experience and concentrating primarily on the ultimately tragic history of this single village. While the architect's explanations offered in the book are extremely compelling and ultimately persuasive, New Gourna is still most significant for the questions it raises rather than the problems it tried to solve, and these questions still await a thorough, objective analysis.

4.3.1 The Context

The idea was launched by the Egyptian department of Antiquities in 1946 to build a new town near Luxor to relocate the inhabitants of the Gourna Village or also called "Sheikh Abd el-Qurna". It was seen as a potentially cost-effective solution to the problem of relocating an entire entrenched community of entrepreneurial excavators that had established itself over the royal necropolis in Luxor.

The village of New Gourna also seemed to offer Fathy a perfect opportunity to finally test the ideas unveiled at Mansouria on a large scale and to see if they really could offer a viable solution to the rural housing problem in Egypt.

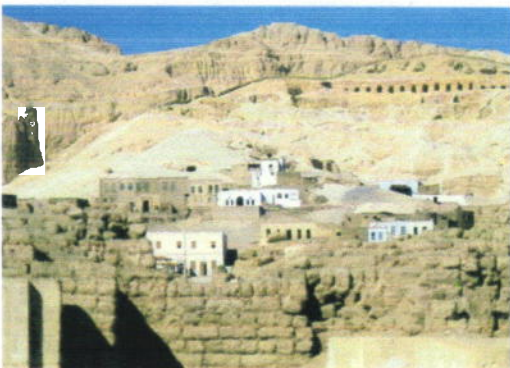


Figure 48: Gourna al Gadida (old Gourna) with the valley of kings visible in the background (Steele, 1997)

The Old Gourna village is built over Pharaonic tombs, many of which were not discovered yet. The residents were famous for being able to bring up suspiciously authentic Egyptian monuments from their cellars. The antiquities were having trouble controlling the tomb-robbing occurring in the areas of the Valley of the Kings, Queens and Nobles nearby. And so, the

perfect solution seemed to be to move the seven thousand locals whose economy depended on tomb looting. This came as Fathy's perfect opportunity. The new location is about five miles downhill towards the river, not far from the old village. Hassan Fathy's saw this as a challenge, as he says in his book. Faced with a 50 acre land intended to home 7000 people unwilling to leave their homes was not to be an easy task.

The "Gourna Village experiment" was not just an architectural experiment. To Hassan Fathy it was more like the development of a town on a cultural, social level following the regional traditions. Relating to the people and knowing their needs while asking them to participate in the construction of their town was a major part of the project.

4.3.1 Analysis of New Gourna through Fathy's principles

4.3.1.1 Master planning

Fathy found the village to be generally divided into five tribes within four distinct zones on the hillside, with every tribe specifically separated into 'badanas', or family groupings, each led by a shekh or patriarch. Fathy determined to retain this four -part division in the new village. The layout of the main streets separated the four 'quarters' of the village. In each of these quarters was to be housed one of the main tribal groups. To ensure good ventilation and isolation of the blocks of houses, as well as to facilitate movement and to mark off the quarters, these streets were at least 10 meters wide. By contrast, the streets giving access to the semiprivate squares were deliberately made narrow- no more than 6 meters wide- to provide shade and a feeling of intimacy, and included many corners and bends. so as to discourage strangers from using them as thoroughfares.

Fathy included an open air theatre, a school, a "Suq" (market) and a Mosque, famous for the unusual shape of its minaret. He also built himself a house in the same spirit of the village, using the same materials.

Because of the need to establish an entirely new economy and lifestyle for the villagers, based on agricultural and craft-based pursuits rather than excavation, the core of the community revolves around a market on the one hand and a Khan (an inn for travelers) on the other. While the market was intended for the sale and shipment for the agricultural produce taken from the fields surrounding the town, The Khan was designed for promotion of traditional crafts.

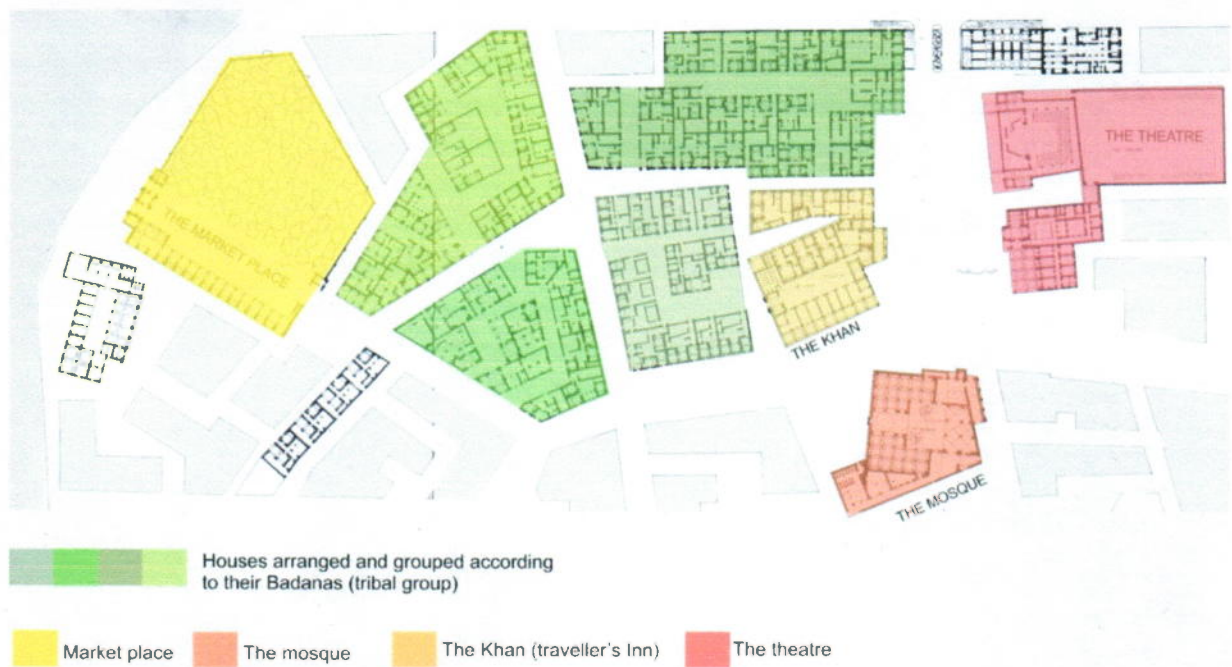


Figure 49: Analysis of Master plan of New Gourma

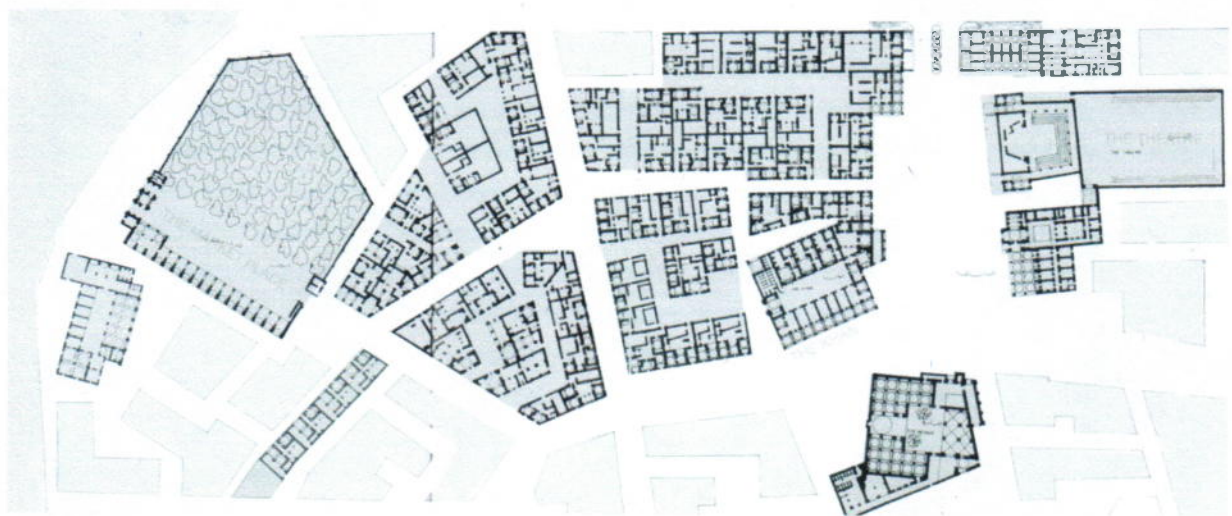


Figure 50: An built-open space analysis of New Gourma: The corners and bends of streets and alleys are intended to give the locality variety of spaces and safety from strangers (Steele, 1997)

References have been made in the past to the architect's failure to provide for running water in the houses here. He explained his concern about disrupting the pattern followed throughout rural Egypt of using a communal well. He was also aware of the subtle social effects that such a change would have, such as removing the only opportunity that young girls have of being seen by prospective husbands who gather to watch the parade to the well each day. Centralized water sources were placed, instead, in the middle of each neighborhood.

The theatre which inflects slightly to one side to guide people around and into the main square, actually seems to make the physical gesture of welcome, and its prominent double gated facade is an important part of this side of the plaza. The seating is designed on the wide low edges that are accessible from a vine covered colonnade that runs around behind them.

Taken as a whole, the main facade of the new Gournia mosque, while appearing simple, uses a very deliberate and sophisticated kind of iconography, combining several architectural elements that each have complex historical connotations. Spatially, the mosque continues this kind of duality, with a prayer area wrapped around an inner courtyard that has three entrances.

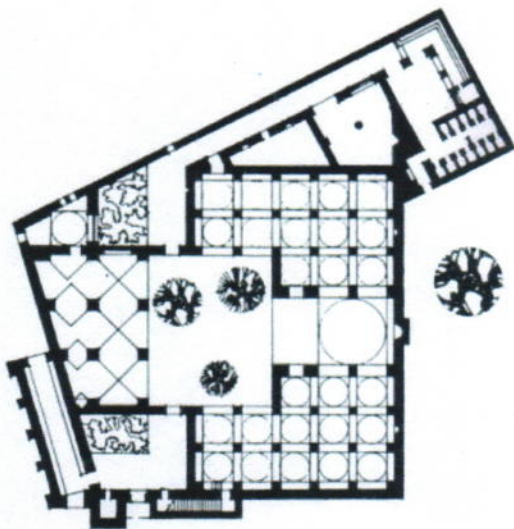


Figure 52: Plan of mosque at New Gournia. Facing it towards Mecca added a dynamic quality to the whole plan.

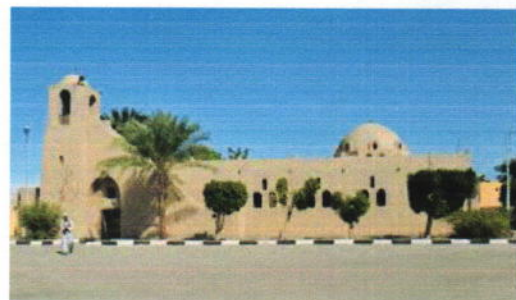
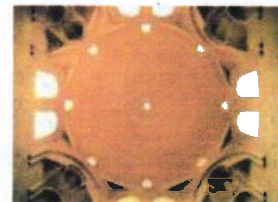


Figure 51: The mosque at New Gournia

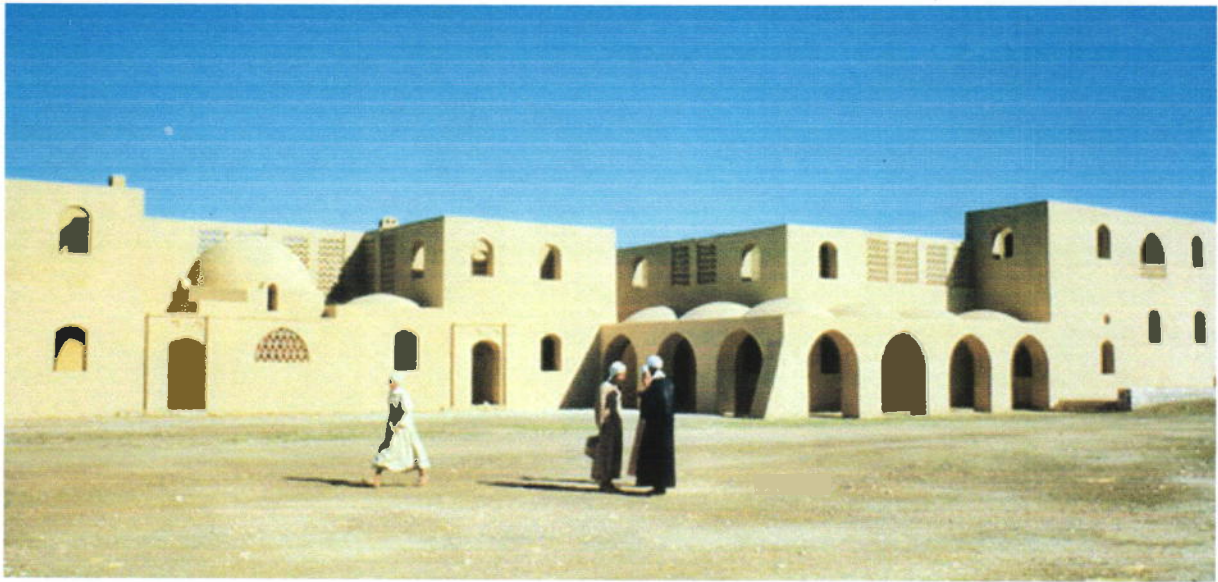


Figure 53: A perspective view of a New Gourna (Steele, 1997)

4.3.1.2 Individual design for each house

The Village was meant to be a prototype but rather than subscribing to the current idea of using a limited number of unit types, Fathy took the unprecedented approach of seeking to satisfy the individual needs of each family in the design. As he said in *Architecture for the Poor*, "In Nature, no two men are alike. Even if they are twins and physically identical, they will differ in their dreams. The architecture of the house emerges from the dream; this is why in villages built by their inhabitants we will find no two houses identical. This variety grew naturally as men designed and built their many thousands of dwellings through the millennia. But when the architect is faced with the job of designing a thousand houses at one time, rather than dream for the thousand whom he must shelter, he designs one house and puts three zeros to its right, denying creativity to himself and humanity to man. As if he were a portraitist with a thousand commissions and painted only one picture and made nine hundred and ninety nine photocopies. But the architect has at his command the prosaic stuff of dreams. He can consider the family size, the wealth, the social status, the profession, the climate, and at last, the hopes and aspirations of those he shall house. As he cannot hold a thousand individuals in his mind at one time, let him begin with the comprehensible, with a handful of people or a natural group of families which will bring the design within his power. Once he is dealing with a manageable

group of say twenty or thirty families, then the desired variety will naturally and logically follow in the housing."

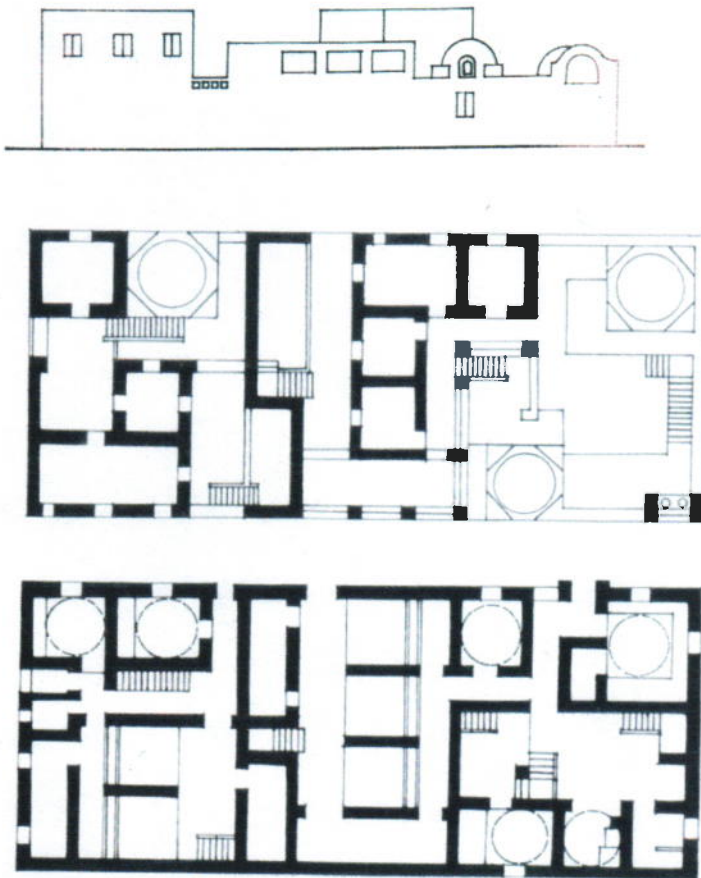


Figure 54: Elevation and plans of typical housing block for New Gourma, On the ground floor (bottom) three livestock stalls can be seen in the centre of the building, connecting with the family's living area, in accordance with the local practice.



Figure 55: Interior views of houses of New Gourma (Steele, 1997)

4.3.2 Analysis of success of the project

All of the architect's best intentions, however, were no match for the avariciousness of the Gourmis themselves, who took every opportunity possible to sabotage their new village in order to stay where they were and to continue their own crude but lucrative version of amateur archaeology. Typically but mistakenly misreading the reluctance of the people to cooperate in the design and building of the village as a sure sign of the inappropriateness of both programming and form, many contemporary critics fail to penetrate deeper into the relevant issues raised by this project. These issues now, as at the time of construction half a century ago, revolve around the extremely important question of how to create a culturally and environmentally valid architecture that is sensitive to ethnic and regional traditions without allowing subjective values and images to intervene in the design process. In the final analysis, the portion of New Gourma that was completed must be judged on this basis.

Hassan Fathy was not very successful at convincing the state of his ideas. His work was considered to be ahead of his time as they were not always welcomed by the government bureaucrats neither were they to the tastes of poor Egyptians peasants who longed for the "luxury" of the concrete city buildings. Fathy's buildings were distressingly inexpensive. This was seen as a back draw.

New Gourna was only a failure in an immediate and functional sense. Many lessons have been learned from it. In *Architecture for the poor*, Fathy includes the costs for the homes he built. In comparison twenty houses of Fathy's were estimated to cost L.E. 3000 while the concrete houses that were actually built cost L.E. 22,000 for twenty. Fathy has shown us that inexpensive houses can be built as long as the developers are willing to put aside personal gain to house the poor. Fathy's work at New Gourna is an example of an architect who cared about the end users of his project. He loved the people and involved himself in their lives, and in his designs he allowed for individuality and creativity. From a sustainability viewpoint Fathy's work with traditional forms such as ka'a, malkaf (wind catch), and mushrabiya (sun shade) shows how energy can be saved with traditional methods. The use of a mushrabiya has been shown to cool air up to 10 degrees without mechanical equipments.

4.4. COMMUNITY BASED HABITAT IN JOGENBABUR MATH, DINAJPUR

4.4.1 The Context

This Housing project was funded by the NGO, SAFE (Simple Action for Environment) at Dinajpur. It is based in a slum area close to the town of Dinajpur in the north west Bangladesh. The aim of the project was to build 10 low cost demonstration houses to practically demonstrate simple low cost building techniques that will reduce the vulnerability of low income households against environmental hazards and save the owner money in the long term by reducing the amount of maintenance required.



Figure 56: Location Map: Jogen Babur Math

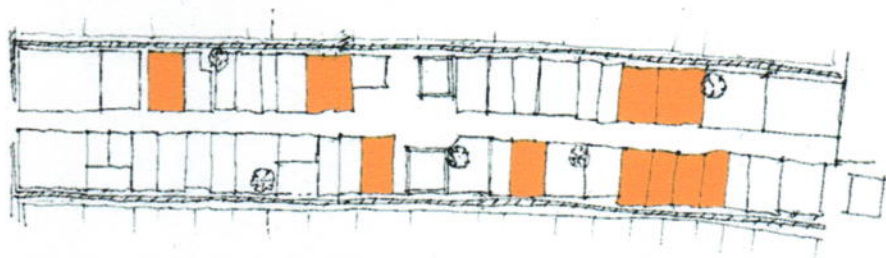


Figure 57: The Slum area showing houses that will be rebuilt/ developed

Jogen Babur Math is an area of informal housing situated approximately 2 km from the centre of Dinajpur. Originally the land belonged to Jogen Babu, a hindu owner who emigrated to India during the partition of India and the former East Pakistan.

Over 500 families currently live on this land. This project focuses on one section of Jogen Babur Math, inhabited by approximately 50 families. The land used to be waterlogged an uninhabitable but was reclaimed 7 years ago. The land was primarily used to resettle families who had previously been evicted from a nearby slum area.

The average income is between 100-250 taka per day. As a result many women generating extra income by rolling poppadom on the street outside their home.

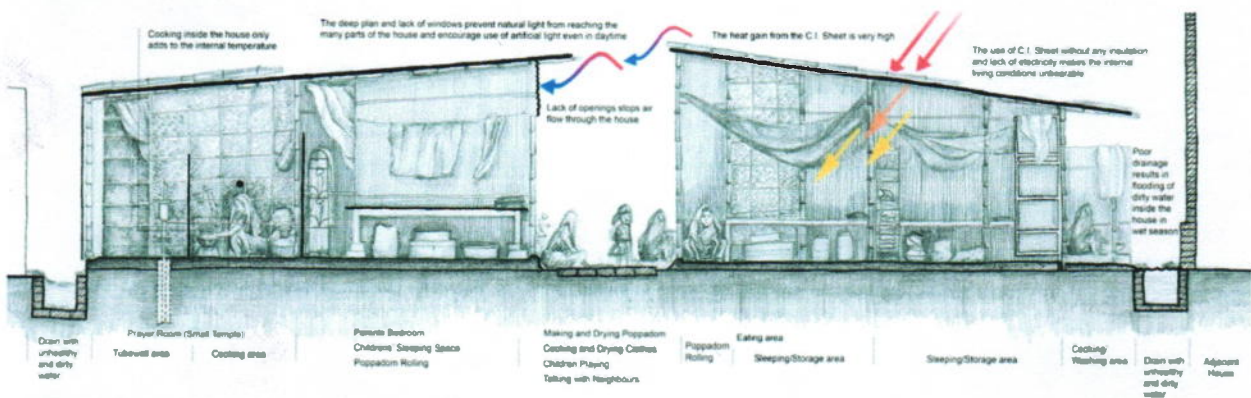


Figure 58: Analysis of the previous situation

4.4.2 The Idea: Process Vs. Product

4.4.2.1 The Process

The project was aimed at increasing community self reliance by creating skilled and informed local builders, craftsmen and house owners. The designer team did not feel the necessity to make major changes in building technology, Instead they promoted, tried and testes techniques that builds on existing construction practices.

Rather than suggesting a single design to be indiscriminately copied the team promoted a range of improved building techniques that will strengthen or improve parts of the house which are

particularly weak and vulnerable to the local climate e.g. treatment of bamboo against insect attack, small concrete foundation posts to keep bamboo out of contact with the ground. These add a small extra cost to the cost of the house (upto 20%) but will make the houses stronger and much longer lasting- saving households money in the long run and making them more resilient to disaster. If these improved techniques are going to spread beyond this project they must be appropriate to place and understood fully by local builders and communities.

The team tried to communicate the ideas with the stakeholders and why those techniques are important through practical workshops and use of traditional song to reinforce the messages and ethos of "spend a little more and make your houses stronger".

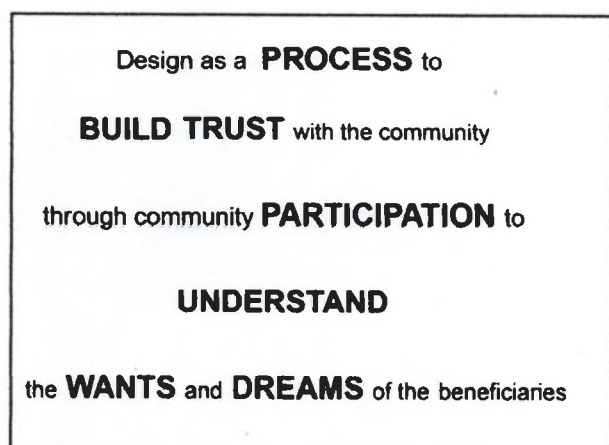


Figure 59: a textual graphic image expressing the main idea of the process.



Figure 60: Community participation in decision making

4.4.2.1 The Product

Wall Materials

Using C.I. sheets for the walls is costly and results in high temperatures inside the house, One system used by some households in this area is to use CI sheet on the lower part of the wall where it is more likely to get wet and with bamboo matting above.

Poppadom

The main income for many of these families are poppadom rolling, However, drying them was problematic due to lack of space. The team have incorporated drying racks that can be out on top of the kitchen roof to free up s[pace] in the street.

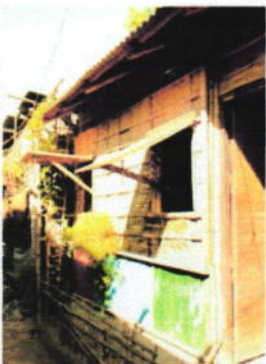
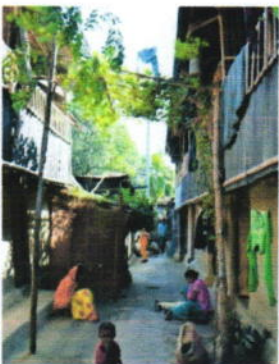
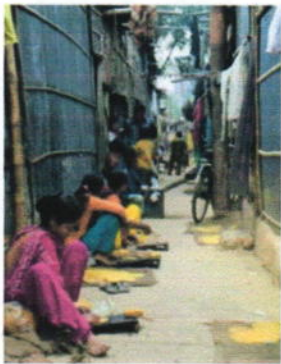
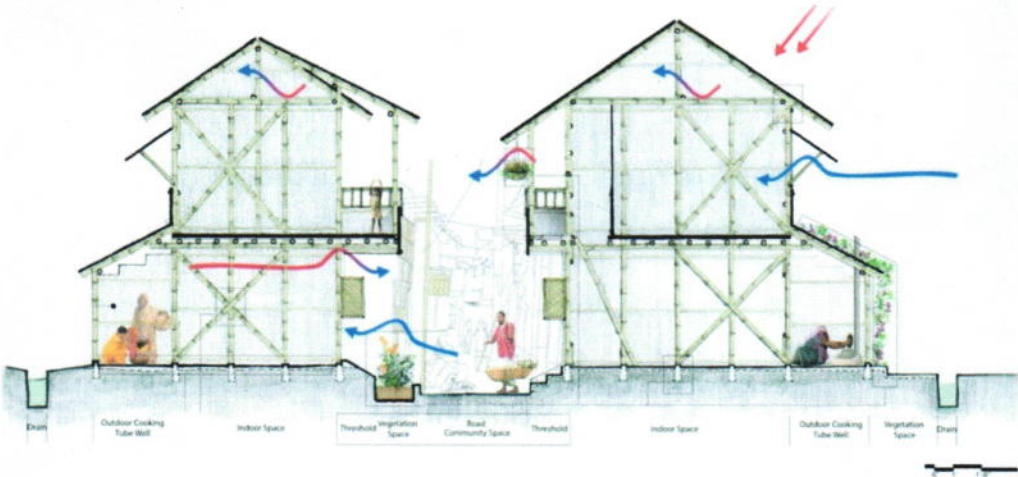


Figure 61: Sketch and images showing modifications done to the existing situation

Bamboo Mat

Bamboo mat ceiling for reducing heat generated from the C.I. sheet roof.

Ventilation and Lighting

Improvements to increase the amount of natural ventilation were recommended:

- adequate sized windows.
- extra openings to improve the natural flow of air.

Improved Cook stove

Improved cook stove or 'bondo chula' is available locally. When maintained and used properly it reduces fuel consumption by up to 40% from a traditional stove. It has been installed with an exhaust flue to remove the smoke from the kitchen area.

Wider streets

Due to 2 storied nature of the houses, the ground floor footprint can be smaller allowing them to be set back from the street, giving more space for community activities such as poppadom rolling and socialising.

Raised Plinth Stabilization

Flood water and rain causes cracking and damage to mud buildings. They require regular maintenance and obtaining this mud from local sources can be problematic. When flood water enters, the house floors usually becomes muddy and create poor environment. Stabilizing the plinth with a small amount of cement has been found to substantially increase its resistance to dampness and erosion by water, preventing the need for regular maintenance. The entire plinth does not need to be stabilised- only a capping layer of approx. 3-6 inch.

Cross Bracing

Cross bracing and plan bracing are essential to increase stability in high winds. Lack of money and awareness prevents many families from using simple techniques such as cross bracing. Bracing should be fixed to the frame with screws r nails and secured with nylon lashing.

4.5. DISASTER RESILIENT HABITAT, SHATKHIRA

4.5.1 The Context

This is a community-based disaster resilient housing project built at rural Shatkhira after the 2009 cyclone Aila. The project was funded and lead by Disaster Resilient Habitat, UNDP, BRAC and the Department of Architecture, BRAC University.

The study of this project is significant as it is helpful to show the effort and process of the important role-play of beneficiaries and builders along with architects and engineers in order to make a housing project truly successful.

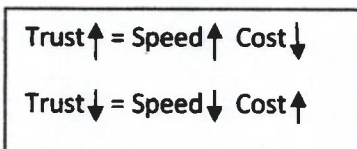
Cyclone Aila hit Bangladesh on Monday 25 May 2009. Substantial damage was done across areas of southern Bangladesh and West Bengal. Survival became very hard because of the massive flooding, drinking water contamination, death of fish reared in freshwater ponds due to saltwater contamination etc., destruction of houses and latrines, break-out of water borne diseases etc.



4.5.2 The Concept

The concept derived for this project is called "Process vs. Product" with a motto, "When we take care of the process, appropriate product happens." Here, the objective is to build "trust" before building houses, trust among all partners; the funding organization, the implementing organization, the local builders, the suppliers, and the user groups. The idea agrees with the significance of trust argued by Stephen M R Covey in his book, *The Speed of Trust*: "our distrust is very expensive" and "technique and technology are important, but adding trust is the issue of the decade."

The effect of increased trust is expressed by the graphic image below:



5.5.3 The Process

Steps of the process:

- Initial contact
- Study
- Design workshops
- Demonstration house construction
- Construction of other houses
- Transition / exit

5.5.3 Contextual analysis

Strengths of the people:

- Survival Skills
- Hard Working
- Fishing Skills
- Boating Skills
- Boat Making Skills
- Expert Mud Walkers

Strength of the place:

- Easy Water Transportation
- Availability of Wood and Golpatta

Weaknesses of the People:

- Critical Minded
- Complex (Back Talking)
- No Sharing
- Relief Minded

Weaknesses of the place:

- Salt Water
- Soil Quality
- Lack of Sweet Water
- Cyclone Prone Area
- Transportation

4.5.4 The process

Design workshop 1: dream houses

In this phase of the process the beneficiaries were asked to brainstorm and make models of their dream houses.

Design workshop 2: options of real houses

In this phase every person on the team; Masons, carpenters, poet, singer, mud-workers, house-owners, engineers, architects, disaster managers, students of architecture. The next phase of the process was to build a demonstration house for the "outsiders"; animator, architects, engineers, disaster manager, poet and singer.

This let the "outsiders" and the villagers start working together in real. They purchased the material together, made study models, and built the house together.

This has been a lesson for the "outsiders" to adapt with the environment, e.g. learning to adapt with the mud and the tide and a lesson for the beneficiaries on more feasible and new technologies of building. In this process, the exchange of technical and traditional knowledge happened.

Innovation / improvement on local building techniques:

- Concrete

Special considerations had to be taken for casting concrete which will be fit for the weather of the site. So, they designed the appropriate ratio of cement, aggregate and water. This was followed by appropriate specification of reinforcement and curing.

- Use of local wood
 - Diagonal and horizontal Cross-bracings
 - Metal clamps under posts
 - Metal straps with roof frames
 - GI wire tie with roof and concrete beams

4.5.5 Basic Design Considerations

- Reduce use of materials which have high embodied energy
- Respect local climate: orientation, lighting and ventilation
- Respect users' and craft-people's participation in design and construction because freedom to design own spaces heightens aesthetic sensitivity.
- Respect local needs as well as aspirations because Sustainability in terms of global environmental point of view might be questionable but sustainability in terms of local needs and aspirations must not be ignored.
- The understanding of expectations that are not limited to basic needs but are also extended to sensitivity about light, smell, sound, view, breeze and openness.

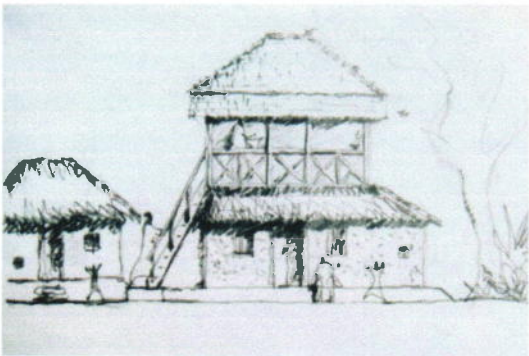
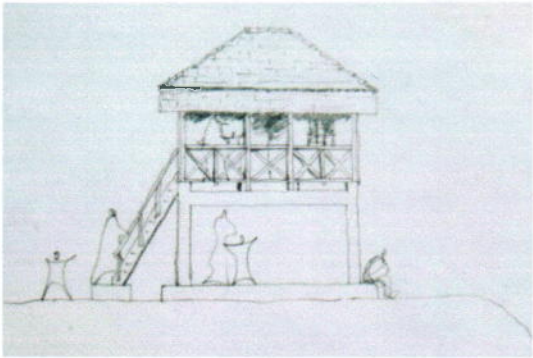


Figure 62: Images and study sketches of the houses at Shatkhira

CHAPTER 05

PROGRAM DEVELOPMENT

The number and ration of the units are developed from the number of employees in the coalmine company. The plot area for an employee of an upper level increases in a notably less amount as compared to the status or salary to an employee of a lower level. This is intended to achieve a statement of social equity within the housing area.

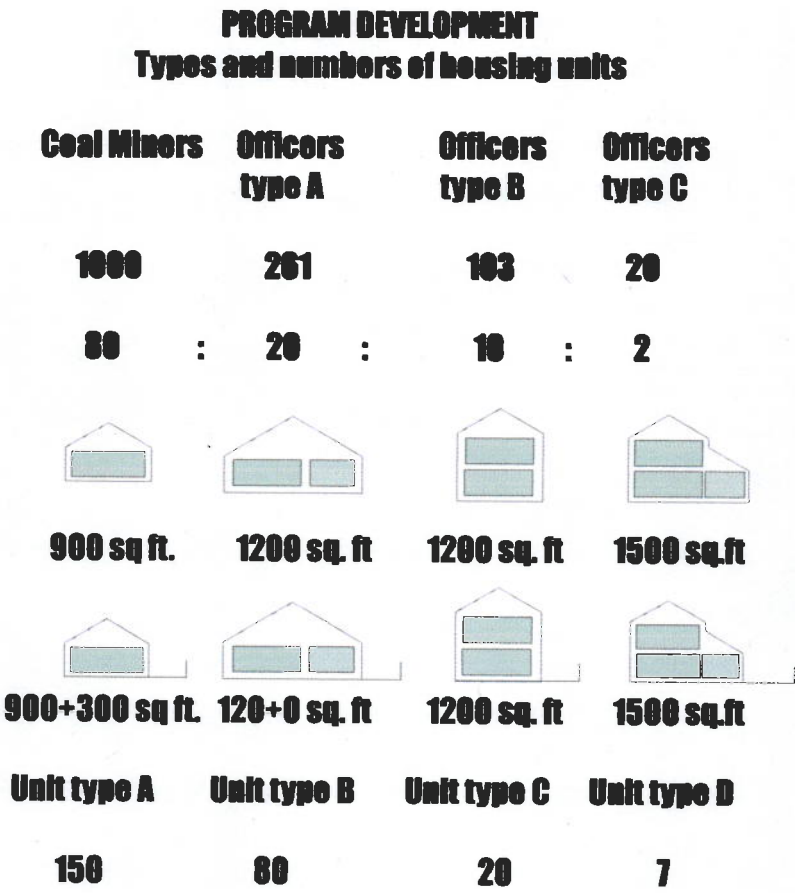


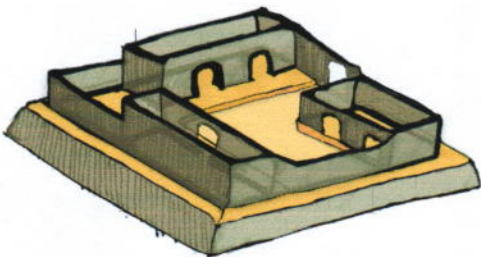
Figure 63: Development of program of housing units

CHAPTER 06

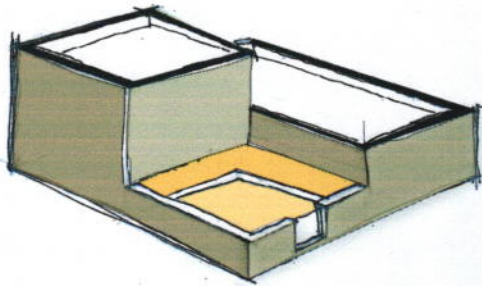
DESIGN DEVELOPMENT

6.1 UNIT DEVELOPMENT

The homesteads in North Bengal are within the closed boundary of a low wall and have a court in the centre and huts around it. This morphology is followed while designing units with a court in the centre and living unit around it.



A Typical Homestead of North Bengal with a court as the core and huts around it



The morphology is followed with a court and the living unit around it

Figure 64: Concept development for units through sketches.

6.2 CLUSTER DEVELOPMENT

The units are duplicated and changed in a manner to create clusters so that the users can enjoy an interesting flow of open spaces.

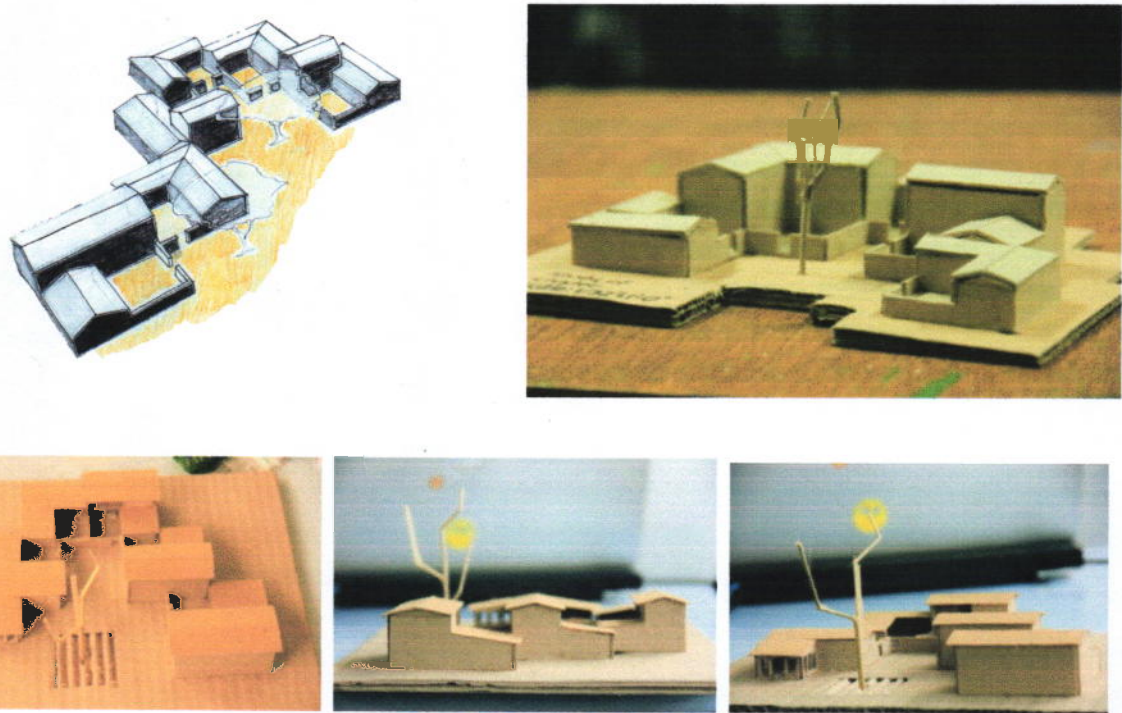


Figure 65: Cluster development through sketches and models.

6.3 MASTER PLAN DEVELOPMENT

The fabric of the master plan is sought in the fabric of rural area of the site; in the way the natural elements, e.g: the forests, the villages, the paddy fields are composed in the natural setting.



Figure 66: Development of a pattern from the satellite image of the site.

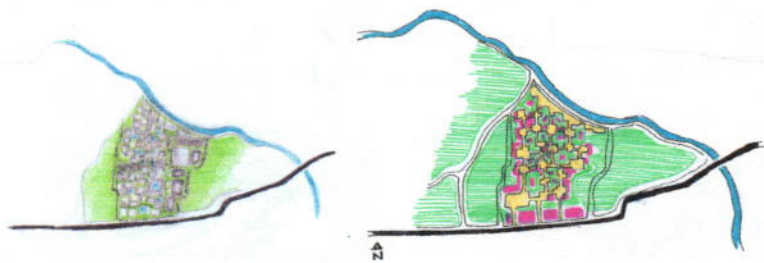
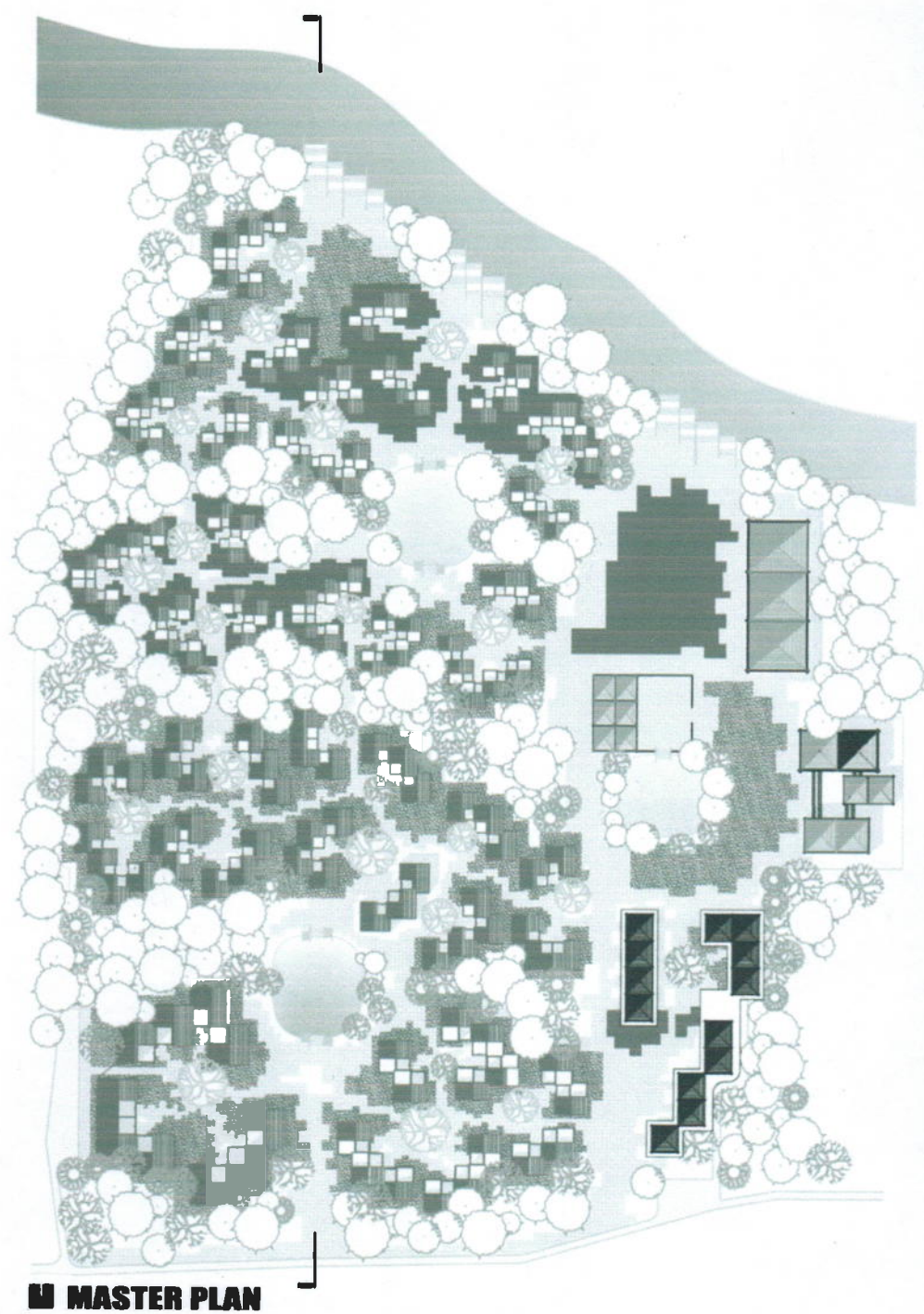


Figure 67: Development of the pattern.



Figure 68: Master plan development

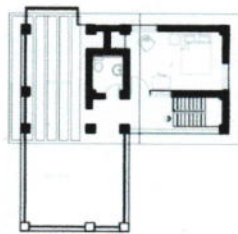
6.4 FINAL DRAWINGS



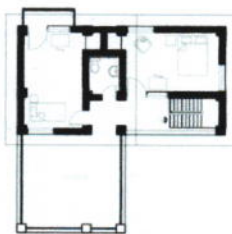
UNIT TYPE A



GROUND FLOOR PLAN



1ST FLOOR PLAN



**1ST FLOOR PLAN
(AFTER EXTENSION)**



SOUTH ELEVATION



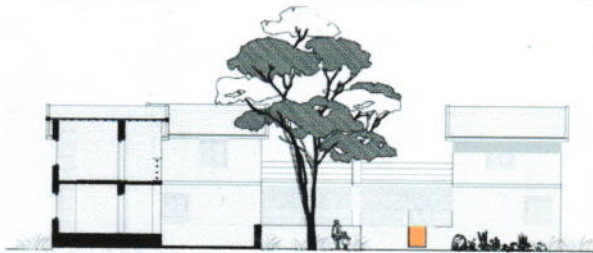
WEST ELEVATION



NORTH ELEVATION



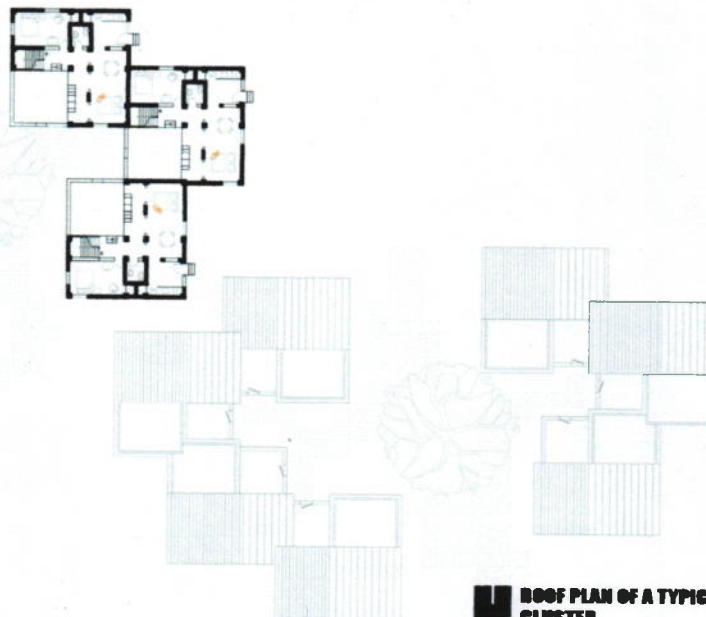
EAST ELEVATION



CLUSTER SECTION



**GROUND FLOOR PLAN
OF A TYPICAL CLUSTER**

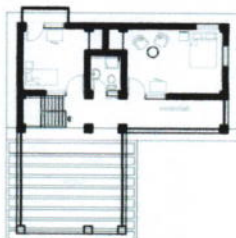


**ROOF PLAN OF A TYPICAL
CLUSTER**

UNIT TYPE B



GROUND FLOOR PLAN



1ST FLOOR PLAN



**1ST FLOOR PLAN
(AFTER EXTENSION)**



SOUTH ELEVATION



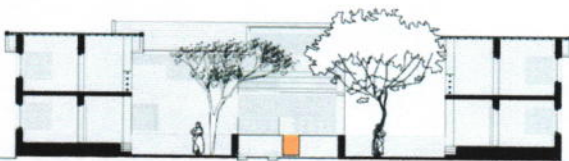
WEST ELEVATION



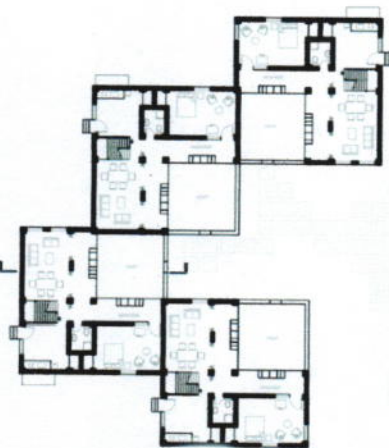
NORTH ELEVATION



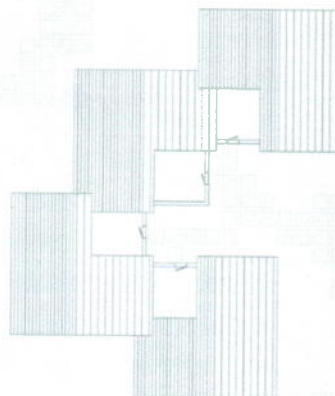
EAST ELEVATION



CLUSTER SECTION

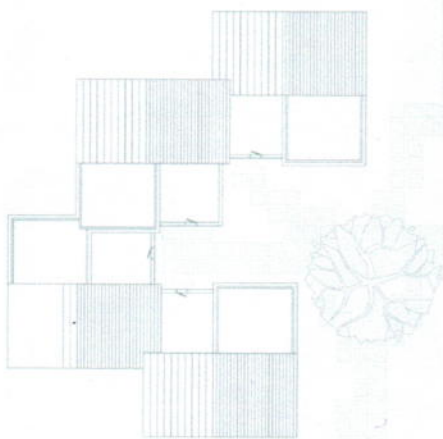
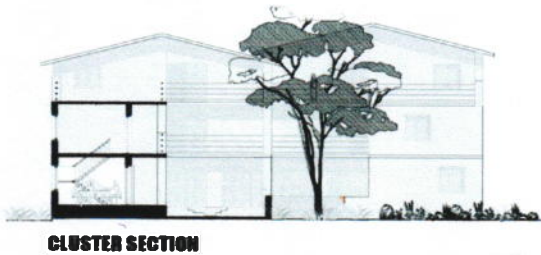
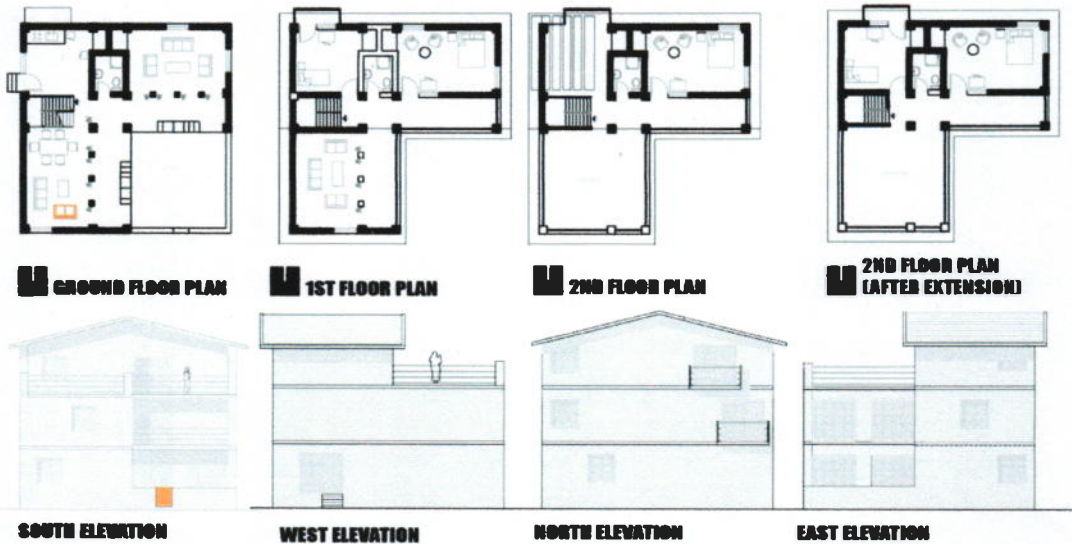


**GROUND FLOOR PLAN
OF A TYPICAL CLUSTER**



**ROOF PLAN OF A
TYPICAL CLUSTER**

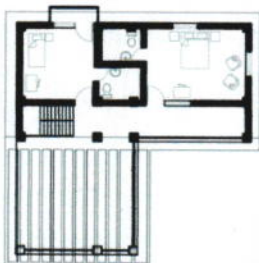
UNIT TYPE C



UNIT TYPE D



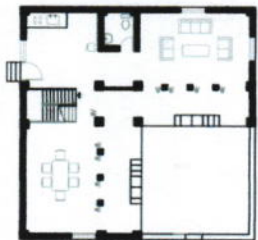
2ND FLOOR PLAN
(AFTER EXTENSION)



2ND FLOOR PLAN



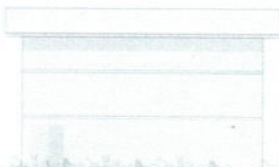
1ST FLOOR PLAN



GROUND FLOOR PLAN



SOUTH ELEVATION



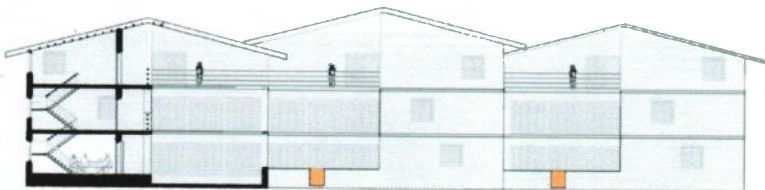
WEST ELEVATION



NORTH ELEVATION



EAST ELEVATION



CLUSTER SECTION

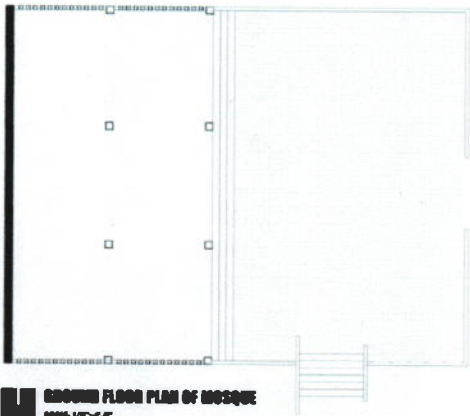


GROUND FLOOR PLAN
OF A TYPICAL CLUSTER

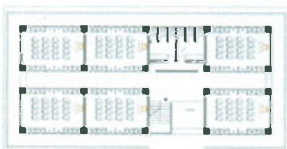
COMMUNITY BUILDINGS



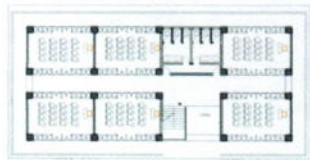
GROUND FLOOR PLAN OF THE COMMUNITY HALL



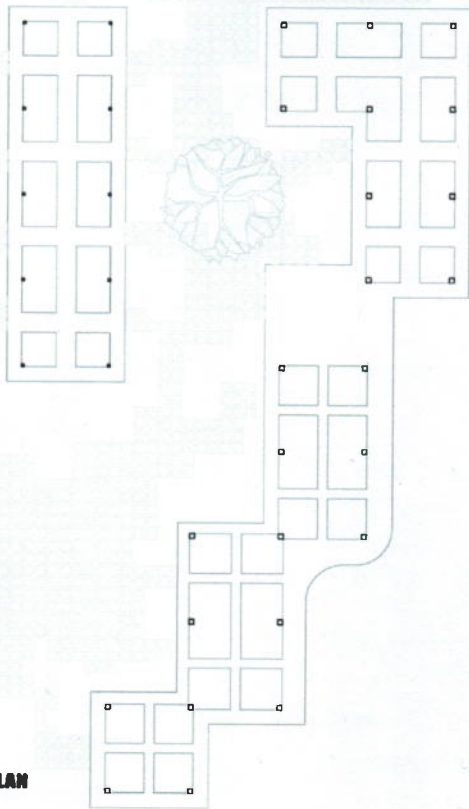
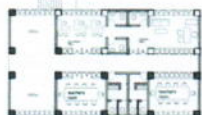
GROUND FLOOR PLAN OF MOSQUE
SCALE: 1/8"=1'-0"



GROUND FLOOR PLAN OF SCHOOL

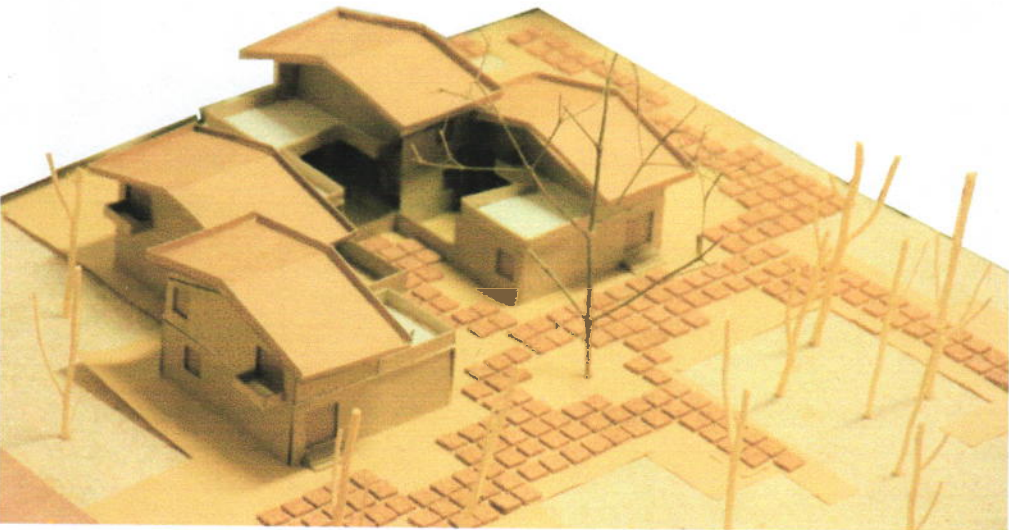
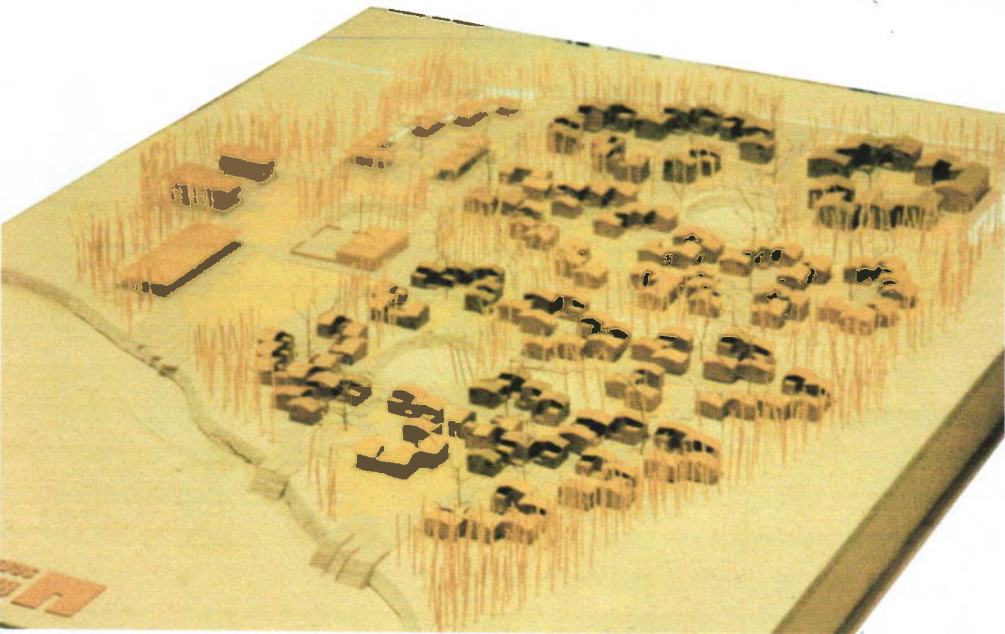


1ST FLOOR PLAN OF SCHOOL



GROUND FLOOR PLAN OF THE BAZAAR

6.5 PHOTOGRAPHS OF FINAL MODEL



BIBLIOGRAPHY

- Ahmed, K. I. (2005). *Design and Construction of Housing for Flood-Prone Rural Areas of Bangladesh*. Bangkok: Asian Disaster Preparedness Center (ADPC).
- Ahmed, K. I. (1994). *UP TO THE WAIST IN MUD*. Dhaka: The University Press Limited.
- Correa, C. (1987). *Charles Correa*. New York: Concept Media Pte Ltd.
- Cucina, M. (n.d.). Retrieved from <http://upcommons.upc.edu/>.
- Fathi, H. (2006). *Building Construction with People*. Tehran.
- Golijani, N. (2008). *Historiology of the Architecture of Iran*. Tehran: Academy of Arts.
- Hasan, D. M. (1985). *A study of traditional house forms in rural Bangladesh*. Dhaka.
- <http://www.bcmcl.org.bd/>. (n.d.). Retrieved April 1, 2013
- Kentucky Geological Survey, U. o. (2012, August 11). http://www.uky.edu/KGS/coal/coal_mining.htm. Retrieved 4 19, 2013
- Khan, H. U. (1987). *Charles Correa*. New York: Concept Media Pte Ltd.
- Nurujjaman, M. (2013, January 20). General Manager, BCMCL.
- Srivastava, R. E. (2008). <http://www.airoots.org/2008/09/an-artist-village-stands-in-mumbabylon/>.
- Steele, J. (1997). *AN ARCHITECTURE FOR PEOPLE: THE COMPLETE WORKS OF HASSAN FATHY*. London: Thames and Hudson Ltd.