

# The Deliverance System for mass Housing for the Urban Poor in India, using Bamboo as an Alternative Building Material

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**Abstract-** For Bamboo to become a mainstream material of the building industry, as a material of substance; an up scaled value of its utility and its deliverance is where research energies have to be spent. Resolution of primary technical issues make it even more compelling to focus on why bamboo construction is not popular despite possessing qualities needed for structural members in tension. Prima Facie; more than the structural vulnerability, appearance, fire and insect attack proneness affecting durability; it is the resolution of the issue of finance, the legal status and the detailed implementation strategy, that appear to be of a greater urgency.

To hand over a dwelling unit to its owner, an extra cost amounting to 28% is incurred in urban areas. The conventional system of a “financed house” becomes financially burdensome and cannot be a solution for the poor. An appropriate Deliverance system for mass housing for the Urban Poor in India, using Bamboo as an Alternative Building Material is therefore an urgent requirement.

**Index Terms:** Alternative Material, Bamboo, Cost Cutting, Deliverance Mechanism, Mass Housing, Urban Poor;

## I. INTRODUCTION

**B**amboo has proven to be a technically sound material for construction of dwelling units for the urban poor. However its low popularity index still requires to be questioned especially among the urban poor. The technical solutions lower costs to an extent after which Housing finance Institutions take over the task of delivering them to the target group.

The poorest of the poor are unable to afford even the low cost house designed using bamboo as the key material for construction without financial assistance. At the technical level any further reduction cannot be without a compromise in the standards of safety quality, durability and adequacy in size and number of rooms or services. The concept of mass housing is with the understanding of bulk economy and the economies of scale, repetition and template development and implementation.

Similarly creative housing finance models have to be developed prescribing clearly about who does what so as to reduce overlapping of procedures and prevention of losses that may occur due to non application of economical financing methods

and deliverance of housing to the target group – in this case the Below Poverty Line households, seeking finance for funding the purchase of a house.

While the utility of engineered bamboo construction cannot be ignored for it to enter the urban housing market it shall require simple thumb rule “template” construction techniques, with an in-built quality of repetitiveness of procedures and methods.

On closer analysis of the National Policies it is clear that what gets promised is what is “Possible to be built in a small budget while keeping the technology constant” and certainly not what is “desirable” or “acceptable” in terms of size and number of rooms. A unilateral decision on compromise of standards is being made uniformly across the country, thereby reducing the area, size of rooms, and number of rooms. Any constraints in exploring possibilities about material, design, technology or creative financial options will affect affordability

## II. PRE DELIVERANCE COST CUTTING SYSTEMS

### A. Scale:

In order to be able to substitute the energy guzzling construction materials, at that high a scale as is required for mass housing, parallel activities involving plantation, drying, seasoning and chemical treatment have to be promoted and up scaled as separate units, as an extension of a “focused agro-based employment scheme” for small and marginal farmers. The product would thus be “especially and exclusively treated bamboo for the purpose of mass housing for the urban poor, following the customized design specifications and construction details.

“Cost reductions through the development of new materials and methods are difficult to come by. Often other costs - services, materials, land, energy, and skilled labor – rise fast enough to over shadow these savings. Clearly modern Technology by itself has not yet provided an answer, and very few realists now believe that it will”. (Angel Shlomo and Stanley Benjamin [1])

### B. Templates:

The technical scope of the research, involves identifying that very specific template treatment process, which can convert

bamboo into a suitable reinforcement material in concrete for structural elements in a humble dwelling unit.

### C. Incremental Housing

Another unexplored possibility is that of phasing out the construction, so that it is affordable at certain given points of time, when constructed incrementally. Frequent small expenditures, spaced out as per the need, urgency for construction, or availability of bulk money through saving or an event resulting in an income peak, has a higher probability of being affordable.

“The Aesthetic desire to produce finished product housing units and all their associated facilities including schools, markets, hospitals, recreation parks, playgrounds, movie theatres, and places of employment – gives rise to the myth of completeness. Yet the vast majority of the third world housing is built in small increments over long periods, and communities take shape slowly over time as needs are felt and money becomes available.” (Angel Shlomo and Stanley Benjamin [2])

### D. Speed of Construction

To expedite the speed of construction, an intensive use of prefabricated bamboo components is recommended.

Engineered bamboo provides more options for increasing speed of construction. Assertive reactions from experts who had been interviewed indicated that whole bamboo has failed to live up to social urbane image and lacked the robustness required for flexibility in planning and designing.

The inability to go multi storied using whole bamboo would create tremendous pressure on urban land creating an artificial freeze in the land market. This would create an imbalance in the demand and supply for public projects and lead to unwarranted increase in land prices, making un-affordability not only an irreversible phenomenon but also widespread

### E. Standardization of Economical Spans for Mass Application

For a modest Dwelling Unit, an economical span of 10-12 feet is considered fairly appropriate and is found to be economical even if steel reinforcement were to be used. Large spans are not possible in bamboo; hence it would prove to be ideal for a small dwelling unit. Though *Dendrocalamus Strictus* is known to grow up to a height of 40 feet, it is the tapering of the diameter of the bamboo culm, with height, that makes it difficult to get splints of uniform cross-sectional area as reinforcement, for very long lengths.

### F. Technical Procedures and Precautions

What are those precautions that are needed to be observed, while converting bamboo into a suitable reinforcement material in concrete for structural elements? The outcome of the detailed technical study by Prof. Falade of Nigeria made bamboo splices ready for reinforcement if the surface was treated to create friction to form a bonding key with concrete, an equivalent of tor

steel, as against plain MS bars with hooks used in the early 80s for the same purpose, i.e. - prevent concrete to slip, on shrinking.

When comparing the equivalence of the quantity of reinforcement required for a beam or a column out of bamboo and steel respectively, it is observed that the former requires a larger proportion of cross-sectional area than the latter for a given factor of safety, load, load type, and span / height as the case may be.

At the next level of refinement of structural design, the same study concluded by recommending that the extra cross sectional area required for BRC, be compensated not by larger cross sectional area of individual bamboo splints, but a larger number of splints, each with a smaller cross-sectional area. This harnesses the full potential of the tensile property of bamboo splints. Slimmer the splint, larger is the tensile strength.

The overall cross-sectional dimensions of beam/column/slab using BRC are required to be larger than those in the case of SRC. While a remarkable saving in the quantity of steel used for the structure can be achieved, a resulting increase in the quantity concrete is indicative of some amount of marginalization in the monetary saving. However the environmental benefits cannot be ignored.

Friction issue is resolved by wrapping a layer of bitumen around the splints and tying a thin wire around them to create an undulated rough surface. It serves a dual purpose of preparing for effective strong bonding as well as waterproofing so as to prevent the dampness from the wet concrete mix from penetrating bamboo splints and causing decay.

How to save quantity of concrete is yet another offshoot for research, and might lead to alternative materials, additives or a completely new technology. Saving of concrete in SRC is not totally unknown and structural engineering practices do already exist. To find parallel methods which can be used for BRC can be a study in itself

Most bamboo culms available for building purposes have gone through some treatment. A slight modification to the process could render it appropriate, even if it means a slight increase in the market prices of treated bamboo.

Given its limitations and potentials, how can they be best countered or harnessed, as the case may be? Having achieved this, through technical research, a methodology for a systematic dissemination of the procedure from plantation to harvesting to the final availability of bamboo as a ready material for use in construction was worked out. As and when these are made known to prospective agencies that will be involved in low cost mass housing projects for the Urban Poor, bamboo will have succeeded in its utility as a construction material for mass housing.

The agencies will be a new cadre of specially trained manpower in handling such projects. Training of all the related personnel specially deputed for the first few years in handling finance, technology, and legalities along with distribution of DUs among

the target group (in this case the Urban Population below Poverty Line) will be part of their skill sets. They will be implementers of smaller action plans either location specific or activity specific.

Training schedules and content will be designed accordingly. Unless policies are converted into programmes, programmes are converted into projects, projects are converted in small action plans, carried out by heterogeneous groups of multi-tasking professionals, who can take responsibility of hands-on delivery of housing, Bamboo technology, would forever remain a part of ambitious Policies.

### III. THE LEGAL, ADMINISTRATIVE AND FINANCIAL MACHINERY FOR IMPLEMENTATION

#### A. Guidelines for Special Area Policies

a national level (special area) strategy has to be proposed. The objective of the analysis is for making a DU thus designed, to become a part of the mainstream housing, with a limited agenda of:

Streamlining the financial/ administrative /local level machinery so that special bye laws are framed for dwelling units using bamboo for their construction. These could extend over seismic zones which may have bamboo readily available

Special relaxations in criteria for housing finance for bamboo houses meant for the urban poor to increase access to loans cross subsidy and property insurance etc.

Training for pre-processing / treatment and customizing bamboo for its use as reinforcement

### IV. CREATE AN ECONOMIC ENVIRONMENT

#### A. A Parallel Construction Industry

##### 1) Structural design measures

Measures and their combinations could transform bamboo into an appropriate material for all the Key building components. It can be considered as a material that can partially replace the key building materials which add up to form a major part of the cost. A material technology that could make architectural design fairly functional, durable, safe, green, climate responsive, affordable and socially acceptable.

##### 2) Treatment related measures

Measures need to be taken to treat bamboo technically up to such a level of fineness, that it gets qualified as a structurally safe and durable material for construction, enough to attract bankers financiers and other funding agencies, rendering it as an appropriate material for mass housing. This would also involve speed of construction, but is outside the scope of this study. A material technology that could redefine architectural design thus making room for a totally new segment and variant called parallel housing. It is only then that the technical innovations can find a market even among the Urban Poor, residing close to bamboo producing regions.

##### 3) Measures for design of techno financial model systems

Measures need to be evolved to formulate techno – financial models which would operationally transform an architecturally designed bamboo house into an easily accessible commodity which can be treated as an asset or an investment, attracting speculation for its value appreciation.

##### 4) Architectural design related measures

It could be visualized as a material which shall simultaneously create a parallel construction Industry, while also being commercially beneficial for the owner. This would encourage investment in a bamboo house. This phenomenon is already in existence among the urban poor, but the properties in most cases are shanties, with a very short life span, hence the values do not appreciate in consonance with the other pucca properties around the same area. Hence the commodity continues to remain at unattractive levels of commercial interest.

As such it becomes imperative to formulate a set of standards for the use of bamboo as a structural material, along with guidelines and regulatory measures, integrated into the National building Code as special specific byelaws for bamboo growing regions.

### V. A STRUCTURED SUPPORT SYSTEM FOR BAMBOO REGIONS

#### A. Corrective Measures

The research in the area of identifying technical corrective measures is only a small part of the exercise. An equally rigorous follow-up exercise to have the systems in place and to evolve standards, codes, byelaws and charters will be required. To ensure the delivery and distribution of affordable housing, using a renewable material such as bamboo, so as to reach the target group

#### B. Financial Management

A parallel research on financial management evolving soft criteria for offering cheap loans, subsidies and formulating social security measures to extend over the right to modest housing and humane living environment for the poor under the provisions of Article 43 which currently focuses only on just and humane environment for work.

#### C. Insurance and Financial Security

Insurance facility against fire, theft, death along with medical insurance to promise financial security will have to be dovetailed to the package of benefits and privileges legitimately acquired by a citizen.

#### D. Acceptance of the Phenomenon of Migration

The Policies have to be thoughtfully framed in order to embrace the phenomenon of migration and accommodate the migrants willingly, instead of allowing them to stay informally on unauthorized patches of land within the city disrupting the rhythm of the city, through overloading the infrastructure which was never meant for them.

### *E. Incentive Package and Fast Clearance of Bamboo House Applications*

Simultaneously the administration wings created especially for the owners of low cost houses out of Bamboo, with special provision for smooth and fast clearance of applications for building bamboo houses, and if possible even providing an incentive package.

### *F. Monitoring Controlling Networking and Training*

The monitoring and control network, the training institutes to provide parallel hands-on education, and the active involvement of voluntary agencies, NGOs, grass-root level workers, and elected representatives, sanitation engineers along with self help groups, all shall have to work in coordination. Funding agencies and research labs providing innovations, and break-through in the bamboo construction field. Construction of architectural live models, for active promotions and display, to attract those who are willing to experiment with construction of bamboo houses, may have to be an integral part of the program. Capacity building measures must precede the actual construction boom for bamboo housing in order to cater to the demands of mass housing. Building components, partially replaced with bamboo shall be used to arrive at permutations and combinations, for creating a variety of architectural designs, which would also provide choices for selecting the one that would best suit the budget, and monthly instalments for the repayment of loans.

### *G. Redefining a Pucca House*

Last but not the least is the political will and the correction in the census definition of a pucca house, for the inclusion of composite bamboo housing to make it easy for such house owners to treat it as an asset through-out its life span.

## VI. SIMPLIFICATION OF TECHNOLOGY AND PROCEDURES

If bamboo technology is made convenient to handle, promoted along with standards, codes and bylaws, tied up with the legal and the financial machinery, then the entire package put together could go a long way in eliminating houselessness. Once a gateway is created for bamboo, all other alternative materials and technology would follow.

Prof. Falade, who experimented with Bamboo Reinforced Concrete, proved that it is a reinforcement which can be, designed in just the same way as Steel reinforced concrete with a few extra precautions. This and many other findings can make bamboo frog leap into the mainstream market and offer great relief to the Houseless and the very poor.

## VII. COORDINATION AMONG MULTIPLE AGENCIES

While the Policies may have an ambitious and well intended package in place for minimizing houseless population and eliminating housing shortages, some of these require fine coordination among multiple agencies. Historically, multiplicity of functions and overlapping of jurisdictions have been the cause for the failure policies, schemes and programs. Limiting the

scope of this study to providing a cheaper solution for constructing a house using Bamboo Reinforced Concrete for the Key structural elements, replacing steel has proved to be technically feasible.

## VIII. SEPARATE STANDARDS TO BE EVOLVED

However; some of the important housing terminology needs to be redefined, in order to have the benefits of the research to reach the urban poor living close to bamboo growing regions; Translating the design into a series of standard thumb rules will make it easy for construction, thereby eliminating the involvement of engineers, contractors and architects, further contributing to cost reduction.

## IX. AWARENESS BUILDING

Awareness Manpower Training is yet another area for action for effective promotion of innovation through lab land transfer furthering the objective of employment generation and self help working environment.

## X. DESIGN GUIDELINES

### *A. Alternative Materials to be Used Based on Merit*

It has to be noted that all alternative materials unconventional materials do not result in a kutchra house. In fact if the damage and destruction caused due to failure of structural design, were to be included in the cost benefit analysis, most unconventional material would qualify as being pucca in the sense of being safer if not durable.

### *B. Habitability is Not a Function of Durability*

A Pucca house despite being durable, safe and secure can still be inhabitable by virtue of its size, climate non responsiveness, persons to room ratio.

### *C. Hidden Costs Add to Non-Affordability of Pucca House*

A pucca house can be durable, safe secure, habitable and still be unaffordable on account of other hidden costs, including travel and other betterment, processing and user charges, taxes etc.

### *D. Hidden Costs Add to Non-Affordability of Kuccha House*

A so called Kutchra (temporary) house (using parallel technology) can also be durable, safe secure, habitable and still be unaffordable on account of its inherent capital cost, other hidden costs, including travel and other betterment, processing and user charges, taxes etc.

### *E. Adequacy Cannot be Sacrificed in the Name of Affordability*

Affordability cannot be equated to size of the house infinitely as being inversely proportional to it, but must stop at a point when it starts to get inhabitable or inadequate. Affordability has to be delinked from minimum size and number of rooms required by a given household.

A pucca (permanent) house cannot be made affordable, unless the safety, size, and quality are partially sacrificed. Housing and Infrastructure cannot be mutually exclusive. Habitat not Housing

is what needs to be planned for. Each being valueless, without the other.

While defining affordability of dwelling units, other miscellaneous hidden costs may mean nothing at higher levels of income, but at Below Poverty Levels, these constitute a large proportion of the household income, and can tilt the balance between affordability or otherwise. Costs of all kinds, including notional, running, sunk, opportunity are more relevant in the case of the Urban Poor, than for higher incomes.

Sensitivity to loss, like a single non earning day could create far more turbulence in the life of a BPL household, than for higher income groups, hence tax holidays, subsidies, grants and waivers to be integrated with other resilient fiscal planning measures capable of absorbing non-repayment or untimely repayment offering flexibility to borrowers.

Similarly, expenditure on extra travelling, for each member of the household due to relocation (if any) could also affect affordability, in which case relocation compensation measures to be in- built in the form of subsidized travel costs using renewable BPL concession passes or travel cards.

#### XI. RECOMMENDATIONS FOR COST CUTTING DURING THE PROCESS OF DELIVERANCE OF HOUSING

Having understood poverty, the plight of the urban poor, the possibilities and constraints, it is clear that an approach needs to be adopted, which identifies the constants and the variables, and the limits the floor and ceiling cut offs for Below Poverty Line category.

The increase in costs during the process of handing over a DU to the urban poor cannot be the same as for those at higher income groups. The system evolved has to be devoid of expenditure to the poor. Hence clearly defined roles are required for the stakeholders involved in reaching out to the target group in question.

#### XII. THE ROLE OF STAKEHOLDERS IS DEFINED AS FOLLOWS

**Table 1: Recommended Role of Various Agencies in Cost Reduction**

<b>Objective : Minimum EMI/ Rent for Below Poverty Line</b>		
<b>Who</b>	<b>What</b>	<b>How</b>
Central Govt. Policy	5-Year plan provisions, Definitions	Annual budgets, Tax exemptions, special target group specific/ area specific exclusive policies, Cross subsidies, modify definitions
Central Government, State Government, Local body, Architect + Structural Engineers + Contractors	Development Control Rules, building Bye Laws, Schemes, Definitions	Design, Supervision, Choice of Material, Specifications Technology special byelaws for Urban Poor
Banks, HFIs.	Special cheaper Loans, Subsidies	Minimize paperwork procedural matters.
Local bodies	Through Development control rules, Master Plan Allocation & Land-use plan	Special land reservations, Relocation schemes and regularization of unauthorized settlements Issue of relevant concession cards for use of public transport,

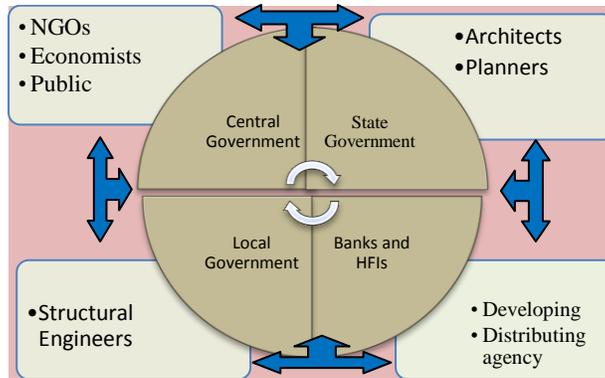


Fig 1. (a) Hierarchy of Roles

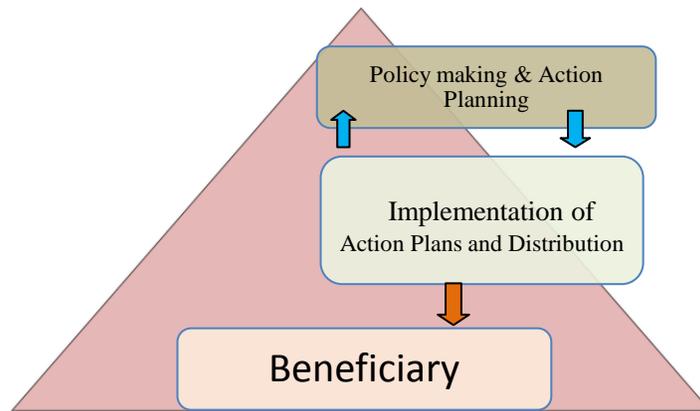


Fig 1. (b) Hierarchy of Roles

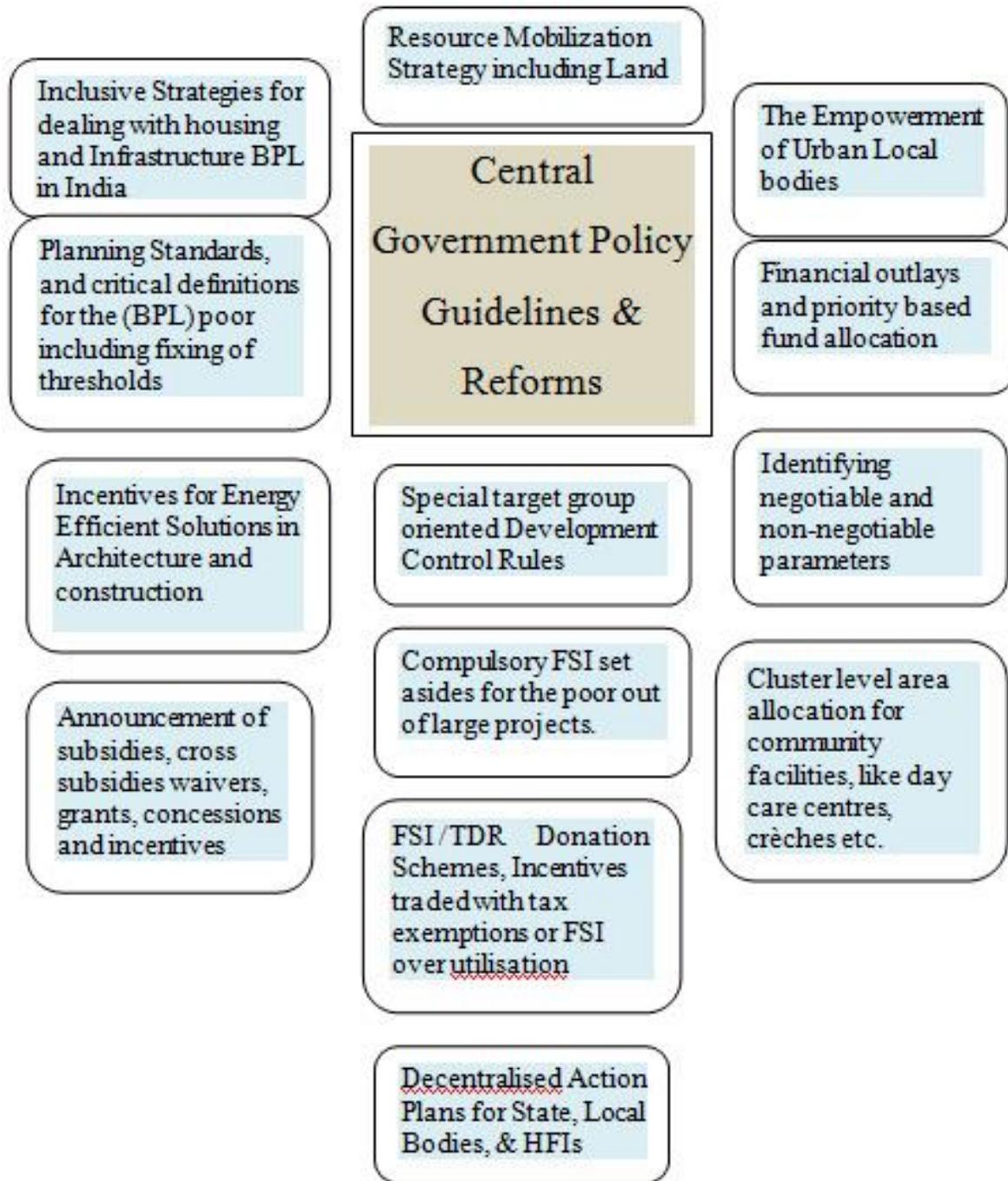


Fig 2. Role of Central Govt.

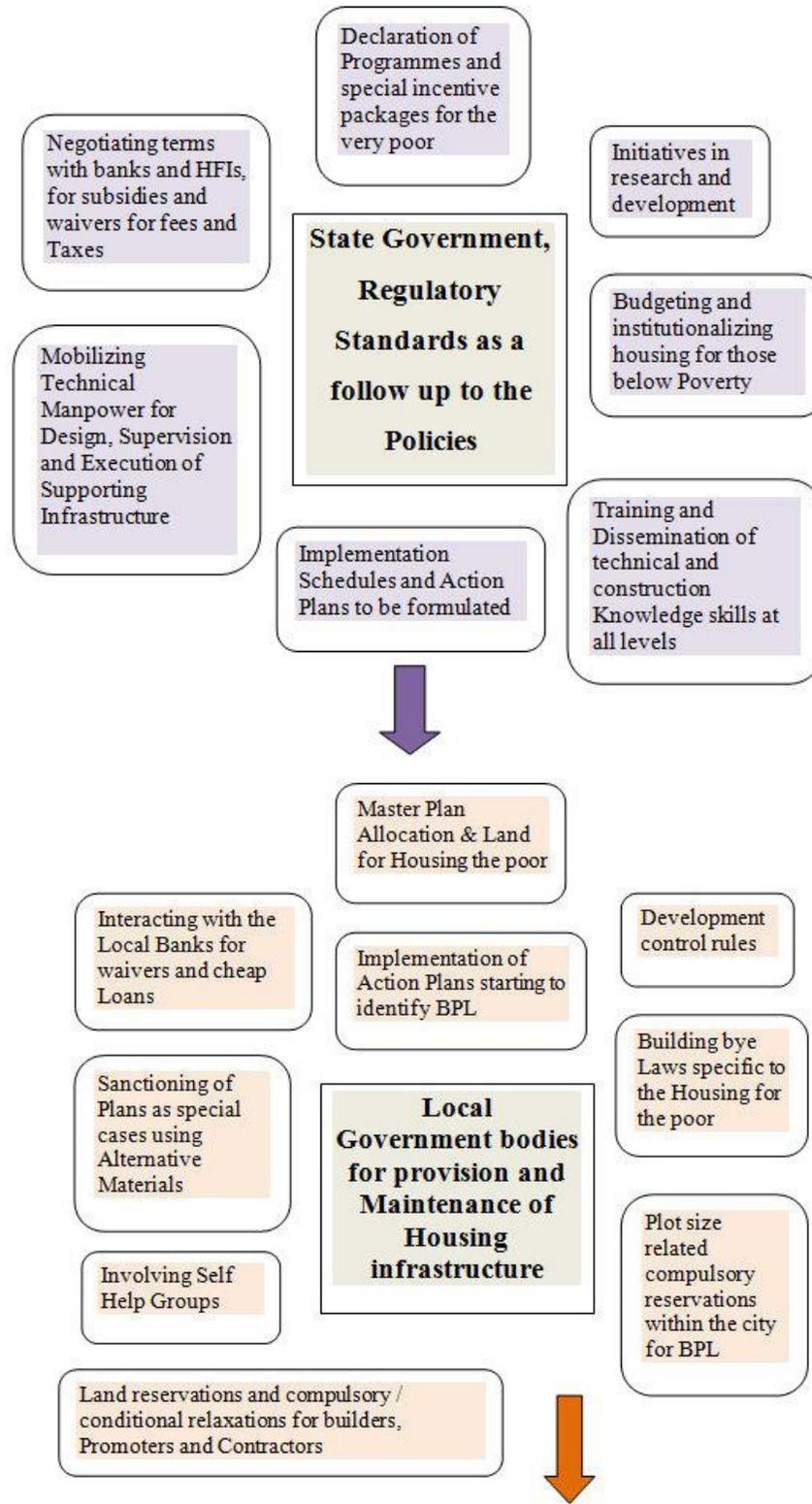


Fig 3. Role of State Govt. and Local Govt. bodies

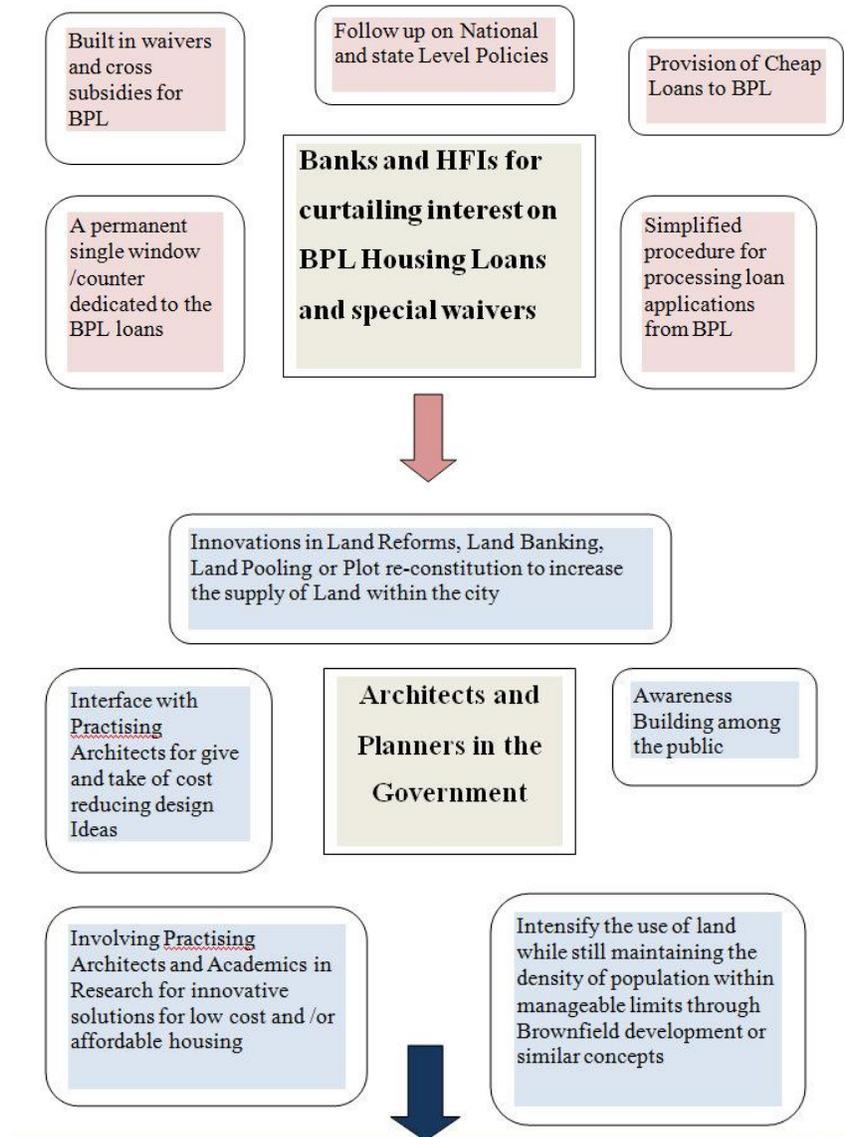


Fig 4. Role of architects and planners in Govt.

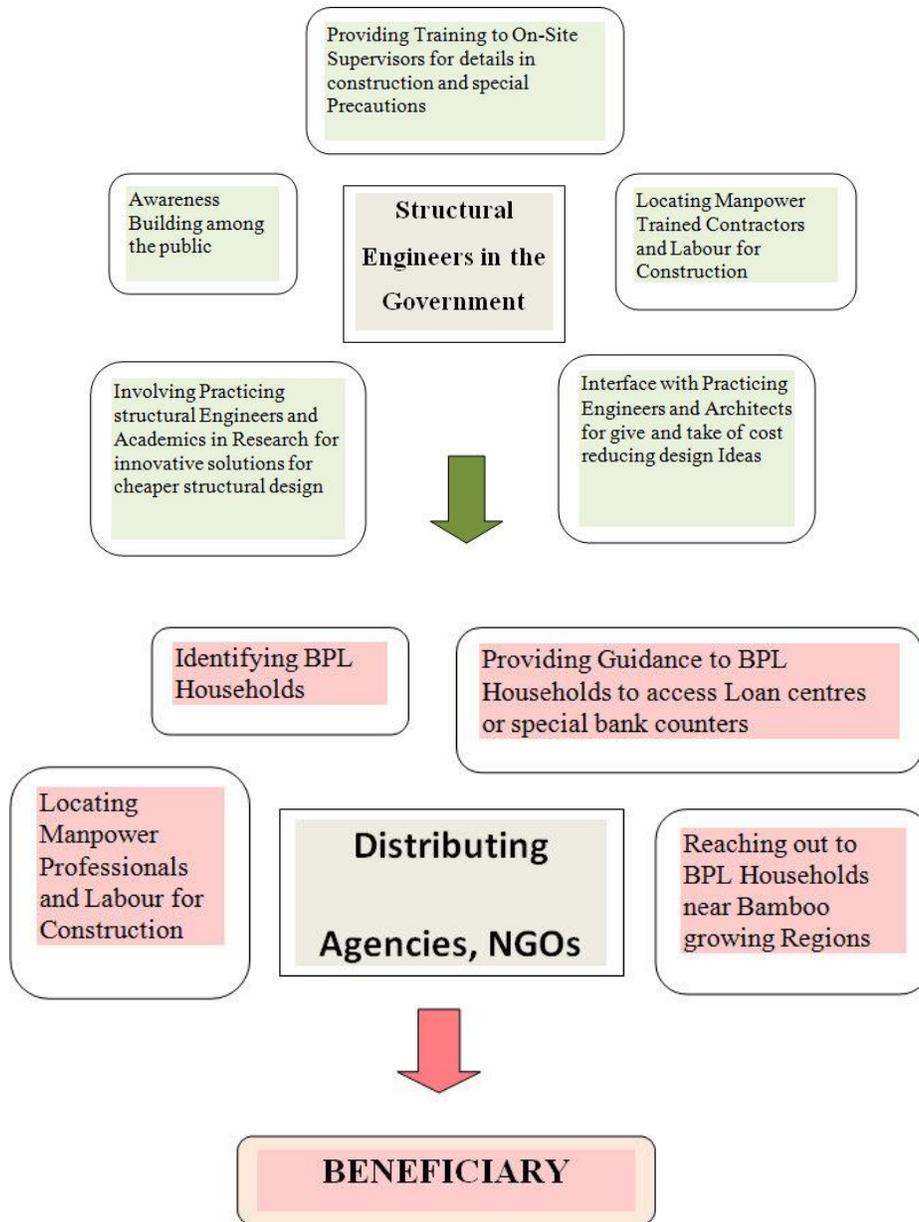


Fig 5. Role of distributing agencies , NGOs and structural engineers

### XIII. CONCLUSION

A streamlined system for the handover of DUs after all design level cost cutting is over can bring respite in the affordability levels for the Urban poor. A complete role chart has been recommended for the purpose. This is with the objective of cost cutting of pilferages due to an inefficient management of housing deliverance systems which could reduce costs up to 28% as per the original research.

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### XV. ACKNOWLEDGMENT

The Author thanks her Co- Author for his valuable inputs from time to time. She would specially like to thank the Members of the Research and Consultancy cell of the Visvesvaraya National Institute of Technology currently, Chaired by Dr. H.M. Suryavanshi (Dean - Research and Consultancy, Professor at the Department of Electrical Engineering, V.N.I.T.), along with the members Dr. Rajesh Gupta (Dean Planning and Development and Professor at the Department of Civil Engineering), Dr. D.H. Lataye (Associate Professor at Othe Department of Civil Engineering, V.N.I.T. Nagpur), for their unstinted guidance and reviews during the six- monthly seminars as part of course work.

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