



A SYSTEM FOR HOUSING IN INDIA

A THESIS SUBMITTED IN PARTIAL FULFILLMENT

OF THE

REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARCHITECTURE

Massachusetts Institute of Technology

Shamoon Mamnoon

---

Edwardo F. Catalano  
Thesis Supervisor

---

Lawrence B. Anderson  
Head, The Department of Architecture

---

A SYSTEM FOR HOUSING IN INDIA : A THESIS

---

June 25, 1963  
68 Prospect Street  
Cambridge 39.

Dean Pietro Belluschi  
School of Architecture and Planning  
Massachusetts Institute of Technology  
Cambridge 39, Massachusetts

Dear Dean Belluschi:

This thesis, A SYSTEM FOR HOUSING IN INDIA, is submitted  
in partial fulfillment of the requirements for the degree  
of Master of Architecture.

Respectfully,

---

Shamoon Mamnoon, B. Arch. (India)

---

**CONTENTS**

---

**CHAPTERS:**

---

**ABSTRACT**

---

- 1 Importance of Housing in Public Planning
- 2 Housing needs in India
- 3 Trends of Growth in Urban Housing Needs
- 4 Magnitudes of Supply
- 5 Agencies Providing Housing

---

**FIRST**

---

**1 to 7**

- 1 Approach for Meeting Demands
- 2 Building Industry: Its Status and Role
- 3 The Role of New Developments: A Survey
- 4 Prefabrication, Precasting, etc.
- 5 Economics of Precasting
- 6 Standardization and Modular Coordination
- 7 Prestressing
- 8 Economics of Prestressing

---

**TWO**

---

**8 to 25**

- 1 Concept of "A House," and Housing Standards, etc.
- 2 Psychological Aspect
- 3 Social Aspect
- 4 Physical Aspect
- 5 Recommendations for the Standards

---

**THREE**

---

**26 to 32**

- 1 Introduction to "The System"
- 2 Critique of Prevalent Systems
- 3 Large Panel System
- 4 Post and Beam System
- 5 Concept of a Total System: Structure,  
Services  
The Life Inside  
Form and Space  
Economy and  
Marketability
- 6 Proposed System

---

**FOUR**

---

**33 to 50**

---

**BIBLIOGRAPHY**

---

To

My father,

He inspired me.

My mother,

She waits with

Indefatigable patience

And

To

"Bade Bhayya"

To him I owe,

Whatever

I

Have.

---

## ABSTRACT

---

Divided into four chapters, the first stressing the importance of housing in national planning probes into the needs of public housing and its commercial enterprise in India.

The second chapter deals with the means of realizing those demands, and discusses different approaches, and techniques including, prefabrication, industrialization, prestressing, and standardization, and their advantages and prevalent systems and their brief comparative survey.

The third chapter evolves a total concept of public housing from different aspects of human existence. It deals with the qualitative analysis of housing from the standpoint of Indian culture, tradition and climate.

The fourth chapter, from a comprehensive study of preceding chapters, analyses the concepts of a system of construction and then in conclusion proposes one.

---

## CHAPTER ONE

---

## IMPORTANCE OF HOUSING IN PUBLIC PLANNING

The importance of housing in the project plans of a developing nation can never be over-emphasized. Even the advanced countries today have an acute shortage of housing facilities within their own standards. The gradual increase in the standard of living tends to outdate older living facilities. Industrialization, more than any other phenomenon of developing economy, creates increasing needs in order to keep itself alive by an artificial demand. And sophisticated modes of advertising help build up such demands.

The problem is the same--whether it be an emerging nation, like India, or an advanced country like America--the strange fact that while other branches of human (or otherwise) needs are conscientiously being catered to, with increased research and innovations, branches like agriculture, defence, communication, etc. the primary needs like shelter and architecture have been indifferently neglected by technology (and architects??). A neat, clean, spacious house is the basic necessity of life--it is an indispensable element of a culture--indecent, unhygienic home is the cancer of a nation--it tends to eat away national morale and social stability--and ultimately national solidarity, and dooms the country to slavery.

**THEREFORE: THE PROBLEM OF HOUSING SHOULD NOT BE LIGHTLY TIPPED OFF, INDUSTRIALLY, AND NEEDS BE PROBED**



INTO MORE SCIENTIFICALLY THAN WHAT WE DID TILL NOW.

It is here that the world at large would be benefitted if a systematic approach is taken to face the housing problem.

#### HOUSING NEEDS IN INDIA

In India, more than anywhere else in the world, this problem is most acute. In almost all big towns the density of present population is highest in the world (only next to Tokyo, probably). The figures below would indicate the grave situation.

CITY	1941	1951
Greater Bombay	18,669	31,269
Bombay Proper City	58,889	92,056
Calcutta	29,321	20,402
Kanpur	30,362	49,000
Hyderabad	28,432	35,321
Baroda	12,000	19,395

(Densities are per square mile)

Densities in most big cities in the United States, as compared to the above, is small.

And the whole thing becomes more distressing when you know that most of these densities are achieved despite an

absence of tall and sufficient buildings, the bulk of the population lives in houses one or two stories high. Most of the tenements contain one or two rooms with one or more families huddled together.

The main compensation lies, I think, in the fact that the tropical climate is such that it forces many people to spend most of their time outdoors, irrespective of the number of rooms "inside"--therefore a courtyard or an open varandah (Bar-Aāmda) is what would be ideal if it can be incorporated in the "house." It is definitely a luxury in urban public housing but, I guess, indispensable.

#### TRENDS IN GROWTH IN URBAN HOUSING

Although efforts on an increasing scale have been made in housing during the first and second plans, the problem of catching up with the arrears of housing and with the growth of population will continue to present serious difficulty for many years to come. Between 1951 and 1961 there was an increase in population of nearly 40 percent in urban areas, with a population of 20,000 or more. It was reckoned in the second plan that the shortage of houses in urban areas might increase by 1961 to about 5 millions as compared to only 2.5 millions of houses in 1951.

The housing shortage which has been more or less chronic in India within living memory, has been rendered

more acute in the last two decades by:

- 1 Rapid increase in the country's population.
- 2 Growth of cities, due to industrialization.
- 3 Constant influx of distressed labor from the rural areas to towns and cities in search of permanent employment.
- 4 The infiltration of refugees from northeastern and northwestern regions seeking settlement (some 30 Lakh refugees).
- 5 Lack of repair and rebuilding of existing houses with the resulting loss of certain percentage of existing houses.
- 6 About 2% of the total number of existing houses has to be written off annually.
- 7 Scarcity of building materials.
- 8 Housing scarcity has led to necessary governmental rent control and official requisitioning of houses. This in turn has had an adverse effect on the already meagre private enterprise in building activity.
- 9 Low returns payable in rent does not attract private capital. House building is not exactly the best available investment.
- 10 The steady rise in the wages of artisans and other building industry workers.
- 11 The high rate of property taxation and rising land values.

#### MAGNITUDE FOR SUPPLY IN URBAN HOUSING

Growth of population and in particular urban population suggests at least three general considerations in relation to

the direction in which housing programmes should be developed during the third and subsequent five year plans. First, housing policies need be set in the larger context of economic development and industrialization both large scale and small scale, and the problems most likely to emerge in the next two decades.

Second, it is necessary to coordinate more closely the efforts of all the agencies concerned, whether public cooperative or private.

Third, conditions have to be created in which the entire programme of housing construction both public and private must be so oriented that it serves specially the requirements of middle and low income housing.

For housing and urban development programs the third five year plan provides Rs. 1420 million as against the revised outlay of 840 million Rs. in the second plan--in addition funds for housing are also expected to be provided by life insurance corporations, whose contribution is expected to be about 600 million Rupees.

The following is the main target proposed for the third five year plan (started 1961).

Subsidized housing	73,000 tenements
Low income and middle income	75,000 tenements
Slum clearance	100,000 tenements
Others	125,000 tenements
<hr/>	
Total housing target	373,000 tenements.

Besides these government sources, there are certain additional housing programmes financed from other sources.

Mine welfare is expected to provide in the third plan about Rs. 140 million, for the construction of 60,000 houses. The programme for the welfare of backward classes includes allotments for housing.

Tentative estimates for the ministries of railways, commerce and industries, communications and others suggest that over the plan period they may build about 300,000 houses broadly in course of the third plan, under various housing schemes and the construction programmes of the ministries. 900,000 dwelling units might be constructed as compared to about 500,000 in the second plan.

In private sector there has been an increasing amount of construction but it is difficult to estimate its precise magnitude. The net investment on housing and other construction (private) which was reckoned at Rs. 9 billion in the first plan, is estimated at about 10 billion Rupees in the second plan. In the third plan private investment is placed at about 1125 billion Rupees--that is about 1.5 million tenements--so that at the end of the third plan we would have some 2.5 million houses. But we would be still short of 2.5 million, plus the increase in population and clearance of slums, etc.

By now I think it should be clear that we are never going to achieve complete satiation of our housing needs,

no matter how far technically we develop--so that we must make the housing provision a primary issue soon, instead of defense.

#### AGENCIES PROVIDING HOUSES

As has been outlined in the third plan, finance provided directly by the government is just a fraction of the demand. The rest is provided by cooperatives and private finances, where the cooperatives are subsidized. Thus the major share of providing the housing goes to the private sector.

And since the private sector has to provide major part of housing, the best way to meet the situation would be to organize and systematize the whole operation and treat it as a major industry for private sector. But that involves the problems of by-laws, rent controls and the like, restrictive or permissive measures, which need be revised in order to encourage such a vital industry in private sector.

But here, what we are specifically concerned with is not those extra-technical details, but technical details to some extent and concrete proposals for at least one scheme.

In the chapter following this, advantages of industrializing public housing, through a systematic operational technique, will be discussed.

---

CHAPTER TWO

---

## APPROACH FOR MEETING HOUSING DEMANDS

As it stands, the government finances, provided directly for the stages of development, can meet only a fraction of the demand for housing. Institutional arrangements are therefore required which will enable large numbers of persons, many of them with small incomes, to build for themselves.

In this respect a central institution like the "National Building Organization" (NBO), can be of paramount importance. It could channelize more funds for housing, encourage the flow of credit in public sector on easy terms by certain techniques like insured mortgage, etc. It could further improve lending practices and provide machinery and markets for a sound building industry under private or cooperative sector. It could set up research facilities, innovation and development centers in order to promote new and improved methods of construction and building practice. It could help develop new indigenous materials, could subsidize individual or corporate builders and help activate building and construction operations on a national scale.

With orthodox construction systems and traditional operational techniques, India can never catch up with the spiralling housing demands. But with thus systematizing and organizing the whole approach on a national level, India can go much faster to meet her colossal housing requirements and plan targets.

Besides systemic and disciplined operational methods,



what we need is a system of construction, in keeping with increased researches and technological advancement. Traditional methods of construction on a craftsman's scale would never take us far, neither would it help the industry. What present-day demands is mass production--shop labor against site labor. Precasting is the "key word" in building technology today.

### BUILDING INDUSTRY

The task of building and construction industry in present day society cannot be neglected. Building is not only one of the oldest but also one of the most essential activities of man. Both the individual and society as a whole need and make use of its products.

In a growing economy which offers more and more goods and services on the one hand, and creates demands and expectations on the large scale on the other, all progress starts with the building industry, which produces about 50% of gross investments in the fixed capital.

In the industrialized countries of Western Europe about half of this again goes into housing, thus serving not only the material well-being of the population, but also helping to create surroundings where the value of privacy and community can develop.

Housing, together with related facilities, including buildings for educational, religious, cultural and recrea-

tional purposes, is by far the most outstanding example of the need for more and better construction at costs which can be afforded by ordinary man, thus necessitating the use of new and less expensive materials and techniques. In short, the building industry and construction is, in the full sense of the word basic to country's (any) development. A well organized industry will:

- 1 Guarantee the security of enterprise and thus would attract the public investment, thus indirectly encouraging the people themselves to take part in national reconstruction.
- 2 Encourage building activity.
- 3 Encourage research and development, innovations and new construction techniques.
- 4 Organize training of skilled labor on a country-wide basis.
- 5 Bring down the cost of buildings and construction by standardization and prefabrication.

#### THE ROLE OF NEW DEVELOPMENTS

New developments in building methods and techniques must therefore make an essential contribution to the industry's effort to fulfill its task in present day society. But it will not be sufficient to promote these developments as such, isolated from the social framework on the one hand and long term objectives on the other hand.

New developments can have various consequences which may be positive under one set of social circumstances or neg-

ative under another--thus labor savings techniques can mean the same volume of production and less employment, or they can also be used for an increase of production and for improvement of quality while the level of employment is maintained.

In the first case in the market economy it can even happen that an individual firm may make extra profit on account of improved methods and techniques. In short, new developments should lead to a better use of existing resources not to the replacement of one source by another.

It is obvious that in general this does not mean that manpower in each industry must remain more or less stable (taking into account the natural increase and decline of the working population)--but in the case of building industry where higher output is so important, redundancy of skilled workers seems contrary to the general need.

It should be borne in mind that the product of the building industry usually serves on long term planning, and forms an essential part of the surroundings of our daily life. Therefore technical progress should not essentially be a one sided affair of cost saving and numerical increase of output. Social responsibility in a building is also a question of design and community planning. While the architect should understand that his best artistic ideas are of little value if he does not take into account that building for the masses is as much an economic problem as an aesthetic

one, the developer of new methods and techniques must not forget that human beings do not want to live and work just between four walls and a roof with the minimum of space inside and outside of a building.

Though it is difficult to over-estimate the importance of new developments in building and construction industries, one should not overlook the fact that these developments find their limits at a point, where innovations for innovation's sake become a purpose in itself. When this happens, account is no longer taken of the human beings who have to spend the best part of their lives in and between the products of building industry.

#### NEW DEVELOPMENTS: PRE-FABRICATION

Building practices in India need re-orientation in view to meet the colossal demands on housing in urban areas. And further more, building operations are likely to expand during the next decade and a half. If the present methods of building are let to carry on, a great wastage of national money, allotted to reconstructional jobs, is in store. To meet the targets aimed at by five year plans, and coupled with the shortage of steel and cement (which is further rendered acute due to defense mobilization, a consequence of Chinese aggression), steps similar to those adopted in other countries may become inevitable.

Building operation and construction in this country, as are existing cause great wastage in materials and labor. All construction processes including the collection of materials are organized at site, with the result that time taken in terms of number of man-hours spent is generally very high, and consequently the overall cost in terms of materials and labor also proportionally goes high. This demands analysis of various operations that are organized into building so as to enable us to find out ways and means of re-orienting them.

The cost of building can be generally divided into four major items; they are:

Materials

Labor

Transportation and

Time. (construction or erection)

Any effort towards each one of these items will result in <sup>all</sup> over saving in building costs. Generally it has been found that percentage cost on account of these items are:

35 to 40 % Materials

35 to 40 % Labor

10 to 15 % Transportation and

10 to 15 % Time.

It must be clear that by having a well-organized factory we can save on all of these items.

The idea of cost saving devices also needs review. There

is a limit to what can be achieved in terms of economy in respect of materials. Therefore "construction and design" becomes by far the most important governing factor which ultimately tells upon the two other cost factors, i. e., labor and time.

Skilled labor is scarce. Growing industrialization and better and permanent job opportunities elsewhere seem to drain away all skilled labor from building industry, with the result that labor is costly and hard to get.

One solution to this problem which seems to be gaining universal acceptance and popularity is "prefabrication."

U. S. A. developed various methods of prefabrication from a small unit to a complete house, fabricated for T. V. A. project and carried on site by means of trailers. Europe has taken strides in developing housing and today is far advanced in prefab techniques than U. S. A. is.

Later in the course of developing the thesis I hope to take a cursory view of prevalent prefab techniques in European countries. Here, I mean to emphasize that India before long should follow into the footsteps of these once underdeveloped countries to attain its gigantic housing targets, with minimum cost and effort.

Advances in precast techniques such as vacuum concrete, shock concrete, etc., have speeded up construction, the lift-slab, tilt-up, and slip-form techniques at site

construction are other notable contributions towards cost-saving techniques.

Prefabrication seems to give the following advantages over the conventional method of construction:

- 1 Components are manufactured in the shop, where because of controlled conditions of production and work, the quality of the product is far better.
- 2 Material can be saved (from waste otherwise) due to organized and mechanized methods of manufacture.
- 3 Permanent skilled labor, economically employed, as the production is continuous.
- 4 Finishes could be applied at the shop-stage cutting the site labor further.
- 5 Savings on site labor and time of construction.

(However it involves new items like transportation and hoisting, storage and handling, etc. But these new items are far less costly in the first place, and far less arduous and time consuming than the ones eliminated; e. g., form work, scaffolding, necessity of a workshop on site, curing, etc., etc.) Moreover:

- 6 Precast unit construction is statically determinate and hence standardized sections are used and time required for detailing, drawing and designing is eliminated.
- 7 If any construction is to be dismantled, precast units can be readily taken apart and a large number of them

could be salvaged for further use.

8 Precasting lends itself admirably to pre-stressing, another sizable achievement of concrete research and technology.

There has never been two opinions about the distinct superiority of prefab over site fabrication, but there are pitfalls too, to be guarded against--as has already been once discussed (Chapter Two) there should be limitations to cost-saving devices--certain design, aesthetic, or traditional values should never be sacrificed for the sake of a few hundred pennies.

The tendency in certain European countries today to prefabricate bigger and bigger building components is essentially an industrial measure of lowering down the cost still further.

It is claimed that it brings down the cost of fabrication and assembly at the site--and solves the difficult joinery problem--granted!--but at the same time it has distinct disadvantages: as follows:

- 1 Heavier and larger units are difficult to transport and give rise to many handling complications--which might tell heavily upon their design (structural).
- 2 Difficulty in transportation imposes a limit on the working radius of a factory's activity--i. e., less distribution of overhead, less business, and hence less economical.
- 3 Heavier components are difficult to hoist, use specially designed hoisting equipemnt, which might, in order to be



economical, impose their own limitations.

4 The most important of all, the bigger the prefabricated component the less is the flexibility of its use.

This is an important consideration, because the biggest objection raised against prefabrication by the architects the world over is its inability to lend itself for individual design and flexibility--I feel the charge has certain force of truth in it--and here is it that the bigger a prefab building component becomes, the less chance it offers of variation in design.

I feel the only way prefabrication can be most advantageous is that the building should be divided in its optimum parts, considering the interchangeability of components, variability of arrangements to get maximum design individuality, economy and ease of site joints, and sound structural behavior, and thus those optimum parts or components be prefabricated.

I am sure a very ingenious system, incorporating these virtues could be developed, which might not sound, at the onset, a very ambitious one, or might appear stark simply but nevertheless it is that which might be most ideal from all points of vantage.

By far the biggest disadvantage of using bigger components is that it leaves us no chance of using indigenous material (and labor if it is cheap too) wherever desirable--for aesthetic

desiderations of giving a local expression, or otherwise.

What need be apprehended is that:

The big centralized industry need not kill the local craft, but help it to thrive and prosper through itself. It would be worthwhile to note that cost is not always the criteria for choosing prefabrication; there might be other motivations too, like shortage of labor, industrialization, ease and rapidity of erection--but probably the likeliest of all are two: shortage of skilled labor, and industrialization--both are mutually interdependent phenomena.

#### ECONOMICS OF PRECAST CONSTRUCTION

Many factors should be taken into consideration when determining the efficiency of the use of precast reinforced concrete structures as compared with others. Calculations show that because of local conditions the importance of some factors changes, not only within the country, but in some cases even for different structures on the same construction site. Therefore it is possible to review only general considerations.

Taking into account the rapid mechanization and consequently the development of all kinds of machine building, using immense quantities of steel, one of the most important factors while choosing the materials for construction, is saving of steel. In erection of industrial buildings the replacement of steel structures by precast reinforced concrete ones led to the following savings of steel.

In columns, trusses, and trussed rafters by a factor of 2-3, in roofs (when replacing steel purlins with small slabs by largesized ribbed slabs) by a factor of 2.5-3.5; in high external walls, (when replacing brick work reinforced with steel framework by largesized panels) by a factor of 2.5-3.0. Data on individual structures are as yet insufficient for obtaining a general picture.

Generally it is believed that the replacement of in situ reinforced concrete construction by precast concrete (for similar structure) reduces the consumption of reinforced concrete (not steel alone!) by 15-25 percent and in some cases by as much as 40 percent taking into account the consumption of reinforcement the use of 1, M<sup>3</sup> of precast reinforced concrete saves up to 300 kg of steel.

The replacement of brick walls with steel framework by walls made of largesize panels made of precast r. c., reduces their weight by 2.5 times and the labor consumption involved in erection by 1.5-1.8 times.

Factory production of precast structures makes it possible to perform merely the erection of buildings and structures at the construction site and to carry on construction all the year round not lowering the rate of construction even during severe monsoon months.

But precasting needs, standardization of precasted parts-- and coordination among different building trades ensure wider interchangeability and hence wide acceptance.

## STANDARDIZATION AND MODULAR COORDINATION

According to Ernest Weissman, Director of Industry and Material Division of the UN Economic Commission for Europe, the lack of integration and dimensional coordination between prefab components, in the building industry imposes definite limitation on its output. This limiting capacity in turn results in high costs of production, and negates the basic idea of economy. Industrialize prefabrication of structures implies a high degree of standardization. However it does not require a rigid duplication necessarily of a few types of building.

For a mass-scale machine production suited to climatic and social requirements, the structure should be broken down into components, designed to suit best the desirable performance requirements and available means of production and --then either all the components be manufactured by one concern or several decentralized factories. But all the components should adopt the same standard module.

The idea of standardization and modulation is primarily to help industry coordinate and also to insure wider consumption of precast commodities and save thereby on "overhead" and consequently attain reduction in costs. One of many aspects of design which has been investigated into with substantial success is that of rationalization of modules, and through a systemic application of modular coordination in the

components are dimensions in such a manner that widest possibilities of interchange are guaranteed without slightest trimming or adjustments while assembling on site. This principle has been adopted in India and promoted, from the very commencement of the standardization programme of building industry, the module adopted being 4" or 10. cm.

#### PRESTRESSING

Concrete technology has made considerable progress and better techniques of designing and placing the mix have been developed. The law of water-cement-ratio has made it possible to design a concrete mix of any specific strength--studies of mechanical vibration have led to a considerable economy in the use of cement and in the production of high quality concrete--advances in precast techniques such as vacume concrete, shock concrete, etc. have helped to speed up construction.

Prestress concrete is another sizable advancement--this technique with the introduction of precompression by suitable jacks and anchorage enable the use of concrete to its best advantage. Precast concrete construction is catching up in India and a number of precast structures have been built. There is little doubt that with the urgent need of economizing (steel is being used now for defense productions) and this method will increase in its popularity.

Prestressing not only enables very large areas to be covered in a simplified way but the quantity of materials re-

quired with these designs is only a fraction of that necessary with more conventional designs.

The adoption of "limit design" methods should be encouraged as it is more rational method of design than the existing "elastic" method.

The development of techniques which makes optimum use of a material and conserves it and permit expeditious construction should be encouraged. Adoption of the techniques of prestressing would result in substantial advantages and material gains. The quantity of concrete in a prestressed concrete structure may be taken roughly as about one-half that in equivalent R.C.C. structure. The quantity of steel necessary is only 25 %, however this has to be high tensile strength.

Although prestressed concrete is being used in India, it is only on a very limited scale. Two conditions militating against increased use of this technique are: 1) diffidence in the adoption of a new technique and 2) non-availability of locally manufactured high tensile steel tendons.

The first difficulty is likely to be overcome gradually through precept and example but specific action appears to be indicated with regard to manufacture of high tensile steel wire in the country.

There is a considerable steel shortage in the country and the building industry is experiencing great difficulties in obtaining its requirements. Even with increased output of

steel envisaged in the second plan, the demand is not likely to be completely satisfied--in purview of these facts, prestressing might prove to be a blessing for present day India.

The following advantages need be noted.

First, prestressed form of construction gives a structure free of cracks under full working load conditions.

Second, savings in deadload on account of reduced concrete area.

Third, for precast products, for limited spans it has an evident advantage due to ease in handling and transport--this appreciable decrease in deadload has thus rendered possible the shop-production of prestressed building components at cheaper costs.

Fourth, the flexibility of the material makes it ideally suitable for precasting techniques, as it permits no cracks while handling.

Fifth, the prestressed structure is resilient and fatigue resisting--an important consideration for long life and better maintenance.

Sixth, diagonal tensile stresses are reduced to a minimum, thus making the use of thin web members possible.

Seventh, considerable economy in multi-story construction due to reduced weight of superstructure.

#### ECONOMICS OF PRESTRESSING

Following are some of the components made by "Hindustan

construction" under "The Hindustan Housing Factory Ltd."  
New Delhi--material and cost comparisons are noteworthy.

- 1 Beams: The precast prestressed concrete beams for roofing, for spans up to 40 feet, have been evolved and erected by the factory. Apart from the considerable savings in steel, the initial cost is cheaper than steel--savings in steel, 90 % as compared to steel structure for the same span and spacing of trusses. Savings in steel, 80 % as against equivalent R.C.C construction.
- 2 Street light poles: only 4.25 % steel of "a steel pole" and the weight of it only 1200 lbs as against similar one in steel of 900 lbs--an equivalent pole in R.C.C. would have 21 % steel and weigh about 1800 lbs.

Standard roof 1: of prestressed joists and precast slabs. Span, 10 feet. Savings in steel 40 % of that required for cast-in-situ concrete. Designed for dead load of 4" average "mud phuska" and 2" tiles and live load of 30 lbs.

Standard roof 2: prestressed concrete planks and precast blocks; span 12 feet, savings in steel 50 % that of in-situ concrete. Slabs designed for live load of 50 lbs and dead load of 1½" tiles, 1½" concrete topping and 1" cement mortar.

Standard roof 3: prestressed joists and precast planks. Span 18 feet. Savings in steel 40 % of ordinary R.C.C. Designed for a live load of 40 lbs. and 2" topping.



All these and many bridge components are successfully commercialized and have a very good market within the factory's range of about 300 miles.

The following were the considerations:

- 1 Smaller and lighter sections due to prestressing afford greater ease in transport handling and erection.
- 2 Absence of cracks and resiliency of the material to close its cracks makes it ideally suitable for rough handling and transport as compared to normal precast reinforced concrete cement products.
- 3 For larger spans where transport problem is to be solved the precast units in smaller dimensions can be transported to the site and post-tensioned to give any length of spans. In a country like India where transport conditions are difficult, this will afford the factories to control a larger area by its production even for larger units of prestressed products to be erected at site--the plant required for post-tensioning can be easily transported to any site.

---

CHAPTER THREE

---

## CONCEPT OF "A HOUSE" AND "HOUSING" STANDARDS"

Public housing in a way resembles ready-made clothing, it is even more complex and comprehensive. Both are unconvincingly simple when ready for use--but the amount of scientific research which generally precedes such an end product is immeasurable--society, customs, mores, fashions, wearing habits, climate, tradition, psychology are only a few of the factors which go to determine the "type of clothing," besides the general study of sizes and materials--almost the same is true of housing too.

A microscopic study of different aspects of human activity is required before we set any standards for housing. It is not enough to know the physical needs.

To design a house for an individual, for his individuality, for his psychological, social and physical needs, is difficult, but to design "a house" for "anybody" is the hardest task if confronted with sincerity and purpose. To select and generalize, to omit and particularize, to check and standardize, are the crucial decisions on which the future of a community hangs. These decisions might ultimately change the patterns of culture, or recreate it for better or worse. Hence it is important to analyse and refabricate the concept of a house from different aspects of human existence.

### PSYCHOLOGICAL ASPECT

Psychological yardsticks of design, which though are not

as clear cut as their physiological counterparts, nonetheless are just as consistent in their ways as the physiological measurement are in theirs.

Psychological definitions of a house are difficult to frame--it varies from individual to individual like the lines in one's hands--for me it might be the place where one feels free from all social inhibitions and realizes complete relaxation and peace--for some it might just mean "the possession" of some particular chunk of space for living in--for still another it might mean a place where one has complete mastery of everything, and so on.

However, it is possible to investigate certain common denominator, which might give us a clue to an approximate "public" concept" of a house for a public housing project--and this concept would help design "a space" where "most" of the "individuals" feel "at home," in ways more than one.

The following is a kind of attempt to sum up such a concept of psychological needs. These are the "features" one cherishes in "a home."

- 1 A sense of identity and individuality
  - 2 A sense of shelter and repose
  - 3 Sense of freedom and privacy in space
  - 4 Sense of integrity and dignity
  - 5 A possessive and exhibitionist sense.
- 1 Sense of identity may well imply a certain tradition and value of living habits, a house may allow in order, to help

the inhabitant identify himself, by way of living. It might be coupled with one's culture and society.

2 A sense of shelter obviously can not be imparted in a house with very high ceilings, say, or with slanting walls, etc.--A quality of repose is sensed through the kind of scale and proportion the house has.

3 Obvious

4 This has a lot to do with many things together, such as moulding of the spaces inside a house, their relationship with each other, the kind of materials used.

(Great Mogals felt a strange dignity in marble palaces, houses in the south with stone as the chief materials, only few have, and so on.)

5 One is always "proud" of one's "own home."

These are commonest features one always aspires to, irrespective of geographical or sociological settings. All of these, obviously, can not be achieved. But the degree of success depends upon the amount of pressures exercised by desiderations other than psychological, which go into the consideration for a total concept of public housing projects.

## SOCIAL ASPECT

Housing needs are entirely conditioned by the traditions and social patterns of a culture--a dwelling that fails to satisfy the sought for living values will be considered just as inefficient as one with wrong dimensions for performance of work. In this respect, with no existing sociological data pertaining to the uses of space in a typical house, what we can rely on is the personal observation and self analysis--such a thing will though only approximate to the real needs, would not however be very far from it.

Patterns of family and social living in the east in general and India in particular, is poles apart from complementary value in the West. The climate and cosmic factors have forced a wholesome social life, with no particular regard for formality and extreme individuality--People in villages still live more or less like "Roman pagans."--loving sunshine and open and retiring to their respective shelters only when it gets physically uncomfortable outside--and most of the rural patterns are relived in urban communities, with little "so-called" sophistication. Movies and hotels are gradually eating away our culture as they are elsewhere; still there are hopes that through proper community developments and housing programmes we can not only preserve but foster our traditional values of "open" living.

Members of the family have stronger emotional bonds

between each other than are found in the West, and hence entertain less privations.

Ways of living are extremely simple, with emphasis on relaxation rather than comfort. Men and women move in separate social circles. Society on the whole is affected by and constantly draws on religion for inspiration and influence.

There are some traditional and religious aspects of a family's life which would not directly tell upon a public housing scheme, but should not however be precluded. Customs like sitting on elaborate rugs and "gaddis" (floor cushions) and moving barefoot in the house might considerably change the outlook on design. Use of "gaddis" would eliminate the space for furniture, and a small room immediately will have not only a "sitting man's" scale but would be spacious too.

Eating on the kitchen floor on "squatting stools" would preserve the age-old tradition and tend to make the kitchen more roomy.

#### PHYSICAL ASPECT

A housing standard does not consist merely of number of rooms. It is unfortunate that many Indian architects and designers have failed to take the necessary cognizance of this and are often carried away by the notion derived from cold countries that every adult should have a room to himself. In fact the climate of hot and humid countries like India, has affected the social customs of the people, more

anything else has. A verandah directly open to space, air and light is a boon to an Indian as far as it enables the family to sit out and enjoy the sun and air and relax. During the greater part of the year weather suggests to people to put on merely a short loin cloth and light vest rather than coat and trousers. Even for sleeping, the members of the family require a verandah or an open space for more than nine months. In the year in most parts of Indian cities, a person likes to be out of doors as often as possible and will sweat and feel uncomfortable if he has to sit in a closed bedroom or living room.

It is therefore not a matter of economy or shortage of space, which suggest a smaller number of rooms in an Indian house, but the climatic and weather conditions necessitate it. Rooms are required for storing and stuffing clothes and other personal articles rather than living purposes. It is a common sight in summer nights to see innumerable people making their beds on roof tops, or on street and such available spaces, who have no roof tops. Therefore the emphasis on having a certain minimum number of rooms in a house appears to be unrealistic.

Through cross ventilation, good reflected sunlight, and provision of adequate water supply and sanitary facilities are necessary.



## RECOMMENDATIONS FOR THE STANDARDS

For a family unit of six persons, the following is the optimum living standard.

Two living-cum-bedrooms.

Two verandahs (or balconies) open to outside.

Kitchen store, bath and w. c.

A courtyard for single story dwellings.

Organization should be such that maximum living space use is available out of the living rooms and the verandah. This is useful for outdoor-indoor living, particularly for long summer months.

Of the two living rooms, one should be at least 150 square feet.

Total space per person should not be less than 80 square feet per adult and 40 square feet per child.

Kitchen should not be less than 40 square feet, with storage space of 20 square feet.

Bath should not be less than 20 square feet and w. c. 12 square feet.

Every room including kitchen should be so designed that there is cross ventilation with windows and openings of any area not less than 10 % of the floor area in case of living rooms and 15 % in case of kitchen.

Height shall be such as to secure good circulation of air and no stagnation in the upper layers, minimum being 8 feet.

---

CHAPTER FOUR

---

## INTRODUCTION

1 The foregoing analysis of the needs for housing, and rather elaborate discussion as to the means of realizing it, leaves us with no doubt that the salvation is in adopting the modern methods of prefabrication, prestressing and mass production.

There are two approaches: out and out prefabrication, i. e., factory fabrication of the biggest units possible--in three dimensions if need be--and truck them to the site for assembly into row-houses, apartment blocks or low-rise --all of them of the same "basic cube unit." --But in different numbers--and another way:

2 To develop a system of "supporting" structure which would fit in various "supported" structures, based on different plans of different types of buildings--thus mass-produce "supporting" and "supported" structure separately and fabricate them on site--(it has advantages as ~~we~~ shall be shown later)

The choice between the two is the choice between "characteristic values."

Europe has tried both of them--former, very recently, and still in experimental stage, therefore in the absence of any "analytical data" it is hard to opine--however overlooking the hardship of stablishing such a venture in an under-developed country like India, and the related technical

intricacies of production, assuming that this method is economical (and it is not far from doubt!) then the biggest advantage of this approach would be that cheaper and faster realization of our aimed at housing targets would be made possible--yes! But what after?

There lies the inherent defect of this system--this rigidity and monotony, as has been discussed at length elsewhere--besides, we would not have solved the problem of housing after all. These "box units," tight in themselves would not allow changes for better living standards or growing families. As a result in a decade these housing units would be slums. What creates slums is not always the "less-than-minimum" requirements for living, but "less-than-adequate" facilities, also may be the reason--and the concept of "adequacy" changes with "production" in a developing economy. And with rapid mechanization and industrialization, a developing economy is inevitable--i. e., adopting this system of "cubic" construction" would not take us very far in solving our housing problem after all, and "slums" would still be a perpetual phenomenon.

In this new context a system of housing which would allow changes readily with least of adjustments, is the more economical as a long term investment and planning even though it might be costlier in initial expenses.

It may be pointed out that, if the aforesaid cubic units were to be designed keeping in view the development in the future, two decades, let us say, then it would solve

the problems anticipated? But then, would they be an economical venture for the first 20 years??--No! For you are providing more than what should be provided for the present.

What we need is a flexible system which is readily adaptable for any changes.

And consideration on variety should be paramount--as it is variety and change that generate a pleasant, livable environment. The works of engineering and architecture are the heaviest part of what we experience in our day to day life, they lie underneath, they loom around, as the prepared place for our activity. Economically they have the greatest amount of human labor frozen into them. Against this background we strive for our ideals, struggle for our freedom, aspire to our ambitions, and it has a profound influence on our total way of life.--Therefore, this background for "human drama" should be most thoughtfully projected and articulated with utmost delicacy--in particular for India where the outdoor life comes more natural to the people. The "piazza" or the "forum" should be as aesthetically articulated and ingeniously designed as the inside of a house.

So that these two reasons render "bigger" units system doubly rigid.

## A CRITIQUE OF PREVALENT SYSTEMS

Prevalent systems of construction prefabrication could be broadly classified into

Large panel system,

Frame system and

Box or cubic system.

The first two systems are mostly in use independently, or in combination with each other--the third one, that of three dimensional fabrication is very recent and has not been used widely enough and long enough to give any computations of merits and demerits, with any degree of assurance. Russia is pioneering this system and advocates its ease of speeding up development of housing schemes--it cuts down assembly at the job site. Although the rapidity of assembly is achieved, the speed of construction has not increased to any significant extent--the cubical units are still fabricated, in the factory, out of posts and beams and wrapped up in light weight panels--supports at the job site are poured-in-place--splayed corners of the cubical units around, forming the shutterings for columns; reinforcements protrude out of this splayed corners in the form of loops.

Photos show that these housing schemes, developed of these cubical units are devoid of any aesthetic value, are extremely regimental and drab. Their long, monotonous facades

remind one of army barracks rather than of a civilian community. As the cost figures are not available, the soundness of this system as an economical proposal can not be weighed. However, as a new frontier for research, the system is commendable.

"It is impossible to say," says M. G. Blache're, director of the center scientifique et technique de batiment (France), "whether the introduction of processes that would be impossible to carry out without a prefabrication in a factory might tip the balance in favor of this method, it is a possibility, however."

Out of the first two systems, the most current in Europe, is the home of prefabrication, is the one with panels and bearing walls. This system grew out of "acoustic and shear" considerations--the argument in favor is that why the party walls which have to come any way, and have to be massy and heavy for "acoustics" and "shear" reasons, should not be made to act for supports--and, prima facie, it seems to bring home the point pressed. But in the ultimate analysis, the validity of the argument turns out to be a sort of defeatist attitude of accepting an escape from a minor problem and imposing the consequences on other problems with least foresight. Shear walls have not to be heavy and massy necessarily. As for acoustics, "mass" is desirable, but there are other techniques of good sound isolation with lighter materials, e. g., air space, etc. Then why subject foundations to

unnecessary heavy loads?? Materials and dimensions on supporting structures also could be saved if the supported structures were lighter. Consequently handling, hoisting, and transporting equipment could be of "lighter" kind, even the structural joints could be made much simpler only if we could reduce the weight of the overall structure. It must be clear that the direction for analysis and solution was led wrong--instead of solving the problem of "acoustics"--to impose its dictums on half a dozen other primary building principles--is irrational thinking, an escape which leads to the negation of the central premise of precast and prefabricated construction. (That is, trying to reduce the structure and loads in order to prefab, transport and hoist with increasing ease.) Once realizing it, Europe is turning towards the other system--namely frame or skeletal system.

3 This system seems to me most ideally suited to prefabrication (unless the prefabrication in three-dimensional units proves in its true sense--not through post and beam--proves it otherwise)--and as it shall be shown it offers many other advantages besides.

Investigating the merits and demerits of the two most prevalent methods would help bring each into a more sharp relief--and thus a comparative assesment would help further investigation and experimentation.



## LARGE PANEL SYSTEM

### ADVANTAGES

- 1 Better acoustics fused with structure.
- 2 Shear taken care of by load bearing wall-- therefore the structural joints have not to be for moments.
- 3 A chance of passing mechanical and plumbing through the walls which could be cored slab with reinforcements on two faces.
- 4 Overall rigidity, gained by heavy weight of the structure.

### DISADVANTAGES

- 1 Concrete is used less exploitedly, that is, used more than necessary.
- 2 Behavior of walls under wind load is not structurally determinable, hence a factor of safety, very uneconomically big has to be provided for in designing them.
- 3 The section of the wall for lateral loads is such that the web action is not properly utilized--meaning, the strength of a wall lies in its longitudinal direction, where as the floors load it laterally--so that for all practical purposes load is the same as that of a column.

The obvious reason for using bigger members is avoiding the number of structure joints and reducing the site labor in terms of man-hours, but load bearing wall accomplishes nothing. The joints become more critical, bigger and tedious and complicated.

- 4 Site labor is more since bigger units are to be handled
- 5 Heavy loads of the superstructure require heavier foundations, i. e., increase in job-site labor.
- 6 Heavier members mean heavier handling and hoisting cranes, and of course, the cost of transport increases too.
- 7 If the walls be made of smaller units, then leaks and cracks in the vertical joints become all the more critical if not properly done because of sound insulation, because that is what is the whole reason for using walls.
- 8 It seems that, after all, just for acoustical reasons this is "much ado about nothing," as the weakest part in the house from the point of view of sound penetration is, as a rule, the window, the front, which even when closed and airtight (which is seldom anyhow!) will only give 20 DB of sound insulation.
- 9 The possibility of incorporating the mechanics and plumbing has been seriously doubted by engineers,

as the easy access to these in case of repairs and maintenance is questionable.

- 10 Since the transport cost would increase, the effective commercial coverage of a production plant becomes limited, for economic compatibility with tilt-up or some other site fabrication.
- 11 It is not flexible, i. e., the plan can not be independent of structures.
- 12 It does not permit the use of indigenous material for non-structural purposes, which might otherwise add to the aesthetic depth of the structure.
- 13 It can not be used for types of structure other than housing, which again limits the possible exploitation of mass-produced items, i.e., they should have widest possible market.

From the above evaluation it should be clear that for mass production purposes there are other considerations than joist acoustics and shear--it is largely a matter of comparative value analysis.

#### COLUMNS AND BEAM SYSTEM

##### ADVANTAGES

- 1 Less rigidity in the structure than with bearing wall system. It is because of less weight and skeletal construction--but once the structure

is clad, it is equally rigid--However shear walls are needed for wind-load, etc.--But this is not unsolveable--Rigid connections that may take "negative moments" could be designed with compatible economy and ease.

- 2 Takes comparatively more steel probably than the load-bearing wall system. But the lightness (comparative) of the dead load more than compensates the loss.

#### ADVANTAGES

- 1 Materials, steel and concrete are used to their maximum strength, thus economically saving the material.
- 2 Since the extra weight of the material which is not structurally needed is cut down, the structure becomes lighter, hence less foundations, etc.
- 3 Easy handling, hoisting and transportation to site, saves man and cost.
- 4 Effective area of the plant operation widens, which results in larger distribution of overhead, i. e., products come to be still economical.
- 5 Lighter members are quicker and easier to assemble, hence less operations on site, and saves time.
- 6 Flexibility and freedom of change, of planning.
- 7 Wider applicability for various types of buildings,

like hospitals, schools, community offices, etc. Therefore, wider market and more attraction for investment.

- 8 Freedom of using indigenous material and labor wherever desirable.

#### CONCEPT OF A TOTAL SYSTEM

Precasting and mass production obliges us to develop a system of construction. However a system of construction independent of "a total concept of building" is unthinkable. There has to be a system of building before we evolve a system of construction.

Now this total concept could be conceived through different points of reference, like:

- 1 Structure and mechanical services
- 2 Life of the building (its people, their activities, circulation, etc.)
- 3 Form and space.
- 4 Economy (relative study).

Projection of these four standpoints would generate a system which could then be developed into a philosophy of architecture, because then it will have incorporated all the "a priori" of sound building.

## SERVICES AND STRUCTURES

Structure and mechanical service (plumbing, air conditioning, electricity, etc.) could be organized in such a way that the flexibility and clarity is achieved in both-- each is independent of the other.

Flexibility has a lot to do with the bays and cores, and their interrelationship. There is an optimum size of a bay in terms of function, change of function, and structural efficiency in terms of each other and optimum economy of design.--And with this bay size is the mechanical core integrated, again with optimum flexibility of service. "Organizational readability" is the indication of thorough integration and ensures the easy access at all times to mechanical services for maintenance and repair.

Module is "the key" to such organization.

## LIFE INSIDE

Life is created in a building with the help of spaces and their proper sequences, entrances, stair halls, corridors, places of common activity and movement are all the "limbs" of a building. They "move" with the moving people if properly conceived. By their placement and displacement inside a building, in an hierarchical order, "space magnets"

can be developed to gravitate the inhabitants together, with the depth of their dimensions. Thus organized the inside of a building wears a definite expression, only of its own-- when this is achieved the structure as if starts "talking" like a living being and "responds."

Life in a building is not only created by the interior organization, but even the outside of a building generates the inner-life--The outside elements are the supports, bays, cores, balconies, etc. These are to be organized on the facade too in order to add to the life inside.

--The most important element outside a building is its approach. Through a careful moulding of the site the approach could be so developed that it serves as a gradual transition, and prepares one for the kind of surprise that is inside.

#### FORM AND SPACE

The form of the structure is modelled by itself, once the life inside is organized, and different elements which go into its formation are integrated with their respective sequences and order.

The facade and the cubic proportions of the structure generate the form of it in three dimensions, and they are themselves generated by the organization of plan and section. --Therefore, the form is not independent of plan.

Space is created by a group of forms--but a single structure is also capable of creating its own space by the virtue of its placement and siting on its plot.

#### ECONOMY

Economy is the "moderator" and imparts to a structure its discipline and sobriety, it helps to gravitate it. Though it does not come into the direct range of building's expression, nonetheless it assumes an important role in the development of its concept--it struggles with the tendency to "over-emphasize" architecture, thus saving it from being fashionable, and ties it "down to the ground."

In the light of these concepts, was developed a system of construction for housing.

#### PROPOSED SYSTEM

From the preceding analysis, it was concluded that "post and beam" would lend itself itself most comprehensively for the ideals of the system. It was adopted. The system is to be developed for middle income standard of urban living.

Spcae requirements of a typical family and economical design of supporting framework projected the proportions of a bay size. And the core for "mechanicals" (plumbing,



electricity, etc.) is integrated with it. All this is to be flexible in as much as to allow the plan arrangements, the freedom of change and growth.

The width of the bay was fixed to be 13'-4" feet, i. e., the optimum width of a room, after various trials of plan arrangements and room sizes.

As the shear wall was to be avoided (the height of the structure was only 12 story)--some sort of rigid frame joint was obligatory, this was to take negative moments due to wind loads also, and consideration for easy and quick erection procedure was paramount too. All these desiderations were achieved with "twin beams," instead of one of bigger dimension --thus column-width worth of gap between the beams solved the problem of passing mechanical services, and this "cavity" between the two thin asbestos cement partition walls would help isolating sound also--this was the key note of the whole system.

Thus with the structural solution was integrated mechanical services and acoustic isolation; all this coupled with easy erection and stiff joints and no shear walls necessary--Above all a perfect expression of precast materials.

The bays would be spanned by precast, prestressed concrete planks, for floor slabs.

This was flexible, economical and integrated.

## LIFE INSIDE

In this particular type of building for living, there is a conflict between the two types of lives: the life of the unit dwelling and that of the building. As has been pointed out different elements and activities in a building recreates a sense of life. Here a very delicate balance has to be maintained, as otherwise it might result in the disintegration of the "family life"--the life of the unit is more important whereas social life of the community comes second in architectural and planning emphasis.

Common spaces like corridors, stair halls, etc. are cut down to shift the identity meticulously to the "basic unit."

Life inside the unit is recreated by splitting the levels of living. Thus giving it a sense of space. The double height in the front ensures thorough ventilation and sunlight. The deep section provides well-ventilated cool interiors.

## ECONOMY

The skip-top corridor system, besides giving economy, helps organize the plan and the section for the best possible enjoyment of living, as it allows each "unit" to

extend over the entire length of the cross section procuring views on either front. This adds also to the identity and recognizability (expression) of the unit in the total form, which otherwise tends to be lost in confusing organization of plan.

Economy is also achieved through the maximum stress development in minimum use of material, in the structural members, ease of erection procedure, saving thereby time and labor, and lighter components of wider applicability (i. e., could be used for schools, hospitals, offices, etc.).

The system consists of the following components:

1 Four and three story high columns, precast, and prestressed (for handling and transport), spaced at  $14\frac{1}{2}$ " apart centers, and placed 25 feet apart, axially.

2 Twin beams bind two columns axially, forming a space frame with a rigid joint. These beams are cantilevered on both sides by about  $3\frac{1}{3}$  feet. Two of these frames put together axially form the depth of the building.

The beams are precast and prestressed and are of dimensions  $4" \times 12" \times 33\frac{1}{4}"$  with a rough "H" shape to receive precast asbestos cement walls.

3 The bays are spanned by precast, prestressed, reinforced

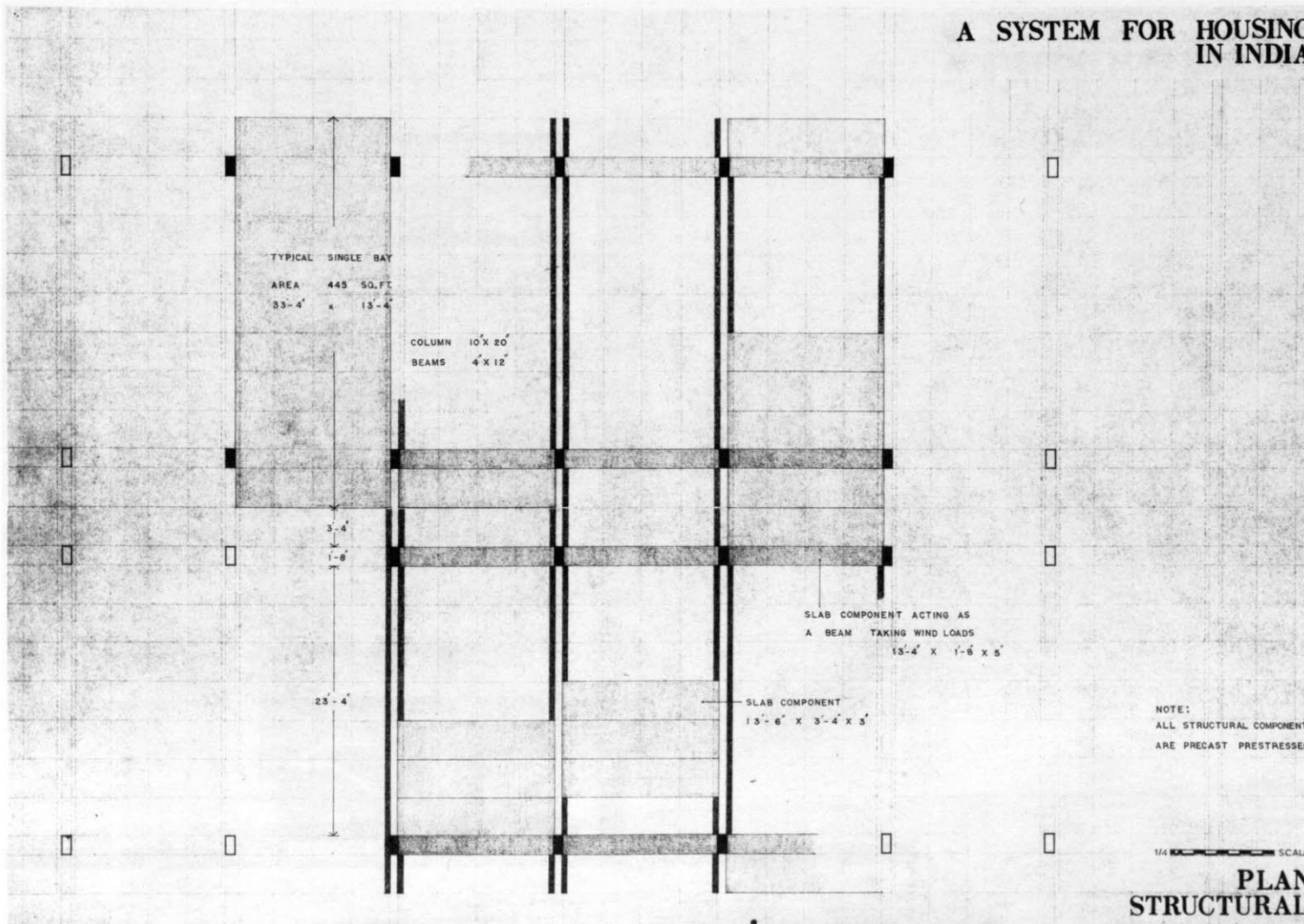
concrete slab units--width of the unit being  $3\frac{1}{3}'$  and length  $13'4''$  thickness of the slab being  $3''$ --it will have a topping of  $2''$  of lime concrete.

4 Wooden stair units are manufactured at the factory and delivered at the site, and the concrete stair units of one flight each, for fire escape and general stairs, are pre-cast and prestressed--the design is given in the drawings.

5 Foundations are in situ.

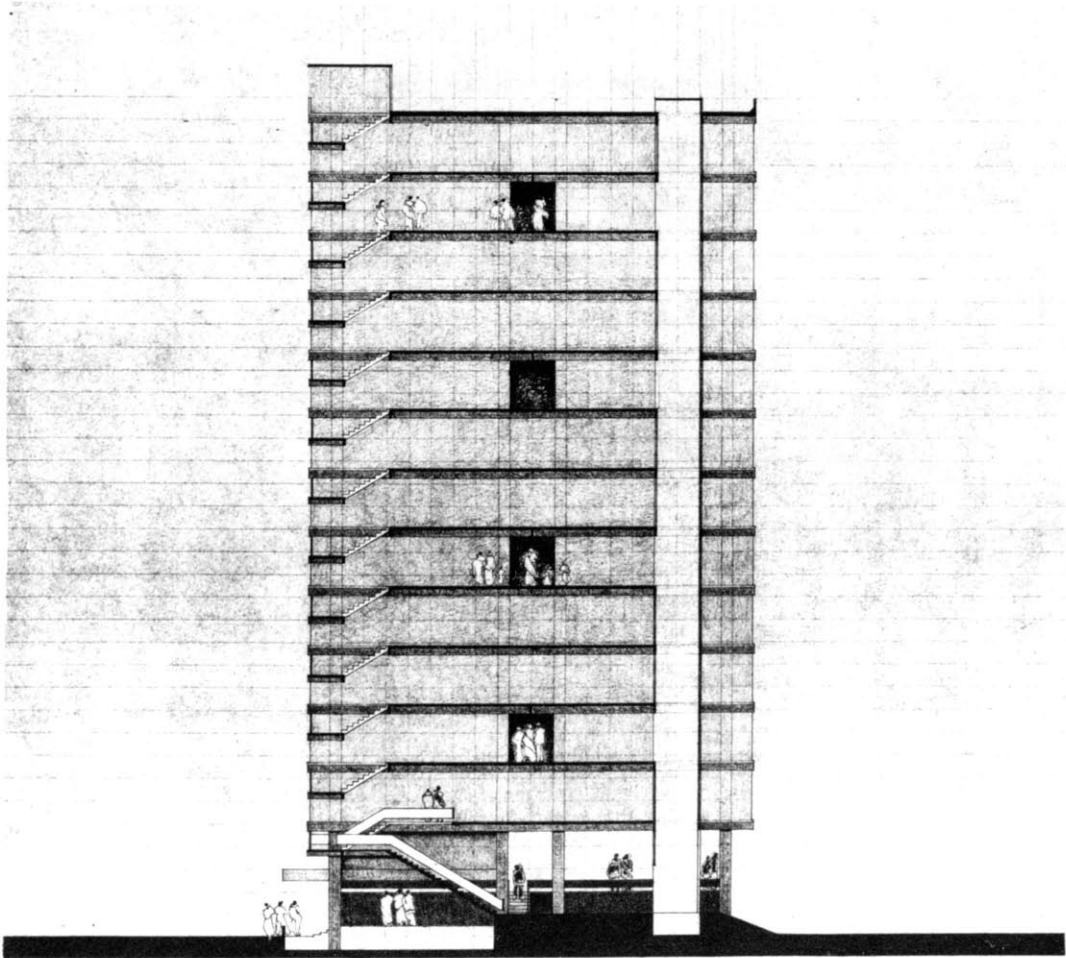
# A SYSTEM FOR HOUSING IN INDIA

1.



SHAMOON MAMDOON  
 barchi, m. s. w.  
 thesis drawings for the  
 Master of Architecture  
 year 1962-63  
 MIT  
 MASSACHUSETTS INSTITUTE OF  
 TECHNOLOGY, CAMBRIDGE, USA

A SYSTEM FOR HOUSING  
IN INDIA



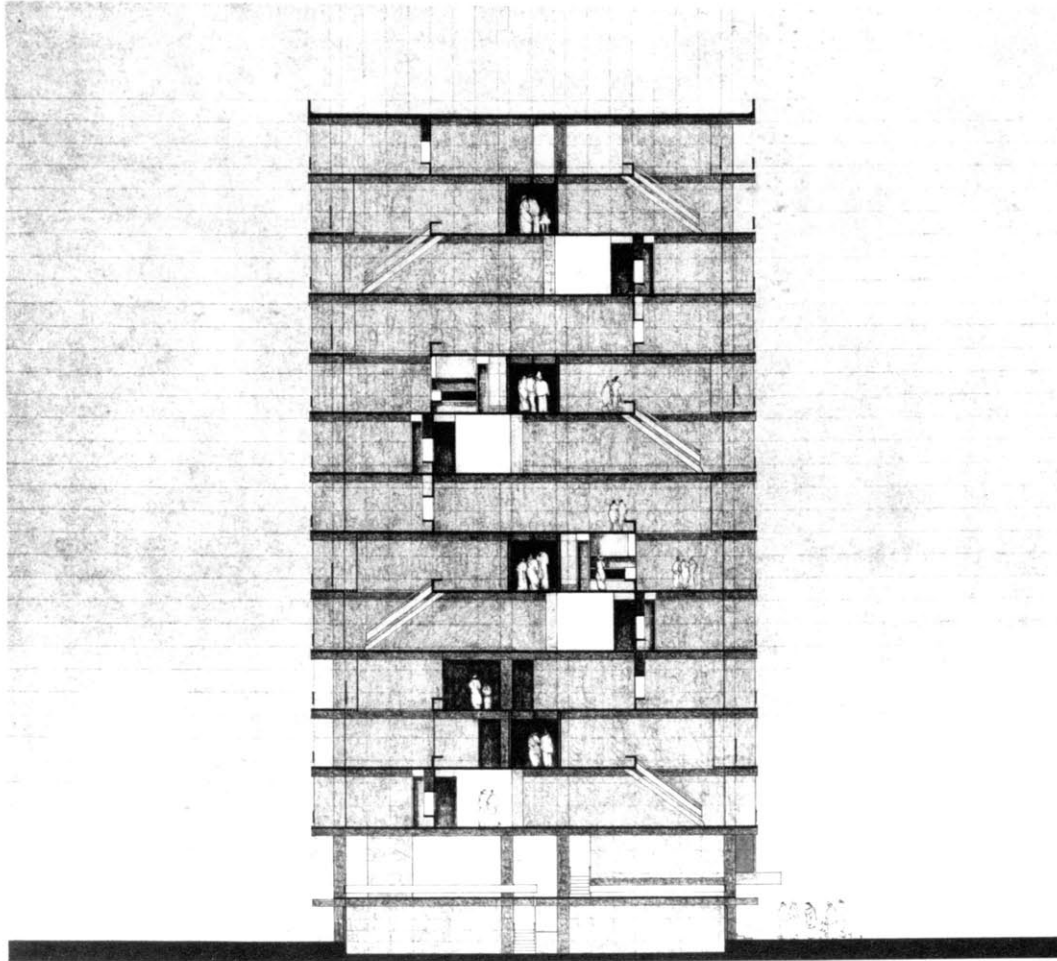
SHAMUON MAMNOON  
branch (M.S.U)  
thesis drawing for the  
Master of Architecture  
year  
1962-63  
Massachusetts Institute of  
technology, Cambridge, USA

1/8" = 1'-0" SCALE

SECTION  
ACROSS STAIRS

A SYSTEM FOR HOUSING  
IN INDIA

3.

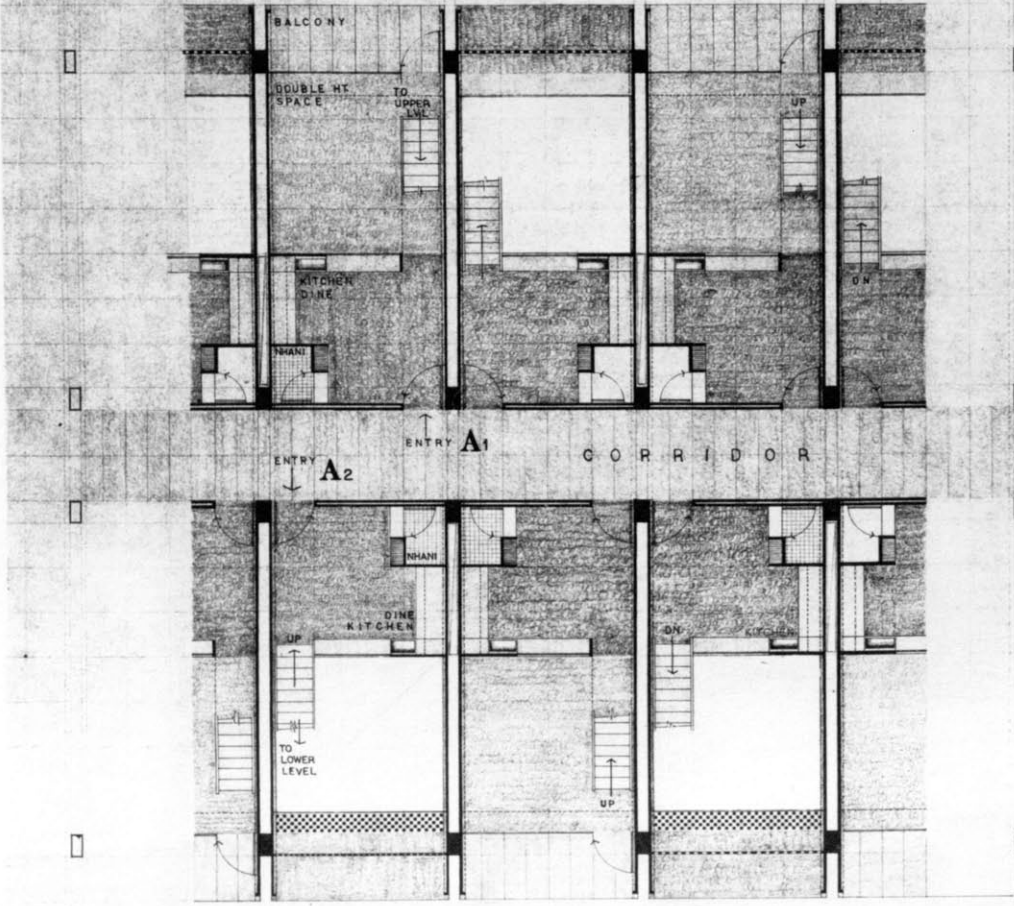


SHAMOON MAMNOON  
B.Arch (Hons.)  
thesis drawing for the  
Master of Architecture  
year 1962-63  
M.I.T.  
Massachusetts Institute of  
Technology, Cambridge, U.S.A.

1/8" = 1' SCALE  
SECTION  
ACROSS UNITS

# A SYSTEM FOR HOUSING IN INDIA

4.



BASIC UNITS A<sub>2</sub>, A<sub>1</sub>  
1:100 SCALE

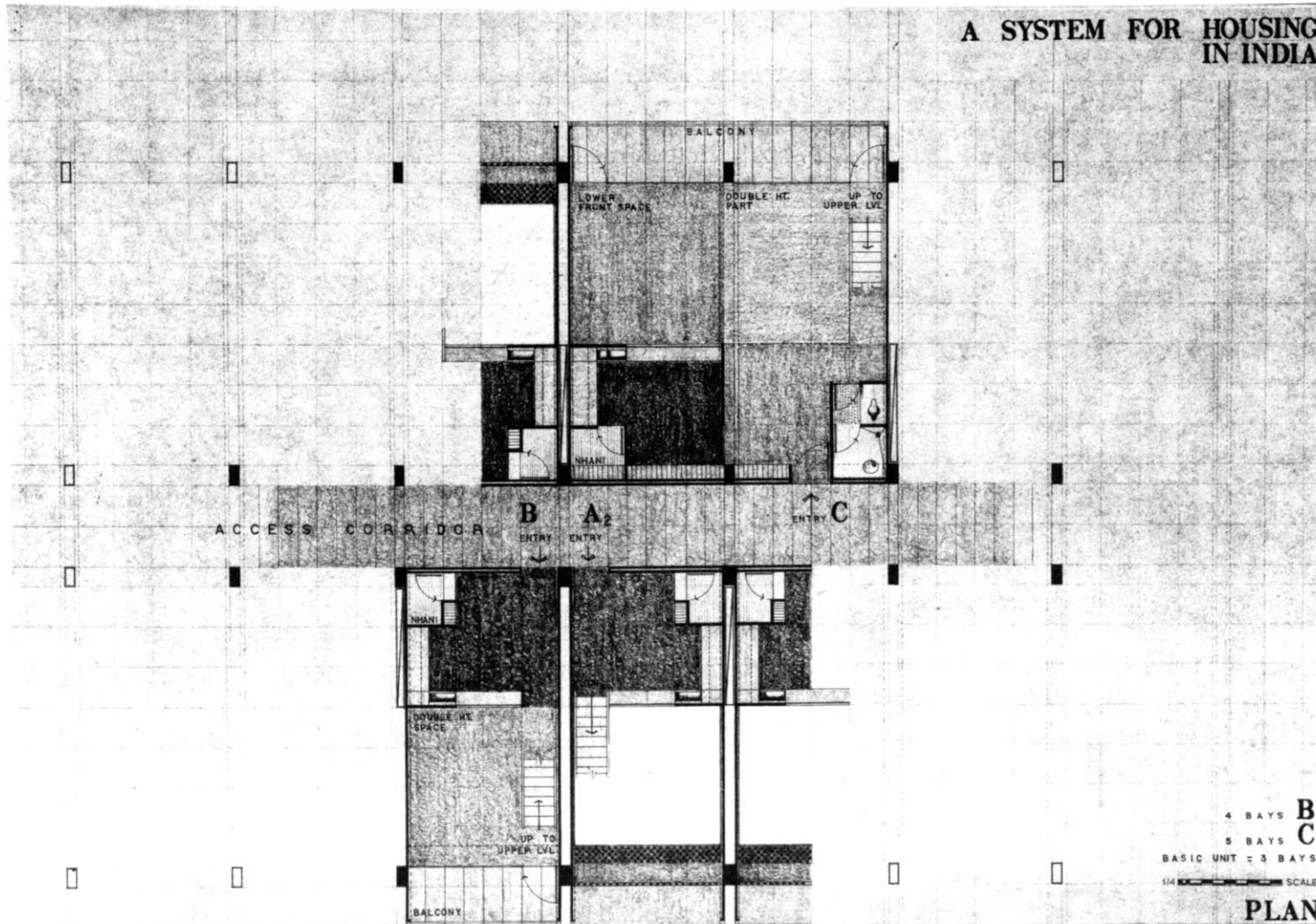
PLAN  
ACCESS LEVEL

SHAMOON MAMNOON  
BARCH/MSU  
thesis drawings for the  
Master of Architecture  
the year MIT  
1962-63  
Massachusetts Institute of  
Technology Cambridge, U.S.A.



**A SYSTEM FOR HOUSING  
IN INDIA**

5.



4 BAYS **B**  
5 BAYS **C**  
BASIC UNIT = 3 BAYS

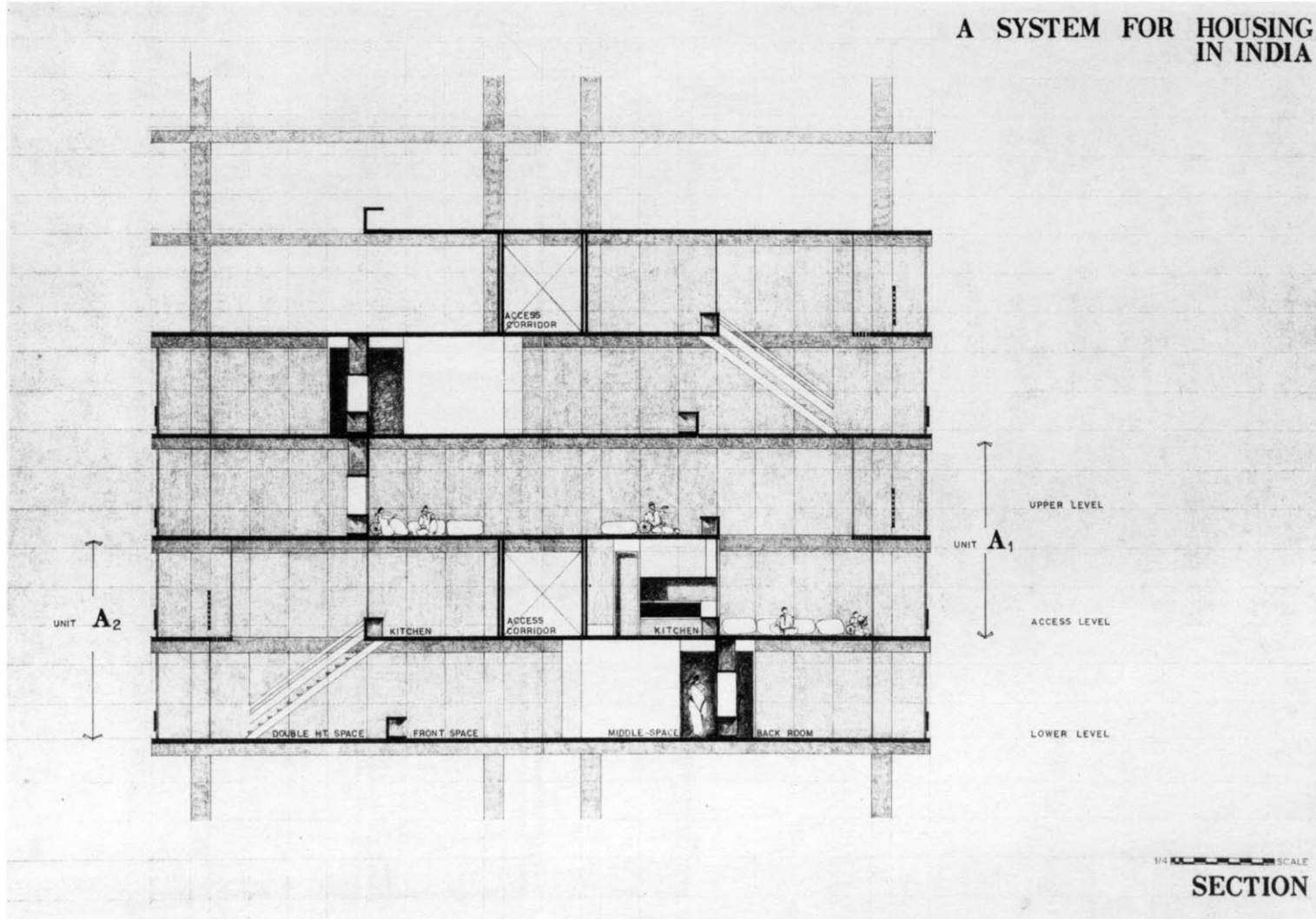
1/4" = 1' SCALE

**PLAN  
ACCESS LEVEL**

SHAMOON MAMNOON  
Arch. (m.s.c.)  
thesis drawings for the  
Master of Architecture  
year  
1962-63  
MIT  
Massachusetts Institute of  
Technology, Cambridge, USA

# A SYSTEM FOR HOUSING IN INDIA

6.

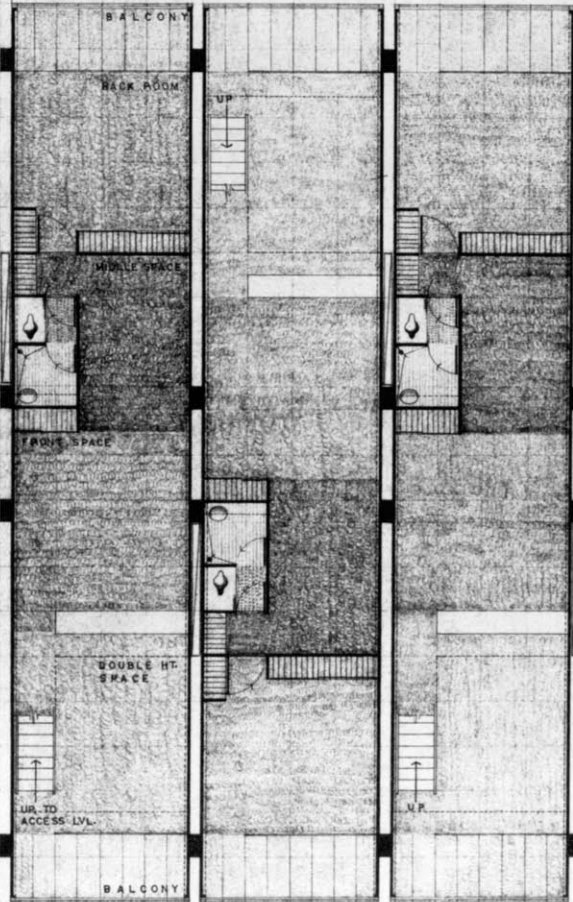


SHAMON, MAMNOON  
 BArch (M.S.U.)  
 Thesis drawings for the  
 Master of Architecture  
 year 1962-63  
**MIT**  
 Massachusetts Institute of  
 Technology, Cambridge, USA

A SYSTEM FOR HOUSING  
IN INDIA

7.

A<sub>2</sub>



SHAMOON MAMNOON  
b. arch. (m.s.u.)  
these drawings for the  
Master of Architecture  
year.  
1962 - 63  
MIT  
massachusetts institute of  
technology, cambridge, (usa)

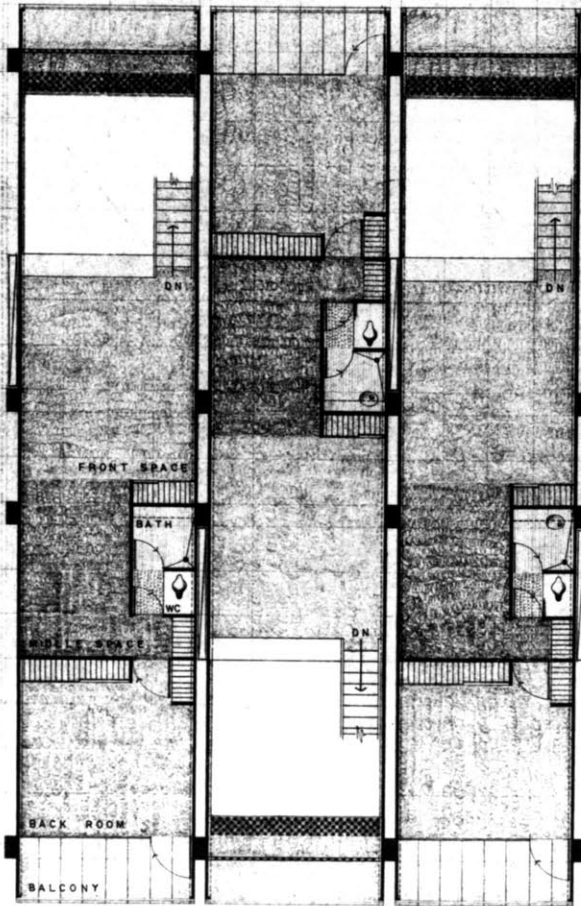
1/4" = 1' SCALE

PLAN  
LOWER LEVEL

A SYSTEM FOR HOUSING  
IN INDIA

8.

A<sub>1</sub>

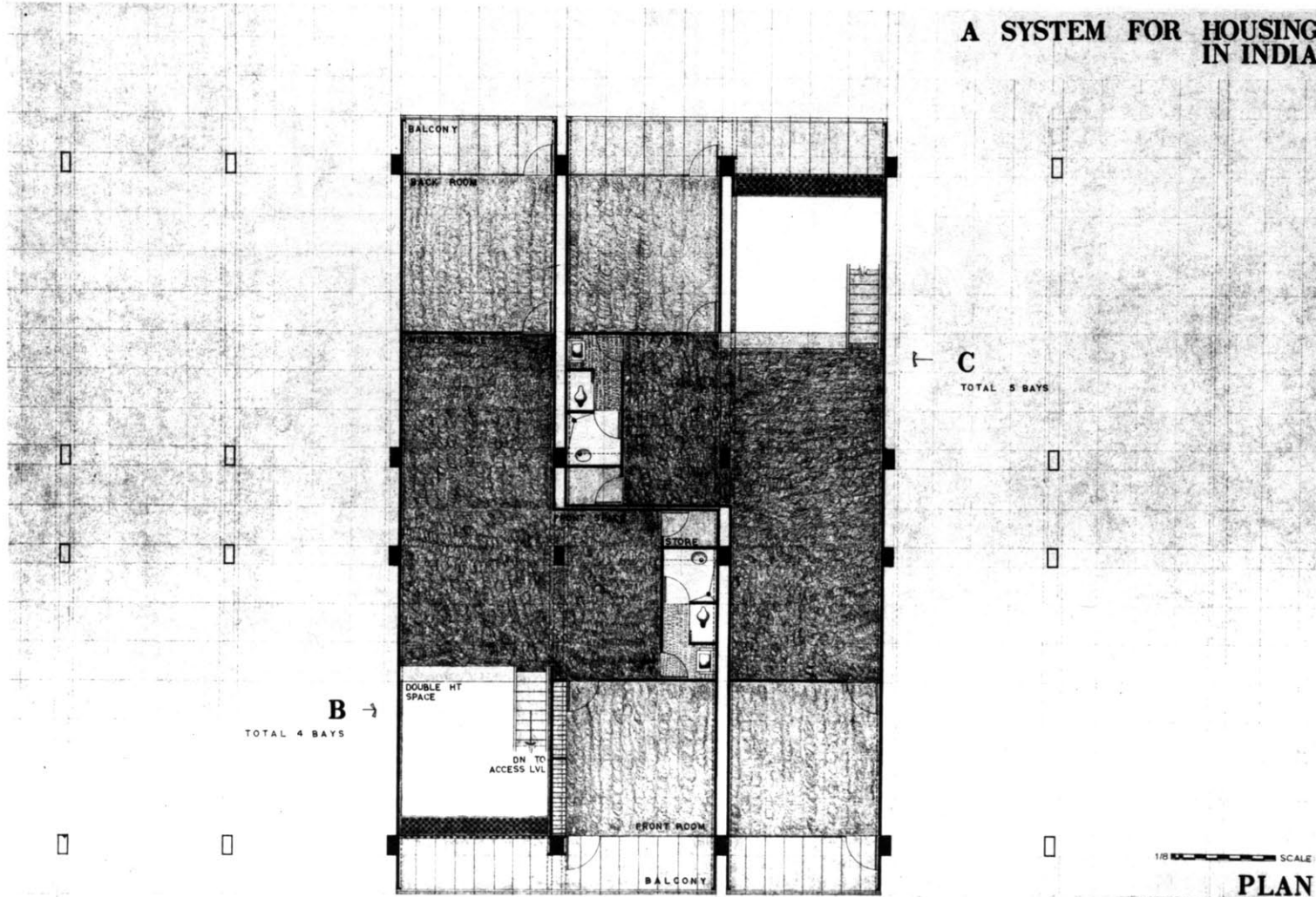


BASIC UNIT, A<sub>1</sub>  
1/4" = 1' SCALE  
**PLAN  
UPPER LEVEL**

SHAMOON, MAMNOON  
BArch (M.S.U.)  
thesis drawings for the  
Master of Architecture  
year 1962 - 63  
MIT  
Massachusetts Institute of  
Technology, Cambridge, U.S.A.

# A SYSTEM FOR HOUSING IN INDIA

9.



**B** →  
TOTAL 4 BAYS

← **C**  
TOTAL 5 BAYS

1/8" = 1' SCALE

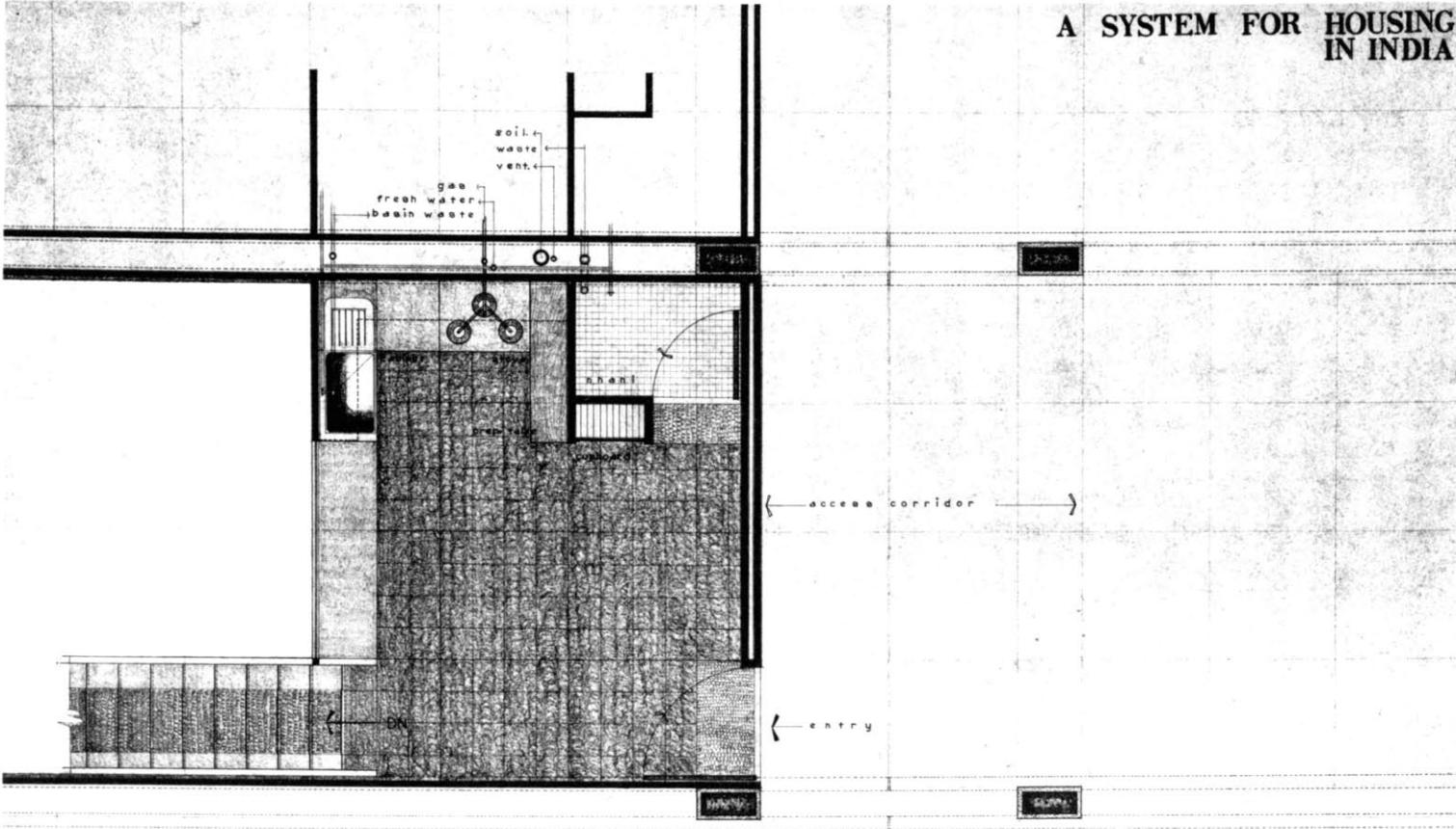
**PLAN  
UPPER LEVEL**

SHAMOON MAMNOON  
B.Arch. (M.S.U.)  
thesis drawings for the  
Master of Architecture  
year 1962-63  
Massachusetts Institute of  
Technology, Cambridge, USA



A SYSTEM FOR HOUSING  
IN INDIA

10.

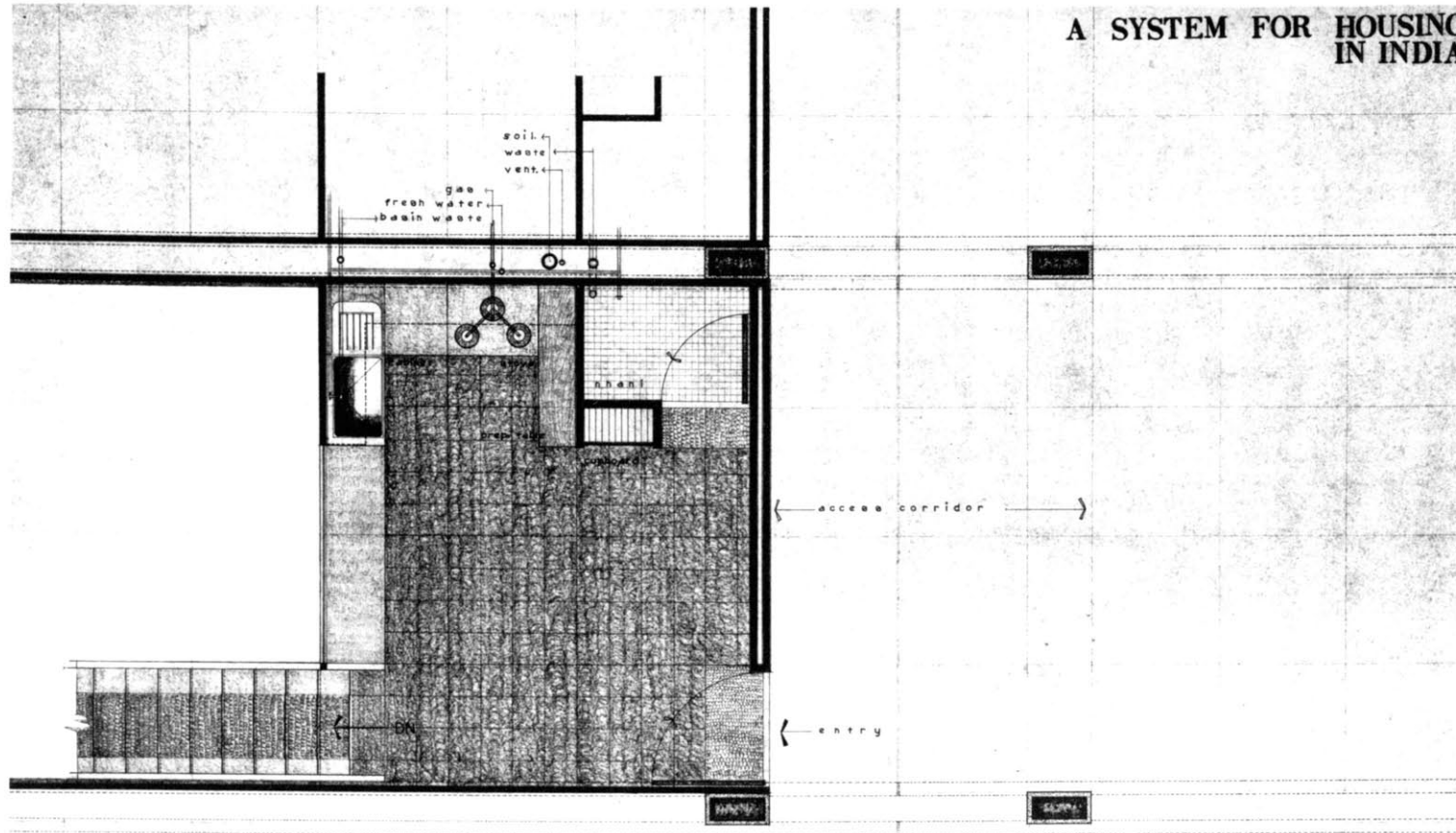


SHAMOON MAMNOON  
barch. (M.S.W.)  
thesis drawings for the  
Master of Architecture  
year 1962-63  
massachusetts institute of  
technology cambridge USA

3/4  SCALE  
**DETAIL PLAN  
KITCHEN**

A SYSTEM FOR HOUSING IN INDIA

10.

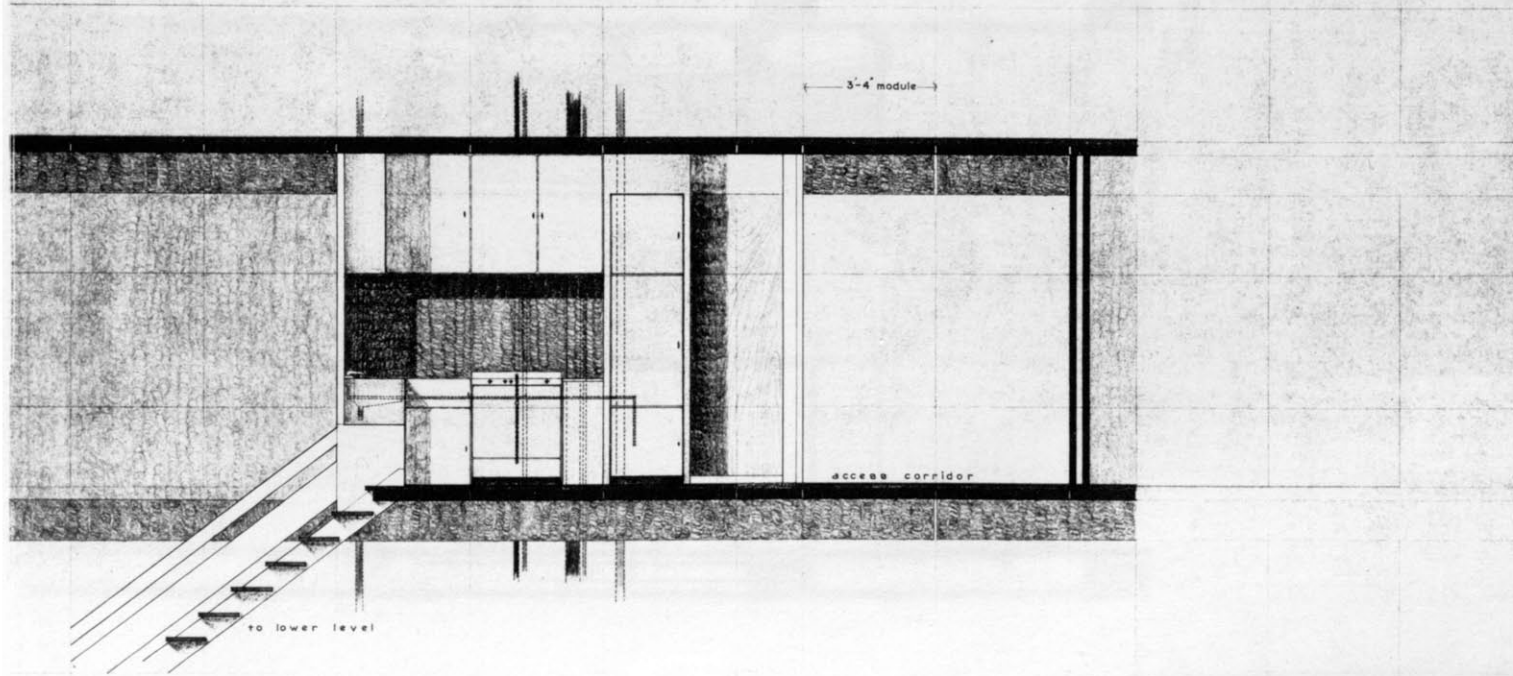


SHAMOON MAMNOON  
BArch (M.S.U.)  
thesis drawings for the  
Master of Architecture  
year  
1962-63  
MIT  
massachusetts institute of  
technology cambridge USA

3/4" = 1'-0" SCALE  
**DETAIL PLAN  
KITCHEN**

# A SYSTEM FOR HOUSING IN INDIA

11.



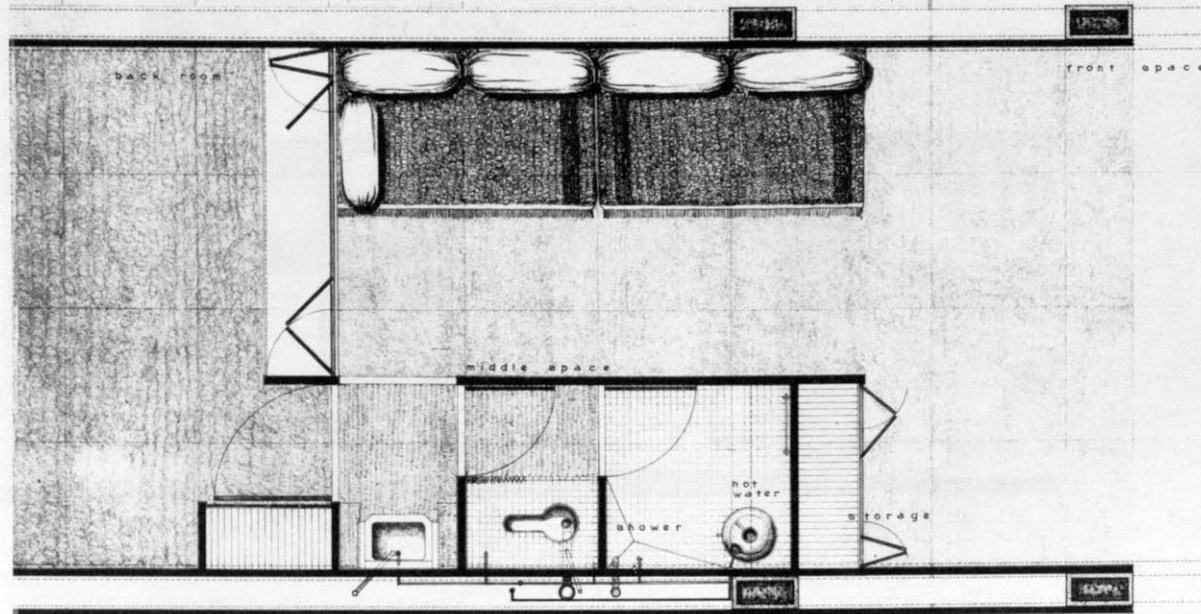
SHAMOON MAJNOON  
B.Arch. (M.S.U.)  
thesis drawings for the  
Master of Architecture  
year 1962-63  
Massachusetts Institute of  
Technology, Cambridge, USA

3/4" = 1'-0" SCALE  
**DETAIL SECTION  
KITCHEN**



A SYSTEM FOR HOUSING  
IN INDIA

12.

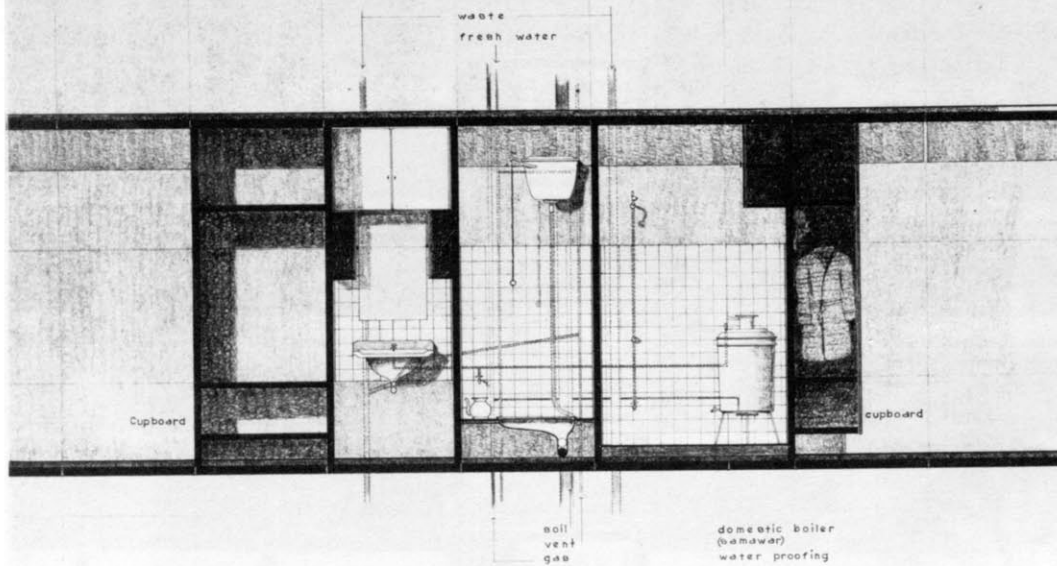


3/4" = 1'-0" SCALE  
**DETAIL PLAN  
MIDDLE SPACE**

SHAMOON MAMMOON  
barchim s.w.  
thesis drawings for the  
Master of Architecture  
year 1962-63  
Massachusetts Institute of  
Technology Cambridge U.S.A.

A SYSTEM FOR HOUSING  
IN INDIA

13.



SHAMOON MAMMOON,  
Architect, Bombay  
these drawings for the  
Master of Architecture  
year 1962-63  
Massachusetts Institute of  
technology, Cambridge, USA.

3/4" = 1'-0" SCALE  
**DETAIL SECTION  
ALONG W. C.**



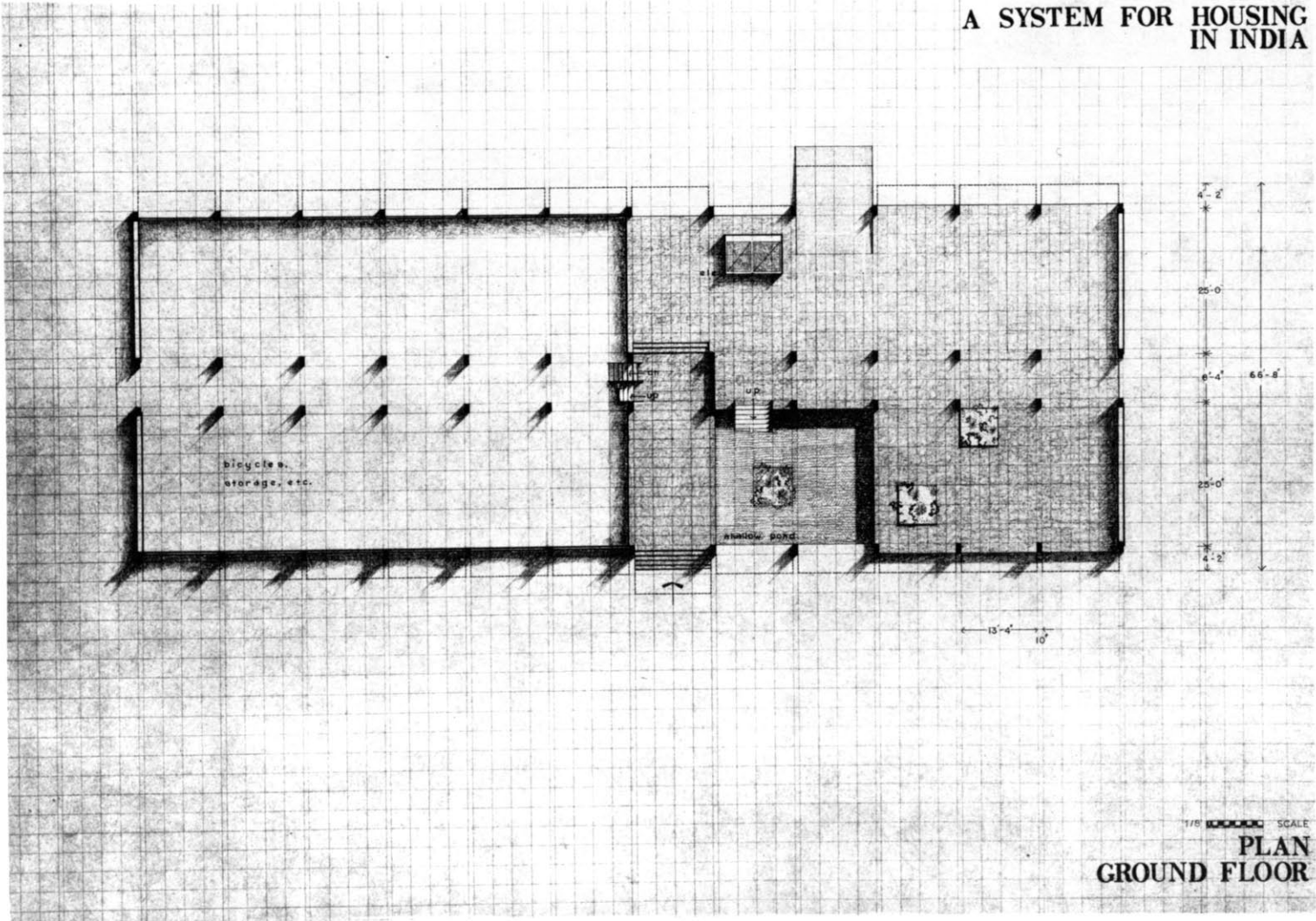
A SYSTEM FOR HOUSING  
IN INDIA

SHAMOON MAMMOON  
arch. (ms.a)  
thesis drawings for the  
Master of Architecture  
year  
1962-63  
massachusetts institute of  
technology, cambridge,usa

1/4" = 1' SCALE  
**PART  
ELEVATION**

A SYSTEM FOR HOUSING  
IN INDIA

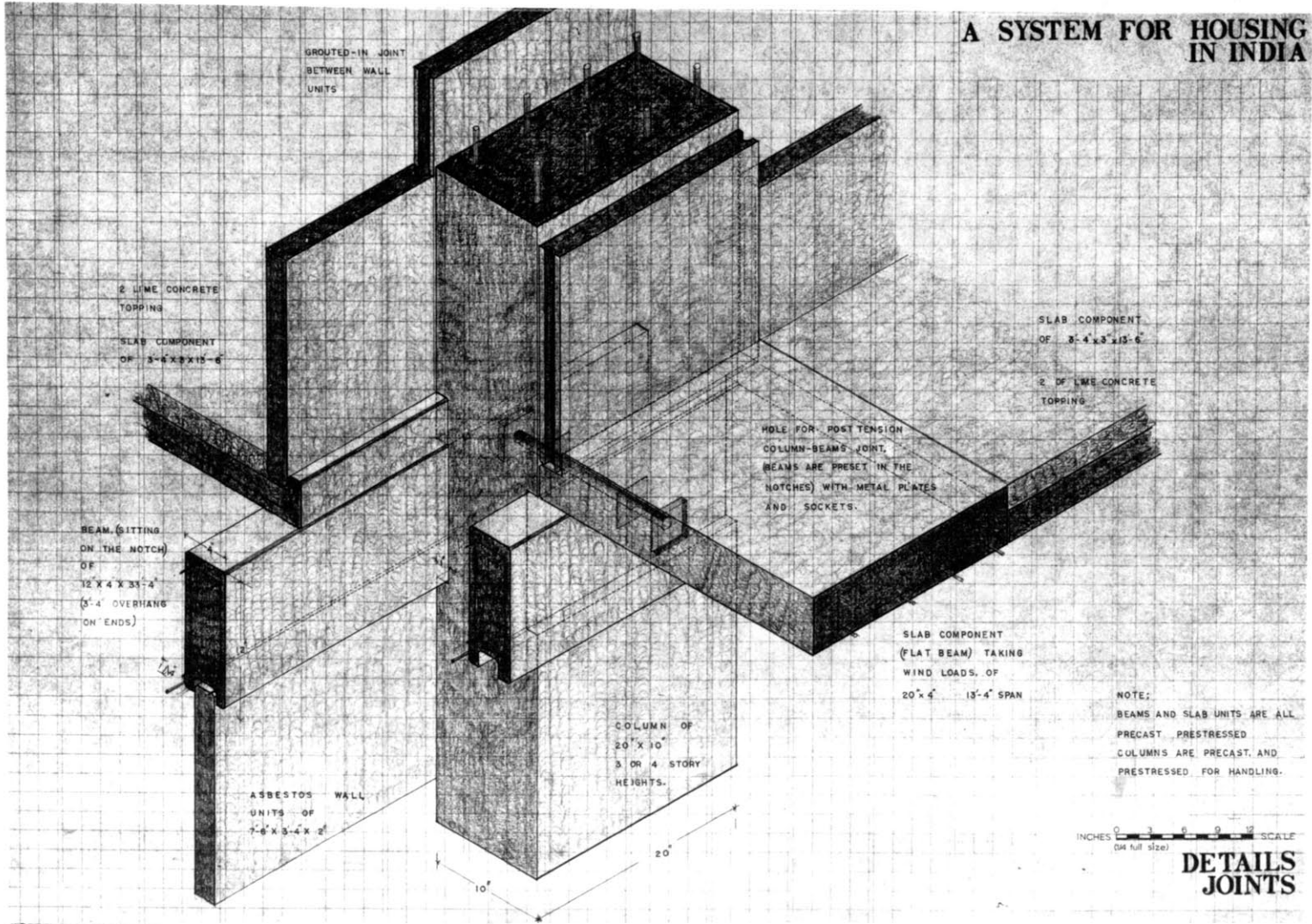
15.



SHAMMOON MANNON,  
D. ARCH. (M.S.U.),  
these drawings for the  
Master of Architecture  
year  
1962-63  
Massachusetts Institute of  
Technology, Cambridge, U.S.A.

1/8" SCALE  
**PLAN**  
**GROUND FLOOR**

# A SYSTEM FOR HOUSING IN INDIA



SHAMONT, MANRUDU II  
 Barch (M. S. U.)  
 thesis drawings for the  
 Master of Architecture  
 year 1962-63  
 MIT  
 Massachusetts Institute of  
 Technology, Cambridge, USA

---

BIBLIOGRAPHY

---

- 1 Third Five Year Plan Government of India publication, 1961.
- 2 J. K. Chowdhry Consulting architect, Govt. of Punjab, "Population trends and needs for future housing"--paper--'56.
- 3 C. R. Desai Housing commissioner, Bombay, "Housing Urban Population,"--paper, '56.
- 4 U. P. Mullick of Hope Honston and Sons, Calcutta, "Need for Future Housing,"--paper, '56.
- 5 M. V. Joglekar Hindustan construction Co., Ltd., Bombay, "Factors in Design," --paper.
- 6 R. Krishnamacharayulu Andhra University, Waltair, "Trend in Development of Prestress and Shell Concrete in India,"--paper.
- 7 C. K. Ramesh Central Research Institute, Rorkee. Application of pre-cast prestressed techniques in India--paper.



- 8 F. Thomas Collins Tilt Up Construction.
- 9 "Prestressed Concrete Buildings" Editors, Lin and Kelly.
- 10 R. P. Mahtre The Hindustan Housing Factory, Ltd., New Delhi, "Prestressed Concrete and Manufacture of Precast, Prestressed Products in the Factory"--a report.
- 11 E. A. Nadirshan Concrete Association of India, Bombay, "Precast Concrete Products,"--a paper.
- 12 "Innovations in Building" The Second CIB Congress, Cambridge (Eng.), '61., edited by International Council for Building.
- 13 A. P. Kanuinde Architect, New Delhi, "Modular Coordination and Prefabrication"--paper.
- 14 G. S. Chadra Shekhar Indian Standard Institution, "Modular Coordination"--paper.
- 15 Joseph A. Stien Consulting Architect, New Delhi, "Influence of Climate on Design of Buildings"--paper.
- 16 Aditya Prakash Architect, Capital Project Chandigarh. "Climate and Civic Art."

- 17 Housing and Economic  
Development Edited by Burnham Kelly--  
Report of the Conference  
at M. I. T., 1955.
- 18 Workers Housing Problems  
in Asian Countries Asian Regional Conference  
in Tokyo, 1953. International  
Labour Organization, Geneva.
- 19 T. J. Manikkam Director, School for Town  
and Country Planning,  
"Housing Standards and  
Residential Densities,"  
New Delhi--paper  
Planning Commission, New  
Delhi, "Residential Den-  
sities."--paper.
- 20 R. B. Gupta Soviet Information Library  
Bulletin.
- 21 Housing from Prefab Units S. Tutuchenko, Foreign  
Language Publishing House,  
Moscow, 1960.
- 22 Housing in U. S. S. R. Director, Bhakra Dam Design  
Division, "Use of Modern  
Construction Equipment."  
--paper.
- 23 C. L. Handa
- 24 Madrass Model By-laws
- 25 Utter Pardesh By-laws
- 26 Bombay Municipal By-laws