

Modern Technologies for Housing– Speed of construction–Challenges in Adoption–Cost Benefits

By.
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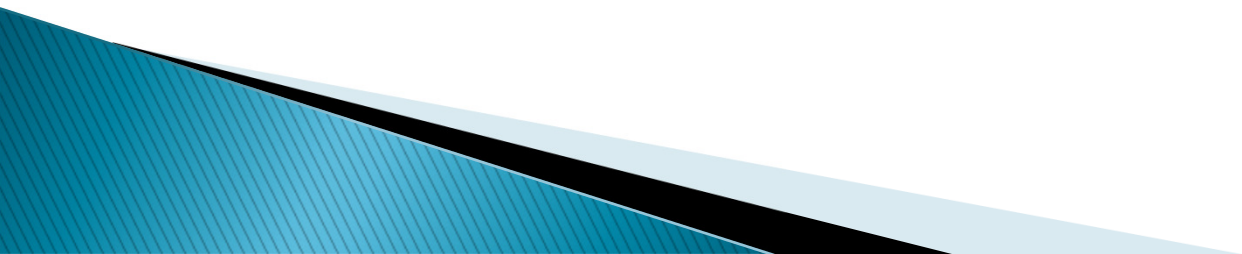
Rural Housing

- ▶ Housing is a basic human need after Food & Clothing (Roti, Kapada & Makaan)
 - Constitution of India: Article 21 (1951)
 - Universal Declaration of Human Rights (UDHR) 1948
 - Istanbul Declaration 1996
 - Sustainable Development goals No.11 (making cities and human settlements inclusive, safe, resilient). 2015-2030
- ▶ **Owning a house provides significant economic security and Social status in village community**

- ▶ The target for 2030 is to ensure access to safe and affordable housing. The indicator named to measure progress toward this target is the proportion of urban population living in slums or informal settlements. Between 2000 and 2014, the proportion fell from 39 percent to 30 percent. However, the absolute number of people living in slums went from 792 million in 2000 to an estimated 880 million in 2014. Movement from rural to urban areas has accelerated as the population has grown and better housing alternatives are available.

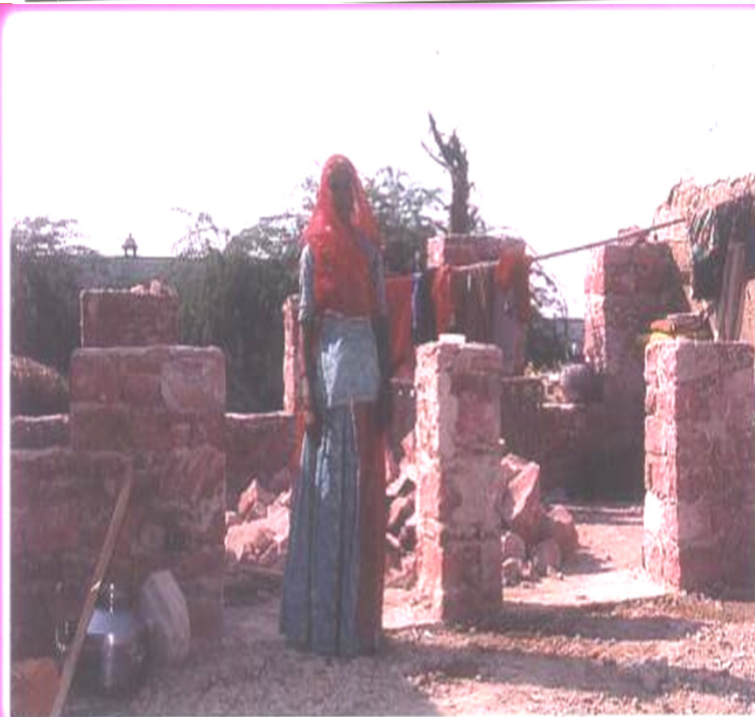
Mission objective

- ▶ “By the time the Nation completes 75 years of its Independence, every family will have a pucca house with water connection, toilet facilities, 24x7 electricity supply and access.”

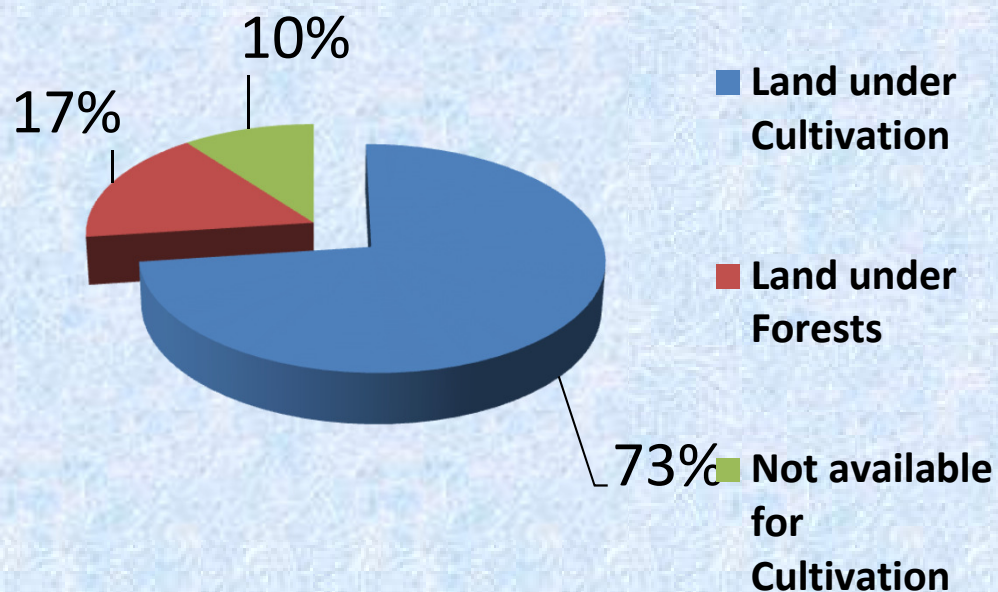


Shortage of Housing in India

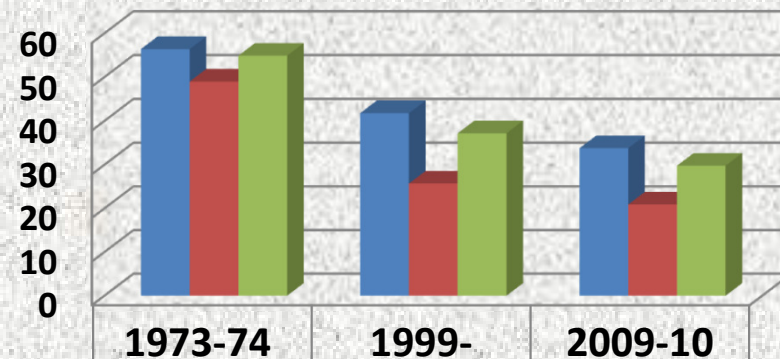
- ▶ 2001 Census
 - Total shortage 35 Million
 - People in Kutcha: 32 Million
 - Houseless : 3 Million
- ▶ Working Group 11th FY Plan
 - 43 Million (2007-12)
- ▶ Working Group 12th FY Plan
 - 48.81 Million (2012-17)
 - BPL (90%) 43.93
- ▶ Decadal GR of RHH 24.31%



Land Use Classification in India (2009-10)



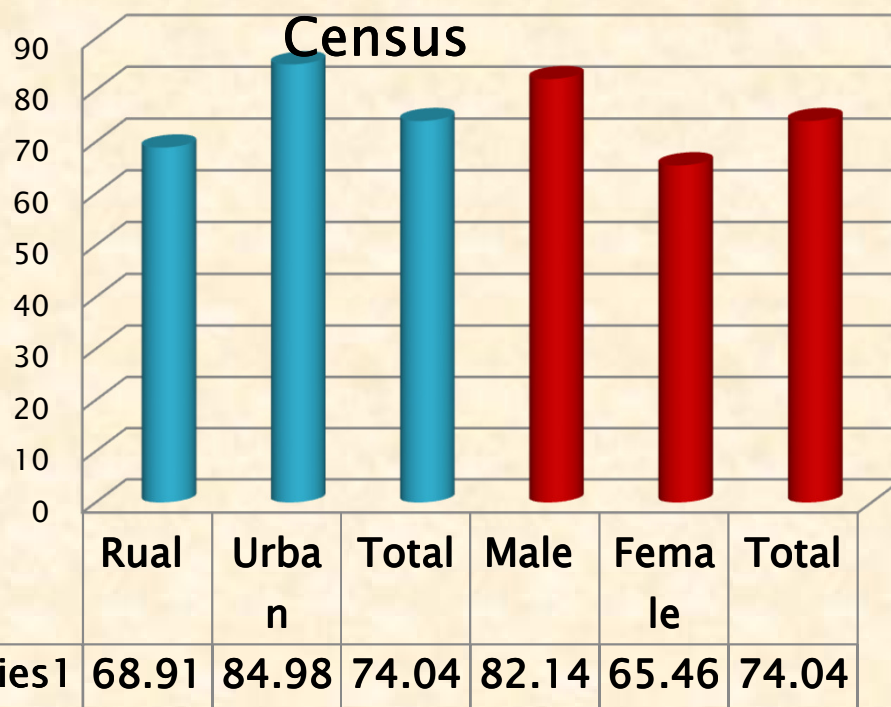
Poverty Ratio in India



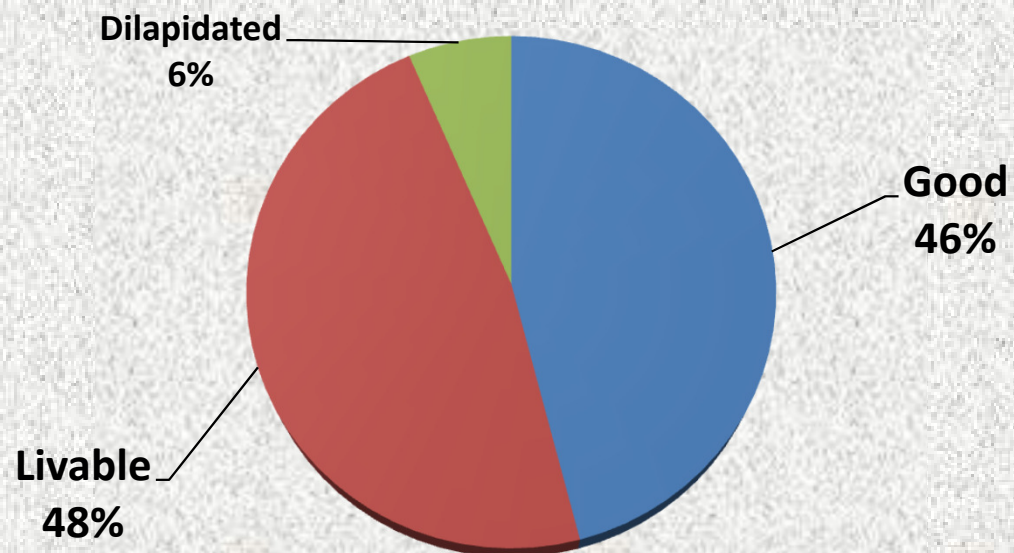
	1973-74	1999-2000	2009-10
Rural	56.4	41.8	33.8
Urban	49	25.7	20.9
Total	54.9	37.2	29.8

Literacy Rate in India – 2011

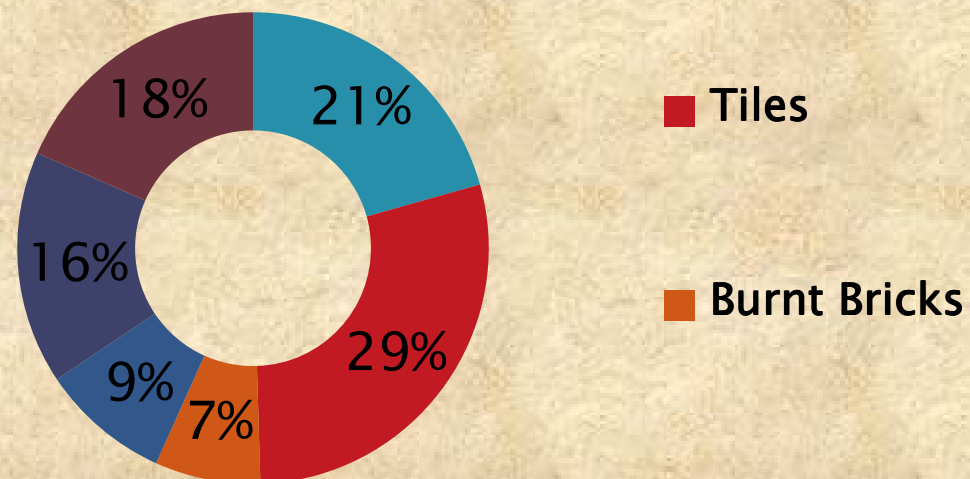
Census



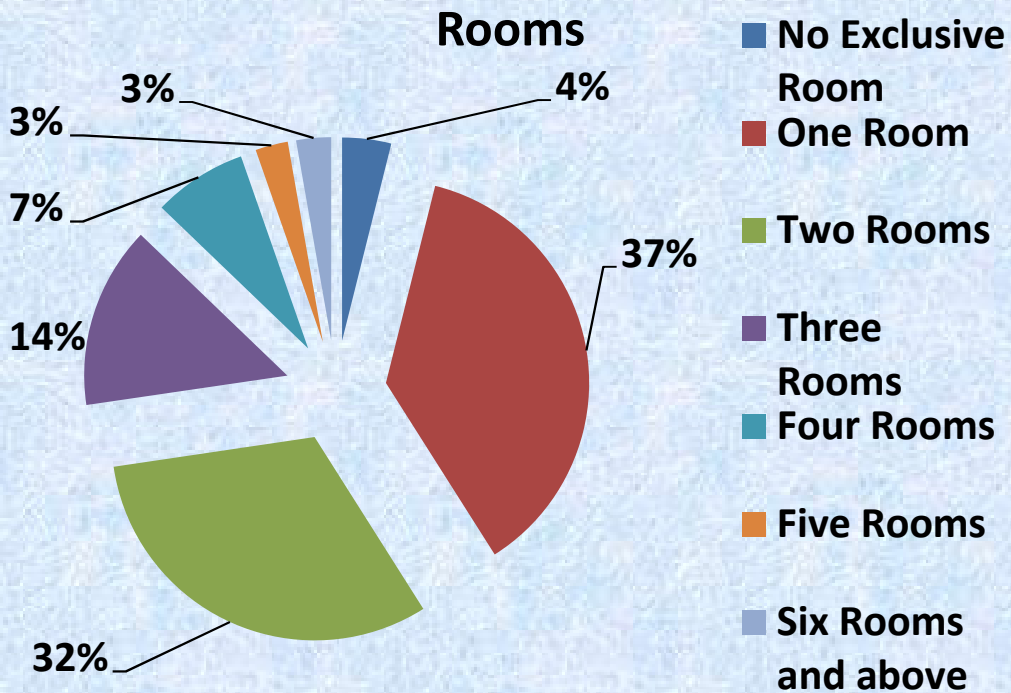
Housing Condition in India

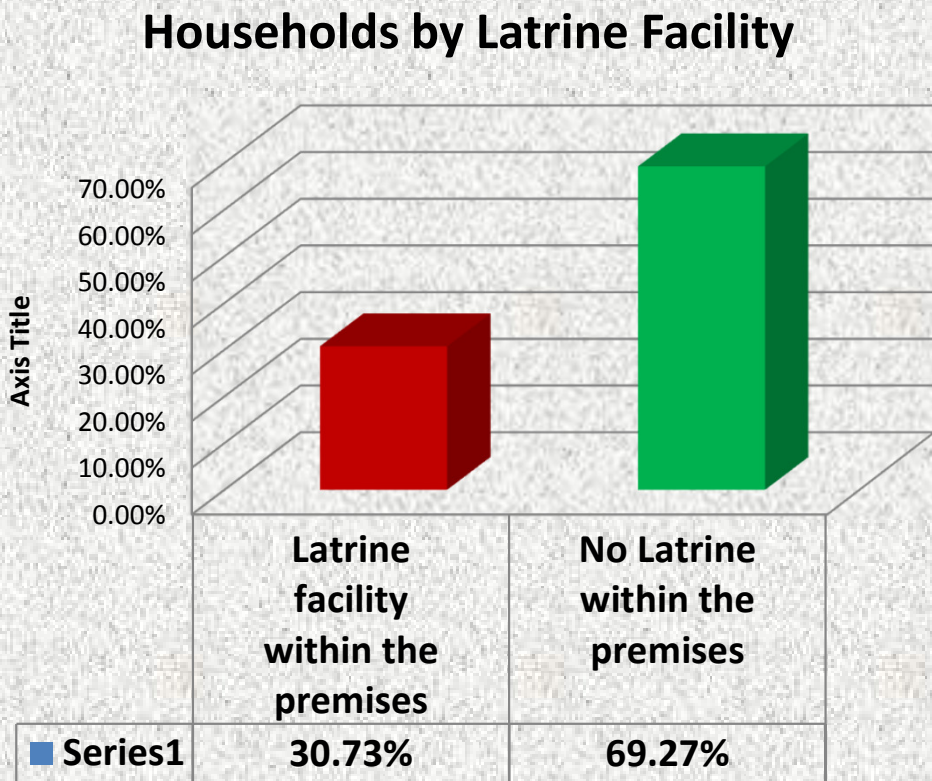
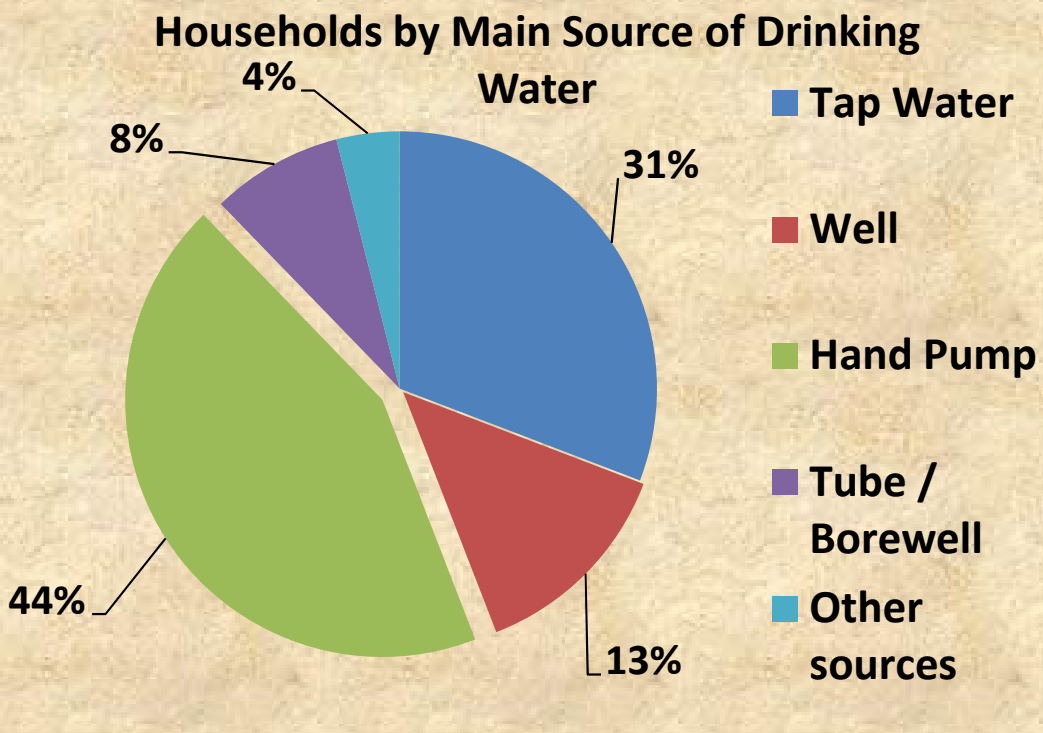


Households used Predominant Material for the Roof



Households by No. of Dwelling Rooms







Pradhan Mantri Awas Yojana (Urban) - Housing for All (HFA)

State wise Progress (since launch of PMAY-U)

[as on 15th Oct, 2018]

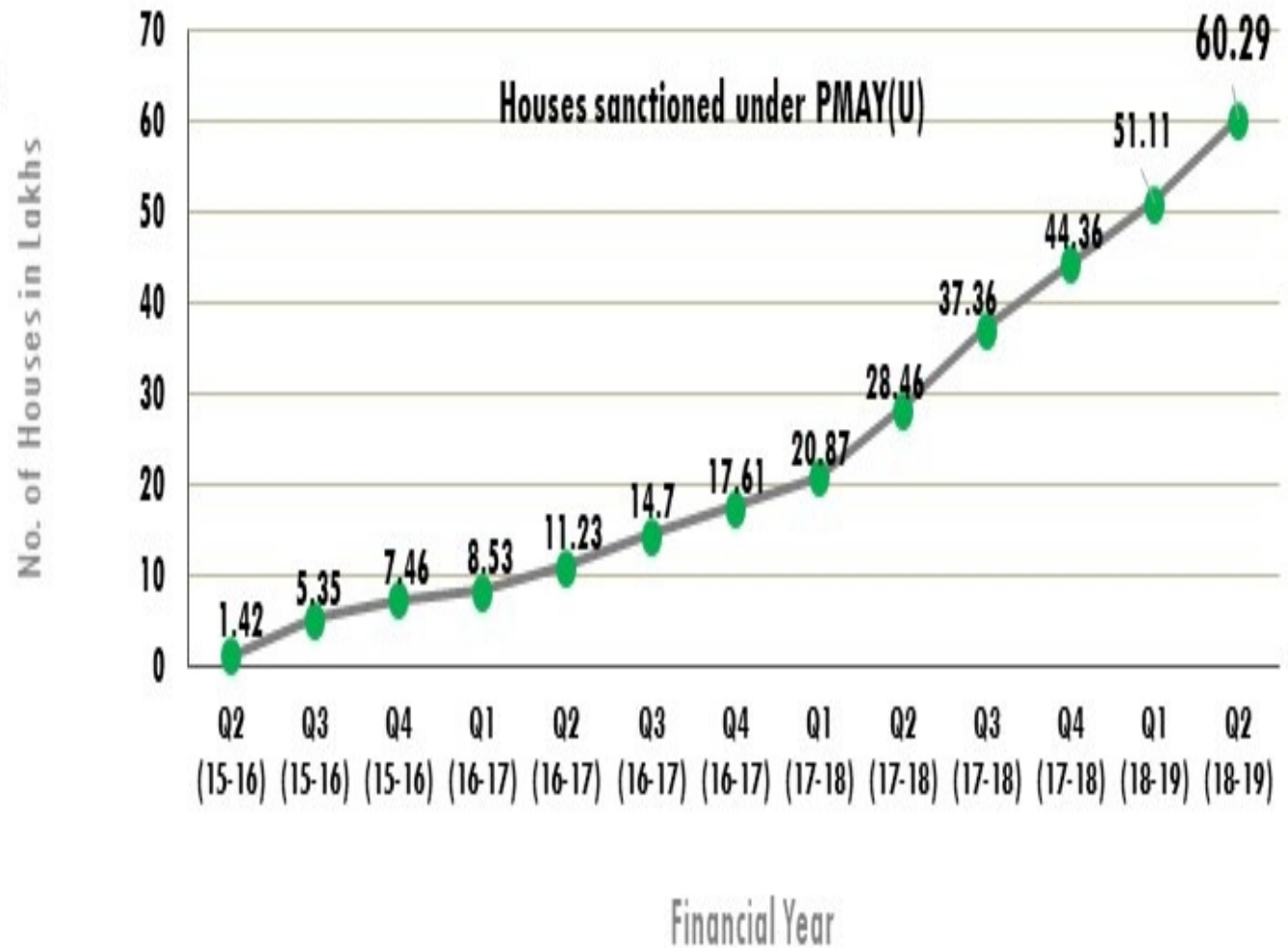
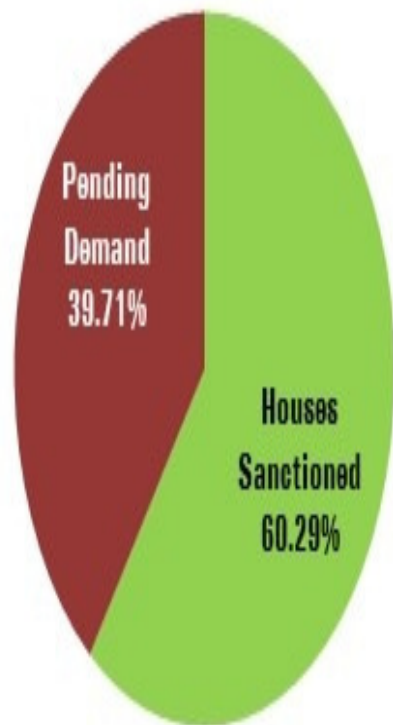
Sl. No.	Name of the State/ UT	Project Proposal Considered	Financial Progress (Rs in Crore)			Physical Progress (Nos)		
			Investment in Projects	Central Assistance Sanctioned	Central Assistance Released	Houses Sanctioned	Houses grounded for construction	Houses Completed
1	Andhra Pradesh	424	50,357.49	13,869.13	3,692.45	9,21,877	6,21,475	1,08,643
2	Bihar	317	9,931.07	3,198.88	873.23	2,04,434	93,340	19,133
3	Chhattisgarh	1,103	8,645.57	3,114.92	774.57	2,09,292	78,123	18,921
4	Goa	10	36.93	4.76	4.22	237	177	177
5	Gujarat	516	28,647.37	5,687.36	2,787.82	3,61,130	2,16,422	1,25,506
6	Haryana	638	23,521.13	3,902.53	437.43	2,48,138	9,663	5,763
7	Himachal Pradesh	101	420.64	148.86	58.84	8,356	3,146	498
8	Jammu & Kashmir	115	1,022.49	296.76	71.69	19,099	8,717	835
9	Jharkhand	330	10,369.26	2,404.69	980.54	1,62,814	1,04,038	41,747
10	Karnataka	1,098	20,059.35	5,981.65	2,480.84	3,75,749	1,88,762	68,753
11	Kerala	341	2,940.45	1,366.75	471.16	88,024	52,044	13,689
12	Madhya Pradesh	1,165	33,203.07	9,214.58	4,123.95	6,02,891	3,87,694	1,41,295
13	Maharashtra	322	36,891.89	8,438.62	2,128.69	6,03,180	1,64,546	98,036
14	Orissa	303	4,060.03	1,646.52	634.44	1,04,043	63,382	19,692
15	Punjab	548	1,699.30	725.07	204.05	49,905	23,743	4,798
16	Rajasthan	315	8,667.13	2,534.39	605.42	1,58,963	72,923	32,948
17	TamilNadu	2,111	22,656.57	7,841.56	2,602.55	5,15,577	3,70,652	93,997
18	Telangana	246	14,871.06	2,961.73	1,306.93	1,94,602	1,50,865	15,170
19	Uttar Pradesh	2,005	29,403.12	10,780.96	2,129.85	7,03,574	2,66,098	37,110
20	Uttarakhand	136	1,296.77	425.12	248.73	22,108	11,735	5,047
21	West Bengal	268	10,051.39	3,569.41	1,644.95	2,35,341	1,15,621	70,252
Sub- total (States) :-		12,412	3,18,752.06	88,114.26	28,262.34	57,89,334	30,03,166	9,22,010
22	Arunachal Pradesh	31	357.79	148.63	83.31	6,284	6,129	202
23	Assam	167	1,766.29	862.94	340.84	57,443	38,869	561
24	Manipur	26	747.27	436.37	160.42	29,079	7,770	340
25	Meghalaya	8	34.70	11.98	5.37	792	1,122	545
26	Mizoram	32	618.47	455.69	83.21	29,853	2,049	700
27	Nagaland	31	635.17	390.95	94.68	24,337	7,659	659
28	Sikkim	11	13.64	7.79	1.74	518	324	19
29	Tripura	63	2,196.41	1,233.06	616.89	79,982	63,657	14,251
Sub- total (NE States) :-		369	6,369.73	3,547.41	1,386.45	2,28,288	1,27,579	17,277
30	A&N Island (UT)	3	54.10	9.18	0.27	611	35	8
31	Chandigarh (UT)	-	20.57	2.08	2.08	98	5,058	5,058
32	D&N Haveli (UT)	2	177.34	55.84	31.91	3,359	2,175	748
33	Daman & Diu (UT)	6	34.75	12.40	5.54	762	537	194
34	Delhi (UT)	-	798.78	95.70	95.70	4,305	36,805	20,205
35	Lakshdweep (UT)	-	-	-	-	-	-	-
36	Puducherry (UT)	17	408.61	142.62	57.93	9,463	4,085	736
Sub- total (UT) :-		28	1,494.14	317.83	193.44	18,598	48,695	26,949
Grand Total :-		12,809	3,26,615.93	91,979.50	29,842.23	60,36,220	31,79,440	9,66,236

DRMC - MoHUA

Houses Sanctioned under 'Pradhan Mantri Awas Yojana (Urban)'

Urban Housing demand: 100 Lakh

Houses Sanctioned: 60.29 Lakh




COST EFFECTIVE TECHNOLOGY

- In Rajasthan, locally available Stone Patties were used for Roof
- In Rajasthan, for flooring and filling the gap between the bricks for the construction of wall – Lime mud mortar with locally available material
- In Tamilnadu, IAY beneficiaries were fixing the tiles on the roofing
- Most of the IAY beneficiaries still using the Asbestos Sheets / steel sheets for the Roof – Maharashtra, Gujarath
- Most of the IAY houses were being built with bullies (local name is wooden patties) for the support of Roof in the states like Maharashtra, Gujarath
- The State Govt. (In A.P. and Tamilnadu) is supplying the material like steel, windows, doors and cement.
- In Himachal Pradesh, people are using 3 types of sand viz., a) Coarse Sand for RCC roofing b) Fine Sand is used for Plastering of walls, flooring purpose and c) Sand mixed with mud is used for filling the gap between bricks etc.

Coverage and Duration

All 4041 statutory towns as per Census 2011 with focus on 500 Class I cities in three phases :

- Phase I (April 2015 - March 2017) to cover 100 Cities selected from States as per their willingness.
 - Phase II (April 2017 - March 2019) to cover additional 200 Cities
 - Phase III (April 2019 - March 2022) to cover all other remaining Cities
 - Flexibility regarding inclusion of additional cities in earlier phases in case there is a resource backed demand from States.
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Components


1. Slum redevelopment of Slum Dwellers with participation of private developers using land as a resource
2. Promotion of Affordable Housing for weaker section through credit linked subsidy
3. Affordable Housing in Partnership with Public & Private sectors
4. Subsidy for beneficiary-led individual house construction


(Beneficiaries can take advantage under one component only)



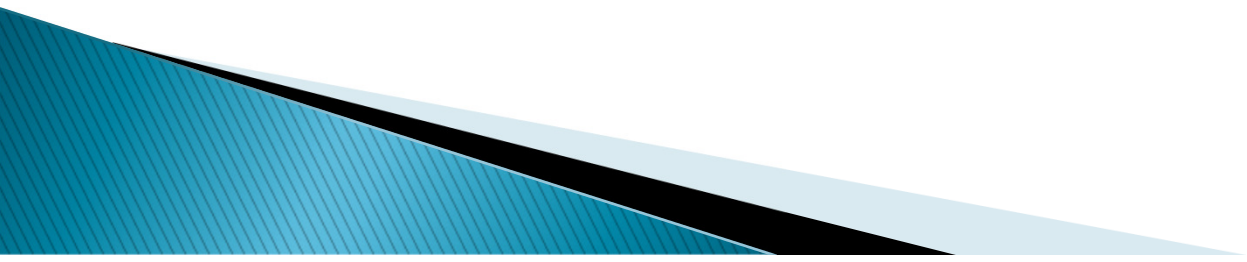
Beneficiary

- A beneficiary family will comprise husband, wife, unmarried sons and unmarried daughters.
 - Should not own a pucca house either in his name or any member in any part of India.
 - States may decide a cut-off date of resident of that urban area.
 - The houses should be in the name of the female head or in the joint name.
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- Beneficiary identification link to Aadhaar, Voter card or a certificate of house ownership from Revenue Authority of Beneficiary's native district to avoid duplication.
 - Preference to EWS/ LIG segments, Manual Scavengers, Women/ Widows, Scheduled Castes/ Scheduled Tribes/ Other Backward Classes, Minorities, Disabilities and Transgender.
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- Construction of houses upto 30 square meter carpet area with basic civic infrastructure like water, sanitation, sewerage, road, electricity etc. and should essentially have toilet facility.
 - The minimum size of houses should conform to the standards provided in National Building Code (NBC).
 - Structural safety against earthquake, flood, cyclone, landslides etc.
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Technology

- ▶ Formwork Systems
 - ▶ Precast Sandwich Panel Systems
 - ▶ Light Gauge Steel Structural Systems
 - ▶ Steel Structural Systems
 - ▶ Precast Concrete Construction Systems
 - ▶ Conventional System using Different Methods.
- 


THE TRADITIONAL CONSTRUCTION METHODS

- ▶ Foundation: Foundation is the lowest part of the structure which is provided to distribute loads to the soil thus providing base for the super-structure. Excavation work is first carried out, then earth-work is filled with available earth and ends with watering and compaction in a 6" thick layer.
 - ▶ Cement concrete: Plain cement concrete is used to form a leveled surface on the excavated soil. The volumetric concrete mix proportion of 1:4:8 (cement: sand: aggregate), with a 6" thick layer for masonry foundation and column footings is used. Plain cement concrete is finished on the excavated soil strata and mixed by manual process.
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THE TRADITIONAL CONSTRUCTION METHODS

- ▶ Wall construction: Size stone masonry for foundation is constructed for outer walls and burnt brick masonry of a 9" thick layer for main walls and a 4 ½" thick layer for all internal walls. Good quality table-moulded bricks are used for the construction.
 - ▶ Reinforced cement concrete slab and beam: The normal procedure to cast reinforced cement concrete slab is to make shuttering and provide reinforcement and concreting. Good steel or plywood formwork is used, with proper cover blocks between bars. Both aggregate and sand used are clean, with aggregate being ¾" graded. After the concrete is poured, it is properly consolidated.
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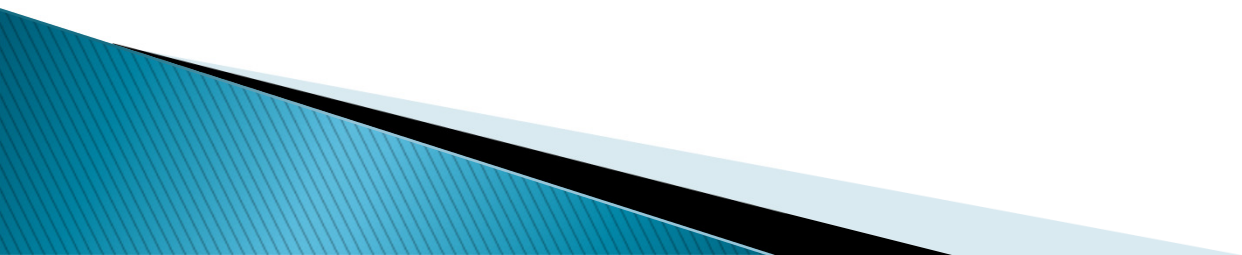
THE TRADITIONAL CONSTRUCTION METHODS

- ▶ Plastering: Plastering is used for the ceiling, inside and outside walls. Joints are raked before plastering and proper curing is ensured.
 - ▶ Flooring: For the flooring purpose, the earth is properly filled and consolidated in the ratio of 1:4:8(cement: sand: aggregate) concrete.
 - ▶ Plumbing: Good quality plumbing materials are used and passed hydraulic test before using it.
 - ▶ Painting and finishing: Before the painting process, surface is prepared with putty and primer and already-made paint is used.
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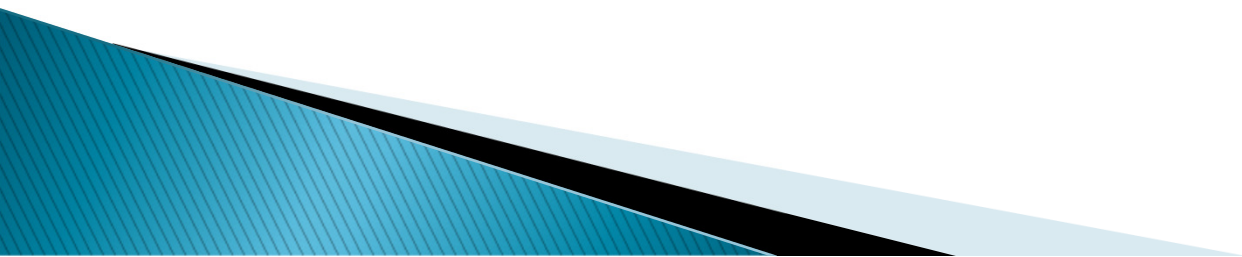
LOW COST CONSTRUCTION TECHNOLOGIES

- ▶ Foundation: Arch foundation is used in which walls are supported on the brick or stone masonry. For the construction of the foundation, the use of available materials such as brick or concrete blocks can be made to resist lateral forces buttresses at the corner.
- ▶ Walling: Rat trap bond technology is used in the case study. It is an alternative brick bonding system for English and Flemish Bond. The reduced number of joints can reduce mortar consumption. No plastering of the outside face is required and the wall usually is quite aesthetically pleasing and air gaps created within the wall help making the house thermally comfortable. In summer, the temperature inside the house is usually at least 5 degrees lower than the outside ambient temperature and vice versa in winter.

- ▶ Roofing: A filler slab roofing system is used which based on the principle that for roofs which are simply supported, the upper part of the slab is subjected to compressive forces and the lower part of the slab experience tensile forces. Concrete is very good in withstanding compressive forces and steel bears the load due to tensile forces. Thus the low tensile region of the slab does not need any concrete except for holding steel reinforcements together.




- ▶ Flooring: Flooring is generally made of terracotta tiles or color oxides. Bedding is made out of broken brick bats. Various patterns and designs are used, depending on shape, size of tiles, span of flooring, and client's personal preference.
- ▶ Plastering: Plastering can be avoided on the walls, frequent expenditure on finishes and its maintenance is avoided. Properly protected brick wall will never lose its color or finish.




- ▶ Doors and windows: As door and window frames are responsible for almost half the cost of timber used, avoiding frames can considerably reduce timber cost. Door planks are screwed together with strap iron hinges to form doors, and this can be carried by 'holdfast' carried into the wall. The simplest and cost effective door can be made of vertical planks held together with horizontal or diagonal battens. A simplest frameless window consists of a vertical plank of about 9" wide set into two holes, one at the top and one at the bottom. This forms a simple pivotal window. Wide span windows can be partially framed and fixed to walls or can have rows of pivotal planks

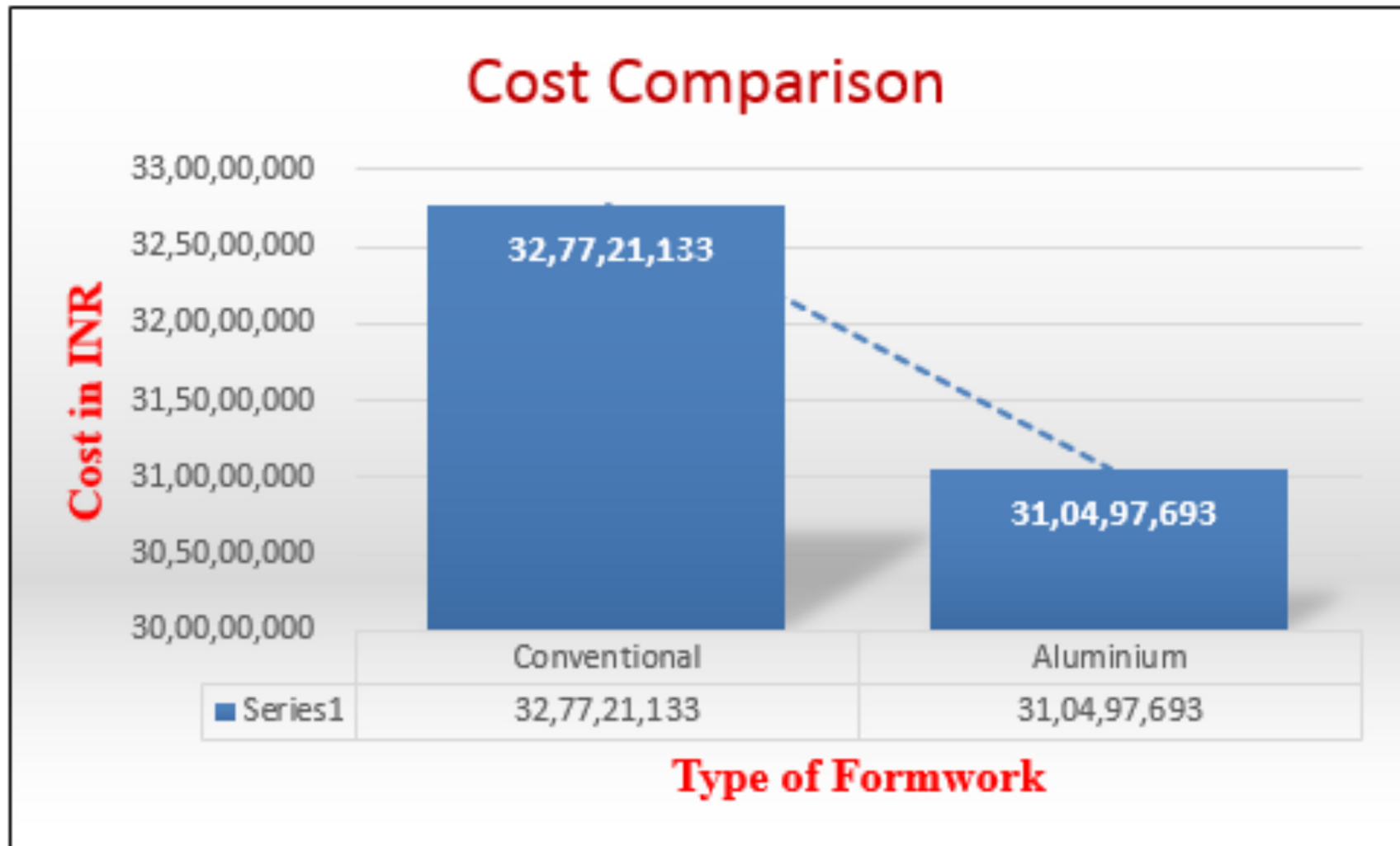
COST EFFECTIVENESS OF USING LOW COST HOUSING TECHNOLOGIES

- ▶ The construction methods of walling and roofing are selected for the detail cost analysis based on available resources from the interviews. Table 1 and Table 2 summarize the cost analysis of the traditional construction methods and the low cost housing technologies in the case studies for walling and roofing respectively. It is found that about 26.11% and 22.68% of the construction cost, including material and labor cost, can be saved by using the low cost housing technologies in comparison with the traditional construction methods for walling and roofing respectively.
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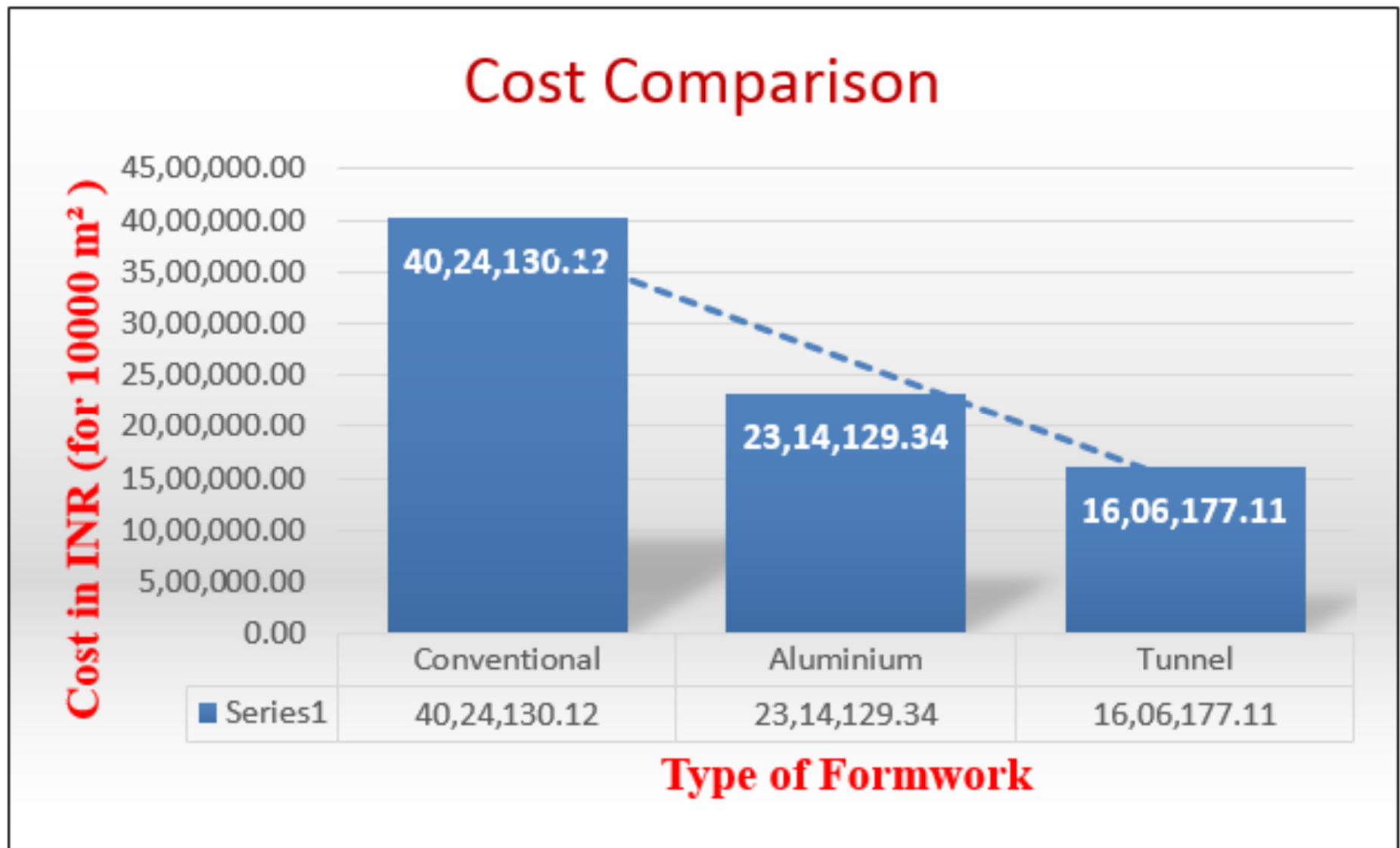
COST EFFECTIVENESS OF USING LOW COST HOUSING TECHNOLOGIES

- ▶ Suggestion for reducing construction cost in this paper is of general nature and it varies depending upon the nature of the building to be constructed and budget of the owner. 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.
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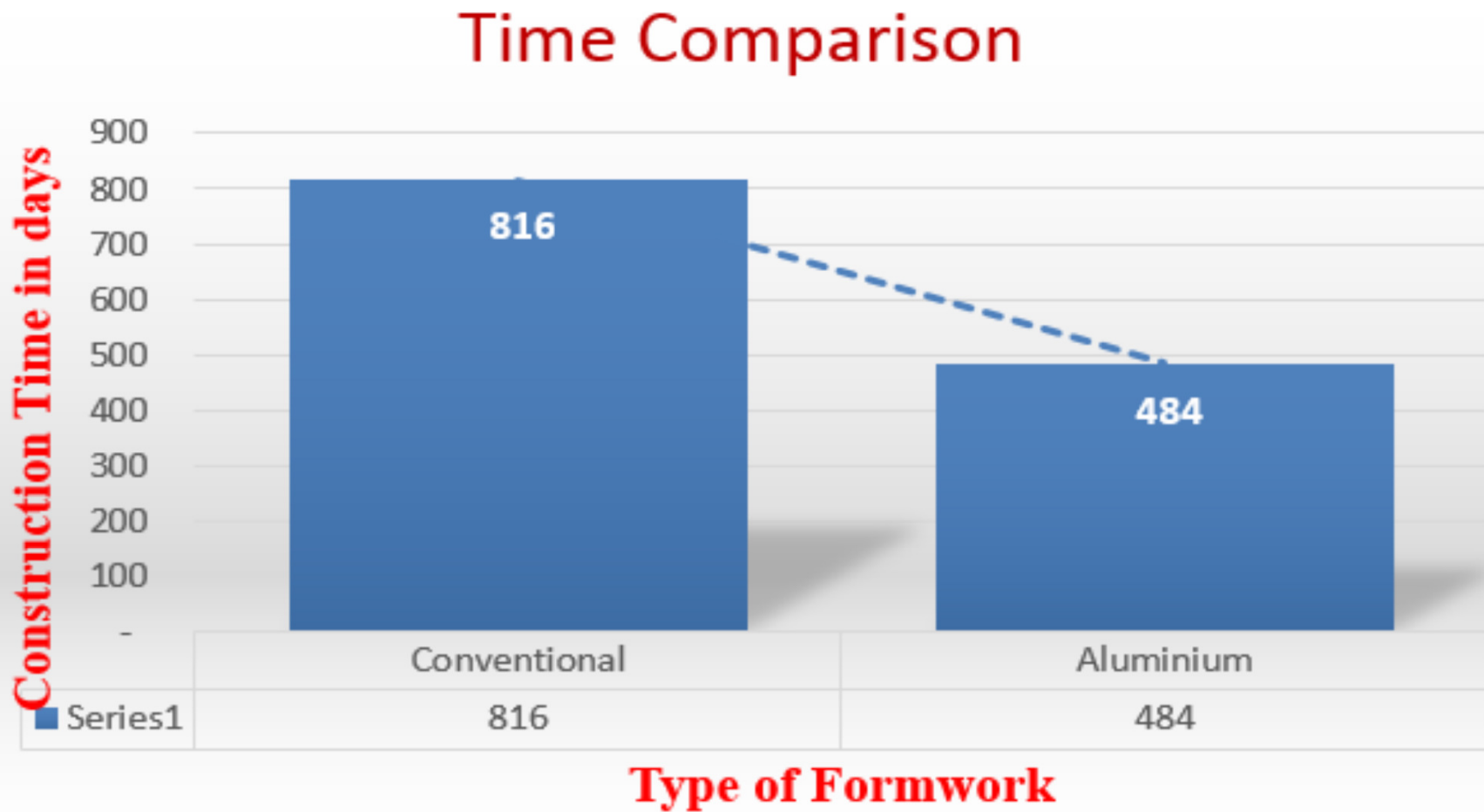
Graph:1 Cost Comparison of Conventional v/s Aluminium Formwork



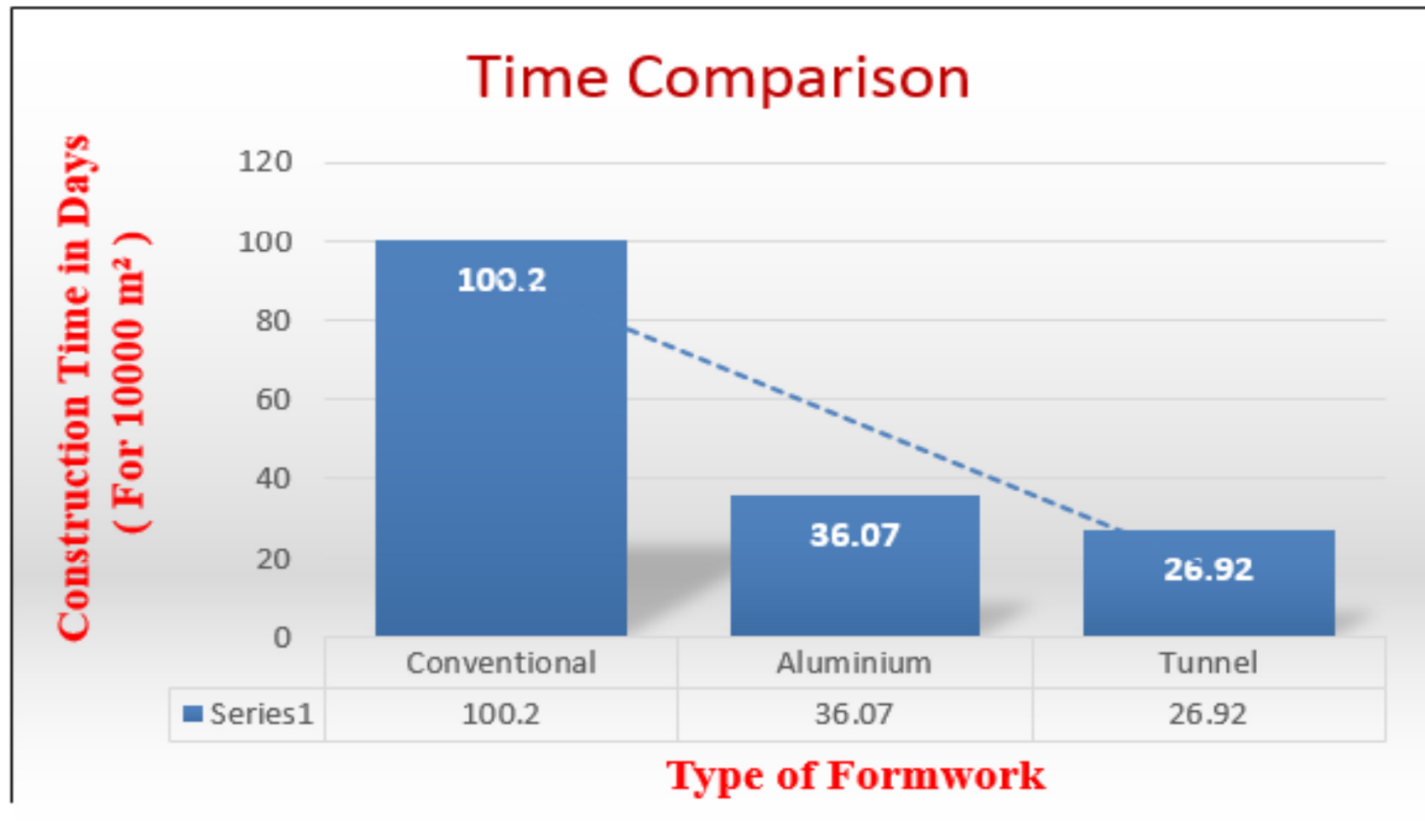
Graph:2 Cost Comparison for Conventional, Aluminium & Tunnel Formwork



Graph:3 Time Comparison of Conventional v/s Aluminium Formwork



Graph:4 Time Comparison for Conventional, Aluminium & Tunnel Formwork



Conventional Building during construction



Aluminium Formwork during construction



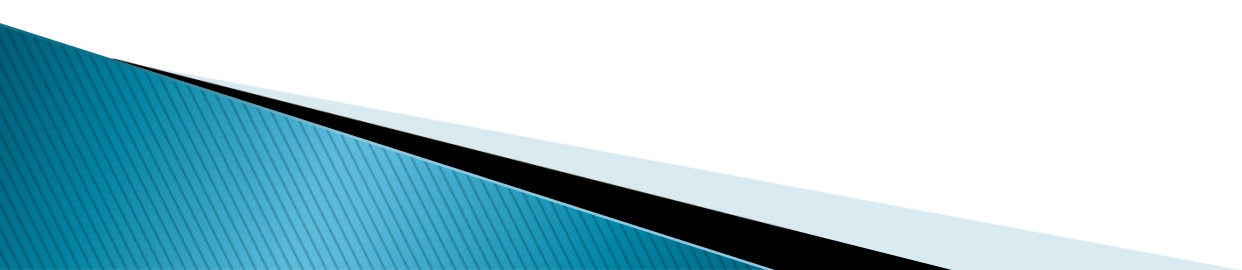
Photograph at Tunnel Formwork site during the construction.



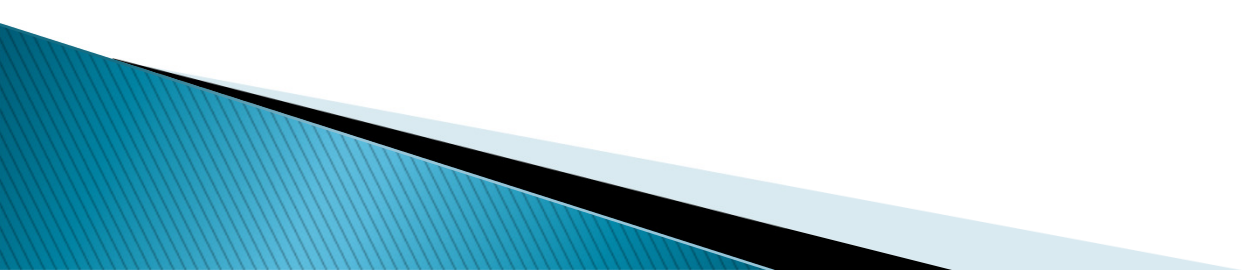
CONCLUSIONS

Item	Conventional Formwork	Aluminium Formwork	Tunnel formwork
Cost for construction of 10,000 m ² of Concrete area in INR	40,24,130.12	23,14,129.34	16,06,177.11
Time for construction of 10,000 m ² of Concrete area in Days	100.2	36.07	26.92

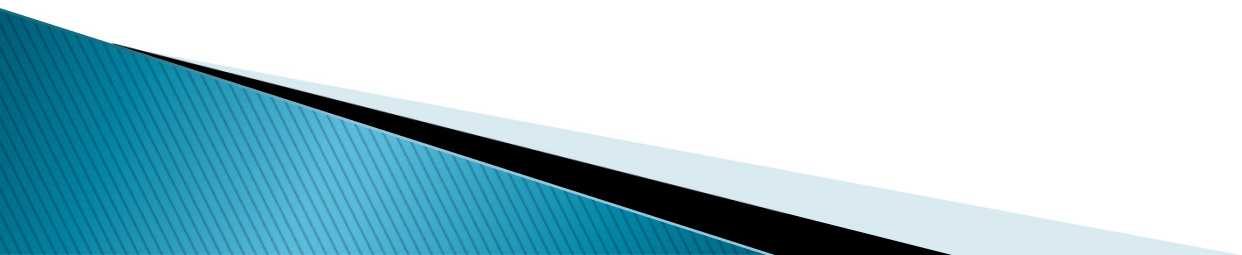
- ▶ From the results obtained we can conclude that, Aluminium formwork is Cost effective in comparison with Conventional Formwork.
- ▶ Aluminium formwork is better for use in the constructions, where Time effective formwork is necessary, than Conventional Formwork.
- ▶ Tunnel Formwork is the most time & cost effective formwork among Conventional, Aluminium & Tunnel Formwork.



- ▶ Also, the duration of the project can be reduced largely with the use of Tunnel formwork where 1–4 days cycle is possible. So this is the fastest formwork system compared to conventional & Aluminium formwork.
- ▶ Time saving is equal to money saving. So, even though initial investment is large, Tunnel Formwork can be suggested for faster construction.
- ▶ If the number of repetitions are more for residential buildings, then Aluminium formwork is suggested as it saves the time & cost of finishing & shuttering.

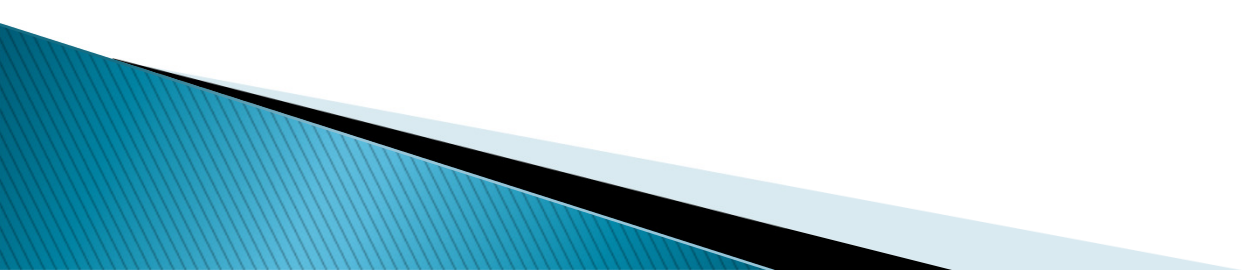


- ▶ Set up regulatory mechanism to ensure that the concessions are correctly targeted
- ▶ Develop and enforce appropriate ecological standards to protect the environment
- ▶ Promote creation of secondary mortgage market.




Role of Stakeholders

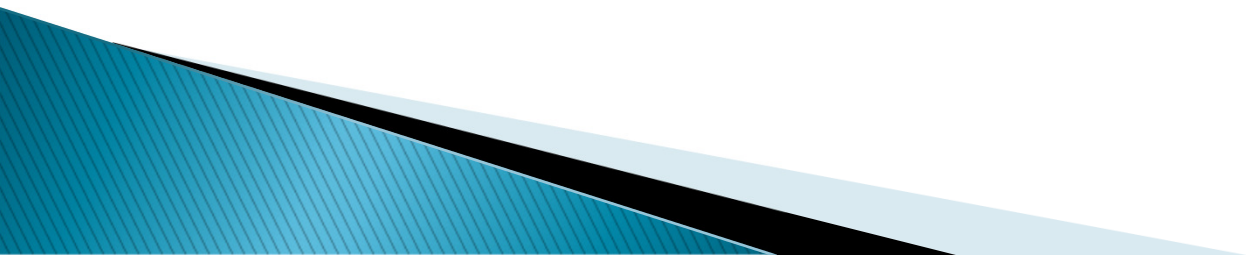
The NHHP has divided the role of all housing sector's stakeholders according to their area of working. Housing being more of a State subject, State Govt.'s have very important role to play in bringing about its growth. The true objectives of the policy would be carried out through time bound initiatives taken by the Government, both Centre and States.

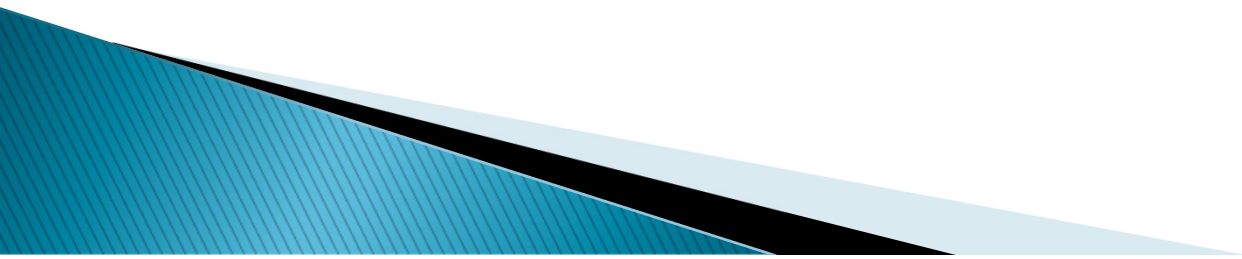


Role of The Central Government


- ▶ Bring in legal reforms; formulation of effective foreclosure laws
 - ▶ Devise macro economic policies for resources to go in housing/infrastructure
 - ▶ Promote R&D and transfer of technology
 - ▶ Evolve parameters for optimal use of available resources to promote development along with growth.
 - ▶ Provide fiscal concessions for housing, infrastructure, energy saving construction materials and methods
- 

The State Government

- ▶ Liberalize the legal and regulatory regime to give a boost to housing and supporting infrastructure.
 - ▶ To promote private sector and cooperatives in undertaking housing construction for all segments in urban and rural areas.
 - ▶ Define the role of public and private agencies particularly in the infrastructure sector. undertake appropriate reforms for easy access to land.
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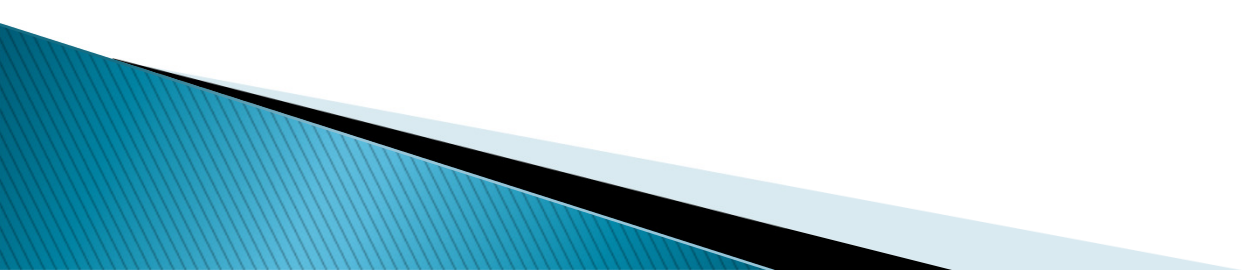
- ▶ To prepare long term programmes for tackling problems in housing and basic services.
 - ▶ Facilitate training of construction workers by converging other development programmes through Building Centres and other agencies.
 - ▶ Empower the local bodies to discharge their responsibilities in regulatory and development functions. Full potential of 73rd and 74th Constitutional Amendments to be unleashed.
- 


The Local Authorities

- ▶ Identify specific housing shortages. Also to prepare District Housing Action Plans for rural areas.
 - ▶ Devise programmes to meet housing shortages and augment supply of land for housing, particularly for the vulnerable group
 - ▶ Plan expansion of both urban/rural infrastructure services
 - ▶ Enforce effectively regulatory measures for planned development.
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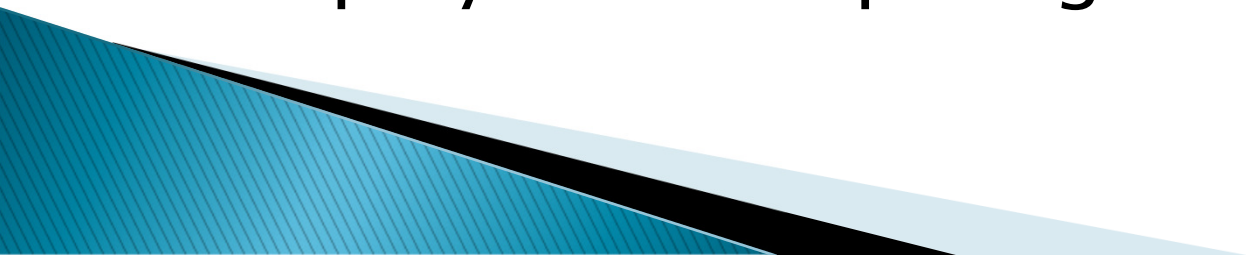
The Public / Private Housing Finance Companies

- ▶ To redefine their role, moving away from their traditional approach to housing finance.
- ▶ Adopt a more flexible approach and modify the present system of collateral, assessment of repayment capacity and system of creating mortgages. To also earmark a part of their resource for rural housing projects.

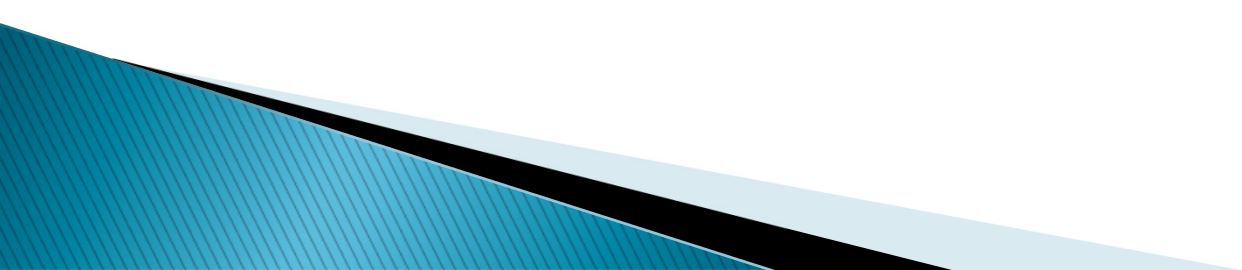


- ▶ Develop and expand their reach and depth to meet the needs of a vast country like ours. They should develop the requisite skills to mobilise domestic saving through innovative methods.
 - ▶ Devise schemes to lend at affordable rates to those who are in dire need of housing finance support.
 - ▶ Need to make credit available for the poorer segments who depend on the informal sector—money lenders etc.
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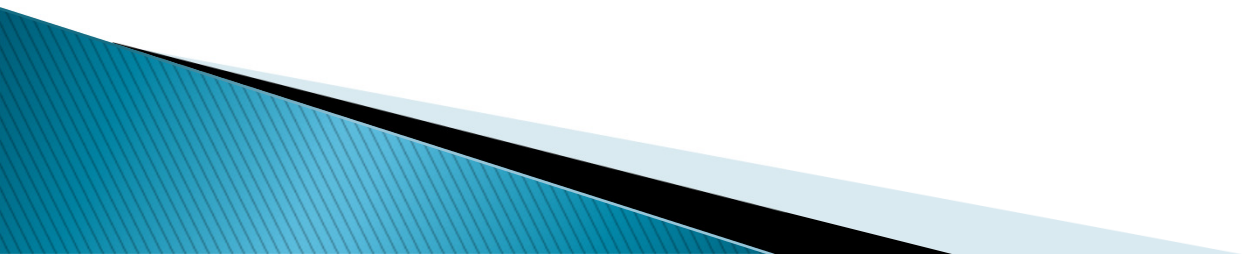
Role of corporate, private and cooperative sectors


- ▶ The Corporate, Private and Cooperative Sectors are to take the lead role in terms of land assembly
 - ▶ Emphasis on creation of housing stock on ownership and rental basis.
 - ▶ Corporate sector to be encouraged to provide for housing for staff and to facilitate their employees in acquiring their own houses.
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- ▶ Corporate Sector is to be given preference in allotment of land and house sites to encourage group housing.
- ▶ State Governments to work out schemes in collaboration with the private sector for slum reconstruction on cross subsidization basis.




Role of Research, Standardisation and Technology

- ▶ Research to be responsive to the different climatic conditions in the country. Effort must also be directed to use locally available raw materials as far as possible.
 - ▶ New technologies to be incorporated in works of various public/private construction agencies.
 - ▶ Public communication for spreading general awareness regarding these technologies
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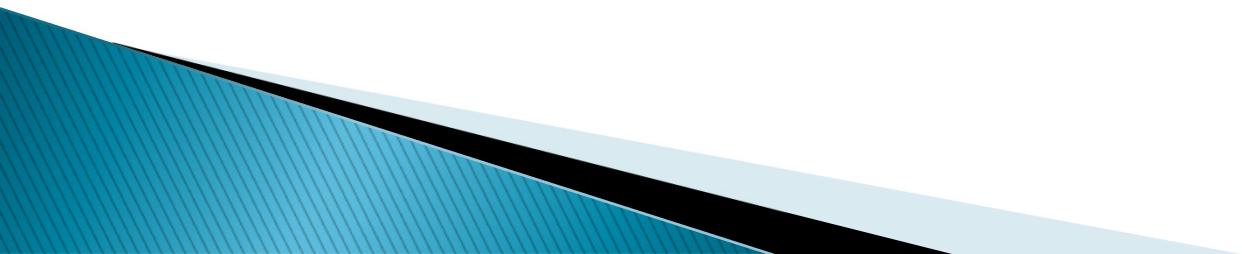
- ▶ Energy efficiency in building materials and construction to be given more attention.
 - ▶ Nearly 1% (about 15 lakh houses) of the housing stock in the country is destroyed every year due to natural hazards. Disaster mitigation techniques for new constructions and existing houses are urgent necessity.
 - ▶ At present the rural housing and to a large extent informal housing do not benefit from the outcome of research and development. Efforts to be made to disseminate information about new technologies in rural areas.
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Specific Action Areas

Land

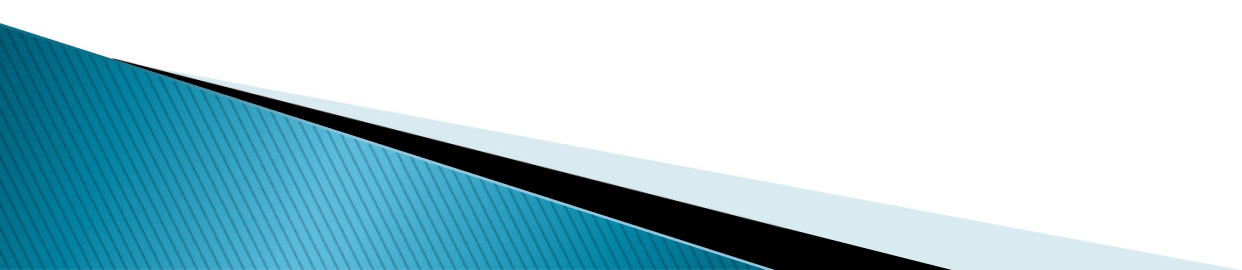
- ▶ The repeal of the Urban Land (Ceiling & Regulation) Act, 1976 to facilitate the availability of land.
 - ▶ Urban Land use to be optimised. Town and country planning regulations to be amended to provide for higher density use.
 - ▶ Planning authorities to re-plan No-Development Zones, because of CRZ restrictions. These zones to balance the need of a growing population and to have green areas.
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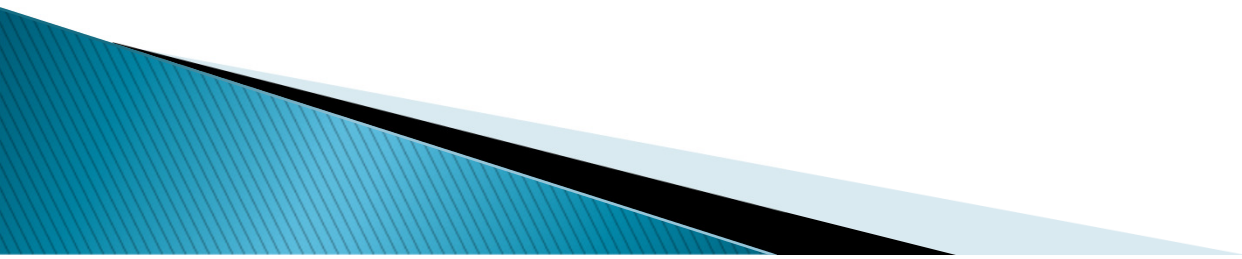
- ▶ An international comparison of the land cost to per capita GDP reveals the exorbitant rates that are prevalent in the Indian land market



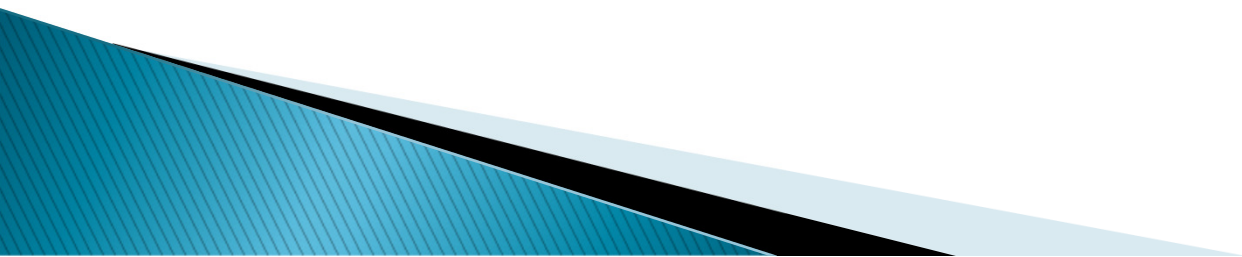
Finance

- ▶ Develop debt market, integrated with financial market for housing/infrastructure
- ▶ Asset securitisation and development of a secondary mortgage market.
- ▶ HFI's to attract resources from provident funds insurance funds, mutual funds etc.
- ▶ Housing be considered on par with infrastructure

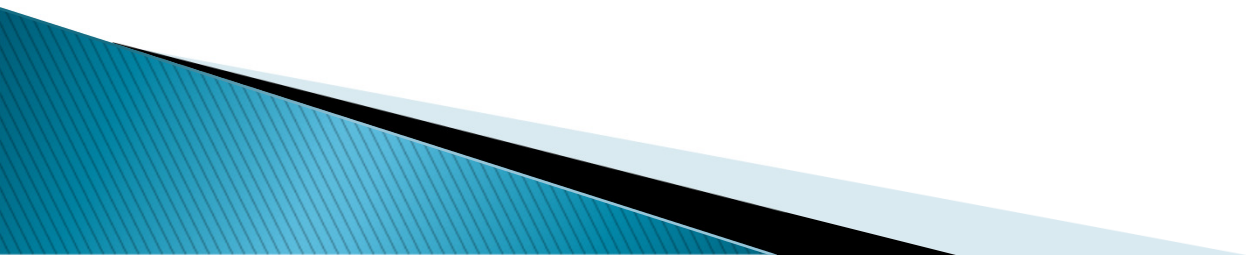


- ▶ Incentives for encouraging investments by FI's, HFIs, mutual funds, etc. in housing
 - ▶ HFC's to mobilise domestic savings in the country.
 - ▶ A National Shelter Fund to be set up to meet the requirement of low cost funds for the housing needs of the poor. Fiscal concessions to be provided to the corporate sector for contributing to this Fund.
 - ▶ Setting up of Risk Fund to cover the risks in financing the rural/urban poor housing
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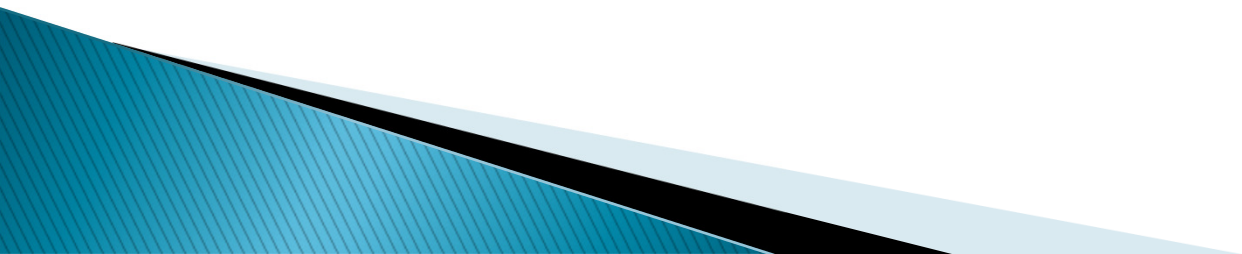
- ▶ Provident Fund managers to come forward to provide long term funds for housing.
- ▶ Banks to provide 1.5% of the incremental deposits for housing.
- ▶ Private sector to invest part of their profits to fulfill the housing needs of the poor.



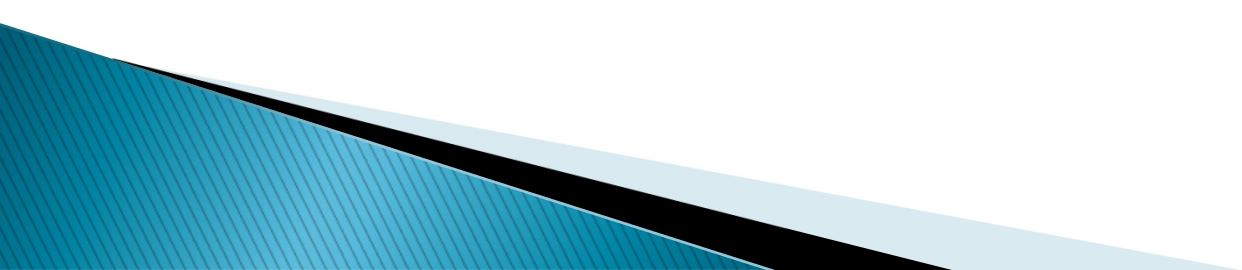
Legal and Regulatory reforms:

- ▶ Immediate implementation of legal and regulatory reforms.
 - ▶ Chartered Registered Architects to sanction building plans. Professional responsibility to be vigorously enforced and heavy punishment for false certification.
 - ▶ Rent Control Legislations in the States to be amended to stimulate rental housing; Union Government to frame National Rent Control Legislation for States.
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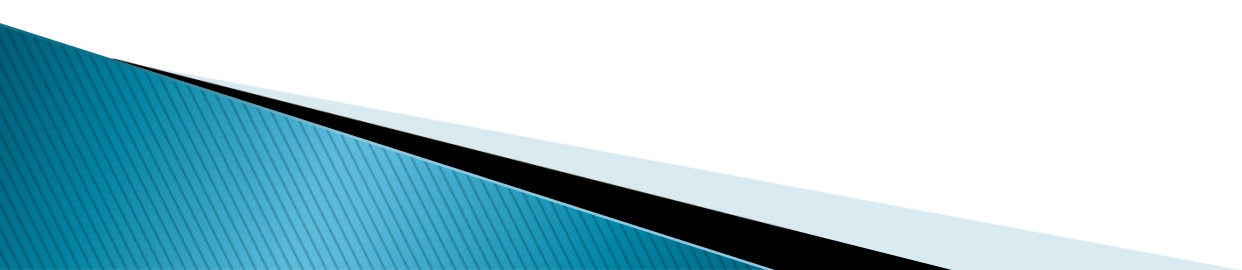
- ▶ State land tenancy laws must confer homestead rights in the rural areas
- ▶ Public/private sector to provide homestead land and housing for the displaced.
- ▶ Concerned Town Planning laws and land-use regulations to be amended to provide statutory support for land assembly, land pooling and sharing arrangements.



- ▶ Appropriate legislation to guide/regulate activities of promoters/builders in people's interest.
- ▶ Amendment of Acts relating to insurance sector to facilitate Mortgage Insurance.
- ▶ Amendment of laws relating to housing cooperatives.
- ▶ States must update and modernise the system of maintenance of land records.

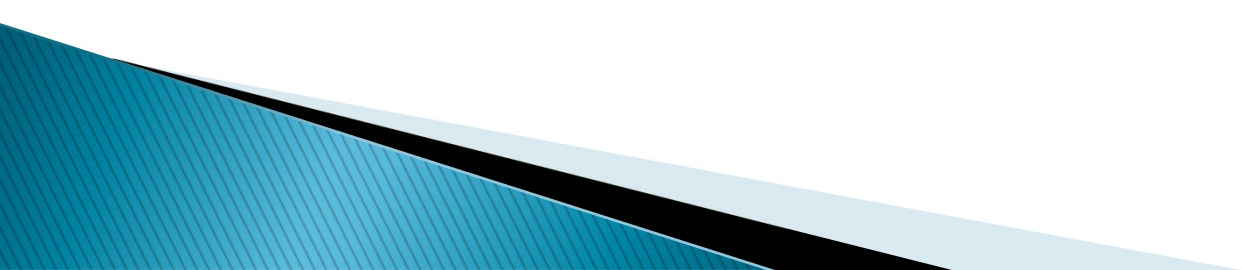


- ▶ Govt. to encourage private participation through BOT and other derivatives.
- ▶ States to be persuaded to enact Apartment Ownership Legislations.
- ▶ Integrate polices regarding air and water pollution, solid waste disposal, use of solar energy, energy recovery from wastes and electricity supply in the planning process.

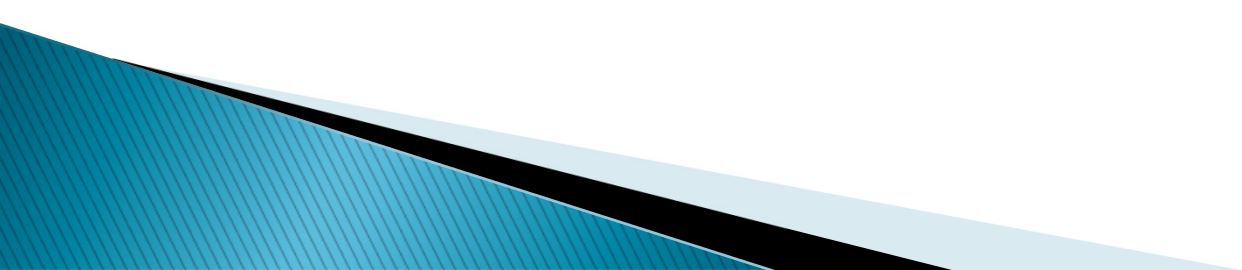


Technology support and its transfer

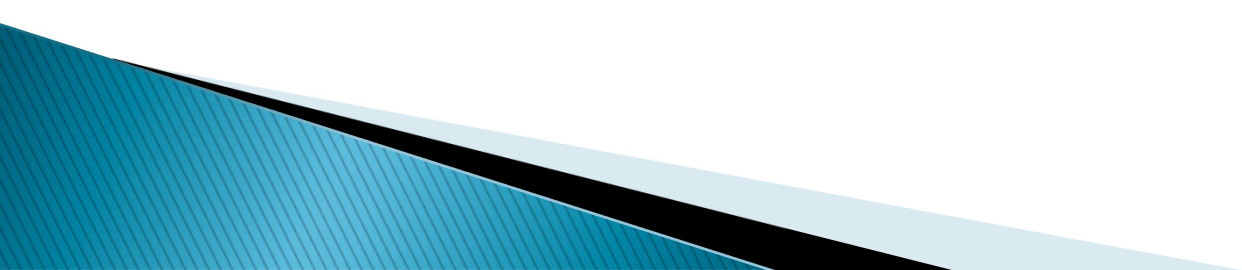
- ▶ Research to strengthen bio-mass based housing by suitable chemical impregnation and treatment techniques to increase the life and quality of the shelter.
- ▶ Govt. to take active lead to promote and use building materials and components based on agricultural and industrial waste. Low energy consuming construction techniques and materials to be used.



- ▶ Code for disaster resistant construction and land use planning be observed and enforced without exception. Public awareness to be created.
- ▶ Innovative building materials, construction techniques and energy optimising features to be an integral part of curricula in engineering colleges and training institutions.



- ▶ The dream of owning a house particularly for low-income and middle-income families is becoming a difficult reality. It is necessary to adopt cost effective, innovative and environment-friendly housing technologies for the construction. This paper examined the cost effectiveness of using low cost housing technologies in comparison with the traditional construction methods. Two case studies in India were conducted. It was found that about 26.11% and 22.68% of the construction cost, including material and labour cost, can be saved by using the low cost housing technologies in comparison with the traditional construction methods for walling and roofing respectively. This proves the benefits and the trends for implementing low cost housing technologies in the industry.







**Thank
You!!!**

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