Cost Effective Building Technology

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1 Shelter Situation Analysis

1.1- Basic General Data

Shortage of dwelling units

As per the conclusions of the Working Committee of the India's 11th Plan (2007-12), the total shortage of dwelling units in India at the beginning of the Eleventh Plan period in 2007 was 15,811,192 out of 249,095,869 families living in India. The total shortages of dwelling units in Tamilnadu State (TN) in India alone are 1,050,624 families out of 16,996,604 families." It is estimated that more than 70 per cent of the shortage of dwelling units are for middle and low income brackets," says the report.

Tackling Urban Housing Shortage

In keeping with the view of changing trends of urbanization, Government has approved National Urban Housing & Habitat Policy, 2007 to replace the existing National Housing and Habitat Policy, 1998. The policy seeks to initiate various measures like public-private participation in land assembly, foreign direct investment, timely formulation and review of Master Plans and Zonal Plans, fiscal incentives for housing sector, strengthening modern technological advances to ensure low cost housing, simplification of various statues, increase in cooperation among Central Government, State Government and Urban Local Bodies etc. It

is expected that the new Policy will give rise to fresh initiatives to tackle the urban housing shortage. In order to cope with massive problems those have emerged as a result of rapid urban growth the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) was launched by the Prime Minister on December 3, 2005 with an objective to provide focused attention to integrated development of urban infrastructure and services in select 63 cities with emphasis on urban poor, slum improvement, community toilets/baths, etc. The Mission has two sub-missions. They are the Basic Services to the Urban Poor (BSUP) and the Integrated Housing and Urban Slum Development Programme (IHSDP). The initiatives have gone a long way in giving impetus to the Government's approach on urban renewal and for improving the quality of life of the urban poor.

1.2- Shelter Related Fact and Figures

Shelter as Pro-poor development

With a population of well over 1 billion people, India is the second most populous nation in the world. According to UN-HABITAT, India is home to 63% of all slum dwellers in South Asia. This amounts to 170 million people, 17% of the world's slum dwellers. As India continues to develop its infrastructure and tries to compete economically with the West, it is important that its poorest citizens are able to work together with government to ensure pro-poor development. As part of the draft National Housing Policy and other earlier initiatives, the Government of India has initiated several States for providing housing for the landless and poorer sections, housing finance, and supply of serviced land, building materials and technology, and removal of constraints on housing activity. These include:-- Earmarked outlays for the construction of houses for landless poor and artisans sections in rural are provided under minimum needs programme; Indira Awas Yojana for providing free houses to SC/ST and free bonded labour in rural areas; construction of night shelters and shelter up gradation for urban poor under Nehru Rozgar Yojana.

Setting up of the National Housing Bank for channelling more resources through Banks and existing housing finance Institutions and promoting new institutions;

Increased flow of resources for Banks, LIC, GIC and Employer's provident funds for housing.

Substantial expansion of operations of HUDCO for financing, land development and urban infrastructure.

Encouraging production of low cost building materials and establishment of building centres for technology transfer and training of workers.

Extension of tax benefits for encouraging private investment in housing and the mobilisation of funds by housing finance institutions

Shelter –A cumulative issue

Shelter issue is not merely a housing problem – it is an education problem and a family problem, and predominantly, it is a poverty problem. We should aim to alleviate the problems of poverty by providing families with the tools necessary to move families out of the shelters and prepare them to live on their own. These include educational resources, job training resources, and Health and Sanitation services. Due to manmade and natural disasters, several million people lose their shelters in India every alternative year.

Affordable Housing

After food and clothing, the most important basic human need is shelter. A major constraint in meeting this demand is the spiralling prices of building materials. This has made the dream of a safe liveable house to go beyond the capacity of a poor family. It is important to go for affordable housing by the beneficiaries by alternative construction options other than the conventional constructions which is very is very expensive. The low-cost shelters are acceptable by the rural population as it has only ground floor but in city slums, the land is the issue and we need to go floors building those are affordable. The Cost Effective Building Technology and community's participation in designing social Housing project as a package is the major component of affordable housing. Low-cost housing or LCH is slowly getting high on the agenda of developers. While this is understandable, because of the enormous gap between supply and demand, what should be worrying is that high land cost, and lack of connectivity owing to poor infrastructure are proving to be major impediments to LCH in India. Add to this, the minimum cost of building. "We can have some saving in cost by doing prefab/new construction technology, however the total saving is not very high," says Mr Vishal Goel, Associate Director, Real Estate Practice, and Ernst & Young. There are workable margins in LCH development, at 15-20 per cent, which are lower compared to gains in high-end projects, he notes, during an interaction with *Business Line* over the e-mail. "It is a moderate risk, moderate return business, whereby volumes give the edge, and ensure the sustainability of steady cash flows to the developer."

Shelter Evaluation

Evaluation of the shelter programme in India should the process of collaborative problem-solving through the generation and use of knowledge. It is a process that leads to corrective action when all levels of users are involved in shared decision-making. Monitoring and evaluation should place throughout the project implementation process, to improve the implementation and planning process, with the active participation of the target participants of permanent shelters. We need to adopt participatory evaluation method which respects the knowledge that the target participants already have and aims to build on this, allowing new knowledge to be generated by the Housing Monitoring committee.

1.3- Housing Policy

Coastal Regulation Zone

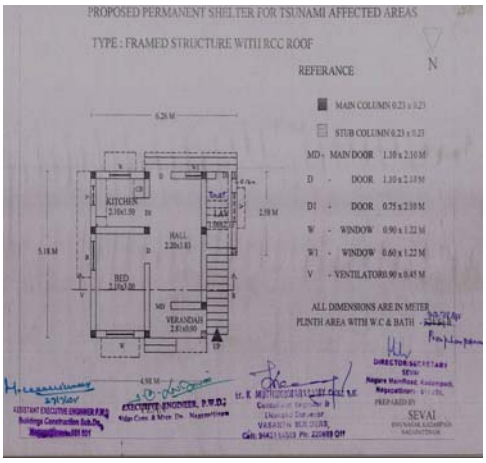
Prior to deciding on the housing project, SEVAI has ensured that the chosen site meets the requirements of Coastal Regulation Zone rules. This housing project had been executed in compliance with the existing and future development plans of the area. The Clearances / permissions had been taken from the Regional offices of the Directorate of Town and Country Planning. All local regulations, such as obtaining permission from the town or village panchayats, had been adhered with. Prior to the selection of the housing site, it was cleared whether the TN Groundwater Authority regulates the abstraction of groundwater in the area.

1.4- Actors in Shelter Delivery and their Roles

The details of the implemented shelter project by SEVAI for the victims of Tsunami:

Poombuhar in Nagapatinam is a village relying almost entirely on the sea - through fishing and prawn farms. In this village 86 people died due to tsunami of 26th December 2004. It is a devastation that nobody had seen or heard of before, has occurred, and devastated their lives. It has destroyed homes, boats, killed men, women, and children indiscriminately. These 518 homes were settled in temporary shelters just after tsunami. SEVAI is able to construct 518 homes for the entire tsunami affected families in Poombuhar. SEVAI possess necessary approval of tsunami house design for construction from the Government officials appropriately. Each home is accommodating a family of five and provides a small backyard, a kitchen, storage and a toilet. The design of the house accommodates the addition of a

second floor in the future. All the beneficiaries had been identified and social engineering components had been implemented with the active participation of these target families. This had been a very challenging work to clear the debris and the safe disposal of the saline water affected damaged building materials.



Single family 32 Sq.metre living area Solid houses for USD 4000

View of Reconstructed Poombuhar Shelters

Disaster Risk Reduction Specifications –followed Advantages.

A) Reduce its mass and make it as light as possible.

B) The structures are rigid enough, making sure that whole structure vibrates together as one unit. Schematically, in such units, the top portions are so joined to the bottom that all movements are transferred immediately from lower levels to the entire building and entire unit vibrates as one rigid body. Consequently, no disharmonious stresses are set up and structure remains safe. We have constructed the structure using horizontal bands at grade beam, continuous lintel and roofing and vertical reinforcement also makes structure more earth quake resistant. The Earthquake proof specifications were strictly provided for these houses like: Footing Mat Reinforcement both ways and the same is designed as 8mm @125mm c/c both ways to withstand the capacity of the Structure both ways for all footings. As per the design verification in Toilet area Column extended up to stub Column. All the stirrups were bent 45 degree with respect to horizontal and anchoring hook length had been 10 dia of the stirrups reinforcement. We Provided Y8 @ 150mm C/c for main reinforcement and Y8@ 175mm for distribution for the toilet roof slab. These were some of the areas given special attention in the tsunami permanent housing and the tsunami survivors tend to go for the first floor in the long run and thus the foundation are strong enough to bear the load of one additional floor for the future extension. Top priority is given for the construction quality in Poombuhar; one is structural and another one is functional.

PERIODICAL TESTING:

SEVAI is periodically testing the concrete quality of bricks and other construction material for its fitness for the Construction purposes and these tests are undertaken by Time Institute for material testing an approved Institute by Government of Tamilnadu for specific Gravity test on fine aggregate; Fineness modules test on fine aggregate; Dry density of coarse aggregate(20 mm);specific Gravity test on coarse aggregate(20mm); Fineness modules test on coarse aggregate(40mm);Finesse modules test on coarse aggregate(20mm);test reports on steel rods; Efflorescence test report on Bricks; test report on bricks, and report on soil investigation etc., for Palayar. All the tests show the quality for ME-20 Standard construction for the Disaster Risk Reduction Houses complying with the Government specifications.

SURVEILLANCE, MONITORING:

The SEVAI team is already closely monitoring the project and gives top most priority for the surveillance, monitoring. We have debuted our senior engineers, quality controllers, construction managers and we also involve the village construction management committee, procurement committee for the materials, store keepers and security for the tight SURVEILLANCE, MONITORING for the construction of earthquake resistant houses.

1.5 Shelter Design:

Key Points Followed In The Earth Quake Resistant Houses:

- PCC 1:5 :10 1.1 Respect the mix of 1 :5 :10 with 17.5cm
- FOOTING CONCRETE 2.1 Foundation: 10mm Dia 9Nos (both side.
- Foundation: 10mm Dia 9Nos with bending 90° at the end
- Foundation: 10mm Dia 9Nos cover to avoid contact with PCC. No contact of water with the steel between PCC and RCC.
- Stirrups: respect 8mm dia, 15cm C/C. 2.5 Stirrups : bending 135°
- Formwork: steel formwork. 2.7 Compact the removed earth
- GRADE BEAM 3.1 3 No’s 12mm Dia in the upper part.
- 12 mm Dia with bending 90° at the end 3.3 Stirrups : bending 135°
- Always using binding wire 3.5 Concrete to be cast in one continuous operation
- Curing of concrete as per checklist. 4. BASEMENT LEVEL
- Houses in the lowland: 9 projected columns and two stub columns.
- COLUMN RAISING 5.1 Stirrups : respect 8mm dia, 15cm C/C
- Stirrups: bending 135° 5.3 Curing of concrete using wet empty gunny bags.

2 Organisation

Background of the Organisation

SEVAI is a non-profit organization functioning since 1975. The founder of SEVAI K.Govindaraju after elaborate consultation and discussions with social minded persons initiated cost effective affordable housing programme in rural and urban slums and also promoted an Integrated Village School for Normal and Handicapped children, promoted Micro-Credit Schemes for round 5000 self help groups for rural Self-Help Women Groups towards their socio-economic upliftment in Pettavaithalai. SEVAI strongly believes that

community is the subject for development and not the object. SEVAI is at present working in 461 Village Communities in Trichirappalli, covering a population about two Hundred Thousand.

Objectives of SEVAI

a) Awareness education and skill development for village youth, b) Rural Construction production, Technologies Agriculture, Agro-industrial and Appropriate Technology. c) Youth and Women Leadership. d) Health and Sanitation ,e)Building cost effective houses for homeless people with a community dimension and f)To initiate and promote co-operation among individuals, organizations and Government agencies having similar objectives.

SEVAI Shelter Focus

SEVAI has established a Rural Technology Centre in Sirugamani as research and development project in the field of cost effective technology in construction of houses, sanitary toilets and other community structures. SEVAI has been involved in promotion of eco-friendly, cost- effective with appropriate, quality permanent/temporary housing project as a package for more than a decade in some 72 villages in Tamilnadu and Pondicherry Union Territory. It's one of the role is to support building and construction projects in rural, slums and catastrophe affected regions in Tamilnadu and Pondicherry. The progress they have made in improving the lives of rural, slum and disaster victims in Tamilnadu is unique. SEVAI has strong opinion that the target community is the agent for its own development; the user group is the subject in the development process and definitely they are not the objects in the community development through Housing project. People's participation in all stages of construction process, continuous effort by the target community, adopting the innovative, eco-friendly cost effective technology and bringing the changes in people's attitudes are the key indicators in the cost-effective housing project. SEVAI over the years constructed around 5000 homes in rural, urban slums and catastrophe hit areas such as tsunami, cyclone, floods, eviction of encroachment dwelling units and fire. In the tsunami region, SEVAI has no other options other than the conventional housing with Disaster Risk Reduction specifications as required by the authorities and constructed 1280 homes for tsunami victims in Nagapatinam and Karaikal.

Low cost housing training centre

Working Methodologies:

These methodologies are formerly referred to as Participatory Rural Appraisal (PRA) and nowadays as Action Oriented Learning (AOL), which have their origin in Shelter community development efforts. . It is a growing family of approaches, methods, visual tools and interactive techniques, which enable community members to share their knowledge, analyze their situation, voice their priorities, plan collective actions, monitor the implementation and assess the impact together. The different aspirations of women and men, young and old, and vulnerable groups are considered thoroughly. The team of Housing Monitoring committees, WATSAN committee, health ambassadors, village health volunteers, peer educators, adopted basic principles, tools and techniques for participation and involvement of the community in all the stages of the program: collection of data and analysis, planning, implementation, monitoring and evaluation. As SEVAI team enjoys a good rapport with the government officials and the affected population, this strengthens our team in utilizing the locally available resources of the target villages to promote this Shelter Completion programme in an integrated manner.

SEVAI mostly adopted the cost effective/low-cost options in most of its housing programme. We adopt participatory methodology wherein the target beneficiaries participate actively from planning, designing, implementation, monitoring and sharing of benefits under this Shelter Completion Program. Field verification, Records and documentation of the same are maintained appropriately. SEVAI has materialised all the foreseen dangers or threats with

reference to the milestones for progress towards the reduction and control of the principal risk factors, as also defined in the "Opportunity and Risk Appraisal".

3 Shelter Problem

Shelter Work done

SEVAI constructed 1280 homes for the tsunami victims with the Disaster Risk Reduction specifications in the coastal Tamilnadu. SEVAI followed the Indian Construction code for M-20 Standard for the risk reduction in the areas of Earthquake, floods and fire. As per the Indian construction code we were not able to apply the cost effective shelters specifications such as Random Rubble Foundation, Rat trap walling, Wood free Arch doors and window openings and roofs such as filler slabs and Ferro cement roofs.

Issue

SEVAI has wide experience in the area of construction of cost effective (Low Cost Shelters) which is affordable by the middle class and the below middle class. Due the regulations, as we were supposed to follow the conventional Indian standard code, the cost of single home had gone to market value. As NGO SEVAI would have saved around 30% amount if we would have been permitted to apply the cost effective technology. As we are forced by Indian Authorities we had to follow the conventional technique which coasted almost same as the market value. The cost is not affordable by the community and it is expensive than the cost effective homes implemented by SEVAI elsewhere and as per the experts of the tsunami area; SEVAI was forced to construct a home of 33sq.metre area with RCC roof with Staircase facilities at a cost of USD 4000. The problem is that the Disaster Risk Reduction specifications housing for tsunami victims goes beyond the capacity of a poor person for the construction of homes on his own/even by a local NGO.

The expectation from the training

The expectation from the workshop is that how to construct homes with Disaster Risk Reduction -DRR Specifications with affordable cost in a cost effective and energy efficient and eco friendly homes in such coastal region. Is there any other technology and design available for the construction of affordable housing in Disaster Risk Reduction areas.

4 Proposal for Change and Improvement

SEVAI initially wanted to follow the alternative construction methods for the tsunami victims' families Such as Arch Foundation, Rat-trap walling, filler slab roofing, Arch doors and windows etc, which would have coasted around 2500 USD whereas SEVAI spent 4000 USD for such a housing. I would like to learn the alternative construction techniques accepted by sphere standards for DRR (Disaster Risk Reduction) housing at low-cost so that we can reach many most needy in the area of Shelter requirements. The expectation from the workshop is that how to construct homes with Disaster Risk Reduction -DRR Specifications with affordable cost in a cost effective and energy efficient and eco friendly homes in such coastal region. Is there any other technology and design available for the construction of affordable housing in Disaster Risk Reduction areas.

Low Cost Housing is a new concept which deals with effective budgeting and following of techniques which help in reducing the cost construction through the use of locally available materials along with improved skills and technology without sacrificing the strength, performance and life of the structure. There is huge misconception that low cost housing is suitable for only sub standard works and they are constructed by utilizing cheap building materials of low quality. The fact is that Low cost housing is done by proper management of resources. Economy is also achieved by postponing finishing works or implementing them in phases.

Building Cost:

The building construction cost can be divided into two parts namely:

Building material cost	: 65 to 70%.
Labour cost	: 35 to 30 %

Now in low cost housing, building material cost is less because we make use of the locally available materials and also the labour cost can be reduced by properly making the time schedule of our work. Cost of reduction is achieved by selection of more efficient material or by an improved design.

Areas from where cost can be reduced are:

1. Reduce plinth area by using thinner wall concept.Ex.15 cms thick solid concrete block wall.

2. Use locally available material in an innovative form like soil cement blocks in place of burnt brick.
3. Use energy efficiency materials which consume less energy like concrete block in place of burnt brick.
4. Use environmentally friendly materials which are substitute for conventional building components like use R.C.C. Door and window frames in place of wooden frames.
5. Pre-plan every component of a house and rationalize the design procedure for reducing the size of the component in the building.
6. By planning each and every component of a house the wastage of materials due to demolition of the unplanned component of the house can be avoided.
7. Each component of the house shall be checked whether if it's necessary, if it is not necessary, then that component should not be used.

Cost reduction through adhoc methods

Foundation

Normally the foundation cost comes to about 10 to 15% of the total building and usually foundation depth of 3 to 4 ft. is adopted for single or double store building and also the concrete bed of 6″ (15 Cms.) is used for the foundation which could be avoided. It is recommended to adopt a foundation depth of 2 ft. (0.6m) for normal soil like gravely soil, red soils etc., and use the uncoursed rubble masonry with the bond stones and good packing. Similarly the foundation width is rationalized to 2 ft.(0.6m).To avoid cracks formation in foundation the masonry shall be thoroughly packed with cement mortar of 1:8 boulders and bond stones at regular intervals. It is further suggested adopt arch foundation in ordinary soil for effecting reduction in construction cost up to 40%.This kind of foundation will help in bridging the loose pockets of soil which occurs along the foundation. In the case black cotton and other soft soils it is recommend to use under ream pile foundation which saves about 20 to 25% in cost over the conventional method of construction.

Plinth:

It is suggested to adopt 1 ft. height above ground level for the plinth and may be constructed with a cement mortar of 1:6. The plinth slab of 4 to 6″ which is normally adopted can be avoided and in its place brick on edge can be used for reducing the cost. By adopting this

procedure the cost of plinth foundation can be reduced by about 35 to 50%.It is necessary to take precaution of providing impervious blanket like concrete slabs or stone slabs all round the building for enabling to reduce erosion of soil and thereby avoiding exposure of foundation surface and crack formation.

Walling

Wall thickness of 6 to 9″ is recommended for adoption in the construction of walls all-round the building and 41/2" for inside walls. It is suggested to use burnt bricks which are immersed in water for 24 hours and then shall be used for the walls.

Rat – trap bond wall

It is a cavity wall construction with added advantage of thermal comfort and reduction in the quantity of bricks required for masonry work. By adopting this method of bonding of brick masonry compared to traditional English or Flemish bond masonry, it is possible to reduce in the material cost of bricks by 25% and about 10to 15% in the masonry cost. By adopting rat-trap bond method one can create aesthetically pleasing wall surface and plastering can be avoided.

Concrete block walling

In view of high energy consumption by burnt brick it is suggested to use concrete block (block hollow and solid) which consumes about only 1/3 of the energy of the burnt bricks in

its production. By using concrete block masonry the wall thickness can be reduced from 20 cms to 15 Cms. Concrete block masonry saves mortar consumption, speedy construction of wall resulting in higher output of labour, plastering can be avoided thereby an overall saving of 10 to 25% can be achieved.

Soil cement blocks technology

It is an alternative method of construction of walls using soil cement blocks in place of burnt bricks masonry. It is an energy efficient method of construction where soil mixed with 5% and above cement and pressed in hand operated machine and cured well and then used in the masonry. This masonry doesn't require plastering on both sides of the wall. The overall economy that could be achieved with the soil cement technology is about 15 to 20% compared to conventional method of construction.

Doors and windows

It is suggested not to use wood for doors and windows and in its place concrete or steel section frames shall be used for achieving saving in cost up to 30 to 40%.Similiarly for shutters commercially available block boards, fibre or wooden practical boards etc., shall be used for reducing the cost by about 25%.By adopting brick jelly work and precast components effective ventilation could be provided to the building and also the construction cost could be saved up to 50% over the window components.

Lintels

The traditional R.C.C. lintels which are costly can be replaced by brick arches for small spans and save construction cost up to 30 to 40% over the traditional method of construction. By adopting arches of different shapes a good architectural pleasing appearance can be given to the external wall surfaces of the brick masonry.

Roofing:

Normally a 5″ (12.5 cms) thick R.C.C. slab is used for roofing of residential buildings. By adopting rationally designed insitu construction practices like filler slab and precast elements the construction cost of roofing can be reduced by about 20 to 25%.

Filler slabs

They are normal RCC slabs where bottom half (tension) concrete portions are replaced by filler materials such as bricks, tiles, cellular concrete blocks, etc. These filler materials are so placed as not to compromise structural strength result in replacing unwanted and non-functional tension concrete, thus resulting in economy. These are safe, sound and provide aesthetically pleasing pattern ceilings and also need no plaster.

Jack arch roof/floor

They are easy to construct, save on cement and steel, are more appropriate in hot climates. These can be constructed using compressed earth blocks also as alternative to bricks for further economy.

Ferro cement channel/shell unit

Provide an economic solution to RCC slab by providing 30 to 40% cost reduction on floor/roof unit over RCC slabs without compromising the strength. These being precast, construction is speedy, economical due to avoidance of shuttering and facilitates quality control.

Finishing Work

The cost of finishing items like sanitary, electricity, painting etc., varies depending upon the type and quality of products used in the building and its cost reduction is left to the individual choice and liking.

Lobbying with Government

For the construction of houses, the building materials are being used with Central and State excise-8%, Value Added tax -4% Tax deducted at source -4% for the materials such as steel, cement, prefabricated door frames and window frames, and all the steel related items such as lock etc. 8% tax deduction for both central and state excise duty can also requested for exemption for Mangalore tiles. The sand and filling sand can be collected without duty to the Government for those houses constructed for the poor and disaster affected families. Thus the overall cost can be reduced by 20% from the open market. For example cement in the open market is available for Rs.275 for 50 kg bag and we need 200 bags for one house of 320

sq. feet .The Government can supply at a cost of Rs.200 per bag by waiving all the taxes. The steel we need for one house is one tone and the steel cost per tone is Rs.36000, we can request for 8% tax waiving for cement. Sand requirement for one house is 30 units and open market rate is Rs.1200 per unit and we can get at a cost of Rs.800 per unit if all taxes waived. For other materials 4% tax deductions can be requested. By lobbying with Government for the houses for the disaster victims, the cost can very well brought to 80% from the open market cost. We need to make advocacy and lobbying with the Government.

Conclusion

The above list of suggestion for reducing construction cost is of general nature and it varies depending upon the nature of the building to be constructed, budget of the owner, geographical location where the house is to be constructed, availability of the building material, good construction management practices etc. However it is necessary that good planning and design methods shall be adopted by utilizing the services of an experienced engineer or an architect for supervising the work, thereby achieving overall cost effectiveness to the extent of 25% in actual practice.