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Disaster Rehabilitative Housing In India

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DISASTER REHABILITATIVE HOUSING IN INDIA

A Thesis Presented

by

SHEHLA HUSSAIN

Submitted to the Department of Art, Architecture and Art History
of the University of Massachusetts in partial fulfillment of the requirements for the
degree of

MASTER OF ARCHITECTURE

September 2010

Architecture + Design Program
Department of Art, Architecture and Art History
DISASTER REHABILITATIVE HOUSING IN INDIA

A Thesis Presented

By

SHEHLA HUSSAIN

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DEDICATION

To my father, for always watching over me.

And my mother, for her limitless love and encouragement.
ACKNOWLEDGEMENTS

I’d like to thank my professors and guides Kathleen Lugosch and Joseph Krupczynski as well as Simi Hoque, for their time, encouragement and valuable critique. I’d also like to thank Professor Alexander Schreyer in guiding me through the key technical aspects of the project.

And a special thanks to all the organizations and individuals who not only were valuable sources of information but also inspired me through the process as they continually work in challenging situations to better people’s lives in devastating circumstances.
The project explores the design development of housing within the scenario of Post Disaster Rehabilitation of populations displaced by natural disasters. By looking at the house as a system that combines two distinct phases of rehabilitative housing, namely Transitional Housing and Durable Housing, the design seeks to reduce the complications of relocation every time there is a need to move on to the next phase of shelter aid. To truly make the house construction an owner driven experience, the system aims to be designed such that it can manipulated by the owner/user to suit their long term needs and personal tastes. By doing so, the house strives to imbibe a sense of belonging, making it less likely for the shelter to be rejected by the owner.

For this purpose, the aesthetic of the shelter would need to be carefully designed and organic patterns of settlement growth studied to realize the need of the types of public, semi public and private spaces.
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CHAPTER 1
INTENT OF PROJECT

The thesis project proposes to explore the design of a housing system/set of systems which provides for one system to cater to two important phases of disaster rehabilitative housing, namely the ‘transitional phase’ and the ‘durable housing phase’ without the need for relocation or reconstruction.

This approach would not only serve to minimize the time, energy and cost of providing durable housing to displaced populations, but also minimize the psychological trauma involved in moving from one place to another, covering the many loopholes in disaster rehabilitative housing.

The success of any housing project in a rehabilitative situation is heavily dictated by acceptance of the shelter by the community provided for. In my opinion, this is more likely if there is direct involvement in its construction by the user. Hence my main focus is to be able to deliver a manipulative housing system, which would help each user make a technically sound ‘core design’ in the first phase (transitional housing) their own by manipulating it in the second phase (durable solutions) or in both phases, as per the design development.

Being a heavily design oriented process which would have to deal with separate requirements for each ‘phase’ of the housing system, the project would have to deal with disaster resistant construction and planning strategies, all the while incorporating culturally sensitive influences in the architecture.

The final goal of this project is thus to design housing systems which can be
manipulated in their latter phase by the user group to suit their personal needs, while being provided with technically sound disaster resistant ‘core’ designs.

I will look at two environmentally and culturally distinct site conditions to develop ‘single phase’ disaster rehabilitative housing which essentially combines two phases into one. Through this process I will be able to identify aspects of disaster relief housing that is prototypical and can be erected in multiple situations, and how well this base structure can be adapted to and completed in culturally and environmentally diverse situations.
CHAPTER 2
HAZARD MAPPING

The following maps have been combined to understand the various hazards in the regions for the design. The regions selected are similar in climate and cultural conditions and so possible alternative locations for the application of the design have also been highlighted.

- Possible areas of application
- Focus areas: South (TamilNadu) West (Gujarat)

**Figure 1: Hazard maps of India: Wind and cyclone; Earthquake Zone; Flood Hazard**

**Figure 2: Combined Hazard map of India Source:** PlaneMad/Wikipedia(http://en.wikipedia.org/wiki/File:Chennai_area_locator_map.svg) under license to use as per: http://creativecommons.org/licenses/by-sa/3.0/
Disasters Leading To Long Term Disasters

**Storm surges and flooding**: inundation of fields by saline water

Due to varying soil types, salt water remains logged for months on fields

**Wind storms**: unsafe for fishing

handicapping fishing communities

Fishing communities rely 90% on traditional knowledge systems (sound of the sea, estimations of wind conditions) and 10% on official information

**Earthquakes**: massive loss of usable land and water systems

90% of homes destroyed and 80% of usable land and water resources affected in most situations lead to a very slow return to normalcy.
Factors that hamper/support shelter and settlement Initiatives

<table>
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<th>Aspect</th>
<th>Temporary Shelter</th>
<th>Permanent Shelter</th>
<th>Settlement</th>
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| **Development** | • Availability of safe land  
• Price of material/source  
• Topography & ground conditions  
• Accessibility | • Design options  
• Selection of location  
• Incorporating local practice  
• Incomplete historical report of past natural disasters  
• No skilled expert  
• Poor governance and corruption | • Land availability  
• Existing assessments and plans  
• Identification if various types of land rights  
• Access to basic infrastructure and equity |

| User Satisfaction | • Speed  
• Appropriate size of the building  
• Climate and context  
• Accessibility  
• Gender  
• Role of ‘gram sabhas’ (village level governing) | • Selection of the site  
• House design  
• Choice of materials and techniques  
• Timeframe | • Safety  
• Access to basic infrastructure  
• Layout  
• Orientation  
• Participatory mapping |

Table 1: Factors affecting shelter and settlement initiatives

Challenges In Shelter Recovery

Figure 3: considerations for shelter and settlement
CHAPTER 3
SITE SELECTION AND ANALYSIS

Location: Ennore (Kathivakkam district), North Chennai, State of Tamil Nadu
Along Manali High Road

Background: Currently in use for temporary housing of Tsunami (2004) victims

Surrounding areas: Ennore Thermal Power station (ETPS)

  ETPS Residential colony
  ETPS factory shed
  Burma Nagar, a completely self sustained settlement
  Kathivakkam railway station
  Burma Nagar Bus stop

Advantages:

  • Close proximity to railway station and bus stand
  • Close proximity to settlements and primary care facilities

Disadvantages:

  • Pollution from Thermal Power station a health risk
  • Site is dislocated from urban center of Chennai
  • Access to neighboring communities and transportation hubs is unsafe due to railroad tracks and highway and no footbridges to cross them.
Figure 4: Site location

Figure 5: Site analysis
Figure 6: Site topography
Figure 7: Site outline

NOTE:
1. All dimensions are in metre
2. Total surveyed area = 11.14 acres
3. BM+100.000 taken from building floor level
4. Grid spacing 36.5 x 36.5 m
CHAPTER 4
PRECEDENT STUDIES

Reusable earth shelter

Figure 8: Case study 1- construction. Source: Satprem Maini/Self

Architect: Satprem Maini
Location: Auroville, Puducherry India
Climate: Tropical wet and dry
Construction time: 1 week

Expected Life: 20 years

Service Facilities: Toilet, Kitchen, Waste water treatment system

Figure 9: Case study 1- construction elements. Source: Satprem Maini/Self
Figure 10: Waste Water management. Source: Satprem Maini/Self

Conclusions:

Advantages:

- Cost of building cut down by 30% due to low cost of materials and negligible use of cement compounds
- House can be dismantled and rebuilt in alternate locations
- Is self sustainable with solar power supply and sewage treatment system

Disadvantages:

- Transportation of materials is difficult due to heavy bricks and easy breakage
- The Compressed Stabilized Earth Blocks (CSEB) are durable for construction but are brittle to transport and chip easily
• Ferro cement doors had to be rejected as they were found to be too heavy for the hinges.

• Setting up of the precast roof channels was difficult for manual labor to implement. Heavy components must hence be minimized if this is to be used in a disaster rehabilitation scenario where a family must be able to build it themselves with minimal help.

**Paper tube shelters**

Paper log houses built in various locations

![Paper Log House Kobe, Japan. Beer crate foundation for water resistance and durability](image1)

![Paper Log House Kobe, Japan. Inside view](image2)

![Paper Log House with barrel vaulted roofs, Guimaraes, Portugal](image3)

![Paper Log House with tarp roofs without side vents for colder climate, Turkey](image4)

**Figure 11: Case study 2. Source: Shigeru Ban Architecture**
Figure 12: Case study 2- components

Architect: Shigeru Ban

Location: Bhuj, Gujarat

Climate: Arid Desert: Cold (but not freezing) winters and scorching heat in summer. Light rainfall, but high velocity windstorms.

Construction time: 2 hours

Expected Life: 10 years

Service Facilities: Kitchen, Living
Sources: Shigeru Ban Architecture;

Design Like You Give a Damn;


http://www.jstor.org/stable/1567332

Figure 13: Case study 2 – observations. Source: Shigeru Ban Architecture
Conclusions:

Advantages:

- The houses were found to be dismantle-able even though this was unintended.
- The houses could be made more durable and hence used in permanent housing by tweaking the panels to include chicken mesh wire being nailed to the panels and the panels finally coated with mud plaster.

Disadvantages:

- Cost of structure too high to cater to larger settlements (this one catering to only 20 households)
- Transportation of panels from the factory to the site proved a hassle due to bulk and time required to set them up on site, lengthening the construction process.
CHAPTER 5
CULTURAL ANALYSIS

West India

Table 2: Culture studies- West India

This region is a mix of city lands and green farms, exhibiting a vast and diverse landscape.

**It is divided into 3 major strips, namely:**

- North- saline desert- the Great Rann
- Central- semi desert with perennially dry rivers- the Banni Grasslands
- South- coastal- good water availability for varied flora and fauna

**Climate**

(Temp: Max 118.4 deg F/ 48 deg C; Min 35.6 deg F/ 2 deg C)

North- Hot and Dry

South- Hot and Humid

Rains: Scanty Monsoons (below 40 cm), during July and August

Demographics: Mainly Hindus, Muslims and Jains

Main Occupation: Salt production (40% of national production); Cottage Industry; Cattle breeding

2 distinct architectural typologies have been observed to have evolved due to climatic conditions, social and economical conditions:
• Traditional Urban Settlements- The Central, Western and Southern coastal area with hot and humid climate has long row type houses with narrow streets and dense population.

• Nomadic Rural Settlements- Northern Banni area with hot and dry climate and some parts of Southern Coastal Desert living in beautiful circular mud and thatch houses with scarce resources for building.

Table 3: Culture studies- West India- views
South- Bidada Village

The settlement grows in an organic fashion, branching out at points where it forms widened spaces called ‘chowks’ for social gathering. The streets are narrow, making them shaded and comfortable to pass through and also channel the wind throughout the village. The winds get cooled by the shade. The streets are predominantly oriented southwest, the direction of the wind in that region.

Street Networks

Front door ‘aangan’  Neighborhood space  Main street node ‘chowk’  Main Village square ‘chowk’

Flow of Open Spaces

The street network is such that the width reduces as one approaches a residence. The largest open space is the village square, from where streets branch out and lead to open chowk intersections. Again streets branch out into narrow streets leading to a smaller
intersection which branches out into narrower lanes, finally leading to the front of the house/‘aangan’. The common ‘aangan’ shared by a cluster of houses, helps form a secure area for the children to play under the watchful eye of the neighbors. These smaller ‘aangans’ are also well shaded due to their scale as compared to larger sized ‘chowks’.

The curvilinear streets are formed by staggering the houses by a few feet. It can be noted that if one enters a house on one side of the street, they enter a covered room and then enter the house. On the opposite side of the street, they would enter a court before entering the main house. Together with the alternating courts and rooms, there exists a certain sense of privacy and multidirectional flow of breeze.

Table 4: Street networks of south bidada village
House layouts

Table 5: West India house layouts

House types 1 and 2 are similar in terms of flow of space and the same is true for types 3 and 4.

Spatial Planning

<table>
<thead>
<tr>
<th>Entry steps</th>
<th>Courtyard</th>
<th>Kitchen</th>
<th>(Family room)</th>
<th>Bedroom</th>
</tr>
</thead>
</table>

The size and scale of the house depicts a higher economic status. The toilets and services are generally separate on another part of the compound. The entrance or ‘delly’ is located in front, functioning as a porch. On entering the house, the kitchen is accessible from the entry court (which may or may not be covered). In the case of a joint family, the entry court would be from where each household could be entered and the kitchens would increase in number depending on the number of families in the joint family. The kitchen is, as per social customs, for the lady of the house in charge of household chores, dominating the kitchen.
**South- Mandvi (Coastal town)**

The town of Mandvi is in the coastal part of the region. The main occupation of the town is trade, the architecture is hence influenced by modern construction and styles. Mandvi is a bustling and densely packed settlement, due to the large population and the climatic conditions. The street network is similar to that of Bidada village, but clustering is much more geometric and simple.

Often the houses around a common court belong to the same family. The enclosed space also acts as a protected area and the houses as such are at least two to three storeys. The houses are of solid brick masonry and mangalore tiled roof.
The settlements are organic in their layout, with residual spaces between houses acting as streets. The circular or rectangular houses called ‘bhoonga’ are placed on platforms. A household can have two or more huts, each one for different functions such as cooking, sleeping, storage etc. If there is only one hut, the cooking area is on the periphery with a small opening above it.

The daily activities are mostly carried out on the platform outside the hut, which also connects the other huts of the same family. The huts are never linked directly to each other due to the mud blocks developing cracks. This lends an organic sense of planning especially during expansion.
The circular mud houses are an integration of exact geometry and property of materials to evolve the form. The habitants themselves build the house. The circular plan allows warm air to circulate around the house and also ensures that at any time of the day, at least half the house is in shade. The house also withstands to a certain extent, the lateral forces caused by earthquakes, due to the conical form of the structure.

Figure 19: West India Clustering- rural
Reference: Architecture for Kutch-Sanjay Udamale

South India

Table 7: Culture studies- South India

Climate
(Temp: Max 88.7 deg F/ 31.5 deg C; Min 77 deg F/ 25 deg C)
Tropical wet and dry
Rains: Monsoons during June till September
Demographics: Mainly Hindus, Muslims and Christians
Main Occupation: Coastal Fishing, Industrial labor, City employment
Village studies of coastal settlements (namely Perianeelankarai, Chemmencheri and Pattipulamkuppam) and one traditional settlement off the coast have been made. While the coastal settlements are self sustained, the traditional study shows access to city infrastructure.

**Typical Village (Village: Thillaisthanam)**

The settlement pattern is row type along a simple street network arising from social conditions i.e the caste system, where each street is inhabited by members of the same caste.

*Figure 20: South India- village layout*

The village studied is typical of most villages in the state of Tamil Nadu, consisting of 3 major areas:

- Brahmin area / ‘Agraharam’
- Non Brahmin
- Harijan area

The village studied also has a marginal population (3 families) of weavers and potters. Almost all streets intersections are marked by a temple, similar to Bidada village in Gujarat, where intersections were marked by a ‘Jhak’ or shrine. The streets are all fairly wide and straight and support the agricultural population’s land needs. The main road easily connects the village with regular public transportation and connection to
Table 8: South India- house types

The Brahmin houses are in the ‘agraharam’ and are mostly ‘pucca’ i.e. made of brick masonry and wood and with ‘madras terraced’ roofing (Flat roof with red oxide flooring). The house consists of a porch or ‘thinnai’ for relaxing and socializing. Adjacent houses are almost always connected by a common wall and tend to be narrow in width and very long. They are often without an interior courtyard, but have open spaces in the back. Light and air are in most cases allowed in through a clerestory which substitutes for the open courtyard in the flat roofed houses.

Harijan Houses are very simple, with just a living space and a kitchen or storage area.

Weavers houses have internal courts used as workspace. Both living and working spaces are common for sleeping. The construction is ‘kuccha’ with thatch roofs and mud walls. There is hardly any plinth level given, but a threshold member at the door keeps out any water from entering.
The settlement pattern in fishing communities is row type (similar to their inland counterparts), along informal main streets and clusters of 4 to 5 houses spread in between.

The villages have one large open space along the side facing the sea, sometimes concreted or just left leveled, for the fisher folk to dry fish, separate the catch etc.

Community facilities such as community halls for gatherings, occupation based facilities
such as drying yards, auction area, storage for nets and outboard motors is also a necessity.

Each house consists of a prayer room or ‘pooja’ room facing the sea, a living space to sleep and a lot of storage area. Toilets are not generally built, but some ‘pucca’ houses have their toilets separately placed outside.

House types: thatched huts of one room; one room houses of mud walls and tiled roofing; pucca houses with ‘madras terrace’ roofing.

References: Village studies-SRM School of Architecture- Chennai;
CHAPTER 6
PROGRAM ANALYSIS

The following program has been outlined as per the precedent and cultural analyses:

Single Family Units: Living space
- Kitchen
- Washroom

Semi Private spaces: Clustered developments
- Common space (courts)

Community units: School
- Community/Resource center
- Water resource

Infrastructure: Connections/roads
- Services/Utilities
- Wastewater systems/treatment
- Power Supply

Alternative technologies:
- Cooking gas
Waste water management systems

Building materials

Program for houses:

**Dwelling Unit**-
- Live space
- Sleeping area
- Storage
- Kitchen/Cooking space
- Wash Area (for vessels, clothes etc)

**Common facilities**-
- Bathroom/Toilet

**Community facilities**-
- Community/Resource Center
- School
- Water pump areas
CHAPTER 7
PHOTO STUDY

South India

Figure 22: Photo study- South India. Source: Flickr creative commons licensed work for non commercial use; Dominic Sansoni for non commercial work

West India

Figure 23: Photo study- South India. Source: Flickr creative commons licensed work for non commercial use; Dominic Sansoni for non commercial work

The photo study is intended to bring in a sense of place and context to understand the life, color, simplicity and to connect on a human level. The design success depends
heavily on how well the proposed structures can be adopted by the people and if they will be able to continue their daily activities in them just as they were in their original homes.
CHAPTER 8
DESIGN CONSIDERATIONS

Planning Criteria

Spaces to keep and why

- Front Porch – Rest, Selling goods, Socializing
- Inner Courtyard – Traditional feature to let light in, Expanded courts used for socializing
- Semi Open Cooking/Washing – To keep away smells and easy drainage of water, invariable interactions with neighbors

Aesthetic catered to

- Flat roofs and sloped roofs are constructed commonly (”madras roof”)
- Bamboo/thatch panels
CHAPTER 9
DESIGN DOCUMENTATION

Base Configuration

Figure 24: Base configuration
Components

Figure 25: Components
Details

Adjustable Foundation Piers

To suit variable terrain, piers similar to ones used for homes in hilly regions have been proposed for use here. The piers will be adjusted and fixed depending on the particular site.

Panel

Bamboo Mat Board Panels: Versatile use as wall, floor, roof, thinner boards for doors and windows

‘EcoBoard’ Panels: Made from agro waste (‘bagasse’ from sugar industries), used for wall, floor, roof.

Figure 26: Adjustable piers

Figure 27: Panels
Structural Frame

Figure 28: Structural frame

Frame Details (Aluminum)

Figure 29: Framing details

Gutter Details

Figure 30: Gutter details

The design uses bamboo culms as the gutter and tarp to guide the water to the outer edges of the house. The tarp comes from under the bamboo mat band so as to act as the waterproofing layer and extends to the edges. The tarp wouldn’t be seen from ground level.
since it slopes within the 3 inch structural roof beam.

Figure 31: Gutter details

Configurations for Alternative Uses

Figure 32: Water Resource and Community Center/School
Alternative Livelihood Technology

Hydroponics

It is a method of growing plants using mineral nutrient solutions, in water, without soil.

A 20sqm(251sqft) garden of simplified hydroponics should produce about 2 kilos of fresh vegetables every day.

Household Biogas Plant (‘Aarti’ Biogas Plant)

Leftover food, flour, vegetable waste, ripened fruit etc. can be turned into methane in 24 hours. The biogas system here is a domestic fridge sized biogas plant and produces no soot or smoke. Made from two cut down standard HDPE tanks and standard plumbing pipes.

Decentralized Waste Water Treatment Systems (DEWATS)

This method of waste water management decentralizes the waste water treatment to cater to how many ever households or structures as necessary. Water is treated to CPCB discharge standards, recycled for irrigation, is operable with semi skilled/unskilled labor, has no mechanical parts, requires little space, has no smell, is less expensive than conventional systems and has very low maintenance costs.
Figure 33: DEWATS process diagram

Phasing

Figure 34: Phasing diagrams showing expansion

- Core house

Bamboo screen wraps around the structure, giving it identity and encloses future space. It also acts as a canopy for shading.

The core space is minimal, but with levels, hence allowing for privacy and safety as well as an already dynamic shelter.

- Expanded house

With more time and money, more panels are added to expand the initial core and play with rooms and floor/ceiling panels. Jute weave screens may also be used as a railing, the wide weave acting as a visual barrier but yet allowing for air circulation.
Figure 35: Construction sequence

Configurations and Clustering

Clustering of various configurations

Figure 36: various Configuration- layouts and views

STREET SIDE

REAR OF HOUSES
Figure 37: Clustering various configurations

Clustering of same configuration

Figure 38: Clustering same configurations
Figure 39: Community layout

**Site Planning**

Simple axial planning for ease of infrastructure layout has been used here. All houses are laid out on a 4’x4’ grid and oriented for variation in arrangement: Row or Cluster.

**Components**

- Houses
- Community Center/Schools/Information centers
- Water Resource centers: For drinking water and shared bathrooms with
independent rain water harvesting systems.

- Waste Water management: DEWATs units serving every 8 or so units.

**Street Elevations**

![Street Elevations](image)

**ELEVATION A**

**ELEVATION B**

Figure 40: Street elevations with context
BIBLIOGRAPHY


