

A Study of Suitability of Prefabrication for Affordable Urban Mass Housing In India

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Abstract

This paper aims to point out the various aspects of prefabricated building methodologies suitable for affordable Indian housing by highlighting different prefabrication technologies, and the advantages achieved by their adoption. In Indian low rise affordable housing sector, the major building components are the foundation, walling, doors, windows, floors and roofing. These components can be easily prefabricated for ease/speed of construction and cost saving. Some total/partial system approaches are also necessary for obvious advantages of their industrialized production facilities. A case has to be presented to Indian builders and developers for adopting prefabrication, if good quality low-income group housing has to be developed, in a short time, to mitigate the increasing housing shortage.

Keywords: housing, low cost, modular, prefab, system building.

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INTRODUCTION

In India, affordable housing is synonymous to suitable housing for low income group people; as it is believed that housing shortage in this sector continues to be at maximum level. While housing needs for other income groups namely high and middle, are being addressed by several private builders/developers; still there is a dearth of private agencies making significant progress in low income sector, i.e., developing affordable housing for them. In one hand various clearances are required from several development agencies, like Town & Country Planning, etc. In other hand the housing loan/mortgage rates are strictly regulated. In spite of these determinants if any housing development actually does take place, there exist various degrees of speculative buyers, who eventually successfully decrease the quantity of completed housing stock to reach to its intended beneficiaries. If these problems are

amicably addressed then there is a vast untapped market opportunity for Indian builders/ real estate developers and slowly they are warming up to it. Further, public sector undertakings also can take up this challenge of bridging this ever widening housing shortage of our country.

APPROACH FOR AFFORDABLE HOUSING

The major considerations here can be:

1. Designing habitable spaces for living with dignity by the occupants.
2. Economical design solutions for achieving level of affordability needed.
3. Cost effective construction systems should be promoted.
4. Whole Life usage and repetitive design prototypes will be looked at.
5. More than 3 storied constructions will necessarily advocate use of lifts.
6. Use of barrier free designs is a must.

7. Standardized construction techniques and materials should be used for the targeted group.
8. Comfortable conditions inside and maintenance free construction alternative has to be attempted.
9. Sustainable construction practices are to be encouraged.

ADVANTAGES OF PREFABRICATED CONSTRUCTION

1. It will facilitate delivery of standard quality products to remote areas of our country.
2. It will help to build in uniform quality products and simultaneously enhancing the durability of housing components.
3. Prefabrication saves construction time from 40% to 60%.^[1]
4. It is a cost effective alternative considering the life cycle of the built facility.
5. It will generate substantial downstream employment in industries, which is a necessity in our country.
6. It will reduce demand on skills/building trades, such as bar benders, form workers, finishers, masons, etc. who are in acute short supply in India.
7. In case of natural calamities, etc. this process will be very helpful in providing rapid accommodation to the affected masses in disaster prone areas.
8. This will help building industry to organize their production and serve community effectively by fulfilling large scale needs of consumers, with an orientation to prefabricated production method/planning processes.
9. Prefabrication reduces cost of shuttering/scaffolding at site and helps speedier construction as removal of Shuttering is a hindrance in conventional system of construction.^[2]
10. Prefabrication reduces waste production and delivers quality products.

THE DUAL ASPECTS OF QUALITY AND QUANTITY

Shelter is an essential ingredient in the basic requirements of civilized living; Quality of life depends largely on the kind of housing facilities, which are available. However, in most have the developing & Underdeveloped countries, the existing housing conditions leave much to be desired both in terms of quantity and quality of housing. The main feature of the housing problem plaguing these countries is an acute shortage of residential dwellings. According to the Planning Commission, the housing shortage in the beginning of the Fifth Five Year Plan was around 15.6 million housing units.

The housing problem in India is multidimensional. The problem is simply not that of the magnitude of shortage, i.e., the number of dwelling units, which need to be built, but a variety of other structural aspects, which need to be considered for a proper evaluation of the housing problem. Many of the existing housing units are barely fit for human habitation. A large number of dwellings in dilapidated condition and several others are kutcha or semipucca constructions. A number of others do not have proper sewerage system and of course, not to forget about the omnipresent slums in urban areas. Therefore, the housing problem in India has both qualitative and quantitative dimensions.

HOUSING NEED, SUPPLY AND SHORTAGE

Here, a distinction will have to be made between housing need and housing demand. The distinction lies in the fact that the former indicates some kind of a requirement of housing irrespective of the ability of the customer to pay for it, whereas the latter represents effective

demand for housing backed by the willingness and ability of the consumer to pay for it. The question as to whether or not the house hold can afford to have a house at the prevailing market prices is the question of housing demand, while the welfare goal of the society that every family should be provided with a house is the indicator of the housing need, As already pointed out the difference between the housing need and the existing housing supply shows the extent of housing shortage, Whether or not the additional houses as indicated by the extent of housing shortage will actually be demanded depends upon the following relative price of housing service income of the consumers and willingness to pay it. Several alternative criteria can be put forward for housing need as well as housing supply, which in turn will suggest several alternative criteria for measuring housing shortage.

Housing Need

1. First and the foremost of these criteria will be that every household is in need of a house and must, therefore, be provided with one. Therefore, the problem of measuring housing shortage reduces itself to estimation the number of households and the available stock of residential dwellings in the country. However, this criterion is too sketchy and ignores the average size of the household in relation to the average size of the dwelling, It is, therefore, likely to involve a certain degree of overcrowding especially in the case of lower income groups.
2. To overcome this limitation the second criterion which suggested having one housing unit for every five persons? According to this criterion the extent of housing shortage can be determined as the difference between total population divided by five (which indicates housing need) and the

available stock of residential dwelling (which indicates housing supply).

3. This criterion is based on the norm that for every two persons, one room should be provided. Therefore, housing need can be estimated by dividing the total population by two to derive the required number of rooms which can be further divided by the average size of the house measured in terms of the number of rooms per dwelling to arrive at the required number of houses.

Both these criteria, second and third are based on the basic assumption that the total number of dwellings of rooms which are available can be equally distributed among the existing population irrespective of the income groups to which the different sections of the population belong, However, in practice, this may be extremely difficult, if not impossible to achieve this perfectly equitable distribution of housing services.

To overcome this, it may be given that the norm of two persons per room should be applied to those sections of the population who suffer from overcrowding (a Phenomenon which is found generally in households living in houses having three or less number of rooms per dwelling). The housing need can then be calculated by dividing the population living in these houses by two to derive the required number of rooms and from the number so obtained the number of rooms actually occupied by these sections of the population can be subtracted to arrive at the additional rooms that need to constructed The extent of housing shortage can then be derived by dividing the number of additional rooms required by the average number of rooms per dwelling.

Housing Supply

Two important aspects of housing supply deserve consideration in this respect:

1. The first involves the conditions of the existing housing unit while the other involves a distinction between the types of structure or housing units. Thus, housing supply can be measured in two ways: one which includes all existing dwellings and the other which excludes the dwellings that need replacement or are unfit for habitation.
2. The second aspect of housing stock that deserves consideration while measuring housing supply involves three fold classifications of the existing housing stock viz. pucca houses, serviceable kutcha houses and unserviceable kutcha houses. It is, however, possible to define housing supply consisting of only pucca houses and serviceable kutcha houses.

URBAN HOUSING SITUATION IN INDIA POPULATION

It scarcely needs to be emphasised that the population of the country has been increasing at a tremendous rate. The situation is clear that the percentage of urban population to total population has also been increasing slowly but steadily and the increase has been much more pronounced from 1971 to 1981 and the number of dwellings added to the existing stock has not been able to keep pace with increase in urban population as has been indicated by the increase in percentage of homeless population.

PLAN ALLOCATION FOR HOUSING

Investment on a large scale is required to tackle the housing problem in our country; however, it is often argued that in a developing economy, like ours the resources available for housing are severely limited in relation to the needs. Besides the need to invest in building up

the infrastructure facilities and basic industries, there are pressing demands on account of nutritional, health, and transportation and schooling gaps in addition to housing gaps. Under these conditions, it is obvious that housing would have to compete with other sectors for public as well as private investment.

In view of the above considerations, it is customary to treat housing policy as one of the several components of overall socio-economic development policies having multiple objectives, none of which can be attained in the short run without serious neglect of others.

Thus, the decision regarding housing investment cannot be made without properly resolving the complicated problem of plan allocation for housing which will be decided in the light of the amount of investment that would be required to achieve the specified goal.

According to estimates, nearly three-fold increase in the annual plan expenditure on the housing sector (valued at constant prices) is required in each of the subsequent plans if the existing backlog of housing shortage is to be wiped out over a period of 20 years. However, if we examine the trend in the plan allocation we find that the total housing as a percentage of aggregate plan expenditure has been steadily declining.

The breakup of total expenditure on housing by public sector and private sector has shown the decline in percentage allocation to housing vis-à-vis total plan expenditure. It may be noted in regard to the plan investments on housing that a significant proportion of total plan allocation for housing investment takes place in the form of private sector expenditure on housing.

Table 1. Share of Housing in Total Plan Outlay.

Sector	Plan							
	I st	II nd	III rd	IV th	V th	VI th	VII th	VIII th
Plan allocation for housing								
Expenditure on public housing	250	300	425	625	796	1491	2458	5273.02 (At 1991 – 92 Prices)
Private sector expenditure on housing	900	1000	1125	2175	3640	11,500	29,000	NA
Total expenditure on housing	1150	1300	1550	2800	4436	12,991	31,458	NA
Aggregate plan expenditure								
Plan expenditure on public housing	1960	4672	8577	16,201	39,322	NA	NA	NA
Plan private sector expenditure on housing	1800	3100	4100	8980	16161	NA	NA	NA
Total plan expenditure on housing	3760	7772	12,677	25,181	55,483	185,575	NA	NA

Source: Various Plan Documents issued by the Planning Commission, Government of India.

CLEARING THE BACKLOG

Studies show that, in order to catch up with merely the annual recurring demands, speed of construction was to be increased by 2.3 times. In order to step up the rate of construction of new dwellings in the economy, a certain amount of increase in volume of investment will have to be done. Therefore, increased investment is a prerequisite for any meaningful effort to eliminate the housing shortage. This is the bottleneck of the situation; In spite of being the state of affairs the total plan allocation for housing (or construction sector in general) has been declining speedily since the first plan period. However this phenomenon can, perhaps be explained by following considerations on part of the planning authority:

1. Housing development is merely one of the necessary adjuncts to agricultural and industrial development.
2. In the context of an acute scarcity of inevitable resources at the national level, housing investment should compete with alternative investment opportunities on the basis of its marginal contribution to economic development.
3. Housing investment is primarily a welfare measure and hence, in development-oriented plans; its

share should essentially form a part of the residual funds that can be spared after meeting other requirements.

4. Housing is one of those sectors where the primary responsibility for further development should be left entirely to the private sector and the public sector can only play a supportive role whenever necessary.

BACKGROUND OF BUILDING INDUSTRY

Building industry in India today are poorly organised and overburdened with wasteful constructional practices leading to expensive building costs, which inhibit substantial investments in house, building. Its archaic building methods characterised by “high labour input”, low labour output and major deficiencies in quality, price and supply of building materials uncertain weather and difficult site labour retard the progress of construction. The handicraft method of placing brick by brick manually by a human chain at snail speed is too slow to be of any redress to the gaping houses shortages. All this calls for immediate rethinking of the present practices in vogue to give a spur to the Industry, which it needs badly today. Following are the constraints in

which the housing industry today is functioning:

Difficult Economic Situation

We are passing through a near economic crisis in India. Our foreign exchange reserves are dwindling. Thus, heavy capital investment involving foreign exchange cannot be taken for granted under the present conditions. Thus foreign construction firms entering Indian market with their technology is not always feasible.

Level of Industrialization

Industrialization in India has not reached that level when we can immediately produce any machine indigenously. However, it should be noted that this is just a passing phase and more machines and material handling devices are being produced indigenously in the country.

Nonavailability of Good Skilled Labour

The concept of family profession is not very popular now. May be because of the spread of education or because of the discontentment among the younger generation, there are very few sons who take up after their father, profession-wise. Conventional building industry is very much depended on the skill and talent of the traditional craftsmen who is, no longer available (indicated by, among others the proposal of a training centre for these craftsmen). The labourers' condition has never improved during the years. He finds no use in acquiring skills, as it would be marginally beneficial.

Heavily Burdened Transportation Systems

In India the existing transportation systems are working to capacity and any heavy dependence on them would be misguided, Even in European countries where prefabricated components and assemblies have to be transported

enmasse night movements often resorted to.

Slow Progress on Standardization and Dimensional Coordination

In our country hardly any progress has been made on standardization of building components and their coordination of sizes and dimensions. Also antiquated quantitative standards, which inhibit efficiency and economy, are in vogue in our building codes.

Absence of an Integrated and Organized Housing Market

The material market, the labour force in the industry and the market for finished products lack coordination between them resulting in inefficiency and increased costs of construction. Under such conditions, house building has become a Herculean task and many prospective owners of houses in urban areas prefer to stay in an overcrowded rental house than to build their own houses though they have the financial means to do so.

Reluctance to Change from Conventional Methods

Traditions are hard to die and changes always invariably are resisted by the people at large. The worker's fears of technological unemployment and the general apathy that standardized methods might lead to monotony have no rational logic behind them. Here is a great need for the architects and the building engineers to take initiative and popularize improved methods of construction.

Restrictive Building Codes

It is a matter of common knowledge that our building codes are antiquated and are not in tune with the technological developments in the fields of building construction. Instead of encouraging such innovations as would affect cost reduction the building codes became

stumbling blocks on the path to progress.

Quality of Construction: Quality of construction has been going down steadily. Now the average life of ordinary first class brickwork is estimated to be not more than 15 years. These are some of the possible explanations:

1. Bad quality of bricks- this knowledge is commonplace.
2. Bad quality of cement- the calculation for the mix is done for good quality cement and moreover the cement is mixed on the basis of weight/ or bags and generally the bags do not contain the right amount of weight, hence, the strength of the mortar goes down.
3. Bad workmanship-lack of good skilled and efficient labour.
4. Specifications, byelaws and Codes-written in such a way that there is much scope for finding loop holes which can be easily exploited.
5. Too much of scope for vested interest to flourish.

Inadequacy of Research and Documentation for Housing Industry

Whatever meager research is being carried out in the field of housing does not find sufficient application in the field since hardly any live contact between the research workers and the site executives is maintained.

There is utter lack of coordination between the architect, structural engineer, contractor and the site engineer in introducing more efficient and economical developments in the field of housing industry.

Lack of Coordinated Approach to the Problem

Since there is no central controlling and coordinating body to keep in check the

diverging forces, the industry is lacking production-oriented sense of direction.

PRESENT DISPERSION OF THE HOUSING INDUSTRY

The housing industry in India today is characterized by its one-at-a-time, traditional building methods which served its purpose hitherto of an agrarian age when there have hardly been any population shifts in the country necessitating large scale provision of housing in urban area. The industry is also characterized by its lack of continuity and contractual chaos, which spelt its inefficiency. The housing industry today is at cross roads when the need for organizing it on more scientific lines is all the more great.

One-at-a-Time, Custom Building

Housing industry today is tradition bound and is resistant to labour saving devices. It is at the mercy of unpredictable weather besides being unable to offer job security to its labour and do anything to their increased productivity. Every year hundreds of thousands of independent operations are conducted under new projects for the bulk of dwellings built in our country and almost all used the same age old, time consuming traditional methods of construction. There is no wonder that we are unable to produce not even 1/5th of the annual fresh demands, not to talk of the backlog which is mounting up year by year.

Lack of Continuity and Identity in the Industry

When a client has given an architect a program that is generally incomplete in its details in turn architect devises a new plan on the strength of this program. When this new plan is put out to tender among contractors each of whom uses his own special technical process, if at all any, it is inevitable that the results are those arrived at in current practice. At

present when the client decides to make a house of his own he is embarking on a Herculean task the ultimate shape of which he does not know and the price of which he is not aware. Our house building industry thus, lacks transparency, continuity and identity.

The Contractual Chaos

The domineering general contractor is responsible for structural work including floors and walls while other contractors work in specialized fields such as plumbing, sanitation, electricity, etc. Co-operation and coordination between these are lacking resulting in colossal waste of time and money. In this dual role as planner designer and builder contractor the architect is hard pressed and his individual attention to each house impede the growth of a more efficient housing industry. At present we have the following 5 groups of contractors:

1. Big firms (works up to 20 Crores) undertake heavy construction jobs and have Own Equipment and technical staff.
2. Large contractors (Rs. 50 lakhs to 1 Crore) take-up large commercial and residential construction jobs. Medium size contractors (Rs.10 lakhs to 20 lakhs).
3. Small size contractors (Rs.1 lakh to 10 lakhs) very small contractors (Less than 1 lakh).

All these have limited funds with them except with a small number of large and successful contractors whose number is negligibly small. The rank and file of the contractors in India thus is dependent on construction advances by owner/builders resulting in delays and increased costs. The average contractor cannot introduce basic changes. He is averse to doing so. Moreover, being weak in organization and finance he is unwilling to incorporate labour saving devices, so as not to antagonize the labour force. He is also not technique minded. Small contractor

has no chance to try building techniques and the larger ones lack trained supervisors and labour.

THE MYTH OF CHEAP LABOUR PRODUCING CHEAP HOUSING

A study of India's urban housing reveals, "If one cause of India's urban housing problem is lack of financing facilities another is the fact that India's cheap labour is not producing cheap housing." The skilled building worker in Indian counterpart gets while the cost of average daily wage is only 5% of his American counterpart gets while the cost per square meter of residential space is almost half of that of a comparable housing unit in USA. There are other factors too, which contribute to this high housing costs such as high cost of materials, clinging on passionately to age old methods, poorly organized construction industry infested with small, slow moving, and inefficient contractors reluctant to adopt new cost reducing innovations which are within their reach. In the Governments justification of giving job opportunities to more people by having high labour input but without organizing the labour into some skilled aspect of construction is ill founded. The worker is left to be exploited by the contractor and remains in the same hand to mouth state of existence throughout his life.

FACTORS RESPONSIBLE FOR INDIFFERENCE TOWARDS INDUSTRIALISED HOUSING

The major reasons why the much desired industrialization of housing has not been able to find a foothold in India is complicated. Academicians, researchers, architects, builders, practicing engineers, economists all have been unanimous on the point that systematization of building is a must for the speedy removal of the housing shortage, but there is hardly any implementation, if at all of their recommendations.

MARKET AND INVESTMENT

A considerable risk is involved in investment without a market, but on the other hand a market cannot be generated until production and supporting network reaches the volume at which unit prices are low. Entry of the private sector in housing and infrastructure and less of public sector is called for. With the proper market incentives the private sector is highly responsive to downmarket housing demand.^[3] Suitable market can be found for Industrial workers' housing schemes, whose need and space requirements are generally same.^[4]

IMPORTANT MANUFACTURERS OF PREFAB COMPONENTS

There are very few organizations or consortiums manufacturing prefabricated components in India. Some of them are^[5]

1. M/s B. G. Shirke Construction Technology Pvt. Ltd., Pune is manufacturing its 3S system of precast beams and hollow concrete columns, aerated concrete slabs reinforced and unreinforced are being manufactured for roofing and walling. They are also making steel window and door frames, concrete blocks for walling and terrace tiles for flooring.
2. Simplex Prefab Infrastructure (India) Pvt. Ltd., Mumbai, is manufacturing Pre-stressed precast prefabricated technology using hollow core slab, beams, columns, solid walls, stairs, etc.
3. Sintex Industries Ltd, New Delhi is offering Monolithic Concrete Construction System using Plastic - Aluminium Formwork.
4. Cellular Concrete Factory (Polish Collaboration) Chennai is making Celcrete lightweight concrete walling blocks and lightweight panels for composite slabs.
5. AAA Engineers Faridabad is making Insulated Pre-Fabricated structural

House. Houses made up of MS Structure, walls of insulated sandwich panels with proper lighting & ventilation. These can be made in a day and can be moved to any place. They are claimed to be safe from earth quake, flood, heat wave, cold wave, external sound, rain, and wind storm.

As can be seen, none of the existing companies except the first two are giving a complete building system. Unless the manufacturers themselves give a package deal to the consumers i.e. completed building using entirely their own prefabricated techniques, no advances at present can be seen in the prefabricated industry; however this proposal would require large capital for which there is no incentive to the manufacturers. Prefabricated cannot be successful till the Government itself finances the large prefabricated housing projects.

GOVERNMENT POLICIES

The Government has not been able to update its working item according to the needs of the time. The age old almost directly prohibits the use of new materials and techniques by prefixing the design, methods and materials. This acts as an effective dis-incentive to the innovators and industrialists who might have come up with some more economic technologies, which are unconventional. Even though there are clear directives from the Government to encourage more major step, which the Government should take in encouraging prefabricated industry, has not been taken. The successive five-year plans proposed construction of millions of houses per annum, which could be easily done by prefabricated, but the Govt. must realize this first. The need to conserve available resources, economize, in production techniques, improve the quality of products, eliminate wastes, ensure

consumer protection etc., are the most important considerations which the developing countries face which are missing due to absence of standardization. It is not sufficient to specify the performance it must be capable of being evaluated as well. This may call for extremely sophisticated evaluative techniques and in most of the cases they have not been developed.

SOCIAL ACCEPTANCE

It is the poor technology and the bad quality of construction which has earned prefabs a bad name. Further the time tested and conventional technologies have a greater impact of robustness upon the consumers and they are reluctant to changes.

MANAGEMENT AND CONSTRUCTION TECHNOLOGY

India is lagging behind by miles in these two fields. We are dragging on the same old construction practices despite proven advantages of the modern techniques. The present construction technology involves large human labour at site and hence uncertainty. It is more difficult to manage. With systematization control of cost, time, and quality becomes easier. A need for better organization for smooth coordination and monitoring is badly felt in India. If we have set out to solve the housing problem, we cannot settle for anything less than a total building system.

EVALUATIONS AND CERTIFICATION OF INNOVATION

In India there is no established procedure for evaluating and certifying innovations in building materials or components. True that BIS and NBO have many widely employed test methods and specifications, none of these constitutes a complete evaluation of a new component.

A permanent all India apex body competent to carry out such work, should therefore, be constituted under the aegis of BIS with the representatives of various bodies like NCST, CBRI, SERC, BMTPC, CPWD, State PWDs, MES, manufacturers and consultants on the Pattern of the "Agreement" system of France. After the various sections stated above are satisfactorily completed, the new Products and technologies should come under BIS, ISO marking. Though successful experimentations exist, the general mass has yet not started appreciating the benefits of rapid construction techniques.^[6]

RESEARCH

Extensive research is desired to solve problems of, technology and its constraints. Though nearly twenty-six research organizations are working all over the country information building as a total system is lacking. Presently the trend seems to be towards development of new materials and elements. NBO has had many experimental Projects but the confidence of putting them into practice for mass production seems to be absent.

Non-implementation of the new techniques can also be attributed to the reluctance of the manufacturers in introducing them. However the manufacturers always have the good excuse of a poor market.

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