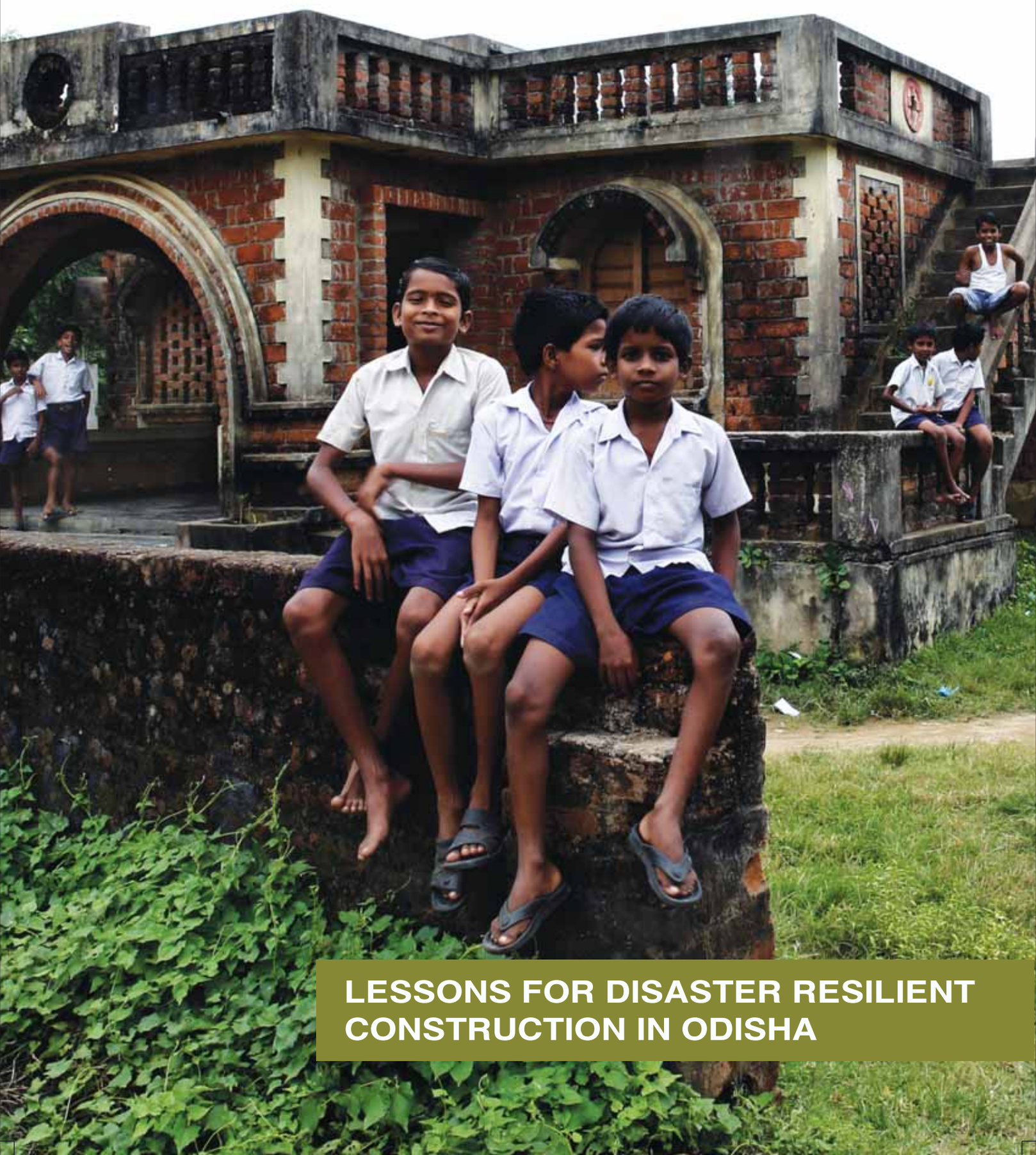
APPROPRIATE TECHNOLOGIES SUSTAINABLE LIVELIHOODS

UNDP

Empowered lives.
Resilient nations



LESSONS FOR DISASTER RESILIENT CONSTRUCTION IN ODISHA

Empowered lives.
Resilient nations

APPROPRIATE TECHNOLOGIES SUSTAINABLE LIVELIHOODS

LESSONS FOR DISASTER RESILIENT CONSTRUCTION IN ODISHA

ACKNOWLEDGEMENT:

UNDP acknowledges the contributions of Mr. Hari Kumar, Mr. Anindya Sarkar, Mr. Ram Chandra Panda and Mr. Mrinal Nath of GeoHazards Society India in conducting the study, and Ms. Prachi Acharya (Intern, UNDP) in finalizing the report.

Photo credits: Odisha State Disaster Management Authority; Ishan Tankha/ UNDP India

TABLE OF CONTENTS

PREFACE

Odisha with its unique geo-climatic conditions characterised by a 480 kilometre long coastline, drought prone areas, large number of perennial and semi perennial rivers is highly vulnerable to natural hazards such as floods, cyclones, storm surges, droughts, heat waves, earthquakes, etc. Climatic variability and frequent occurrence of extreme weather events have further exacerbated the risks faced by communities. The loss of development gains due to recurring disasters in a state where about half of the population in rural areas live below poverty line, is a matter of grave concern to the Government.

Recognizing this, the Government of Odisha has been investing in building disaster preparedness and strengthening risk reduction through a range of activities under the leadership of the Odisha State Disaster Management Authority, established after the 1999 Super Cyclone. These include construction of cyclone shelters, strengthening of coastal embankments, setting up of evacuation protocols, creation of dedicated response force i.e., the Odisha Disaster Rapid Action Force, training of community members and first responders, and conduct of annual mock drills, especially in Odisha's coastal districts. Sustained actions towards raising awareness and building capacities in dealing with disasters facilitated the largest pre-disaster evacuation ever conducted in the country, where about 850,000 people were evacuated to safe shelters in Odisha, before Cyclone Phailin made landfall in October 2013.

Despite the significant number of lives saved, Cyclone Phailin affected more than 10 million people and caused extensive damage to assets, both public and private. These disaster events underscore the need to strengthen our risk reduction initiatives so that along with reduction in the number of deaths, loss of livelihoods and assets can be minimized. Government of Odisha has adopted a holistic approach to disaster management, by incorporating into it the growing concern for environment, risk assessment, risk reduction and for ensuring peoples' participation in creating a disaster resilient Odisha. The recent calamities also highlight the need for greater synergy between all stakeholders as government may not be able to provide to all at the same time, and underscore the vital role played by non-governmental, private and civil society organizations in all phases of disaster management.

UNDP has been a credible partner of Government of Odisha since 1999, joining hands in its efforts to strengthen disaster risk management capacities in the state. The UNDP-SDC Shelter Project is of great relevance to Government of Odisha in its efforts towards creation of disaster resilient housing for the vast majority of its vulnerable population. The Report offers valuable lessons that could reform future reconstruction efforts as well as shape housing programmes and policies. Appropriate sites for houses/buildings, provision of technical assistance to the beneficiaries, local mechanisms for construction delivery, use of local materials and local skill building, highlighted by the UNDP initiative, should be key elements of a long-term housing strategy that builds resilience and is sustainable.

Dr. Taradutt, IAS
Addl Chief Secretary, Revenue and Disaster Management Department and
Managing Director, Odisha State Disaster Management Authority

FOREWORD

Natural disasters pose an increasingly significant threat to development gains around the world. From the tsunami that swept coastal Tamil Nadu in 2004 to Cyclone Phailin in Odisha in October 2013, India is familiar with the devastation and destruction that disasters can cause. And it is the poor who are most vulnerable to the impacts of these disasters.

The United Nations Development Programme (UNDP) has worked with government institutions and supported efforts to strengthen the capacities of communities who live in hazard prone areas of Odisha since 1999, when a Super Cyclone claimed about 10,000 human lives, destroying two million homes and causing extensive damage to physical and social infrastructure. Under the leadership of the Government of Odisha, and in partnership with the Swiss Agency for Development and Cooperation, the Shelter Project was implemented by UNDP in the state between 2002 and 2007. Recognizing that shelter is often worst impacted by disaster, the project demonstrated locally appropriate, cost effective and disaster resilient construction technologies to enable communities to build safer homes and be prepared for and reduce disaster risk. Sustainability was ensured by creating a cadre of grassroots masons and artisans that still use these technologies in buildings and homes that are being constructed in the area today.

The positive impact of this partnership is evident a decade after it began. In 2013, when Cyclone Phailin struck the coast of Odisha, 44 people lost their lives as a result of the cyclone and the flash floods that followed. This reduction in lives lost compared to 1999, can be attributed to the state's comprehensive preparedness and effective coordination between national and state institutions, non-governmental organizations (NGOs) and local communities. However, the cyclone did leave behind a trail of devastation, destroying infrastructure, crops, buildings and homes. A post-cyclone assessment has shown that many of the buildings constructed using the disaster resilient construction technologies promoted under the Shelter Project withstood the force of the cyclone, providing shelter to hundreds of families and serving as hubs for the distribution of emergency relief. Beyond the social, economic and environmental benefits associated with the use of the technologies promoted, the project also demonstrates the effectiveness of an owner-driven approach to house construction that uses local materials and builds skills of local artisans towards meeting the housing needs of vulnerable communities.

Reconstruction and rehabilitation activities in India will confront challenges similar to those in the post-1999 reconstruction phase in Odisha. Therefore, it is crucial for new reconstruction programmes to consider lessons learnt from earlier efforts. The assessment in this report of the appropriate technologies promoted through the Shelter Project offers some guidance in adopting suitable materials and construction methods in post-disaster reconstruction and in building sustainable livelihoods for community resilience.

UNDP thanks the Government of Odisha and partners in this endeavour. We hope that the recommendations of the report will guide decision-makers and practitioners in adopting owner-driven habitat development that optimizes financial resources, ensures sustainability and improves livelihood options of vulnerable communities.

Jaco Cilliers
Country Director
UNDP India


ମମତା ଯୋଜନା ହିତାଧିକାରୀଙ୍କ ଦେୟ
ଗୋଷ୍ଠୀ ଓଜନ ବୃଦ୍ଧି ଚାର୍ଟ

EXECUTIVE SUMMARY

1. INTRODUCTION

When Cyclone Phailin made landfall over Gopalpur, Odisha on a Saturday evening in October 2013, with winds over 200 kph (125 mph), it was extraordinary in more ways than one. Equivalent to a Category 5 hurricane or super typhoon, it was the strongest storm to hit India in more than a decade, and destroyed hundreds of millions of dollars' worth of crops and tens of thousands of thatch homes.

What was most extraordinary however was the disaster preparedness and mitigation in response to the cyclone warnings. Effective collaboration between governments at all levels, non-governmental organizations (NGOs) and communities enabled the timely evacuation of over one million people from the direct cyclonic path and accompanying storm surge. Such a response was the result of extensive efforts in disaster risk reduction (DRR) at all levels, including construction of important infrastructure such as village roads, cyclone shelters and schools following the devastating Odisha Super Cyclone in 1999 that had claimed about 10,000 human lives.

This success story of disaster preparedness and mitigation began when the Ministry of Rural Development, Government of India (GoI), approved construction of 600,000 houses under its national flagship housing programme, **Indira Awas Yojana (IAY)**, following the massive destruction in wake of the 1999 Super Cyclone.

However, a review conducted two years after the cyclone found that most IAY houses remained incomplete as rural communities lacked the requisite skilled manpower and access to technical assistance for house construction within a limited budget. This gave impetus to the **Shelter Project** implemented by the **United Nations Development Programme (UNDP),** in partnership with the **Swiss Agency for Development and Cooperation (SDC)** and **Care Today**.

The project, from 2000 to 2007, promoted locally appropriate, cost-effective and disaster resistant construction technologies in Odisha's cyclone-affected districts. It showcased the effectiveness of these technologies by constructing 63 Technology Demonstration Units (TDUs) across four districts in three phases (see Table 1).

Table 1: Construction of TDUs under the project

Project Phase	Year	Funding Agency	Number of TDUs	Budget per TDU (INR)	Area (sq. ft)	Districts
Phase I	2001-2002	SDC	40	1,20,000	550	Balasore, Kendrapara, Jagatsinghpur, Puri
Phase II	2002-2003	Care Today	8	2,25,000	750	Jagatsinghpur
Phase III	2004-2005	Care Today	15	2,25,000	750	Balasore, Kendrapara, Jagatsinghpur, Puri

The TDUs were constructed between 2001 and 2005. Other activities such as training and capacity building for IAY construction continued until 2007, which resulted in increasing local capacities related to appropriate construction.

While the loss of human lives in the Phailin aftermath has been minimal, damage to housing stock has been substantial—256,633 units have been damaged, including 57,966 fully or severely destroyed (World Bank 2013). Upcoming reconstruction and rehabilitation activities could confront challenges similar to those in the post-1999 reconstruction phase. Lessons learnt from the UNDP Shelter Project will be particularly useful for new housing reconstruction programmes to consider.

A detailed assessment of TDUs in districts affected by the 1999 Super Cyclone and Cyclone Phailin has been conducted by GeoHazards Society for UNDP. This report, based on the assessment, aims to understand the post-Phailin relevance and suitability of construction technologies and materials promoted under the UNDP Shelter Project.

2. OBJECTIVES

The main objectives of this study were to:

(i) **Assess** the contextual suitability of various technologies promoted under the Shelter Project;

(ii) **Evaluate** the extent to which TDUs have been utilized as community buildings and as shelters during emergencies such as floods and cyclones; and

(iii) **Recommend** ways in which appropriate construction technologies can be used in post-Phailin reconstruction programmes.

3. METHODOLOGY

The study was carried out over two months, beginning in November 2013. It was conducted in three stages:

i. **Prefield Visit:** Information collected through literature review, individual and group meetings with United Nations Volunteers (UNVs) involved in the Shelter Project, and UNDP (Odisha) representatives;

ii. **Field Visits:** Field visits to four districts, namely, Balasore, Jagatsinghpur, Kendrapara and Puri were made to assess 20 TDUs. These districts had been affected by the 1999 Super Cyclone and Cyclone Phailin. Ganjam district, worst affected by Cyclone Phailin, was also visited to study the shelter needs of its communities; and

iii. **Post Field Visit:** Sharing of findings with state authorities and preparation of report.

4. FINDINGS

The UNDP Shelter Project was perhaps the first example of owner-driven reconstruction in India following a natural disaster. The main technologies promoted under the project have proved to be contextually appropriate and have reasonably endured despite zero maintenance. Additionally, the use of local building materials has boosted the local economy. Across the assessed villages, communities and masons expressed their confidence in the durability and disaster resilience of technologies used in the TDUs constructed under the project, since most buildings had withstood moderate to high floods and winds over the decade.

Starting with two houses in March 2001 to over 4,700 by June 2007, the UNDP Shelter Project has successfully influenced construction of many buildings beyond IAY houses such as government buildings, schools, multistoried residences, shopping complexes and block offices. It has influenced a 'Building Movement' where *raj mistries*, sensitized as a result of the UNDP Shelter Project training programme, began to support and promote appropriate technologies within the villages, which influenced many other IAY beneficiaries. Shortly after the end of the training for masons, many other IAY houses using these technologies mushroomed in the project districts.

Although the then IAY guidelines did not require houses to be disaster resistant, the UNDP Shelter Project encouraged beneficiaries to build using disaster resistant features such as anchorages and horizontal bands. These features have helped the IAY houses withstand the fury of recurring floods and cyclones since 2001, thus reducing the vulnerability of communities and recurring post-disaster rebuilding costs.

Following the 2001 Gujarat earthquake, due to the increased awareness of earthquake hazard in the project districts, TDUs were built with reinforced rat-trap masonry construction. UNVs adapted the standard rat-trap brickwork into 'reinforced masonry construction'. The additional features improved the building's earthquake resistance and yet construction was more cost-effective compared to conventional brickwork. This has been a major technological innovation in the Shelter Project.

I. Contextual Suitability

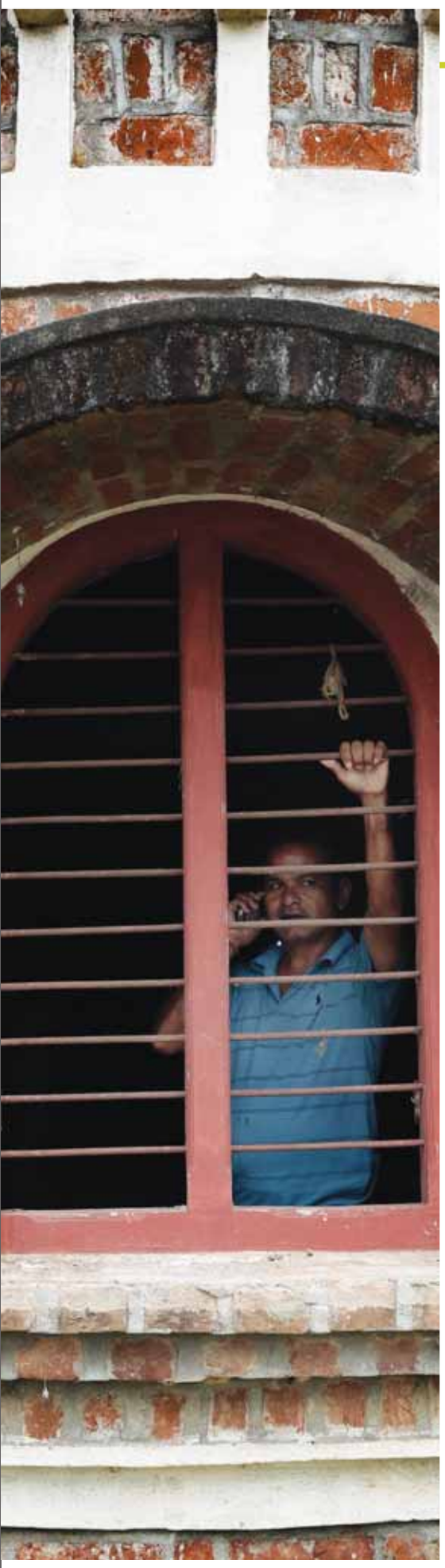
The contextual suitability of the technologies promoted under the UNDP Shelter Project can be seen in terms of social, economic and environmental benefits.

a. Social Benefits to the Communities

- **Better Access to Information** on rural housing schemes and appropriate technologies;
- **Continuous Technical Assistance** from UNV architects, civil engineers and planners in IAY house design, space optimization and detailing;
- **Assistance in Reducing Vulnerability of Communities** by inclusion of multi-hazard resistant features in IAY houses;
- **Experience in Managing Funds,** through individual savings, loans or IAY funding and enhancing communities' understanding of the need for resource optimization;
- **Promoting Community-based Construction Management** leading to the evolution of community contractors, namely, *nirmaan samitis*;
- **Encouraging Empowerment of Women** to understand habitat and construction issues, by providing a platform to strengthen their role in village-level decision-making, training in appropriate construction methods and encouraging involvement of Self Help Groups (SHGs) in production and supply of building materials; and
- **Providing Assistance in Creating a Pool of Local Masons with Expertise** in appropriate technology, disaster resilient construction features and comprehensive construction aspects, which can be a manpower resource available for future construction projects in other villages.

b. Economic Benefits

- **Construction Costs Reduced by 20 to 25 Percent** due to reduced building material requirement in wall construction with rat-trap bond and roof construction with filler slabs;
- **Encouraged Use of Local Building Materials and Optimized Costs** without compromising on the quality, durability, structural stability or disaster resilience of buildings;
- **Reduced Recurring Post-disaster Rebuilding Costs and Associated Vulnerabilities** for communities through incorporation of disaster resistant features, such as anchorages and horizontal bands, in IAY houses and constructed TDUs; and
- **Increased Income of Trained Masons** due to their enhanced service delivery of affordable housing with increased thermal comfort.



c. Environmental Benefits

These house construction technologies had positive environmental impacts through:

- **Reducing the Overall Consumption of Building Materials** by over 20 percent;
- **Reducing the Top-soil Consumption** through less brick consumption in rat-trap bonds;
- **Encouraging Use of Coal Fly Ash Bricks**, thus reducing land usage for its disposal and potential leaching of metal into proximate groundwater or surface water; and
- **Enhancing Indoor Thermal Comfort** through additional insulation provided by air gaps in the rat-trap cavity walls and between tiles in filler slab roofs.

II. Utilization as Community Buildings and Emergency Shelters

Most TDUs, designed as Anganwadi Centres [1] (AWCs), are still being used for this purpose. Some TDUs, located within the premises of local primary schools, are being used for kindergarten classes. Others are being used for health check-up camps, youth clubs, after-school extra classes and as a meeting place for the community or women SHGs. Most TDUs have also been used as emergency shelters and/or relief distribution shelters during floods in the last decade and for Cyclone Phailin.

These buildings had been handed over to the local communities after completion, along with directions for proper use and maintenance. As they were not formally handed over to the local government, no government funds are committed or spent for their maintenance. Despite this, most TDUs appeared tidy and dirt-free since they are used almost daily and are kept clean by the community.

1. Anganwadi, meaning 'courtyard shelter', is a government sponsored child and mother-care centre in India. The scheme started in 1975 as a part of the Integrated Child Development Services (ICDS) Programme to address child hunger and malnutrition. It caters to children in the age group of 0-6 years. For more details see: http://www.aanganwadi.org/

5. RECOMMENDATIONS

Phailin-affected community members are eligible for Rs. 45,000 per household under the state housing scheme **BIJU PUCCA GHAR YOJANA** earlier, **MO KODIA YOJANA** i.e., **MY HUT SCHEME.** This scheme assists those not covered by central schemes such as IAY. However, most community members consider the Biju Pucca Ghar Yojana funding insufficient for house construction and aspire to receive support from IAY as well. At Rs. 70,000, grant money is considerably higher in IAY. As a result, most communities had not commenced house construction and continued to live in makeshift *kutcha*[2] shelters or repaired mud-thatch houses, making them more vulnerable.

Based on the assessment of suitability and performance of appropriate technologies in the UNDP Shelter Project, this report recommends the following for post-Phailin reconstruction and rehabilitation programmes:

- **Sustainable habitat development through convergence of ongoing national schemes must be prioritized.** Schemes for housing, such as IAY and Biju Pucca Ghar Yojana, rural water supply and sanitation, and for rural lighting should be converged to ensure holistic rural habitat development.
- **Sustainable reconstruction with the help and availability of technical assistance at various levels must be encouraged.**
  - **At state level,** the Technical Support Agency must assist the government, State Public Works Department and State Disaster Management Authority to ensure the delivery of sustainable reconstruction programmes.
  - **At community level,** technical assistance must be provided to guide communities for optimal resource utilization and to design culturally sensitive, disaster resilient and appropriate settlement plans and shelters that minimize the construction's environmental impact.
- **Community ownership through social mobilization must be encouraged.** To ensure complete community ownership of reconstructed housing settlements, shelter programmes should have a social mobilization component.
- **Sustainable and improved livelihood options through local skill development** must be adopted and integrated in reconstruction schemes to optimize available financial resources, ensure sustainability and improve livelihood options for affected communities.
- **Effective construction delivery through community-based construction management must be encouraged,** which is more likely to ensure better quality control of materials and construction, induce much deeper ownership, and better use and regular maintenance of community structures (as seen in the TDUs).
- **Sustainable reconstruction by using locally available materials and disaster resilient technology must be prioritized,** while ensuring cost effectiveness and minimal environmental impact. All construction must follow updated Indian Standard (IS) codes, regardless of whether the local building bye laws incorporate them or not.
- **Use of technology and maintenance manuals is necessary** to sustain appropriate construction methods and local skills developed within communities.
- **Construction of TDUs and model houses are effective means of communicating advantages of the use of appropriate technologies.** These models can also be used to promote sustainable sanitation practices and rainwater harvesting.
- **Following context-specific shelter reconstruction guidelines can ensure consistency in delivery of housing types.** The Technical Support Agency should assist state government to bring out context-specific shelter guidelines (e.g., see http://tsunami.icsf.net/images/stories/tn0501.pdf) specifying built-up area requirements, sample designs and scope for incremental growth. These guidelines must be followed by agencies and organizations involved in housing reconstruction to avoid major inconsistencies in housing types built for various beneficiaries.
- **An effective coordination mechanism for participatory and community needs-based approach** must be put in place to link all stakeholders and various levels of government concerned with habitat planning and reconstruction.

2. Kutcha houses are those houses whose walls and/or roof are built with materials that may need to be replaced frequently, such as un-burnt bricks, bamboo, thatch, loosely packed stones, etc.

LIST OF ABBREVIATIONS

AWC	Anganwadi Centres
BDO	Block Development Officer
BGVS	Bharat Gyan Vigyan Samiti
BPL	Below Poverty Line
CFA	Coal Fly Ash
DPC	Damp Proof Course
DRR	Disaster Risk Reduction
EFICOR	Evangelical Fellowship of India Commission on Relief
GOI	Government of India
IAY	Indira Awas Yojana
ICDS	Integrated Child Development Services
IEC	Information Education Communication
MPCS	Multi-Purpose Cyclone Shelter
NGOs	Non-governmental Organizations
ODTF	Orissa Development Technocrats' Forum
ORHDC	Orissa Rural Housing and Development Corporation Limited
OSDMA	Odisha State Disaster Management Authority
PRAVA	Professional Assistance for Voluntary Action
PWD	Public Works Department
RCC	Reinforced Cement Concrete
SDC	Swiss Agency for Development and Cooperation
SDMA	State Disaster Management Authority
SHGs	Self-Help Groups
TDU	Technology Demonstration Unit
TSA	Technical Support Agency
UNDP	United Nations Development Programme
UNV	United Nations Volunteer

LIST OF FIGURES, TABLES AND BOXES

LIST OF FIGURES

LIST OF TABLES

LIST OF BOXES

1. INTRODUCTION

1.1 BACKGROUND

The extraordinary response to Cyclone Phailin, which hit Odisha in October 2013, is a recent success story of disaster preparedness and mitigation across the world. Effective collaboration between governments at all levels, non-governmental organizations (NGOs) and communities enabled the timely evacuation of over one million people from the direct path of the cyclone and accompanying storm surge. Such a response was the result of extensive efforts in disaster risk reduction (DRR) at all levels, including construction of important infrastructure such as village roads, cyclone shelters and schools, following the devastating 1999 Odisha Super Cyclone that claimed about 10,000 lives.

The 1999 Super Cyclone had destroyed a large number of houses. The Ministry of Rural Development, Government of India (GoI), approved construction of 600,000 houses under its national flagship programme, Indira Awas Yojana (IAY). However, two years after the cyclone, most of these IAY houses remained incomplete as rural communities lacked the requisite skilled manpower and access to technical assistance to construct a house within a limited budget. In response, the United Nations Development Programme (UNDP), in partnership with the Swiss Agency for Development and Cooperation (SDC) and Care Today, initiated the Shelter Project from 2000 to 2007.

A significant achievement in the post-1999 reconstruction phase, this project promoted locally appropriate, cost-effective and disaster resistant construction technologies in Odisha's cyclone-affected districts. The UNDP Shelter Project showcased the effectiveness of these technologies by constructing Technology Demonstration Units (TDUs) that also resulted in increasing local capacities related to appropriate construction. The TDUs were mostly constructed between 2001-2005; other activities such as training and capacity building for IAY construction continued until 2007.

While the loss of human life has been minimal, damage to buildings in the aftermath of Cyclone Phailin has been substantial—256,633 houses were damaged, including 57,966 which are fully or severely destroyed (World Bank 2013). Reconstruction and rehabilitation activities will confront challenges similar to those in the post-1999 reconstruction phase. Therefore, it is imperative for new housing reconstruction programmes to consider lessons learnt from earlier efforts. This timely study, a detailed assessment of TDUs in districts affected by both the 1999 Super Cyclone and Cyclone Phailin, will help to build understanding of the relevance and suitability of construction technologies and materials promoted under the Shelter Project for post-Phailin reconstruction.

1.2 OBJECTIVES OF THE STUDY

The main objectives of this study were to:

- **Assess** the contextual suitability of various technologies promoted under the UNDP Shelter Project;
- **Evaluate** the extent to which TDUs are being utilized as community buildings and as shelters during emergencies such as floods and cyclones; and
- **Recommend** ways in which appropriate construction technologies can be used in post-Phailin reconstruction and rehabilitation programmes.

1.3 ASSESSMENT METHODOLOGY

The following steps were undertaken to address the objectives of the study:

A. Before the field visits

(i) **Literature review** was used for collecting data on the UNDP Shelter Project from various UN publications and websites.

(ii) **Individual meetings with United Nations Volunteers (UNVs) team**, who had been involved in the UNDP Shelter Project, were arranged to seek information about their experiences, present condition of the communities involved, TDUs constructed and the 'building movement' engineered by their team.

(iii) **Group meetings with UNV team members** available in Bhubaneswar focused on understanding lessons learnt, challenges faced and changes required for future interventions.

(iv) **Individual meetings with UNDP (Odisha) representatives** were conducted, which provided critical insights for the study team's field visits to Phailin affected regions.

B. During the field visits

(i) **Field visits** to four districts were conducted over two months, starting November 2013. Balasore, Kendrapada, Jagatsinghpur and Puri districts, which had been affected by the 1999 Super Cyclone and Cyclone Phailin, were covered. Conditions of 20 TDUs across the four districts, constructed under the supervision of UNVs, were documented (see Table 2). Ganjam district, the worst affected in 2013, was visited to study the shelter needs of its communities.

(ii) **Buildings indirectly influenced by the UNDP initiative** were also visited, such as particular IAY houses, other non-IAY houses, masons' residences and training venues.

(iii) **Community meetings** with people living around the TDUs were organized. Members of *nirmiti* or *nirmaan samitis* were also consulted in cases where they had managed construction of the TDU. Additionally, partner NGOs that had assisted in TDU construction were consulted regarding their potential involvement in post-Phailin recovery programmes and for their insights on using appropriate technologies in recovery and reconstruction programmes in Phailin affected districts.

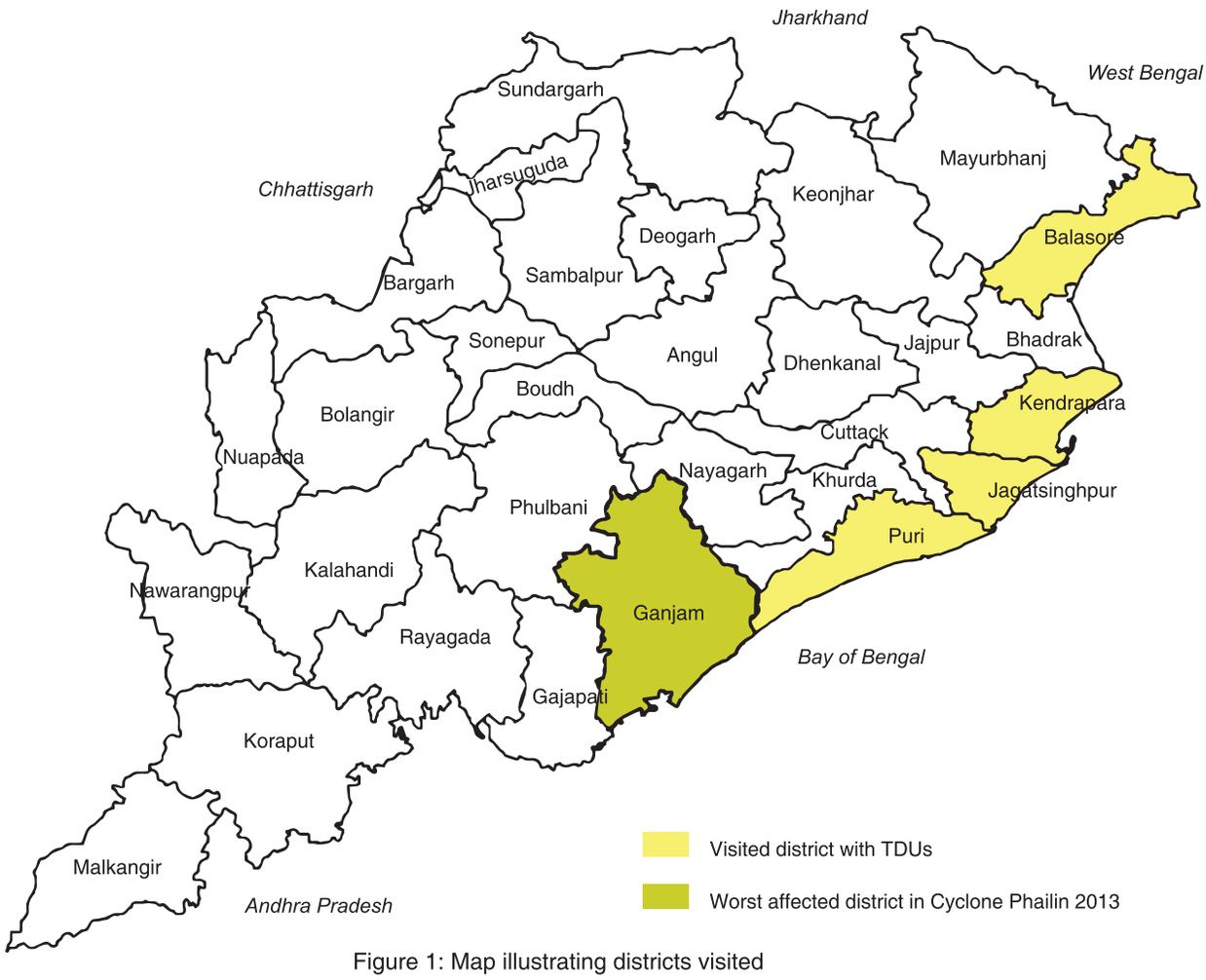


Figure 1: Map illustrating districts visited

C. After the field visits

(i) **The findings were shared** and discussed with the Regional Divisional Commissioner and officials at the Odisha State Disaster Management Authority (OSDMA).

(ii) **Ways to mainstream and incorporate appropriate technologies** in the reconstruction phase in Phailin affected areas were examined.

(iii) **Final report was prepared** based on the TDU documentation, analysis of findings and discussions held at the sharing meetings.

Table 2: List of TDUs visited during the study

S.No	District	Block	Gram Panchayat	Village/ hamlet	Supported by
1	Balasore	Sadar	Nagaram	Fulwar Kasba	CareToday
2		Sadar	Saranga	Sundari	CareToday
3		Bahanaga	Kalyani	Arala	SDC
4		Bahanaga	Gopalpur	Gopalpur	SDC
5		Bahanaga	Kuruda	Kuruda	SDC
6		Bahanaga	Kochia Koili	Kochia Koili	SDC
7	Kendrapara	Kendrapara	Jamadhar	Kasoti	CareToday
8		Kendrapara	Khamal	Khamal	CareToday
9		Marsaghai	Dumuga	Kusunpur	SDC
10		Marshaghai	Silipur	Danrmund	CareToday
11		Mahakalpara	Mahakalpara	Gopalpur	SDC
12	Jagatsinghpur	Ersama	Bhitar Andhari	Baulopara	SDC
13		Ersama	Japa	Bhuansahi	CareToday
14		Ersama	Khrusna-chandrapur	Arada	CareToday
15		Balikuda	Borikina	Olasa	CareToday
16		Balikuda	Baragaon	Badarodang	SDC
17	Puri	Astarang	Patalada	Khatiari	SDC
18		Astarang	Korona	Kantaimundali	SDC
19		Gop	Dhumala	Gadanipania	CareToday
20		Gop	Jungalbari	Bisulipara	SDC

1.4 OUTLINE OF THE REPORT

The main components of this report are:

Chapter 1 describes the context and objectives of this report, and explains the assessment methodology followed;

Chapter 2 explains the background of the UNDP Shelter Project, including the rationale of the project, the constitution of the project team and the project implementation strategy;

Chapter 3 provides an overview of the visited TDUs and evaluates the effectiveness and challenges faced in the utility and maintenance of the TDUs as community buildings and emergency shelters. This chapter also documents and assesses the contextual suitability of the construction technologies promoted under this project with respect to its social, economic and environmental impacts, including the extent to which TDUs played a role in regional technology transfer; and

Chapter 4 summarizes the lessons learnt from the UNDP Shelter Project. It further discusses the post-Phailin conditions in Ganjam district, followed by recommendations for future reconstruction and rehabilitation programmes based on the assessment of suitability and performance of appropriate technologies.

2. THE UNDP SHELTER PROJECT

2.1 BACKGROUND

The 29 October 1999 Super Cyclone was Odisha's most intense tropical cyclone after the 1885 False Point cyclone. With wind speeds exceeding 250km/h and a 8m high storm surge that travelled over 20 km inland, the Super Cyclone claimed 10,000 human lives and destroyed over 275,000 houses, leading to a major housing crisis in coastal Odisha. The villages which the cyclone tore through comprised entirely of *kutcha* houses.

To rehabilitate the homeless families, the government through its national flagship housing programme, IAY, provided grants to build 600,000 houses. Each Below Poverty Line (BPL) homeless beneficiary was awarded Rs. 22,000 for house reconstruction (see Annexure A for IAY Ready Reckoner). However, two years after the Super Cyclone, most IAY houses remained incomplete and cyclone affected populations continued to live in make shift shelters.

An inquiry about such large-scale incompletion of IAY houses in 2001 by the Panchayati Raj Department revealed[3]:

- Affected villages had very few master masons, or *raj mistries,* due to limited pre-disaster IAY house construction in these areas;
- With other livelihood options absent post-disaster, many began to work as (unskilled) masons. Without the required know-how, these masons could not complete even one *pucca*[4] room within the grant amount;

3. The findings of this inquiry are in Section 5: Rural Housing Scheme (page xii) of the report, available at: http://www.cag.gov.in/html/cag_reports/orissa/rep_2002/civil_over.pdf Panchayati Raj is the nodal department for rural housing.
4. *Pucca* houses are those made with permanent materials that have longer durability and do not need frequent replacement such as burnt bricks, compressed stabilized earth blocks, stones packed with lime, concrete, etc.

- As a way to strengthen the house, beneficiaries spent a large percentage of the grant amount on foundations to withstand future devastating cyclones;
- Without access to guidance, some beneficiaries started constructing more than one room and could not progress much beyond the foundation;
- Post-cyclone, costs of conventional building materials and their transportation had increased; and
- There was no guidance for optimizing locally available building materials.

In response to these findings, UNDP, supported by SDC and later Care Today, launched The Shelter Project: Promotion of Appropriate Construction Technologies for Disaster Mitigation and Sustainable Livelihoods in Odisha to facilitate IAY house construction within the grant amount. The UNDP Shelter Project, aimed at addressing the gaps revealed in the inquiry report, engaged trained professionals to map available resources and to identify technologies for optimizing the use of locally available materials. The main objective was to determine appropriate technologies suitable for disaster-affected districts in Odisha and demonstrate them through construction of TDUs.

On completion, the TDUs went on to be used as community buildings for various purposes such as Anganwadi Centres (AWCs), meeting places for SHGs and as recreation centres. Particular TDUs also serve as shelters during emergencies such as cyclones and floods. The actual construction of TDUs was carried out in three phases (Table 3).

Table 3: UNDP Shelter Project phases

Project Phase	Year	Funding Agency	Number of TDUs	Budget per TDU (INR)	Area (sq. ft)	Districts
Phase I	2001-2002	SDC	40	1,20,000	550	Balasore, Kendrapara, Jagatsinghpur, Puri
Phase II	2002-2003	Care Today	8	2,25,000	750	Jagatsinghpur
Phase III	2004-2005	Care Today	15	2,25,000	750	Balasore, Kendrapara, Jagatsinghpur, Puri

The project also assisted the cyclone affected rural poor to complete their core houses within the IAY funding by providing technical assistance with the help of UNVs[5]. For basic services, such as water supply, electricity and drainage, the beneficiaries received additional financial support from other government schemes such as the Rural Water Supply and Sanitation Scheme and the Rural Electrification Scheme.

2.2 THE PROJECT TEAM

Aligned with the aim of the project, a multi-sectoral team, comprising engineers, architects, planners and social workers, was selected and trained by UNDP to deliver IAY pertinent technical assistance to the affected villages. The team members were posted as UNVs in remote villages that were still in the recovery phase and had minimal amenities.

Concurrently, three NGOs, namely, Evangelical Fellowship of India Commission on Relief (EFICOR), Bharat Gyan Vigyan Samiti (BGVS) and Professional Assistance for Voluntary Action (PRAVA), active in the four project districts (Balasore, Jagatsinghpur, Kendrapara and Puri), were selected to assist in constructing TDUs in five blocks under the guidance of the UNVs. In the three remaining blocks, village committees called *nirmiti samitis* were formed to implement construction.

5. As per the IAY guidelines (2013), a 'core house' is defined as a house that can provide the basic requirements of functional space for a family within a limited area, which is complete in all aspects including a toilet, and has scope for incremental growth, expansion and development as the family grows or improves its economic status. Design and adequacy of a core house would vary from culture to culture. The UNDP Shelter Project provided only technical assistance through the UNVs. No additional financial assistance was made available to the beneficiaries to complete their houses.

2.3 PROJECT IMPLEMENTATION STRATEGY

Following the principle of 'seeing is believing', the construction of TDUs was considered as the most viable implementation strategy that could facilitate the entry of appropriate technologies in the cyclone affected villages. The construction of TDUs was undertaken primarily to:

- Create a team of local masons proficient in appropriate construction technologies, who could thereafter build IAY houses effectively. With no contractor involved, local masons would receive hands-on training during TDU construction; and
- Help communities appreciate the merits of appropriate technologies while simultaneously building their confidence in these technologies by demonstrating the construction process.

2.3.1 SELECTION OF VILLAGES AND SITES

Based on the extent of damage due to the Super Cyclone and the communities' physical, social and economic vulnerabilities, the district administrations selected villages in the four districts (Annexure B) .

Within each village, site selection was determined by factors such as availability of firm and elevated land, accessibility and visibility. However, in many cases, low-lying areas around the village were the only available land. UNVs assigned in each block held community meetings in order to appraise the project, construction of the TDU and its potential use as an AWC and a disaster shelter. In many cases, sites containing AWC *kutcha* structures were selected to demonstrate the chosen technologies.

2.3.2 RESOURCE MAPPING AND APPROPRIATE TECHNOLOGY SELECTION

For the Shelter Project to be locally appropriate, indigenous material, skills and technologies available in each district had to be mapped. Technologies which were found to be cost effective, labour intensive, exerting least environmental externalities and could facilitate delivery of district-specific sustainable disaster resilient housing were selected[6].

Table 4: Select building materials and technologies across districts

Building Element	Building Materials	Building Technology
Foundation	Reinforced Cement Concrete (RCC) or Bricks	Pile or well foundation or stepped footings in brick and cement mortar with 25mm Damp Proof Course (DPC)
Walls	Bricks	Rat-trap bond with reinforcement and 1:6 cement mortar
Roof	Mangalore tiles and concrete	Filler slab with Mangalore tiles as filler material
Lintels and openings	Bricks	(Reinforced) Brick lintels and arches
Doors and Windows	Wood or Ferro Cement	Wooden doors, wooden window shutters or Ferro cement doors and windows without window casings
Parapet	Bricks	Brick *jali* work

6.The UNV team undertook a study to understand the geo-climatic condition, economic and social scenario of each district. Local materials, technology and skills most appropriate to the contextual realities were selected for TDU construction in each village.

A. FOUNDATION

In most districts, stepped footings in brick and cement were used. In Balasore district, however, poor soil quality required foundations to be either under-reamed pile or well foundations. Well foundation, most suitable for black-cotton, marine silt and sandy soils, is more cost effective than pile foundations as they require less concrete and also provide a rigid structural frame. Well foundations comprise of:

(i) RCC well-rings, placed one over the other and filled with sand inside and around it;

(ii) A concrete cap covering the sand filling; and

(iii) A continuous I-section grade beam cast over the cap that ties all isolated well footings into a monolithic foundation.

B. WALLS

Copious availability of bricks across all districts determined their use for building walls, lintels and openings. Rat-trap bond was used for walls, where bricks are placed on edge with 1:6 cement mortar (see Figure 2).Rat-trap brickwork consumes19 percent less bricks, 54 percent less cement mortar and has 25 percent less dead weight. Airgaps created within the wall offer good insulation and improve the building's thermal comfort, e.g., the indoor temperature in summer remains at least 5°C lower than outdoors and vice-versa on cooler days.

This is particularly useful for coastal Odisha's climate where summer temperatures can soar to 40°C. Additionally, the bond pattern is aesthetically pleasing and does not require exterior plastering, thus saving on cement and water. The use of recycled Coal Fly Ash (CFA) bricks was also encouraged due to its superiority to conventional bricks owing to 30 percent less fuel usage for firing, compressive strength, durability, lighter weight, fire resistance, low water absorption, and response to efflorescence and salinity.

The TDUs built initially in Phase-I were laterally reinforced by header courses at plinth, sill, lintel and below roof slabs. However, following the 2001 Gujarat earthquake and increased awareness of earthquake hazard in the project districts, UNVs adapted the standard rat-trap brickwork into 'reinforced masonry construction'. The walls incorporated inbuilt vertical reinforcement bars running along the wall with RCC clips at all corners and wall junctions connecting foundations, walls and roofs as a monolithic unit. These additional features improved a building's earthquake resistance and yet was more cost-effective compared to conventional brickwork. This has been a major technological innovation in the Shelter Project.

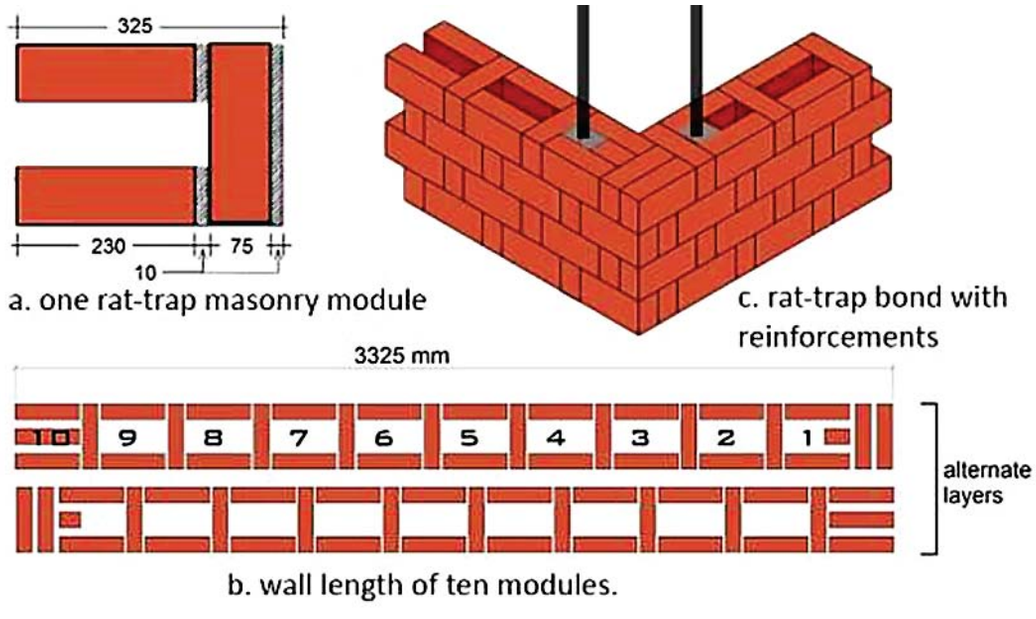


Figure 2: Rat-trap bond brick work

C. ROOF

Since all IAY beneficiaries desired concrete roofs, filler slab was considered most appropriate within the available options. Raniganj or Mangalore tiles, or lightweight bricks, plentiful in most districts, were used as filler material. Old tiles available from collapsed buildings were also re-used.

In a simple roof slab, the part above the neutral axis is subjected to compression, normally withstood by concrete, and the lower part to tension, borne by the reinforcement bars. Thus, concrete in the lower part is redundant except for its bonding with reinforcement bars and can be replaced with other lighter and cheaper filler materials, e.g., Raniganj or Mangalore tiles, which reduce the slab's self-weight and costs by 25 per cent. Additionally, the air gaps between the tiles enhance the insulation properties of the roof (see Figure 3).

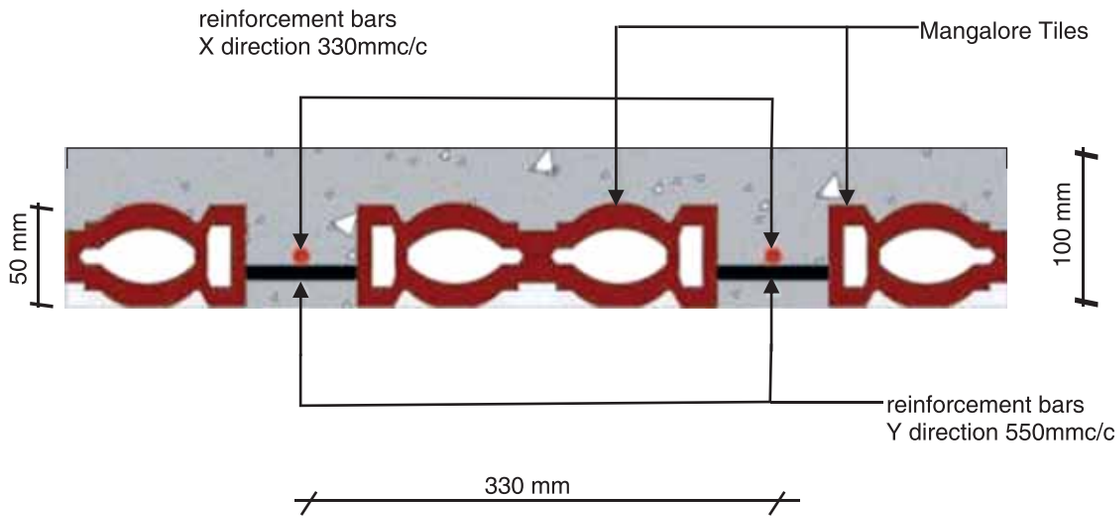


Figure 3 : Filler slab roof with Mangalore / Raniganj tiles as fillers

2.3.3 TRAINING OF TRAINERS

With technologies and materials determined, the UNV team and representatives from the partner NGOs were trained to use appropriate technologies, emphasizing rat-trap brickwork and filler slab. Experts such as G. Shankar, Dr. P.K. Das and Prof. B. Mishra headed the trainings, conducted mostly at the Narayangarh Building Centre. Trainings were repeated throughout the project and included hands-on construction of model houses. Additionally, UN experts working with other cyclone affected communities trained the UNVs in community mobilization.

2.3.4 CONSTRUCTION OF TECHNOLOGY DEMONSTRATION UNITS

A. Culturally appropriate designs

As a next step, UNVs calculated site-specific maximum areas that could be constructed within the available funding from SDC of Rs. 125,000. Further, to ensure culturally appropriate designs relating to the communities' way of living, UNVs organized participatory community meetings to agree on the orientation of various rooms in the TDUs, such as verandah, hall, classroom, kitchen and toilet. For instance, many communities considered orienting the kitchen with respect to the village temple of high importance, as the kitchen was going to be used to prepare *bhog* (offering of food to the Gods). It also meant that the toilet was located facing away from the kitchen and the temple (see Figure 4). At the end of this community participation exercise in Phase-I, 40 different community- and site-specific designs were developed for 40 sites and have been documented in UNDP publication (2001) *Prerana*: Sustainable Recovery through Appropriate Technology Transfer.

In Phase I, the 40 TDUs had a plinth area of 550 sq. ft, entrance through verandahs, a multi-purpose hall, a staircase to access the flat terrace, a kitchen and a toilet below the staircase landing accessible from outside. The 23 TDUs constructed in Phase II and Phase III had plinth areas of 750 sq. ft. All 63 TDU designs were finalized by UNV architects, civil engineers and planners.

B. Community contracting through *nirmiti samitis*

In Phase I, 25 of the 40 TDUs were constructed through partner NGOs and the other 15 through *nirmiti/ nirmaan samitis*. *Nirmiti samitis* comprise village representatives with fair representation from Scheduled Castes, Scheduled Tribes and various religions. Women members make up 50 percent or more of these *samitis*, thus encouraging the role of women in decision-making and community participation. *Nirmiti samitis* opened bank accounts, where UNDP transferred funds in installments. The UNVs assisted the *samitis* in maintaining bank records for credits and debits. Further, engaging *nirmiti samitis* in construction management proved effective since the quality of work had to maximized within available resources.

In Phases II and III, UNVs successfully used their experience in forming, training and operationalizing *nirmiti samitis* to manage all TDU construction. However, prior to constructing TDUs, about 25 local masons received hands-on training in appropriate technologies. These masons built the TDUs through community contracting under the supervision and support of UNVs, which proved more effective in developing ownership of the TDUs and in technology transfer.

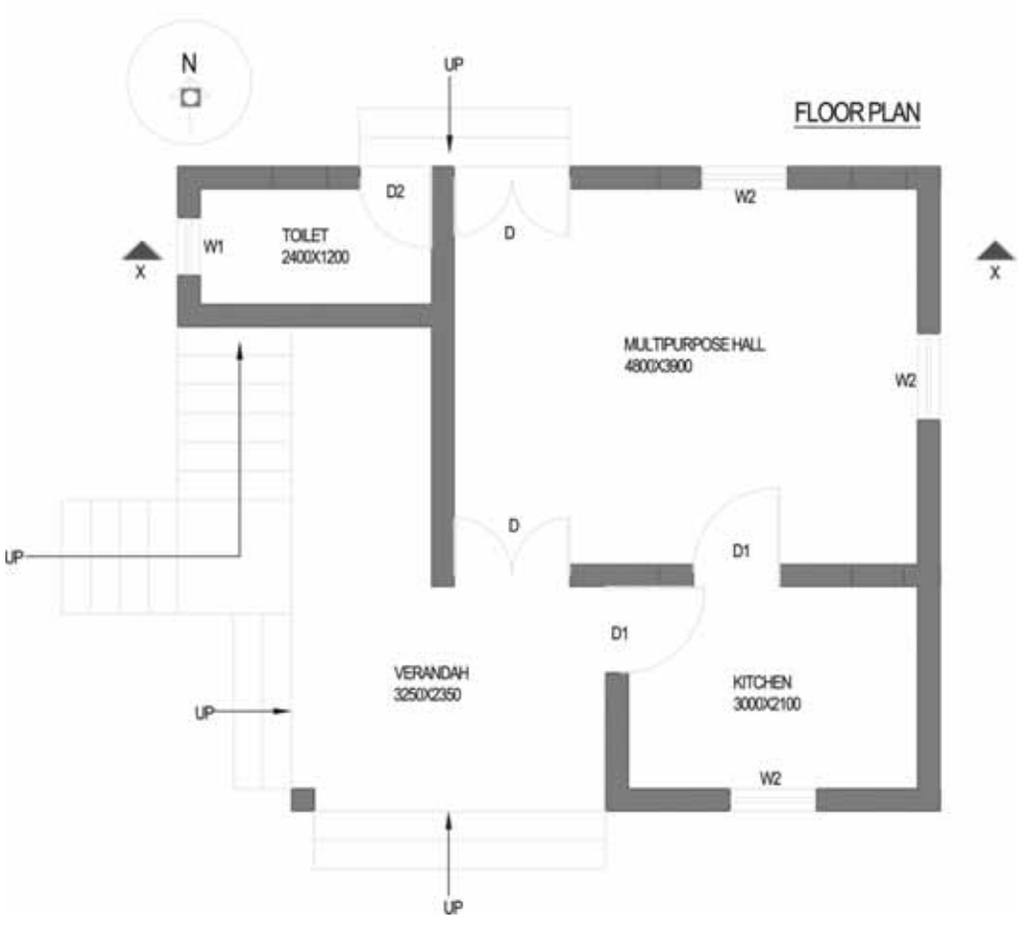


Figure 4: Plan of TDU Pratiksha in Madhupur village, Puri district

2.3.5 TRAINING OF MASONS: APPLICATIONS IN IAY

As a first step, it was considered more effective to train master masons, or *raj mistries,* who could then pass on the knowledge of appropriate technology to other unskilled masons unfamiliar with construction. UNVs organized meetings around proposed TDUs sites to identify the *raj mistries*.

Trainings were organized as community events where the local people could observe the entire construction process. Initial trainings commenced with constructing a modest toilet block within a local school or in an appropriate location suggested by the community. The *raj mistries* constructed the entire structure under the guidance of UNVs.

Since the Shelter Project ultimately aimed at facilitating IAY, a few trainings focused on constructing IAY houses. This required much planning and coordination, including convincing the Block Development Officer (BDO) about the efficacy of the appropriate technologies[7]. The protocol followed to commence the training on construction of an IAY house is described in the following chart (see Figure 5).

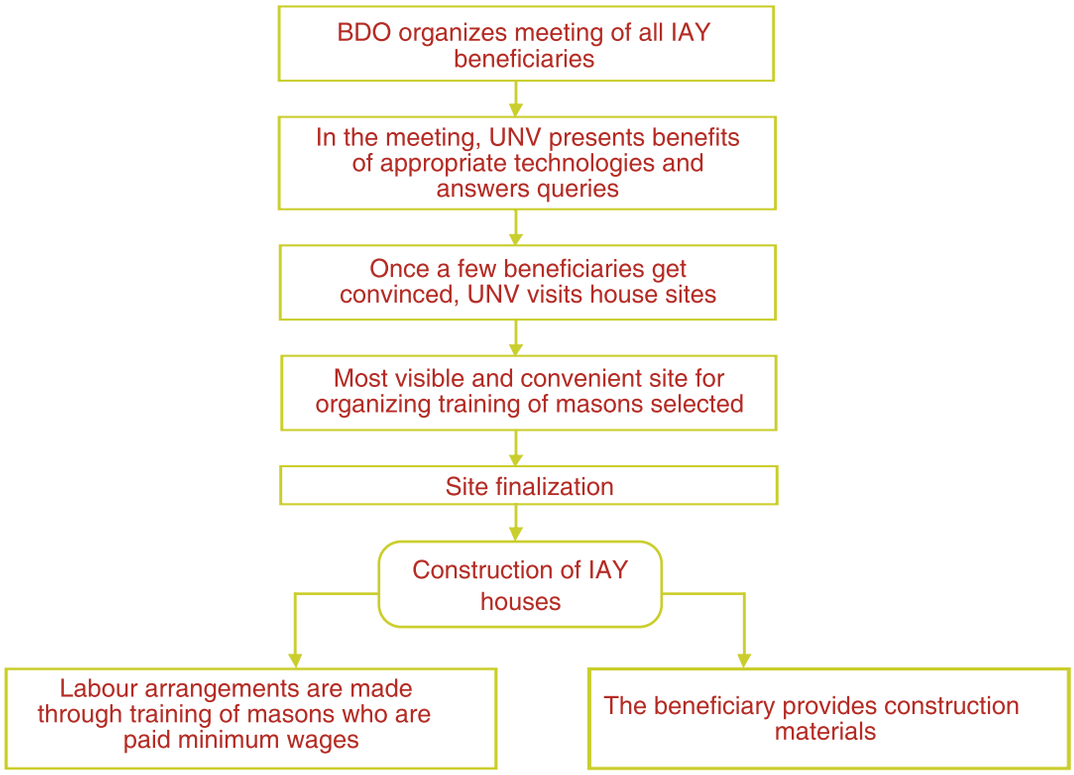


Figure 5: Protocol followed for IAY house construction under masons' training programme

For the Construction of IAY Houses, the following steps were followed:

(i) Before building material procurement, UNVs assisted beneficiaries to calculate house sizes that could be completed within allocated IAY funds.

(ii) Before commencing the training of masons, the house's foundation and plinth were constructed under UNV's supervision.

(iii) Masons were nominated by the community and were briefed about the training background, the technologies being used and their benefits.

(iv) The masons underwent hands-on training that addressed all aspects of IAY house construction including all jointing, reinforcement and tiling details.

7. A Block Development Officer (BDO) monitors the implementation of all planning and development programmes in their assigned blocks.

(v) To enhance masons' understanding and to further sensitize communities, technical videos on buildings constructed with these technologies were shown.

(vi) The UNVs also clarified queries that any community member had regarding these appropriate technologies.

(vii) Trainings ended with casting the filler slab roof. In many cases, house owners also assisted in training and construction while maintaining records of construction related expenditure. During these five-day trainings, the female head of the household or local women's SHG were contracted to provide lunch and tea for the participants. This encouraged local entrepreneurship, albeit in a modest way. Additionally, women's involvement was important since many IAY houses had been granted to female-headed households or jointly to husband and wife.

BENEFITS OF TRAININGS THROUGH IAY HOUSE CONSTRUCTION:

- Community members observed IAY house construction and appreciated benefits of technologies;
- The IAY beneficiaries benefitted from constant technical UNV support;
- The IAY beneficiaries saved on labour costs during construction; and
- Local entrepreneurship was encouraged through contracting women SHGs and female heads of households to provide food during trainings.

2.3.6 OTHER METHODS FOR PROMOTING APPROPRIATE TECHNOLOGIES

Beyond hands-on trainings, the UNVs and partner NGOs used several innovative methods to promote appropriate technologies within villages.

(i) Community meetings and discussions;

(ii) Use of Information Education Communication (IEC) materials such as street plays, songs and poetry on appropriate technologies;

(iii) Organizing visits of masons and IAY beneficiaries to large two-storied houses constructed with such appropriate technologies in Bhubaneswar, the state capital, to dispel the idea that appropriate technologies are just meant for the poor villager; and

(iv) Organizing mobile video shows on benefits of appropriate construction technologies, from one village to another, using a hired cycle trolley, a TV and a video cassette player.

Sensitization on appropriate technologies was greatly assisted by other UNVs working in disaster preparedness programmes with these communities. Community meetings, video shows and street plays were scheduled during late evenings to ensure participation of community members engaged in daytime livelihood activities.

2.4 THE 'BUILDING MOVEMENT'

Sensitized as a result of the UNDP Shelter Project training, *raj mistries* began to support and promote appropriate technologies within the villages, which influenced many other IAY beneficiaries. Shortly after the end of the training of masons, many other IAY houses using these technologies mushroomed in the project districts. This was possibly the first example of owner-driven reconstruction following a natural disaster. Starting with two houses in March 2001 to over 4,700 by June 2007, the UNDP Shelter Project has successfully influenced construction of many buildings beyond IAY houses such as government buildings, schools, multistoried residences, shopping complexes and block offices.

Among all these activities, training of masons was found to be the most critical task, especially since local masons are all-in-one architects, engineers and builders and are among the most important players in the rural housing delivery system. The UNDP Shelter Project also aimed at building capacities of informally trained or untrained construction workers so that they could become 'catalysts of change' for technology transfer and support the promotion of appropriate technologies.

3. ASSESSEMENT OF TECHNOLOGY DEMONSTRATION UNITS

3.1 OVERVIEW OF THE TDUs VISITED

The assessment team visited and documented the condition of 20 TDUs (of the 63 constructed under the project) across 20 villages in Balasore, Kendrapara, Jagatsingpur and Puri districts. Table 5 provides a summarized overview of the TDUs visited. Detailed assessments of the 12 TDUs visited are provided in Annexure C.

Table 5: Overview of the TDUs visited

District	Block	Gram panchayat	Village/ hamlet	Documented condition in November 2013
Balasore	Sadar	Nagaram	Fulwar Kasba	- Subjected to recurrent floods - Used as a meeting place for local women's SHGs and health check-up camps - No maintenance of the building - Structurally intact - Used as shelter during 2006 and 2013 floods
	Sadar	Saranga	Sundari	- Due to its location inside primary school premises, the TDU is used as a kindergarten - It is well maintained - It is structurally intact
	Bahanaga	Kalyani	Arala	- Requires major repair work - Soil conditions have affected the foundation resulting in cracks in the floors and staircases - AWC has discontinued functioning in these buildings - The TDU in Arala village was used as shelter by families during floods in 2006 and 2010
		Gopalpur	Gopalpur	
		Kuruda	Kuruda	
		Kochia Koili	Kochia Koili	
Kendrapara	Kendrapara	Jamadhar	Kasoti	- Located within temple premises - Used daily by AWC and women SHGs - Maintained and cleaned well by *nirmaan samiti* - Used as relief distribution centre during emergencies - It is structurally intact, however with visible dampness of walls
	Kendrapara	Khamal	Khamal	- Used by village youth for after-school classes and recreational purpose - Has grown incrementally with an additional first floor constructed by the community - It is well maintained
	Marsaghai	Dumuga	Kusunpur	- It is located within school premises and used regularly for AWC classes - It is well maintained - Trained masons used appropriate technology to build other surrounding houses in the village - Used as shelter during emergencies
	Marsaghai	Silipur	Danrmund	- Located within temple premises - Used as AWC, for village meetings, recreation and after-school classes - Used as shelter during 2006 and 2008 floods - Has been designated as relief distribution centre by the panchayat - No maintenance done by the community
	Mahakalpara	Mahakalpara	Gopalpur	- Used as an Anganwadi Centre - Found to be in good condition

Table 5: Overview of the TDUs visited

District	Block	Gram panchayat	Village/ hamlet	Documented condition in November 2013
Jagatsinghpur	Ersama	Bhitar Andhari	Baulopara	- Used as shelter during flood warnings - No maintenance - Requires maintenance and repairs work of walls
	Ersama	Japa	Bhuansahi	- Located within temple premises - Used as relief distribution centre during emergencies - Well maintained by the community
	Ersama	Khrusna-chandrapur	Arada	- Used for meetings, storage space and health check-up camps - Well maintained by the community - Designated as relief distribution centre during emergencies
	Balikuda	Borikina	Olasa	- Used for community meetings - Recognized as a model for the houses of villagers
	Balikuda	Baragaon	Badarodang	- Used for community meetings, AWC, meetings of women SHGs and health check-up camps - Used as relief distribution centre - No maintenance
Puri	Astarang	Patalada	Sunderkhatiari	- Used as AWC - Used as shelter during floods - No maintenance by the community - Requires repair work, particularly of walls and parapets
	Astarang	Korona	Kantaimunduli	- Used as AWC, for extra classes and for health check-up camps - Used as shelter during flood warnings - Well maintained by the community
	Gop	Dhumala	Gadanipania	- Located within school premises - Used as AWC and community meeting centre - Used as relief distribution centre during emergencies and as shelter during Cyclone Phailin - Well maintained by the community
	Gop	Jungalbari	Bisulipara	- Used regularly for community meetings - Well maintained by the community

3.2 EFFECTIVENESS AND CHALLENGES IN UTILITY AND MAINTENANCE

Most TDUs, designed as AWCs, are still being used for the same. Some TDUs, located within local primary schools, are being used for kindergarten classes. All TDUs had staircases for roof access, in particular to provide access to a safe place during floods. Although these buildings had been handed over to the local communities after being completed, along with directions for proper use and maintenance, there has been no formal handing over of these buildings to the government.

As a result, no government funds are committed or spent for the maintenance of TDUs. Despite such zero maintenance, most TDUs appeared tidy since they are used on a daily basis and kept clean by the local community (see Box 1 and Box 2).

Box 1: TDU at Kusunpur village, Marsaghai block, Kendrapara district

Condition of TDU in 2013

The TDU at Kusunpur is part of the school premises where AWC classes are regularly held. It has been maintained well. The masons from this village, trained under the UNDP Shelter Project, also explained the technologies and showed a number of houses they had built themselves using these technologies.

Box 2: TDU at Kantaimundali village, Astarang block, Puri district

Condition of TDU in 2013

The TDU at Kantaimundali, with an area of 528 sq. ft, has been maintained well and is used as an AWC. Its foundation comprises of stepped footing in brick and cement mortar with 25mm thick DPC; the walls are made of 250mm thick brickwork in rat-trap bond in 1:6 mortar; the roof is made of 100mm thick filler slab in 1:6 cement mortar using Mangalore tiles as filler material.

3.3 EFFECTIVENESS OF TECHNOLOGY TRANSFER: IAY AND BEYOND

IAY beneficiaries were initially reluctant to adopt appropriate building technologies. Some trained masons built their own houses using these construction methods to demonstrate their confidence and to persuade community members of its merits. In particular, rich and affluent families in these villages built large houses using these methods, encouraging IAY beneficiaries to adopt them in constructing their own dwellings (see Box 3).

Box 3: Effectiveness of technology transfer

Non-IAY building at Gop Block, Puri

Non-IAY building at Kujang, Jagatsinghpur

Non-IAY building with filler slab, Kujang, Jagatsinghpur

Non-IAY building at Ersama, Jagatsinghpur

A number of houses, government buildings, schools and religious buildings have been built with appropriate technologies that have withstood the cyclone and flood impacts.

3.4 CONTEXTUAL SUITABILITY AND EFFECT OF PROMOTED TECHNOLOGIES

3.4.1 SOCIAL BENEFITS

The UNDP Shelter Project was perhaps the first example of owner-driven reconstruction in India. The involved communities have benefitted under the project through:

- Gaining better access to information on rural housing schemes and appropriate technologies;
- Receiving continuous technical assistance from UNV architects, civil engineers and planners in IAY house design, optimizing space utilization and detailing, e.g., for niches, alcoves and windows;
- Gaining experience in managing funds, through individual savings, loans or IAY funding and understanding the need for resource optimization;

- Being encouraged to undertake community-based construction management that leads to the evolution of *nirmaan samiti*s as community contractors;
- Receiving enabling conditions for IAY house completion;
- Receiving assistance in reducing communities' vulnerabilities by inclusion of multi-hazard resistant features in IAY houses;
- Women being encouraged to participate in the construction sector through:
- Representation in most *nirmaan samitis*;
- Enhancement of their understanding of habitat and construction issues;
- Provision of a platform for voicing their opinion in village meetings and in decision-making;
- Trainings in appropriate construction methods; and
- Involvement of SHGs in entrepreneurial activities, such as production and supply of building materials.
- Receiving assistance in creating a pool of local masons with expertise in appropriate technology, disaster resilient construction features and all construction aspects, who are now available for future construction projects in the villages (see Box 5 and Box 6).The participant masons also received certificates and identity cards which, apart from boosting their self-esteem, assured prospective clients about their skills.

Box 4: A story from the field: Astarang block, Puri district

Sushama Kandi, a physically challenged Dalit woman, dreamt of having a roof over her head. The technical assistance provided by UNVs and trained masons helped her construct her house in Sundar Khatiari village in Astarang block in 2002. She continues to live there happily with her three children. She has been plastering her house incrementally and plans to construct another room, also using appropriate technologies.

Box 5: Champion of appropriate technologies

Karunakar Swain, a mason trained in 2002, is a resident of Gadanipania village, Gop block, Puri district. He has received numerous trainings from UNVs and other UNDP experts on appropriate technologies as well as disaster resistant technologies.

Today, Karunakar is a champion of appropriate technologies in Puri district and is very well known in Kakatpur, Gop, Astarang and Nimapara blocks. All his buildings, including houses, schools, government buildings, temples and *ashrams* have been constructed using appropriate technologies. Karunakar and his team have many ongoing construction projects and new clients usually have to wait at least two months before his team can initiate work. Karunakar has augmented his income by procuring tiles from villages across Puri and Jagatsinghpur districts and selling them for filler slab roof casting, thereby catering to a demand that his team has created. Karunakar is perhaps one of the true champions that the project has left behind and is testimony to the sustainability of the impact of the project.

Box 6: From mason to barefoot engineer

Sudam Charan Sethi, from Balikuda block in Jagatsinghpur district, was just 20 years old when he met UNVs who had come to his village to meet IAY beneficiaries in 2001. Being a self-trained mason and sculptor, he became interested and eventually worked as a mason to construct IAY houses. He received formal training in 2001 that completely changed his life. After consistently being involved in construction of TDUs and houses, Sudam has evolved as a 'barefoot engineer'. He has worked with various organizations, national and international NGOs, in Tamil Nadu (post-Tsunami), Bihar, Assam, West Bengal and Uttarakhand. Sudam's example highlights UNDP Shelter Project's success in bridging the knowledge gap between untrained masons and professional architects and engineers.

3.4.2 ECONOMIC BENEFITS

The use of appropriate technologies in IAY houses helped reduce overall costs by 20 to 25 percent.

The two major building elements where costs were significantly reduced are walls and roof, through rat-trap bond and filler slab respectively. These technologies, encouraging the use of local building materials, were designed for cost optimization without compromising on the quality, durability, structural stability or disaster resilience of the buildings.

A. Rat-trap bonded brick walls

- Used locally available bricks;
- Reduced cost of wall by about 25 percent;
- Provided better insulation and enhanced indoor thermal comfort;
- In Phase-I, TDUs were laterally reinforced by header courses at plinth, sill, lintel and below roof slabs; and
- Post-2001 Gujarat earthquake, TDUs were built with reinforced rat-trap masonry construction.

B. Filler Slab Roof

- Most TDUs had roofs at two different levels: an intermediate small roof at 8 feet height and a main roof at 10 feet height. While mainly done for aesthetics, it also reduced costs by limiting staircase access to the lower roof;
- In some TDUs, joints between lower roof and brick wall above were not water tight and was subject to dampness; and
- In many TDUs, roof waterspouts had not been cleaned leading to water logging that may significantly and rapidly deteriorate the roof condition.

The overall saving in costs allowed marginalized community members to complete their IAY houses and emerge from the vicious cycle of living in vulnerable *kutcha,* makeshift shelters near their half-completed *pucca* houses.

The income of masons has also increased due to their enhanced service delivery of affordable housing with increased thermal comfort.

Although the then IAY guidelines did not require houses to be disaster resistant, the UNDP Shelter Project encouraged beneficiaries to build using disaster resistant features such as anchorages and horizontal bands. These features have helped the IAY houses withstand the fury of recurring floods and cyclones since 2001, thus reducing the vulnerability of communities and recurring post-disaster rebuilding costs (see Box 7).

Box 7: Disaster resilient TDU, Fulwar Kasba, Balasore Sadar block, Balasore district

Following Cyclone Phailin, Balasore district faced one of the worst floods in over 40 years. The TDU at Fulwar Kasba in Sadar block was inundated with over 10 feet of water for three days. Despite its 3'6" high plinth, the water level crossed the lintel level. The women's SHG, using the TDU as their office, remarked that the TDU only required thorough cleaning after the flood waters receded. The community expressed their confidence in these building technologies, which had multiplied several fold post Cyclone Phailin.

3.4.3 ENVIRONMENTAL BENEFITS

The technologies promoted under the UNDP Shelter Project also reduced negative environmental impacts of housing construction by:

- Reducing overall consumption of building materials, such as steel, cement and aggregate in filler slab roofs by over 20 percent;
- Reducing top-soil consumption through less brick consumption in rat-trap bonds;
- Encouraging use of CFA bricks, which also reduces land usage for its disposal and potential leaching of metal into proximate groundwater or surface water;
- Enhancing indoor thermal comfort through additional insulation provided by air gaps in the rat-trap cavity walls and between tiles in the filler slab roof. All IAY house occupants and community members using the TDUs highlighted the higher indoor thermal comfort levels of buildings built with appropriate technologies as compared to a conventional building, e.g., in summer, indoor temperatures remained 5°C lower than outdoor ambient temperature and vice-versa in cooler winters.

4. LESSONS LEARNT AND RECOMMENDATIONS

4.1 LESSONS LEARNT

Siting of Buildings

Several TDU sites, particularly those constructed initially in Phase-I, are amongst the lowest in the village. Since adjacent road heights have increased over the years, the TDUs have become more flood prone. Therefore, although limited by site availability and funding, selecting elevated sites and constructing raised plinths for TDUs, houses and other community buildings is important.

Resettlement strategies must be contextualized in accordance with existing or previous community settlement patterns, needs and cultural aspects.

Importance of Technical Assistance

While implementing the project through newly trained masons and NGOs inexperienced in construction had been challenging for the UNVs, it successfully paved the path for long-term technology transfer of cost-effective and disaster resilient appropriate construction technologies in these vulnerable areas. The constant on-field construction supervision and technical assistance provided by UNVs to local masons have been instrumental in this large-scale technology transfer. It facilitated a greater degree of community mobilization towards these technologies.

Additionally, partner NGOs continue to use these technologies in other projects across the state. In similar projects in the future, however, minute construction details must be designed and implemented with greater care to enhance the buildings' durability, e.g., roof slab grading can be continued in a curved manner on the walls.

Construction Delivery

UNDP had chosen two implementation modes:

a. TDU construction through partner NGOs; and

b. TDU construction through *nirmaan/ nirmiti samitis.*

When compared, the TDUs constructed by *nirmiti samitis* have demonstrated better quality control of materials and construction. Construction management by *nirmiti samitis* has been able to induce much deeper ownership, and better use and regular maintenance of the TDUs as compared to those delivered by partner NGOs.

Using Locally Available Materials

The main technologies promoted under the project have proved to be contextually appropriate and have reasonably endured despite zero maintenance. Additionally, the use of local building materials has boosted the local economy.

Local Skill Development

Local skill development was prioritized and integrated to optimize available financial resources, ensure sustainability and improve livelihood options for affected communities.

Technology Demonstration Units

TDUs have played an important role in helping communities understand the advantages of appropriate construction techniques and means of incorporating disaster resilient features in construction. They have also served as shelters during floods and cyclones in particular districts.

Promoting Disaster Resilient Technology

Overall, the rat-trap brickwork and the filler slab roofs displayed no signs of weakness despite being subjected to cyclones and floods in the last 12 years. Across the assessed villages, communities and masons expressed their confidence in the durability and disaster resilience of technologies used in the TDUs, since most buildings had withstood moderate to high floods and winds over the decade.

Maintenance of Buildings

TDUs located within school premises are among the best-utilized and maintained buildings. The Anganwadi workers and school authorities use and clean it on a daily basis and oversee its maintenance regularly. School maintenance funds are utilized for painting and upkeep. A major impediment in the maintenance of TDUs has been the absence of a 'formal' handing over of these buildings to the government. No government agency has been assigned the responsibility for their repair and maintenance.

4.2 POST-PHAILIN HOUSING CONDITIONS IN GANJAM DISTRICT

To assess the scope of applying these appropriate technologies in future reconstruction projects, the assessment team visited Ganjam district, the worst affected by Cyclone Phailin. Within Ganjam, the condition of housing and other built infrastructure were evaluated in two villages, Markandi and Podumpetta, where majority of the villagers are fishermen (see Figure 6).

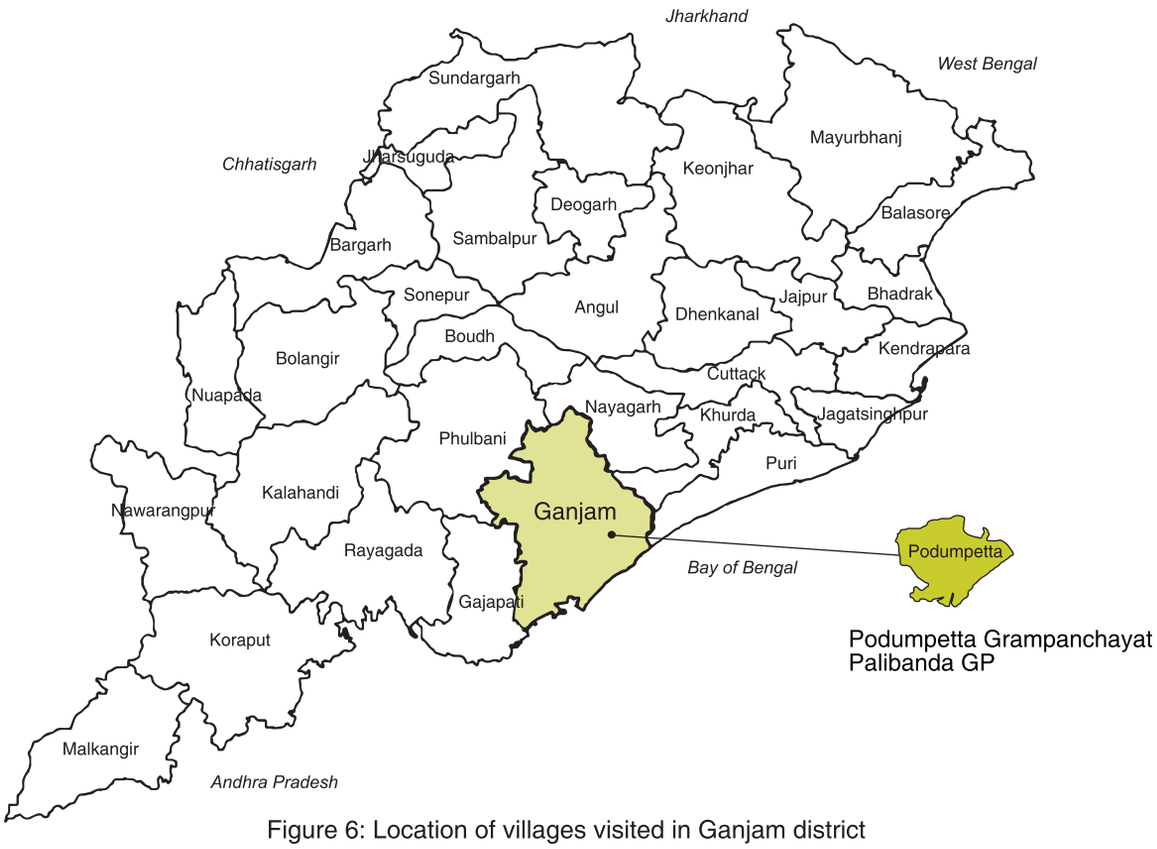


Figure 6: Location of villages visited in Ganjam district

4.2.1 VILLAGE 1: MARKANDI, INDRAKHI GRAMPANCHAYAT, RANGEILUNDA BLOCK, GANJAM DISTRICT

Markandi, located at the mouth of the River Rishikulya close to the Odisha - Andhra Pradesh border, is a fishermen's village with about 1300 households. The settlement, organized in a grid-iron plan, has east-west main *kutcha* roads with perpendicular arterial lanes. The settlement has only one *pucca* house with two floors constructed in brick and concrete. Cyclone Phailin and its storm surge damaged and flooded dwellings located in the low-lying and riverine portions, while dwellings on higher elevations were spared. Many roofs were blown away and some walls collapsed. The *pucca* house and the village temple did not suffer damages (see Figure7).

Figure 7: Village temple undamaged by Cyclone Phailin

The settlement's small plot sizes, about 10 feet x 30 feet, determine the prevalent linear housing typology. The housing typology is sub-divided into three areas: a front verandah leading indoors; a single habitable room, sometimes with a small puja space with some provision for storage; and a kitchen with outdoor access. However, there are no toilets and residents defecate outdoors. Additionally, the dwellings lack adequate daylight and ventilation.

The building materials used are primarily mud, bamboo and thatch. Most dwellings do not have foundations or plinths. The walls are constructed with mud, reinforced with bamboo. The roof structure, supported by vertical bamboo posts, comprises of a simple bamboo truss. Thatch and straw are common roofing materials, which are often secured onto the truss by fishing nets. Post-Phailin, many residents covered damaged roofs with the tarpaulin sheets supplied as relief material.

Figure 8: Damaged dwellings in Markandi village, Ganjam district

4.2.2 VILLAGE 2: NEW PODUMPETTA, PALIBANDHA GP, GANJAM BLOCK, GANJAM DISTRICT

Podumpetta is a seaside fishermen's village affected by coastal erosion. Until early 2013, it comprised of 146 households. However, pre-Phailin, 110 families were relocated to the safer 'New Podumpetta', located besides the Eastern Ghats extensions. It was this relocated settlement the team visited to understand Phailin's impact and the shelter needs of the community. New Podumpetta, also within a grid-iron layout, comprises of 20 feet x 45 feet sized house plots, an AWC and a *kutcha* primary school that is attended by 57 children (see Figure 9).

For housing construction, New Podumpetta community members have been allocated Rs. 45,000 per household under the state scheme, Biju Pucca Ghar Yojana. This scheme assists those not covered by central schemes such as IAY. However, while community members have received the state funding, they consider it insufficient for house completion and aspire to receive support from IAY, where grant money is considerably higher at Rs. 70,000. Thus, the community has not commenced house construction and continues living in makeshift *kutcha* shelters[8].

8. In New Podumpetta, two families have combined their plots and have constructed foundations for their combined six-roomed house, aspiring to complete it with their savings. The house has a high 4 feet plinth, with two rows each having three rooms. Each room measures 13 feet x 11 feet and is adjoined by a 5 feet wide front verandah and a backyard. Foundations have been completed using isolated RCC footings to support a RCC column structure.

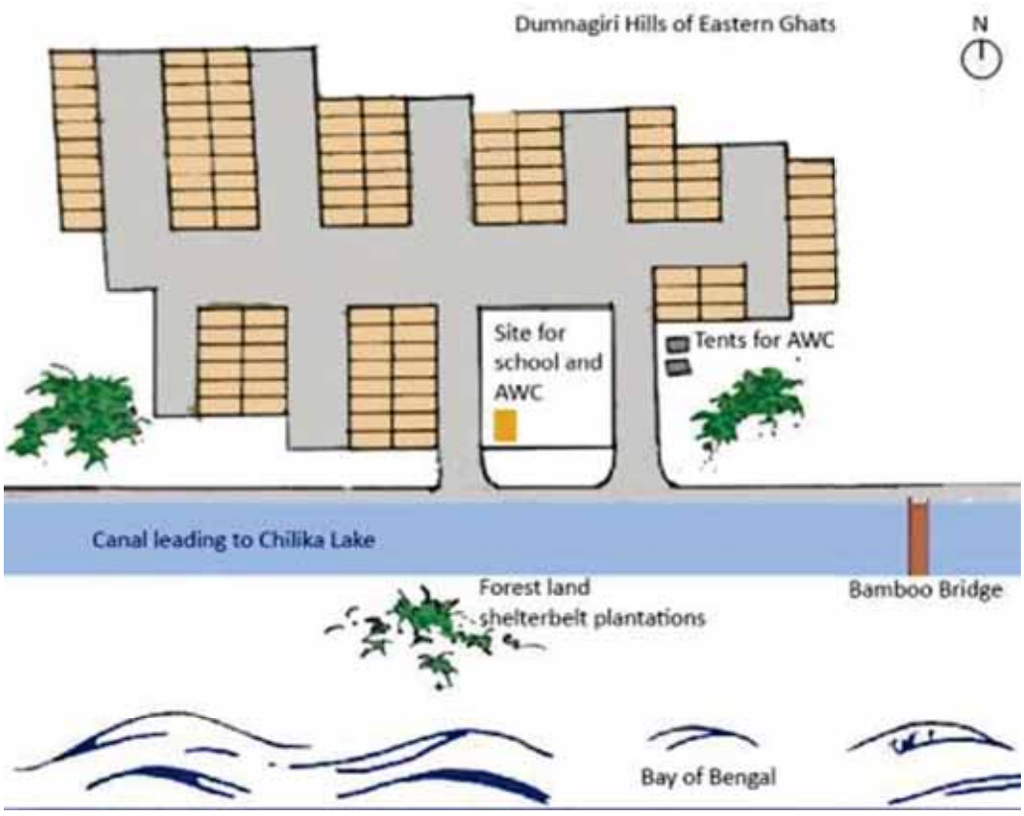


Figure 9: New Podumpetta settlement layout

BIJU PUCCA GHAR YOJANA beneficiaries could benefit from technical support, similar to that provided under the UNDP Shelter Project, to understand and calculate manageable plinth areas, the scope of using existing resources and the necessary extra investment. This example also highlights the problems created by various government and state housing schemes offering varying grant amounts. Indeed, it is reminiscent of problems arising due to different funding and terms for implementation in IAY and the housing schemes of the Odisha Rural Housing and Development Corporation Limited (ORHDC) after the 1999 Super Cyclone.

The New Podumpetta community highlighted particular preferences regarding construction of houses under the Biju Pucca Ghar Yojana, such as front verandahs without setbacks adjoining the road and backyards, and no windows on the sides. While some families preferred to combine adjacent plots to build bigger houses, many desired a smaller house on their allocated plot. All community members highlighted pre-construction technical assistance in selecting and understanding building technologies and family-specific house designs.

Fishing communities have been the most affected by Cyclone Phailin. Thus, the planning strategy for new resettlement colonies must ensure proximity to the original seashore settlements, but away from immediate coastal hazards risks, as done in the reconstruction of fishing colonies in Tamil Nadu after the 2004 tsunami.

4.3 RECOMMENDATIONS

Post-Phailin, many families in coastal settlements are living in makeshift shelters or repaired mud-thatch houses and have become even more vulnerable. While there is an urgent need for shelter rehabilitation, community and household participation must be encouraged to 'build back smarter', incorporating disaster resistance and promoting and upgrading local skills while minimizing its environmental impact.

Based on the assessment of suitability and performance of appropriate technologies in the UNDP Shelter Project, this report recommends the following for post-Phailin reconstruction programmes:

- **Sustainable habitat development through convergence of ongoing national schemes**

  Various central and state government programmes must be converged for overall sustainable habitat development. Schemes for housing such as IAY and Biju Pucca Ghar Yojana, for rural water supply and sanitation, for village roads such as Pradhan Mantri Gram Sadak Yojana (PMGSY) and for rural lighting should be converged to ensure holistic rural habitat development.

- **Sustainable reconstruction with the help and availability of technical assistance at various levels**

- At the state level, reconstruction programmes must be supported by a Technical Support Agency that assists the government, state PWDs and state disaster management authorities in ensuring overall sustainable and disaster resilient development through resource mapping, identification of technologies, capacity building and construction delivery mechanisms.
- At the community level, constant technical support and attention to detail is critical for successful reconstruction projects involving community participation. Technical assistance must be provided to guide communities to optimally utilize available resources and to design culturally and environmentally sensitive, disaster resilient and appropriate settlement plans and shelters.

- **Community ownership through social mobilization**

  In order to ensure complete community ownership of reconstructed housing settlements, shelter programmes should have a social mobilization component. Intense interactions with community members are important before finalizing house designs to ensure their cultural appropriateness and an understanding of structurally safe multi-hazard resistant technical features.

- **Sustainable and improved livelihood options through local skill development**

  Local skill development must be prioritized and integrated into reconstruction schemes to optimize available financial resources, ensure sustainability and improve livelihood options for the disaster affected communities. Beyond appropriate disaster resilient technologies, skills must be developed in finishing details to improve the durability of construction, particularly with respect to roof drainage.

- **Effective construction delivery through community-based construction management**

  Community-based construction management, e.g., through *nirmiti samitis*, must be encouraged. This approach is more likely to ensure better quality control of materials and construction, induce deeper ownership, and better use and regular maintenance of community structures as compared to those delivered by partner NGOs.

- **Sustainable reconstruction by using locally available materials and disaster resilient technology**

  Construction technologies promoted in any post-disaster housing reconstruction, rehabilitation and resettlement scheme must use locally available buildings materials while ensuring cost effectiveness and minimal environmental impact. Technologies adopted must be multi-hazard resilient. All construction must follow updated Indian Standard (IS) codes, regardless of whether the local building bye laws incorporate them or not.

- **Sustaining appropriate construction methods through dissemination of technology manuals**

  To sustain the appropriate construction methods and local skills developed, development and dissemination of manuals on technologies, finishes and maintenance are necessary. Construction methods must move beyond appropriate disaster resilient technologies and consider finishing details to improve the construction's durability, particularly with respect to roof drainage.

- **Communicating benefits of appropriate technologies by constructing TDUs and model houses**

  TDUs are effective means of communicating to communities the benefits of incorporating disaster resilient features in construction. In situations where resolving maintenance and ownership issues of TDUs is difficult, technologies can be demonstrated through model house construction. Sustainable sanitation practices and rainwater harvesting can also be promoted in the construction of model houses.

- **Consistency in housing type delivery by following context-specific shelter reconstruction guidelines**

  The Technical Support Agency should assist state governments to bring out context-specific shelter guidelines (for example, see http://tsunami.icsf.net/images/stories/tn0501.pdf) specifying built-up area requirements, sample designs and scope for incremental growth. Further, donor agencies and NGOs involved in housing reconstruction should follow these guidelines to avoid major inconsistencies in housing types built for various beneficiaries.

- **Sustainable human settlements through culturally sensitive planning**

  Original community settlement patterns must be considered while planning new settlements. Relocated settlements must also consider proximity to communities' livelihood options while ensuring distance from immediate coastal hazards. Communities must enjoy usufructuary land rights[9].

- **Effective coordination mechanism for participatory and community needs-based approach**

  An effective coordination mechanism must be put in place to link all stakeholders and various levels of government concerned with habitat planning and reconstruction. The coordination mechanism must ensure a participatory- and community needs-based approach to reconstruction.

While human losses have been low in the aftermath of Cyclone Phailin, damages and losses to the shelter sector have been very high. Given the large scale of reconstruction required in Odisha, reconstruction programmes must emphasize the use of appropriate building materials and construction technology, e.g., use of local, cost-effective, good quality and environmentally friendly materials that can be recycled or reused; encouraging local production of sustainable building materials that can also ensure the long-term local availability of trained masons; promoting sustainable construction technologies that are climate, culturally and socially appropriate, are affordable, use local materials or encourage local production of sustainable materials; and adoption of disaster resilient technology that must follow updated IS codes. These can be ensured by provision of technical assistance to the affected communities at every stage of design and construction.

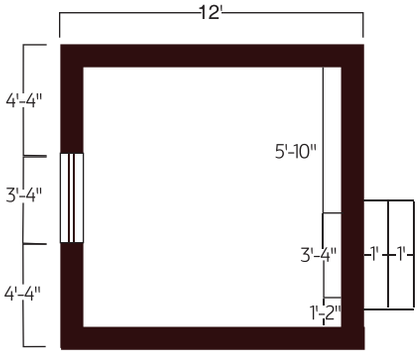
9. Usufructuary rights of land signify the right of temporary possession and enjoyment of land that that does not belong to them, so far as that can be done without causing damage or changing its substance.

ANNEXURES

ANNEXURE A:

Ready reckoner for an IAY core house using alternative technologies

Indira Awas Yojana (IAY) was launched as a sub-scheme in 1985 and has been made into an independent scheme with effect from 1 January 1996. The objective of IAY is to provide grants for house construction to the rural poor falling below the poverty line. In order to ensure house-owner satisfaction, the IAY requires the house to be constructed by the beneficiaries instead of being constructed and delivered by any external agency or contractor.



Following the 1999 Super Cyclone in Odisha, a grant of Rs. 22,000/- was allotted to a female member of cyclone-affected households or jointly to husband and wife. Beneficiaries had complete freedom to choose the manner of construction in order to ensure cost-effectiveness, control over construction quality and house-owner satisfaction.

IAY guidelines also emphasize efforts to maximize, to the extent possible, the use of local materials and cost-effective technologies. The construction technologies used in Odisha for construction of IAY houses under the UNDP Shelter Project, i.e., rat-trap bonded brickwork for walls and filler slab concrete for roof, have been selected based on the materials available in all coastal districts of Odisha.

COST ESTIMATE OF IAY CORE HOUSE IN ALTERNATIVE TECHNOLOGIES

Sl. No	Description	No	Measurements in ft			Quantity**		Unit	Rates*	Amount (Rs.)
			l	b	d	cft/sft	m^3/m^2/ kg			
1	Earthwork in Excavation-trenches***	4	11.16	2.50	2.50	279.00	7.90	m^3	30.96	244.56
2	Sand filling in foundation	4	11.16	2.50	0.67	74.77	2.12	m^3	107.42	227.41
3	Providing 100 mm thick brick khoa well watered and rammed in foudation	4	11.16	2.50		111.60	10.37	m^2	55.80	578.74
4	Providing good quality C.B brickwork in 1:8 cement mortar in foundation and plinth	4	11.16	2.08	0.50	46.49				
		4	11.16	1.67	0.50	37.27				
		4	11.16	1.25	2.00	111.60				
					Total	195.37	5.53	m^3	922.83	5104.49
5	DPC 1:1.5:3 at plinth [38mm thick]	4	11.16	1.25	0.083	4.63	0.13	m^3	2199.30	288.39
6	Brickwork (1:6) in rat-trap bond	4	11.16	0.83	9.670	358.29				
	deduct for door	1	3.33	0.83	6.500	17.97				
	deduct for window	1	3.33	0.83	4.000	11.06				
					Total	329.26	9.32	m^3	733.20	6835.12
7	CC 1:2:4 in RCC lintel and Chajja									
	Lintel over door and window	2	5.00	0.83	0.41	3.43				
	Chajja over door and window	2	5.00	1.50	0.23	3.44				
					Total	6.86	0.19	m^3	2053.28	398.97
8	Providing shuttering for RCC work									
	roof	1	13.00	13.00		169.00				
	side shuttering for lintel	4	5.00		0.50	10.00				
	shuttering below lintel at openings	2	3.33	0.83		5.53				
	chajjas for door & window	2	3.33	0.83		5.53				
					Total	190.06	17.66	m^3	64.00	1130.44
9	No of tiles required for RCC filler slab	80							3.00	240.00
10	CC Work in RCC Filler slab roof	1	13.00	13.00	0.33	55.77				
	deduct for tiles	80	1.30	0.83	0.10	8.98				
					Total	46.79	1.32	m^3	2053.28	2720.23
11	Sand filling in the room	1	10.08	10.08	1.25	127.01	3.60	m^3	107.42	386.27
12	Providing 100 mm thick dry brick khoa well watered and rammed in flooring	1	10.33	10.33		106.71	9.92	m^2	55.80	553.38
13	CC work in AS flooring	1	10.33	10.33	0.13	13.34	0.38	m^3	1955.50	738.50
14	Inside plastering	4	10.33		9.67	399.56				1193.76
	deduct for door	1	3.33		6.50	21.65				
	deduct for window	1	3.33		4.00	13.32				
					Total	364.60	33.88	m^2	35.23	
15	Steel reinforcement (Kg) including cutting, bending, and fixing for-	Reinforcement specifications				**Total (in kg.)**				
		12#	10#	8#	6 (mm dia)					
	Filler slab			70.00		70.00	**Total (in quintal)**			
	Chajja & Lintel			14.80	3.00	17.80		.		
					Total	87.80	0.88	qtl.	1881.25	1651.74
Total										**22291.99**

** The rates of all materials excluding cement and steel (as these are supplied at Govt. rates) are provided as per average current rates prevailing in coastal Odisha. The 2% added for Tools & Plant (T & P) have been excluded as this core house is for IAY beneficiaries. Average labour rates have been incorporated.
** The inner dimension of the Core house is 10'4" x10'4" (with a plinth area of 144 Sq.ft and a roof area of 169 Sq.ft)
*** If the beneficiary contributes labour by himself the core house can be completed within Rs. 21,000/-.

Total Material requried for an IAY House

CB Bricks	4600 nos.		Cement.	29 bags		Tiles		92 nos
Sand	4.6 Cum.		Brick Khoa	2.85 Cum.		Shuttering Material		18 Sq.mt
Chips	1.83 Cum.		Filling sand	5.9 Cum.		Steel	8mm dia	85 Kg.
							6mm dia	3 Kg.

ANNEXURE B:
List of Technology Demonstration Units (TDUs)

ANNEXURE B.1

Phase I (2001-2002): SDC funded TDU projects

S.No	District	Block	Gram Panchayat	Village/ hamlet
1	Puri	Astarang	Patalada	Khatiari
2		Astarang	Astarang	Harinula
3		Astarang	Nuagarh	Nanpur
4		Astarang	Nuagarh	Madhupur
5		Astarang	Korona	Kantaimunduli
6		Gop	Birtunga	Girima
7		Gop	Mahalpara	Kundula
8		Gop	Jungalbari	Bisulipara
9		Gop	Ganeswarpur	Ganeswarpur
10		Gop	Konark NAC	Mulisahi
11	Jagatsinghpur	Ersama	Kunjakothi	Nalapai
12		Ersama	Kunjakothi	Kunjakothi
13		Ersama	Bhitar Andhari	Baulopara
14		Ersama	Balaipur	Barabatia
15		Ersama	Andhari	Jamukan Harijansahi
16		Balikuda	Ichhapur	Badaghar
17		Balikuda	Alabol	Alabol
18		Balikuda	Osakana	Paikerapur
19		Balikuda	Baragaon	Badarodang
20		Balikuda	Rahana	Rahana
21	Kendrapara	Marsaghai	Jampada	Goudgaon
22		Marsaghai	Jalpok	Jalpok
23		Marsaghai	Jalpok	Pakshyot
24		Marsaghai	Karilopatna	Naranpur
25		Marsaghai	Dumuga	Kusunpur
26		Mahakalpara	Khursia	Bandhakuda
27		Mahakalpara	Mahakalpara	Gopalpur
28		Mahakalpara	Mangalpur	Mangalpur
29		Mahakalpara	Mahakalpara	Kyarbank
30		Mahakalpara	Mahakalpara	Chadheiguar
31	Balasore	Soro	Pakhara	Balanga
32		Soro	Pakhara	Panada
33		Soro	Tentai	Sologaon
34		Soro	Tentai	Tentai
35		Soro	Nadigaon	Bailanda Mangarajpur
36		Bahanaga	Kalyani	Arada
37		Bahanaga	Gopalpur	Gopalpur
38		Bahanaga	Bishnupur	Sahaspura
39		Bahanaga	Kuruda	Kuruda
40		Bahanaga	Kochia Koili	Kochia Koili

ANNEXURE B.2

Phase II (2002-2003): Care Today funded TDU projects

S.No	District	Block	Gram Panchayat	Village/ hamlet
1	Jagatsinghpur	Ersama	Japa	Bhuansahi
2			Khrusnachandrapur	Arada
3			Ambiki	Pimperkani
4		Kujang	Gandeikpur	Polei
5			Balia	Mallipura
6		Balikuda	Kalio	Bhota
7			Machhagoan	Singtalia
8			Borikina	Olasa

ANNEXURE B.3

Phase III (2003-2004): Care Today funded TDU projects

S.No	District	Block	Gram Panchayat	Village/ hamlet
1	Balasore	Remuna	Gududa	Gududa
2		Remuna	Inchudi	Inchudi
3		Sadar	Saranga	Sundari
4		Sadar	Nagaram	Fulwar Kasba
5	Kendrapara	Kendrapara	Khamal	Khamal
6		Kendrapara	Jamadhar	Kasoti
7		Mahakalpara	Balipal	Andhuli
8		Marshaghai	Silipur	Danrmund
9	Jagatsinghpur	Biridi	Gopinathpur	Gopinathpur
10		Tirtol	Kolar	Kolar
11		Naugaon	Dahipal	Dahipal
12	Puri	Gop	Dhumala	Gadanipania
13		Nimapada	Sagada	Olikana
14		Kakatpur	Jaleswarpada	Narendrapur
15		Puri Sadar	Baliguali	Samangara

ANNEXURE C:

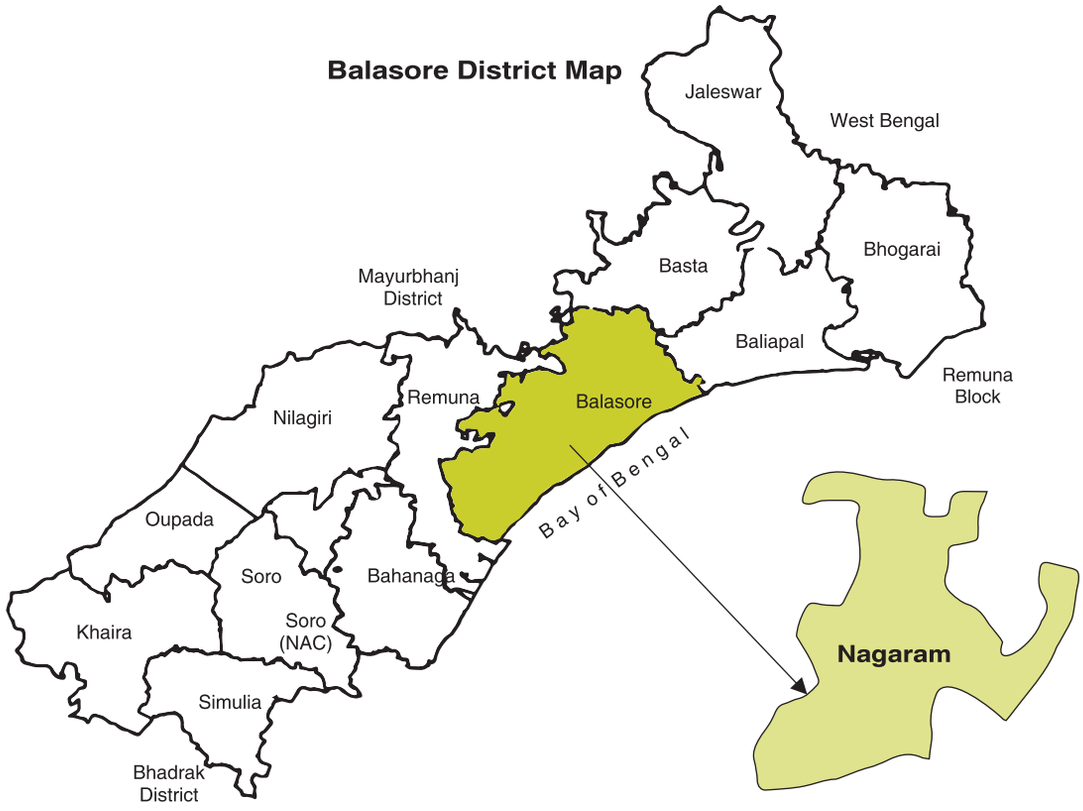
Detailed Assessment of TDUs Visited

ANNEXURE C.1: BALASORE DISTRICT

1. ANNEXURE C.1.1

Ashraya TDU, Fulwar Kasba, Nagaram GP, Balasore Sadar Block

Funded By	Care Today
Year of Construction	2004-2005
Constructed By	Fulwar Kasba Nirmaan Samiti
Technical Guidance	Anandamayee ASHG and DTF



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Pile foundation of 250mm diameter with double under ream of 625 mm at varying depths, 250 x 200 mm grade beam with anchorage bar to tie the three components - roof, wall and foundation
Wall	250 mm brickwork in rat-trap bond in 1:6 cement mortar with vertical anchorage bars and window sill level clips in 'L' and 'T' junctions
Roof	110 mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles and brick as filler material in roofs
Openings	Reinforced brick lintel and brick arches
Doors & Windows	Iron frames with local wood panel shutters for doors and iron frame with shutters for windows
Parapet	Brick *jali* work
Stair	Cantilevered folded slab

GENERAL OBSERVATIONS

Ashraya TDU is situated within the Fulwar Kasba UP school campus. It has been subjected to floods twice in nine years. In 2006, the TDU was flooded for three days; the flood waters had reached above plinth level. In the recent post-Phailin floods, flood waters from the River Budhabalanga reached up to a height of 8 feet from ground level. About 10 families took shelter in the Multi-Purpose Cyclone Shelter (MPCS) built near the school campus after the TDU had been constructed. The TDU is presently being used by a women's SHG federation office for meetings and the local youth club.

STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	In good condition. No cracks or settlement in the foundation.	Pile foundation has been chosen according to the site's black-cotton soil.
Wall	No damage found.	No building maintenance.
Roof	No water leaks. Roof surface not cleaned properly. Shrubs have taken root at the parapet bases.	Needs to be cleaned periodically.
Openings	No damage found.	
Doors & Windows	In good condition.	Painting required.
Parapet	In good condition.	Cleaning required.

USES OF THE TDU BUILDING

During Normal Times	During Emergencies
• The women's SHG federation uses one room as an office to conduct meetings. • Youth club members use another room for storing sports equipment and for meetings. • Space provided for health check-up camps, e.g., Pulse Polio campaign	• Ten families took shelter in the TDU in the 2006 floods. • In 2013, some families had shifted to the TDU. Due to rise in water level, they moved to the MPCS.

Maintenance of the TDU

Till the survey date, neither the community, government agencies nor NGOs had carried out any maintenance.

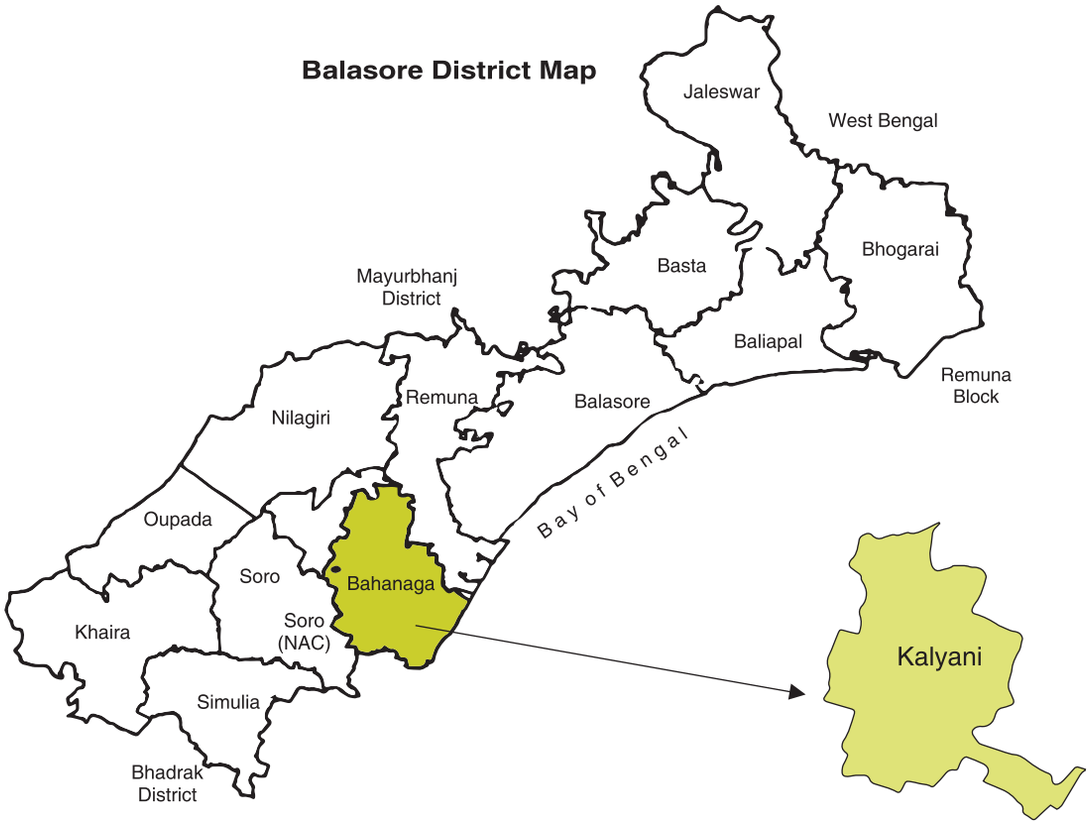
Community Views on TDU

- Unlike the buildings constructed using conventional technologies, the TDU building is cooler inside in summer and warmer in winter.
- These construction technologies consume less materials and cost less compared to conventional technologies.
- Masons trained under the UNDP Shelter Project have migrated to urban areas seeking better opportunities. Thus, trained masons are not available locally for construction of new houses using appropriate technologies.
- The strength of the TDU building appeared to be equivalent to buildings constructed with conventional technologies. The community's conviction was further enhanced since the building withstood the highest levels of flood seen in the village during the 2013 floods.

2. ANNEXURE C.1.2

Bhakti TDU, Arala, Kalyani GP, Bahanaga Block

Funded By	SDC
Year of Construction	2001-2002
Constructed By	Prava (NGO) and UNDP UNVs
Technical Guidance	UNDP UNVs



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Pile foundation of 250mm diameter with an under ream of 625mm at varying depths; 250mm x 200mm grade beam with anchorage bar to tie the three components – roof, wall and foundation
Wall	250mm brickwork in rat-trap bond in 1:6 cement mortar
Roof	110mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles as filler material in upper roof; PP joists and RC planks using M15 grade concrete in lower roof
Openings	Reinforced brick lintel and arches
Doors & Windows	Ferro cement doors and windows without wooden frames
Parapet	Brick *jali* work

GENERAL OBSERVATIONS

Bhakti TDU has withstood floods twice in the last 12 years. In 2006, flood waters reached above plinth level and receded after two days. A few families took shelter in the TDU for a week. In 2010, two families took refuge from floods in the TDU for three days. Since the TDU is located slightly away from the community, it is not used daily.

STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	Most parts have cracks, but negligible settlement.	Pile foundation has been chosen according to the site's black-cotton soil.
Wall	Exterior brick surfaces, near brick *jalis*, were broken.	There has been no maintenance of the walls.
Roof	No visible water leaks.	
Openings	No cracks present.	
Doors & Windows	In fair condition.	Need repairs.
Parapet	Some portions of the lower roof parapet and upper roof portion were broken.	There has been no maintenance of the building and there has been some pilferage of bricks broken from the parapet.

USES OF THE TDU BUILDING

During Normal Times	During Emergencies
• Used as AWC • Periodically, women's SHG meetings are conducted • Health check-up camps such as Pulse Polio campaign conducted here	• In 2006 floods, four families took shelter • In 2010 floods, two families took shelter

Maintenance of the TDU

Till the survey date, neither the community, government agencies nor NGOs had carried out any maintenance of the TDU.

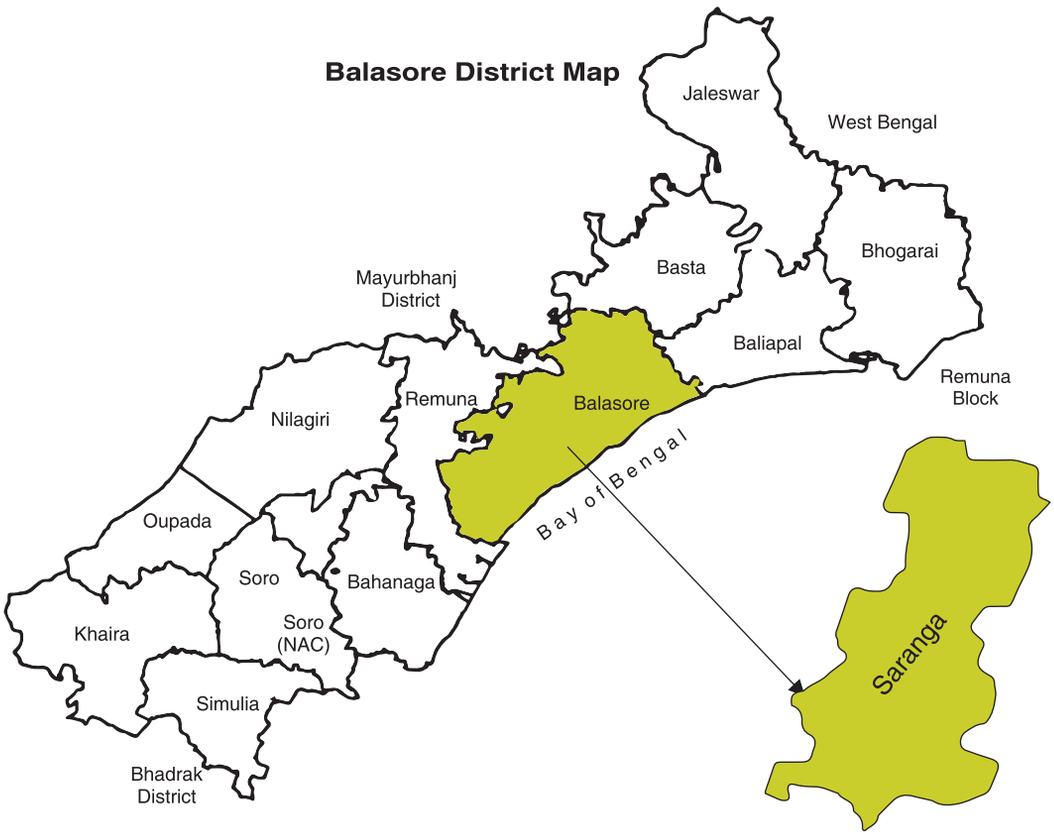
Community Views on TDU

- The TDU building remains cool in summer and warm in winter.
- These construction technologies consume less materials and cost less compared to conventional technologies.
- Masons trained in appropriate technologies were unavailable for reconstruction of houses in the village, as they had migrated to urban areas seeking better opportunities.
- The strength of the TDU building is comparable to buildings constructed using conventional technologies, particularly since no major cracks had developed.

3. ANNEXURE C.1.3

Pratimbha TDU, Sundari, Saranga GP, Balasore Sadar Block

Funded By	Care Today
Year of Construction	2004-2005
Constructed By	Arada Samiti and UNDP UNVs
Technical Guidance	Anandamayee Artisans SHG and DTF



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Pile foundation of 250mm diameter with double under ream of 625 mm at varying depths; 250mm x 200mm grade beam with anchorage bar to tie the three components – roof, wall and foundation
Wall	250mm brickwork in rat-trap bond in 1:6 cement mortar with vertical anchorage bars and window sill level clips in 'L' and 'T' junctions
Roof	110mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles and brick as filler material in roofs
Openings	Reinforced brick lintel and brick arches
Doors & Windows	Iron frames with local wood panel shutters for doors and iron frame with shutters for windows
Parapet	Brick *jali* work
Stair	Cantilevered folded slab

GENERAL OBSERVATIONS

Pratimbha TDU is located within Sundari Primary School campus. Thus, school authorities have taken care of its maintenance through the school maintenance grant and have carried out exterior plastering and painting of walls, doors and windows.

STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	No visible cracks or settlement. In stable condition.	Pile foundation has been chosen according to the site's black-cotton soil.
Wall	In excellent condition.	Exterior plastering and painting has been done.
Roof	No roof water leaks and is cleaned and maintained periodically.	An additional storage room has been constructed on the roof.
Openings	No damage found.	
Doors & Windows	In good condition.	Doors and windows have been painted.
Parapet	In good condition.	

USES OF THE TDU BUILDING

During Normal Times	During Emergencies
• An additional room has been constructed on the roof and is used by the *nirmaan samiti* for meetings and to store materials. • Ground floor of the TDU is completely used by the school for its classrooms and storage. • Used for health check-up camps.	• In 2013 post-Phailin floods, the floodwaters reached within a kilometre of the building. School authorities had handed over the keys to the villagers for emergency use if necessary. However, it was not used.

Maintenance of the TDU

Plastering, painting and all maintenance work have been done by the school authorities from the school maintenance grant.

Community Views on TDU

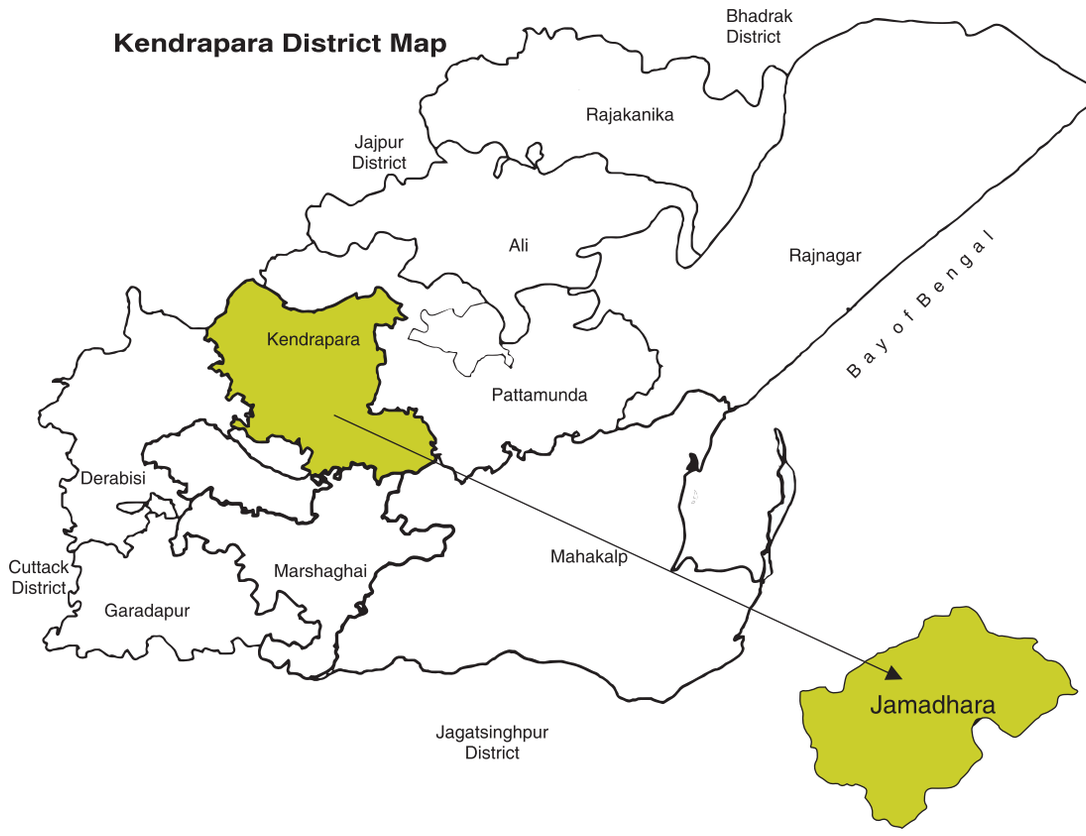
- According to the school teachers, the TDU classrooms were more comfortable than those in conventional buildings, particularly during the summer.
- *Nirmaan samiti* members emphasized the lower building material consumption and cost compared to conventional buildings.
- Trained masons were locally unavailable for construction of new houses using appropriate technologies, as many had migrated to the district headquarters seeking better employment opportunities.
- The strength of the TDU building appeared to be better than ones constructed using conventional technologies, particularly due to the presence of vertical anchorage bars.

ANNEXURE C.2: KENDRAPARA DISTRICT

4. ANNEXURE C.2.1

Ananya TDU, Kasoti, Jamadhara GP, Kendrapara Block

Funded By	SDC
Year of Construction	2004-2005
Constructed By	Baba Swapneswari Nirmana Samiti, Kasoti and UNDP-ODTF
Technical Guidance	Anandamayee Artisans SHG & DTF



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Well ring foundation with 'I' section grade beam (250mm x 400mm) with anchorage bar to tie the three components – roof, wall and foundation
Wall	250mm brickwork in rat-trap bond in 1:6 cement mortar with vertical anchorage bars and window sill level clips in 'L' and 'T' junctions
Roof	110mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles and brick as filler material in roofs
Openings	Corbelled brick arches
Doors & Windows	Iron frames with local wood panel shutters for doors windows.
Parapet	Brick *jali* work
Stair	Folded slab cantilevered from wall

GENERAL OBSERVATIONS

Ananya TDU is situated in the centre of the village within the premises of the Baba Swapneswara temple and is used as an Anganwadi Centre. During emergency situations, the panchayat leaders designate this building as the relief distribution centre. However, it has not faced any floods since it was handed over to the community in 2005.

STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	No cracks and no settlement observed in the foundation. In good condition.	Well ring foundation has been used in accordance with the site's black-cotton soil.
Wall	No damage. Visible dampness on the walls inside the hall.	Requires painting.
Roof	No water leakages. Roof surface is unclean with shrubs sprouting from parapet base.	Roof drainage spouts are broken and need replacement to check dampness and storm water flow along the walls to minimize discoloration.
Openings	No damage found.	Requires painting.
Doors & Windows	In good condition.	
Parapet	In good condition.	Requires painting.



USES OF THE TDU BUILDING

During Normal Times	During Emergencies
• The hall is used as an AWC. • Temple authorities use one room to store puja utensils and to carry out puja on special occasions. • Health check-up camps like polio vaccine for children.	• Designated as the relief distribution centre by the panchayat.

Maintenance of the TDU

Till the assessment date, neither the community, government agencies nor NGOs had carried out any maintenance of the TDU.

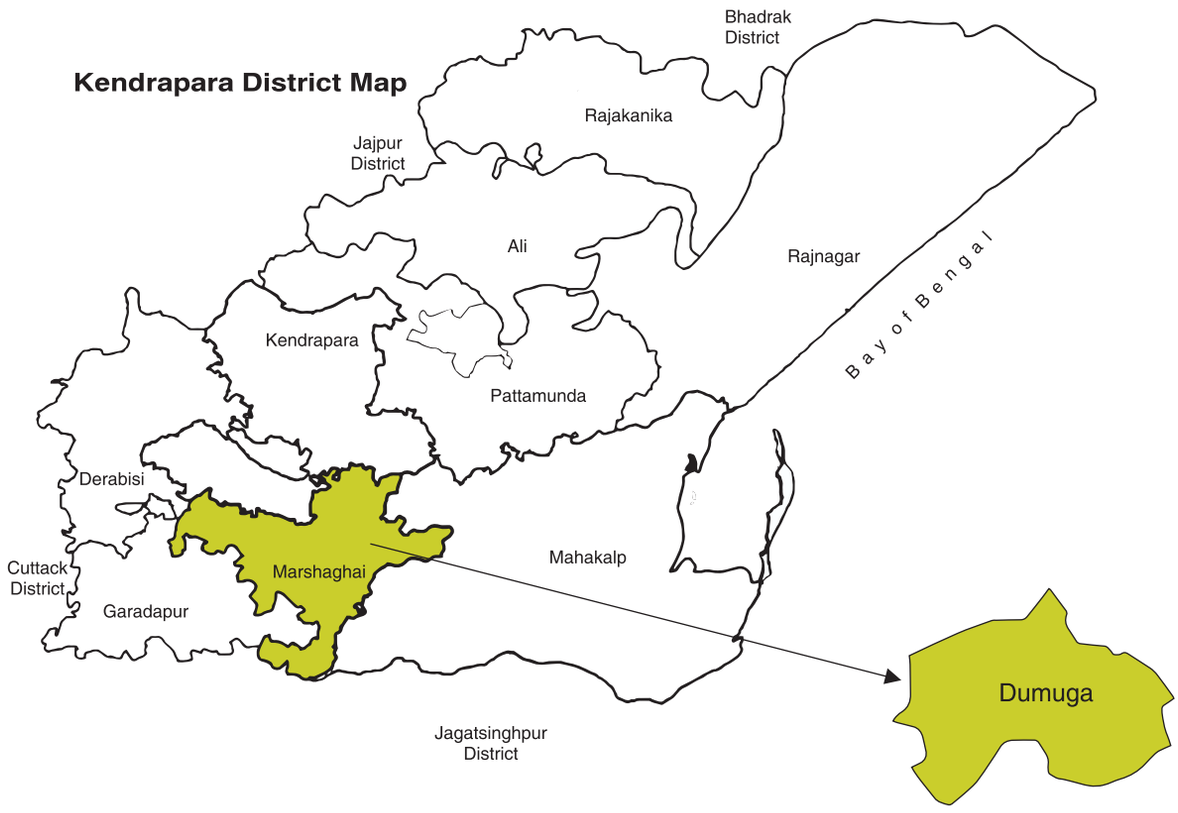
Community Views on TDU

- Rat-trap walls and filler slab roof construction technologies help the TDU building be cooler in summer and warmer in winter.
- These construction technologies consume less materials and cost less compared to conventional technologies.
- Masons trained under the UNDP Shelter Project were not available for local construction since they had gained better employment opportunities following their training.
- TDU building may have better resilience to disasters as compared to conventional construction due to presence of vertical anchoring bars.

5. ANNEXURE C.2.2

Gitanjali TDU, Kusunpur, Dumuga GP, Marshaghai Block

Funded By	SDC
Year of Construction	2001-2002
Constructed By	BGVS (NGO) and UNDP UNVs
Technical Guidance	UNDP UNVs



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Stepped footing in brick and cement mortar with 25mm thick Damp Proof Course (DPC)
Wall	250mm brickwork in rat-trap bond in 1:6 cement mortar
Roof	110mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles as filler material
Openings	Brick corbel, brick lintel and brick arches
Doors & Windows	Wooden doors and windows with wooden shutters.
Parapet	Brick *jali* work
Stair	Waist slab with brick steps

GENERAL OBSERVATIONS

Gitanjali TDU is situated within Kusunpur UP school campus. It has faced floods twice in 11 years. In 2006, flood waters crossed the plinth level and receded after two days. In 2008, flood waters rose to 4 feet from the ground level. The building was not structurally affected in either flood.

STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	No cracks or settlements in foundation. In good condition.	Pile foundation has been used to suit the site's black-cotton soil.
Wall	In good condition.	No maintenance carried out so far.
Roof	No water leaks in the roof.	Maintenance is required, particularly in waterspouts to avoid roof and wall damage.
Openings	No cracks.	
Doors & Windows	In good condition.	
Parapet	Some portions of the lower roof parapet and upper roof were broken.	No maintenance of the TDU building.

USES OF THE TDU BUILDING

During Normal Times	During Emergencies
• Used as an Anganwadi Centre • Used for health check-up camps	Many *pucca* buildings within the school campus, including the TDU, have been used during emergencies

Maintenance of the TDU

Till the survey date, neither the community, government agencies nor NGOs had carried out any maintenance of the TDUs.

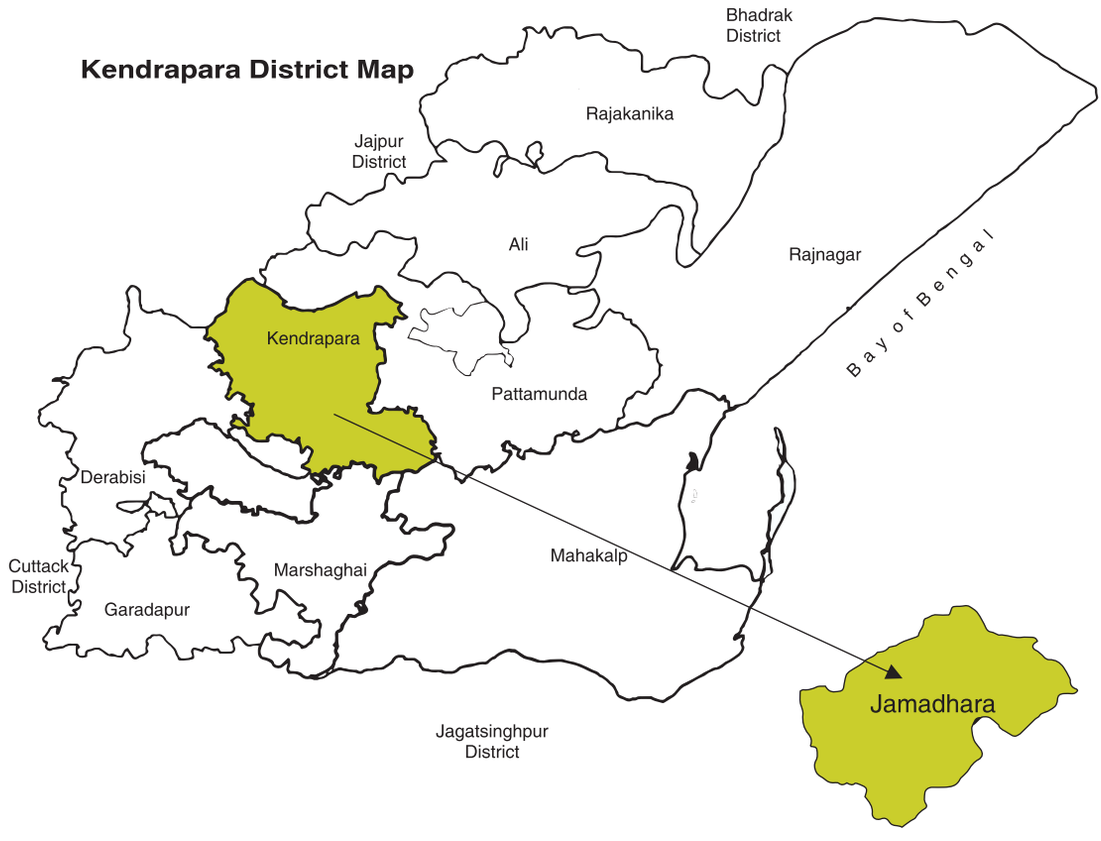
Community Views on TDU

- Rat-trap walls and filler slab roof construction technologies aid the TDU building to stay cooler in summer and warmer in winter.
- These construction technologies consume less materials and cost less compared to conventional technologies.
- A few masons trained under the UNDP Shelter Project were available locally for constructing new houses with these technologies. Other masons had migrated to urban areas seeking better employment opportunities.
- TDU building has the same strength as conventional buildings. Further, disaster resistant technologies such as vertical bars within brick walls, tied from foundation up to roof, increased the durability and resistance of the building to disasters.

6. ANNEXURE C.2.3

Kalinga Bhavan TDU, Danrmund, Jamadhara GP, Kendrapara Block

Funded By	Care Today
Year of Construction	2004-2005
Constructed By	Sri Baldevjew Nirmaan Samiti, UNDP-OTDF
Technical Guidance	Baba Swapneswari and Prerna DTF



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Well ring foundation with 'I' section grade beam (250mm x 400mm) with anchorage bar to tie the three components – roof, wall and foundation
Wall	250mm brickwork in rat-trap bond in 1:6 cement mortar with vertical anchorage bars and window sill level clips in 'L' and 'T' junctions
Roof	110mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles and brick as filler material in roofs
Openings	Corbelled brick arches
Doors & Windows	Iron frames with local wood panel shutters for doors windows
Parapet	Brick *jali* work
Stair	Folded slab cantilevered from wall

GENERAL OBSERVATIONS

Kalinga Bhavan TDU is located within the Dalit community hamlet inside the premises of Bata Mandir. It is used as an AWC and for meetings or religious purposes. In 2006, the TDU was used as an emergency shelter since surrounding areas had been inundated in the floods. In 2008, since the building was itself nearly flooded, its rooftop was used with makeshift tents for shelter for 15 days even after the water receded. It has also been designated as the community relief distribution centre during emergencies.

STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	No cracks, damage or settlement found in the foundation. In good condition.	Suited to the site's black-cotton soil, a well ring foundation has been used.
Wall	No damage found.	No maintenance of the building.
Roof	No water leaks from the roof.	
Openings	No damage found.	
Doors & Windows	In good condition.	Requires painting.
Parapet	In good condition.	
Dampness	Visible dampness on the walls in the hall.	Broken spouts have caused this damage and need to be replaced.

USES OF THE TDU BUILDING

During Normal Times	During Emergencies
• The main hall is used as AWC. • The elderly and club members use one room for meetings. • Health check-up camps like Pulse Polio campaign.	• Has been used as shelter in previous floods. • Has been designated as a relief distribution centre by the panchayat.

Maintenance of the TDU

Till the survey date, neither the community, government agencies nor NGOs had carried out any maintenance of the TDU.

Community Views on TDU

- The TDU was used on a daily basis and the building interiors are more comfortable in summer and winter as compared to conventional ones, attributed to the 'gaps in the wall'.
- These construction technologies consume less materials and cost less compared to conventional technologies.
- Very few trained masons were available for construction of new houses using appropriate technologies.
- The building strength of the TDU is comparable to, if not better than, houses using conventional technologies.

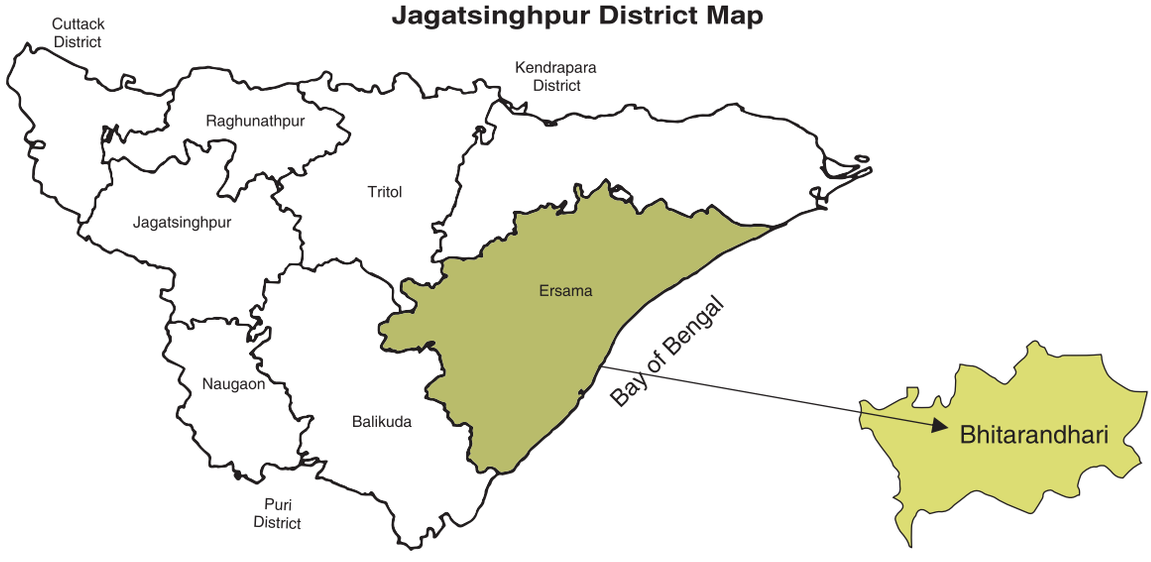
ANNEXURE C.3: JAGATSINGHPUR DISTRICT

7. ANNEXURE C.3.1

Jagrutee TDU, Baulopada, Bhitarandhari GP, Ersama Block

Funded By	SDC
Year of Construction	2001-2002
Constructed By	EFICOR (NGO) and UNDP UNVs
Technical Guidance	UNDP UNVs

Jagatsinghpur District Map



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Stepped footing in brick and cement mortar with 25mm thick DPC
Wall	250mm brickwork in rat-trap bond in 1:6 cement mortar
Roof	100mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles as filler material `
Openings	Brick arches and brick lintel
Doors & Windows	Wooden doors and windows with wooden shutters
Parapet	Brick *jali* work
Stair	Waist slab with brick steps

GENERAL OBSERVATIONS

Jagrutee TDU is located within the village, but has not been affected by any hazard so far. However, it is close to the coastline and vulnerable to cyclones and floods.

STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	No cracks or settlement in foundation. In good condition.	Conventional foundation has been used according to the site's sandy soil condition.
Wall	In good condition.	No maintenance carried out so far.
Roof	No water leaks from the roof.	Roof cleaning and spout clearing is required.
Openings	No cracks.	
Doors & Windows	In good condition.	
Parapet	Some portions are broken.	Maintenance of the parapet wall is required.

USES OF THE TDU BUILDING

During Normal Times	During Emergencies
• Used as Anganwadi Centre. • Used for health check-up camps. • Currently, a nearby school (Saraswati Sishu Mandir) uses the TDU for additional class rooms. • Women SHGs use it as a storage room.	• Few families have taken shelter in the TDU when flood warnings have been issued in past years. • It was not used as a shelter during Cyclone Phailin since people from the entire village were shifted to the nearest MPCS.

Maintenance of the TDU

Although the building appears to be well maintained, neither the community, government agency nor NGOs have carried out large-scale maintenance.

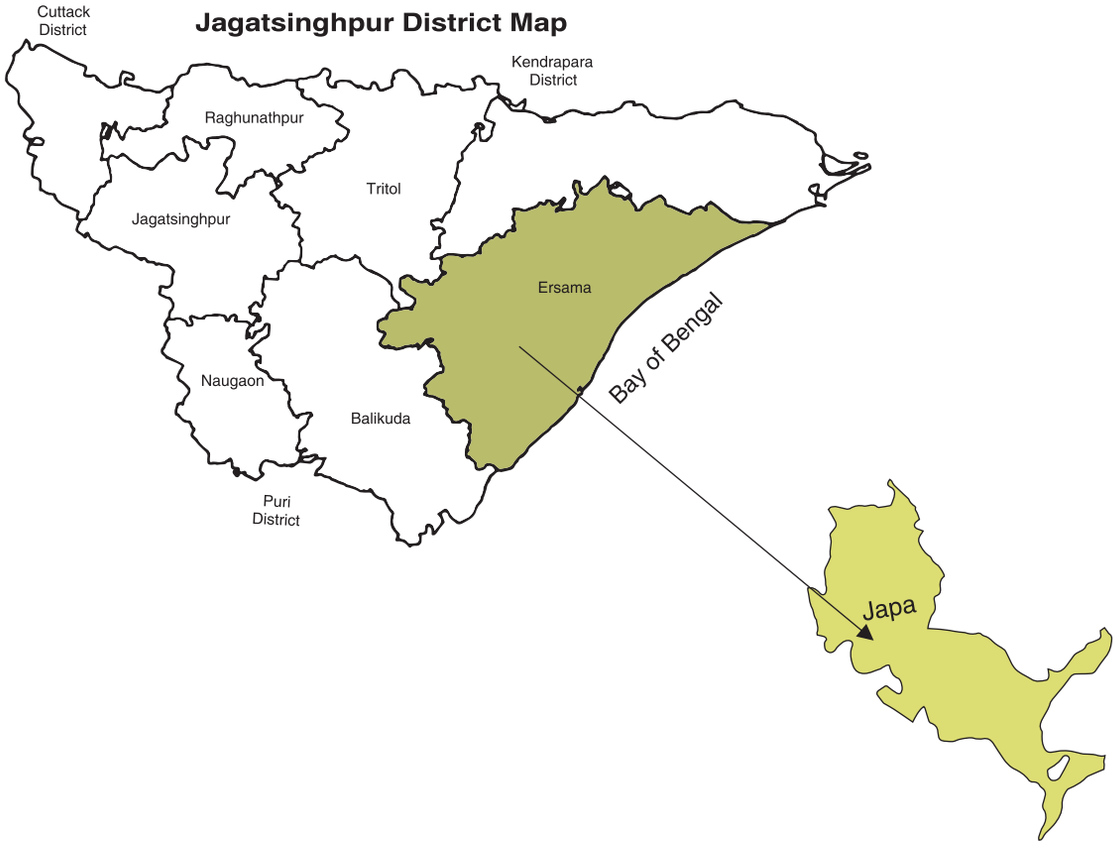
Community Views on TDU

- The interior spaces of the TDU were cool in summer and warm in winter.
- Construction technologies used consume less materials and cost less compared to conventional technologies.
- Masons trained under the UNDP Shelter Project were unavailable locally for construction of new houses due to migration to seek better employment opportunities.
- The building strength of the TDU is considered to be the same that of conventional technologies.
- The TDU has better disaster resistance due to the use of vertical anchorage bars, which conventional buildings do not have.

8. ANNEXURE C.3.2

Ananda TDU, Bhuansahi, Japa GP, Ersama Block

Funded By	Care Today
Year of Construction	2004-2005
Constructed By	Bhuansahi Nirmaan Samiti and UNDP
Technical Guidance	UNDP UNVs



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Well ring foundation with 'I' section grade beam (250mm x 400mm) with anchorage bar to tie the three components – roof, wall and foundation
Wall	250mm brickwork in rat-trap bond in 1:6 cement mortar with vertical anchorage bars and window sill level clips in 'L' and 'T' junctions
Roof	100mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles and brick as filler material in roofs
Openings	Corbelled brick arches in semicircular, segmented and flat shapes.
Doors & Windows	Wooden frames with local wood panel shutters for doors windows.
Parapet	Brick *jali* work
Stair	Waist slab using Raniganj tiles as filler material

GENERAL OBSERVATIONS

Ananda TDU is located within the temple premises of Bhuansahi village. For emergencies, panchayat leaders have designated its use as a relief distribution centre. However, it has not faced any floods since its completion. Currently, it is used for storage as well as a meeting place for the community. The community has maintained the TDU building well.

STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	No cracks or settlements in the foundation. In good condition.	Well ring foundation has been provided suited to the site's black-cotton soil.
Wall	No damage found.	No large-scale maintenance of the building is evident.
Roof	No water leaks from the roof. Shrubs sprouting up from the parapet bases.	Users need to clean the roof and the spouts periodically.
Openings	No damage found.	
Doors & Windows	In good condition.	Requires painting.
Parapet	In good condition.	Required cleaning.
Dampness	Visible dampness on the walls in the hall.	Some spouts on the roof are broken and need to be replaced.

USES OF THE TDU BUILDING

During Normal Times	During Emergencies
• The temple authorities are currently using one room to store puja utensils. • Used for health check-up camps such as Pulse Polio campaign.	• Designated as a relief distribution centre.

Maintenance of the TDU

Although the building appears to be well maintained, neither the community, government agency nor NGOs have carried out large-scale maintenance.

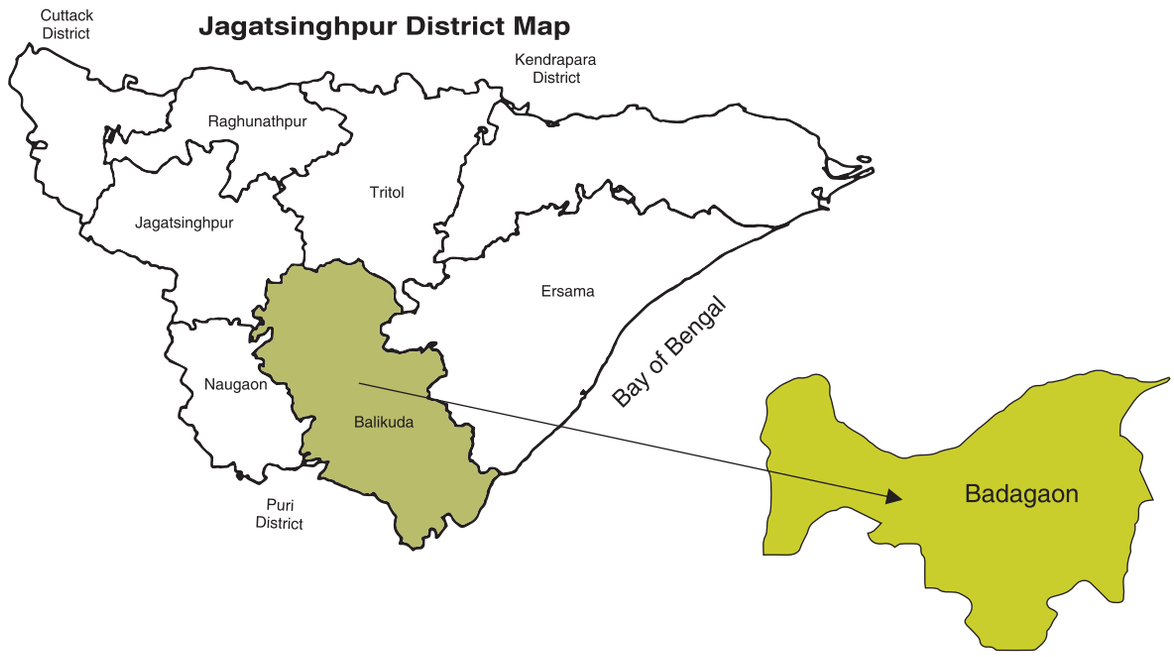
Community Views on TDU

- The interior spaces of the TDU were cool in summer and warm in winter.
- Construction technologies used consume less materials and cost less compared to conventional technologies.
- Masons trained under the UNDP Shelter Project were unavailable locally for construction of new houses due to migration to seek better employment opportunities.
- The building strength of the TDU is considered to be the same as those built with conventional technologies.
- The TDU has better disaster resistance due to the use of vertical anchorage bars, which conventional buildings do not have.

9. ANNEXURE C.3.3

Anubhav TDU, Badarodang, Badagaon GP, Balikuda Block

Funded By	SDC
Year of Construction	2001-2002
Constructed By	Nirmiti Samiti and UNDP UNVs
Technical Guidance	UNDP UNVs



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Stepped footing in brick and cement mortar with 25mm thick DPC, 225mm x 150mm plinth beam with vertical anchorage bar to be the three components – roof, wall and foundation
Wall	250 mm brickwork in rat-trap bond in 1:6 cement mortar
Roof	100 mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles as filler material
Openings	Reinforced brick lintel and arches
Doors & Windows	Wooden doors and windows with wooden shutters
Parapet	Brick *jali* work
Stair	Built on filler slab cast with single layer of tiles

GENERAL OBSERVATIONS

Anubhav TDU is located at the centre of the village, close to the main village temple. It is used as the local AWC and also for community meetings and storing materials for temple construction. The building has not been affected by any disaster so far.



STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	No visible cracks or settlement.	
Wall	In a few places, exterior surface of the bricks is broken, particularly near brick *jalis*.	No TDU maintenance has been done despite ongoing temple construction activity in the same premises.
Roof	No water leaks to the roof.	
Openings	No cracks.	
Doors & Windows	Need minor repairs.	Minor repair and painting required.
Parapet	Some portions of the lower roof parapet and upper roof are broken.	Parapet walls need repair and maintenance.

USES OF THE TDU BUILDING:

During Normal Times	During Emergencies
• Used as AWC • Used periodically for women SHG meetings • Used for health check-up camps such as Pulse Polio campaigns.	• Designated as are relief distribution centre in case of emergencies.

Maintenance of the TDU

Till the survey date, neither the community, government agencies nor NGOs had carried out any maintenance of the TDU.

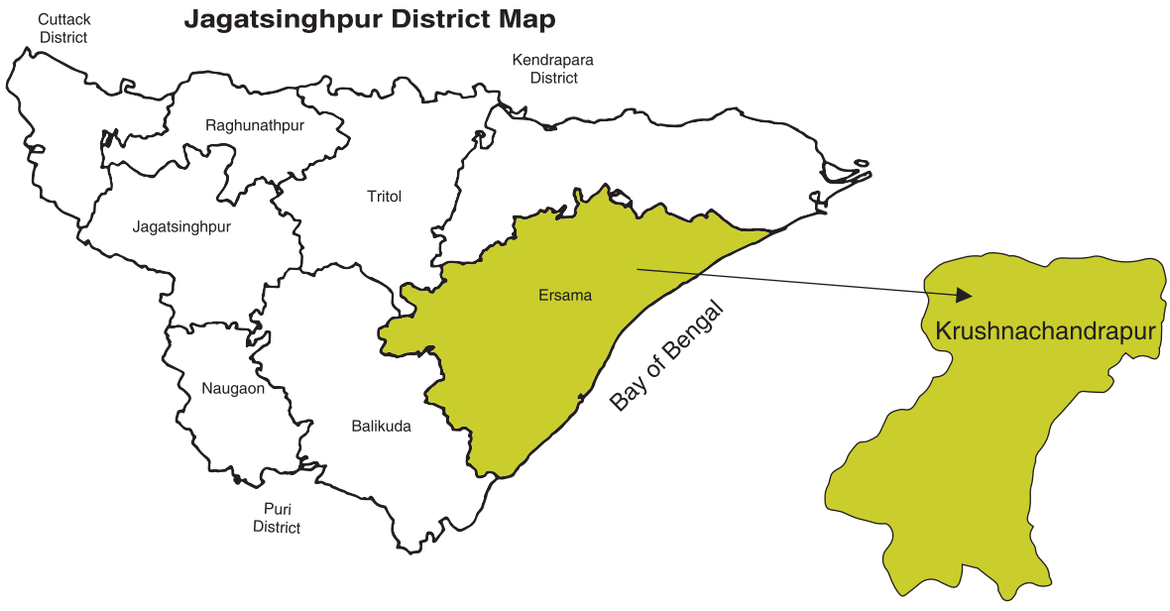
Community Views on TDU

- The interior spaces of the TDU remain cool in summer and warm in winter.
- Construction technologies used consume less materials and cost less compared to conventional technologies.
- These construction technologies did not compromise on the structural strength of the building.
- Some trained masons were available and were constructing new houses in the vicinity using appropriate technologies. Some masons had even constructed their own houses using rat-trap walls and filler slab roofs.

10. ANNEXURE C.3.4

Sampark TDU, Arada, Krushnachandrapur GP, Ersama Block

Funded By	SDC
Year of Construction	2001-2002
Constructed By	Nirmiti Samiti and UNDP UNVs
Technical Guidance	UNDP UNVs



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Well ring foundation with 'I' section grade beam (250mm x 400mm) with anchorage bar to tie the three components – roof, wall and foundation
Wall	250mm brickwork in rat-trap bond in 1:6 cement mortar with vertical anchorage bars and window sill level clips in 'L' and 'T' junctions
Roof	100mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles and brick as filler material in roofs
Openings	Corbelled brick arches in semicircular, segmented and flat shapes
Doors & Windows	Wooden frames with local wood panel shutters for doors windows
Parapet	Brick *jali* work
Stair	Folded Reinforce Cement Concrete (RCC) slab

GENERAL OBSERVATIONS

Sampark TDU is located within the village and has not faced any disaster so far. The community is presently using it as a storing and meeting place. It has been maintained well by the community.

STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	In good condition.	Well ring foundation has been used suited to the site's black-cotton soil.
Wall	No damage found.	No painting has been carried out so far.
Roof	No water leaks from the roof. Shrubs are emerging from the parapet base in some places	Minor maintenance and cleaning required ofthe roof, clearing spouts and removing shrubs.
Openings	No damage found.	
Doors & Windows	In good condition.	Needs painting.
Parapet	In good condition.	
Dampness	Visible dampness on the walls in the hall.	One broken spout needs to be replaced.

USES OF THE TDU BUILDING

During Normal Times	During Emergencies
• One room is currently being used by youth club members for after-school extra classes for children from the village. • Used for health check-up camps.	• Designated as a relief distribution centre by panchayat leaders.

Maintenance of the TDU

Till the survey date, neither the community, government agencies nor NGOs had carried out any maintenance of the TDU.

Community Views on TDU

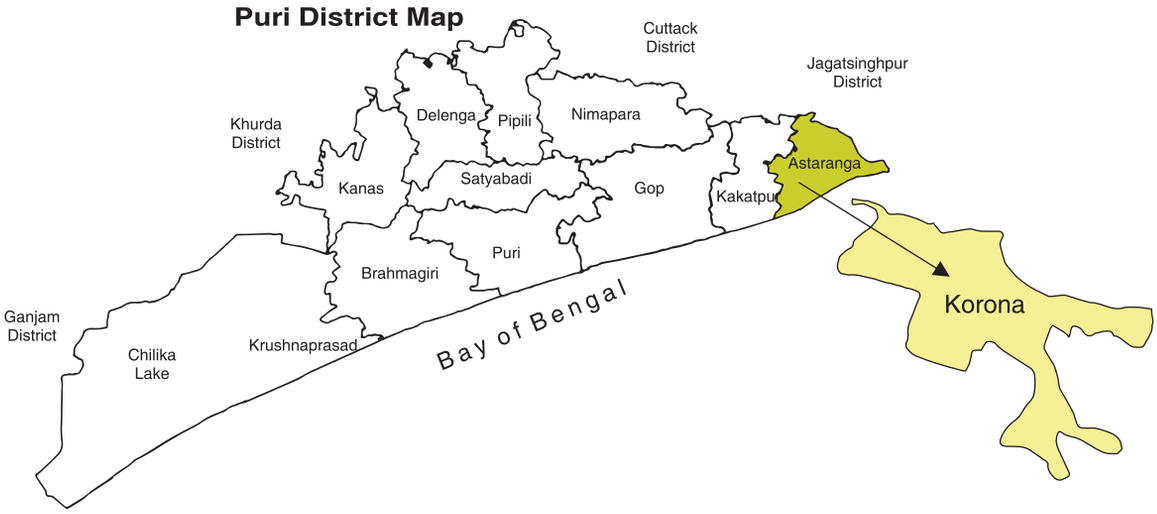
- The interior spaces of the TDU remain cool in summer and warm in winter due to the air gaps in the rat-trap wall and filler slab roof.
- Construction technologies used consume less materials and cost less compared to conventional technologies.
- The use of these construction technologies has not compromised the building's structural strength.
- Many community members have adopted these appropriate technologies when building their own houses with assistance from masons trained under the UNDP Shelter Project.

ANNEXURE C.4: PURI DISTRICT

11. ANNEXURE C.4.1

Aradhana TDU, Kantaimundali, Korona GP, Astaranga Block

Funded By	SDC
Year of Construction	2001-2002
Constructed By	Nirmiti Samiti and UNDP UNVs
Technical Guidance	UNDP UNVs



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Stepped footing in brick and cement mortar with 25mm thick DPC
Wall	250mm brickwork in rat-trap bond in 1:6 cement mortar
Roof	100mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles as filler material
Openings	Brick arches and brick lintel
Doors & Windows	Wooden doors and windows with wooden shutters
Parapet	Brick *jali* work
Stair	Waist slab with brick steps

GENERAL OBSERVATIONS

Aradhana TDU is located within the village and has not faced any floods so far. The community has taken complete ownership of this TDU and keeps its premises clean.



STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	No cracks or settlement found in the foundation. In good condition.	Conventional brick stepped foundation has been used according to the site's sandy soil.
Wall	In good condition. Interior painting intact.	No large-scale maintenance of the building.
Roof	No water leaks.	Community members have added some waterspouts to improve drainage from the roof.
Openings	No cracks.	
Doors & Windows	In good condition, except the main door.	Main door needs repair.
Parapet	Some portions of the lower roof parapet and upper roof are broken.	No maintenance of parapet walls.

USES OF THE TDU BUILDING

During Normal Times	During Emergencies
• Used as AWC. • Used for health check-up camps. • Extra classes conducted by village youth before school hours, which is attended by many village children.	• Some families have used the TDU as a temporary shelter following past flood warnings. • It was not used during Cyclone Phailin since community members were forcibly evacuated to the nearest MPCS.

Maintenance of the TDU

Till the survey date, neither the community, government agencies nor NGOs had carried out any large scale maintenance of the TDU.

Community Views on TDU

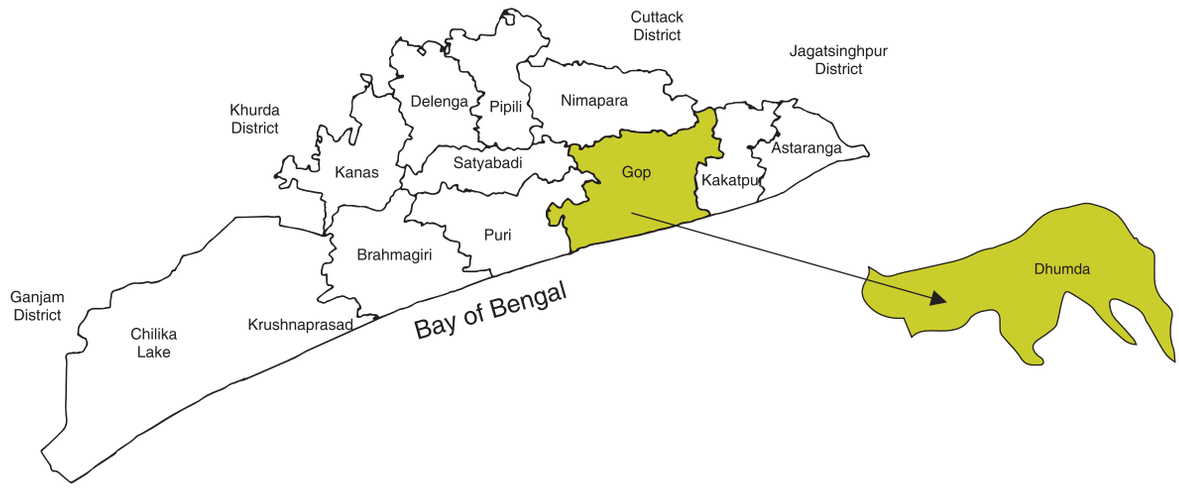
- The interior spaces of the TDU remain cool in summer and warm in winter due to the use of 'new' and appropriate building technologies.
- Construction technologies used consume less materials and cost less compared to conventional technologies.
- The building strength is equivalent to those built using conventional construction technologies.
- Some trained masons are still available for constructing houses using appropriate technology.

12. ANNEXURE C.4.2

Sanskar TDU, Gadanipania, Dhumda GP, Gop Block

Funded By	Care Today
Year of Construction	2004-2005
Constructed By	Gadanipania Nirmaan Samiti and UNDP UNVs
Technical Guidance	UNDP UNVs

Puri District Map



TECHNOLOGIES USED

Building Element	Construction Details
Foundation	Well ring foundation with 'I' section grade beam (250mm x 400mm) with anchorage bar to tie the three components – roof, wall and foundation
Wall	250mm brickwork in rat-trap bond in 1:6 cement mortar with vertical anchorage bars and window sill level clips in 'L' and 'T' junctions
Roof	100mm thick filler slab in M15 (1:2:4) grade cement concrete using Raniganj tiles and brick as filler material
Openings	Corbelled brick arches, semi-circular and segmented
Doors & Windows	Wooden frames with local wood panel shutters for doors windows
Parapet	Brick *jali* work
Stair	Waist slab using Raniganj tiles as filler material

GENERAL OBSERVATIONS

Sanskara TDU is located within the Gadanipania UP school premises and hence has been maintained well by the community. It functions as an AWC and as a community meeting centre. For emergency situations, the panchayat leaders have designated it as a relief distribution centre.

STRUCTURAL CONDITIONS

Components	Status as on November 2013	Technical Observations
Foundation	No cracks or settlement in the foundation. In good condition.	Well ring foundation has been provided suited to the site's black-cotton soil.
Wall	No damage found.	No building maintenance.
Roof	No water leaks from the roof, but the roof is not being maintained properly.	Users need to clean the roof surface periodically.
Openings	No damage found.	
Doors & Windows	In good condition.	Requires painting.
Parapet	In good condition.	Requires cleaning and painting.
Dampness	Visible dampness on the walls in the hall.	Spouts in some parts of the roof are broken and need to be replaced.

USES OF THE TDU BUILDING

During Normal Times	During Emergencies
• Used as an AWC. • Used for health check-up camps.	• The panchayat leaders have designated it as a relief distribution centre. • Community members occupied the building after receiving the cyclone warning in October 2013.

Maintenance of the TDU

Till the survey date, neither the community, government agencies nor NGOs had carried out any large scale maintenance of the TDU.

Community Views on TDU

- The interior spaces of the TDU remain cool in summer and warm in winter. Additionally, houses in the community built with appropriate technologies exhibit good thermal comfort.
- These construction technologies consume less materials and cost less compared to conventional technologies.
- Since no cracks have developed in the TDU, its building strength is considered equivalent to those built using conventional construction technologies, particularly due to its better disaster resistance through presence of anchorage bars within the walls.
- Trained masons are available for constructing houses with appropriate technology. Some trained masons have been able to successfully expand their construction business with appropriate technologies.

REFERENCES

- Comptroller and Auditor General of India (2002). Audit Report (Civil) for the Year Ended 31 March 2002. Available [online] at: http://www.cag.gov.in/html/cag_reports/orissa/rep_2002/civil_over.pdf

- Government of Tamil Nadu (n.d.). Guidelines for Reconstruction of Houses Affected by Tsunami in Tamil Nadu. Available [online] at: http://tsunami.icsf.net/images/stories/tn0501.pdf

- Ministry of Rural Development, Government of India (2013) Indira Awas Yojana Guidelines. Available [Online] at: http://iay.nic.in/netiay/IAY%20revised%20guidelines%20july%202013.pdf

- UNDP (2001) Prerana: Sustainable Recovery through Appropriate Technology Transfer.

- World Bank (2013). Cyclone Phailin in Odisha: Rapid Damage and Needs Assessment Report. Available [online] at: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/01/10/000461832_20140110162742/Rendered/PDF/838860WP0P14880Box0382116B00PUBLIC0.pdf

Empowered lives.
Resilient nations

UNITED NATIONS DEVELOPMENT PROGRAMME (UNDP)
55, Lodhi Estate, New Delhi - 110 003
Tel: 91 11 46532333
Email: info.in@undp.org
www.in.undp.org
@UNDP_India
/UNDP-in-India