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CASE STUDY AND ANALYSIS OF A LOW COST HOUSING PROJECT IN AN URBAN AREA IN INDIA

By

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SYNOPSIS

An urban development project involving residential and school buildings as an extension of Madras city is described. The analysis of the project is made using the systems approach as a problem of human settlements. The methods adopted for efficient utilisation of space at optimal cost by functional planning, use of prefabricated units and use of new constructional procedures is described. The interrelationship between environmental, technical, social, cultural, psychological, economic, financial and management factors in making decisions for the project is discussed.

INTRODUCTION:

In low cost housing projects there is a need to get innovative solutions by considering the totality of the problem. There is also a need to review experimental housing projects and analyse various interactions.(10) This would be helpful to evolve more meaningful solutions in the future to tackle the complex problem of low cost mass housing. In emphasizing the role of ''total planning,'' Buckminister Fuller says that life in this planet is a total environment comprising of men, resources, ideas and possibilities. The present case study is intended to show how some possible solutions can be iterated by considering systematically the overall problem and interrelationships between various elements.

In the past few years repatriates of Indian origin have been arriving from Burma in several groups and attempts have been made to house them in urban and rural areas of Tamil Nadu in Southern India since the language and social customs are somewhat similar (although it calls for adjustments). The project under discussion is to house 600 such repatriate families in the periphery of the city of Madras which has a population of about 2,500,000. The project is treated as a problem in Urban Systems Engineering which considers technical, social, cultural, psychological, economical, financial and management aspects. Residential buildings and school buildings are included in this case study to show the considerations in arriving at design solutions and the need for attempting construction methods hitherto not used in Madras. The role of aided self-help in housing schemes is discussed. Based on the analysis of similar housing projects in India, it is shown that the systems approach can result in more meaningful solutions and about 30-40 percent reduction in costs. The resulting housing groups planned in this project are in harmony with adjacent neighbourhoods and modern living in technological age.

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ENVIRONMENT ASPECTS OF THE PROBLEM:

The city of Madras is situated on the sea coast at a latitude of 13°N. It has a temperature range of 80°-120°F, very high humidity, intense sunlight and heat throughout the year and heavy rains in the monsoon. Winds and gales of high velocity upto 100 mph have been recorded. However, it is not in the earthquake region of the country.

The site allocated for the housing colony by the Housing board of the state government, is on the periphery of the city and is a low lying area hitherto used for farming. The area is waterlogged in the rainy season for an average depth of about 12''. The soil is expansive clay which badly cracks when exposed to sun and is highly cohesive when wet.

Because of the large distance (about 10 miles) from the core of the rapidly growing city, the city water supply, sewage and storm water systems could not be used or extended. The water available at site was not palatable. Electric power supply was available at site. A well maintained asphalt road passes through the site connecting Madras city and Mahabalipuram, (a place of relegious importance and tourist attraction about 30 miles away from the site).

SOCIAL, CULTURAL AND PSYCHOLOGICAL ASPECTS:

It is problematic to rent housing in the city because of high rents and social conditions. The problems are similar to those faced by minority or special groups.(15) There are no cultural centres, markets and schools within a radius of two miles from the site. A small village of 100 houses and small scale industries are in close proximity of the project site. Most of the repatriates were of the middle income business group while they were in Burma and were repatriated to India without their savings and material possessions. However, the families were highly motivated in their aspirations to upgrade their situation by starting small scale industries and business with whatever help the government gave. Hence the planning of housing had to take care of possible extensions within the site alloted to them (60' x 40'). Besides this, the size of families varied from 3 members to about 8 members.

FINANCIAL ASPECTS:

The finance for rehabilitation is given by the state government which amounts to Rs. 3,000/= (= $ 400) per family for the actual construction of house on sites of 40' x 60' laid out in grid pattern and given to them through the housing board. Finance for water supply, power lines and sanitation were forthcoming. The prevalent cost of buildings is about Rs. 22.50/sq.ft (3 $/sq. ft) for conventional construction at Madras.

MANAGEMENT ASPECTS:

The repatriates manage their affairs through a cooperative society of their own. With the limited funds available, the cooperative society sought the technical help of the college of Engineering, Madras for solving their low cost mass housing problem. The environmental and structural aspects were planned and a model residential house and community building were successfully erected under the supervision of the first author. The systems analysis of the project was completed with the help of the second author and the mass production of the buildings is being undertaken by the cooperative society through structural and construction firms. Help was also sought from Rotary clubs to build the design models.

SYSTEMS APPROACH TO THE PROBLEM:

The housing problem posed many challenges. The problem was considered in its totality and the participation of architects, engineers, building science specialists, management experts and philanthropic agencies was required to help these families in starting a new life. Thus the project takes the form of aided self help enterprise and voluntary help was taken.[11] A visiting architect from U.S.A., Mr. J.E. Castopolous helped in evolving plan for community center, schools, markets etc.

Problems of industrialised housing are discussed in references (2) and (4). The systems approach to buildings and other problems is discussed in references (1), (5) and (6). Urban Systems Engineering is an emerging discipline.[3] Project reports on low (7, 8, 9, 10) cost housing schemes were also studied. Some Indian projects were investigated from references (12) and (13).

The detailed study of the above references provided the basis for planning the project. The essential interactions between components of a low cost housing project are shown in Fig. 1. The phases of a industrialised housing project and the basic cycles operative in such a process is shown in Fig. 2 adapted from the one given by Asimow.[6]

While the systems concept is the basic fabric on which this report is built up, the decisions taken are intuitive in nature, the associated value systems are subjective and only a part of the information generated and used is objective. Keeping the interaction chart in Fig. 1 as the basis, the following technical decisions were taken.

DESIGN DECISIONS:

The materials of construction chosen were reinforced concrete and bricks because of environmental and cost considerations. The conventional low cost housing in Madras city consists of plain concrete footing, brick basement, brick masonry load bearing walls and brick terrace roof on timber joists. These show extensive cracking when founded on expansive clay. The waterlogging problem in rainy seasons demanded the use of high basements and the poor soil requires the use of deep footings, all contributing to disproportionate foundation cost. Storm water drainage for an area of two square miles, the laying of permanent roads in the water logged area deserved attention. The construction of an elevated concrete water tank to hold 50,000 gallons of water and pumping of water from tube wells situated a mile away from the site were considered. Flushout latrines for each house with combined septic tanks for ten houses were proposed. At least five light points per house and a plug point were decided. Material chosen for doors and windows was wood and glass was avoided because of cost, excessive light and winds.

Considering the social and cultural aspects, schools, shopping centres, cultural centers, hospitals were planned to be built and integrated with housing. A temple with parks all round it was also planned. The generation of small scale and cottage industries was considered. In trying to find out how much space was required for an average family (five members in this case), a participative planning session was initiated with the actual users. From this it was concluded that the families could be satisfied with the building of a core unit of 250 sft. initially, with facilities for future expansion when money is available. Large families had to be satisfied with combined bed/dining/living area with the kitchen and W.C. separated by interior walls, while others required fully partitioned conventional houses with various areas physcially separated. The prefabricated mass housing concept had to allow the above flexibility in choosing the proper structural scheme. There was no response for community living in multi-storeyed apartments.

At the prevailing rate and with the finance available, an area of 135 sq. ft per faimily could be provided while a minimum of 250 sq. ft was desired without sacrificing strength, durability and utility. A feasible solution was eventually obtained for the houses and school buildings (funds were separately provided) within the stipulated cost thus obtaining 40 per cent reduction in prevalent cost by using modern concepts of planning and construction methods.

FUNCTIONAL AND STRUCTURAL PLANNING DECISIONS:

A solution was finally iterated upon, wherein a square flat slab roof with cantilever overhang, ~~which~~ directly transmits the load to the foundation through the four R.C. columns. Lightweight partitions to suit individual requirements were planned. Since wall spaces could also be used for storage it was decided that R.C. shelves could themselves act as partitions combined with minimum brickwork to accomodate doors. Except for bath and bed rooms, interior doors were avoided. An entrance door in front and a rear door were proposed. Flat slabs with square arrangement and cantilevered from interior columns (kept to a minimum in this case) are structurally efficient to take partition loads also. To avoid heavy basement brickwork and foundation settlement for this waterlogging prone area it was decided to have a flat slab for the conventional ground floor. Thus the solution iterated to two flat slabs (15' x 15') supported on 4 columns spaced 10' c/c and 4 column footings; with the exterior and interior walls built as required for different families. The above concept permits prefabrication by lift slab techniques and allows the ground floor to be away from the ground by 3' to 4' or more so that dampness in a waterlogged region could be avoided. Some families even preferred a gap of 6' between the ground and the floor so that in dry season the bottom space could be used by children for playing and such other incidental uses. The verandah and steps are planned to be precast as a unit with support on separate foundations with 9'' brick wall at one end which need be shallow. Functional planning decisions are shown in Fig. 3 with all relevant details for the residential building. The use of flat slab avoids beams requiring costly formwork and reduces the height between floor and the roof which is selected as 8' to reduce cost of brickwork, plastering.

On the other hand for the school building, a hexagonal planform was used by the architect so that it could be also converted into a community cultural center in the evenings. Also extensions of this form for shopping centers, health centers are easily obtainable by use of hexagons arranged in honeycombed pattern as shown in Fig. 4. In terms of spatial utilisation for schools it is efficient and the area of 450 sq ft can be partitioned for different purposes. The central portion had a ventilator for exhaust. Doxiadis has also indicated the advantages of this form.[16] The roof was planned to be a sloping one so that it is a center of attraction and also helps drainage. As shown in fig. 4, precast portals with braces and tie beams at foundation level were assembled with cast in situ foundation blocks and bolted. To reduce formwork costs and to obtain tensile membrane effects, a thin welded wire mash 6'' x 6'' of $\frac{1}{8}$'' diameter (3 gauge) with a layer of chicken mesh (1/2'' gap) to serve as formwork and reinforcement for the 2'' thick R.C membrane roof was provided, with the bottom plastered. About 20 per cent of the concrete with 3/4'' aggregate laid on top of this mesh falls through and was reused again. The self weight of the roof resulted in a membrane shape of good structural efficiency.

PLANNING FOR CONSTRUCTION:

It may be recalled that modern advances in building construction is based on mass production. The 15' x 15' flat slabs can be precast at the site of the colony and transported mechanically and connected to the four columns and erected with a 10 ton crane. The shear and moment connections are made of steel inserts. If the precast units are readily available, the foundation work which is just 4 pits for each house could be started in the morning and the basic structural core could be erected an hour or so. The exterior brick walls and interior components could be added by a separate team. For 600 houses, this approach is ideal for mass production and fast completion of the houses for occupation as compared to conventional methods used in Madras city.

ECONOMIC ASPECTS:

Low cost mass housing in developing countries has been notorious for poor functional utility, low durability and poor standards. However the possibilities due to mass production, innovative planning and design could be exploited for economy. The full scale models erected proved to be costlier by 20 per cent than the estimated cost of Rs. 13 per sq. ft. This is because of nonavailability of construction machinery and non mass production orientation which requires use of skilled labour. The final reduction was planned to be around 40% of existing costs. Better buildings were obtained which were aesthetically appealing besides being safe and durable. Economy was achieved by removing materials from unwanted places and using them where they are required for functional and environmental considerations. The dead load has been cut to a minimum consistent with materials used.

ADDITIONAL CRITERIA:

Aided self help housing has been suggested for housing in developing countries.[11] In the planning of the housing project, this was kept in mind and only the structural skeleton was prefabricated and considerable opportunities were provided for contributing unskilled labour by the sepatriate families, students and the community. The model of the school building was erected with the help of students and staff with a minimum of skilled labour. With the technical and organisational assistance, considerable progress in low cost housing for motivated communities can be planned.

COMPARISON WITH OTHER HOUSING PROJECTS IN INDIA:

The Housing Board of Madras city which is a quasi-governmental agency, has number of housing projects in urban development programmes. However, the methods are quite traditional and the the cost of construction works out to Rs. 20/ sq. ft approximately. Recently there is a factory being constructed in Madras for producing lightweight building components. For a desired rate of atleast 1000 prefabricated houses per annum for cities[14], unless systems concepts are used for building, the problem of housing becomes more critical.

The housing projects under Calcutta Metropolitan Planning Organisation have assistance from Ford Foundation [12], [13]. A universal concrete panel system is adopted based on the use of modular prefabricated concrete panels for roofs, walls and floors which can be handled by workmen skilled in traditional techniques. Manual handling of components with simple levers and pulleys have been considered. This system easily accomodates variations in plan and elevations, and future expansions on self-help basis are feasible. The cost works out to Rs. 11/sq. ft. ($1\frac{1}{2}$ \$ per sq. ft) but is not feasible for waterlogged areas and places where severest environmental conditions exist.

CONCLUSIONS:

In this paper it is shown that a systems approach to mass housing in an urban environment, which incorporates available knowledge in many disciplines, can result in the following advantages:

1. The buildings can be erected more quickly with a smaller labour force at site.
2. Buildings are lighter in weight resulting in savings on materials and foundation.
3. Better insulation and with improved systems of layout, spatial planning ventilation and plumbing, the houses are

more suitable for human occupation. Low cost need not be at the cost of conveniences, quality, function, efficiency etc.

4. Clean and healthy surroundings pleasing to the aesthetic sense can be obtained at a cost within the means.

5. Systems approach coordinates the participation of many interacting elements to achieve economy and fulfillment of needs in a housing development project (Fig. 1). In this case study it is found that the combination of functional planning, structural planning and construction methods, yields economical solutions.

6. The role of aided self help is more important in the solution of housing problems.

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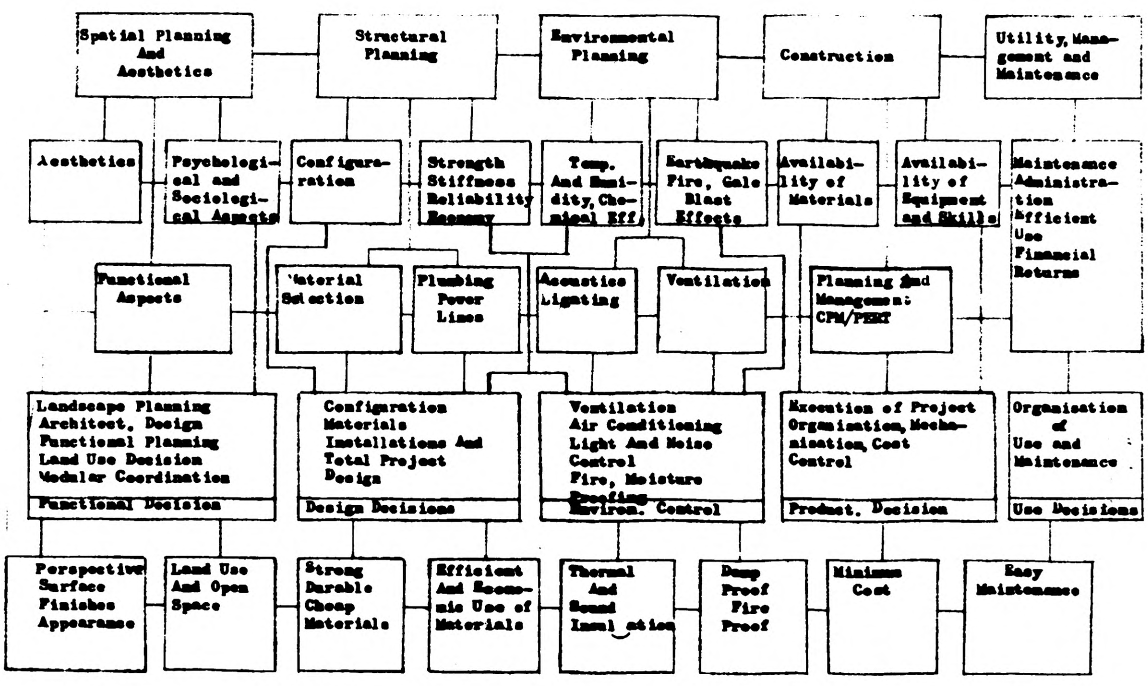
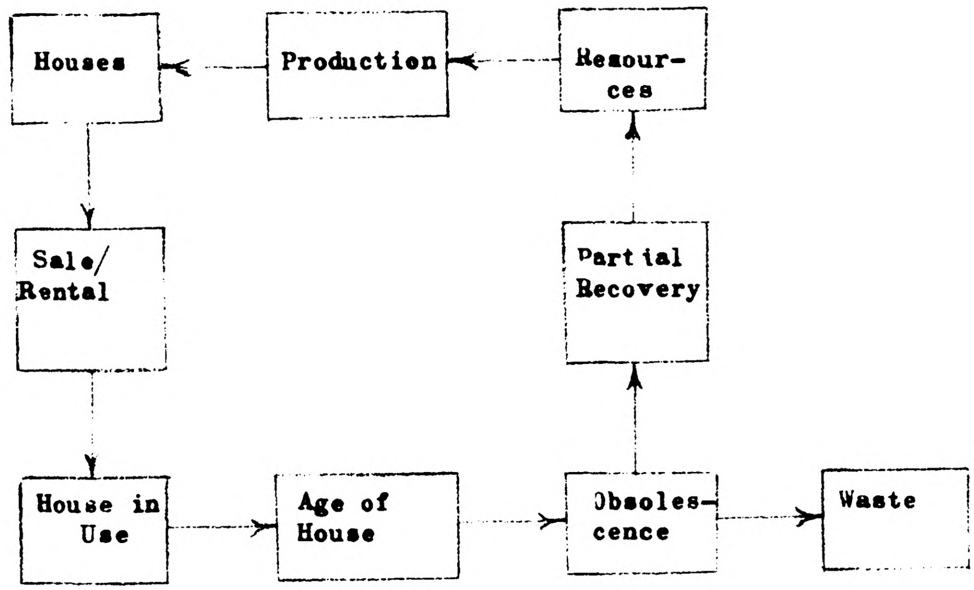
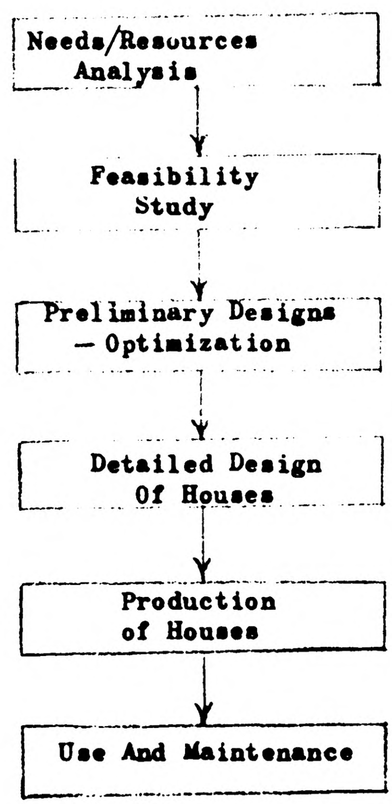


Fig. 1 PROJECT DESIGN COMPONENTS AND NATURE OF INTERACTION

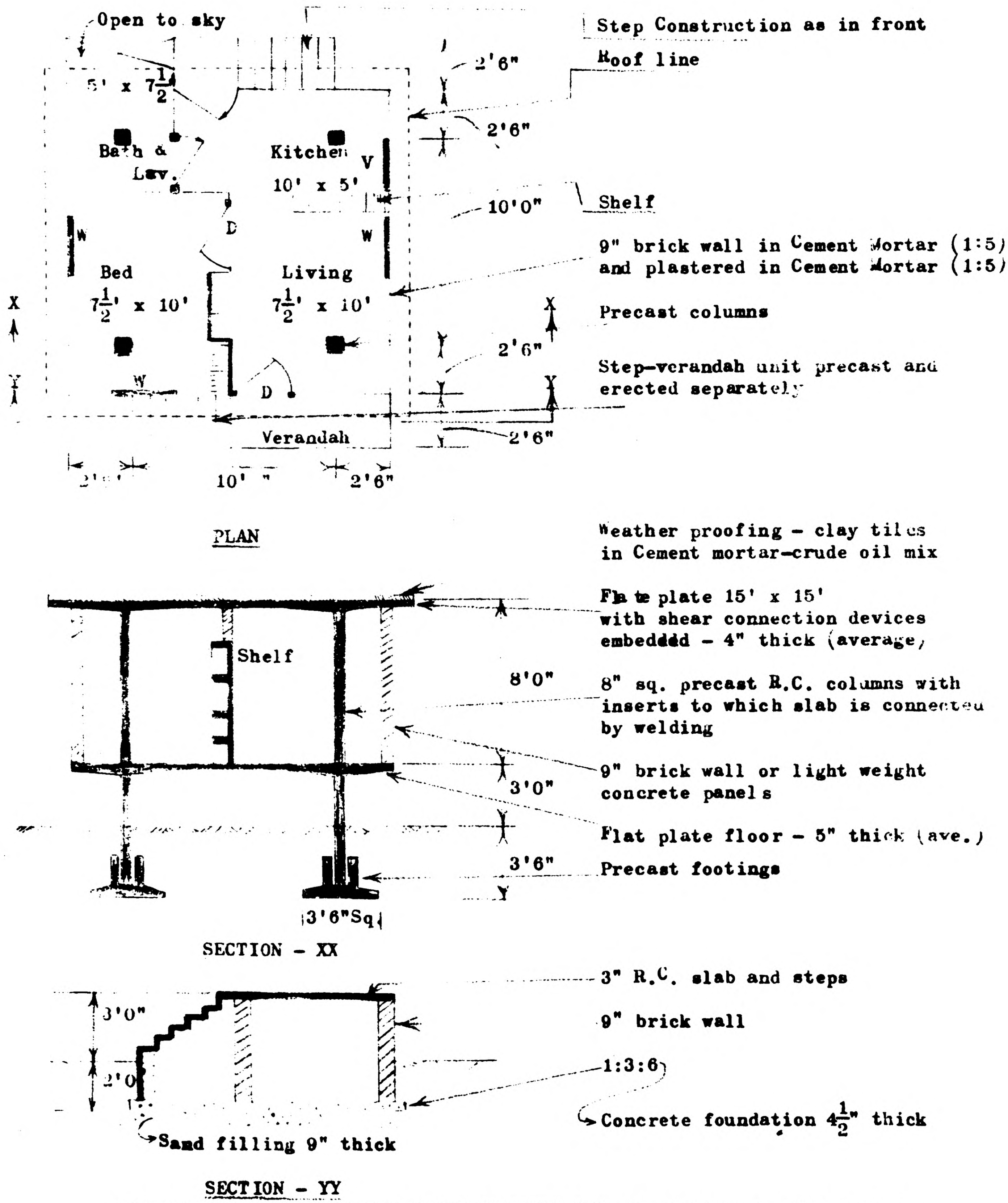


BASIC CYCLE FOR MASS HOUSING



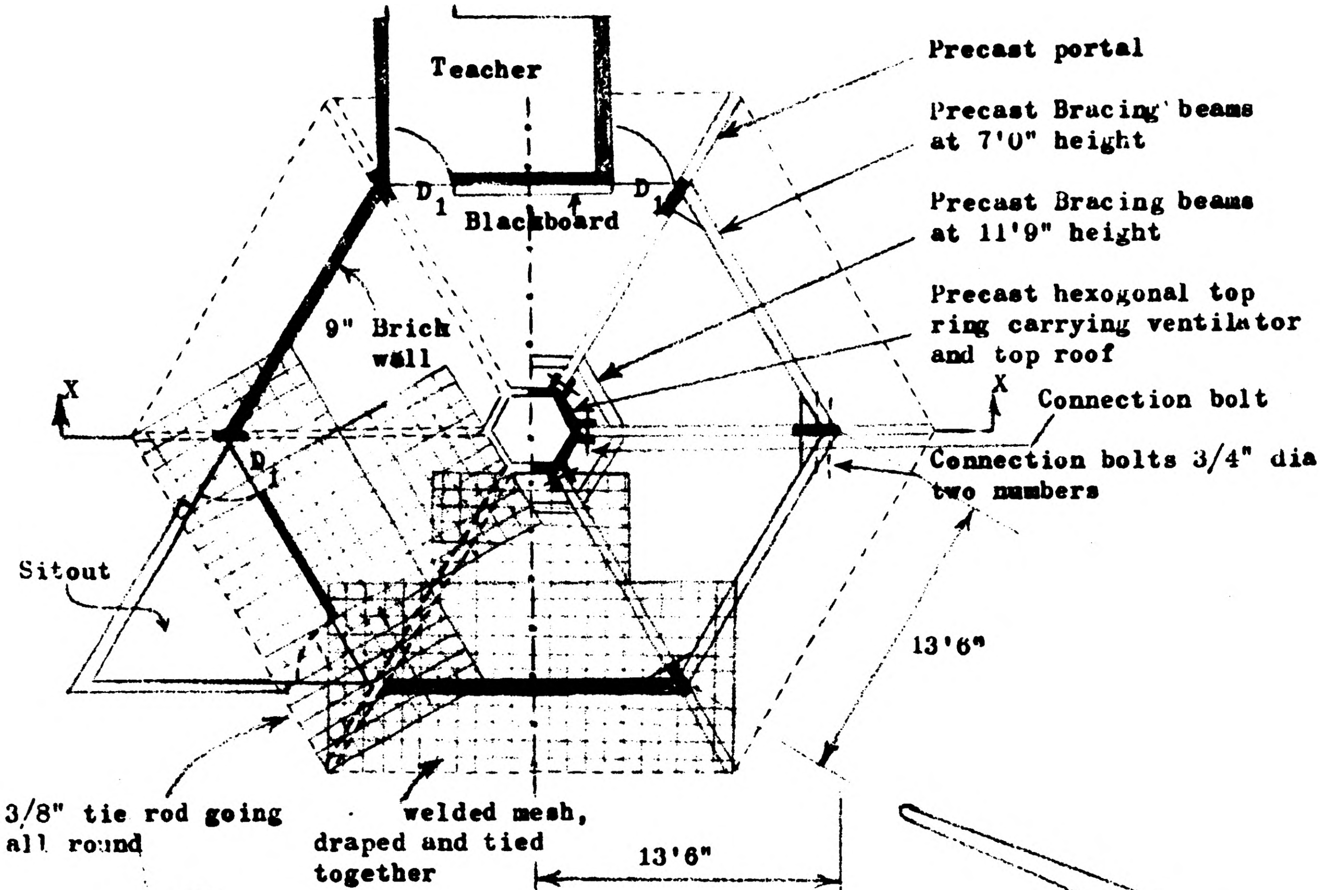
PHASES OF HOUSING PROJECT

Fig. 2

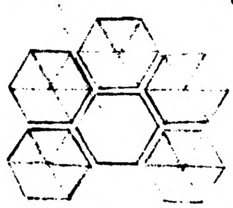


TYPICAL HOUSING UNIT FOR BURMA REPATRIATES ASSOCIATION, MADRAS, INDIA

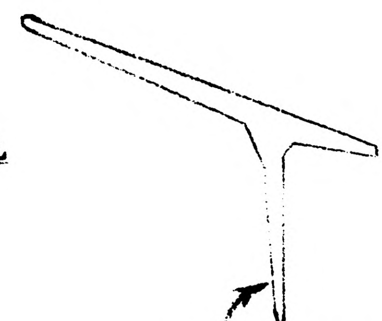
Fig. 3



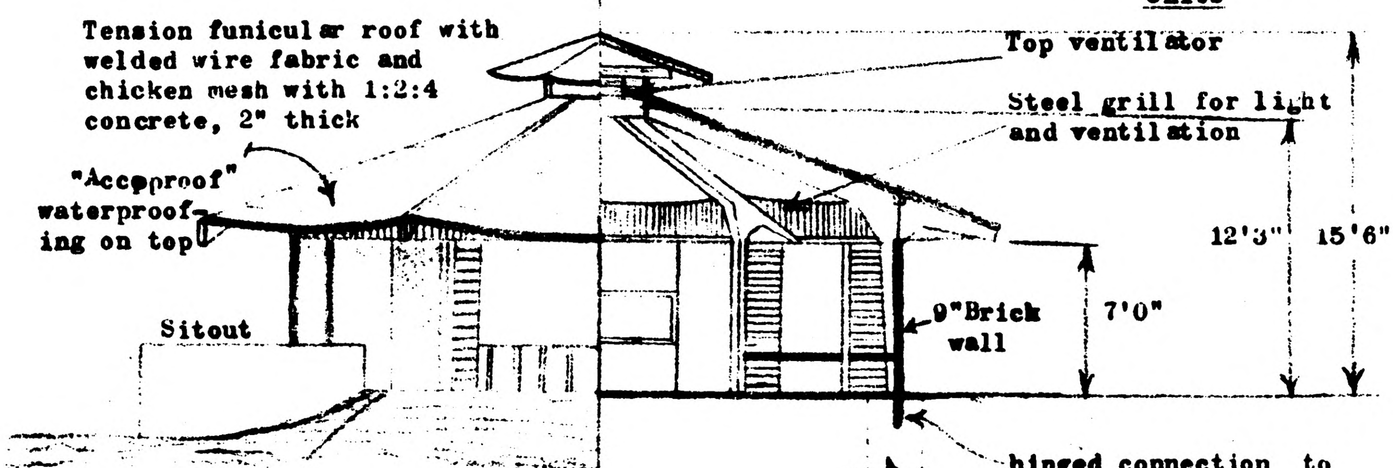
COMPOSITE PLAN SHOWING ESSENTIAL DETAILS (Not to Scale)



TYPICAL UNIT ARRANGEMENT



Typical Precast Portal Units



TYPICAL UNIT ELEVATION & SECTION - XX

TYPICAL CLASS ROOM UNIT FOR SCHOOL BUILDING

Fig. 4