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Low-Cost Residential Development And Renewal In Greater Bangkok, Thailand

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LOW-COST RESIDENTIAL DEVELOPMENT AND RENEWAL IN GREATER BANGKOK, THAILAND

BY

SATHIT CHAIYASIN

THESIS

Submitted in Partial Fulfillment of the
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ABSTRACT OF THESIS

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This study presents an overview of the needs and the problems involved in providing housing for the low-income group in Greater Bangkok, Thailand. It examines the pressing need for housing and analyzed the problems involved in planning, designing and developing such housing projects, which traditionally, have been subsidized by the government. Recognizing these factors, and based on the studies and the author's experience with the socio-economic needs of low-income groups, presented herein is a basic concept of housing design and methods for low-cost housing construction. This basic concept is the most fundamental living unit and is simple, both in design and construction. To explain the specific details, one of the five selected slum areas in Greater Bangkok that are considered in the worst condition and are in the programs for development will be selected. The site is divided into six neighborhoods, a light industrial area, recreational areas and a community center. Each neighborhood consists of two primary schools and a religious center (temple), a neighborhood center, and a neighborhood shopping area. To improve human circulation within the area, the street system was redesigned and the block system is used. For housing, each block is divided into long and narrow lots to reduce the cost of public utilities. Bamboo is abundant in Thailand and can be obtained at a very low cost. The properties of bamboo have been tested and found to be a good

building material, especially for concrete reinforcement. Bamboo is, therefore, used as a building material to cut down material cost. An aided-self-help method is employed to reduce labor cost for housing construction.

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I. INTRODUCTION

A thousand million people are living in substandard housing. Many countries have found themselves unable to provide even one-fifth of the required number of the houses in the past decade. Urban population has increased four times over in the last forty years; by the year 2000 it is likely to be twenty times what it was in 1920.[1] The task of housing the current generation, or even more generations to follow, present a monumental challenge.

It was with the urban growth that the housing problem in its present intensity began. Transformation of the former economic based chiefly on agriculture and the shift to urbanized economy - without planning for change - brought urban slums in many parts of developing countries. Large numbers of people migrated from rural areas and added to the rapid natural growth in the urban area itself and the city could not provide sufficient amounts of housing. On the other hand, most people who just moved in from rural areas could not afford to pay for the high cost of housing in the city because they were poor, unskilled laborers who earned only a small amount of income. Consequently, most of them stayed in slum areas close to their working places and where they paid only a little to stay or sometime did not pay at all.

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1 United Nations, Improvement of Slums and Uncontrolled Settlements, U.N., New York, 1971, p. 17.

Housing problems resulted in congested and deteriorated conditions in large cities. Greater Bangkok, the capital of Thailand, is the one of the cities under consideration. It was poorly planned, primarily due to an inadequate planning staff. Planning work has always lagged behind actual expansion. In the recent years, city planning has received more attention than before. Nevertheless, chaotic human circulation, overcrowded narrow streets, and no public facilities or utilities are still common scenes in urban areas.

The critical condition in Greater Bangkok, as described above, may be partially alleviated by utilizing low-cost housing developments. The formulation of methods and procedures for such developments in Greater Bangkok is the primary objective of this study.

HOUSING PROBLEMS IN ASIA AND THE FAR EAST

II. HOUSING PROBLEMS IN ASIA AND THE FAR EAST

Population Study

There are three factors of demographic dynamism which may be expected to have major impact on the social and economic development of Asian countries. There are: 1. Rapid population growth which is of significantly different proportions than the rate of growth experienced during the early period of industrialization in those countries now more technically developed. 2. Extraordinary absolute and relative growth of the urban population which indicates a lack of synchronization between change in economic structure and the urban-rural population changes. 3. Rapid increasing rural to urban mobility.

A. Rapid population growth

Since these three factors may be expected to have a direct and considerable impact on housing needs, it is pertinent to consider them in somewhat greater detail. Analysis of statistics eventhough they are admittedly inaccurate and incomplete, does provide information of importance in considering these dynamic processes.

Demographic trends indicate that, in general, the change which took place in the now most industrialized societies from a relatively low rate of population increase (due to the restraining effect of a high death rate upon a high birth rate) to a correspondingly low rate of increase (due to the

restraining effect of voluntary control of fertility) has not taken place widely in Asia, especially Southeast Asia. There has been a rapid decrease in mortality due to greater control of famine, war and particularly to control of disease through improvements in sanitation and medical care. There has not been any apparent decline in the rate of fertility.

This has contributed to a rapid increase in population over the past three decades and during the past decade to a growth rate for the Asian and Southeast Asian area which is one of the highest rates in the world. The United Nations calculates the average annual rate of increase at about 2.3 percent in Asia, against the world rate of 2.0 percent. Africa had 2.4 percent, North America 1.4 percent, Latin America 2.9 percent and Europe 0.9 percent. The highest annual rate of increase was in Southeast Asia (2.8 percent) and Middle South Asia (2.6).[1]

This rapid increase is expected to continue because the fertility rate is expected to remain high. While there is no simple way to predict the future fertility rate, it is generally considered by population experts that resistances to reduce family size may be high in Asia due to religious and social attitudes. There is, at any rate, no obvious reason to expect a decline through voluntary control within

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[1] United Nations, Demographic Yearbook 1970, U.N., New York, 1970, table 1.

the next few decades. There is undoubtedly value in carrying out further studies of possible differences between urban and rural fertility rates.

Although Asia has more cities - and more people living in them - than Europe or North America, taken in its entirely it is the least urbanized region of the world, excluding Africa.[2] This distinction points up the difference between the mere presence of cities and "urbanization", reserving the latter term to refer to proportion of the total population which is resident in cities. In 1950 about 14 percent of Asia's population lived in cities of 20,000 or more inhabitants; by 1960 it is estimated that this proportion had increased to around 17 percent (actually 16-18 percent, depending on different estimates of urban growth trends in Mainland China).[3]

In spite of a relatively low level of urbanization, the rate of population growth in large cities has been very high. In 1900, cities of 100,000 inhabitants and over in Asia accounted for a population of 19.4 million but fifty years later these large cities contained 105.6 million, an increase

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2 United Nations, Urbanization in Asia and the Far East, Proceeding of the Joint UN/UNESCO Seminar, Bangkok, August 1956 (UNESCO, S.S.57.V.7.A.), p. 98.

3 United Nations, World Survey of Urban and Rural Population Growth, Preliminary Report by the Secretary-General, U.N., Sale No. E/CN.9/187, table 3 and para. 43.

of almost 450 percent as compared with only 160 percent in Europe and America, and 250 percent in the world as a whole.[4]

An important factor in such rapid population increase is that the adult person in as Asian country has a large number of dependents since the rapid rate of natural increase produces a population with a relatively high proportion of children and adolescents. Forty-four percent of the population of Malaysia, for instance, is less than fifteen years old or more than twice the corresponding percentage, twenty-one, in Sweden.[5] In the majority of Southeast Asian countries at least forty percent of population is said to be dependent on adults of productive age group between 15 and 59 years of age except Japan.

The following graphs indicate some of the outlines of the age structure for Southeast Asian countries. The general form is similar in other Asian countries.[6]

Few statistics are available in regard to family size in Asia and the Far East. Considering the nuclear family, the 1970 United Nations Demographic Yearbook reported average family size in Philippines to be 6.5, Malaysia 5.9, Singapore

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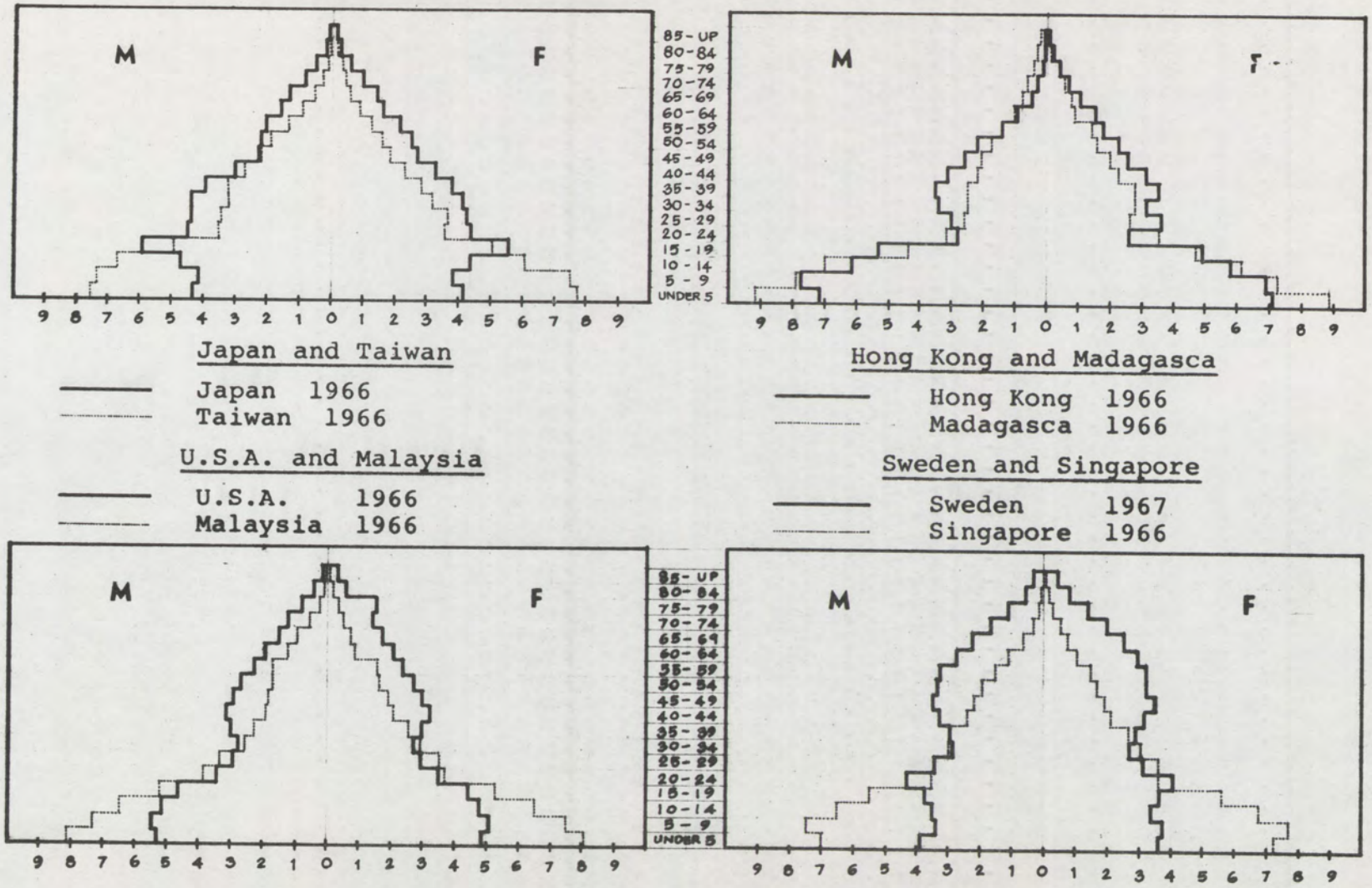
4 Urbanization in Asia and the Far East, op.cit., p. 59.

5 Keyfitz, Nathan and Flieger, Wilhelm, Population, Facts and Methods of Demography, W. H. Freeman and Company, San Francisco, p. 402 and p. 464.

6 Ibid.

Figure 1. Composition of Population by Age and Sex



Source: Based on data as published in "Population, Facts and Methods of Demography" by Nathan Keyfitz and Wilhelm Flieger, W.H.Freeman and Company, San Francisco, 1971.

5.8, Taiwan 5.8, Turkey 5.7, Pakistan 5.4, Ceylon 5.4, Korea 5.6, India 5.2, Iran 5.9, Indonesia 4.9 and Japan 3.9. Though many commentators or Asia mention that households frequently include "distant" relatives, no specific information was found that indicates the extent to which extended family households exist of the degree of willingness to provide support for a relative not directly within the nuclear family.

Some information on age dependency ratio (estimate of the number of persons under 15 and over 60 years of age per one hundred persons between 15 and 60) indicates that such ratios are now high and will generally remain high. (See table 1.)

Table 1. Age Dependency Ratio

Countries	1966	1976	1981
Ceylon	91		82
Taiwan	108		104
Hong Kong	85		78
Indonesia	96	83	
Israel	73	74	72
Japan	53	49	48
Malaysia	100	95	96
Singapore	94	74	75

Source: Based on data as published in Population, Facts and Methods of Demography by N. Keyfitz & W. Flieger, W. H. Freeman and Company, San Francisco, 1971.

The importance of a large number of dependents is that it contributes to the "vicious circle" which keeps personal income level low and allows only a small percentage of personal and national budgets to be available for expenditure on satisfaction of housing needs while at the same time physical needs for housing are increasing through natural population increase.

B. Urbanization

In addition to the rapid population increase with the probable impact of large numbers of dependents on potential for economic growth, a second major demographic factor to be considered is the extraordinary, rapid urban growth. It must be remembered, however, that the definition of "urban" in some countries includes as urban those communities with more than 2,000 inhabitants. The total percentages for some countries may, therefore, indicate a larger urban population than would be considered true if criteria of "urban" were related to behavior patterns representative of modern, industrial-communication areas. Nevertheless, the statistics which follow give an idea of the dynamics of the process.

From table 2, it may be noted that most of the selected countries are increasing their urban population at a rate of more than five percent yearly. The country showing the fastest rural growth rate is Thailand with a yearly increase of 4.0 percent, but when compared with the rate of population growth

Table 2. Urban and Rural Population in 1950-1960 (in thousands)

Countries	Population 1950			Population 1960			% Urban		Average annual rate of increase per 100 persons 1950-1960		
	Total	Urban	Rural	Total	Urban	Rural	1950	1960	Total	Urban	Rural
Taiwan	7,554	4,067	3,487	10,792	6,230	4,562	53.0	57.7	4.3	4.9	3.1
Hong Kong	---	---	---	2,993	2,292	701	--	76.6	---	---	---
India	356,742 (1951)	61,872 (1951)	294,869 (1951)	432,543 (1962)	77,534 (1962)	355,003 (1962)	17.3 (1951)	17.9 (1962)	0.2 ('51-'62)	2.1 ('51-'62)	2.0 ('51-'62)
Japan	83,200	31,203	51,997	93,419	59,333	34,086	37.5	63.5	1.2	9.0	-3.5
Iran	18,772	3,761	15,011	21,719	7,445	14,274	20.0	34.3	1.6	9.8	-0.2
Iraq	5,198	1,903	3,295	6,885	3,001	3,884	36.6	43.6	3.2	5.8	1.8
Israel	1,552 (1951)	1,113 (1951)	439 (1951)	2,150	1,649	501	71.7 (1951)	76.7	4.2 ('51-'60)	5.3 ('51-'60)	1.5 ('51-'60)
Korea	21,502 (1955)	5,263 (1955)	16,239 (1955)	24,989	6,997	17,992	24.5 (1955)	28.0	3.2 ('55-'60)	6.6 ('55-'60)	2.1 ('55-'60)
Singapore	Reported to be urban 100%										
Thailand	20,095 (1956)	1,743 (1956)	18,352 (1956)	26,258	4,779	21,479	8.7 (1956)	18.2	7.6 ('56-'60)	43.5 ('56-'60)	4.0 ('56-'60)
Turkey	20,947	5,244	15,703	27,755	7,308	20,445	25.0	26.3	3.2	3.9	2.9

Source: Demographic Yearbook 1970, United Nations, New York, 1971.

of the country (7.6%) and the urban population growth (43.5%) it is very low. In most cases rural growth rate is approximately less than 2 percent. There is, therefore, a marked different between population growth rates in urban and rural areas. This is despite the generally accepted, though statistically unanalyzed, idea that urban birth rates are lower than those in rural areas.

Urban growth, as noted, has been occuring rapidly and capital cities have been experiencing the most rapid growth. A study on urbanization in Asia and the Far East[7] indicates that the cities should not necessarily attract people in large number for industrial employment, the growth of these cities then represents a different social process from that experienced in the now industrialized nations where cities were limited by needs and capacities of the rural hinterland and grew with improvement in agricultural techniques, as well as transportation and industry.

It is obvious, however, that much of this urban growth is due to the third important demographic characteristic of Asia: rural to urban migration.

C. Migration

Information on the magnitude of migration from rural to

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7 Hauser, Philip M., Edit., Urbanization in Asia and the Far East, UNESCO, Calcutta, 1957, pp. 128-162.

urban areas is very limited in Asia and the Far East region. A clue to the size of the rural-urban movement, however, is given by statistics of urban population growth which are available for most countries, eventhough use of these data inevitably involves complicated problems of definition of urban and rural areas which differ from country to country,* and may be changed from time to time.

Rural-urban migration movements in developing countries are typically characterized by a more rapid growth of population in the "primate" or great city than of the total population. Table 3 shows the annual rates of population growth in selected large cities of Asian countries. The fact that these rates in most cases markedly exceed the rates of population growth of the countries in which the cities are situated, is some indication of the increasing degree of urbanization being brought about by large rural-urban migration.

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* The definition of an urban area is not uniform among the countries in Asia and the Far East. For example, the Federal of Malaysia takes as "urban" towns and villages of 1,000 or more inhabitants; India, localities (municipalities and towns) of 5,000 or more inhabitants, and having definite urban characteristics; Japan, municipalities usually having 30,000 or more inhabitants; and Korea, incorporated cities of 40,000 or more inhabitants.

Table 3. Annual Rates of population Growth in Selected Cities and Countries of Asia

City	Period	Annual rate of growth of city population (percent)	Country	Annual rate of growth of total population 1950-1960 (percent)
Colombo	1953-63	1.7	Ceylon	2.3
Taipei	1956-60	4.5	Taiwan	3.4
Kuala Lumper	1947-57	6.2	Fed. of Malaysia	2.9
Bombay	1951-60	3.3		
Delhi	1951-60	4.3	India	1.9
Madras	1951-60	2.0		
Djakata	1955-59	10.8	Indonesia	2.0
Tehran	1956-60	5.0	Iran	2.2
Tokyo	1950-60	4.9	Japan	1.2
Karachi	1951-61	4.2	Pakistan	2.1
Manila	1948-60	1.3	Philippines	3.1
Bangkok-Thonburi	1947-60	6.9	Thailand	3.2

Source: The Asian Population Conference 1963
United Nations

So far as it is possible to judge by available data, there is apparently no great difference in the rate of natural increase between urban and rural areas in many

countries in this region. It is therefore inferred that the increase in urban population is mostly attributable to migration into cities from rural areas.

Why the migration? The following is a summary of propositions put forth by various experts of population growth in Asia and the Far East.[8]

- Unequal distribution of land in rural areas and decreasing size of plots worked by small farmers due to divisions after inheritance.

- Inaccessability of areas in the tropics or mountains. This makes it impossible for agriculturalists, who no longer find the land they currently work suitable, to find other agricultural opportunities except as peons, tenants or "frontiermen".

- Concentration of industry in a few urban areas in each country. This makes the city the most important source of employment other than agriculture. Imported capital and extensive techniques of production have meant industries employ only a small percentage of the labor force even though they contribute a large share of national product.

- Concentration of government administration and services in the capital. Centralization draws any persons with business with the government to the city at least for a visit.

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8 Ibid.

- Enactment of social legislation favoring the urban worker. Social security, medical care, minimum wage laws have been enacted in most countries in Asia, but since resources are limited, ability to enforce them in rural areas has been minimal.

- Development of the first steps of a system of universal education. Primary schools in rural areas are taught by urban teachers who teach with urban oriented, central government planned textbooks which perhaps prepare students for tools of better use in the city than in agricultural pursuits. Secondary schools in rural areas are limited in number, primarily for men. Most of both the rich and the poor who wish to educate their children beyond the primary level must move to an urban area.

- Development of modern means of transportation which link various parts of a given country, even across geographical boundaries, encourage young people to seek the city.

- The growth of a middle class, living almost entirely in urban areas promotes urban growth by encouraging the continued assignment of a disproportionately large share of public revenue to urban centers for construction, education, health, and police.

- Through a growing conviction that industrialization is the solution to economic problems, leaders inadvertantly encourage movement to the city through publicity about urban industrial development programs. For example, Klong Jun,

Haumark construction programs in the Bangkok area are said to have attracted many rural dwellers to Bangkok to seek construction jobs.

- Early colonization patterns which set the tone for the cultural dominance of the central capital city, usually port city, for trade. These cities still continue to be the dominant modernizing sectors of Asian societies, such as Calcutta, Singapore City, Hong Kong, etc.

- Close kinships and friendship ties that continue to exist between urban and rural residents. Urban residents frequently encourage family members and friends to migrate, helping with their first problems of residence and work.

- Recruitment into the military usually means at least a brief residence in an urban area for rural recruits.

The United Nations, in the 1957 Report on the World Social Situation, has drawn several tentative conclusions about the migration process in general which seems pertinent to mention here.[9]

> "The migratory process is not simply a movement of peasants and farm laborers from a complete rural setting to the big cities. The migrants are not, in the main, the poorest or least able to make a living in their place of origin. The migrants include representatives of various social strata from the small town as well as the countryside and many of the people who ultimately go to the big cities spend sometime in small

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9 United Nations, Report on World Social Situation, U.N., New York, 1957.

towns first.

> The effect is not one of rural population since the rural areas continue to have a majority of the people in the country and also increasing rapidly. While qualitative depopulation is... owing to a selective character of migration; young adults, amtitious, literate move to the cities leaving the rural areas to stagnate."

It may be best here to make a few comments on the general attributes of cities in Asia and the Far East. They are not similar to those of cities in the United States where the poorest area of the city is in the center with the wealthier citizens and newest industries lying on the outskirts. The cities of Asia, in general, have several districts or zones which are imperfectly integrated: a modern commercial and administrative section, an upper-class residential area or areas, an "old city" of narrow streets and density occupied buildings, and a zone of huts or shacks sometimes within the city, but most frequently on the edges of the city limits which lack most urban features except density of settlement and non-agricultural types of employment among the residents.

There are ususally scattered within the cities, primarily in areas close to open, country-style markets, crowded communities of one room or two-room dwellings usually strung along a long hallway or corridor. These are perhaps the worst form of housing for the urban poor since the crowded conditions increase health hazards.

Housing Conditions and Needs

Many problems resulting from rapid urbanization are chaotic use of land, congested traffic, squatter shacks and slums, insufficient recreational space, increase in the rate of crime and delinquency, inadequate systems of water supply and sewerage, poor sanitation, inadequate community facilities and inadequate housing. The following section will be devoted to a study and analyze on the housing conditions and needs in Asian countries.

A. Slums and squatter settlements

Slums and squatter settlements are mostly the result of the lack of housing in the city. The rural migrant come into an unfamiliar urban atmosphere and find themselves surrounded by inhospitable circumstances. They cannot find a place to live within the limited expense that they have. They squat on public or private land, or they double up with friends in already crowded shacks, so that slum conditions only continue to worsen and magnify. The following figure (table 4) will give an idea of the number of slums and uncontrolled settlements in some countries in Asia and the Far East.

B. Evaluation of current housing conditions and deficits

An important aspect of analysis of housing needs is the evaluation of current housing conditions and deficits. The

Table 4. Selected Data on Slums and Uncontrolled Settlement

Country	City	Year	City population	Population in Slums	
				Total	As percentage of city population
Africa					
Senegal	Dakar	1969	500,000	150,000	30.0
U.R. Tanzania	Dar-es-Salaam	1967	272,800	93,000	34.0
Zambia	Lusaka	1967	194,000	53,000	27.0
Americas					
Brazil	Rio de Janeiro	1957	2,940,000	650,000	22.0
		1961	3,326,000	900,000	27.0
Panama	Panama City	1968	373,000	63,000	17.0
Peru	Lima	1961	1,715,971	360,000	21.0
		1969	2,800,000	1,000,000	36.0
Venezuela	Caracas	1961	1,330,000	280,000	21.0
		1964	1,590,000	556,300	35.0
	Ciudad Guayana	1966	86,000	34,000	40.0
Asia and the Far East					
Afkhanistan	Kabul	1968	475,000	100,000	21.0
Ceylon	Colombo	1963	69,500	30,500	44.0
China (Taiwan)	Taipei	1966	1,300,000	325,000	25.0

Table 4. (Continued)

Country	City	Year	City population	Population in Slums	
				Total	As percentage of city population
India	Calcutta	1961	6,700,000	2,220,000	33.0
Indonesia	Djakarta	1961	2,906,000	725,000	25.0
Iraq	Baghdad	1965	1,745,000	500,000	29.0
Malaysia	Kuala Lumper	1961	400,000	100,000	25.0
Pakistan	Karachi	1964	2,280,000	752,000	33.0
		1968	2,700,000	600,000	27.0
Philippines	Manila	1968	less than 3,000,000	1,100,000	35.0
Republic of Korea	Seoul	1970	440,000	136,550	30.0
Singapore	Singapore	1966	1,870,000	280,000	15.0
Thailand	Bangkok	1968	2,608,470	628,030	24.0

Source: United Nations, Improvement of Slums and Uncontrolled Settlements, U.N., New York, 1971.

taking of housing censuses in Asia is a recent development with the first ones being carried out in 1950 in Japan, India, Hong Kong and Singapore. In 1960 Ceylon, Pakistan, Indonesia, Philippines, Malaysia, Taiwan and other countries carried out their first housing censuses so more information is available

for that year.

There is no clear definition of what is meant by minimum housing which underlies the collection of data related to housing stock and need in Asia and the Far East. Minimum requirements which have been most generally established seem to be those as follows: permanent materials which do not allow the transmission of sickness, enough sanitary equipment, area and facilities adequate to family size.

Considering this basic definition, it appears that the housing situation is very bad in Asia and the Far East. A brief summary of data for various countries will give an idea of the situation. The following summary is taken from a report by the United Nations published in 1965.[10]

> "The backlog or urban housing requirement in Pakistan, which was 600,000 units in 1960, is expected to increase to 950,000 in 1965 and to 1,200,000 units by 1970. Ceylon was estimated to have a shortage of 172,000 dwelling (84,000 in urban areas and 88,000 in rural areas) in 1957, or 10 percent of the existing housing stock. The housing shortage in Indonesia at the end of 1961 was estimated to be 4,500,000 units.
>
> Many of the metropolitan areas of the region are faced with an ever-increasing squatter population. Kuala Lumper, Capital of Malaysia, has a squatter population of 105,000 consisting of 20,000 families in 10,000-12,000 huts. On the basis of surveys made early in 1960 it was

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10 United Nations, World Housing Conditions and Estimated Housing Requirement, Department of Economic and Social Affairs, New York, 1965, pp. 21-23.

estimated that nearly 10 percent of the population of metropolitan Manila were squatters, comprising more than 50,000 families; the yearly increase in squatter population is about 40,000. The squatter population of Hong Kong is estimated to be about 670,000. In the metropolitan cities of India such as Bombay, Calcutta, Madras and Delhi, it runs into several hundred thousands.

Apart from the shortage of dwelling units in countries of this region, the condition of the existing housing stock is far from satisfactory. Information collected by a National Sample Survey in India in 1953-54 showed that in rural areas about 85 percent of houses have need plinths, 83 percent walls of mud, bamboo and reed, and about 70 percent roofs of straw, grass, reeds, etc. More than 95 percent of houses have no latrines, and only 25-45 percent of the families have water supply in their houses.

In Pakistan housing census of 1960 (excluding population of Frontier Regions of West Pakistan) reported a total of 17 million households, of which 1.7 million live in well-built houses. The rest live in huts, temporary tenements or are homeless.

In Indonesia it is estimated that only 5 percent of existing housing stock is of durable material and the corresponding proportion for the Philippines is about 12 percent.

Out of 4.6 million occupied dwellings in the Philippines, only 20 percent have a piped water supply and only 7.6 percent are served by sewers. Even in Japan where housing conditions are generally better, only 45 percent of the population is served by a protected water supply. In 1960, in the Republic of Korea, only 13.7 percent of the dwellings had any access to piped water supply, while less than 1.0 percent of dwellings had flush toilets.

Overcrowding is a similarly conspicious feature of housing in this region. In Hong Kong the average number of persons per household is 4.6, while the average number of person per dwelling unit is close to 13. In Djakarta, Indonesia, a dwelling unit is frequently shared by two or

three households consisting of 10-15 persons. At the same time as houses tend to be occupied by a large number of persons, the houses themselves are, for the most part, small in size. In Iran, for example, one-roomed dwellings account for 40 percent of the housing stock and another 30 percent are two-roomed. In the Republic of Korea, 68 percent of all occupied dwelling have one or two rooms only, while the corresponding proportion for Pakistan in 1960 was 82 percent. The position in India is indicated below:

Percentage of families living in one room or less by locality, India

Rural India	34 percent
Urban India	44 percent
Four big cities	67 percent
Calcutta	79 percent

These examples drawn from particular countries may be regarded as broadly indicative of the housing situation in most of Asia. In the absence of more precise data an arbitrary assumption is made for purposes of this report that about 60 percent of urban population and 50 percent of rural dwellers are adequately housed."

C. Data analysis

The following tables present some of the most recent data encountered which give an idea of the total urban and rural housing and some indicators of the standards of that housing.

Table 5 is a report of the number of occupied dwellings, average number of rooms per dwelling in urban and rural areas. Table 6 shows the average number of persons per room. Clearly, if most housing units consist of only one or two rooms while most families or private households are composed of

Table 5. Number of Private Dwelling Occupied, Average Number of Rooms per Dwelling and Percentage Breakdown of Occupied Private Dwelling by Number of Rooms. For Selected Asian, American and European Countries.

T = Total, U = Urban, R = Rural

Countries	Year	Area	Number of occupied dwelling	Avg. no. of rooms per dwelling	Percent of dwelling with:			
					1-2 rooms	3-4 rooms	5-6 rooms	7 rooms or more
Malaysia	1960	U	8,314	2.3	64.5	28.4	5.1	2.0
Pakistan	1960	T	16,560,379	1.7	82.5	14.5	2.3	0.7
		U	1,997,930	1.8	81.2	14.1	3.1	1.5
		R	14,562,449	1.7	82.7	14.6	2.2	0.5
Philippines	1967	T	----	---	56.9	33.8	6.8	2.5
		U	----	---	45.5	38.9	11.1	4.2
		R	----	---	61.9	31.5	4.9	1.7
Sikkim	1960	T	29,255	1.8	83.5	12.7	--- 3.7	----
		U	1,560	2.4	69.7	18.2	--- 12.1	----
		R	27,695	1.8	84.3	12.4	--- 3.3	----
Brunei	1960	U	6,101	2.3	72.8	20.8	5.4	0.9
China (Taiwan)	1966	T	----	3.2	----	----	----	----
India	1960	T	79,193,602	2.0	76.5	17.4	--- 6.1	----
		U	14,061,836	1.9	78.4	15.8	--- 5.8	----
		R	65,131,766	2.0	76.1	17.8	--- 6.1	----
Indonesia	1961	T	20,928,187	1.5	88.5	10.2	--- 1.3	----
		U	2,813,814	1.7	81.9	15.3	--- 2.8	----
		R	18,114,373	1.4	89.5	9.4	--- 1.1	----
Japan	1963	T	20,372,000	3.8	29.0	40.0	21.4	9.5
		U	14,402,000	3.6	33.8	39.6	18.4	8.1
		R	6,688,000	4.3	18.8	40.9	27.9	12.5
Korea	1960	T	4,097,770	2.2	68.7	28.4	2.5	0.4
		U	1,082,790	1.9	77.9	19.3	2.2	0.6
		R	3,014,980	2.3	64.9	32.1	2.6	0.3
United States	1960	T	53,023,875	4.9	6.4	32.4	45.1	16.1
		U	38,320,370	4.8	7.2	33.3	45.3	14.2
		R	14,703,505	5.1	4.1	30.1	44.8	21.0
Canada	1961	T	4,554,493	5.3	4.6	28.5	45.1	21.8
		U	3,280,468	5.2	4.3	30.6	47.6	17.5
		R	1,274,025	5.7	5.4	23.1	38.6	32.9
Netherland	1956	T	2,519,488	5.1	5.4	28.3	49.8	16.5
		U	1,549,398	5.1	2.7	34.0	49.3	14.0
		R	970,090	4.9	9.9	30.1	43.7	16.3
Norway	1960	T	1,075,145	4.2	13.0	49.2	28.2	9.5
		U	389,295	3.6	20.2	58.9	17.9	3.0
		R	685,850	4.6	8.9	43.8	34.1	13.2

Source: United Nations Statistical Yearbook 1970, U.N., New York 1971.

Table 6. Occupation Density of Private Dwellings and Percentage with Persons per Rooms, in Selected Asian, American and European Countries.

T = Total, U = Urban, R = Rural

Countries	Year	Area	Average persons per room	Percent of dwelling with persons/rooms			
				Less than 1.5	1.5 or more	2.0 or more	3.0 or more
Malaysia	1960	U	3.1	14.9	85.1	77.9	52.2
Pakistan	1960	T	3.1	10.9	89.1	83.7	60.5
		U	3.1	14.6	85.4	80.4	59.0
		R	3.1	10.3	89.7	84.1	60.7
Philippines	1967	T	---	28.9	71.1	60.7	38.1
		U	---	33.9	66.0	54.2	30.1
		R	---	26.9	73.1	63.4	41.7
Sikkim	1960	T	3.1	----	----	----	----
		U	1.8	----	----	----	----
		R	3.2	----	----	----	----
Brunei	1960	U	2.3	24.2	75.8	64.3	35.1
China (Taiwan)	1966	T	1.9	----	----	----	----
India	1960	T	2.6	----	----	----	----
		U	2.6	----	----	----	----
		R	2.6	----	----	----	----
Indonesia	1961		---- No Data ----				
Iran	1966	T	2.3	20.6	79.4	70.7	46.5
		U	2.2	23.5	76.5	67.4	42.8
		R	2.4	18.8	81.2	72.8	48.8
Japan	1963	T	1.2	64.0	36.0	21.6	6.2
		U	1.2	62.0	38.0	23.8	7.1
		R	1.1	68.4	31.6	16.7	4.3
United States	1960	T	0.7	96.0	4.0	1.4	0.3
		U	0.6	----	----	----	----
		R	0.7	----	----	----	----
Canada	1961	T	0.7	94.1	5.9	2.1	0.5
		U	0.7	95.4	4.6	1.3	0.1
		R	0.7	90.7	9.3	4.4	1.4
Netherland	1956	T	0.8	90.4	9.6	4.3	1.1
		U	0.8	94.6	5.4	1.8	0.3
		R	0.8	83.0	17.0	8.9	2.4
Norway	1960	T	0.8	91.5	8.5	3.5	0.7
		U	0.8	91.5	8.5	3.8	0.8
		R	0.8	91.5	8.5	3.3	0.6

Source: United Nations Statistical Yearbook 1970, U.N., New York 1971.

Table 7. Percentage of Dwellings with Piped Water, System for the Disposal of Human Wastes, Bath Facilities, Electricity, in Selected Asian, American and European Countries.

T = Total, U = Urban, R = Rural

Countries	Year	Area	Percentage of dwellings with facilities specified					
			Piped water		Sys. for disposal of human wastes		Bath Fac.	Elec.
			Inside or outside dwelling	Inside dwelling	Any type	Flush toilet		
Malaysia	1960	U	70.9	56.6	93.6	36.3	----	63.9
Pakistan	1960	T	----	----	----	----	----	----
		U	----	----	----	----	----	----
		R	----	----	----	----	----	----
Philippines	1967	T	34.0	----	66.4	19.9	----	22.9
		U	62.9	----	83.9	48.2	----	62.8
		R	22.1	----	59.1	7.8	----	5.8
Sikkim	1960		---- No Data ----					
Brunei	1960	U	94.1	88.1	99.5	62.6	----	90.0
Ceylon	1963	T	24.3	10.3	87.2	11.6	----	21.1
		U	53.1	21.7	94.3	28.3	----	50.6
		R	10.8	8.1	83.8	3.8	----	7.2
India	1960		---- No Data ----					
Iran	1966	T	20.7	13.1	----	----	----	25.4
		U	57.4	37.8	----	----	----	68.6
		R	2.3	0.7	----	----	----	3.7
Japan	1963	T	67.9	----	100.0	9.2	59.1	----
		U	77.8	----	100.0	12.8	51.2	----
		R	46.8	----	100.0	1.4	76.1	----
Korea	1960	T	21.4	12.1	84.4	0.2	1.8	28.4
		U	47.2	18.6	66.2	0.5	3.6	57.3
		R	10.8	9.5	91.9	0.1	1.0	12.4
Jordan	1961	T	36.2	21.3	55.4	9.7	8.7	17.0
		U	68.7	48.6	90.4	22.6	18.0	39.2
		R	13.5	2.1	30.8	0.7	2.2	1.4
U. S. A.	1960	T	94.0	92.9	----	89.7	88.1	----
		U	99.4	98.9	----	98.1	96.3	----
		R	81.2	79.0	----	70.3	69.1	----
Canada	1961	T	89.1	----	----	85.2	80.3	----
		U	98.3	----	----	97.4	93.2	----
		R	65.5	----	----	53.8	47.4	----
Netherland	1956	T	89.6	----	99.9	67.5	26.8	98.1
		U	96.7	----	100.0	82.9	31.8	99.2
		R	78.3	----	99.8	42.9	18.8	96.3

Source: United Nations Statistical Yearbook 1970, U.N., New York 1971.

four or five members, the result is overcrowding. This is exactly what is indicated in the majority of Asian countries as can be seen in the tables where more than half of the families are reported to have only one or two room dwellings.

Table 7 indicates the number of dwellings (ascertained in the censuses taken by various countries in the period of 1960-70) to have water, toilets, bathing facilities, gas, or electricity. This table indicates the problems of sanitation which exists in both urban and rural areas. It also indicates dramatically the better living conditions, at least in the aspect of access of water and electricity, which are enjoyed by the urban dweller in comparision with the average rural dweller.

Summary

On the assumption that 40 percent of the urban population and 50 percent of people in rural areas now live in bad housing, the need in Asia in 1960 is estimated at about 147 million units, of which 22 million were in urban areas and 125 million in rural areas. Table 8 and 9 show for urban and rural areas respectively the average annual output of dwellings required to eliminate this deficit over a period of thirty years, to house the increase in population resulting both from natural increase and migration to the cities in the period 1960-1975 and also to provide for the gradual replacement of the present stock of good housing over a period of

Table 8. Number of Additional Dwellings Required in Urban Areas, Asia, 1960-1975

	Average annual requirement			Total requirement 1960-75
	1960-65	1965-70	1970-75	
	Dwelling units (million)			
Dwellings needed to house population increase	2.2	2.7	3.2	41.0
Dwellings needed to replace obsolescent housing stock	1.1	1.1	1.1	16.5
Dwellings needed to remedy existing housing shortages	0.7	0.7	0.7	14.6
Total	4.0	4.5	5.0	72.1

Source: United Nations, World Housing Conditions and Estimated Housing Requirements, U.N., New York, 1965, p. 24 (table 14).

thirty years in urban and twenty years in rural areas.

Available statistics for countries in Asia show that the present volume of house construction is substantially below the number that would have been required in 1960 to eliminate the accumulated need of housing and to provide for the growth in population. In only Japan and Hong Kong has the rate of housing production approached the desired

Table 9. Number of Additional Dwellings Required in Rural Areas, Asia, 1960-1975

	Average annual requirement			Total requirement 1960-75
	1960-65	1965-70	1970-75	
	Dwelling units (million)			
Dwellings needed to house population increase	4.0	4.2	4.3	62.1
Dwellings needed to replace obsolescent housing stock	6.3	6.3	6.3	94.0
Dwellings needed to remedy existing housing shortage	4.2	4.2	4.2	62.6
Total	14.5	14.7	14.8	218.7

Source: United Nations, World Housing Conditions and Estimated Housing Requirements, U.N., New York, 1965, p. 25 (table 15).

target. The housing deficit in the past has accumulated mainly in the low-income groups and present indications are that this will continue in the future with countries experiencing increasing difficulty in overcoming their needs. Spiralling land prices, the increasing pressure on urban land, lack of finance, high building costs and continuous shortage of building materials are all contributing to the increase in the gap between the demand and supply of houses.

HOUSING SITUATION IN GREATER BANGKOK

III. HOUSING SITUATION IN GREATER BANGKOK

As indicated before, housing problems are critical especially in urban areas. The following section is devoted to a study on housing conditions and government action on housing in the urban area of Greater Bangkok.

Review of Present Conditions

As statistical data on housing census are not yet available, the following analysis based on some existing studies serves to explain the present housing conditions.

A. Population growth

Greater Bangkok (Bangkok and Thonburi), with the population of 2,608,470 in 1968 and 3,041,000 in 1970,[1] has annual rate of population increase of 5.8 percent (see table 10). It is one of the cities that have the highest rate of population increase in Southeast Asia.

The municipal area of Greater Bangkok is 293 square kilometers with an average density of 8,995 persons per sq.km. (36.3 persons per acre) in 1968. The annual population rate of increase is 5.8 percent; therefore each year the population increases by more than 151,291 persons. If the

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[1] Government of Thailand, Preliminary Report of the 1970 Population and Housing Census of Thailand, National Statistical Office, Bangkok, November 1970.

Table 10. Population in Municipal Area of Greater Bangkok

Year	Population
1955	1,458,680
1960	1,703,346
1963	2,067,860
1968	2,608,470
1970	3,041,000

Source: Statistical Yearbook 1970
United Nations, New York.

average family has 6 persons (average persons per family in Bangkok is 6.2[2]), the demand is 25,215 new houses each year to accomodate the increased population.

B. Slums and squatter settlement

In recent years, many slum areas in Greater Bangkok have been cleared by the local government. One of these area was at Raja Vitee which included 1,570 families or about 10,105 persons. These families were removed from this area by a rezoning law; it was easy because the government owned the land. From a study of this project that has been done, one notices that the government provided only 103 houses with

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2 Government of Thailand, Statistical Yearbook Thailand, 1964, National Statistical Office, Office of the Prime Minister, Bangkok, 1964.

The sequences of inadequacy in housing in urban areas, the houses were put up crowded together, lack of public facilities, drainage disposal systems, fire protection, street, park, etc.

land and 600 units walk-up apartments for them.[3] About 600 families had to find their own way in searching for shelter; in this they usually created new slum areas. It is estimated that there is an annual increase of about 50,000 housing units needed, caused by destruction of houses by disasters, the rehabilitation of torn-down illegal housing and slum clearance.

There is a large number of squatters located in many areas in Greater Bangkok. From "The Report on Housing Survey in Bangkok-Thonburi", there were 72 slum areas scattered throughout Greater Bangkok in 1968 which included 104,300 families or about 626,030 people (about 24 percent of population of Greater Bangkok). In the District of Bangkok Noi, for instance, there are more than 4,500 squatter families in this area.[4]

C. Problems involving urbanization

Problems resulting from rapid urbanization involve inadequate housing, chaotic use of land, congested traffic, squatter shacks and slums, insufficient recreational space,

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[3] The Ministry of Interior, Urban Renewal in Bangkok, The Municipal Office, Bangkok, Thailand, 1962.

[4] The Ministry of Interior, The Report on Housing Survey in Bangkok-Thonburi, City Planning Office, Bangkok, Thailand, 1968.

Congestion and chaotic land use.

inadequate systems of water supply and sewerage, poor sanitation and inadequate community facilities.

Insufficient housing often results in the following conditions:

- Illegal construction appears everywhere, poorly built and not up to the minimum standards of safety and sanitation.
- Overcrowding in small houses is a common phenomenon.

Government Action

To alleviate slum conditions and accomodate national and migrational population increase, a public housing program in Thailand was concieved as early as 1942 when the government proposed to reorganize sub-standard habitations and build low-cost housing for rent or hire-purchase by the low-income section of the urban population. An act was passed in the same year creating a committee under the chairmanship of the Minister of Interior in charge of housing projects. Wartime conditions, however, made it impossible to carry out the plan and the work was only resumed in 1949. By this time the shortage of housing had become more evidently acute, especially in the city of Bangkok whose population had already doubled itself and had continued to grow steadily since the end of World War II.

The Department of Public Welfare has been put in charge of the housing programs since 1942, and in 1953 a Government

Two bedroom houses

Three bedroom houses

Housing provided by the government and at a low price, long-term-installing payment.

Bank for Housing Promotion was founded to supplement this work. The Ministry of Interior and Municipal Authorities also help to take care of the slum clearance and in the general planning of relocation of displaced occupants.

Three principle programs have been designed to aid the people in need of adequate housing:

1. Provision of mortgage-loans for construction or renovation of buildings.
2. Provision of houses complete with land on a long term hire-purchase basis.
3. Provision of houses for rent especially for people in the low-income groups.

One of three housing projects in Greater Bangkok, started in 1963, is in the area owned by the government at Din Dang Road, Phya Thai District. This project included 79 flat houses of 5,000 units for accommodating 30,000 persons in low-income families and was complete in 1967. The project area consists of primary and secondary schools, a health center operated by the municipality, two privately owned market places, a recreational area and two youth centers. Three bus lines are operated through this project area.

Two other housing projects, of about the same scale, are being developed at Tung Mha Mek, District of Yanawa and at Klong Jun, District of Bangapi.

Housing Bank Program

Loans for housing welfare projects may be obtained from two main sources, i.e. the Department of Public Welfare and the Housing Bank.[5]

The Housing Bank was established in 1953 under the act of B.E. 2496 (1953). The Bank was under the general supervision and control of the Minister of Finance. Its management is vested in the Board of Directors, composed of seven members, three of which are responsible for the day-to-day work of the Bank. The Bank received an initial capital of 20 million Bahts (US$ 1 million) from the government. Its fund has been supplemented by advances and loans totalling 75 million Bahts (US$ 3.5 million) from the Minister of Finances and the Government Saving Bank.

The business activities of the Bank are confined to:

- selling houses and land by installment payment
- making and renovating houses for redeeming mortgages on houses and land
- making loans on mortgaged property
- accepting fixed deposits of more than two years (the actual amount of deposit is very small).

So far the Bank has provided more than 1,350 houses to homeless families under a long-term installment basis and

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5 Silcock, T., Thailand: Social and Economic Study in Development, Duke University Press, Durham, N. C. 1967.

granted more than a thousand loans amounting to 60 million Bahts (US$ 3 million) for housing projects.

GENERAL BACKGROUND IN GREATER BANGKOK

IV. GENERAL BACKGROUND IN GREATER BANGKOK

Introduction

The Kingdom of Thailand occupied a territory of about 514,000 square kilometers (198,404 square miles) in the Indo-Chinese Penisula of Southeast Asia. It extends from 6 degrees to 20 degrees North latitude while it stretches from 97 degrees to 106 degrees East. The greatest width is 780 kilometers (487.5 miles). The coast line contains roughly 1,875 kilometers (1,181.9 miles) on the Gulf of Thailand and 740 kilometers (460.5 miles) on the Indian Ocean. Listed clockwise, countries bordering on Thailand are Loas and Cambodia on the North and East, Malaysia on the South and Burma on the West and North. According to a preliminary estimate resulting from the population census conducted in April 1970, the population of Thailand in 1970 was around 34.15 million persons, with 17 million males and 17.5 million females, and a population growth rate of 3.01 percent per year.[1] Greater Bangkok is the capital and also the principal port of Thailand.

Greater Bangkok, the capital of Thailand, is a curious

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[1] Government of Thailand, Preliminary Report of the 1970 Population and Housing Census of Thailand, National Statistical Office, Office of the Prime Minister, Bangkok, Thailand, November 1970.

amalgam of ancient pomp and ceremony contrasting with an extremely active program of modernization. Completely rural type slums and busy city streets are located side by side. Greater Bangkok is a bustling metropolis; yet, in the midst of its up-to-date hotels and multi-storied office blocks are temples and places of fairy tale magnificience. It is the center of commerce, industry, communication and education. There are about 9,000 industrial establishments, a big railway station, a well equiped port, the biggest international airport in Southeast Asia and six universities. The population in 1970 is 3.04 million[2] and has grown steadily since the end of World War II.

General Conditions

To provide background information about Greater Bangkok, geographical information, facts on the people's domestic lives, and economic conditions are presented in this section.

A. Geographical information

Greater Bangkok is situated in the central part of Thailand, on the bank of Choa Praya River. The total territorial area is 1,549 square kilometers (597.9 sq. miles), which is almost all flat with plains and a basin. The elevation is about 3 meters (10 feet) above sea level. It

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2 Ibid.

$$\frac{°C}{5} = \frac{°F - 32}{9}$$

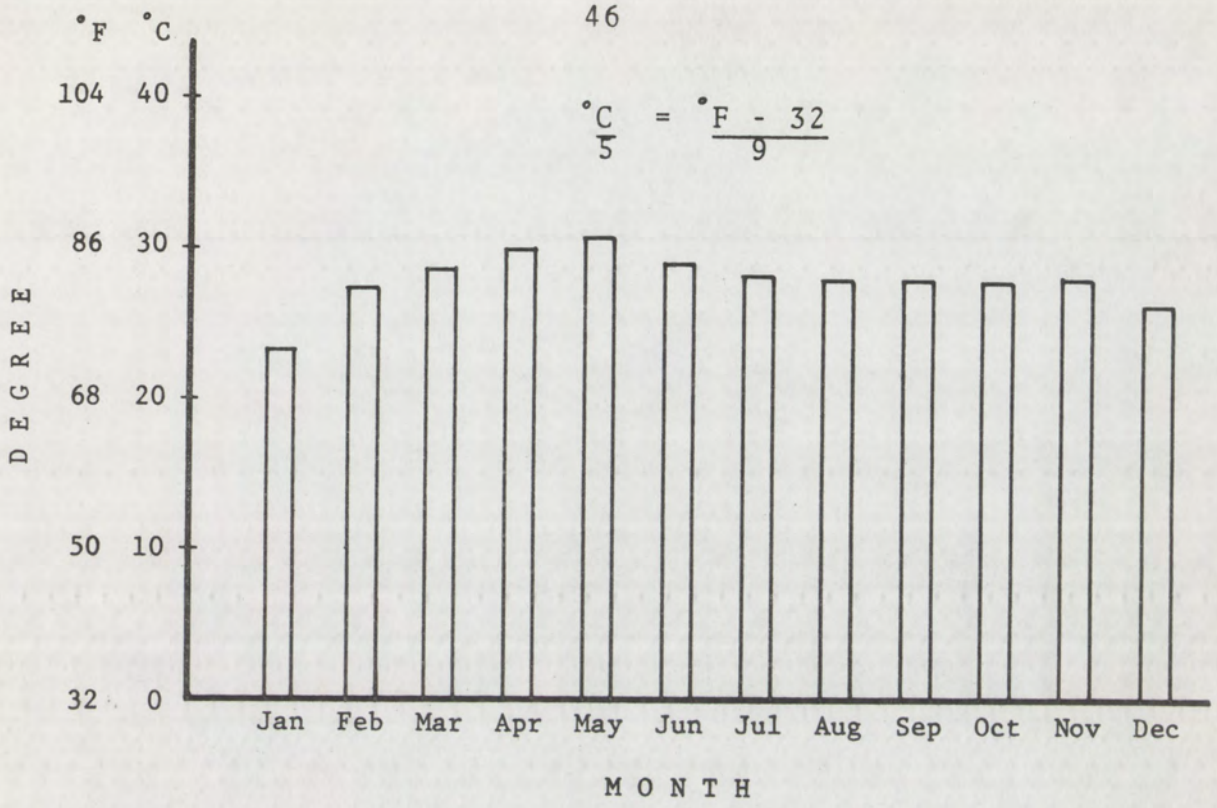

Figure 2. Temperature

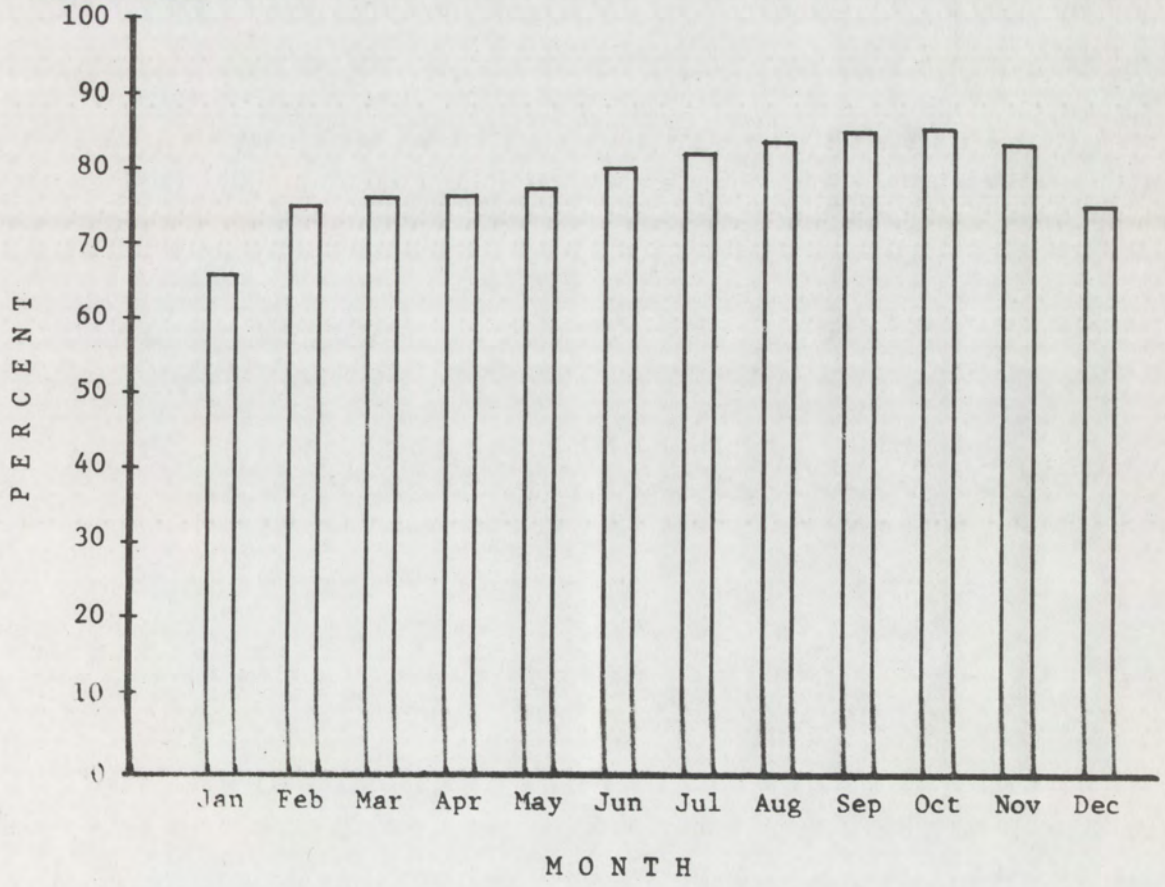

Figure 3. Humidity

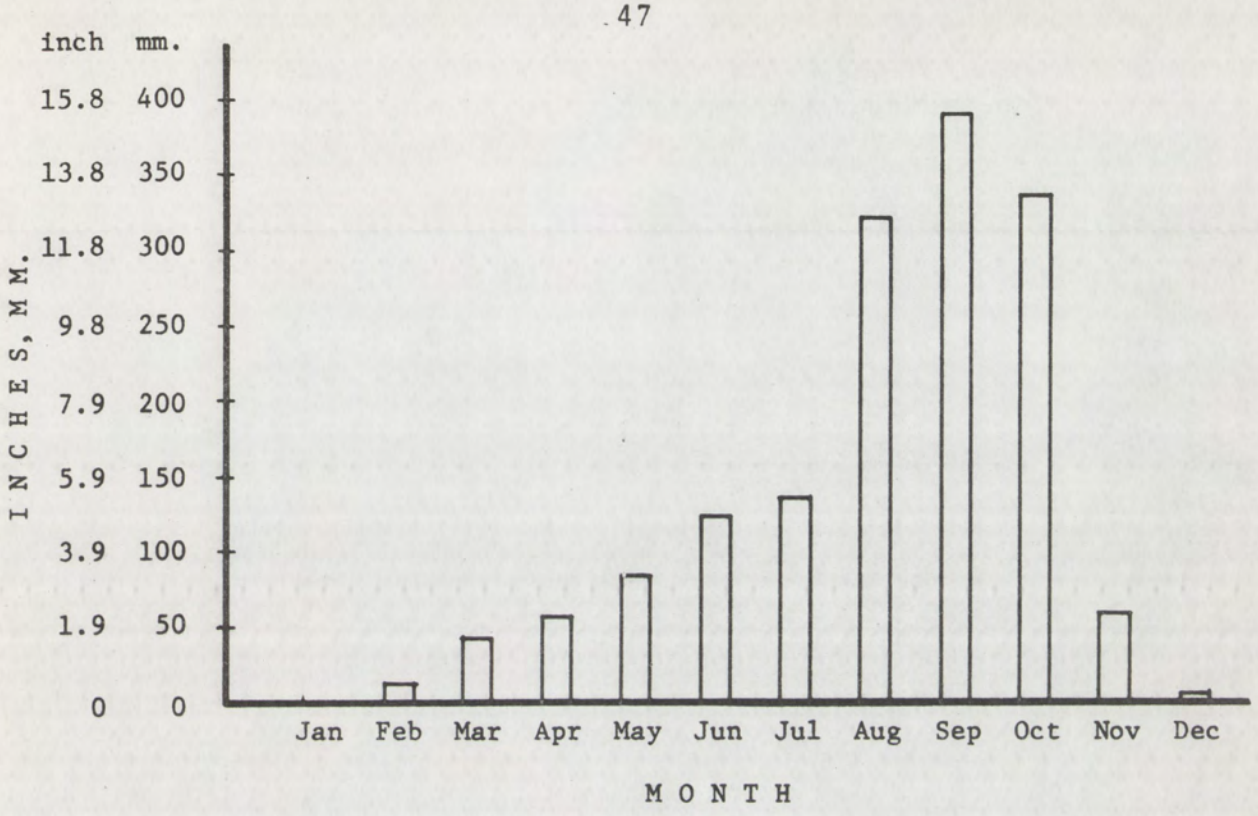

Figure 4. Rainfall Average

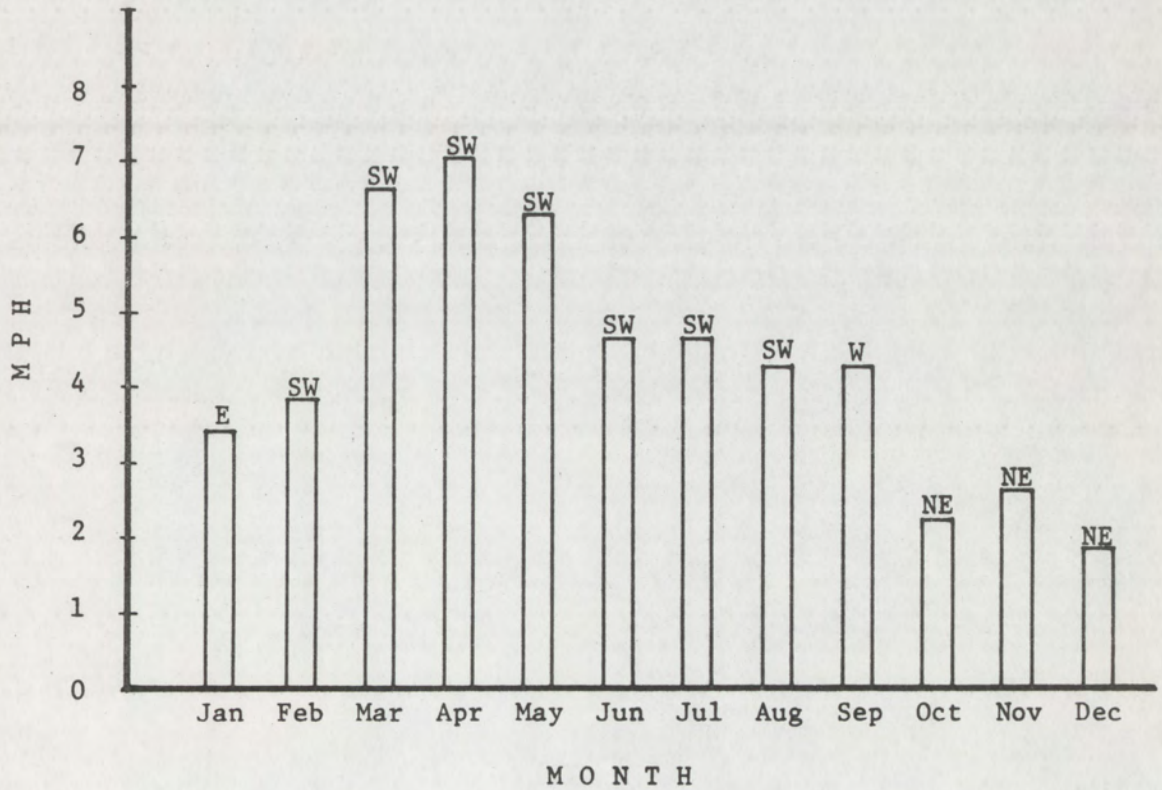

Figure 5. Wind Average Velocity and Direction

is located at 14 degrees North latitude and 100 degrees East longitude. The weather in Greater Bangkok does not change very much throughout the year. The Summer and Rainy Seasons are very long and overlap each other. The temperature changes very little all year round, with the highest temperature of 30.5°C (88°F) in May and the lowest of 23.1°C (73.4°F) in January (see figure 2). Rainfall is abundant, from March to November and has the highest precipitation (it rains almost everyday) between the month of August and October (see figure 4). At the same time the humidity is very high with an average of 79.1 percent. The highest is 85.8 percent in October and the lowest 65.9 percent in January. The wind velocity in Greater Bangkok never exceeds 20 miles per hour. There were only 2 strong typhoons, within a 25 year period, occuring in the Southern part of Thailand that resulted in property damage, but never occured in any other part. There are very minor earthquakes in Thailand which never caused any damage.

B. People's domestic lives

Thailand is an old country that moved down from Mongolia more than a thousand years ago. Almost all customs and traditions are derived from Buddhism and Confucius sayings; therefore, all Thai people emphasize morality and politeness. This shows in every aspect of their life, such as family structure, social relationships, training of children,

literature, music, houses and food.[3]

In recent years, after World War II, the way of living changed a great deal, especially in family structure. While Thai households may still consist of three generations, larger family units no longer exist. The family is closely united, and social life is somewhat confined to the family group. Visiting, talking, celebrating are usually done at home. The main recreational activities outside the house are movies, plays and Thai Classical Dance. Athletics are not popular, although basketball and soccer have gained increasing popularity.

Buddhism is the major religion, more than 80 percent of Thai people are Buddhist.[4]

Because of the fast growth ratio, the average family size in Greater Bangkok is 6.2 persons.[5] Therefore, about a half of family income is spent on food, the other half is divided into general use, medicine, recreation, education and housing. As a result, it is not easy for any family at middle and low income level to build a new house. What they

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[3] Silcock, T., Thailand: Social and Economic Study in Development, Duke University Press, Durham, N. C. 1967.

[4] Government of Thailand, Statistical Yearbook Thailand, 1964, National Statistical Office, Office of the Prime Minister, Bangkok, 1964.

[5] Ibid.

are able to do is attach simple shelters on their original houses in order to solve the housing problem caused by increasing family size.

On the other hand, people usually try their best to save money in order to buy modern appliances such as radios, televisions, and record players. It is not surprising to see a handsome phonograph or a television set in a simple shelter.

The housewives have the habit of going to the food market every morning or afternoon, so the refrigerator is usually considered a luxury. The most common food is rice, fresh pork, beef, sea food, poultry, eggs, green vegetables, chili and garlic. Popular fruits are bananas, oranges and coconuts. Lard is one of the most popular items among fat and oil since most of the dishes are prepared by frying. This is one of the main reasons why kitchens are preferred to be located outdoors or placed where they can have direct ventilation; frying causes a lot of smoke and also creates a very strong smell.

Economic Condition

Average income per capita in Greater Bangkok was 800 Bahts (US$ 40) per annum in 1952, but it jumped to 2,150 Bahts (US$ 112.50) in 1963 and 2,960 Bahts (US$ 148) in 1966. The annual growth ratio is about 10 percent in recent years (see Table 11).

Table 11. Average Income per Capita in Greater Bangkok

Year	Baht	US$
1952	800	40
1960	1,780	89
1961	1,920	96
1962	2,040	102
1963	2,350	112
1966	2,960	148

At the same time the cost of living in Greater Bangkok has increased a great deal. Table 12 gives the idea of how the low-income family spends their money. The cost of living for low-income families in Greater Bangkok has increased almost a hundred percent within fifteen years (from 1948 to 1963); the rent cost increased by more than two hundred percent.

In general, the majority of people in Greater Bangkok are at the middle and low-income level.

Table 13 indicates that the food expenditure is about half (49.5%) of the total income, but the money to spend on housing is only 16.2%. If it is assumed that the average family has 6.2 persons and per capita income is US$ 148 a year, then the total family income is US$ 917. The average family can, therefore, spend US$ 148.55 a year or US$ 12.40 a month on housing. The National Statistical Office conducted a Household Expenditure Survey in the Greater Bangkok Municipal area in 1962 and determined that the average rent

Table 12. Cost of Living Index for Low-Income Families in Bangkok 1951-1963

1948 = 100

Year	All Items	Food	Clothing	Rent	Fuel & Light	Miscella-neous
1948	100	100	100	100	100	100
1951	110	106	101	116	131	139
1952	123	119	93	116	151	157
1953	135	131	72	156	151	180
1954	135	128	73	189	150	189
1955	141	135	76	211	143	192
1956	150	141	77	267	152	192
1957	159	152	81	267	155	192
1958	168	164	85	267	159	192
1959	160	152	81	311	152	189
1960	159	151	80	311	141	193
1961	170	165	82	322	135	194
1962	177	174	79	322	133	194
1963	178	174	81	322	143	194

Source: Statistical Yearbook, Thailand 1964, Office of the Prime Minister.

Table 13. Average Family Expenditure

Food & Drink	Cloth	House	Medical	Transportation	Recreat'n & Educat'n	Misc.	Taxes
49.5%	8.9%	16.2%	6.7%	6.4%	5.5%	5.7%	1.1%

Source: Statistical Yearbook, Thailand 1964
Office of the Prime Minister.

cost for middle and low-income families is US$ 12.13 (242.60 Bahts).[6]

In order to give some idea about the family of low-income level, it should be mentioned here that the average yearly income of low-income family is only US$ 550 and average expenditure on housing is 33.90 percent of the total income. From this figure one can see clearly that there is a big gap of family income between low-income level and the average income. Also, the low-income family has to spend much greater percentage of its income on housing than the average family does.

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6 Government of Thailand, Household Expenditure Survey, National Statistical Office, Bangkok, 1962.

LOW-COST RESIDENTAL DEVELOPMENT FOR GREATER BANGKOK

V. LOW-COST RESIDENTAL DEVELOPMENT FOR GREATER BANGKOK

On the basis of the information presented previously, specific measures of low-cost residental development for Greater Bangkok were studied. The proposed measures are illustrated by using a particular district in Greater Bangkok as an example. The district selected for this purpose is the District of Bangkok Noi, the location of this district is on the other side of the river from the major business area of Bangkok (shown in the map of Greater Bangkok, illustration 1, p. 120). In this thesis, the information of the present housing conditions are obtained from the Report on Housing Survey in Bangkok and Thonburi.[1] Based on this information, the recommended solution which would improve the present housing conditions is then formulated.

In this section, the present housing conditions of the district are discussed first, the proposed measures of improving housing conditions are presented later.

District of Bangkok Noi

The reasons for choosing this district as an example site are the following:

1. It is one of the most rapidly growing areas in

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[1] Ministry of Interior, The Report on Housing Survey in Bangkok-Thonburi, City Planning Office, Bangkok, Thailand, 1968.

Greater Bangkok.

2. It is one of the areas known to be most crowded.
3. It is the area having a lower average income than other parts of Greater Bangkok.
4. There are more illegal houses in this area.
5. It is one of the districts near the major business area and yet suitable for living.
6. It is one of the five selected districted for the government housing condition survey in 1968.

A. General information

From a study of the map as shown in illustration 2, p. 121, one third of the district of Bangkok Noi is scarcely populated (people grow vegetable and fruit plants on this area), while the other two thirds has a population of more than 165 thousand. This district has no plan at all, most of the residents are land invaders. Consequently, roads are narrow and inconvenient. Fire engines cannot reach the heart of the squatter area, causing it to be constantly threatened by fire. Also, as the road system cannot reach the whole site, houses tend to crowd along the road for easy access. Since the population grows at a higher rate than the development of the road system, the already urbanized area gets more heavily populated while the vacant land is left open.

This district is one of the fastest growing areas in Greater Bangkok. The population was 63,300 in 1950, ten

year later, in 1960, it jumped to 105,655 and to 165,758 in 1967. The average annual growth ratio in recent years is 7%.

B. Housing condition survey

The only information on housing conditions in Bangkok Noi is provided by "The Report on Housing Survey in Bangkok-Thonburi" conducted by the Staff of City Planning Office, Bangkok, 1968.

Finding of the survey in this area are as follows:

1. Age distribution

The age distribution was as shown in table 14.

Table 14. Age Distribution

Age	Percentage
Under 5	15.7
5 - 9	14.0
10 - 14	10.0
15 - 19	9.0
20 - 25	12.0
25 - 60	34.0
Over 60	5.3

From the above table, one notices that the ratio of the dependents (persons under 15 and over 60 years of age) to the economical active persons (persons between 15 and 60) is very high, 82 percent. This situation will keep personal income levels low and at the same time increase physical needs for housing in the area.

2. Family size

a) The average persons per family was 7.46.

b) There were 72.7% of the families having 5-9 persons; 83%, 4-10 persons.

c) Families per unit: More than half (57%) of the dwelling units had two or more families, 19.3% had 3 or 4 families, and 12.8% had 5 families or more. The average number of families per unit was 2.6.

3. Floor area

a) 22% of the families had floor areas of 20 square meters (216 sq.ft.) or less: 40% had 32 sq.m. (346 sq.ft.) or less; 22.6% between 32 sq.m. and 61 sq.m. (659 sq.ft.); 23% between 61 sq.m. and 91 sq.m. (983 sq.ft.).

b) Those who lived in overcrowded living spaces made up 23.7% of the total population.

c) In 1967, the government set 5.2 sq.m. (56.2 sq.ft.) per person to be the minimum required floor area. According to this criteria, 42% of the families were living in substandard housing.

4. Ownership and rent

a) The ownership of house and land is 42%.

b) The number of house-rent family equals 30.5% of

the total families. The average rent per family is 348 Bahts (US$ 17.4) per month, the average rent per expenditure is 33.9%.

C. Income and expenditure

The range of family incomes are tabulated below:

Table 15. Family Income by Occupations

	Occupation	Percent	Monthly income	Annual income
1.	Professional, technical & managerial	0.9	$150.00	$1,800
2.	Commercial	15.2	84.00	1,008
3.	Government official	8.6	70.00	840
4.	Clerical, sales	19.4	42.50	510
5.	Industrial workers	15.7	38.00	456
6.	Farmers	9.4	32.00	384
7.	Common labors	19.9	30.10	361
8.	Peddler	10.0	27.80	553
	Average	100.0	$ 46.10	$ 553

The average annual income per capita in Greater Bangkok was 148 in 1966, since in this area the average family size is 7.46, the average family income would then be US$ 1,104. But in reality, it is only US$ 553. This indicates that the family income in this area is very low.

The distribution of monthly family income and family

expenditure are tabulated below:

Table 16. Family Monthly Income and Expenditure

Monthly income	Percent of total family	Monthly expenditure
US$ 25 - less	7.9	US$ 28.6
25 - 35	33.4	36.2
35 - 50	21.5	46.8
50 - 65	18.0	58.0
65 - 78	6.9	70.1
78 - 90	5.6	82.4
90 - 105	2.0	90.6
105 - up	4.7	116.3
Average	100.0%	US$ 51.5

In this area, there are 77.7% of the total families whose monthly expenditure are more than their monthly regular income. This means that they have to work overtime or to find a second job in order to make up the balance. The percentage of the families with expenditure over regular earnings are shown in table 17.

There are 26% of dwellings in need of small repair, 25% need large repair, and 9% are unused or beyond repair.

The average monthly cost of house repairing is 106 Bahts (US$ 5.3). The ratio of monthly cost for house repairing to the average monthly expenditure is 10.5 percent.

Table 17. Percentage of Families in this Area with Expenditures over Regular Earnings

Income level	% of families in this level	% of total families
US$ 300 - less /Y	100%	41.4%
300 - 599 /Y	75%	30.0%
600 - 1,200/Y	50%	6.3%
1,200 - more /Y	00%	0.0%
Total		77.7%

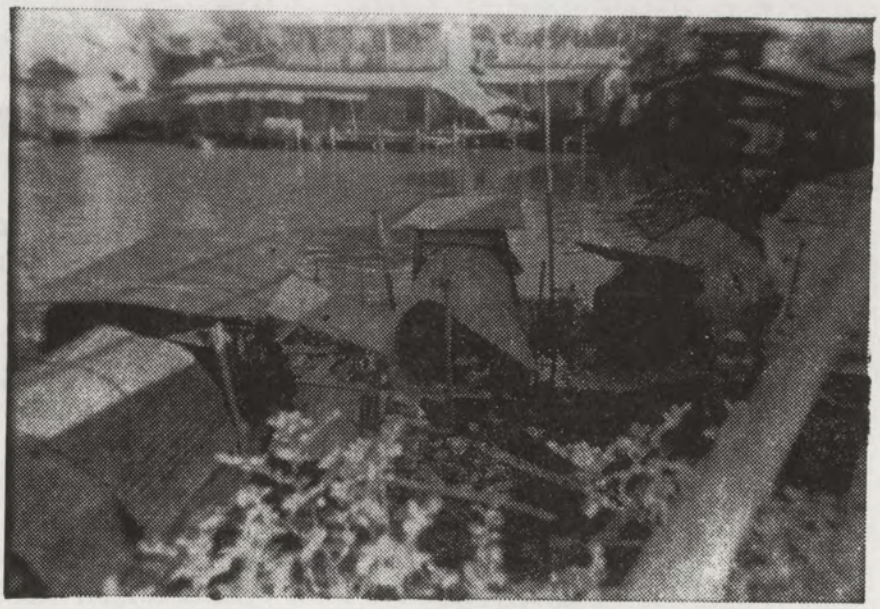
D. Conclusion

Comparing to the average figure, the family incomes in this area are very low. As a result, most families do not have enough money to spend on housing. They are forced to live in substandard dwellings which are often over-crowded as well. However, in spite of this general low income, housing problems must be solved in some way, and living conditions must be improved. The following sections will discuss the proposed measures for reaching these goals.

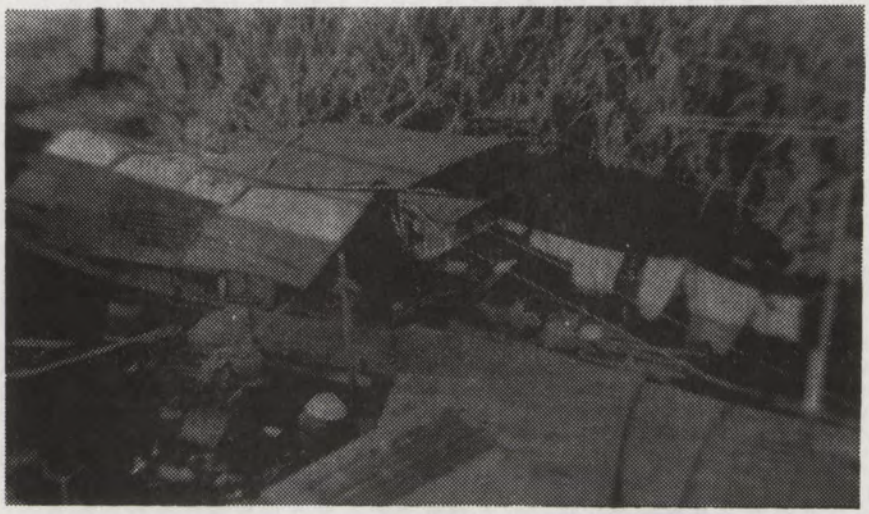
Proposed Measures for Low-Cost Residential Development

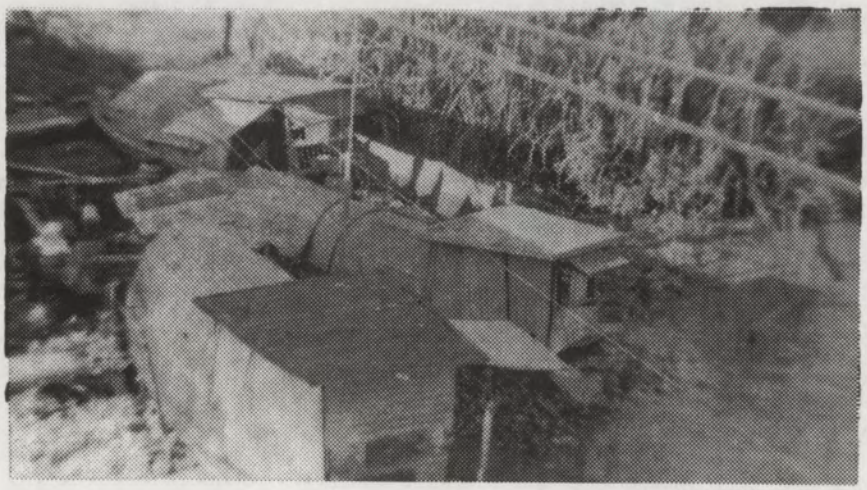
The specific measures for low-cost residential development in the District of Bangkok Noi were formulated on the basis of the existing conditions as well as the expected development in the future.

Crude shelters under a bridge



Mobile home





Because of inadequate housing in this area, these mobile home can be found easily along Bangkok Noi Canal and Morn Canal.

A. The community

1. Community concept (illustration 3, p. 122)

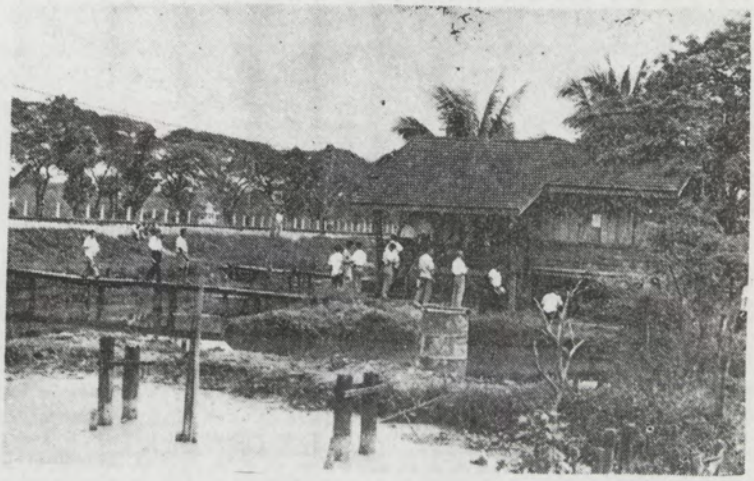
The basic concept is to divide the whole area into six neighborhoods, a recreational belt, and light industrial areas. The recreational belt will be located along the river and canal, where one can enjoy broad, open views. The light industrial area will be located near the railroad and Bangkok Noi canal, as proximity to railroad and water ways are essential for convenience in transportation.

2. Educational facilities (illustration 3, p. 122)

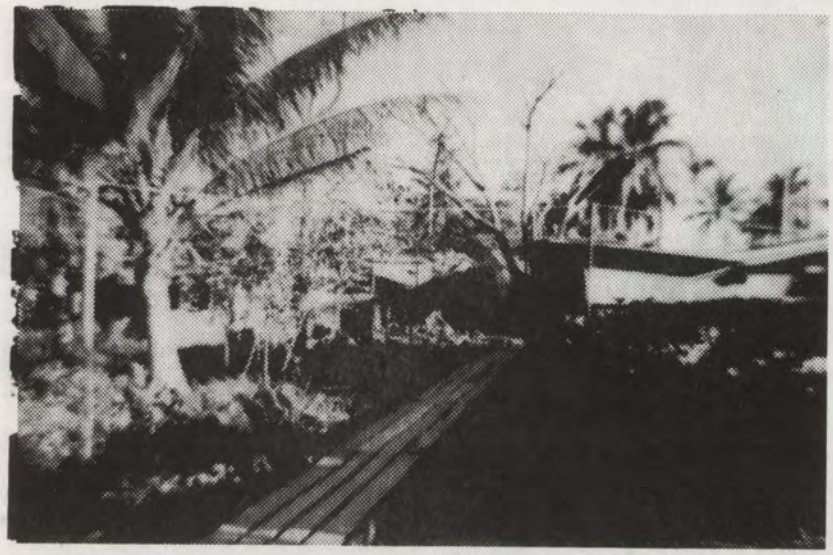
Because of the uneven distribution of existing primary schools, some children have to walk a long distance to the nearest school. In order to improve this condition, new primary schools will be added, and some schools will be relocated. As there are already a sufficient number of high schools and higher educations, additional facilities of this type will not be provided.

3. Circulation (illustration 4, p. 123)

The existing circulation condition is poor, chaotic and improperly distributed. People cannot easily reach the vacant land. As a result, they tend to crowd around already heavily populated sections. The proposal is to develop circulation throughout the district to give the residents



Some areas were about 1.00 to 1.50 meters below the street surface. Most part of the area was full of water all year round. It was served by one-meter-wooden passages as the service ways.



Wooden passage is generally used in this area.

The only mean to get to some houses in this area is by boat.

convenient access.

There are six bus lines operating from this area to major business areas in downtown. From the map one notices that major business areas are just across the river from the District of Bangkok Noi. That is why most people in this area prefer using the water way (boats) to go to work. In this particular area, six boat stations will be provided along the water-front of the river and canal.

4. Commercial facilities (illustration 4, p. 123)

In this particular site, existing commercial facilities are grouped into two strips, on the way to major business areas. Since the whole site will be divided into six neighborhoods, the proposed commercial facilities will follow the existing trend, but it will be extended into the whole site. In addition to the neighborhood shopping areas, a community center will be provided for the entire community.

B. The neighborhood

As mentioned before, in this area there are six neighborhoods, each with a population between 20,000 to 30,000. In each neighborhood there will be two primary schools, a neighborhood center, a food market and neighborhood shopping areas.

Primary education is compulsary. Every child of primary school age, 6 to 12, must go to school. Seventeen percent

of total population is composed of children in this age group, totaling approximately 28,000. Therefore, each school will have 2,300 students. This is definitely below the average figure of Bangkok, 2,550 students per school. The longest distance between school and home is around 400 meters (532 yards) which is about 15 to 20 minutes of walking.

The neighborhood center will have a nursery station, first aid, administration office, a paper and magazine reading room, a television room and a social hall. It is not necessary to provide an athletic field in each neighborhood, since the field and other facilities of the schools can also be for the use of the neighborhood residents.

The food market is an important place, every housewife meets her friends here almost everyday. Therefore, the food market serves two main functions: it provides daily needs and also a place for social centact.

Concentrated neighborhood shopping sections provide daily needs other than fresh foods. Special shops, such as laundry, tailor shop, barber shop, stationary, ice-cream shops and magazine stands also will be found here. Corner shops will be located at various points. They will not have special structures, ordinary residential dwelling units can be used for this function.

The dwelling units are arranged in such a way that every family is within a short distance to an open court.

In this open court, there is a playground for children. Outdoor furniture is also placed there for convenience of grand-parents and mothers. Adults can watch children play as well as socialize among themselves.

C. Dwelling units

1. Basic requirement

Because this thesis deals with low income level families in Greater Bangkok, the unit design has to meet a few requirements as stated below:

- The structure should be reinforced.
- A canopy is needed to protect openings because of the abundant rainfall.
- The aided-self-help and prefabrication methods should be considered as means of saving labor cost and material cost.
- Expandibility of units should be considered for future family expansion and move-up situations.
- Expansion of structure should be accomplished with convenience and without any waste of material.
- The interior partitions, doors, windows should be at a minimum for saving building cost.

2. Unit size and cost

According to the housing survey, there were 72.2 percent

of the families with 5-9 persons. If the housing unit is provided for this group, the unit size can be obtained by taking the government's minimum area per person (5.2 square meters or 56.2 square feet) as the standard, and multiply that with number of people in the family. Suppose most families have 5, 7 or 9 persons, the size would then be 26, 36 and 47 square meters (281, 389 and 508 square feet), respectively.

3. Construction systems and cost analysis

An attempt has been made to organize and present data in a form that is both meaningful and helpful in making a decision in selecting the right methods for low-cost housing construction. Material and labor costs will vary over the kind of materials and methods of construction that have been employed. An attempt has also been made to present a comparision of the costs, advantages and disadvantages among each method.

The basic model chosen for analysis is a small 26 square meters (281 square feet) unit, one of the types that will be provided for the development in District of Bangkok Noi, Greater Bangkok.

A traditional steel reinforced brick house costs about US$ 33 per aquare meter (excluding utilities costs). There is no way of reducing the cost if the existing construction system is used. The proposed construction system (see the

Table 18. Construction Systems and Costs Analysis

Description	Cost			Advantages	Disadvantages
	Mat.	Labor	Total		
Footing					
A. Continuous steel reinforced concrete.	$ 70	$ 45	$115	Strong, lasting, versatile, termiteproof.	Expensive.
B.* Continuous bamboo reinforced concrete.	$ 48*	$ 40*	$ 88*	Relatively strong, cheaper than steel reinforced concrete.	Waterproof treatment is required for bamboo.
Floor					
A. Steel reinforced concrete	$125	$ 65	$190	Strong, enduring, can be precasted.	Expensive, requires form work if pouring system is used.
B.* Prefabricated-bamboo-reinforced concrete.	$ 82*	$ 58*	$140*	Strong, enduring, easy for on-site prefabrication, unskill labor can be used, availability.	----------
C. Wood.	$ 77	$ 60	$137	Availability, clean.	Subject to insect and fungus attack unless first grade or treated. Short life.
Wall (Exterior)					
A. Brick masonry.	$ 90	$135	$225	Availability, long lasting, cool.	Requires supporting, incapable in carrying large loads, often of poor size, shape and quality if not machine made.
B.* Concrete block.	$162*	$ 81*	$243*	Availability, capable in carrying large loads, fast	Cost more if buy in small amount.

Table 18. (Continued)

Description	Cost			Advantages	Disadvantages
	Mat.	Labor	Total		
				in laying, unskilled labor can be used, size is easy for one man to handle, cool.	
C. Wood frame and stucco.	$126	$ 92	$218	Availability, light weight.	Subject to insect and fungus attack, must be first grade or treated, short life, incapable in carrying large loads.
Wall (Interior)					
A.* Wood frame (asbestos sheet outside and bamboo inside.	$ 28*	$ 32*	$ 60*	Availability, light weight, easy work.	Must be first grade or treated.
Doors					
Wood.* (Wood frame and bamboo louver).	$ 15*	$ 6*	$ 21*	Availability, cheaper than other materials	Must be first grade or treated.
Windows & Louvers					
Wood.* (Wood frame and bamboo louver).	$ 25*	$ 29*	$ 54*	Availability, cheaper than other materials	Must be first grade or treated.
Roof					
A. Tar & gravel built-up roof on ½" sheathing.	$ 73	$ 45	$118	Built easily, light weight.	Difficult to remove in case of expansion, leak (due to abundant of rainfall in Greater Bangkok).
B.* Wood trust & corrugated asbestos.	$ 65	$ 40*	$105*	Light weight, built and removed easily, tradition-	----------

Table 18. (Continued)

Description	Cost			Advantages	Disadvantages
	Mat.	Labor	Total		
C. Reinforced concrete built-up roof.	$113	$ 68	$181	al method. Strong, enduring, leak-proof.	Expensive, difficult to remove for expansion.
Utilities.					
Electricity.*	$ 25*	$ 13*	$ 38*	----------	----------
Plumbling, sink, kitchen sink, toilet bowl, shower.*	$ 50*	$ 25*	$ 75*	----------	----------

The costs of materials and labor are based on the data published in "Study on Building Costs in Asia and the Far East", United Nations, Bangkok, 1961.

* Selected methods for low-cost housing construction in Greater Bangkok.

Sub-total the cost of selected methods (not include utilities costs) Material = $425
Labor = $286
Total = $711

The cost of construction per square meter (not include utilities costs) = $\frac{711}{26}$ = $27.5 / sq.m.

Percentage of labor cost to construction cost (not include utilities costs) = $\frac{286 \times 100}{711}$ = 40%

Remark Labor cost can be cut out completely (except for utilities costs) if aid-self-help method is employed.

following section for detail discussion) is bamboo reinforced concrete block. The cost of this system is less than the traditional one.* From the costs analysis, table 18, it is about US$ 27.5 (excluding utilities costs) per square meter. Suppose we omit the idea of reducing the material cost by

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* The average need of steel in a conventional house is 1,600 kilometers (from "Study on Building Costs in Asia and the Far East", United Nations, 1961). The steel would cost about US$ 251.40 (steel costs US$ 157.00 per 1,000 kilometers). Since the floor area of a conventional house is 60 square meters, 26.6 kilometers of steel is required for each square meter of area. That amount of steel costs US$ 4.16. If ½" diameter steel bar is used for reinforcements, 87' of steel bars is required. If bamboo is used instead of steel, then 30 meters of bamboo will be required. If the diameter of bamboo is assumed to be 1¼", this amount of bamboo will cost only 40 cents. And if the bamboo is chemically treated to prevent water absorbtion, it will cost about an additional 30 percent. Therefore, the cost of treated bamboo will be only 52 cents. Thus, one can conclude that the cost of bamboo reinforced concrete is cheaper than steel reinforced concrete. Furthermore, bamboo is abundant in Thailand, contrary to importing steel from other countries. More often, the construction in Bangkok has to be suspended in order to wait for the deficient steel.

ordering in the large amounts; we then have building costs (excluding utilities costs) of US$ 711, 980 and 1,292 for houses with floor area of 26, 36 and 47 square meters, respectively.

If a building is to be constructed in a good community, considerations should be given to the land cost, land improvement, public utilities, access, administration, etc.

In general, the land cost in this area is about US$ 2.00 per square meter. Since each lot is 50 to 60 square meters, the land cost will be US$ 100 and 120, respectively.

The cost of land improvement and administration are the same, each 10 percent of structure cost, thus the cost should be added into the cost of the house.

If the interest of the building loan is 6 percent per annum, and the term is 15 years, the total interests for 15 years will be 40 percent of the building cost.

From economic point of view, a person can only borrow money as much as his three year's salary. If it is beyond this limit, very possibly, one can never pay it back. Therefore, the minimum monthly salary could be derived from the total cost of the building divided by 36 months.

The building costs of contractor-built houses that are owned by families of various income groups are tabulated in table 19. It can be seen that only 40 percent of the families could afford to buy a 36 square meter house.

From construction systems and costs analysis, table 18,

Table 19. Building Costs of Houses Built by Contractors

Item	Floor area per family 26m²	36m²	47m²
Structure (Material & labor)	$ 711	$ 980	$1,292
Utilities (Material & labor)	113	113	113
Land	100	100	100
Land improvement	79	105	134
Administration	79	105	134
Sub total	$1,082	$1,403	$1,773
Interest	432	561	709
Total cost	$1,514	$1,964	$2,482
Minimum salary per month	$42	$54	$69
% of families can afford	60%	40%	26%

we know that the average labor cost of a house in Greater Bangkok is about 40 percent of the total cost (excluding utilities costs).

If the houses are constructed by the aid-self-help method the labor cost, except for utilities, may be eliminated as given in table 20.

Table 20. Labor Cost

Unit	Structural cost	Labor cost (40% of struct. cost)
26m²	$ 711	$284
36m²	980	392
47m²	1,292	516

It is clearly shown that when the aid-self-help method of construction is employed, the building costs are reduced to the cost that a family in the low-income level can afford to buy.

Table 21. Building Costs of Houses Built by Self-Help

Item	Floor area per family $26m^2$	$36m^2$	$47m^2$
Structure (Materials)	$ 425	$ 588	$ 776
Utilities (Material & labor)	113	113	113
Land	100	100	100
Land improvement	79	105	105
Administration	53	70	89
Sub total	$ 770	$ 976	$1,183
Interest	308	390	473
Total cost	$1,078	$1,366	$1,656
Minimum salary per month	$29	$37	$46
% of families can afford	90%	65%	53%

As indicated in table 21, 90 percent of the total families can afford to buy a 26 square meter house, 65 percent can afford to buy a 36 square meter house and 53 percent can afford to buy a 47 square meter house.

For those families (8%) with extremely low incomes, such as US$ 25 or less per month, the government can help by providing land and public utilities and finance structure,

roof, door and windows, then let them build their own houses under the government or organizational control and supervision (this process has been successfully done in many countries in Latin America and Africa where it is called roof-loan program[2]). The reason of doing this is to encourage the self-help program and to give every family an equal opportunity to grow, to move up to the house-owner level.

D. Procedures for development

In order to establish a workable procedure for changing the deteriorated housing area to a healthy housing area, the program is designed in such a way as to develop the district step by step, rather than to demolish the whole site and then build a new community. It will take a long time to accomplish the development, but it involves less problems.

To begin the development, establishment of a team planning staff must first be considered. This team could be organized either by the government or the said community. It should take full responsibility for designing the possible layout of the site and carry out the development. Of course, designing the layout can be simplified if the recommended layout in this thesis is followed. Also, in this team, there should be a consulting engineer. The duty of this engineer is

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2 Abrams, Charles, Man's Struggle for Shelter in an Urbanizing World, Cambridge, M.I.T. Press, 1964, pp. 182-194.

to give technical assistance to the families who will build their houses by self-help method.

After a planning team has been established, development of vacant land and new roads can be started. When this phase of development is completed, people who presently live in slum areas can be relocated to these new housing units. Because development starts from vacant land, many legal problems can be avoided. This newly developed section can then be used as a demonstration project to test the attraction and stimulation of interest concerning residents as well as investors, and the workability of the development procedures.

At the second phase, development could start at the sites from which inhabitants have been relocated. Also, during this phase, we can carry out the development of light industrial areas, improve the railroad station in the site, and partially renew the community centers.

The third phase includes the construction of new primary schools, as well as the development of neighborhood centers, and building of river front walk-up apartments.

Recreational areas are to be completed in the last phase, the fourth phase. Any unfinished work concerning renewal of community centers and development of neighborhood centers must also be carried out.

Building Materials and Their Uses in Greater Bangkok

Building materials cannot be selected according to climatic requirements only, because their suitability for an area of the country also depends on the case with which they can be worked by hand or machine, on the degree to which they are attacked by plant or animal pests, on imported facilities and, last but not least, on their production and maintenance costs. All materials suitable for building are adaptable to Thailand provided that their particular properties are noted and utilized. Here, only the factors that seem relevant to the working of individual materials will be analysed.

In Greater Bangkok, traditional building methods are still used in a large part of all construction. Some of the advantages of traditional materials are their plentiful supply, low costs, good reaction to climate, and the fact that they can be handled by local skilled labor, who are familiar with both the production and repair of traditional construction.

The difficulties in using traditional building methods on a large scale are the limited durability, the limited availability and the quality of traditional materials, which are unsuitable for mass-production and confine employment to rural areas. Production of modern building materials, hitherto imported and thus of limited availability, is now developing in towns.

Table 22. Summary of Building Materials

Materials	Processing and applications	Advantages	Disadvantages
Canes, straw, leaves grass, organic waste products.	Inter-woven matting- blinds. Waste products compress into slabs or brick (coconut fibres, wood-shavings etc.). Slabs of cement or mud-bound reeds.	Extremely well adapted to their respective climates. Waterproof. No heat storage. Good ventilation. Using traditional building methods.	Little heat insulation. Storm and wind risk. Liable to be eaten by termite. Refuge for insects and small animals. Risk of fire. Not durable.
Timber.	All usual timber constructions. Glued construction using only synthetic resin adhesives. Production of plywood and wood-fibre boards. Usually hand or machine processing.	Hardwoods are little affected by climate. With proper care, normally very resistant to rain and periodical water. Resistant to wind and storms if suitably constructed. Easy to repair and replace. Local availability.	Potential termite food. Destructive decay from fungi. Risk of fire.
Bamboo.	Inter-woven matting, blinds. Interior decoration. Used with timber.	Traditional building material. It is abundant in Thailand, thus can be obtained cheaply. Strong enough for reinforcing. Traditional methods can be used.	Requires treatment for duration and waterproof. Potential termite food. Risk of fire.
Soil, clay, sand.	Simplest form piles up by	Good heat insulation.	Risk of damage from di-

Table 22. (Continued)

Materials	Processing and applications	Advantages	Disadvantages
	hand. Timber framed construction daubed with clay. Air-dried clay bricks, clay tamped down between shuttering. Hand-rammed compressed clay bricks. Stabilized soil blocks or tamped clay walls. Mud plaster quite durable with bitumen added.	Low-cost materials. Suitable for dry areas.	rect exposure to continuous rain. Large heat storage capacity. Low resistant to humidity. Nesting places for insects and small animals. Rather high risk of termite damage.
Plaster and mortar.	Usual methods of productions, also mortar mixtures containing sea-shell or coral rock, termite soil, bitumen and tar products, dung and organic material.	Relatively low thermal conductivity. Used to protect walls from heavy rain, insects and fungus growth.	Large heat storage capacity. Water repellent to water-proof (addition of chemicals). Fungus attack. Termite destruction of clay and soft mortar.
Concrete and reinforced concrete.	All familiar concrete building materials and methods of construction. Prefabricated components. Prefabrication of prestressed concrete.	Rainproof. Low thermal conductivity. As suspended floor in multi-story building versatile. Enduring, strong. Can be precast. Fire resistant.	Very high heat storage capacity. Requires form work and highly-skilled labor and design. Very expensive.
Concrete blocks.	Brick work, dry brick work, floor blocks. Production by hand or with tamping machine. Hollow or homogeneous cellular	Low thermal conductivity. Average heat storage capacity, according to self weight. Waterproof. Fire	Crack formation resulting from shrinkage and expansion due to humidity and temperature

Table 22. (Continued)

Materials	Processing and applications	Advantages	Disadvantages
	blocks. Sawable and cuttable light weight concrete blocks. Sand aggregates (also laterite) for almost blocks.	resistant. Easy repair possible. Load bearing.	differences (reduced by surface treatment, rendering).
Steel, cast iron.	Usual methods. Limitations on account of high import costs and lack of skilled labor.	Air-tight and waterproof. No deterioration by animals or plants. Suitable for concrete reinforcement.	Not local material. High heat storage capacity. High thermal conductivity. Risk of rusting from high humidity. Low fire resistant. Expensive.
Cement asbestos.	Sheets, pipes, wall and roof sections, self-supporting folded building components, monolithic fittings (shells, furniture, etc.). Industrial production only.	Local availability. Eminently suited to the tropics. Waterproof. Limited thermal conductivity. Windproof. Fire resistant.	Considerable transport losses. Sensitive to sudden mechanical stress. Termite resistance uncertain.
Glass.	Usual construction methods with normal glass, at the same time, special glass and large size imported, therefore expensive. Usually used in doors and windows. Heat absorbing glass for solar control.	Rain and waterproof. Low thermal conductivity. Allow the light into rooms. Close contact between indoor and outdoor.	High risk of breakage during transport, fire, impact and deflection. Surface deterioration from dust. Expensive.

Table 22. (Continued)

Materials	Processing and applications	Advantages	Disadvantages
Fire clay bricks.	All common, traditional methods of construction. Considerable differences in size, shape, material composition and quality. Very varied standard of construction if fire material used.	Resistant to mechanical damage. Fireproof and fire resistant. Traditional materials. Low heat storage capacity.	Permeable to continuous rain and persistant high humidity. Nesting space and unchecked passage for insect in inadequately sealed cellular bricks. Algal or fungus deposit after continuous soaking.
Paint.	Imported from industrial countries, especially plastic based paints. The usual methods of painting, spraying or dipping. Possible impairment of quality by negligent work and lack of skilled labor.	The response to climatic conditions extremely varied, depending upon chemical composition. Protect walls from climatic conditions.	Tendency to chalking with rapid changes between rain and sunshine. Considerable deterioration from continued humidity and rain directly to surface.
Plastic.	Mainly imported from highly industrialized countries. Limited experience and lack of skill labor, so far. Much replacement of common building material such as wood, sheet, metal, etc., (very few structures warrant usage) however, wider usage in finishing work (pipes, cables, decoration, etc.). Creative design often suspect (imitation of traditional materials).	Rain and damp-proof. Low thermal conductivity. Low heat storage capacity. Usefully translucent. Minimal transport damage.	Deterioration accelerated by high temperatures, rapid temperature changes, large temperature differences between outside and inside.

Contrary to frequent assumptions, the deterioration of building materials is due, not so much to purely climatic factor as to incorrect application and maintenance. Solar rediation, humidity, wind, extreme temperature differences, salt content in the air and dust have particularly negative effects.[3]

Method of Construction for Low-Cost Housing

To implement the development of residential areas, it is necessary to adopt improved methods of construction for low-cost housing. The information obtained from a survey of current methods of construction and the specific details of the proposed method are presented in this section.

A. Survey of current methods of constructions

As for construction methods, hand labor constitutes the major element of building construction. Mechanized means are generally quite crude, because man power is abundant.

There are basically four different types of construction systems which are discussed briefly in the following paragraphs.

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3 Lippsmeier, Georg, Building in the Tropics, Callwey Verlag München, Germany, 1969.

1. Timber structure system

In this system precasted concrete footing is put down first, then a timber structure can be added onto it. Panel between the post is ¼" x 4" or 6" (usually asbestos sheet is used for exterior) on 1½" x 3" @ .50 studd. For roofing, corrugated asbestos is employed (see figure 6). It is rether difficult to get good timber for construction now since people keep on cutting young trees. In the future timber will become more expensive; concrete and precast concrete will become more common.

2. Reinforced brick structure system

Reinforced brick structure system is a very commonly used because of its permanency and ease of construction. Exterior walls are 8" thick layer of brick. Reinforced concrete columns are used. On top of the walls are continuous reinforced concrete tie beams. These beams prevent differential settlement of the brick walls. Coorugated asbestos is employed for roofing (see figure 7).

3. Reinforced concrete structure system

The reinforced concrete system is mostly used for public buildings. In this system, the frame is built first, then brick or blocks are laid in place. This system is the strongest; it is also the most expensive. Therefore, it is not common for building small houses (see figure 8).

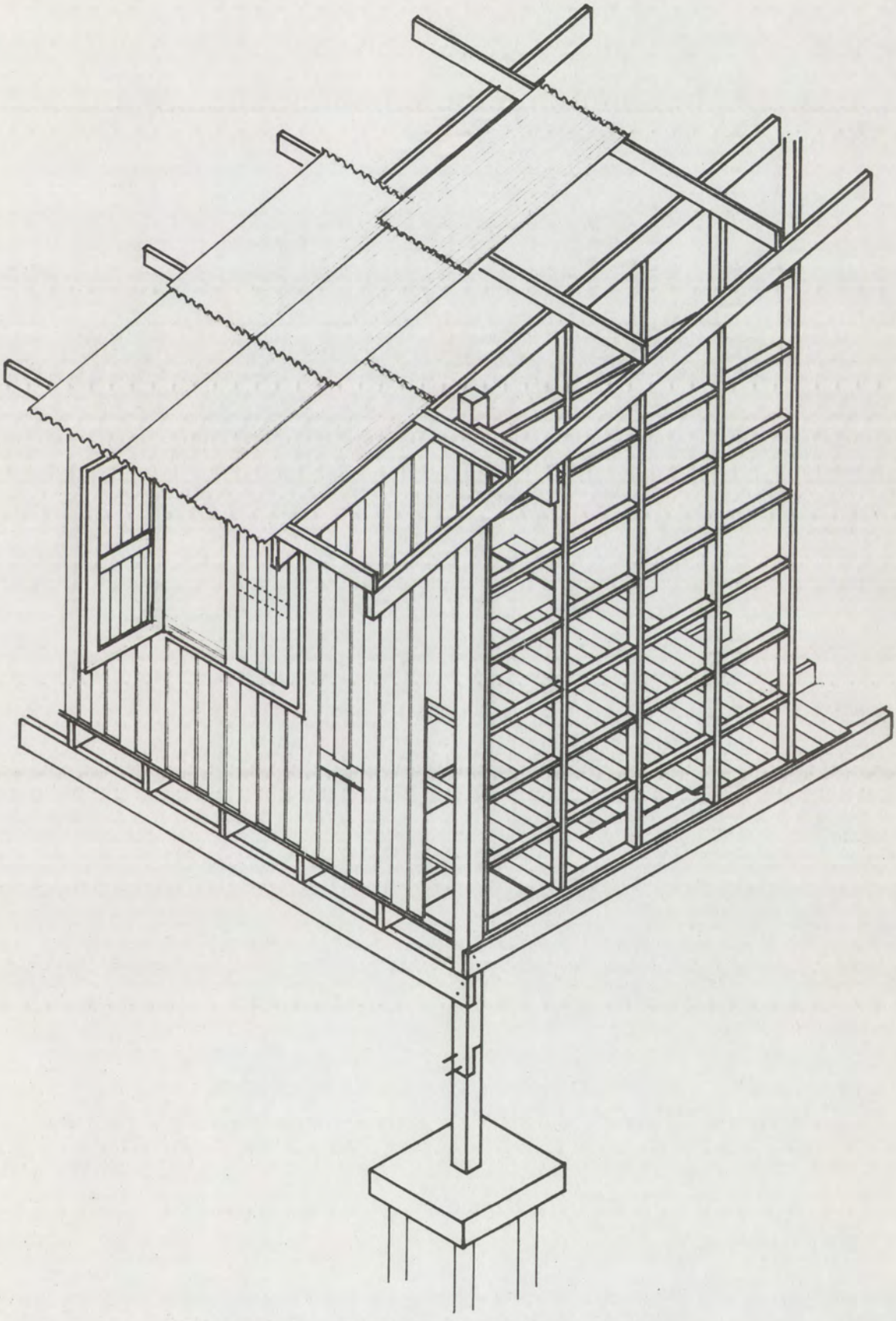


Figure 6. Timber Structure System

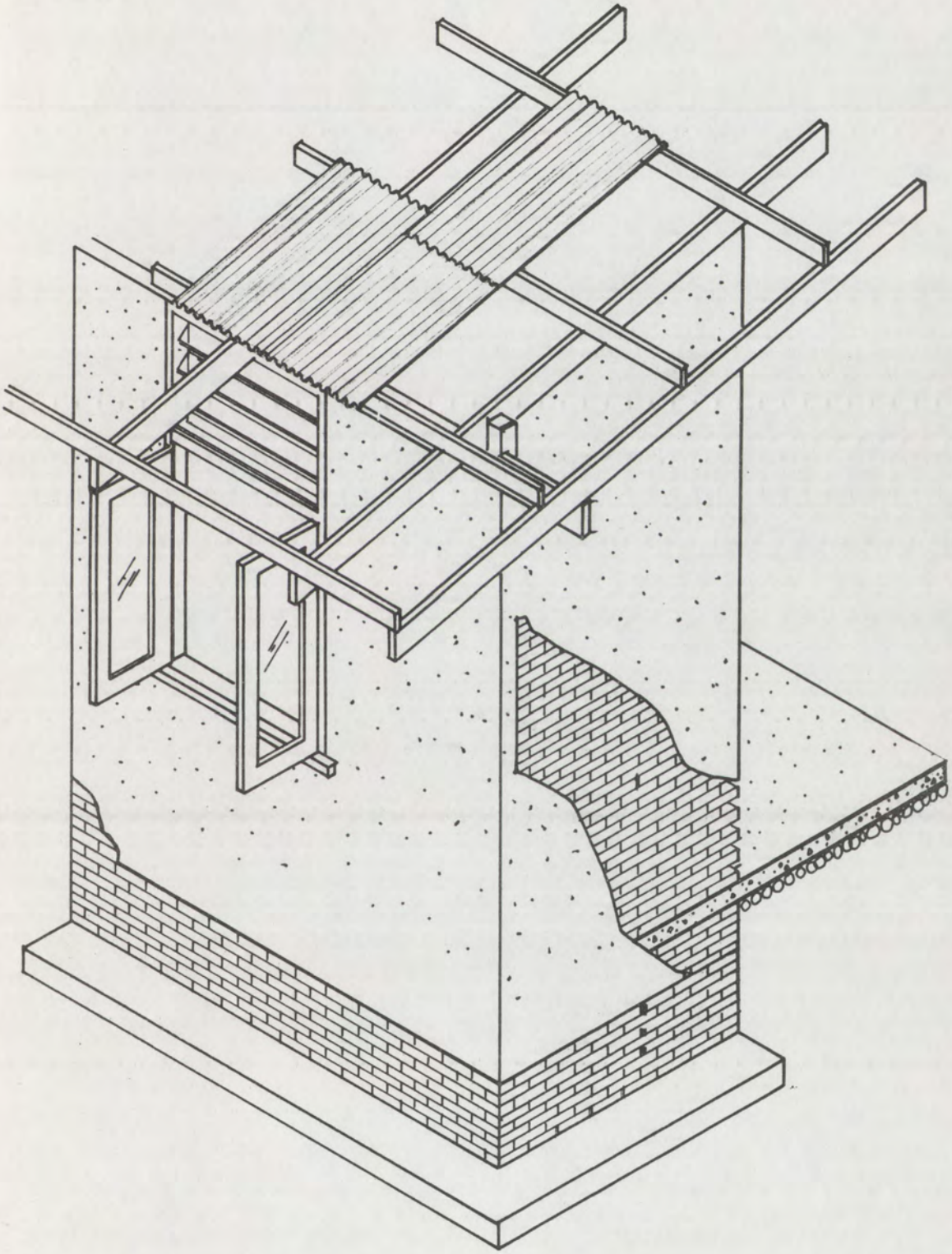


Figure 7. Reinforced Brick Structure System

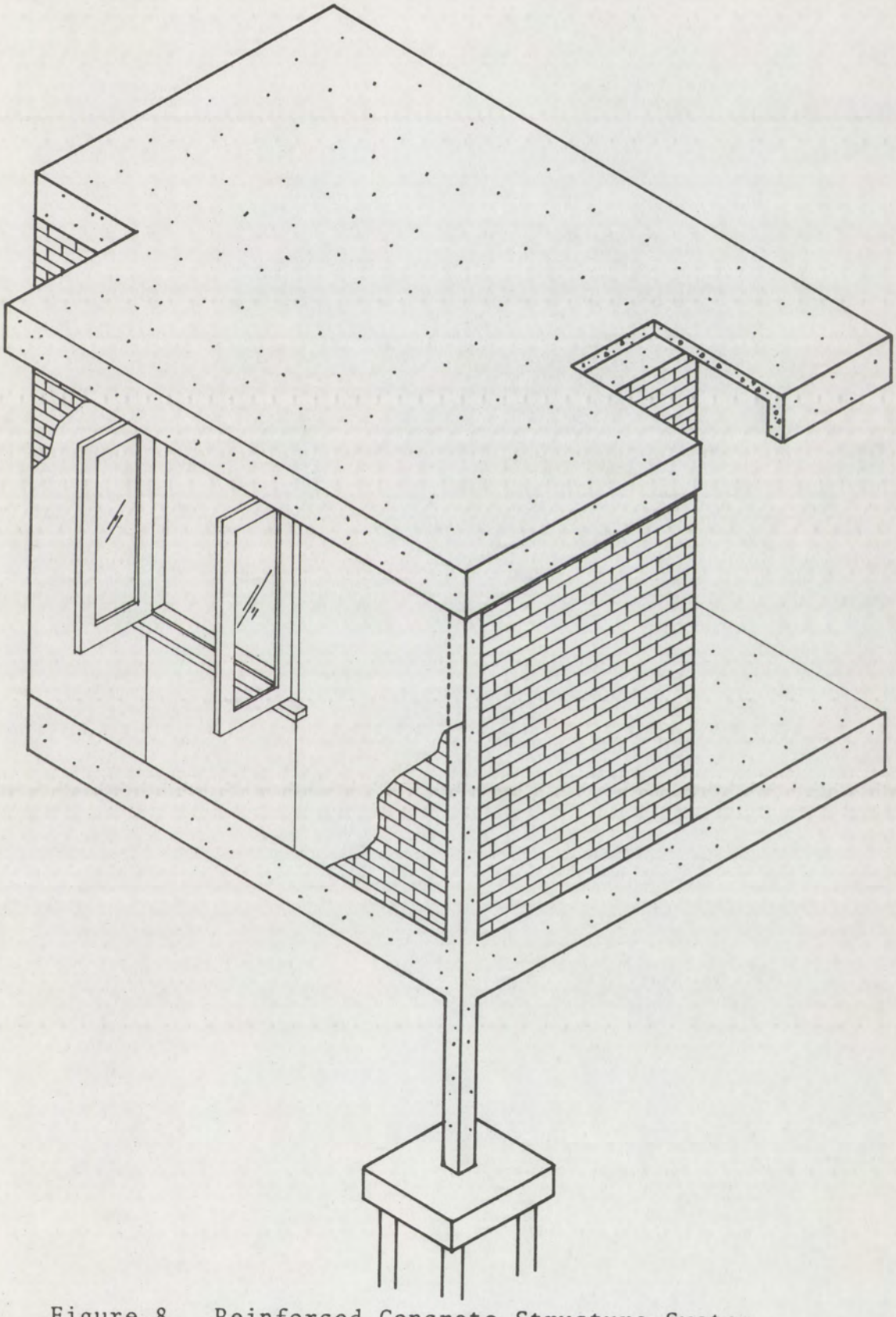


Figure 8. Reinforced Concrete Structure System

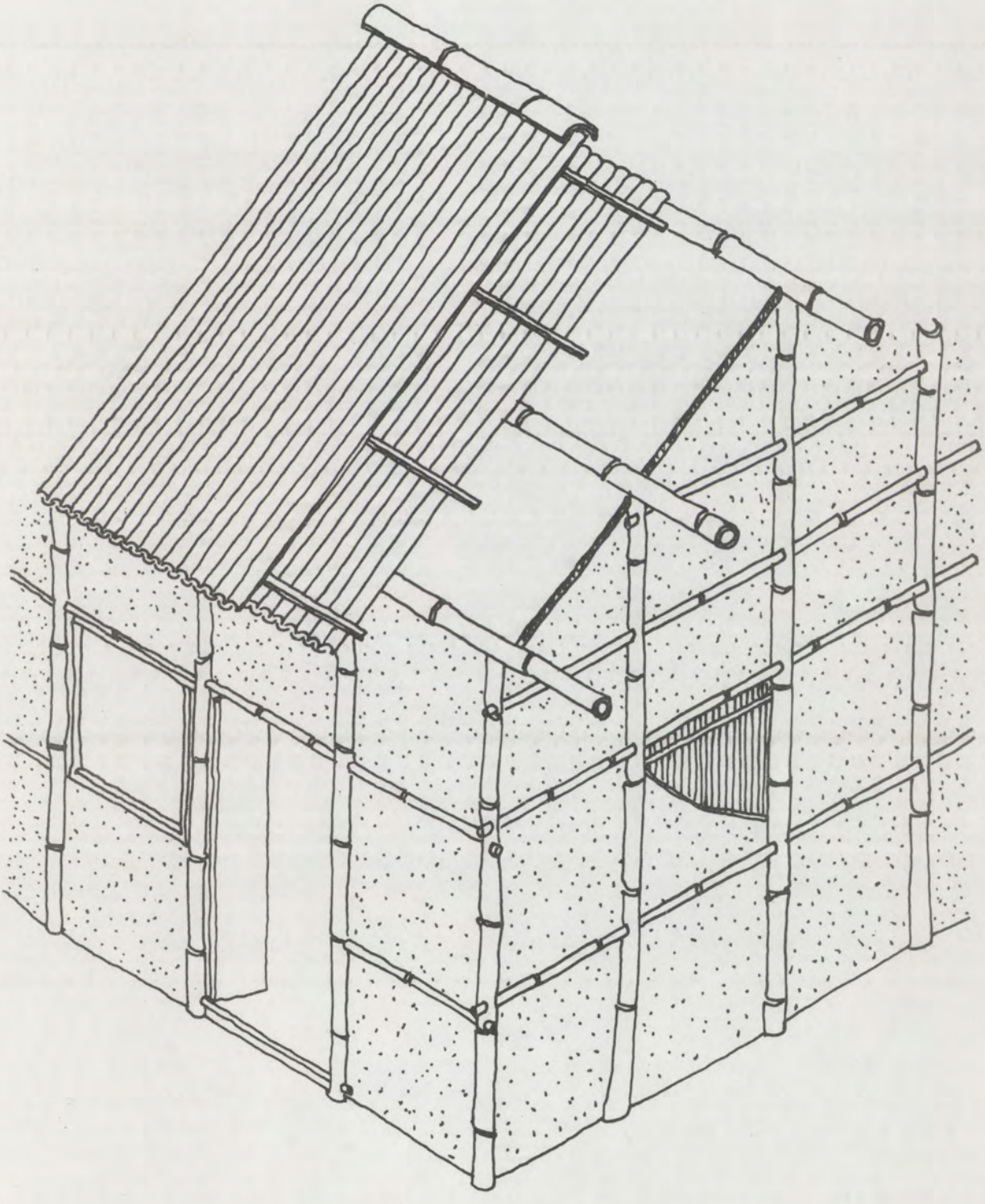


Figure 9. Bamboo Structure System

4. Bamboo structure system (figure 9)

Bamboo structures are product of cheap materials and cheap labor. Therefore, the bamboo system is often seen in developing countries, but not in more advanced countries such as the United States. Relatively speaking, bamboo structure lacks permanency. It can last only 15 years or less, if the bamboo is left exposed.

B. Proposed methods of construction

Because of the gap between family income and housing cost, it is quite common that the cost of new house of sound construction is higher than the buying power of the low and lower-middle classes. This section discusses methods of construction that can reduce this house construction cost to bring it down to the level of low-income families.

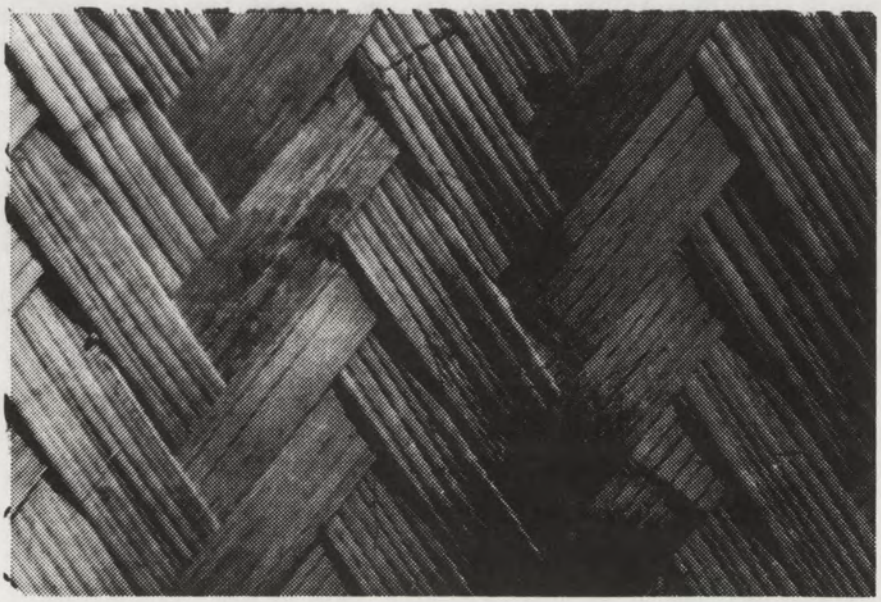
1. Methods of reducing construction costs

In order to avoid the risk of developing into slums in the future, providing minimum living space for everyone is recommended rather than cutting down floor area. Thus, the only way to reduce the cost of housing is to cut down the construction cost. There are two ways to accomplish this.

a) Cut down labor cost

Use an aided-self-help method to construct the house in order to save labor cost (usually labor cost is

Houses built of bamboo in rural area.



up to 40% of the total construction cost). The aided-self-help method will be discussed in more detail later.

b) Cut down material cost

In general, the material cost can no longer be cut down. For permanency, reinforced construction systems must be used. Among the different types of construction systems, reinforced block is the lease expensive at the present.

According to the local prices, reinforcing steel is the only material with a high cost. This situation makes it desirable to consider bamboo as the reinforcing material instead of steel. As there are abundant supplies of bamboo in Thailand, the price of bamboo is relatively low. The ability of bamboo in reinforcement will be studied in more detail.

2. Self-help and mutual aid

These terms relate to constructions in which the householders erect all or part of their own houses. As usually used, "self-help" means that each family constructs its own house, whereas "mutual aid" means cooperative effort on the part of a number of families working together to build each others' houses. This usually makes possible the subdivision of labor with different subgroups of families specializing

in certain aspects of construction.

There are all degrees of self-help. At one extreme the owners may not only erect their houses completely but may even manufacture the materials such as concrete blocks made in a simple mold. More commonly the materials and equipment are purchased and the owners erect them. In other instance, the more difficult parts may be built by regular craftsmen and the owners do the rest. Not uncommonly, the utilities including plumbing and electrical work will be done by regular craftsmen, even if all the rest of the work is done by the occupants. On sufficiently large projects such parts may be precut and at least partially preassembled. One dangerous result usually follows. It is highly probably that the area will be turned into a slum because of the inadequate planning, insufficient utilities and unhealthy environment.

Therefore, in this design, the project will be carried out by an organization which can be a part of the government. The organization acquires the land, possibly with financial assistance from the Housing Bank of Government funds, lays out the plan, constructs streets, and provides the utilities, i.e., water, sewers and electrical power. Individual lots are sold under favorable terms to the owners, and the necessary materials are also provided under favorable terms of low interest rates and a generous amortization period. Terms are variable but are likely to include a down

payment of 10 to 20 percent (although none may be required), interest rates ranging from 4 tc 12 percent per annum, and amortization periods of 10 to 20 years. There may be a stipulation that in order to qualify the owner must agree to put in at least a minimum amount of time per week in his house; 20 hours is perhaps an average figure.

In both self-help and mutual aid self-help, especially the latter, a careful screening of families has been found by experience to be desirable. In addition to need for housing and ability to pay, they must have the physical and mental ability to engage in self-help, the ability to perservere and to cooperate with others. The organization also takes full responsibility for controlling the plan and giving technical assistance to those people who build houses on the site. Instruction is given to the families before and during construction. Groups of 30 to 40 families are organized around the group leader and social workers (from the organization) who give instruction in building and community organization. In this way, predictability of final environment can be assured.

Bamboo Reinforced Concrete

The "Thai Engineer's Handbook", published in 1956 at Bangkok, states that many concrete works with bamboo reinforcements were constructed. Bamboo was found to be an efficient reinforcing material.

A. Properties of bamboo in reinforcing

The properties of bamboo are as follows:

1. The tensile strength of bamboo is from 1,465 to 3,042 kilograms per square centimeter (21,000 - 43,000 lb./in.^{2}). (The allowable tensile in mild steel bar, which is used construction in Thailand is 17,000 lb./in.^{2} : From "Building Costs in Asia and the Far East, United Nation, 1961).
2. Compressive strength is 540 kg./cm^2 (7,700 lb./in.^{2}).

B. Properties of bamboo in general

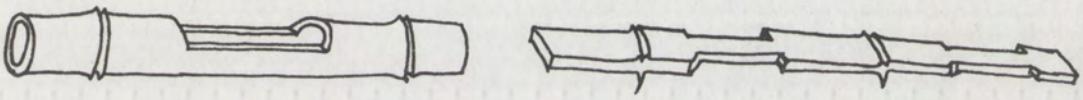
The two major possible weaknesses to the bond stress for using bamboo as reinforcing material are surface smoothness and water absorption of bamboo.

1. Surface smoothness

Bamboo is a very usefull material. One of the reasons is the surface smoothness. It can be used to make furniture, build houses, decorate rooms and for many other things. However, this same property which make bamboo desirable in other uses makes it quite undesirable for concrete reinforcing. Surface smoothness causes bamboo to slip when force is applied on the bamboo reinforced concrete. The bond stress is too small for resisting the applied forces. Therefore, bond between bamboo and concrete must be improved. There are two ways to improve bond.

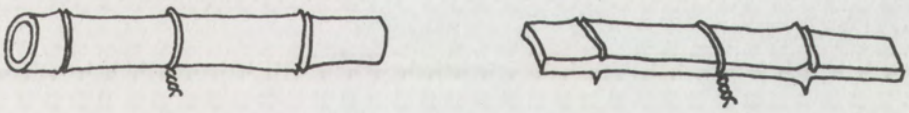
a) To cut part of bamboo between nodes for providing more contact surface between the bamboo and concrete to increase the bond.

Figure 10.



b) To use 0.09 wire as tie around bamboo reinforcings to increase anchorage.

Figure 11.



2. Water absorption

During the period when the concrete is poured and being cured, bamboo will absorb water from concrete, and as a result the volume of bamboo will increase. After setting when concrete get dry, concrete will decrease. As soon as bamboo reduces its size, the bond stress will largely be destroyed.

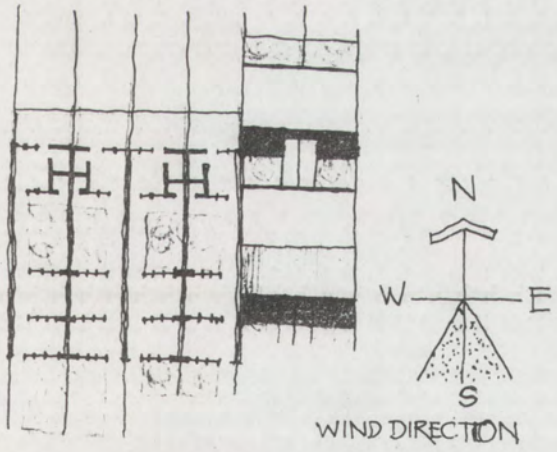
The effect on bond stress in a bamboo reinforced

concrete will mainly depend upon the volume change of bamboo. The volume change of bamboo in turn depends on how much water is absorbed. The test of the properties of bamboo, made by a group of senior students in the Material Laboratory of the Department of Civil Engineering, Chulalongkorn University in Thailand (see detail in the appendices), stated that the water absorption of bamboo is quite high. However, from the most outstanding research work carried out in 1954, (done by the Wood Preservation Branch of the Forest Research Institute at Dehra Dun in India. The Institute's processes were demonstrated at the Indian Government's National Exhibition of Low-Cost Housing staged at New Delhi during January-March 1954), it has been shown that bamboo could be properly chemical treated for waterproofing and durability which adds only 30 percent to its cost.

HOUSING DESIGN CONCEPT

The Site

Problem Human comfort in Greater Bangkok (humid tropics) necessitates the use of currents of moving air supplied by prevailing breezes (from the south), by a suitable orientation of dwelling and wall openings to allow the air to pass through the dwelling. At the same time orientation for sun protection calls for a compromise. Land cost in Greater Bangkok is quite high ($2 per square meter).

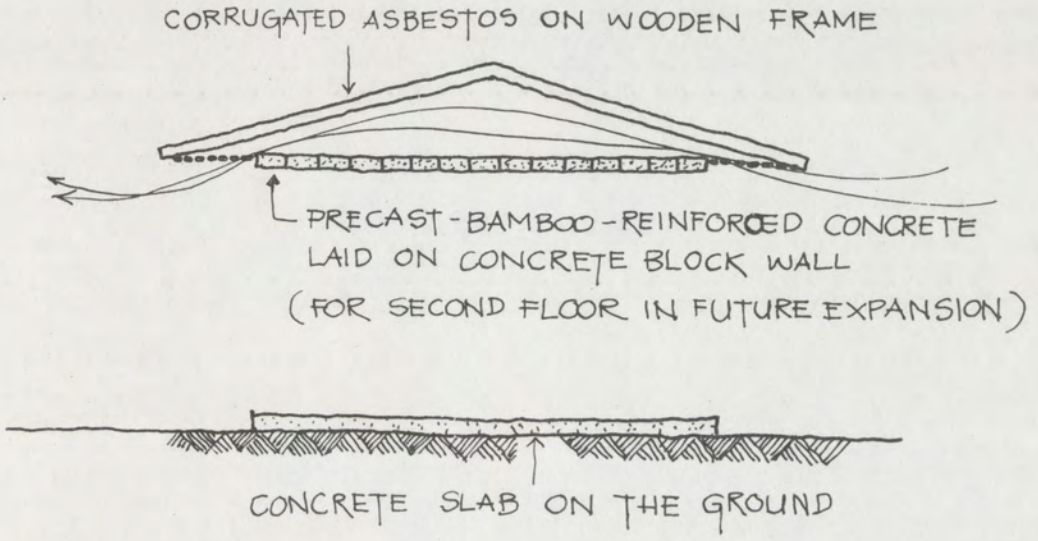


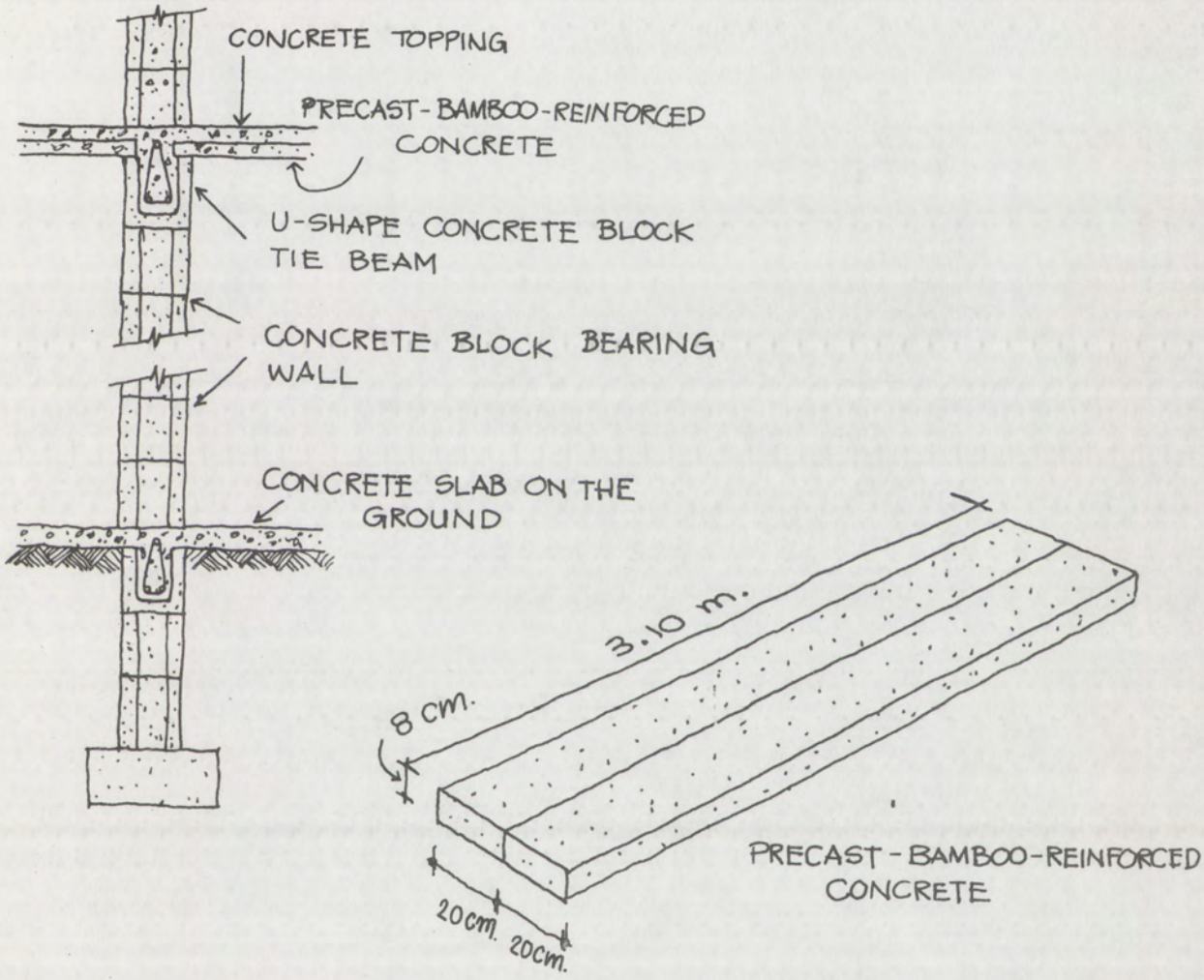
Solution The lots are provided at a minimum requirement for saving land cost. The site is divided into lots of about 50 to 60 square meter in long-narrow shapes. All lots are the same width (3.20 meters) but vary in length from 15 to 19 meters. With long-narrow-shaped lots, the costs of public utilities are reduced and a side effect there is an increase in social contact. The houses are built on these lots, have windows and doors opened to the north and south for cross ventalitation. The sun protection is provided by the common walls which are shared by adjacent dwellings.

Floor

Problem The pleasant coolness of a floor is greatly desired in Greater Bangkok (and other hot humid areas) since Thai people prefer doing everything (sitting, sleeping, eating, etc.) on the floor, which is usually the coolest place of the house. Therefore easy care and simple cleaning are required. Termite-proof and damp-proof floors are required because of the humidity.

Solution Paved floors are, as always, to be recommonded for naturally ventilated buildings which are exposed to external climatic conditions and considerable dirt. The requirement for easy care and simple cleaning are best met by a smooth surface. Reinforced concrete is termite-proof and also damp-proof. Reinforced concrete with a finished surface is easy to keep clean and cool. For the upper floor,





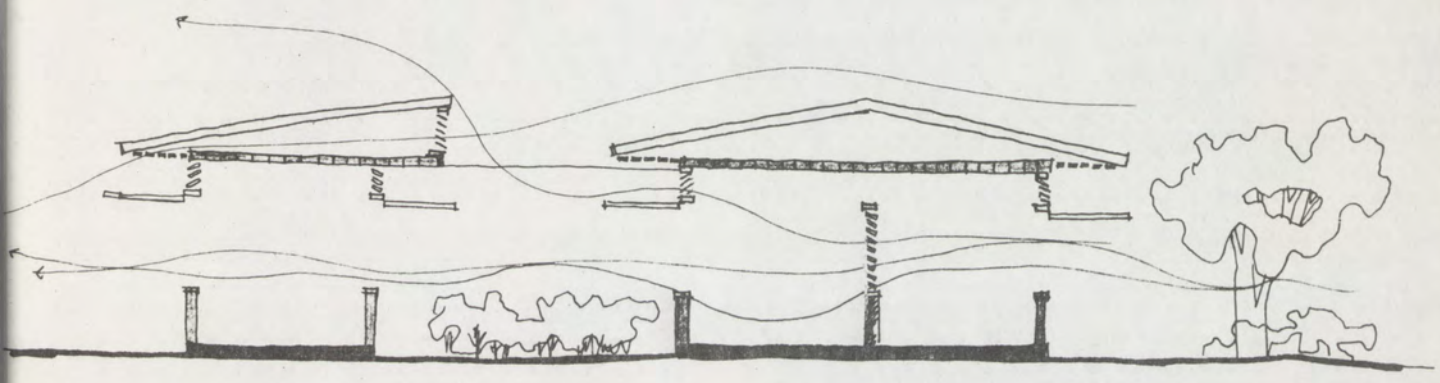
precast bamboo-reinforced concrete is laid for future expansion, meanwhile it serves as a lower part (ceiling) of a double roof.

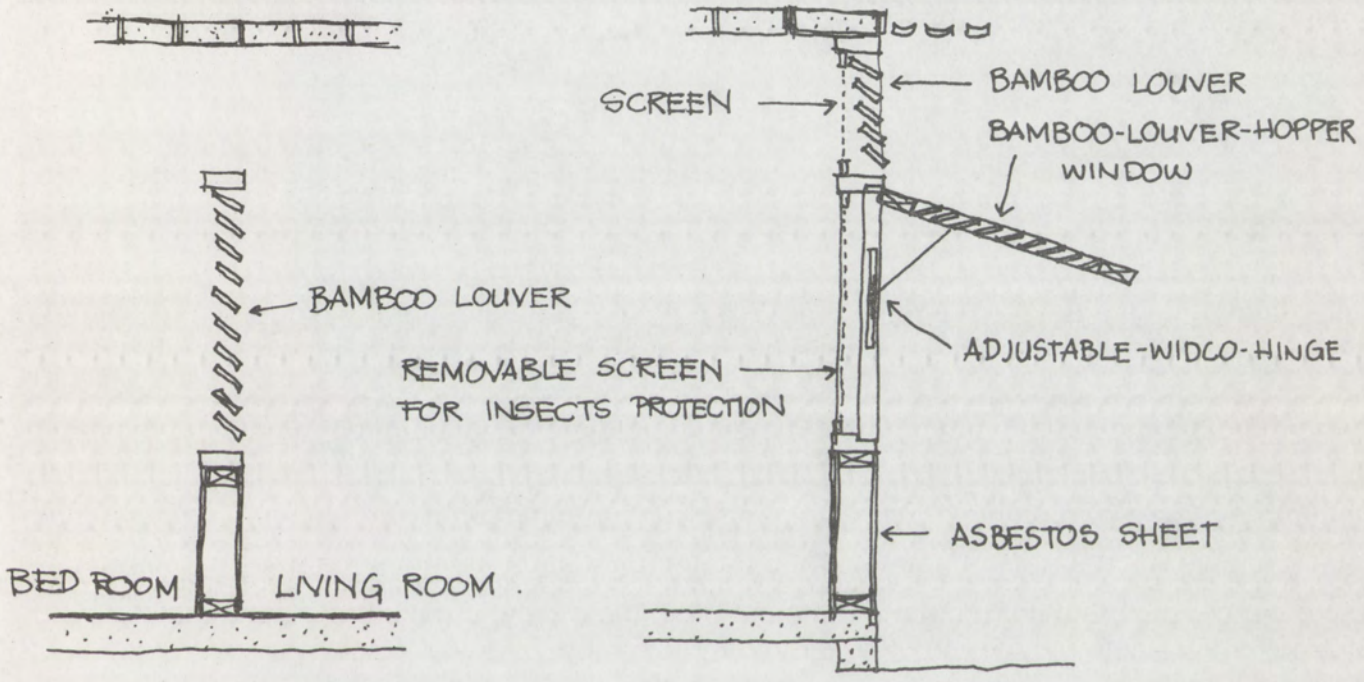
Opening

Problem Windows, doors and gates have a more important role in the tropics than in the temperate zones, because they contribute consederably to the control of the microclimate of the building. Owning to the rain squalls in Greater Bangkok, one factor which has a considerable bearing on the design of openings is the need to let the air in but keep the rain out. Maximum cross ventilation is preferable while at the same time, privacy should be maintained and the house should be protected from the sun.

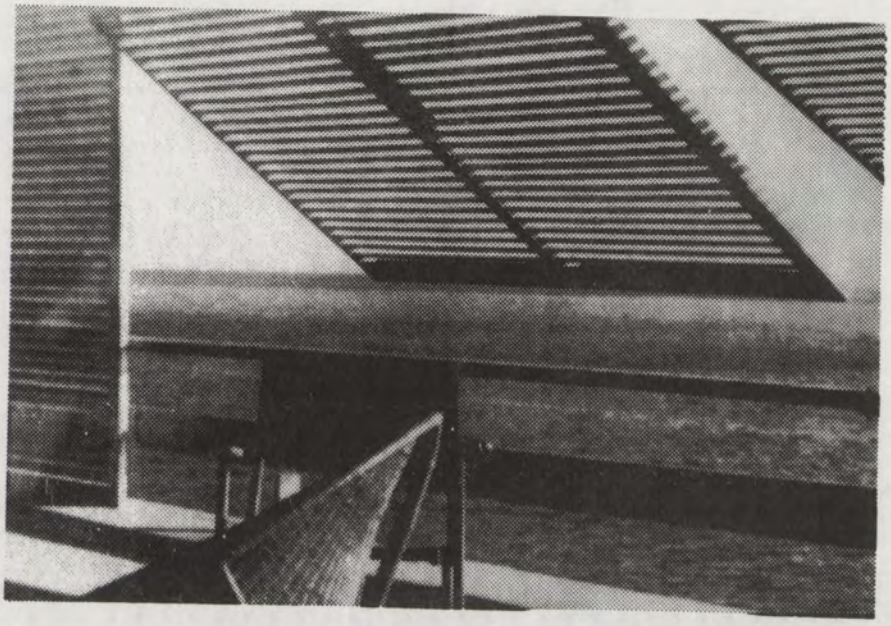
Solution Closures should be removed as much as possible in Greater Bangkok area to permit maximum cross ventilation. Privacy can be obtained from louvers, hopper window and wooden screen which allow air movement, at the same time it is fairly satisfactorily for rain and sun protection. To obtain air current at body level in the rooms of the houses the window sills need to be sufficiently low.

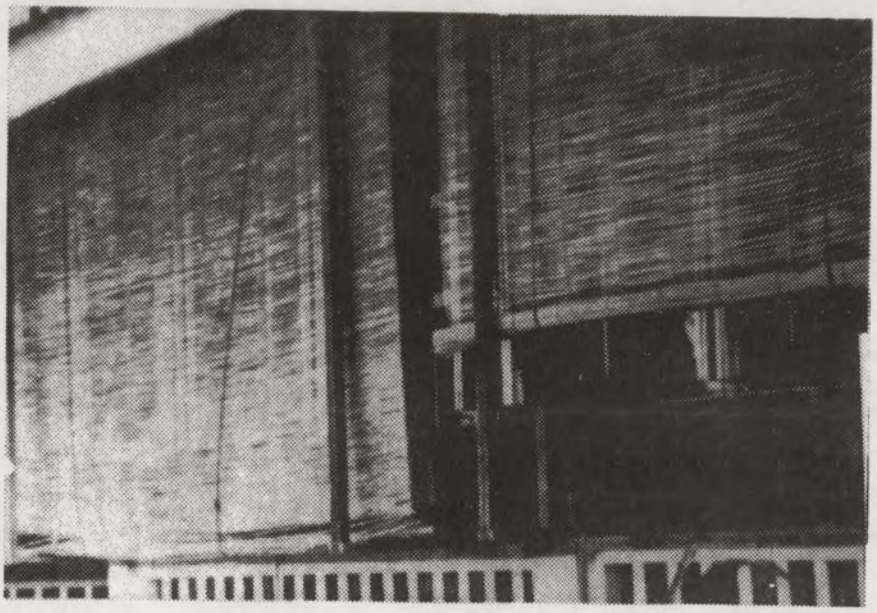
To provide a cross ventilation for the room, the windows





must be in line of the prevailing breeze - one upwind, the other downwind - so that the breeze blows through the rooms.

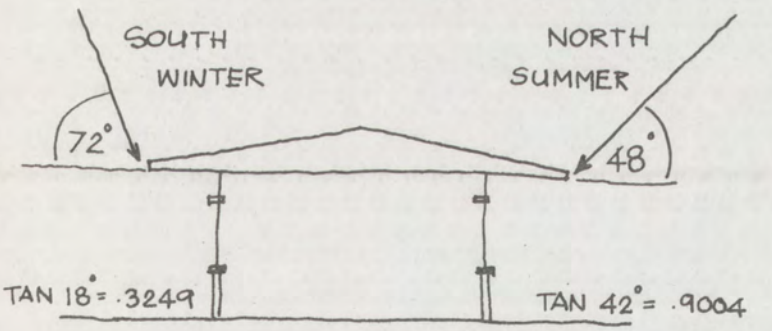




Louver-hopper window and bamboo blind are popularly used for sun and rain protection. At the same time they allow air movement in the house and create privacy.

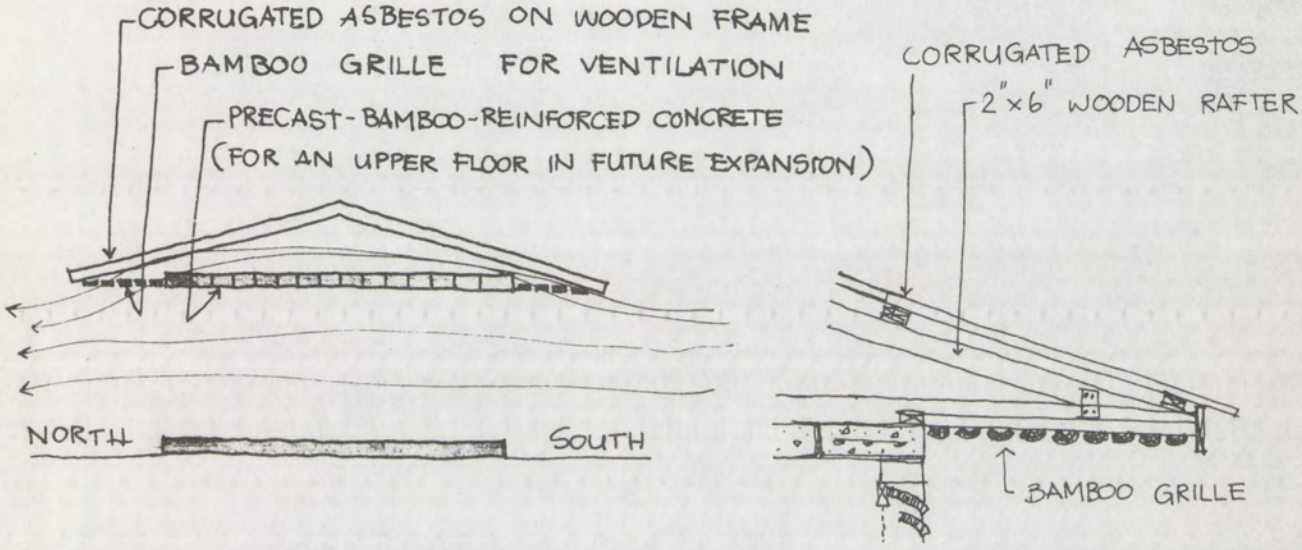
Roof

Problem The roof of the house has the greatest exposure to the sun. Great amounts of heat is generated during the day, and the problem is one of reducing the penetration of heat to the interior, and of dispensing any accumulation of day heat to prevent further radiation on the sleeping quarters at night. Because of the abundant rainfall and sunlight, the house should be protected from these climatic conditions. The structure of the roof should be easy to build and be removable for future expansion. Between September and April the sun is in the south the whole day and makes an angle of 72° at noon and between May and August the sun is in the north the whole day making angle of 48° at noon.



SUN ANGLE AT NOON IN GREATER BANGKOK

Solution Construct a double roof (having an upper surface of fair reflective quality) of corrugated asbestos, held above a ceiling layer, with an adequate air gap between for a good ventilation. Grilles are provided under both side of the eaves, on upwind and the other downwind, for

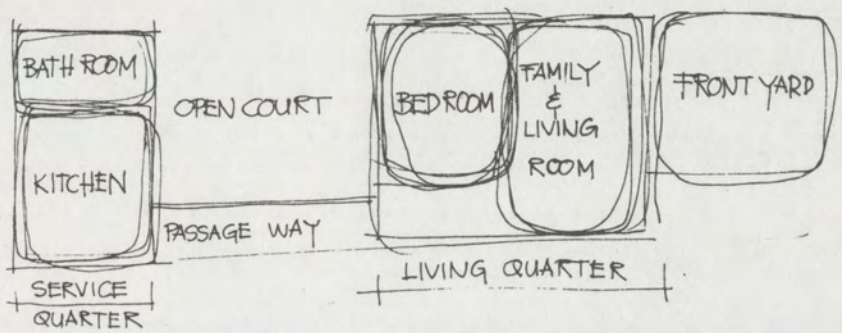


ventilation. The roof should have large overhang to protect the house from the sun and rain. By sloping the roof, the rain can be drained rapidly. All north and south openings are protected by overhangs which are at least 90% of the height from the window sill to overhang on the north and 32% on the south.

Kitchen

Problem The location of the kitchen is a particularly difficult problem. Because most Thai cooking is done on a charcoal grill, apart from the smell and smoke the kitchen adds a considerable heat-load to the dwelling.

Solution A separate kitchen from the house is preferable where the house is built of easily combustible materials. In a hot climate cross ventilation in the kitchen is very desirable; for this reason kitchens are usually detached or separated from the living quarters which access from a porch or verandah. More often a verandah is used as a kitchen in the Greater Bangkok area; this is hardly satisfactory unless storage space is provided in which food and cooking utensile can be locked. In Greater Bangkok, where the rainfall is heavy, the passage way between the house and the detached kitchen should be covered.

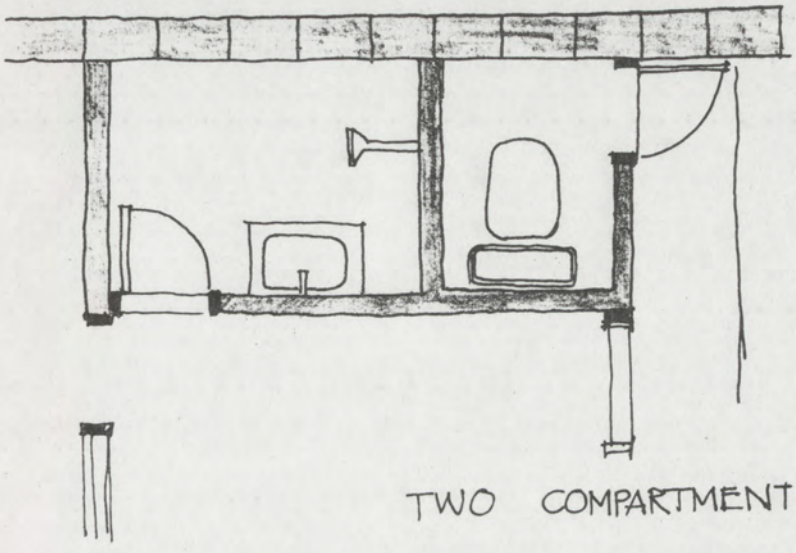


SEPARATED KITCHEN

Bathroom

Problem In a humid climate frequent washing or cleansing of the skin is a necessity and a pleasure. Whether the operation should be performed in a shower or a bath is undecided. In large families with one bathroom, there is a major problem in the morning. Everyone wants to use the toilet, wash basin, and shower at the same time. Seperate, the use of each element is doubled.

Solution The bathroom has at least two compartments: toilet in one, wash basin and shower in the other. A shower is provided since it cleanses the skin quickly and well, consumes a minimum of water, and occupies the least space.

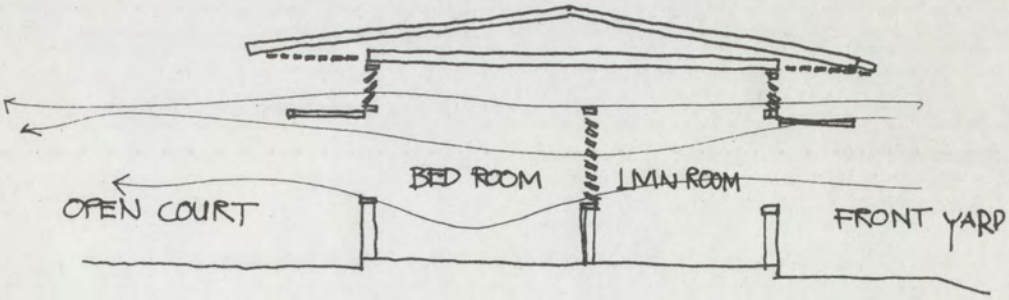


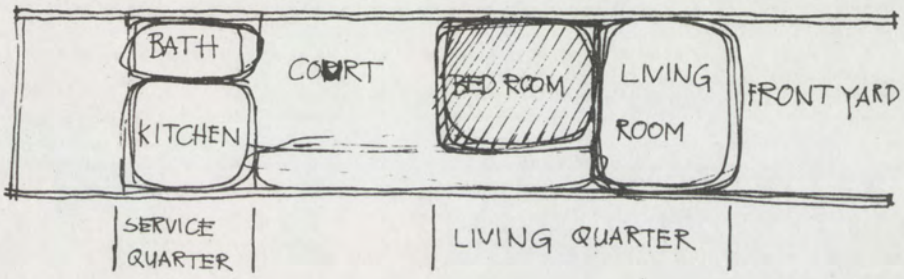
TWO COMPARTMENT BATHROOM.

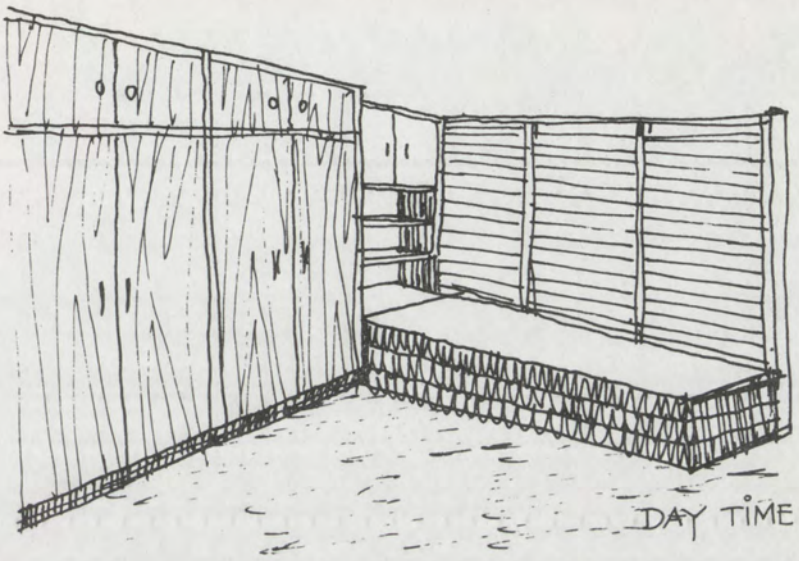
Bedroom

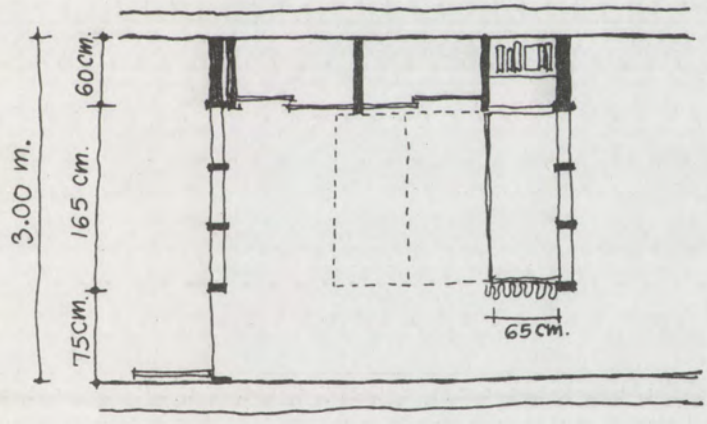
Problem Resting is the most important thing in a man's life to get more energy for working the following day. The bedroom has an important role for a man in sleeping well. Comfort, privacy and security are required for a bedroom. For a small house, flexibility of space should also be provided.

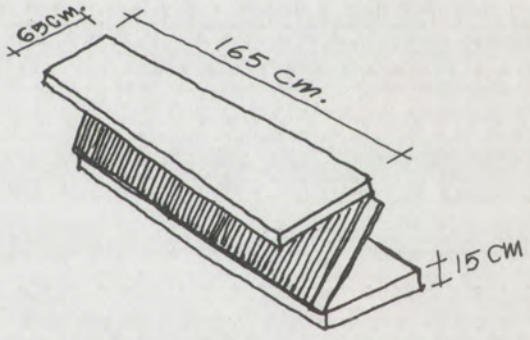
Solution The bedroom should have protected south and west wall and low cross ventilation secured by louvers or a door opening on to courtyard. Since Thai people get used to sleeping on the floor at night and fold the mat or couch and keep them in storage during the day. For flexibility, a folding couch is provided. It can be folded and used for sitting in daytime.



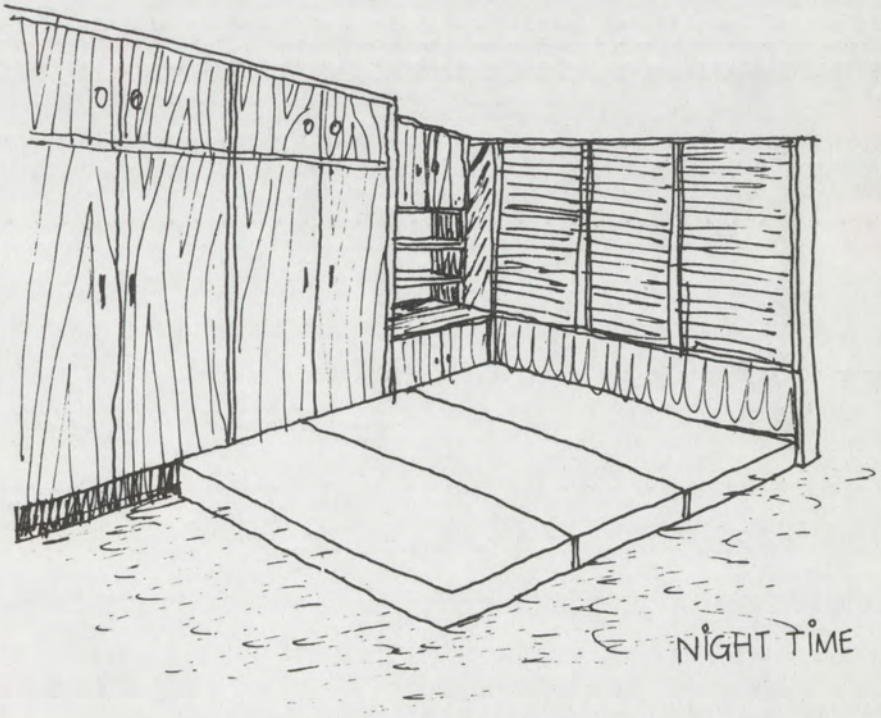








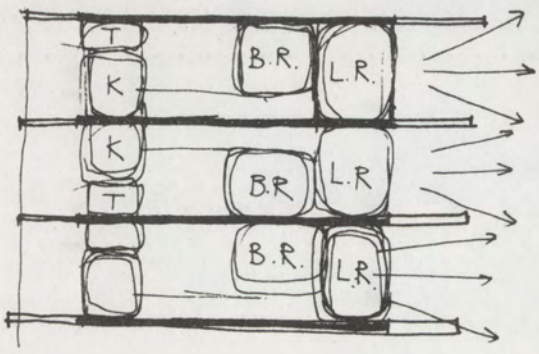
FOLDING COUCH



Living room

Problem The members of a family spend most of their time in the living room. Good ventilation is required for comfort. Flexibility is also required for a living room in a small house.

Solution Maximum openings are provided for good cross ventilation. The living room is open to a front yard which can look out on a wide open view. The parent can sit in the living room and watch the children play in the front yard or in the play area at the front of the lot. At night, the living room can be altered to be a sleeping room for the children in the family that cannot yet move up to the second floor. Folding couches are provided and can be used for sitting during the day.

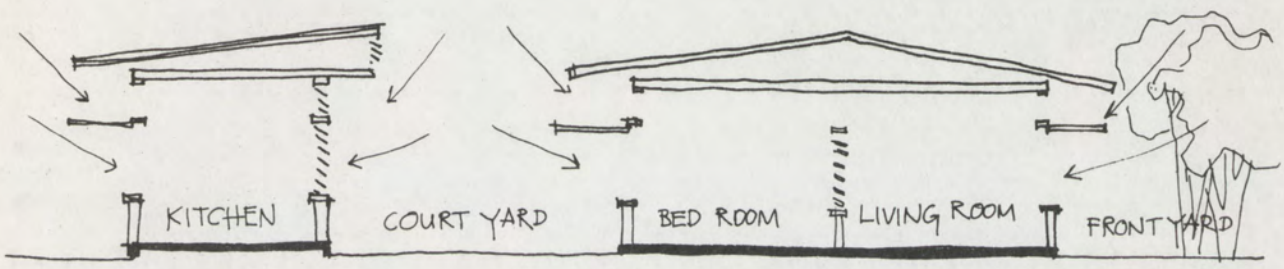


Day-lighting

Problem There should be sufficient daylight in a house to allow dirt to be seen and normal household tasks to be performed.

In Greater Bangkok (and other humid tropic areas) the sun is less strong and the sky is more cloudy. A cloudy sky, especially during the middle of the day, can be very bright and it is usually the main source of light. With bright (cloudy) sky, the strong contrast between the view of the sky through a window and the surrounding wall may cause the sensation of glare.

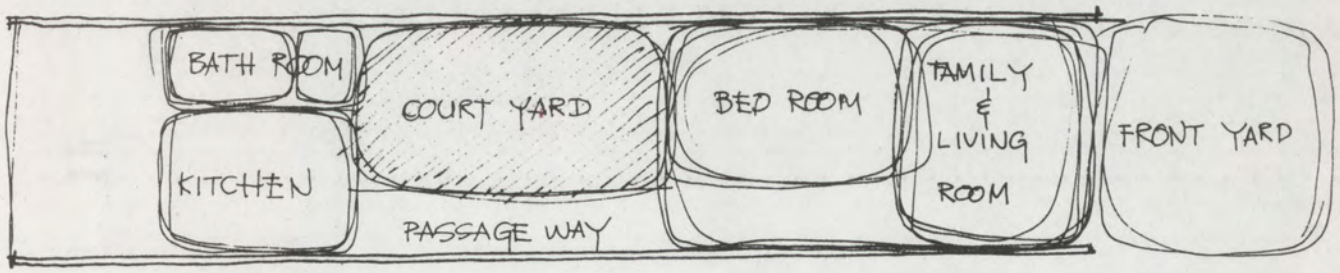
Solution The glare of the bright sky can be reduced by cutting off the view of the sky with a canopy, overhang or louvers or by cross lighting. Alternatively, the size of opening can be increased so that there is more light in the room and the contrast between inside and outside is reduced.

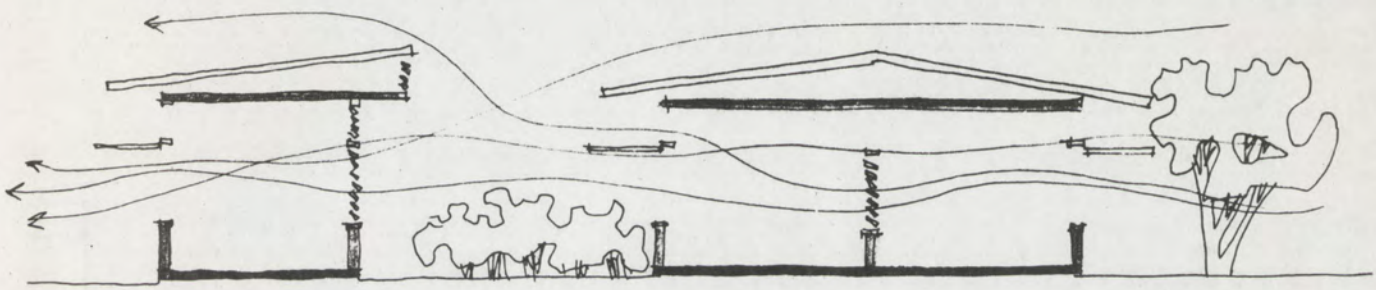


Courtyard

Problem A house with too long a shape or with too many rooms does not always allow a good movement of air.

Solution A private court is very desirable for every family, and therefore should be provided. The value of a courtyard is to ventilate and provide entrance for air to cool the interior of the living quarters. Trees and ground cover are planted for shading the ground and to help create cool air. In Greater Bangkok, where the prevailing breeze comes from the south, all houses are oriented north-south. Since each house has a courtyard, living quarters and service quarters have openings both south (upwind) and north (downwind). By this way air movement within the house will be sufficient for comfortable.

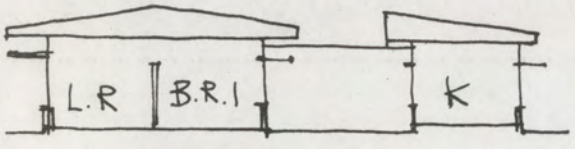




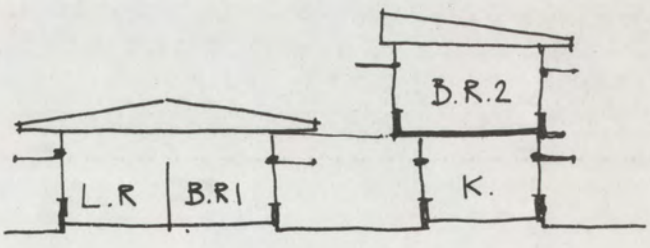
Flexibility

Problem A family develops, grows, and eventually contracts, and current housing production does not accomodate itself to this cycle. It is well within our present technology to consider the house as an organic entity whose parts are replaced and areas added or removed as needs change.

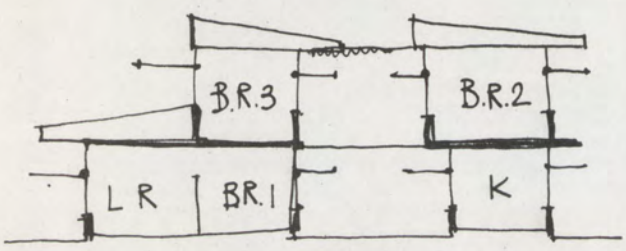
Solution The house is designed for move-up expansion. The illustrations on this page show this concept: The house, consisting of one bedroom, a living room (can be used as a bedroom at night), a kitchen, a toilet room and a shower room, would be the initial increment of construction for a dwelling. As the family's needs expand, additional bedrooms and increased areas of living space are added until stage four is reached. As the children left home or established homes of their own the previous cycle could operate in reverse.



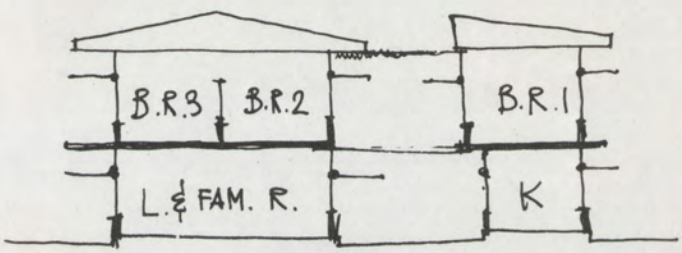
STAGE 1.



STAGE 2.



STAGE 3.



STAGE 4.

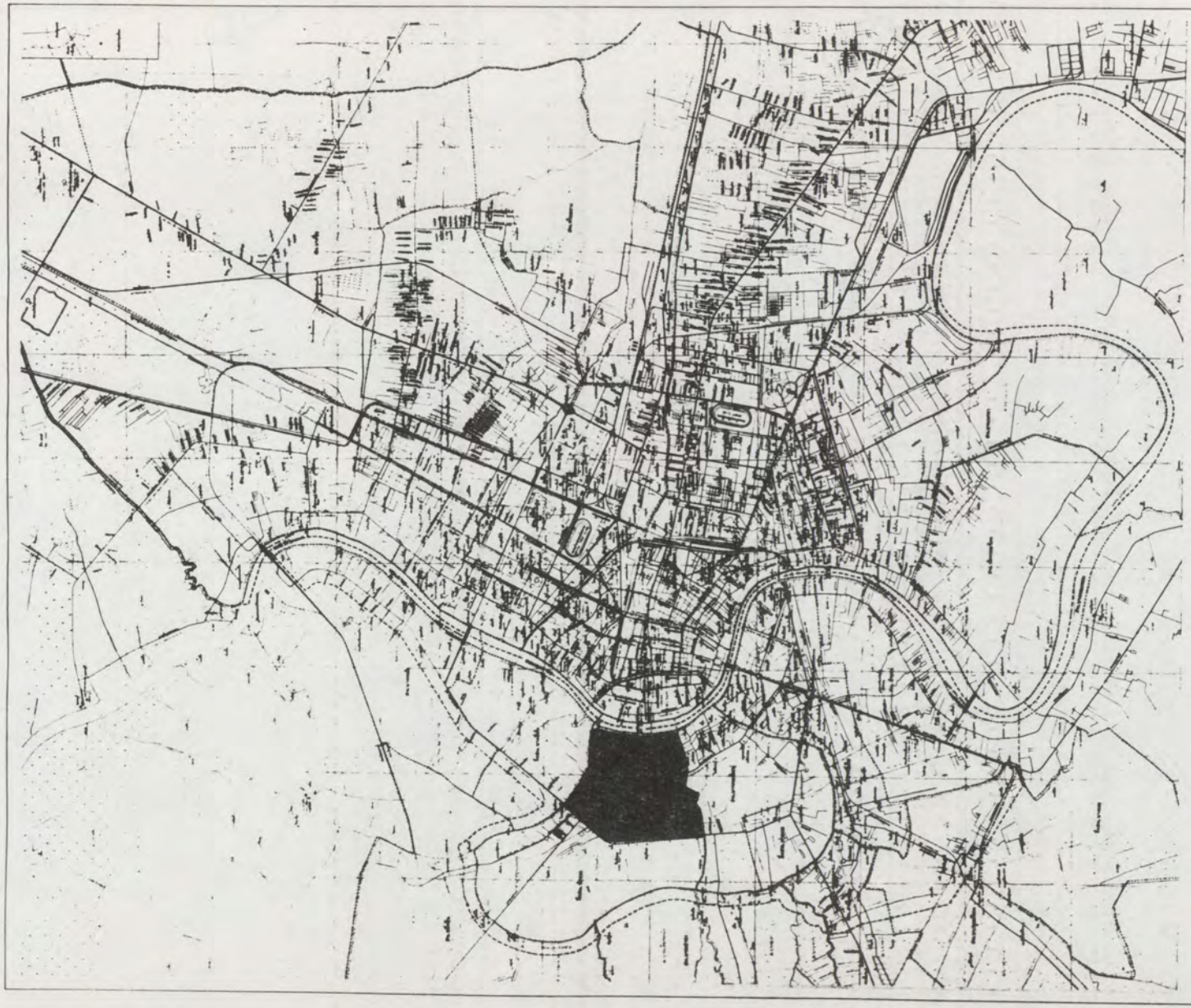
SUMMARY

VI. SUMMARY

The main objective of this thesis is to study methods and procedures for low-cost residential development in the city of Greater Bangkok. In the particular site selected for discussion and study, the family incomes are very low. Therefore, low-cost construction is the main consideration. Low-cost construction can be attained by using aided-self-help construction and the bamboo reinforced construction system. As for the whole community, an organization should be established to plan and control the development processes. The community should be properly zoned, with different sections of the area serving different functions. Community development should be accomplished step by step. Special attention should be given to road development and lot division. Ample roads must be provided to avoid the concentration of population carefully studied so that there will be enough living space for each resident.

It is believed that with a proper combination of the above mentioned measures, the housing problems in Greater Bangkok can be greatly alleviated.

ILLUSTRATIONS


N
MAP OF GREATER BANGKOK
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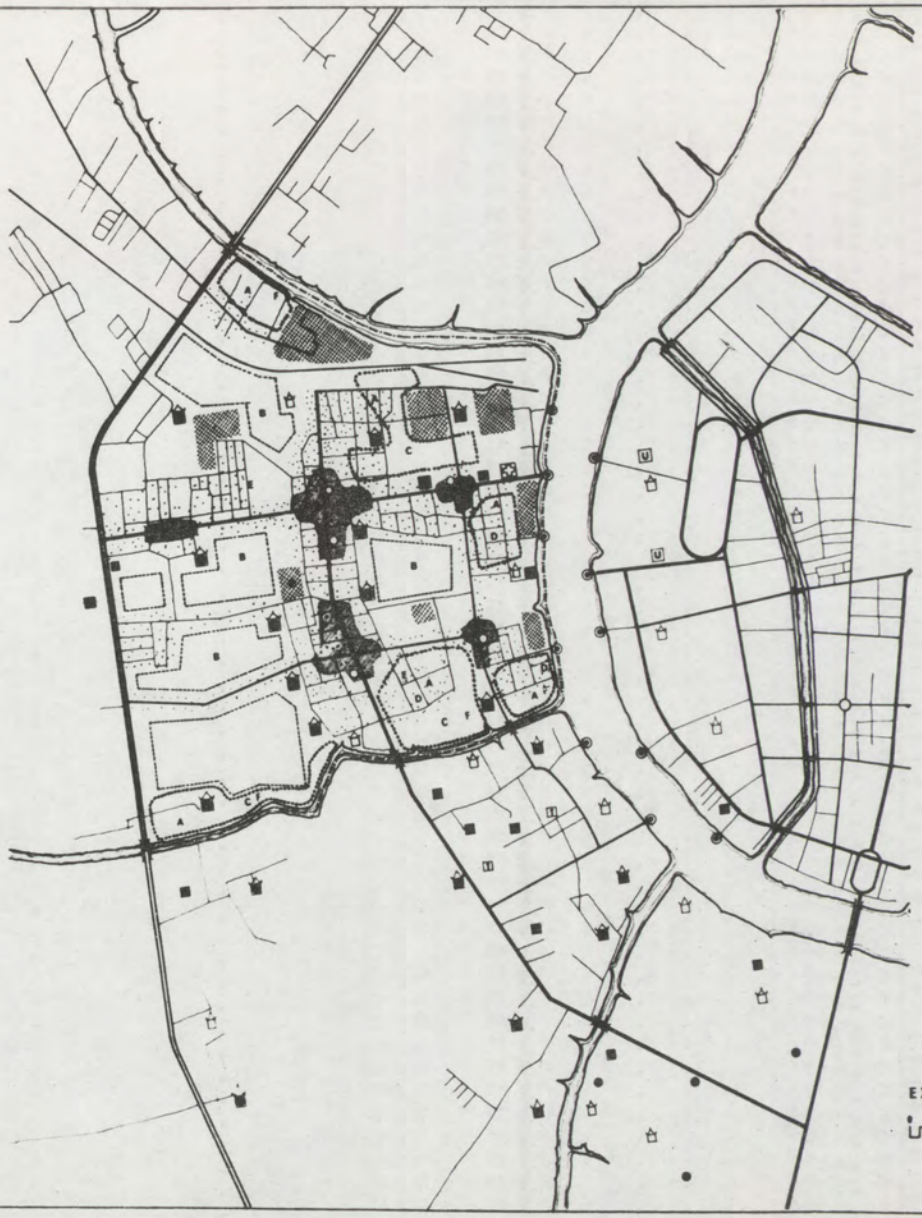
SATHIT CHAIYASIN
1



LAND USE
- BUILT-UP AREA
- COMMERCIAL
- LIGHT INDUSTRY
- VACANT LAND
- SQUATTER
- BOUNDARY OF SITE
- MAJOR ARTERY
- SECONDARY ARTERY
- COLLECTOR
- SERVCE
- RAILROAD

SCHOOLS
- PRIMARY
- TEMPLE
- PRIMARY ON TEMPLE GROUND
- HIGH
- TECHNICAL
- UNIVERSITY
- HOSPITAL & MEDICAL SCHOOL

OTHER FACILITIES
- FOOD MARKET
- THEATER
- BUS TERMINAL
- FERRY STATION

CONDITIONS
- A OVER CROWDED AREA
- B IMPROPER USE OF LAND
- C INCONVENIENT ACCESS
- D NARROW STREET
- E LACK OF COMMUNITY FACILITIES
- F LACK OF PUBLIC UTILITIES

EXISTING LAND USE

0 500 1000 2000 3000 M

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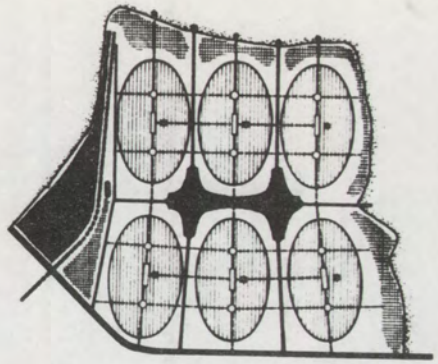
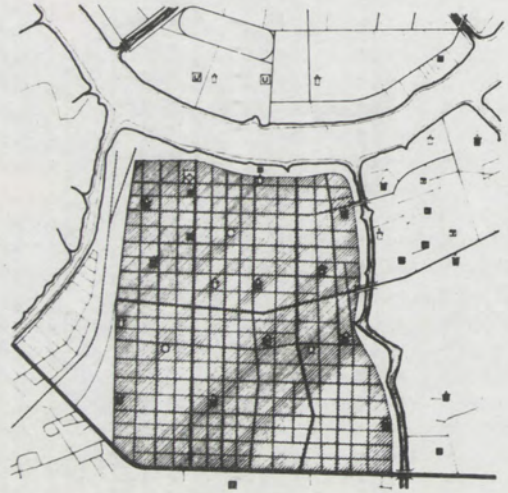


Community Concept

- Neighborhood
- Community Center
- Light Industry
- Recreational Area
- Water Front
- Neighborhood Center
- Neighborhood Shops & Market
- Primary School
- Railroad Station
- Ferry Station
- Major Artery
- Main Artery
- Minor Artery
- Railroad
- Bus Line

Existing Educational & Religious Facilities

- Temple
- Primary School on Temple Ground
- High School
- Technical School
- University
- Hospital & Medical School
- Urbanized Area



Proposed Educational & Religious Facilities

- Existing Temple
- Existing Primary School on Temple Ground
- Proposed Primary School & Temple
- Proposed Primary School
- High School
- Technical School
- University
- Hospital & Medical School
- Urbanized Area

CONCEPT & ANALYSIS

0 500 1000 2000 3000 4000 m

LOW COST HOUSING

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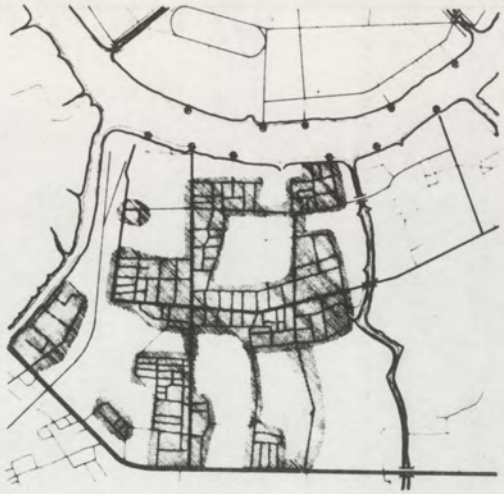
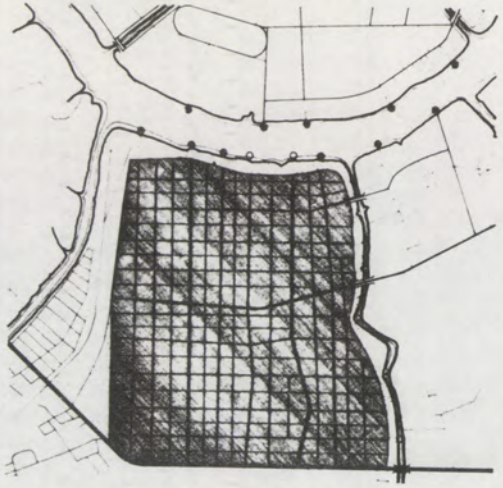
3



Existing Circulation

Condition

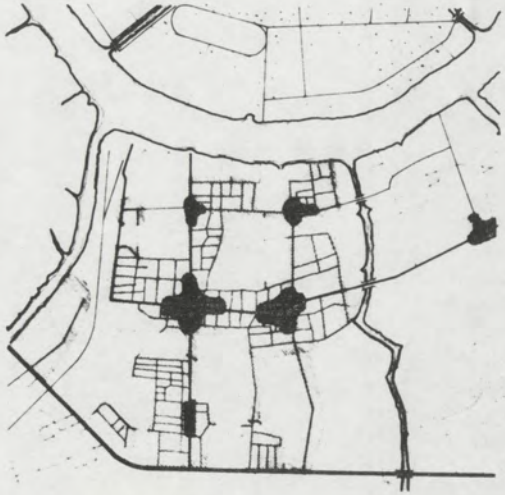
- Major Intercity Traffic
- Minor Intercity Traffic
- Main Road
- Feed Road
- Railroad
- Ferry Station
- Urbanized Area



Proposed Circulation

Pattern

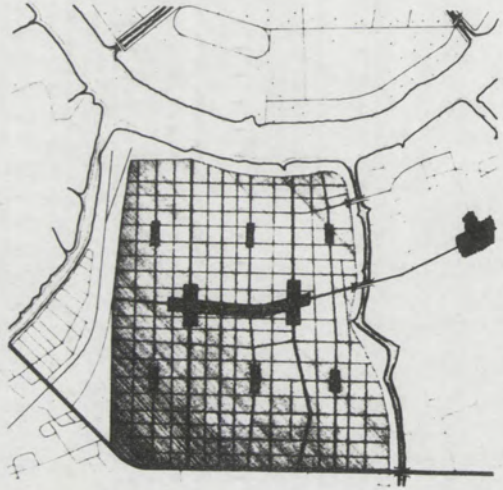
- Major Intercity Traffic
- Minor Intercity Traffic
- Collector Road
- Feed Road
- Railroad
- Existing Ferry Station
- Proposed Ferry Station
- Green Area
- Urbanized Area



Existing Commercial

Condition

- Sub Commercial Area
- Neighboring Commercial Area
- Major Business Area
- Urbanized Area



Proposed Commercial

Pattern

- Commercial Center
- Sub Commercial Center
- Neighboring Commercial Area
- Major Business Area
- Urbanized Area

SITE ANALYSIS

0 800 1000 2000 3000 4000 ft

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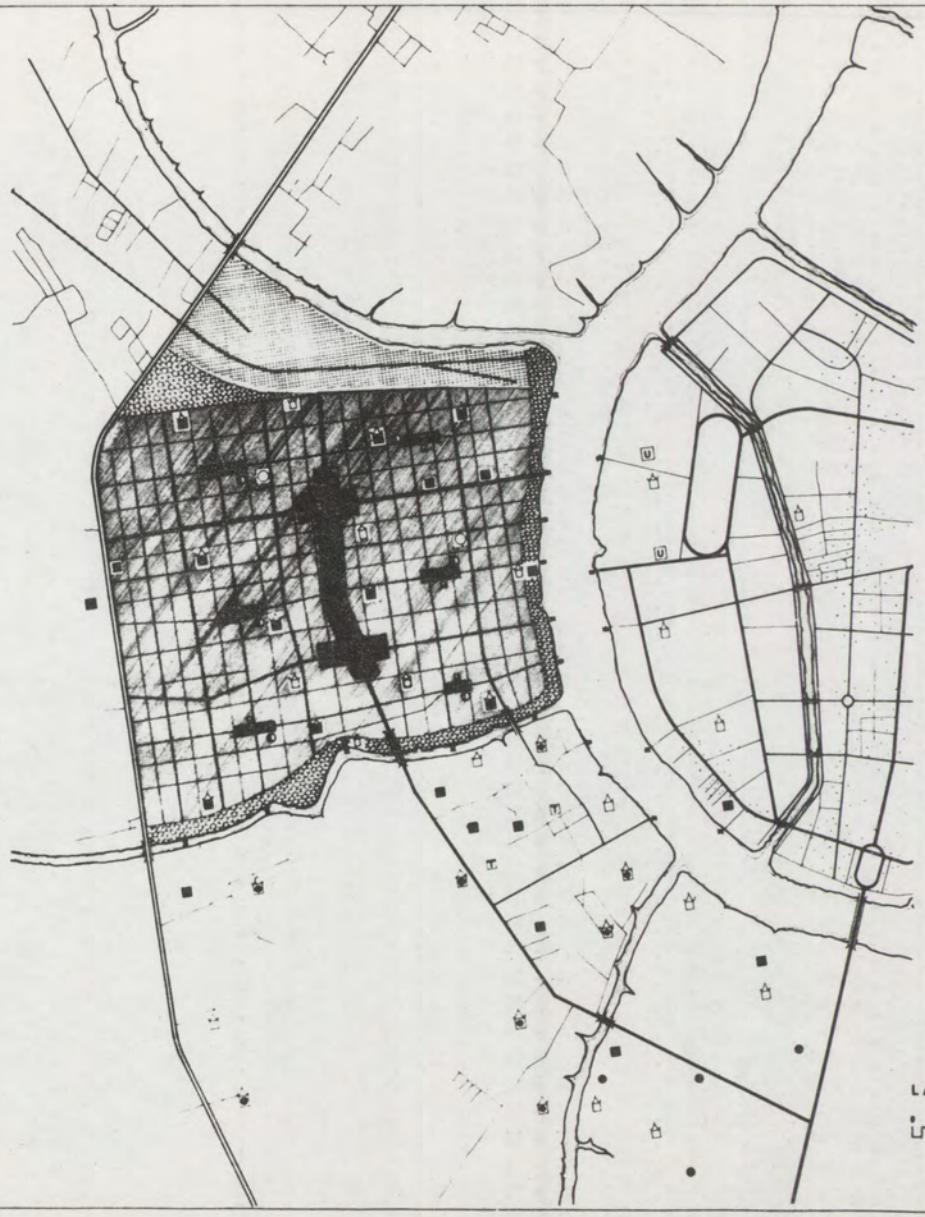

HOUSING
NEIGHBORHOOD SHOPPING
COMMUNITY CENTER
MAJOR BUSINESS CENTER
LIGHT INDUSTRY
GREEN AREA
MAJOR ARTERY
MAIN STREET OF SITE
SECONDARY ARTERY
COLLECTOR
SERVICE
RAILROAD
TEMPLE
PRIMARY ON TEMPLE GROUND
EXISTING PRIMARY
PROPOSED PRIMARY
PROPOSED PRIMARY & TEMPLE
HIGH SCHOOL
TECHNICAL
UNIVERSITY
HOSPITAL & MEDICAL SCHOOL
PROPOSED FOOD MARKET
EXISTING FOOD MARKET
NEIGHBORHOOD CENTER
BUS TERMINAL
EXISTING FERRY STATION
ADDITIONAL FERRY STATION

LAND USE PLAN

0 500 1000 2000 3000 M

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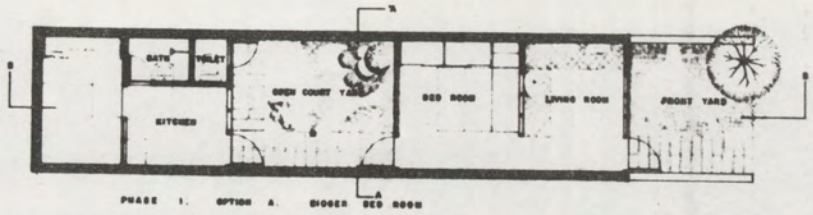
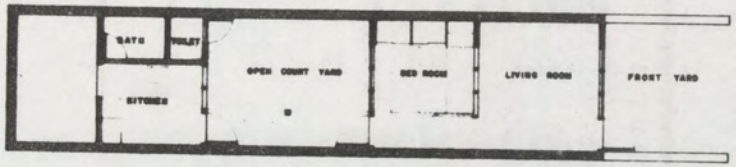
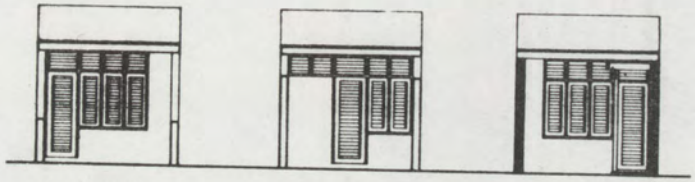


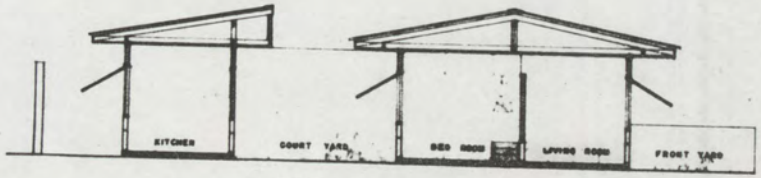
PHASE I. OPTION A. BIGGER BED ROOM



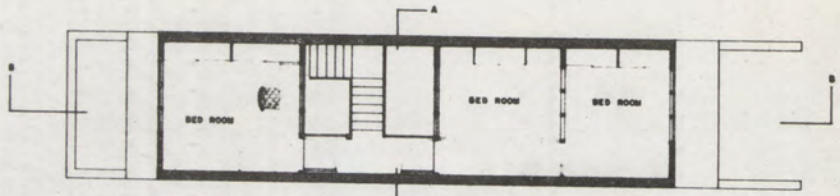
PHASE I. OPTION B. BIGGER LIVING ROOM



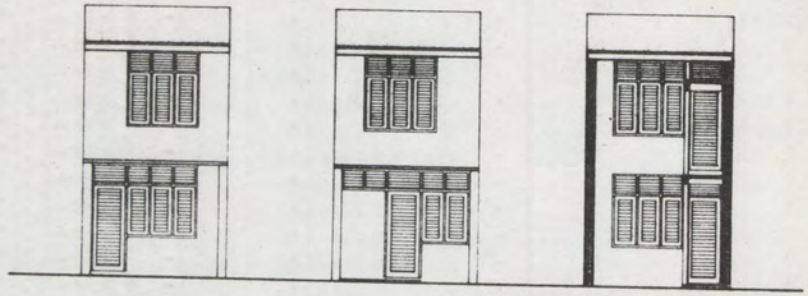
FRONT ELEVATION BACK ELEVATION SECTION A - A



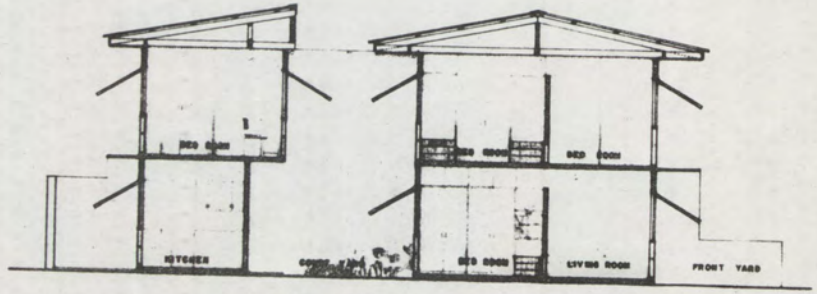
SECTION B - B



PHASE II. PHASE III. PHASE IV.

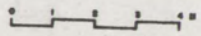


FRONT ELEVATION BACK ELEVATION SECTION A - A



SECTION B - B

DWELLING UNIT



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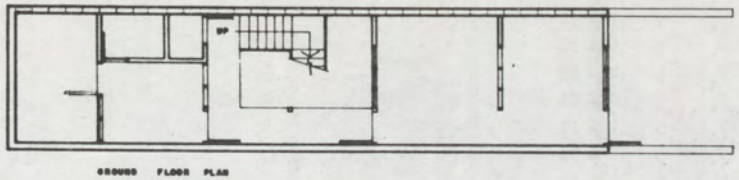
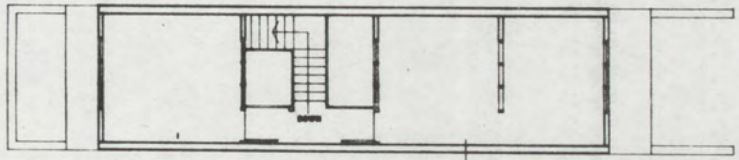
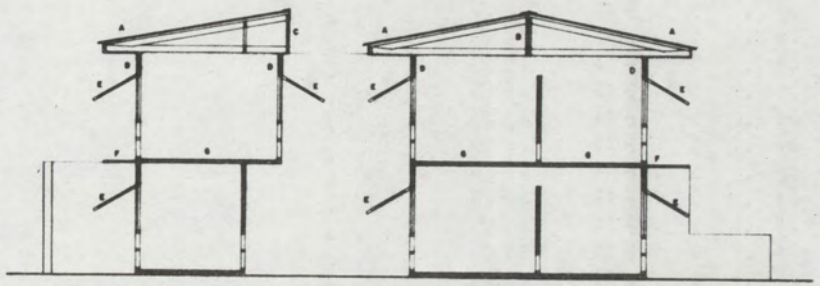


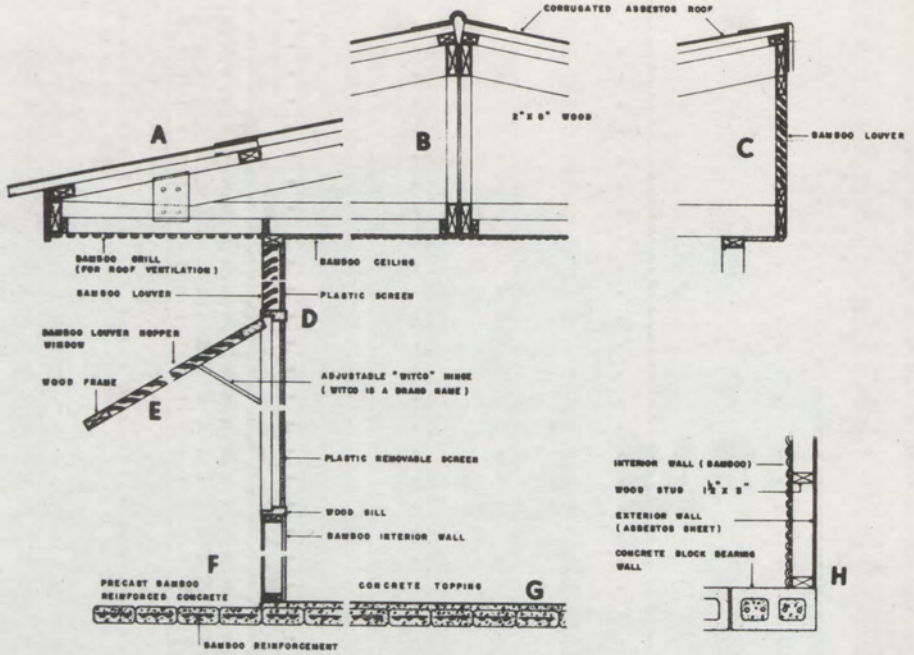
GROUND FLOOR PLAN



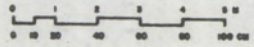
SECOND FLOOR PLAN



SECTION



STRUCTURE



LOW COST HOUSING

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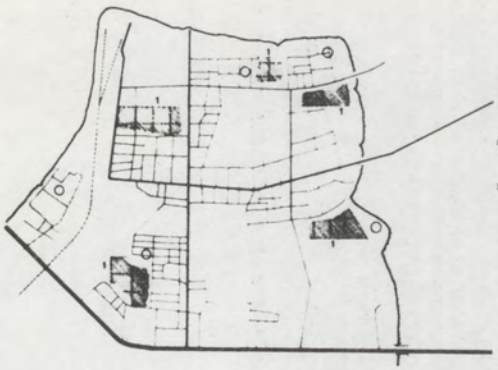
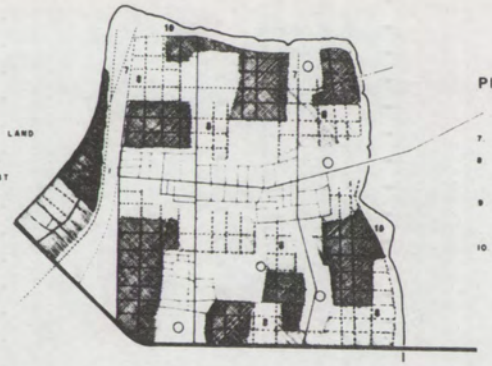


Phase I

1. DEVELOPMENT OF VACANT LAND AND ROADS
2. PEOPLE FROM THE WORST AREA ○ MOVE IN



Phase III

7. DEVELOPMENT OF ROADS
8. DEVELOPMENT OF THE WORST AREA
9. CONSTRUCTION OF PRIMARY SCHOOL
10. DEVELOPMENT OF RECREATIONAL WATER FRONT AREA

Legend

AREA

EXISTING URBANIZED

BEING DEVELOPED

ALREADY DEVELOPED

CIRCULATION

EXISTING

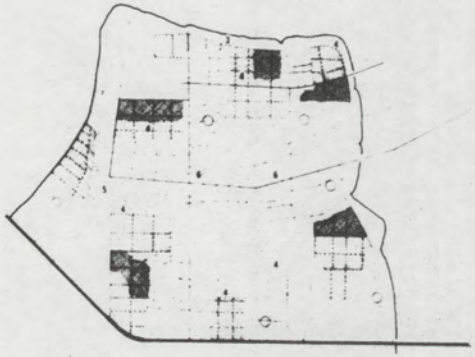
BEING DEVELOPED

ALREADY DEVELOPED

RAILROAD

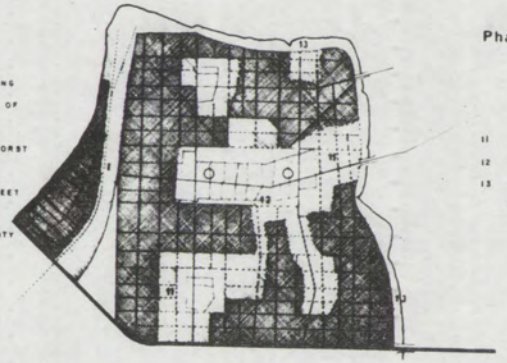
RAILROAD STATION

THE WORST AREA



Phase II

3. IMPROVEMENT OF EXISTING ROADS & DEVELOPMENT OF NEW ROAD
4. DEVELOPMENT OF THE WORST AREA
5. EXTENTION OF MAIN STREET & RAILROAD STATION
6. DEVELOPMENT OF COMMUNITY CENTER



Phase IV

11. DELOPMENT OF ROADS
12. DEVELOPMENT OF CENTRAL AREA
13. DEVELOPMENT OF RECREATIONAL AREA

DEVELOPMENT PROCESS

0 500 1000 2000 3000 4000 M

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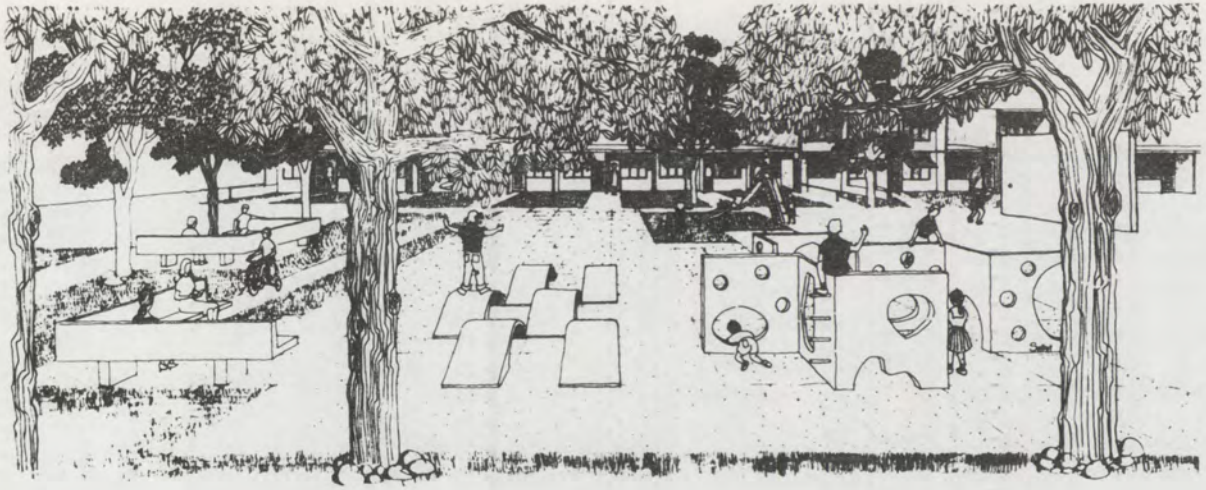
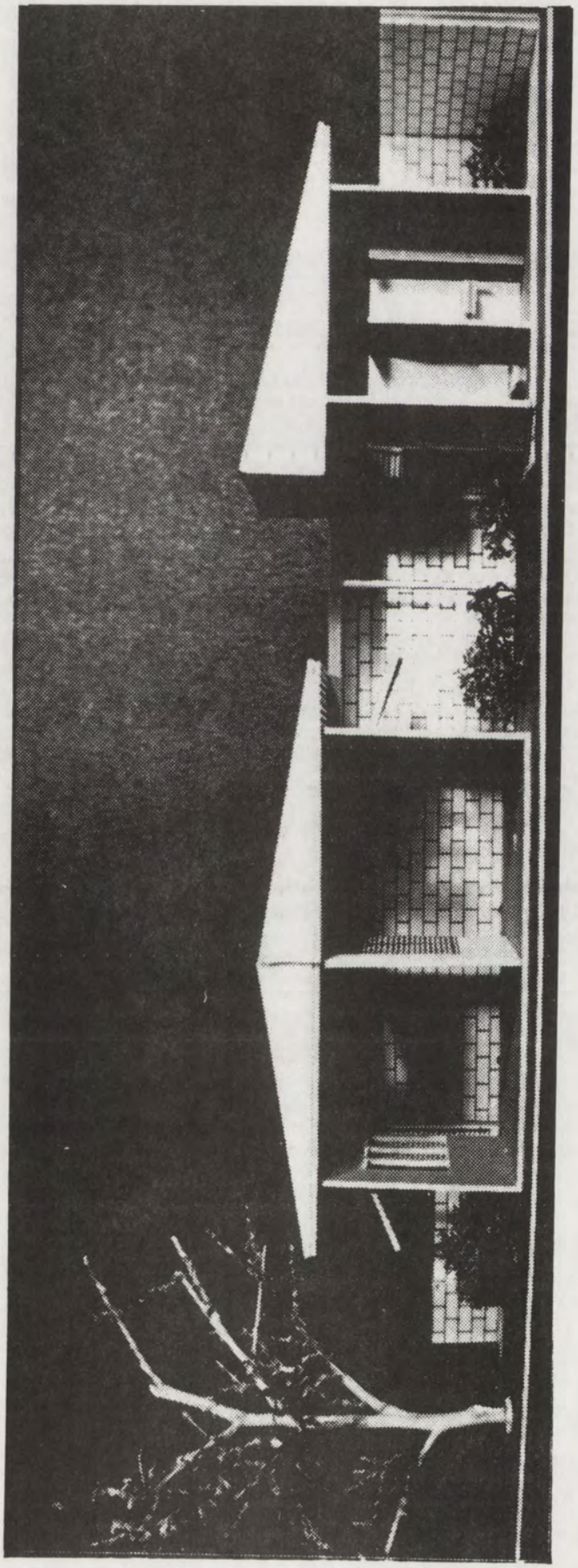
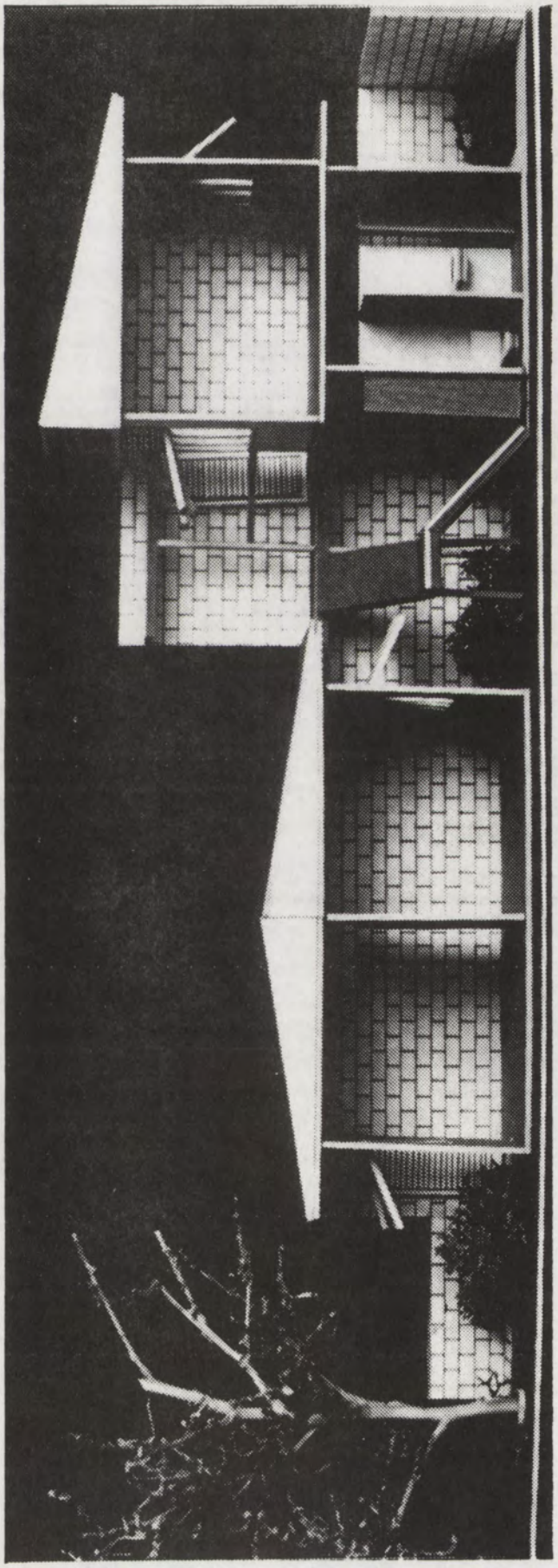


View from Playground

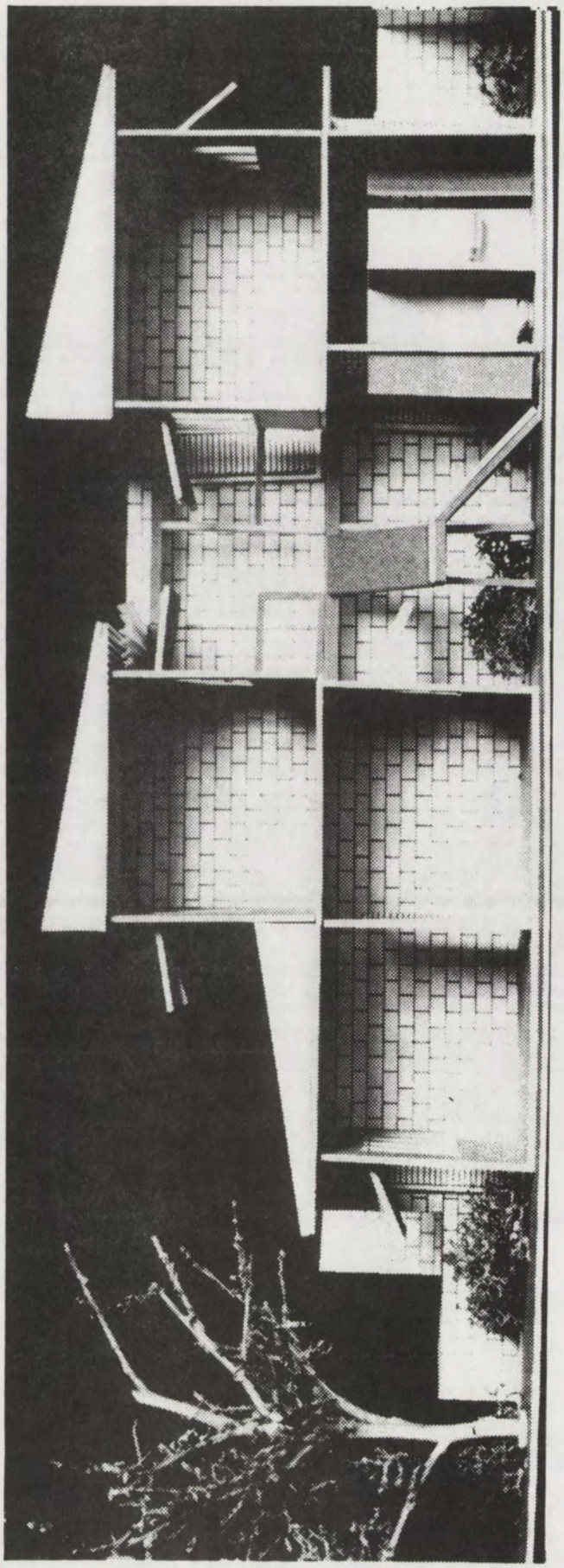
View from Waterfront Park



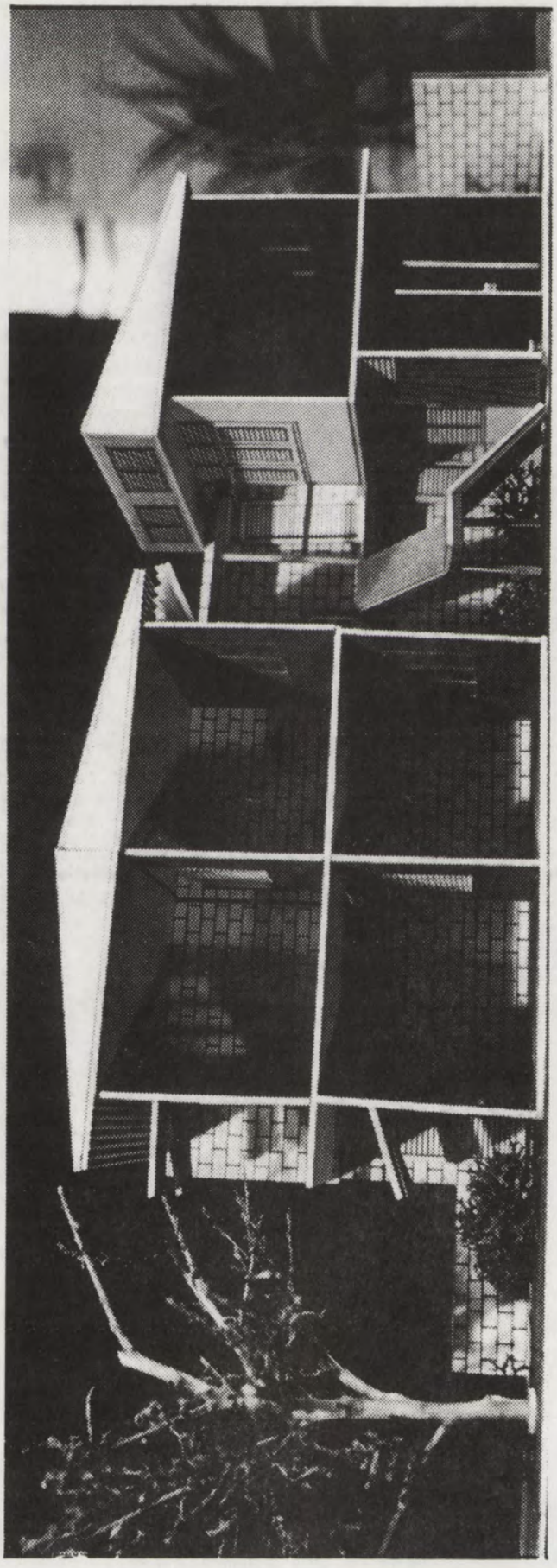
Stage 1. A house consisting of one bedroom, a living room (can be used as a bedroom at night), a kitchen, a toilet room and a shower room, and an open court.



Stage 2. One bedroom is added above the kitchen.



Stage 3. As the family's needs expand and economic is improved, the third bedroom is added.



Stage 4. The fourth bedroom is added to complete the whole second floor.

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APPENDIX

APPENDIX

The Test of the Properties of Bamboo

This section is obtained from "The Report the Test of the Properties of Bamboo for Concrete Reinforcement" by a group of senior students in the Department of Civil Engineering, Chulalongkorn University, Thailand in 1958.

A. Bamboo tensile strength test

1. Objective: To test the tensile strength of bamboo and its behavior under large loads.

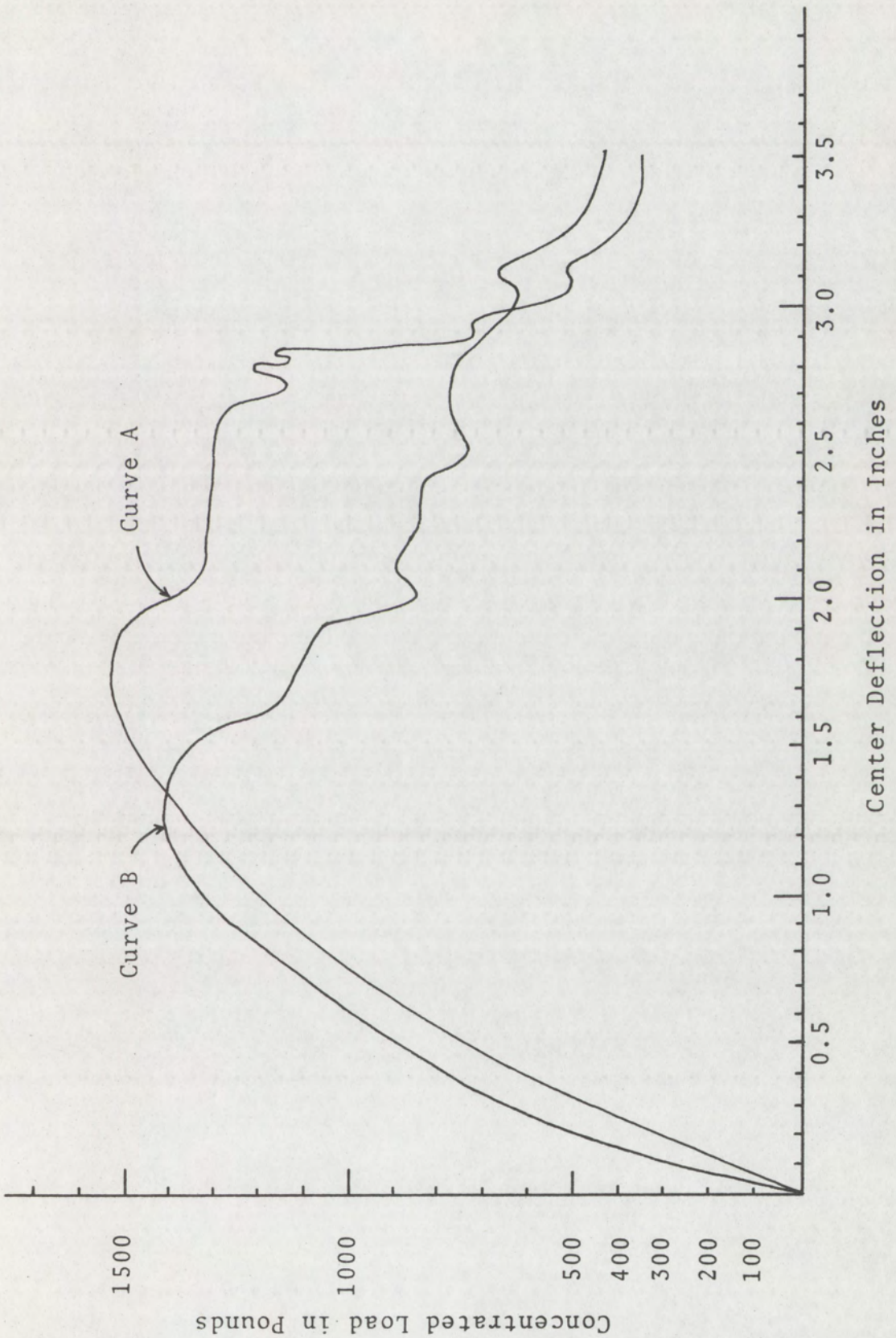
2. Material and equipments: Bamboo and Instron (Multipurpose testing machine).

3. Procedures:

a) Two bamboo testing samples were prepared. Sample A, as shown in figure i., was cut between nodes. Sample B, as shown in figure ii., was cut with node in the center.

b) Samples were tested on the Instron, both samples were tested to complete failure.

4. Data and conclusion: Resulting graphs are included in the next page. The area of sample A was 0.065 $in.^2$ The


Curve A
Curve B
1500
1000
500
400
300
200
100
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Concentrated Load in Pounds
Center Deflection in Inches

highest load that could be carried by this sample was 1,900 lbs. This gives an ultimate strength of 28,600 psi. The area of sample B was 0.0885 $in.^2$ The highest load resisted was 1,660 lbs. This gives an ultimate strength of 18,800 psi.

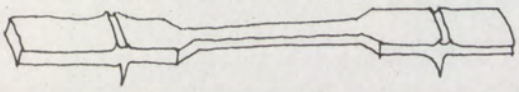


Figure i. Sample A

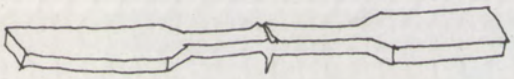


Figure ii. Sample B

In both cases, skin failed first. Then skin and inner part split. Finally, the inner part failed.

Another interesting fact was noticed. The bamboo with a node began to fail at the nodal location, and its ultimate strength was 36% less than that of the sample without nodes.

In both tests, failure occured at the clamped ends. Skin at the clamped places were damaged. As a result, the bamboo sample slipped out of the clamps. One has good reason to believe that much higher loading could be applied if more secure supports were used. According to the study, the bamboo has the largest tensile strength when it is 4 to 5 years old.

B. Water absorption test

1. Objective: To study the water absorption charac-

teristics of bamboo.

2. Materials and equipments used: Bamboo, measuring tape and scale.

3. Procedures: Essentially, two tests were performed. One involves the change in weight and the other considers the change in dimensions.

a) Weight considerations

- Two short samples of bamboo were prepared. They are as shown in figure iii, and figure iv. Sample A was unsplit and had nodes at both ends, while sample B was a split piece.
- Weigh both samples on the scale.
- Immerse both samples in water for 24 hours.
- Weigh both samples again.

b) Size considerations

- Two samples were prepared. Sample C is the same as sample A. Sample D as shown in figure v, did not have nodes at the ends.
- Measure the perimeters of both samples.
- Samples were immersed in the water for 24 hours.
- Measure the perimeter of both samples again (taken at the same point).

4. Conclusions: In the first test, after immersion

in the water, sample A and B increased weight by 12.2% and 26.8%, respectively. In test two, sample C increased its perimeter by 0.86%, while sample D increased its perimeter by 1.78%.

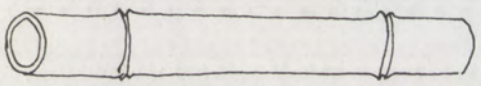


Figure iii. Sample A & C

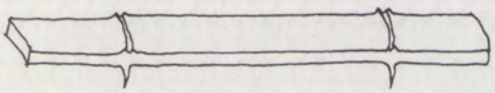


Figure iv. Sample B

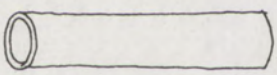


Figure V. Sample D

In conclusion, it is clear that the water absorption of bamboo is quite large, but the change in perimeter is relatively small. Apparently most of the absorbed water filled the pore spaces of the bamboo plank. It is also obvious that closed bamboo segments with inner skin well prevented from coming into contact with water tend to absorb less water and thus do not expand as much as an open segment.

C. Bamboo reinforced concrete beam test

1. Objective: To investigate the behavior of bamboo reinforced beam under concentrated load.

2. Materials and equipments used: Portland cement, sand, gravel, bamboo sticks, 1/16 inch diameter steel wires, motor oil, 1/2 inch plywood, deflection guage, and hand operated machine.

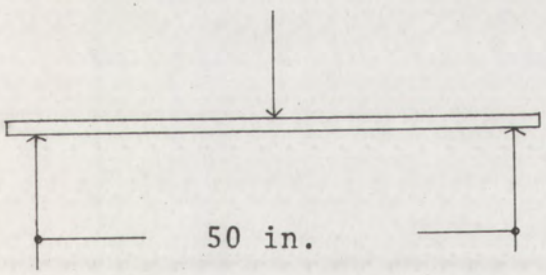
3. Procedures:

- Two plywood forms were made. Each with a cross section of 3.15" x 7.9" (8 cm. x 20 cm.) and a langth of 5 feet.
- Bamboo reinforcing bars were cut and coated with motor oil for waterproofing. Form works were also coated with motor oil.
- Bamboo reinforcing bars were placed into the forms. This was then followed by the mixing and pouring of 1:2:4 concrete.
- Beams were covered by wet paper and permitted to stand for 23 days.
- At the end of setting period, beams were tested by a hand operated machine. Sharp edge supports were used for support at both ends of the beam so that the beam was allowed to rotate freely. Concentrated load at the center was used to test the strength of the beams. Load was gradually increased and corresponding deflections were recorded by reading off the deflection guage.
- Conditions of the beams at various stages of

loading were photographed.

4. Computations and conclusions: Loadings are plotted against corresponging deflections at the center in the graph on following page. Curve "A" is for the beam with cross section as shown in figure vi, and curve "B" is for the other beam with the cross section as shown in figure vii.

Both beams started to crack at about 700 lbs. of concentrated load. This corresponds to a maximum moment at the center of 730 ft-lb.



$$M = \frac{PL}{4}$$

$$M = \frac{700 \times 50}{12 \times 4}$$

$$M = 730 \text{ ft-lb}$$

Or:

$$\frac{M}{ft} = \frac{730}{(7.9 \times 12)}$$

$$= 1{,}111 \text{ ft-lb/ft}$$

This is equivalent to the moment resulting from a uniformly distributed load of 92.6 lb/ft^2.

$$\frac{wL^2}{8} = M$$

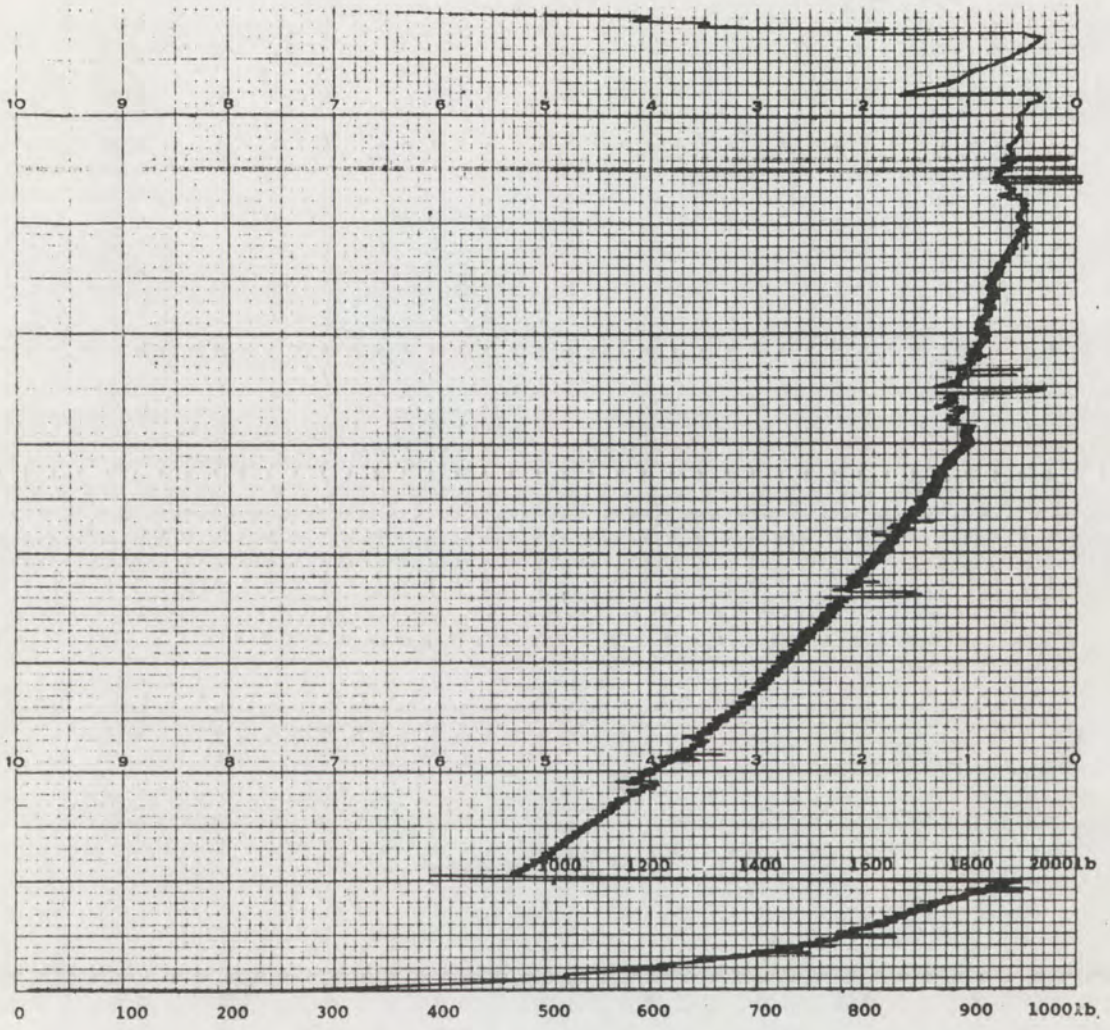
$$1{,}111 = \frac{w(300 \times 0.0336)^2}{8}$$

$$w = 92.6 \text{ lb/ft}^2$$

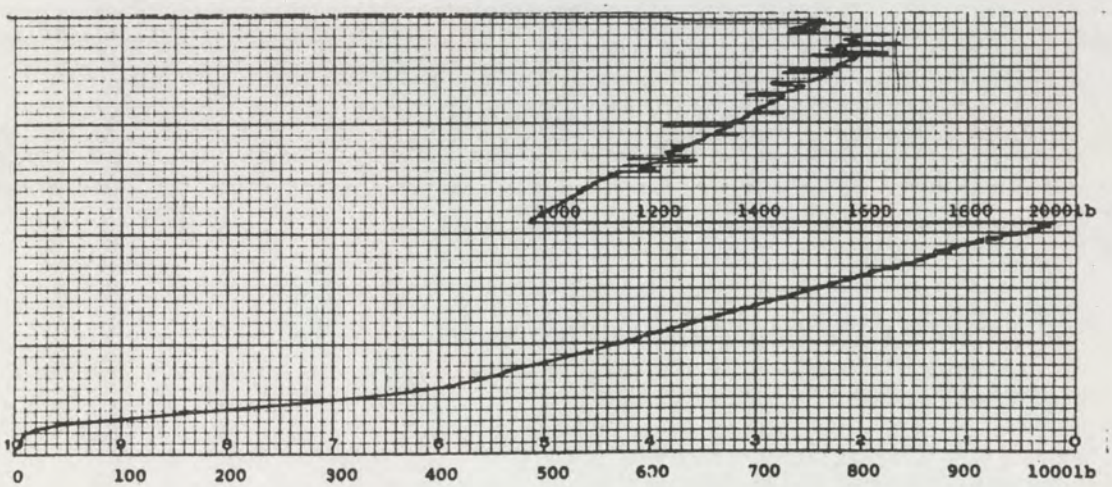
$$\text{Dead load of slab} = \frac{3.15 \times 120}{12}$$

$$= 31.5 \text{ lb/ft}^2$$

$$92.6 - 31.5 = 61.1 \text{ lb/ft}^2$$



Tensile strength of bamboo without knots



Tensile strength of bamboo with knots

The liveload which can be resisted is 61.1 lb/ft^2, which is about the usual design value.

From the graph, one can see that after the appearance of the first crack, the beams continued to increase their strength. Maximum load was around 1,500 lbs. Even after testing, the bamboo reinforcing bars did not crack. Thus, a design based on 700 lbs. of loading would be quite conservative. Also, crude equipments were used in mixing the concrete and in testing the beam. With a little more skill, the strength of bamboo reinforced beams will probably be much higher.

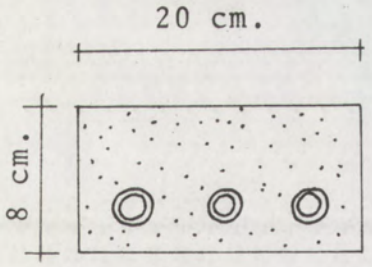


Figure vi. Beam Section A

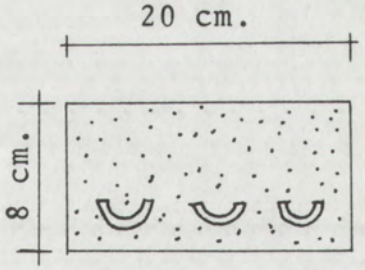


Figure vii. Beam Section B

With the above facts in view, it seems that bamboo reinforced concrete can be an economical structural material for use in low cost housings.