Documentation of the Demonstration Housing Project
at
Raipur Phulwari, Amethi, Uttar Pradesh

bmtpc

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2012

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1.0 Introduction

1.1 Background

Housing is among the most basic requirement for human survival. It assumes great meaning for the poor as it lays the base for a life of self-esteem by conferring a distinct, secure identity for them. The Government of India has paid close attention to addressing the need for housing since independence. Cities and towns have a vital role in India's socio-economic transformation and change. Host to about 30 per cent of the country's population, they contribute 50-55 per cent of the gross domestic product (GDP). At the end of the 10th Five Year Plan, the housing shortage was estimated to be 24.7 million housing units. An estimated 99% of this housing shortage pertains to households falling in the Economically Weaker Sections (EWS) and Low Income Group (LIG) segments in urban areas. The problem is aggravated by urban rural migration. As per the 2011 census, for the first time since Independence, the absolute increase in population is more in urban areas that in rural areas. The level of urbanization increased from 27.81% in 2001 Census to 31.16% in 2011 Census and the proportion of rural population declined from 72.19% to 68.84%. This is adding more and more pressure in urban housing sector and on urban basic services and infrastructure.

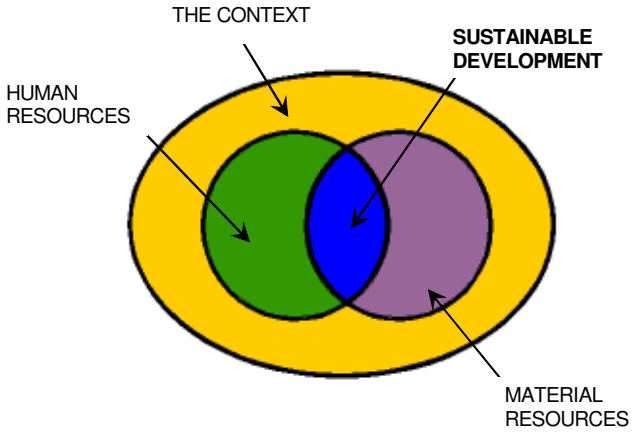
Addressing housing shortage is also an important strategy of poverty alleviation in India. In order to mitigate the housing shortage in consonance with the changing policy environment, the Ministry of Urban Development and Poverty Alleviation has announced the National Housing and Habitat Policy, 2007. This Policy focuses on affordable housing for all with special emphasis on economically weaker sections of the society. The Ministry has also has formulated a new scheme of Integrated Housing and Slum Development Programme (IHSDP) which is applicable to all cities and towns as per 2001 census not covered under JNNURM. This scheme aims at combining the existing schemes of VAMBAY and NSDP under the new IHSDP scheme for having an integrated approach in ameliorating the conditions of urban slum dwellers who do not possess adequate shelter and reside in dilapidated conditions. Understanding the need to promote technologies that are affordable, yet using materials that are commonly used in urban housing construction, the Building Materials Technology Promotion Council took up a housing project in Amethi to demonstrate cost effective appropriate technologies that can be replicated by aspiring house builders.

1.2 Origin of the Project:

From 1990, BMTPC has been working towards operationalising a comprehensive and integrated approach for promotion of cost-effective, environment-friendly & energy-efficient innovative building materials and construction technologies for housing in urban and rural areas including disaster resistant practices. Understanding the importance of BMTPCs role in ensuring 'shelter for all' objectives of the Government and the need to promote appropriate cost effective technologies, it embarked on a pilot demonstration project at Raipur-Phulwari village in Amethi, Sultanpur district, Uttar Pradesh. The pilot aimed to demonstrate cost effective, disaster resistant construction technologies and also build capacities in local masons in the use of these technologies. The technologies were chosen after a resource mapping study of locally available materials and human resources were carried out by the BMTPC team.

1.3 Resource mapping

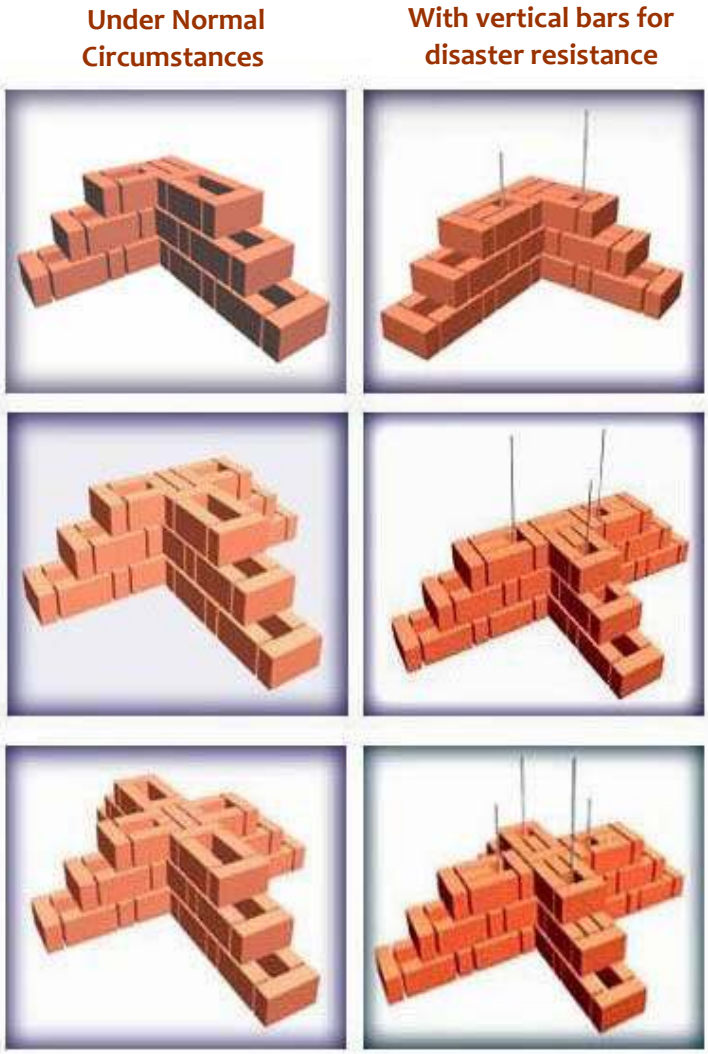
The word 'resource mapping' means mapping the existing local resources, which can be used in the future.The main objective of the resource mapping exercise is to explore and map the various indigenous resources available so as to facilitate sustainable housing delivery and infrastructure development. Resource mapping is very much contextual to the place and time. To understand the context we have to understand the geo-climatic condition, political and social scenario of Raipur Phulwari and Amethi.



The two types of resources that were explored included a) Material resources and b) Human resources. Technologies and designs that were low-cost, labour-intensive and had the least impact on the environment were adopted. For a demonstrative housing construction such as this, the two major elements are the walling and the roofing. Since bricks were available in plenty, it was decided to utilise it in a conservative manner in the walls using the rat trap bond for construction. As for the roof, since the entire aspiring house owners dreamt of a concrete roof over their heads, it was decided that the filler slab method of concreting will be used in the construction. Both these construction methodologies have been found to be cost effective as well as disaster resilient. Since

tiles were not available in plenty, it was decided to use bricks to replace the concrete in the compression zone to make it cost-effective.

1.4 Cost effective technologies

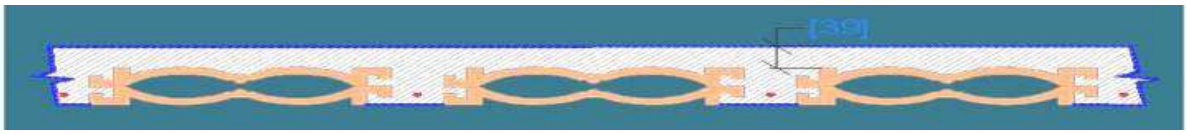


Brickwork in Rat-trap Bond: Rat-trap bonded brickwork is a method of brick bonding which optimises the use of building materials. Bricks are placed on edge in 1:6 cement mortar as shown in the pictures below. This uses 19% less bricks, 54% less cement mortar and has 25% less dead weight. These walls have very good insulation capacities and disaster-resistant features can be incorporated as shown.

No plastering of the outside face is required and the wall usually is quite aesthetically pleasing and the air gaps created within the wall help make the house thermally comfortable. In summer the temperature inside the house is usually atleast 5 degrees lower that the outside ambient temperature and vice versa in winter. Thus this technology is very much efficient for places such as Amethi where the summer temperatures soar upto 40 degrees and the winter temperatures are below 5 degrees.

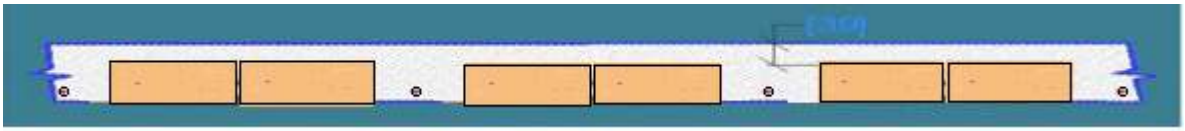
Filler Slab Concreting: In any slab, concrete withstands the load due to compressive forces and steel reinforcement bears the load due to tensile forces. In any simple roof, the upper part of the slab above the neutral axis is subjected to compressive forces while the lower part is subjected to tensile forces. Thus, the concrete in the lower part of the slab is redundant except for bonding with the reinforcement. This can be replaced with any filler material that is lighter and cheap - to cut down the self-weight of the slab and

the costs by 25%. The simplest fillers will be a pair of low grade Raniganj tiles, which also enhance the insulation capacities of the slab or it could be a pair of bricks.



Filler slab with a pair of Raniganj tiles as filler

Sectional View



Filler slab with a pair of Bricks as filler.

1.5 Project Brief

The project is a group housing project aimed to provide permanent shelter to twenty-four families as a part of the pilot demonstration initiative. The site is plain land adjoining agricultural fields with a paved road access to the south corner of the plot as in the layout plan. The twenty four Dwelling Units (DUs) are arranged in three two-storied apartments with a built up area of 38.22 sq.mt each. Each Dwelling unit consists of one living room, one bedroom, a kitchen, one separate bath and WC. The three apartment buildings are placed in a C shape with a central open area that provides space for circulation.

The Project, called “Demonstration Housing Project’ of BMTPC at Raipur Phulwari, Amethi,Sultanpur District, Uttar Pradesh” was located in Uttar Pradesh as it was one of

the states with a large housing deficit. Sultanpur is among the sixty threedistricts of UP

which have not achieved saturation in Indira AwasYojana housing.Sultanpur, the fifteenth most populous district in Uttar Pradesh is mainly an agricultural district.

Raipur Phulwari is a mid-sized village about 2.5 km from the Amethi Railway Stationwith a population of about 1803 persons living in around 283 households of whom about 14% belong to Scheduled Caste families. There were a total of 77 BPL families in the village as per the Below Poverty Line Survey (2002), but only 3 in the IAY waiting list. The village was thus an ideal location for initiating a project that would not only provide housing to 24 families from the village, but would also demonstrate technologies that other families could use to construct their own houses. The total project construction cost was one crore seven lakh rupees.

1.6 Location

The village Raipur Phulwari (26°09 N, 81° 41E, at an elevation of 100 feet)is located in Amethi Tehsil of Sultanpur district in the State of Uttar Pradesh in India.Amethi is one of the seven municipal/ town areas in the district and is also the most developed. It is situated in the south-west on the Sultanpur-Raebareli Road at about 40 km from Sultanpur city. It has developed into an industrial area due to its geographical situation and also due to it being connected to the Indian railways network.

1.7 Target community

The village Raipur Phulwari has a present population of 1803 persons with 931 males and 872 females.The beneficiaries were selectedby the local Nagar Palika from among the BPL and Dalit families.The average household size varies from four to five. While most are nuclear families, there are few exceptions wherein three generations live together within the same dwelling unit.Lottery system was adopted for allocation of flats and the lottery register is maintained at the Nagar Palika office.

1.8 Date of implementation

The foundation stone for this important project was laid by Sri. Rahul Gandhi, M.P on the15th of July 2008. The actual construction activities commenced on the ground in July2009 and were completed by October 2010.

2.0 DESIGN BRIEF

2.1 Target community

The site plan below shows the housing blocks arranged in a C-shaped cluster with a single large open space, the physical infrastructure and amenities.

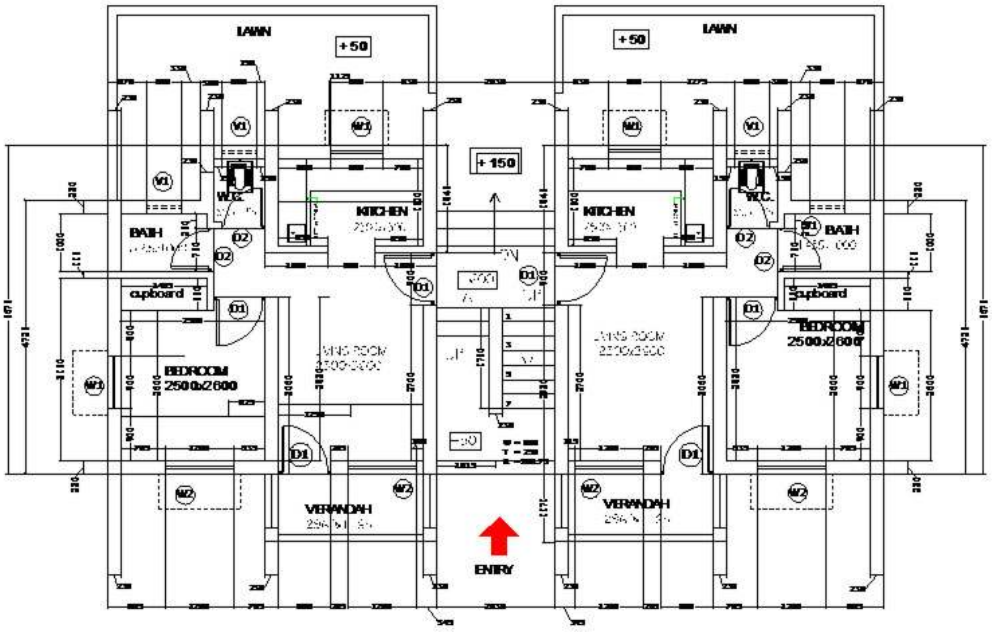
Figure 1: Site layout showing primary C shaped circulation loop with the entrances to the individual buildings.

The primary circulation within the site is a single C-shaped loop and all the building entrances are from this single loop. This makes the layout legible to both residents and visitors as one can orient oneself easily. Moreover, since this is the only

primarycirculation path, it invites constant use by residents and therefore lends itself well to the informal systems of unobtrusive surveillance creating a truly "defensible" and secure space for the residents of the colony. The path acts as a "hard" transition between the private zones representing the dwelling units and the community space at the center which acts as a focus area for the residents. The layout of the housing makes it possible forpeople of all ages, classes, and family configurations to live in close proximity.

2.2 Design description of Dwelling units

A typical dwelling unit consists of a Living room of size (2.42m x 3.83m), a bed room of size (2.420m x 2.76m), a kitchen (2.42mx 1.65m), a bath (1.40mx 1.00m) and a toilet of size 0.90m X 1.05m. The layout is as shown in the next page.



The entrance door leads on to the living room which has a direct link to the kitchen. The bed room has its own privacy with the bath and toilet close to, but not directly attached, so as to facilitate its use for visitors when required. The layout of the rooms is such that it brings the individuals closer together and they can easily converse with another household member regardless of where in the house they are. For parents with small children who need supervision, every corner is in easy view. The windows and the verandah enhance the spaces and makes it feel bigger that it actually is.




Interior of the rooms

3.0 THE BUILT FORMS

3.1 Architectural aspects

There are three two-storied buildings with eightdwelling units (DUs) in each building (four in each floor separated by two staircase blocks in between). The plans inside the dwelling units show hierarchy of spaces in term of functionality and usage, as the living room leads on to the kitchen and to the private areas of bed room, bath and toilet. The carpet area of each dwelling unit is about 25 sq. m.

Learning from local practices prior to designing:

A typical vernacular design inside the settlement was studied and found that within a homestead, individual buildings were grouped around a centrally placed courtyard, which was actively used for outdoor works and leisure by all the family members. The emphasis is on the use of open space in the courtyard. A similar concept has been portrayed herein.

The elevations of the buildings (all similar in size and form) are simple yet articulate with the use of faced brick-work coloured red and slabs and concrete portions coloured white. The clear height in each storey is adequate.The site plan has also promoted the usage of the open space in front, more to be culturally compatible with the target community.

3.2 Structural Aspects

These buildings are load-bearing structures with adequate reinforcements provided for disaster-resilience.

4.0 IMPLEMENTATION PROCESS

The project was implemented through a contractor well experienced in grounding such housing projects using such innovative technologies, particularly a very similar project in Bangalore. The contractor, AwasVikas Limited, is a company of the Rajasthan Housing Board. A participatory process was adopted in selecting the land for the project. However, the major constraint was that Government or community land was not available inside this residentially dense village. Thus private agricultural lands adjoining the village were acquired and developed for residential use.

Most materials were procured locally, except for the chequered tiles, pavement blocks, doors and windows, which were procured from Lucknow to adhere to better quality standards. After much market survey, bricks were sourced 16km away from the site, sand and aggregate from Banda just outside Amethi. Master trainers from AVL trained local masons who carried out the construction work under the project.

During construction

5.0 TECHNICAL REVIEW

5.1 Architectural, Structural and Construction observations

- ✓ The hierarchy of spaces within the DUs is well-defined.
- ✓ The window sill levels have been kept low, which provides the additional benefit of allowing light and ventilation more in the lower parts of the room, which is more likely to be used, as the people prefer to sit, work and sleep on the floor.
- ✓ The flooring is generally using kota stone with a marble slab provided for the kitchen shelf. Kota stone is easy to maintain and acquires a shinier and more aesthetic look over prolonged use with regular cleaning and wet mopping.
- ✓ The construction of the DUs using innovative cost-effective technologies like rat-trap bond walling and filler slabs incorporating elements of disaster-resilience is commendable.
- ✓ For vector protection, the doors and windows have been provided with iron nets, which reduce the flow of wind inside, but are a necessary precautionary measure.
- ▪ The plinth was maintained at 450mm above the ground level; however, this has got reduced with development of internal roads and pathways inside the campus post construction of buildings.
- ▪ The RCC chajja projections are inadequate and there is also alack of slab or roof projections. This is causing many walls to get wet.

- Some of these chajjas are pre-cast while some are cast in-situ. Pre-cast chajjasare not advisable for seismic resistance for which a continuous lintel is advisable in zone III.
- There is a 5" free-standing parapet wall which may be falling hazard in earthquakes.
- 16mm rods is said to have been used for anchorage but there are no continuous lintel bands.
- Ventilators are absent, which could have been included in the design of the rooms to ensure that hot air is expelled during the summer months.
- Rain-water harvesting provisions have not been included.
- There is no water supply inside these dwelling units due to the lack of access to electricity. The pump for drawing ground water cannot be used by the beneficiaries because there is no electricity connection to the site. Due to this, the toilets and baths are not being used. This problem is critical and needs to be addressedimmediately.
- During rainy days, the stairs are getting wet, since there are large openings at the landings, and also because the slabs above are not projected. The wall at the half-landing side of the stair especially at its last flight portion could have been continued upwards. This would have prevented the rain water from flowing inside down along the steps, making it dangerous to access during the rains, especially for the children and the elderly.
- Shrinkage cracks are noticed at the junction of the walls and slabs. Bearing plaster could have been used to prevent these shrinkage cracks.

5.2 Socio-cultural aspects:

The inhabitants are basically rural, and in spite of rapid urbanization around them, the village remains more rural than urban. The beneficiary community expressed their desire to have cattle sheds along with the houses as most of them own cattle. Cultural representations like *tulsi-manch* etc. have not been considered; though these are very important to the rural and culturally bound population.The assessment team was of the opinion that the connections between the inside and the outside spaces could have been better established since the beneficiary community here is more rural than urban. There could have been hierarchy of open spaces from single family usage to a cluster etc.

Thebeneficiarieswould have benefited from more connections between the interior spaces and the adjacent exterior spaces through a system of transitional spaces ranging from fully covered building interiors to semi covered to fully open external spaces. However, the project has been constrained in this by the limited land available. It is expected that the flat roofs will likely be put to good use in the summer months as an extension of the indoor sleeping areas, as is common in the traditional rural set up where people tend to sleep outdoors during the summer.

On the ground floor, a door opening could have provided access to the rear of these buildings, where kitchen gardens could have been developed in congruence with traditional rural lifestyles and space usage patterns.

Another design error is that the DUs on the ground floor have been provided with two doors for entry. The door along the stair side is an acceptable solution, but probably the door through the front verandah was not required, instead the verandah could have been provided with a parapet wall for better utilization of space.

5.3 Construction Technologies and Management

The innovative Blending of Cost-effective technologies using locally available building materials and the much-needed multi-hazard resilient principles and climate change adaptation techniques.

Cost-Effective Technologies

- A Load-bearing structure (no use of roof beams and columns, thereby reduction in use of concrete – energy intensive steel, cement and stone chips)
- Local Cost-effective Technologies like Strip foundations in brick masonry, Rat-Trap bonded brick walling, RCC Filler (brick as filler) Slabs for Roofing.

Multi-hazard Resilient Features: efforts towards Disaster Risk Reduction (DRR)

Disaster-resilient principles applicable to geographical locations that is vulnerable to high winds, High Flood Zones and Eq. Zone III

- Vertical anchorage bars at corners and mid-spans running through the walls and fastened with adequate bond length to the roof slabs.
- Raised plinth heights
- Plinth bands

a) Climate Change Adaptation Techniques

- The rat-trap bonded walling is a type of cavity wall, where the air gap in between offers insulations against the intense tropical summer heat and cool winters.
- The filler slab roof is an RCC slab with brick fillers in between. This also resists heat transfer through the roof.
- Thus cool interiors in summers and warm interiors in winters are ensured.

The project construction was managed well by BMTPC, as the project could be completed in time adhering to the stipulated overall quality standards, within the set time-frame and adhering to the budgets in spite of the delays in identifying and acquiring the land for construction.

5.4 Community ownership and participatory process of construction

Once the land was identified and the designs finalized, the beneficiaries were briefed on the design of the houses. The design drawings were also explained and shared with them at the commencement of the project. Therefore, tremendous community ownership was generated right from the onset. This was reflected in the fact that not even a single brick went missing from the site during the entire construction period. This is one of the most appreciable components of the project.

'A participatory process was adopted during the construction process and the beneficiaries also took the responsibility of keeping in safe custody all the building materials and equipment at site," explained a representative of the contractor, AVL.

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6.0 RECOMMENDATIONS AND WAY FORWARD

6.1 As applicable to current project

- Drainage along the approach road to the site is at present a problem, for which the community resolved during the team’s visit to approach the local Nagarpalika for assistance in repair works.

- Boring was done for water supply and pumps were procured. However, there is no running water inside the dwelling units. This is because there is no electrical connectivity in these areas. Thoughts about purchasing and maintaining an electrical generator by the Housing Society were discussed by the team during the visit. However the beneficiaries mentioned that they would not be able to afford the procurement and running costs of the generator.

- The Boundary wall is 5” wall in brick-work with expansion joints in between. A small portion of it has been broken in the front. The community was urged to repair the same at their own cost, to demonstrate their sense of ownership.

6.2 As applicable to future projects

BMTPC’s mission is to work towards an integrated approach for promotion and transfer of potential, cost effective, environment friendly, disaster resilient, building materials and technologies using locally available materials. The current project is a near perfect exhibition of the above mentioned aspects. However, for more effective promotion of the

technologies locally, it would be more effective to build in the promotion of the selected technologies into the project design itself. A small Technology Demonstration Unit consisting of one or two rooms can be constructed at the District Collector's office in order to motivate beneficiaries of the IAY programme to construct their houses using the technologies. The local administration can also be encouraged to build Governmental constructions using such technologies which will instill confidence in the community. One of the hindrances to this approach is that technologies such as Rate Trap Bonded brickwork, filler slab etc do not figure in the State Schedule of rates and BMTPC should spare no effort to work with the concerned State PWDs to include these in the State schedule of rates.

The benefits to the beneficiaries in Amethi and their overall satisfaction should be disseminated to other parts of the country to encourage similar initiatives. The issues of Climate Change Adaptation (CCA) and DRR have been extensively deliberated upon in numerous workshops and seminars in India; ample theoretical studies have been carried out too. But practical demonstrations have been few in India. This effort undertaken on the ground, especially in the construction sector towards integrating affordability, climate change adaptation and disaster-resilient techniques in semi-urban context is a definite step forward towards meaningful sustainable development.

Annexure 1. ASSESSMENT TEAM MEMBERS

- Prof. CVR Murty, IIT Madras
- Prof. Keya Mitra, BESUS, Kolkata
- Hari Kumar, GeoHazards Society, New Delhi
- AnindyaSarkar, Development Professionals Forum, Bhubaneswar

with support from

- AlokBhatnagar, BMTPC, New Delhi

Annexure 2. Comparitive Rate Analysis for Cost effective technolgies and conventional technologies

Annexure 2. A: COMPARATIVE RATE ANALYSIS FOR RAT-TRAP BONDED BRICKWORK

Comparative Rate Analysis for 1 cu.m. of conventional brickwork vs 1 cu.m. of Rat-trap bonded brickwork using 1:6 cement sand mortar

Details of cost of 1 cum

S. No.		Item	Unit	Rate (Rs.)	Conventional Brick Work		Rat-trap bonded brickwork	
					Quantity	Amount (Rs.)	Quantity	Amount (Rs.)
1	Material	Common Burnt clay Non-modular FPS Bricks including carriage	nos.	3.14	494	1551.16	401	1259.14
2	Material	Cement Mortar 1:6 [Rate as per 3.11 of SH mortars]	cum	2825.3	0.25	706.325	0.18	508.554
3	Material	Sundries	LS	1.49	2.73	4.0677	2.73	4.0677
4	Labour	Mason (brick layer) 1st class	day	301	0.47	141.47	0.6	180.6
5	Labour	Mason (brick layer) 2nd class	day	273	0.47	128.31	0.47	128.31
6	Labour	Unskilled labour (Coolie)	day	247	1.8	444.6	0.88	217.36
7	Labour	Unskilled labour (Bhisti)	day	260	0.2	52	0.2	52
		Scaffolding	LS	1.49	22.36	33.3164	22.36	33.3164
				Total:		3061.25		2383.348
				Add water charges @1%		30.6125		23.83348
				Total:		3091.86		2407.182
				Add CPOH @ 15%		463.779		361.0772
				Cost of 1 cum		3555.64		2768.259
				Say		**3556**		**2768**
				Cost of conventional Brickwork per Cu. Metre		**3556**		
				Cost of Rat trap bonded Brickwork per Cu. Metre				**2768**
				Savings per Cubic Metre of Rat Trap Bond brickwork				787
				Approximate Percentage savings				22.14

Annexure 2. B: COMPARATIVE RATE ANALYSIS FOR FILLER SLAB CONCRETING

Comparative Rate Analysis for a conventional slab vs filler slab of 4" thickness

S. No.	Item	Unit	Rate (Rs.)	Conventional Slab		Filler Slab	
				Quantity	Amount (Rs.)	Quantity	Amount (Rs.)
Details of cost of 1 sqm of slab of 100mm thickness							
1	RCC 1:2:4 DSR 2012 Item no 5.3 [excluding cost of centering, shuttering & reinforcement]	cum	5495	0.1	549.46	0.08	439.56
2	Steel Reinforcement [Thermomechanically treated bars] DSR 2012 5.22A-5.22.6	kg	62.25	12	747.00	7.2	448.20
3	Mangalore tiles 20mm th/ Brick including carriage	each	3.14	N/A	0	16	50.24
4	Mason (brick layer) 1st class for aligning bricks/ tiles	day	301	N/A	0	0.1	30.10
Total:					1296.46		968.10
Add water charges @1%					12.96		9.68
Total:					1309.42		**977.79**
Add CPOH @ 15%					196.413		146.67
Cost of 1 sqm					1505.83		1124.45
SAY					**1506**		**1124**
Cost of conventional per Sq metre (assuming 100mm slab depth)							**1506**
Cost of Filler Slab per Sq. metre (assuming 100mm slab depth)							**1124**
Savings per Sq.m							381
Approximate Percentage savings							25.33

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