

MA : SYSTEM OF LOW
COST HOUSING IN INDIA

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Architecture
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quirements for the degree of Master in Architecture.

Respectfully,

✓
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A B S T R A C T

This thesis is concerned with the development of a system of structure and construction for a prototype dwelling unit for low cost housing in India.

The aim is to explore the needs of such a dwelling unit with its basic requirements and to design a structural system of construction that can produce a dwelling unit satisfying all criteria.

To satisfy all the criteria for a dwelling unit of this kind the system will have to accomplish the following:

1. Provide optimum initial conditions in terms of liveable space, services, circulation and environment.
2. Provide possibility for expansion and formation of the varieties of larger dwelling units.
3. Produce a functional dwelling unit based on simplicity and logic of construction.

TABLE OF CONTENTS

	Page
Title Page	i
Letter of Submission	ii
Abstract	iii
Acknowledgements	vi
I. INTRODUCTION	1
A. House Concept	1
B. The Housing Problem in India	2
C. Magnitude of Shortage	3
D. The Growth of Urban Slum	4
II. POLITICO-ECONOMIC ENVIRONMENT	6
A. Indian Government Policy for Housing in Fourth Plan	6
B. Supporting Measures	8
III. A SYSTEM SOLUTION	10
A. Industrialization	10
B. Advantages of Industrialized Construction	11
C. Material for Construction	12
D. Suggestions for Meeting Demands	13
IV. PROGRAMME	14
V. STANDARDS OF ACCOMMODATIONS	16
A. Climate	16
B. Courtyards (Verandahs)	17
C. Orientation	18
D. Minimum Standards for Comforts	18

VI.	THE UNIT	21
	A. Building Expression	21
	B. Structure	22
	C. Construction Procedure	25
VII.	THE COMMUNITY	27
	A. Concept	27
	B. Boundaries	28
	C. Community Requirements	28
	D. Housing	30
	E. Circulation	31
	F. Community Facilities	32
VIII.	CONCLUSIONS	33
IX.	BIBLIOGRAPHY	34

Photographs of Presentation Material

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I. INTRODUCTION

Architecture provides a significant form of shelter for human life. With the vast population explosion in under-developed countries the housing for common people is unquestionably the biggest job for us. Each dwelling built will enclose a life for a small group of people, and if we feel that we have failed in the past to provide a fit setting for these lives then we must try to imagine them fully, both in their individuality, their family groupings and their larger corporate groupings.

The first problem is to find out the dominant elements in present life considered fundamentally and to apply these findings to the wider problems of community planning. Of course, what is true for the individual has its extension in the larger grouping of individuals.

A. HOUSE CONCEPT

Man is an animal differing from the other animals because of rationality he possesses. The will to live or instinct for self-preservation is the strongest instinct men have. The will to live therefore means above all the will to work, for without work there is no food, clothing, shelter and, therefore, no life.

Shelter is the second important element in the make-up of

a town or community as it is in a man's life. Hence design of a dwelling unit and its surroundings are the important factors. The main purpose of dwelling unit is to store up man's bodily and spiritual strength. It is indeed man's one of the best inventions for self-preservation.

The everyday life of an average man is full of work and he draws upon the strength gained from food and rest at home. Hence after work he must relax and rest, protected from cold and discomforts, from anxiety and noise. Therefore, shelter must be well built in all its parts and proof against incoming damp from all sides and keep out the elements that sap energy away.

Some of the most important physical needs described above must be satisfied first. But man has a secondary life of spirit, too. The life of desires, emotions, memories, etc. The spiritual life, for all its intangibility is the life we really feel, and inseparable from the body, and must be given a measure of separate definition in thinking about architecture and the community. All needs both physical and spiritual must be satisfied in the community and town we build.

B. THE HOUSING PROBLEM IN INDIA

A brief review of the housing position in India indicates

an overall shortage in relation to population needs, a generally low level of investment in construction and a high rate of obsolescence on account of elementary temporary, nature of structure.

The housing shortage has now become a serious problem next only in importance to food shortage in India. This has been due to the mass poverty and economic backwardness, both of which preclude the efficient utilization of the existing available resources for social housing and construction on an adequate scale. The continuous growth of population, the rapid progress made by industrialization and unprecedented influx of about six million urban refugees, subsequent to the partition of the country have created housing shortage an acute problem.

C. MAGNITUDE OF SHORTAGE

The rate of population growth every year outblasts the rate of construction of new housing facilities. The problem of housing as it exists today in rural and urban areas shows wide differences both in nature and magnitude. The rural problem is both quantitative and qualitative, whereas the urban problem is chiefly quantitative. The progress made in the first, second and third five-year plan indicates that the fourth five-year plan would call for the construction

of 70.5

of 28.5 million houses¹ (7.1 million in urban areas and 21.4 million in rural areas) for which financial, technical and material resources have to be found.

D. THE GROWTH OF URBAN SLUM

The rapid progress made by industry and commerce has greatly stimulated the rate of urbanization within a short time, and evidently placed a heavy strain on the available housing space, the widespread poverty prevalent in rural and urban areas has resulted in construction on large scale of elementary and temporary structures. This renders a large portion of these houses unfit for human habitation after a certain period of their construction. The elementary nature of the pattern, design, layout and construction makes them highly unsafe, unhygienic, and dilapidated.

The most saddening feature of urban housing is the growth of slums in most of the industrial cities. This factor, reflects the acute shortage of housing needed by low income groups. At a rough estimate, urban slum houses totally unfit for human occupation come to about 20 percent for the big cities and 5 percent for the other towns. The problem of housing has been further worsened by owing to

¹Report of the working group on housing and rural planning for the fourth five-year plan, ministry of works and housing, Government of India.

the slow rate of replacement of old and dilapidated dwellings.

Needless to say, slums provide the breeding ground for many physical diseases and social vices. The haphazard growth of the residential quarters, the emergence of slums, and general overcrowding make the position of civic amenities, sanitary facilities, roads, water supply, and recreational activities more costly and difficult.

II. POLITICO-ECONOMIC ENVIRONMENT

A. INDIAN GOVERNMENT POLICY FOR HOUSING IN FOURTH PLAN

With medium projections for planning purposes, the study of the growth of population indicates that the population in India would be 695 millions in the year 1981.

Considering this colossal need for housing an investment of about Rs.¹ 15,670 millions² (\$3,299 millions) in housing was envisaged in Third Five-Year Plan as following:

i. Private sector housing	Rs. 11,250 Milli. (\$2,368 Mill.)
ii. Public sector housing	Rs. 2,600 Milli. (\$547.6 Mill.)
iii. Social housing	Rs. 1,820 Milli. (\$383.4 Mill.)
Total	Rs. 15,670 Milli. (\$3,299 Mill.)

This amounted to 15 percent of the total investment plan in the economy. The national emergency caused by the Chinese invasion in 1962 necessitated diversion of the supplies of essential building materials like cement and steel and it was felt that only 80 percent of the target would be achieved.

As mentioned earlier the Fourth Five-Year plan calls for construction of 28.5 millions houses. Keeping in view the housing needs as well as the limitations of physical and

¹ 1\$ = 4.75 Rs.

² The Third Five-Year Plan-Government of India

financial resources, Indian Government has recommended an investment target of Rs. 28,900 millions³ (\$6,084 Mill.) for housing in the Fourth Five-Year Plan.

The breakup of the investment target is as indicated below.

THE FOURTH FIVE YEAR PLAN.						
CATEGORY	URBAN		RURAL		TOTAL	
	HOUSES	INVEST.	HOUSES	INVEST.	HOUSES	INVEST.
	IN	IN	IN	IN	IN	IN
	MILLIONS.	MILLIONS	MILLIONS.	MILLIONS	MILLIONS.	MILLIONS
		RS.		RS.		RS.
1. PRIVATE SECTOR	0.71	10700	3.6	7200	4.31	17900
2. PUBLIC SECTOR	0.67	4000	-	-	0.67	4000
3. SOCIAL HOUSING	1.25	5600	0.6	1400	1.85	7000
TOTAL	2.63	20300	4.2	8600	6.83	28900

The above investment target of Rs. 28,900 millions for housing would amount to only 14.5 percent of the proposed Fourth

³ Report of the working group on housing and urban and rural planning for the Fourth Five-Year Plan, Ministry of Works and Housing.

Five-Year Plan total investment in the economy, namely Rs. 200,000 millions (\$42,100 millions) in the Fourth Plan as compared to 15 percent envisaged in the Third Plan.

Government also felt that action should be taken for the expansion of various traditional building material industries taking into account the requirements of housing and other sectors of development. Emphasis is also placed on the research and development of new materials and techniques of construction.

B. SUPPORTING MEASURES

The Indian Government policy suggests that efforts in terms of money and labour, on a tremendous scale are necessary to speed up the rate of progress against vast existing problem. It is important that for successful implementation of the housing programme the population needs to be trained and enthused to co-operate in this task. This is important in rural and semi-urban areas where aided self-help is expected to be a motivating force in construction programme. The efforts should be directed to promote self-help construction among the village community and to raise additional resources by mobilization of local labour and materials.

Housing is essentially labour intensive as 40 to 45 percent

of total building cost is expended on labour. In view of the mounting shortage of skilled labour it is also suggested to mechanize the different phases of construction, to evolve standardization in respect of housing design layout, materials, etc. and prefabrication techniques must be increasingly adopted in building construction.

III. A SYSTEM SOLUTION

A. INDUSTRIALIZATION

A place to live is a main theme and the planning must center around the family which is to use the dwelling unit. Building a house puts into tangible terms a background for living. The aim must always be to accommodate maximum number of families with their widely varying requirements and living habits to find the maximum of contentment.

The urgent need for housing against vast population explosion, which has to be produced at a greater speed and ever-increasing shortage of trained skilled labour has forced the building industry to search for more rational methods of construction. A well-designed system of construction employing the new methods and techniques of prefabrication can help to a greater extent to solve the ever-increasing problem of housing.

Industrialization-industrialized construction is one formula to solve our problems within the limits imposed by shortage of capital time and labour without sacrificing quality. The aim is to attain optimal quality. Although the capital costs may be kept down by reducing the cost of construction the quality of the structure must be such as to avoid unduly high maintenance costs. The aim must therefore be to

keep the capital costs at a reasonable level while producing dwelling unit of a standard higher than that obtained by traditional methods of construction. The solution is to be sought in industrialized production. Industrialized construction give us architecture offering greater variations in the types of building and in the materials and methods which are employed than traditional procedures have done. The opportunity for individual choice will be then greater.

B. ADVANTAGES OF INDUSTRIALIZED CONSTRUCTION

Increased productivity in the building industry could be achieved by mechanization on the site and prefabrication. One of the most obvious characteristics of industrialized construction is that as much of the work as is possible is done in permanent or semi-permanent factories so as to cut work at the building site down to an absolute minimum. By so doing it is possible to achieve extensive rationalism and automation of the production along with the following advantages.

1. Independence of weather conditions, meaning that construction is not delayed by rain, cold, etc.
2. The possibility of very efficient control so as to avoid waste in labour and time of construction.
3. The possibility of more accurate planning.
4. Economy with regard to the use of skilled labour since unskilled workers can easily be trained to carry out

the comparatively simple operations which factory production requires.

5. Advances in precast techniques such as vacuum concrete, shock concrete, etc. have speeded up construction. The life slab, tilt up and slip form techniques at site construction are the other notable contribution towards cost saving techniques.
6. Precast unit construction leads to the standardization of sections and hence time required for detailing drawing and designing is eliminated.

The idea of standardization and modulations help industry to co-ordinate and insure wider consumption of precast elements, consequently saving on "overhead" and reducing cost.

C. MATERIAL FOR CONSTRUCTION

The selection of the material for construction should be based on its cost and good constructional qualities. Steel being very expensive material in India, concrete was chosen as a basic material for construction because of the following advantages.

1. It is fairly cheap compared with other materials.
2. It can be produced from local material almost everywhere.
3. It is rigid, fireproof, sound insulating and requires little or no maintenance.
4. Light weight concrete could be easily of good quality produced.

D. SUGGESTIONS FOR MEETING DEMANDS

With traditional constructional systems and techniques India cannot solve the acute housing shortage problem. Systematization and well-organized planning within limited resources will definitely help India to go fast to meet the colossal housing demands.

To reach the goal the following things need to be considered.

1. a. Careful designing.
 - b. Use of modern techniques.
 - c. Industrialized construction.
2. Careful work organization.

The goal should be the suitable combination of all components which go to make up the housing unit. Besides the basic framework, it is important to produce a satisfactory whole from the point of view both of quality and cost.

IV. PROGRAMME

A programme with the primary objective, the development of a system of construction that can produce a basic dwelling unit, providing possibility of expansion in terms of space and future changes the following programmatic requirements were established.

1. The approach to the housing problem will be within the framework of a community, socially structured, with minimum services and some kind of boundaries.
2. The community is primarily residential and will be one of the many on the larger urban complex which hopefully will include, besides the major source of employment-heavy and light industries, such amenities as business, metropolitan and institutional districts, etc.
3. It will be a balanced community that is consisting of people from different income levels. The community will not be divided into water-tight compartments of various classes of society.
4. Provision of basic and minimum facilities to all the people irrespective of their status or financial resources.
5. To provide the basic needs of life, school, etc. within walking distance of 80 to 300 meters.
6. Adequate communal facilities.

The following are specific qualifications set forth at the beginning of the study.

1. a. Housing will be primarily row housing of 1-2-3 stories and of narrow lot width of 3 to 4 meters.
b. Houses of different areas as follows: (approximately) 66, 96, 112, 150, and 200 sq. meters.
2. Different degrees of self-help construction will be considered. That is different degrees of family or community participation.
3. Tropical climatic requirements shall be considered.

V. STANDARDS OF ACCOMMODATIONS

In housing project for low income groups the main consideration will necessarily have to be the reduction in the cost of construction. A correct appreciation of the essential requirements for human comforts can considerably help in designing of the house so as to ensure maximum comforts within the limitations with regard to cost. In the functional designing of house to provide for healthful living and comforts, particular attention should be paid to environment and climate.

A. CLIMATE

In India, which has a variety of climates, zoning on strictly climatological basis for purpose of housing particularly low cost would be too difficult to interpret differences in climatic conditions in terms of design or form of construction. The physiological considerations themselves suggest zoning into two broad categories.

1. Hot arid zone
2. Hot humid zone.

Hot arid zone:

In hot dry climate radiation from wall is an important factor to be taken into consideration in designing for comfort. In such climate, with its diurnal temperature range it is desirable to build living areas in heavy weight construction

such as brick or concrete. It is also necessary to ventilate the space between roof and ceiling to ensure that the temperature of the ceiling approximates to that atmosphere in room. Indoor comfort will be practically independent of the height of the ceiling. The windows should be limited in size to the requirements for good lighting.

Hot humid zone:

In hot humid zone, the weight of walls and partitions is not an important except that heavy weight construction will be advantageous when walls are not shaded and from acoustical point of view. In such a climate, liberal ventilation is most essential to maintain indoor temperature at approximately the same level as that prevailing outdoors. The features with regard to roofs and height of ceiling are identical with those for hot arid climate. Doors and windows should be so located as to promote free movement of air indoors, in order to secure sufficient utilization of air movement outside. They should also promote movement of air about persons inside the house.

B. COURTYARDS (VERANDAHS)

The courtyards or open spaces enclosed by a wall or hedge, both in front and rear of the house is a very desirable amenity, for, in tropical climate country many activities take place outside the four walls of the dwelling unit.

From the point of view of economy a portion of open space entrusted to the care of the individual tenants as a forecourt would cut down maintenance costs on common lawns and open space to some extent.

Two verandahs should ordinarily be provided; one in front to cater for social needs and the other at rear for housework. In tropical climate the verandahs can be regarded as essential living space and such it should be recessed into the structure of the building, so as to give it a sense of privacy.

C. ORIENTATION

The comfort in a building to a larger extent depends upon its orientation. The two important factors to be considered in respect of orientation are the prevailing winds and intense summer heat. The houses should face the direction of prevailing winds, as far as possible to derive the maximum benefits of these winds. They should also face north south direction so as to avoid excessive heat from the west side. This necessitates all the buildings in particular zone to be oriented in one direction.

D. MINIMUM STANDARDS FOR COMFORTS

It is important to take into consideration certain minimum standards to ensure the provision of essentials necessary

for the maintenance of health and that it also provides conditions compatible with a decent standard of human existence. The most basic requirement for a reasonable even if elementary, family life and the need to provide for the separation of sexes, particularly in sleeping accommodation make a two room house the irreducible and inescapable minimum.

However, the inconvenience resulting out of the insufficiency of accommodation can to a considerable extent be minimized by paying proper attention to the planning and designing of the dwelling unit, so as to enable effective use being made of the limited built up area. If even in the designing of dwelling unit, careful thought is given to layouts and other technical and constructional details, taking into consideration social needs of the occupant it is possible to evolve a satisfactory dwelling unit which would provide facilities for wholesome living.

For a family of six persons the currently accepted minimum standards for housing is as following:

100 sq. ft. per head per adult

60 sq. ft. per head per child.

The above mentioned areas exclude areas for bath and w.c.

From the foregoing discussions it is evident that the following points must not be neglected in the design of a dwelling unit.

Physical aspects:

1. Two living cum bed rooms
2. Kitchen, store, etc.
3. Two verandahs open to outside.
4. Bath and w.c.

Climatical aspects:

1. North south orientation for houses.
2. Large opening for free air movement; cross ventilation.
3. To provide wider front area.
4. Sun control in order to keep rooms cooler; provision of overhangs, etc.

Besides, it is important to create a sense of identity and individuality along with freedom and privacy.

VI. THE UNIT

A. BUILDING EXPRESSION

From the previous discussions the resultant design is a dwelling unit of two stories with four meter wide lot module. The basic house dimensions are 4 meter x 13 meter with 2 meter deep verandahs at the front and the rear. The lower floor provides the usable space of about 36 sq. meter. The front portion of the house is designed as living room and the rear portion as kitchen and dining room. The living room is of double height which helps to establish a hierarchy of life within the dwelling unit and also permits light to reach interior of the house. Bedrooms are located at upper level. The front verandah is also of double height at the first stage of dwelling. There is a possibility of a balcony at an upper space of front verandah, as future expansion. The part of the rear verandah is used for locating bath and w.c.; vertical circulation is located at center of the house. A backyard of at least 25 sq. meter is provided for household and other activities. The house design permits location of one more bedroom as future expansion.

Floor to floor height is 2.60 meter. The comparatively more height was designed to allow the provision of ceiling fan which is an important factor in house in tropical cli-

mate. The louvres are provided at the top of window and at the lower part of door to facilitate cross ventilation and enough air movement inside the house.

The proposed dwelling design was evolved from the basic human needs. The unit is complete within itself and provides space for different activities, areas of privacy and possibility for expansion and growth as a continuing design expression.

B. STRUCTURE

During the study and design of the dwelling unit it was found that most of the problem would be solved if most efficient and simple structural solution is evolved.

With such importance placed upon the structure a variety of different prevalent systems of construction such as large panel system, box system and frame system were studied. After various systems have been studied a one way system was proposed, because the system helps to erect the framework of the basic unit with ease and speed. The system also provides the possibility of expansion of the unit without interrupting the total system. The 4 meter module, the optimum width of a room was fixed after various dimensions and arrangements were studied.

Columns, beams, slabs, party walls and exterior walls are of precast concrete.

Columns: Columns are spaced at 4 meter center to center and spaced at 3 meters (inside the house) and 2 meters (front and rear verandahs) axially. After various shapes of the precast columns were studied, finally the column of "I" shape with external dimensions of 22.5 c.m. x 22.5 c.m. was selected. The shape of the column helps to provide enough seating area for beams without involving complications in precasting. The columns are two stories high.

Beams: It was found that floor beams should be placed on 4 meter span because that was the fixed module dimension and, consequently, it would be much easier to standardize the beams. The shape of the precast beam is "I" shape with external dimensions of 22.5 c.m. x 22.5 c.m. The beam with greater depth was designed in order to eliminate the lintels for doors and windows and also to increase floor to floor height.

Slabs: Precast concrete slabs of 2 and 3 meters spans are designed. The section of the slab is of a trough form and has depth of 15 c.m. The thickness of slab is 6 c.m. The topping of 2 c.m. will be provided. The width of the section is 94 c.m.

Party wall: From the climatic and acoustic point of view it was decided that party wall should be in heavy construction. It was felt that possibility of varieties of materials for party wall should be considered. The party wall of 22.5 c.m. either of brick masonry, hollow light weight concrete blocks or hollow light weight concrete panels (from floor to ceiling) is proposed.

Exterior walls and interior walls: As mentioned earlier, in the programme different degrees of self-help construction was to be considered. Erection of concrete frame, beam, slabs, roof, etc. involve skilled labour and use of machinery, it was felt that people can erect party wall, exterior wall and interior wall by themselves. The exterior and party wall are composed of hollow light weight concrete blocks and could be easily erected by people, if they are guided. Prefabricated doors, windows and interior partitions will also be built by people.

Roofing: The selection of adequate roofing material should be based on lightness of material and ease and speed with which it could be constructed. The other main considerations are durability, and dependability at the lowest cost. Different varieties of roofing materials were studied and it was found that asbestos cement roofing offers the above men-

tioned advantages along with assurance of long life without maintenance, architectural acceptance and exceptional corrosion and rot resistance.

To get acquainted with the material and the process of manufacturing the material, the class trip was arranged to Johns-Manville Company. Technical features, specification, and methods of joining the material were discussed with the people from the company.

A curved corrugated transite roofing unit spanning 4 meters was finally chosen. Possibility of other kinds of roofing such as flat concrete roof, galvanized metal roofing, etc. were also studied.

C. CONSTRUCTION PROCEDURE

1. Footing for columns will be laid at marked locations and precast columns will be placed. After plumbing the columns concrete wedges will be inserted and the space around the columns will be filled with concrete.
2. Pipes for bath w.c., etc. will be laid on the concrete bed and the tops of the pipes will be protected for connection with bath and w.c. accessories. The earth will be filled up to plinth height and will be rammed and consolidated well. The foundation for party walls and exterior walls will be laid along with the ground floor slab.

3. Floor beams will be placed and continuous connection will be developed and joints will be grouted.
4. Floor slabs will be placed and joined with the beams. The topping of 2 c.m. will be laid on the concrete slabs.
5. Top exterior beams will be connected in the same manner as floor beams.
6. Roof beams of "V" shape, will be placed and hinged connection with column will be developed and joints will be grouted.
7. Asbestos cement corrugated curved roofing sheets will be placed and joined to "V" shape roof beams.
8. Party wall of bricks, or concrete blocks will be constructed by people.
9. Exterior walls and interior partitions will also be built by people.
10. Bath and w.c. accessories will be built by contractor.
11. Wooden stair units are manufactured at the factory and delivered at the site and will be placed by people.

VII. THE COMMUNITY

A. CONCEPT

In India, due to industrialization, many new industries are coming into existence. It is very important to control the growth and the development of the new settlements which will not turn into slums in the future. There is an even greater need to stop peripheral development of the large town, because of increased traffic congestion and reduced accessibility to open space. From social and economical point of view, it is difficult to plan the new development in a completely different part of the region. A new residential unit, physically detached from the town creates traffic problems, increases the expenses of the journey to work and results in the creation of the community which is mere dormitory and lacks vitality.

The one solution to the problem is the self-contained satellite township physically separate from the large town and preferably at least 15 to 20 miles distant from it. This will help to discourage it from becoming a mere suburb, yet within the same region. The new industrial development nears the new township can provide employment for all the inhabitants. In the new developments, it is important to regulate the construction programmes for the residential, industrial and service buildings so as to avoid unbalance

of unemployment and social facilities at successive stages of expansion.

B. BOUNDARIES

From the previous discussions and programmatic requirements, a satellite township with the industrial development is proposed. The development of the community is limited by the main highways on two sides. The industrial development on the other two sides will define the limits of the community. This kind of plan arrangement allows the limited growth of the facilities, but compactness and accessibility between the different parts of the community is effectively achieved.

C. COMMUNITY REQUIREMENTS

It is assumed that socially and functionally a community is constituted of groups. These groups are of different sizes. The smallest being a family (average 6 persons to a family); the largest being the whole community (several thousands). Tentatively, groups have been defined in terms of a focus or magnet in the grouping. In addition, the following factors have been considered: number of families, area of land required, walking distances, facilities, etc. For a gross estimate of area of land required in housing 375 sq. meter per family has been adopted. This figure includes lots and streets or primary circulation in front of the lot.

Group GI focus: Small shops

For 31 families = 186 to 190 persons

It is constituted of dwellings and small shops (1 or 2) for daily food supply and miscellaneous shopping. (No more than 80 to 100 meters from the farthest house.)

Group GII focus: Kindergarten

For 250 families (6 persons) :=1500 persons

It is constituted of 8 groups, GI and kindergarten. No more than 160-200 meters from the farthest house.

Group GIII focus: Elementary School - Shops

For 1000 families (6 persons) = 6000 persons

It is constituted of 4 groups, GII and elementary school, Auditorium, shops, and the community house. No more than 300-400 meters from the farthest house.

Group GIV focus: Community Centers and Post Elementary School

For 2000 families (6 persons) = 12000 persons

It is constituted of 2 groups, GIII, post elementary school and the community center. The community center includes:

1. Shops (50 to 60)
2. Market
3. Theatres (2 movies)
4. Open air theatres
5. Professional offices
6. 2 Workshops
7. 2 service stations

8. Fire and Police Station
9. Post Office
10. Health Center
11. Public Library
12. Administration office, Community houses
13. Parking
14. Cemetery

D. HOUSING

The housing facility in the community is composed of row houses and a few 3 to 4 stories walk-up apartments near Community Center. Each unit occupies 4 to 8 meters frontage and is two stories high.

Advantages of Row Housing

1. The row house gives most space at the lowest cost and is the cheapest to maintain.
2. It provides greater privacy and makes much more efficient use of the land.
3. It could be planned at higher density (11 to 12 families per acre-375 to 400 sq. meter per family) and at which adequate public transportation and community facilities can be economically provided.
4. It is much easier to achieve coherent visual spaces with these continuous units and long rows.

Houses

The individual lot dimensions are 4 meters x 25 meters (100 sq. meter) or 8 meters x 25 meters (200 sq. meter). The units are side by side and also attached back to back. The houses have private yards and direct access and are economical. The effective cross ventilation is achieved through enough space (12 meter) between row houses.

Most of the buildings are aligned in one direction with the exception of a few for visual purposes. The houses are set back to form an emphatic space at an intersection and are also used in interlocking fashion to stop vistas.

The commercial development along the highways and main roads is discouraged by facing the house entrances inwards.

E. CIRCULATION

The community is surrounded by 2 highways on the shorter sides and 2 main approach roads on its longer sides. The secondary entrances to the community are also provided from the highways. The two entrance roads from the main approach roads lead to the community center and then to the housing development. In the housing development the use of cul-de-sac is eliminated because of the practical problems of surface drainage and the flow of utilities.

The loop roads lead inside the housing development.

F. COMMUNITY FACILITIES

The requirements of the community center are already discussed in community requirements. It was felt that its location should be within walking distance of 500 to 550 meters and its design should create an atmosphere for pedestrian activities. All community facilities are located in the center of the development which gives necessary concentration and compact development and accessibility to the center, from all the parts. The playgrounds are combined with the school areas and the provision of space is made for future expansion of the community center.

VIII. CONCLUSIONS

In conclusion, a system of structure and construction can be developed that satisfies almost all of the criteria set forth. During the study it was found that size and scope of the project was over ambitious and the problems connected with a dwelling unit and community design were enormous. This thesis can be only considered as an attempt to depart from the more traditional solutions and as an exploration in a new direction. Many aspects of the design became clear during the course of the study and they are worthy of future investigation in an attempt to find still more complete system solution.

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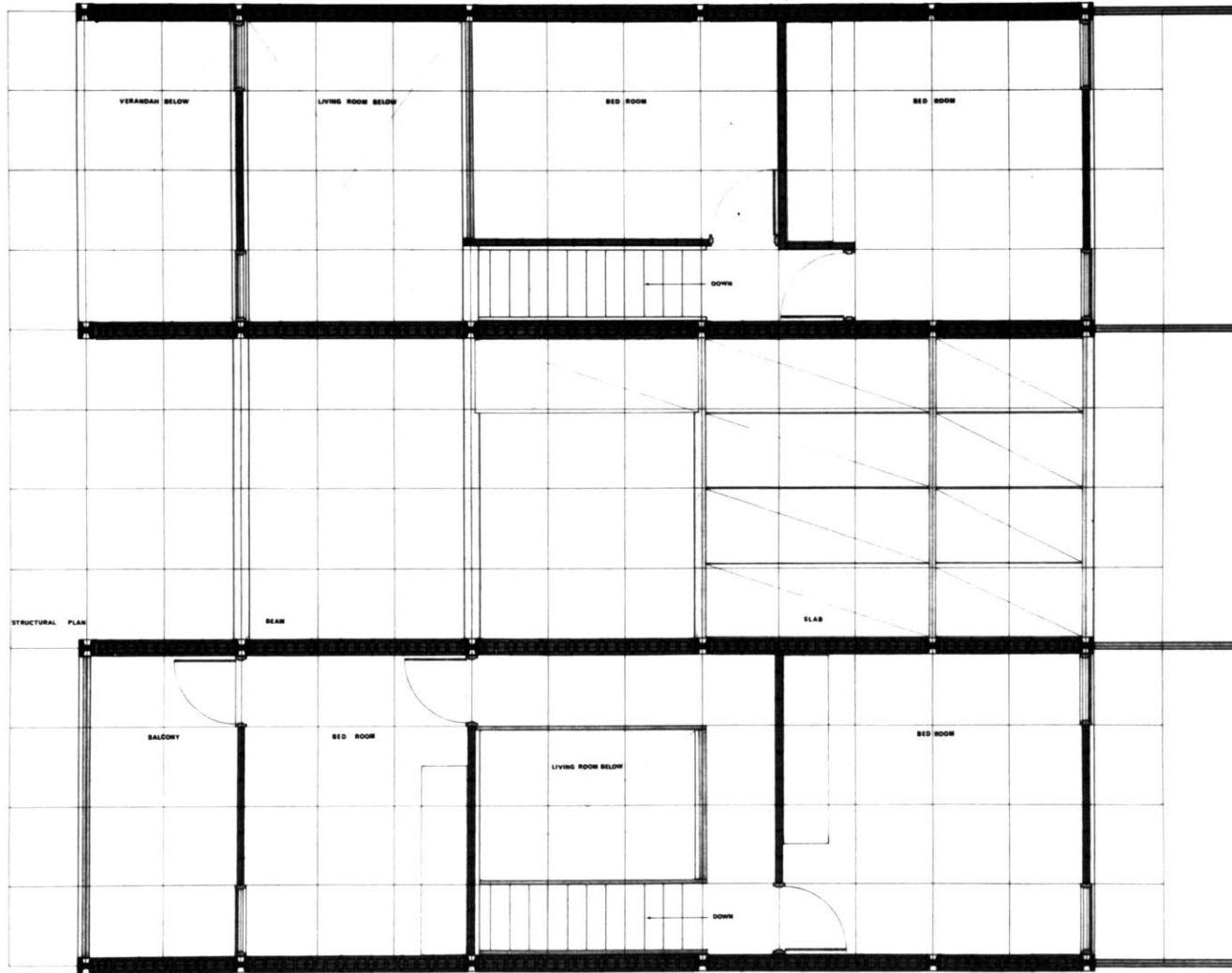
UPPER FLOOR PLAN



LOWER FLOOR PLAN

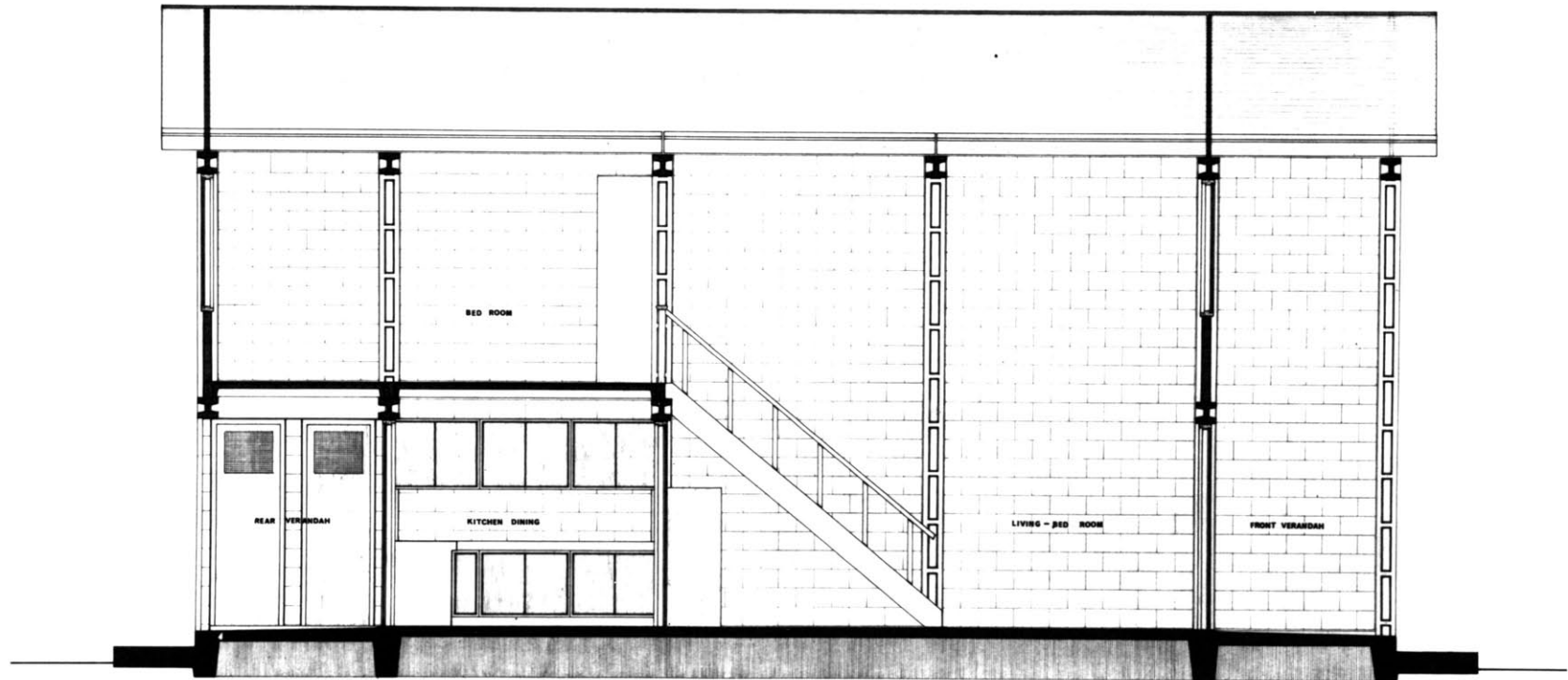
PLANS OF A DWELLING UNIT
SCALE 1/32

UPPER FLOOR PLAN - ALTERNATE FUTURE EXPANSION

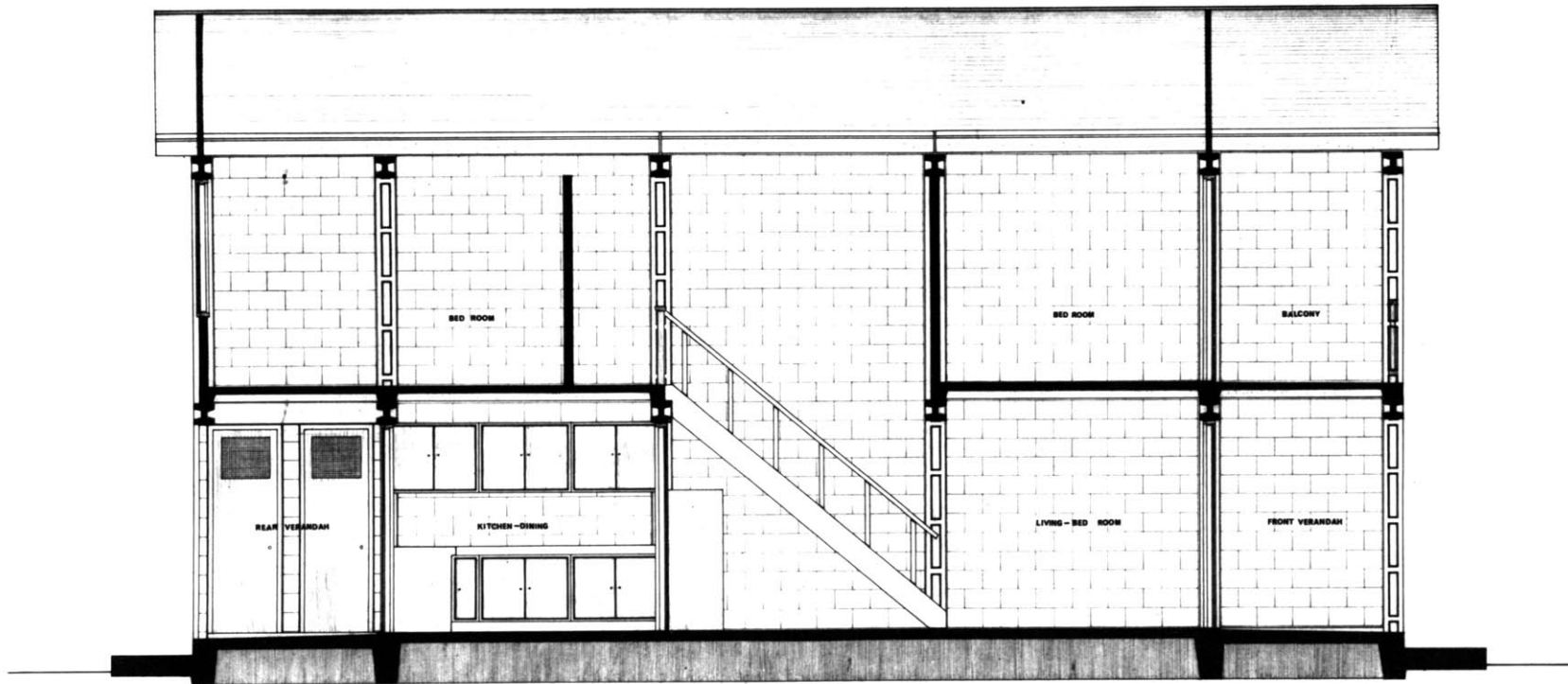


UPPER FLOOR PLAN - FUTURE EXPANSION

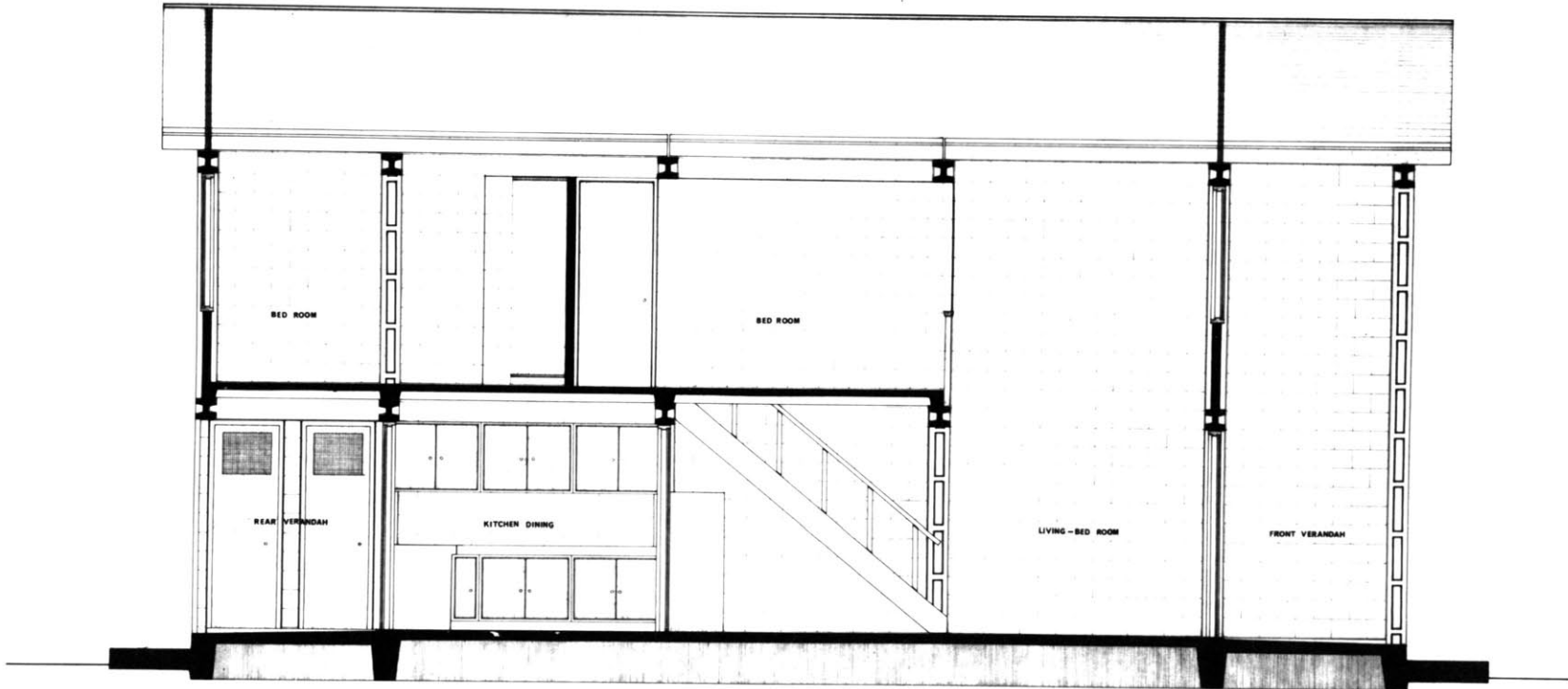
PLANS
SCALE 1/24



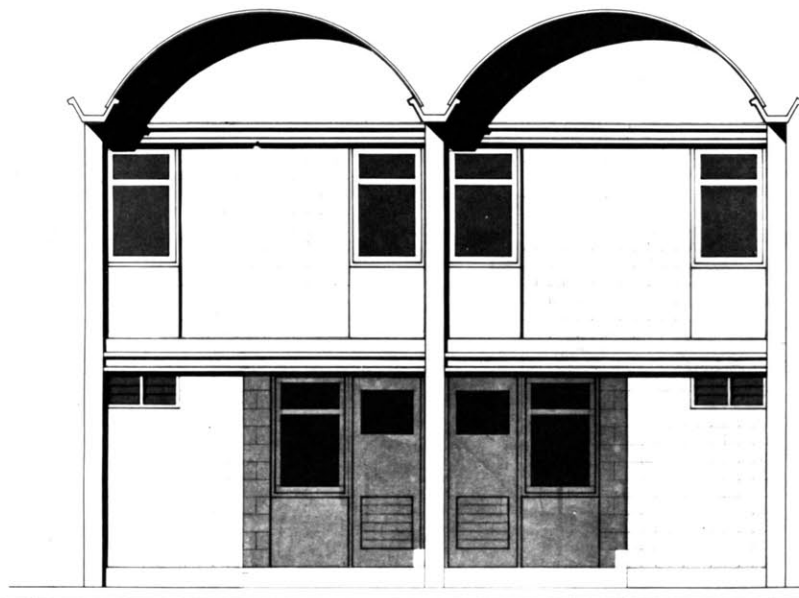
LONGITUDINAL SECTION
SCALE 1/20



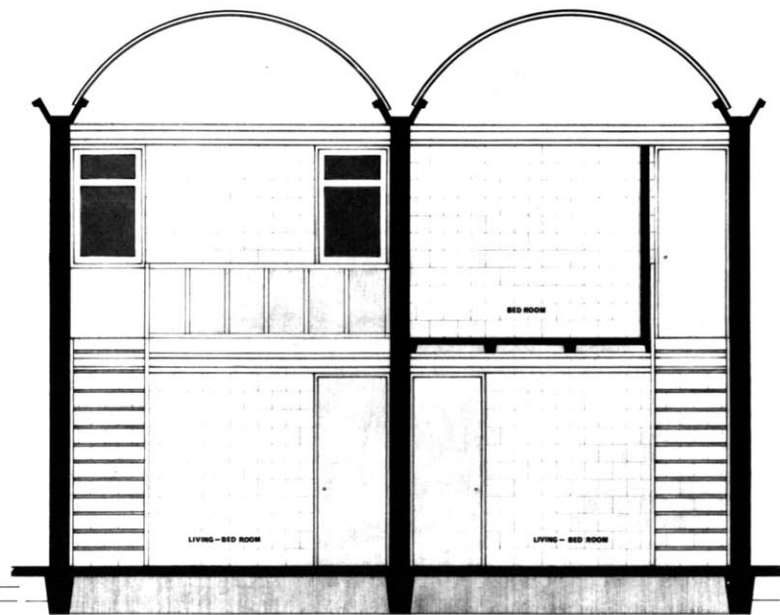
LONGITUDINAL SECTION - FUTURE EXPANSION
SCALE 1/20



LONGITUDINAL SECTION - ALTERNATE FUTURE EXPANSION
SCALE 1/24



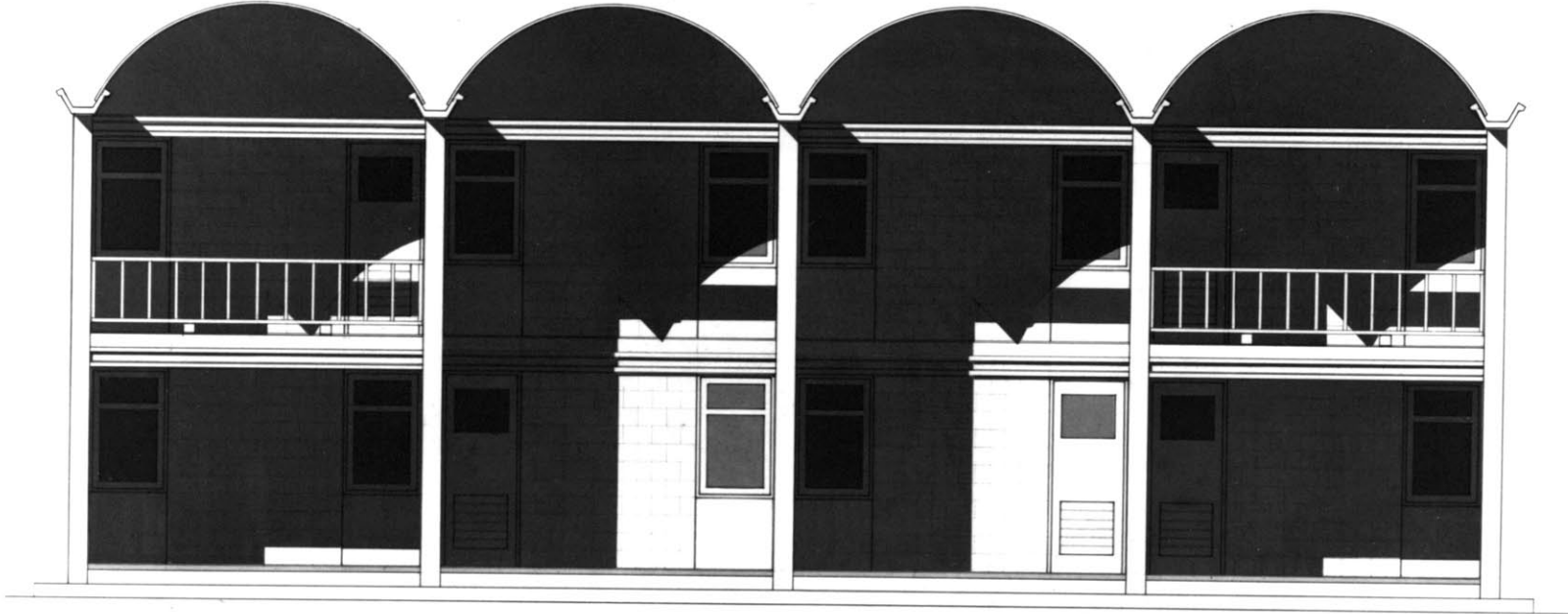
REAR ELEVATION



CROSS SECTION

ELEVATION - SECTION
SCALE 1/24

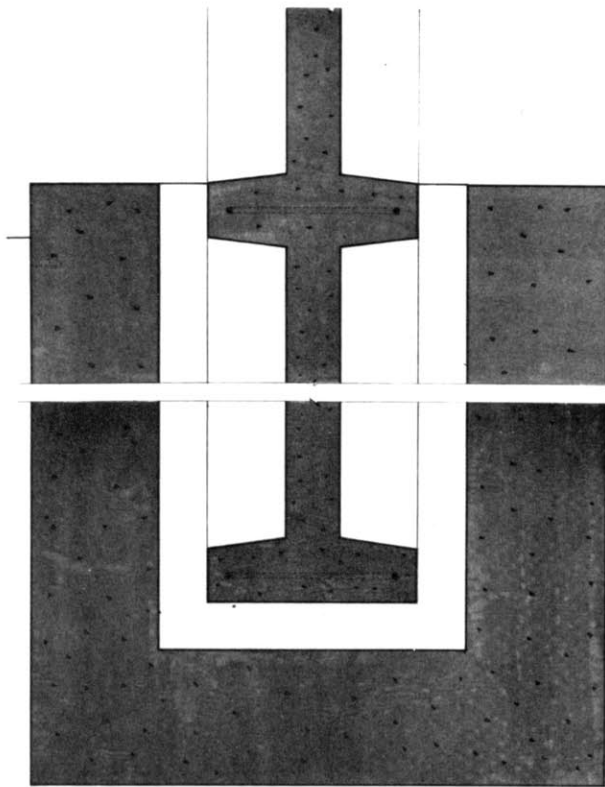
6 A SYSTEM OF LOW COST HOUSING IN INDIA
MASTER IN ARCHITECTURE THESIS
GANTAR B. SHAH M. I. T. JUNI 1961



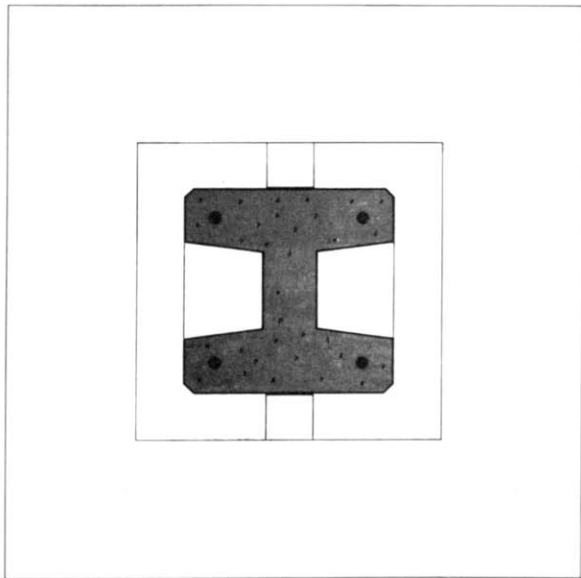
FRONT ELEVATION

ELEVATION
SCALE 1/24

7 A SYSTEM OF LOW COST HOUSING IN INDIA
MASTER IN ARCHITECTURE THE SIX
GAUTAM B SHAH M I T JUNE 1985

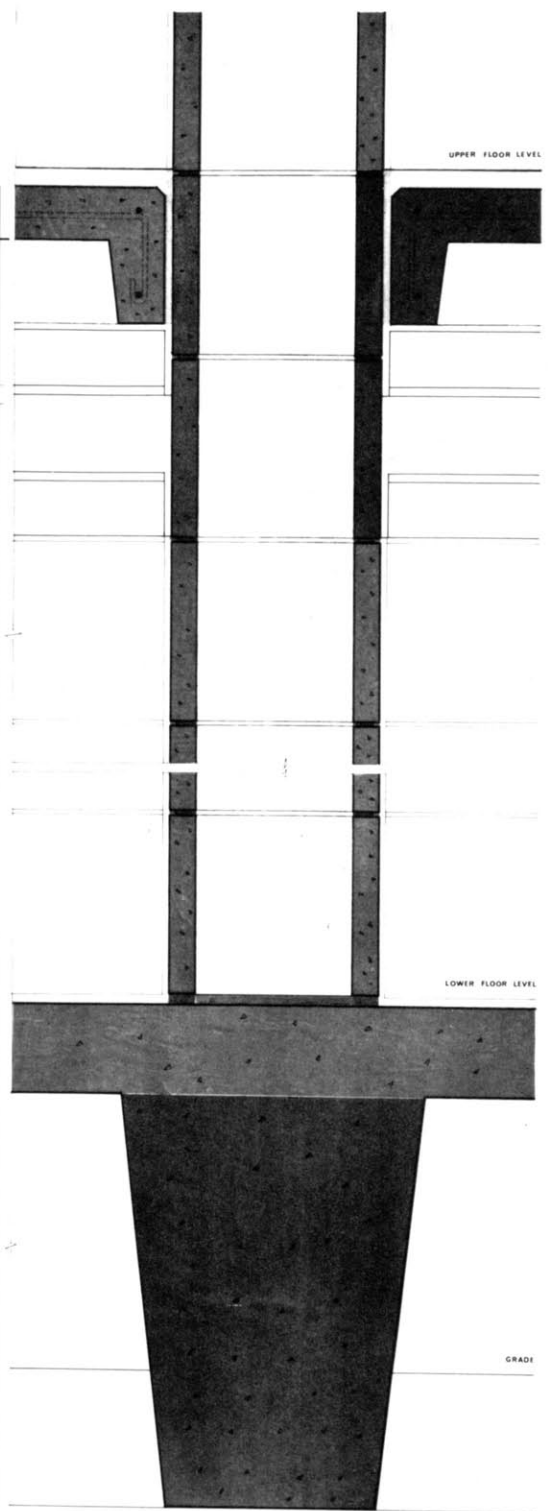


SECTION



FOUNDATION PLAN

CONSTRUCTION DETAILS
SCALE 1/2

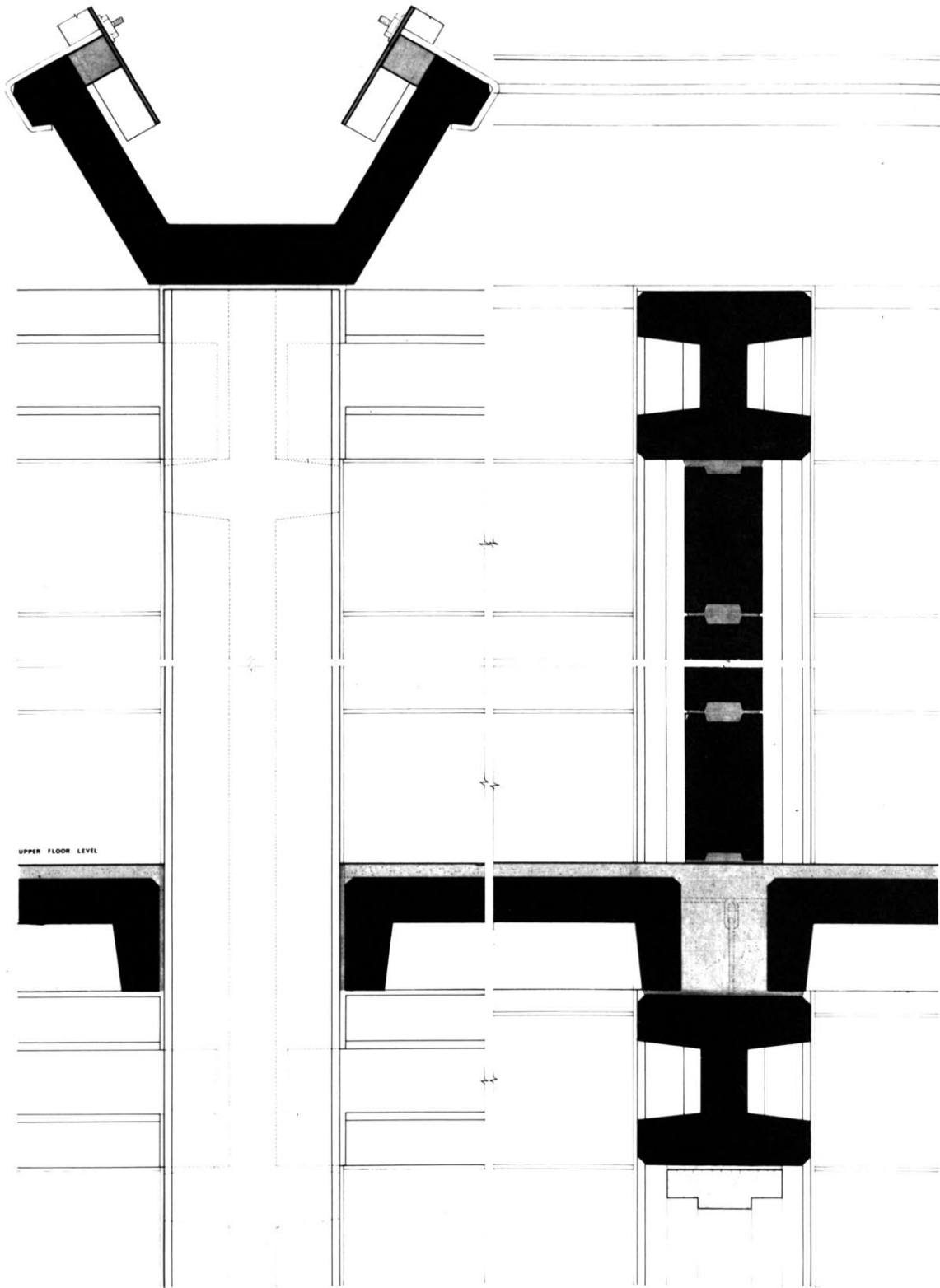


UPPER FLOOR LEVEL

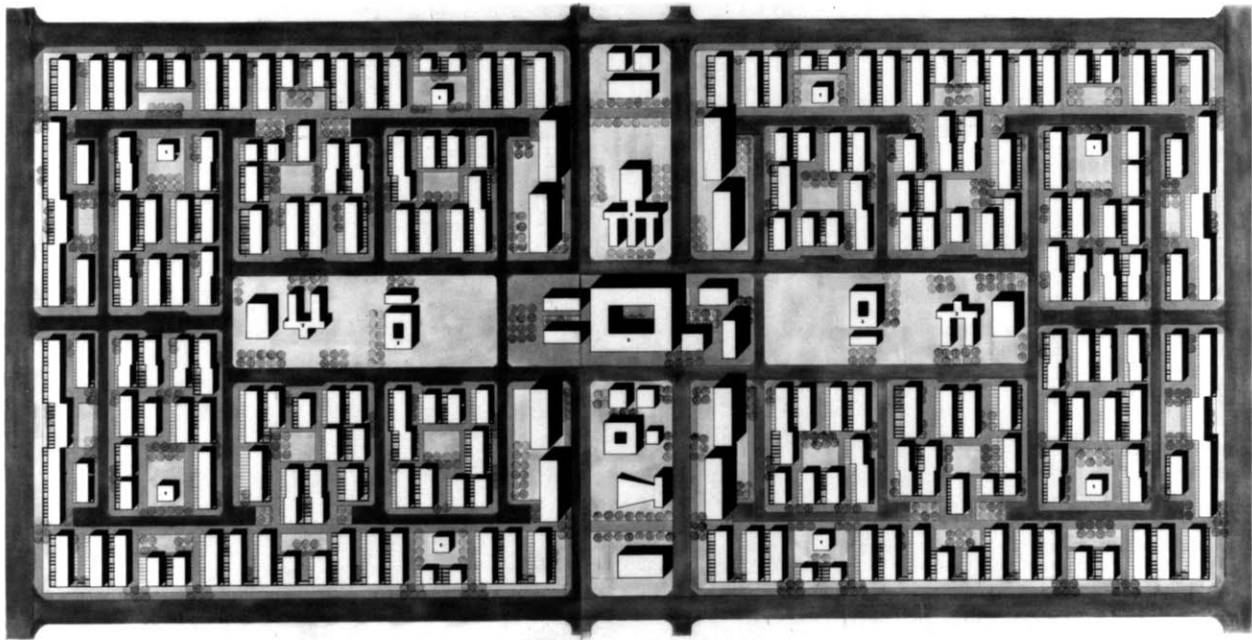
LOWER FLOOR LEVEL

GRADE

PARTY WALL SECTION



STRUCTURAL DETAILS
SCALE 1/2



1. ENTRANCE
2. RECEPTION AREA
3. OFFICE
4. CONFERENCE ROOM
5. STORAGE ROOM

1. ENTRANCE
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