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PROPOSED BANGNA HOUSING PROJECT
BANGKOK, THAILAND

By

CHATCHAI GADAVANIJ

Bachelor of Architecture

Chulalongkorn University

Bangkok, Thailand

1960

Submitted to the Faculty of the Graduate
School of the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF ARCHITECTURE
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Report Approved:

Report Advisor

Dean of the Graduate School

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CHAPTER I

INTRODUCTION

After World War II, the Government of Thailand had to undertake a number of housing projects in Bangkok because of the increase in population and a lack of proper housing for the masses. Spacious sites were selected and rows of apartment buildings in ferro concrete were constructed. Though, in outward appearance, these are ordinary western-style buildings, the individual units in the complex maintain Thai character. There are several projects of this sort comprising groups of 1000 units or more. Each apartment complex also has such supplementary buildings as primary schools, kindergartens and supermarkets.

Building projects like these in Bangkok, as it has been observed, have to be designed according to the requirements of the climatic and environmental conditions of the tropical areas. In the design of housing in the tropics, the principal object is to provide free air movement through the building and to provide effective insulation from the heat outside. These considerations may influence the design of openings in the walls and the thickness of the exterior walls. Careful consideration of such factors affecting the buildings is needed for their successful function in the tropical zones. The housing in Bangkok and its design with particular reference to these considerations is therefore of topical interest.

CHAPTER II

CLIMATIC AND SOCIOLOGICAL CONDITIONS

Bangkok, the capital city of Thailand is situated at latitude $13^{\circ} 44'N.$, longitude $100^{\circ} 30'E.$ with the altitude being about 2 meters above sea level. The total area is about 889 square kilometers. The city is on the flat plain along the left bank of Chao Phya River. It is about 30 kilometers north of the Gulf of Thailand.

1. The Seasons. Meteorologically, the seasons in this region may be divided into four seasons, namely;

(1) Cold season or Northeast monsoon season, November to February. The lowest temperature that has ever been registered was a low of $9.9^{\circ}C.$

(2) First transitional season, March to mid-May is the hottest period of the year when the extreme maximum temperature has risen up to $39.9^{\circ}C.$ ($104.0^{\circ}F.$) on the 27th of April 1941.

(3) Rainy season or Southwest monsoon season, mid-May to September, is the wet period of the year.

(4) Second transition season, October, changeable weather, that is, frequent rains with thunderstorms dry and cool in the second half.

2. Temperature. Because the location of Bangkok is in the tropics the temperature generally is high, especially in the afternoon. Even though in the cold season, November to February, the mean

minimum temperature in the early hours is about 21.5°C . (71.10°F .) but in the afternoon the mean maximum may rise to 31.7°C . (89.0°F .) which shows great variation. In the hot season, March to mid-May, the temperature will climb up to the season's high in April or the first part of May. The mean maximum temperature during this season is about 35.0°C . (95.0°F .) with $2 - 3^{\circ}\text{C}$. above the mean value. The factors reducing temperature are winds from the sea and rain. The sea breezes are the principle cooling factor and usually come in the afternoon and evening and sometimes the wind velocity will rise to 20 or 25 miles per hour. Because of this sea breeze, kite flying is one of the national sports.

3. Rainfall. The average annual rainfall at Bangkok is 1531 mm. (60 inches) with 131 rainy days average. The rainfall may be divided into seasons as follows: 60% comes in the rainy season, 34% comes during the two transitional seasons, and 6% falls during the cold season.

4. Relative Humidity. The average relative humidity is high because of the nearness of the sea. The annual average humidity is about 80% with the maximum value of about 85% in the rainy season and the minimum value of about 75% in the cold season. During the cold spells, most frequent in January, the apparent relative humidity may be reduced to 30% depending on the strengthening of the north-east monsoon.

5. Winds. Surface wind and rainfall are closely related. During the Southwest monsoon (wet season), mid-May to September, winds are generally westerly and southwesterly. In October, variable

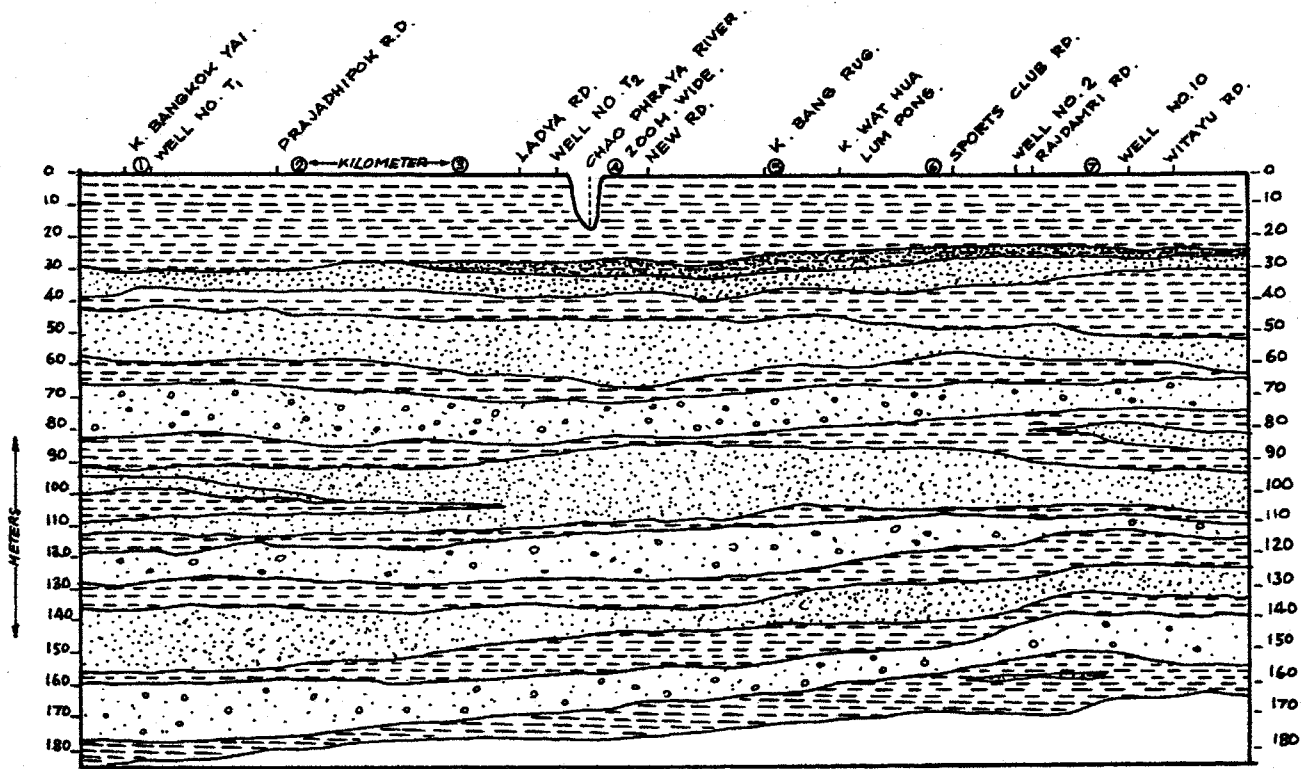
CLIMATOLOGICAL DATA OF BANGKOK
PERIOD B. C. 2480 - 2505 (A. D. 1937 - 1962)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year B. C.
Temperature(C)													
Mean	26.2	28.0	29.3	30.1	29.7	29.0	28.5	28.4	28.1	27.7	26.9	25.6	2480-2503
Mean Min.	20.2	22.7	24.4	25.2	25.1	24.9	24.5	24.5	24.3	24.1	22.8	20.3	2480-2501
Mean Max.	32.1	33.0	34.3	34.7	34.3	33.0	32.5	32.3	31.9	31.3	30.9	30.8	2480-2501
Rainfall (mm)	9.0	28.6	34.3	89.4	166.3	170.7	177.9	190.9	305.9	254.7	57.3	7.1	2474-2503
Humidity %	71.4	74.1	73.6	74.3	78.6	79.4	79.4	80.1	82.1	82.7	79.3	73.5	2480-2498
Wind Direction %													
N	15.1	5.0	2.8	2.0	0.9	0.7	0.6	0.8	5.1	21.4	33.9	34.6	2493-2497
NE	22.6	12.1	7.2	4.7	2.6	0.8	1.2	1.0	4.3	16.5	22.5	24.1	" "
E	14.5	16.5	7.9	5.6	5.0	2.1	3.0	1.5	4.9	7.7	6.7	6.1	" "
SE	3.6	12.5	11.1	13.7	12.1	9.7	8.8	5.7	7.6	6.2	1.3	0.3	" "
S	7.6	20.7	35.0	37.5	30.1	35.7	25.9	26.3	19.3	7.1	0.8	0.3	" "
SW	4.8	14.0	18.5	16.7	18.2	24.5	27.4	25.9	20.8	5.5	1.5	0.1	" "
W	4.0	2.3	2.8	4.7	8.0	8.1	12.1	20.5	12.9	6.3	2.8	2.3	" "
NW	8.0	3.0	1.0	1.3	1.3	0.3	2.1	2.6	3.9	7.4	10.7	18.8	" "
Calm	19.9	14.0	13.7	13.9	21.8	18.0	19.0	15.6	21.2	21.8	19.9	13.4	" "
Extreme Max(BF)	5.0	5.8	6.4	7.4	7.4	7.8	7.8	7.6	6.2	6.4	6.8	5.2	" "
Average Force	1.2	1.5	1.7	1.9	1.4	1.5	1.5	1.6	1.3	1.2	1.1	1.3	" "
Sunlight (hr)	292.6	214.4	270.6	268.6	180.6	167.4	132.3	150.5	143.1	215.4	265.0	265.8	2505

winds with an easterly tendency prevail and occasional gusts due to thunderstorms will occur in the first half of the month. From November the winds shift, cool weather sets in gradually then until February when the winds are mostly from the north and northeast. From March through mid-May, surface winds are again variable with the tendency of southerly direction. However, sea breezes have a considerable effect on the wind direction. It is steady from the southerly directions in the afternoon and most of the time continues blowing until late in the evening. (Typhons in this area are rare.)

6. Bangkok Subsoil. Bangkok subsoil has developed on the alluvium of the Chao Phraya River combined with that of the coalesced delta of the Mae Klong, Pasak, Prachin and other rivers which have worked together to build the central plains. Great quantities of silt are carried down and deposited on the bar at the mouth of the river during the rainy season each year. Numerous sand banks containing sea shells of a recent date are to be found all over the central plains. These sand banks were at one time sand bars which guarded the former mouth of the river. The plain has grown by the development of a succession of bars, with the lagoons filling up behind them.

The developed profile in the soil is about 2 m. deep. The dark gray (nearly black when wet) surface soil is characteristic and is typical of clay soils under alternating seasons of saturation and then intense drying, with deep wide cracking of the surface soil. The dark color does not indicate any considerable quantity of organic matter nor any marked amount of fertility.



JUNE 2502 B.E. (1959)

-  CLAY.
-  SANDY CLAY.
-  SAND.
-  SAND & GRAVEL.

NOTE: GRANITE BED AT APPROXIMATELY 365 M.

GEOLOGIC CROSS-SECTION OF BANGKOK - THONBURI.

The low flat terrain of the Bangkok plain, and its very slight elevation above mean tide level means that hardly more than a few meters below the surface the soil is usually permanently saturated; at less than 2 m. depth the undisturbed soil is always saturated with ground water.

A vertical sequence of soil types encountered beneath the ground surface is as follows:

- (1) Dark gray or black clay for a depth of about 10 m.
- (2) Light brown to yellow clay for a depth of about 10 m.
- (3) Sandy clay for a depth of 4 - 8 m.
- (4) Successive layers of sand, clay and gravel and clay of various depths.

2-1. History of Bangkok

Fifteen hundred years ago, the present site of Bangkok and Thonburi was entirely beneath the water of the Gulf of Siam. The alluvial deposits of fine silt brought down by the Chao Phraya River has built the fertile delta lands. In that time Thai people lived in South China, but they gradually drifted southward because of the presence of the enemy. (Mongol). In 1238 two Thai chieftains defeated the Khmer commander at Sukhothai and built there the capital of a powerful and vigorous Thai Kingdom. When Sukhothai declined, an even greater capital was established at Ayutthaya. When Ayutthaya in its turn fell to the Burmese, the present capital, Bangkok arose in 1767.

Bangkok, "City of the Angels", is the great city of the plain and the only cosmopolitan city in this land of villages. Bangkok is the center of the center — economically, politically, culturally. The country's nascent industry is here. Through the city flows goods entering Thailand from the capitals of world trade. All highways and railroads carry products to Bangkok, some to be consumed in the city, others to be routed to ports around the world.

2-2. Systems of Unit in Thailand

It may be of help to the reader unfamiliar to Thailand, to give a brief resume of the units in common use in the field of construction.

The metric system is generally used for measurement of length and weight. However, basic materials such as reinforcement and lumber materials are specified in inch sizes. Moreover, the incidence of engineers, trained in the United States, Britain and Australia, and of equipment from these countries, occasionally leads to a bewildering mixture of British and metric units, for instance, they use $1\frac{1}{2}$ " x 8" x 4.00 for the lumber.

Thai units used for land measurement are:

$$1 \text{ rai} = 0.167 \text{ hectares} = 0.412 \text{ acres.}$$

The Thai unit of currency is the Baht (20.85 baht = 1 U.S. dollar; 58 baht = 1 pound sterling).

In Thailand Buddhist Era (B. E.) is generally used instead of Anno Domini (A. D.). (eg., A. D. 1965 = B. E. .2508)

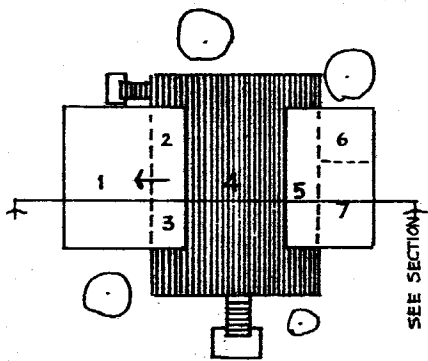
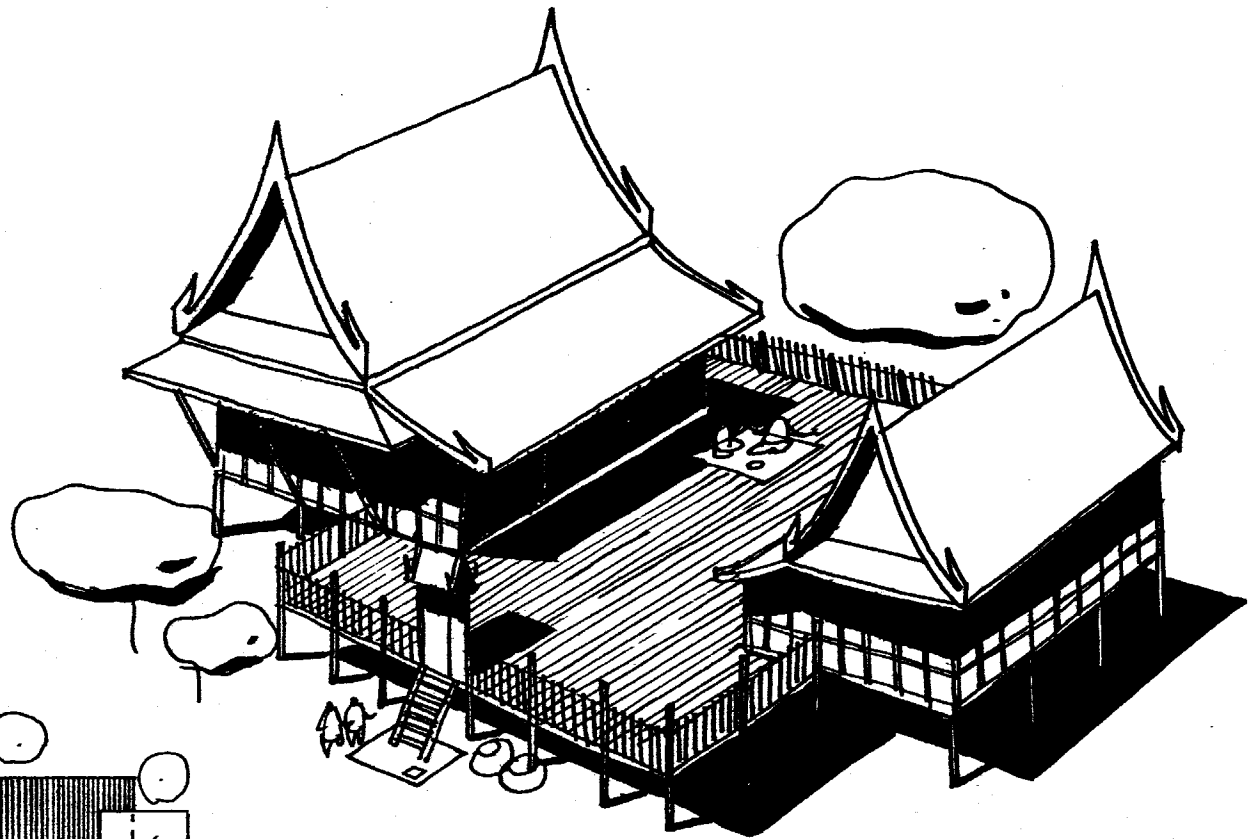
2-4. Housing in Ancient Times

Thai Architecture consists of two main parts; one is domestic and the other one is the temple. The modern house tends to be quite different from the temple expressions because it has been influenced by the European style since contact with the Europeans in the period of Rama IV.

In general the characteristic house is raised on posts some five to six feet above the ground. In the region near the river where there will be flooding in the rainy season, houses are built on taller posts than in other parts of the country. In such areas during the flood season, canoes are used to get from house to house. Houses are raised on posts mainly for protection from floods, animals and marauding thieves. The ladder is usually drawn up into the house at night.

In planning, the housing is composed of two main parts, the living room, bedroom, and the kitchen, connected with an open veranda which serves as the major means of circulation. In some large houses the space is divided between bedrooms for children and parents, and the living room. If the houses are small, the living room serves also as a bedroom. Some houses have the veranda open at the front where the meals are eaten. The family rests during the day, visitors are entertained, and the older boys sleep.

The other element is the kitchen and storage area, usually located at the rear of the house. The kitchen area is built like an open lean-to to allow smoke to escape from the clay stove since it has no chimney. The floor of the kitchen is built with wide chinks through



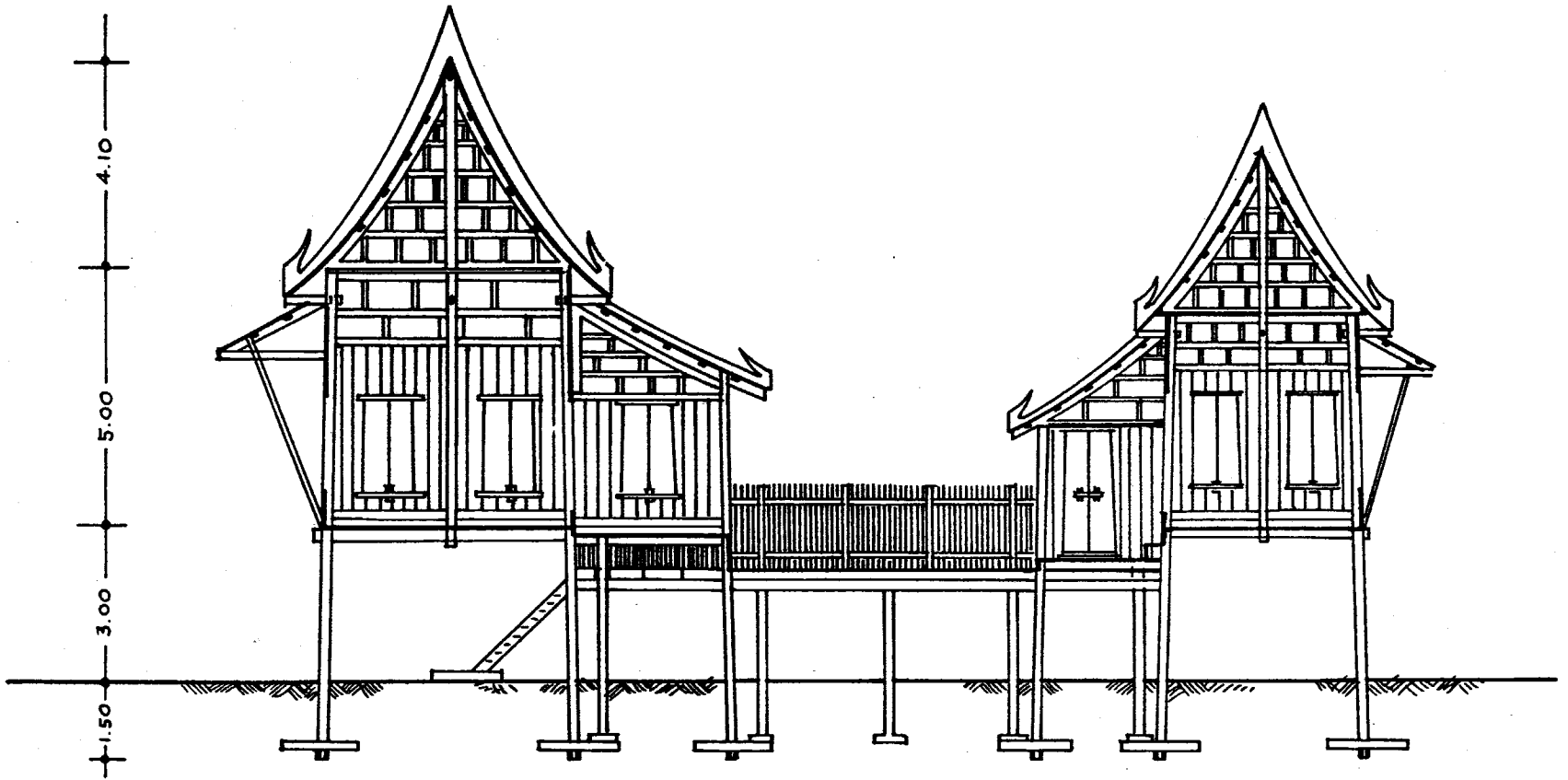
HOUSING IN ANCIENT TIME

- | | | |
|--------------|---------------------|--------------|
| ① BEDROOM | ④ TERRACE | ⑦ DINING RM. |
| ② LIVING RM. | ⑤ CORRIDOR | |
| ③ GUEST RM. | ⑥ KITCHEN + STORAGE | |

which garbage can be dropped. There is no restroom or bathroom in the house. The bathroom is a public area belonging to a small group of neighbors. In fact, it is not a room at all but an open space with a well. Bathing by both sexes is done at the same time in a manner which does not require complete disrobing. Women use their "pasin" skirts as a bathing sarong and men keep their bath clothing wrapped around their thighs. After the bathing is completed the dry clothes are slipped on and the wet bath clothes are dropped to the ground. In the region near the river they take a bath in the river or in the waterways in large groups.

2-4. Materials and Construction

The materials used for the house vary from bamboo and thatch to heavy teak wood and clay tile. The most used material is teak which is plentiful and inexpensive. It is necessary to build structures of teak or some hard wood. There are many sizes of wood which are used 10 by 10 & 4 by 4 in columns, 24" by $2\frac{1}{2}$ " to 6" by $1\frac{1}{2}$ " for floors. Beams can take long spans but not more than six meters, three and four meters are most usually found. In the old houses floors are smooth and greasy by nature. The floors are not fixed but are moved every year when they are seasoned. The walls are usually made of wood in moulding ribs and panels; the panels are about $1\frac{1}{2}$ " by 2" and ribs are about 4" by 2". There are many sizes of panels which are used in a modular system that effects the spacing of the columns. The width of the panels must be uniform, but it is not necessary to keep the height uniform because of the windows. The



SECTION

open space between the upper part of the wall and the beam that supports the roof is a space for ventilation. The ribs are used for the frame of the windows and doors at the same time. Roofs are the important part of the dwellings and express the remarkable individual character. Because of the heavy rain and strong sunshine all year round, most of them are gable roofs with a steep angle and an overhang.

The materials that are used to cover the roofs are thatch or tiles that are made of clay (like some pots and bowls which are still used in the country). The color of the tile is brown and dark orange; the roof is composed of a simple structure (See Figure p. 12). The footing is of quite simple construction. There are two kinds of footings; (1) concrete block or a block of stone, or concrete block with concrete column. This type of foundation is good for the area that may have flooding in the rainy season because foundations which are built of wood will decay at the level of the water. (2) Wood with a cross at the end of the column; this kind of footing is not built on the ground but about 1 meter under the ground level. Nearly every column has a cap which is made of thin metal in order to guard against the animals getting into the house.

Mosigneur Pallegoix said in 1830 when he first arrived, "The private houses in Bangkok are of three types; some made of brick and very elegant, others are made of wood, and the poor people's houses are made of bamboo. Therefore, it happens that fires occur frequently and disastrously. It is not rare for a fire to destroy four or five hundred houses, but everything is rebuilt like new in seven

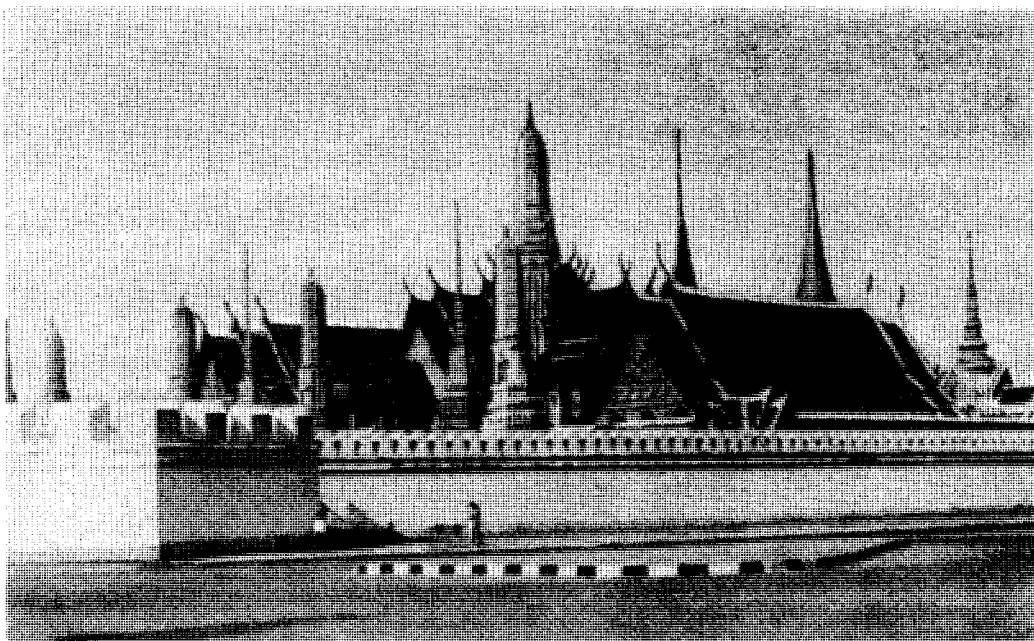
or eight days because parents and friends come to help those who have burned out."

2-5. Temples

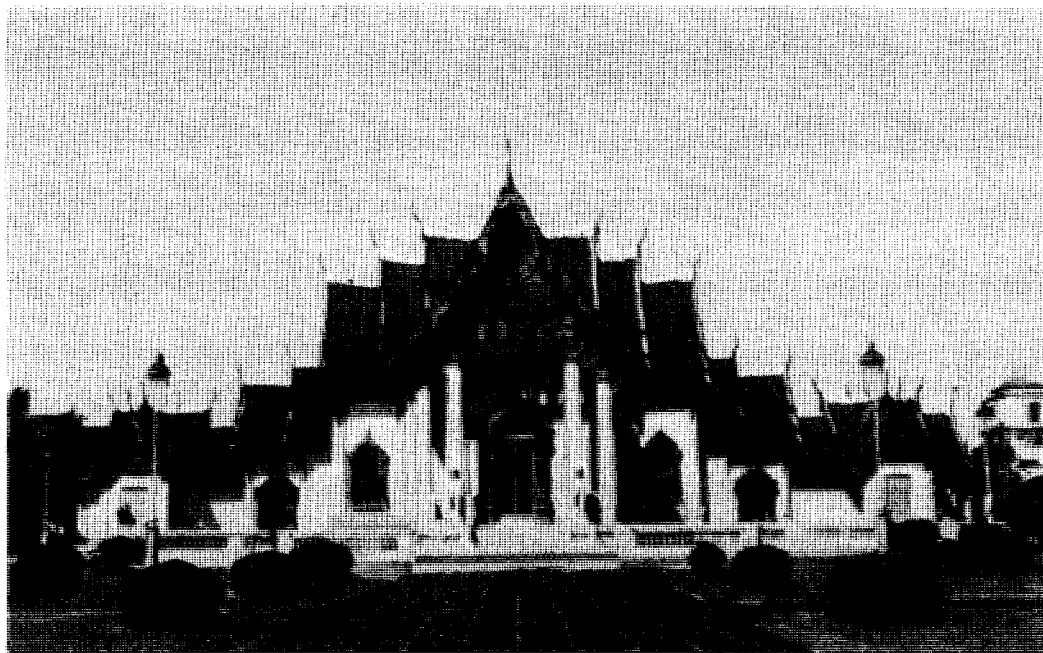
The remarkable architecture of Thailand is in the temple or monastery, a place of worship. It is called in the language of the country "Wat" and is always a large square enclosure. It consists of church, library, and the dwelling of the Talapoint. There are many temples in Thailand, but all the large and beautiful temples are in Bangkok, the capital of Thailand; there are "Phra-chet-tu-pon", "Ben-ja-ma-bor-pitch", "A-run", "Pra-keau", etc.

The temples are financially supported by the people. People believe that everything they do will affect the next time they are born. So they do good work like feeding priests, giving them alms, and building "Wats" or temples. This last charity is popular with the rich Thai people. None of them would dream of giving money to a "Wat" in need of repair when a little more can pay for a new one. Because of this there are more than three-hundred wats in Bangkok.

The Thai Wat is an enclosure surrounded by a wall, containing a number of buildings, small and large. Its principal axis runs east to west with entrance on the east. There is no regular plan. A large wat may contain a temple for lay worshipers (the vihara); a sacred temple for monks (the bot); a dormitory for monks, novices, and temple boys; a library; a number of rest houses (sala); a stupa (chedi); and frequently the public primary school; but not all of these are necessarily in every wat. Set off from the rest of the village and

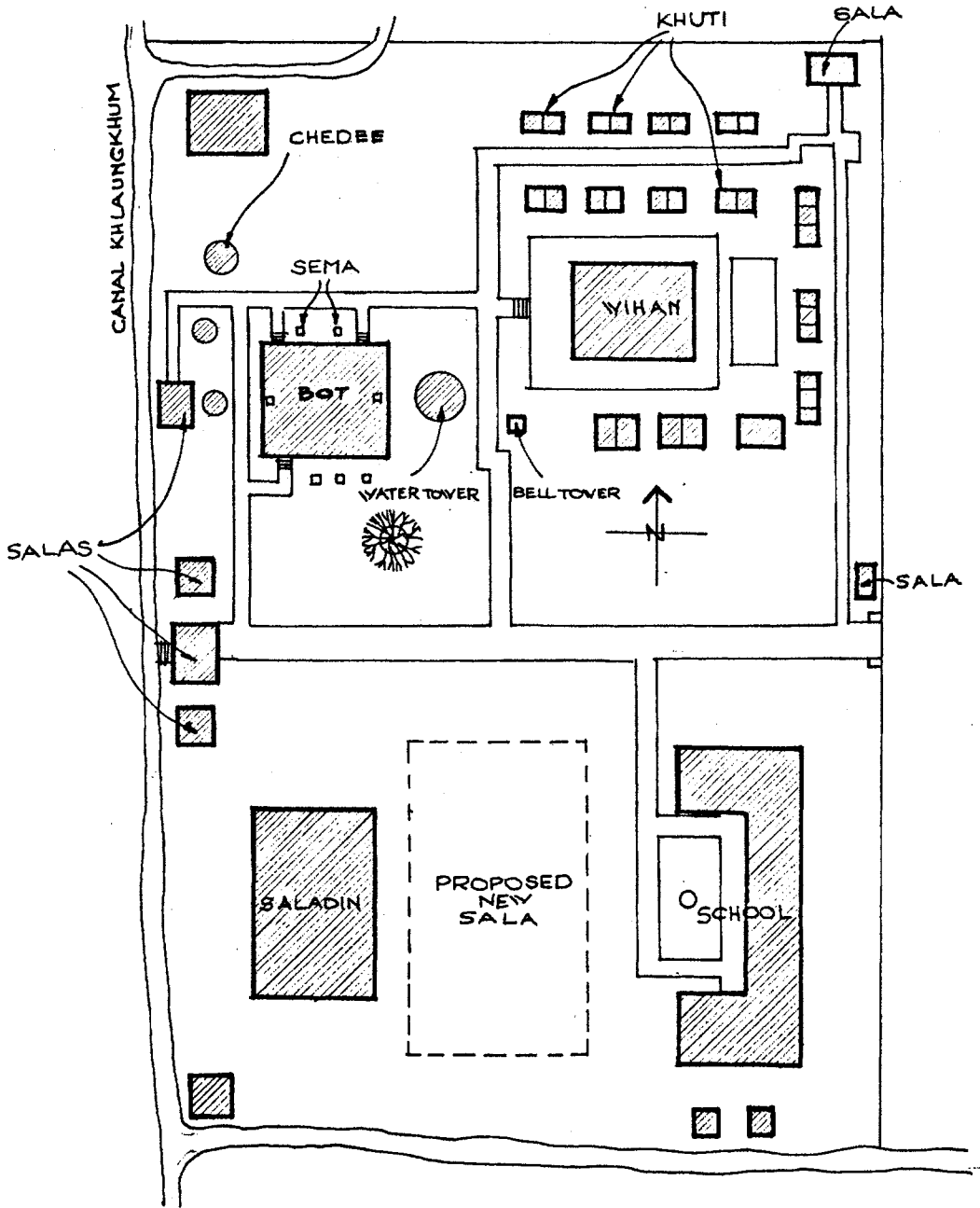


The Emerald Buddha, Bangkok



The Marble Temple, Bangkok

THE WAT COMPOUND



surrounded by tall coconut palms and fruit trees, the wat stands in a cool, inviting grove. Within the compound are more trees - coconut, betel palm, and the sacred bodhi tree. Annually at the New Years festival fresh sand is brought in as an act of merit by worshipers; in time the level of the temple grounds is raised above that of the rest of the village. (See plate, Plan of a Typical Thai Village Wat or Temple Compound.)

2-6. Thai Painting

The art of painting in Thailand started as a linear expression imitating the characteristic of the figures engraved on the slabs of stone which, like painting, were used to decorate the old temples of Sukhothai. From the few mural printings or the architectural monuments of Ayuthai of the 15th century A. D. one notices that some effect of chiaroscuro and polychromy is added to lines by using black, red and gold. The characteristics of Thai painting are:

1. Use of scientific perspective which affects the harmony of linear composition.
2. Use of chemical tints many of which jar the chromatic effect of the painting.
3. Rendering of atmosphere effects in landscapes and rendering of volumes of the painted figures, two features which, as we have seen are quite opposite to the Thai art.

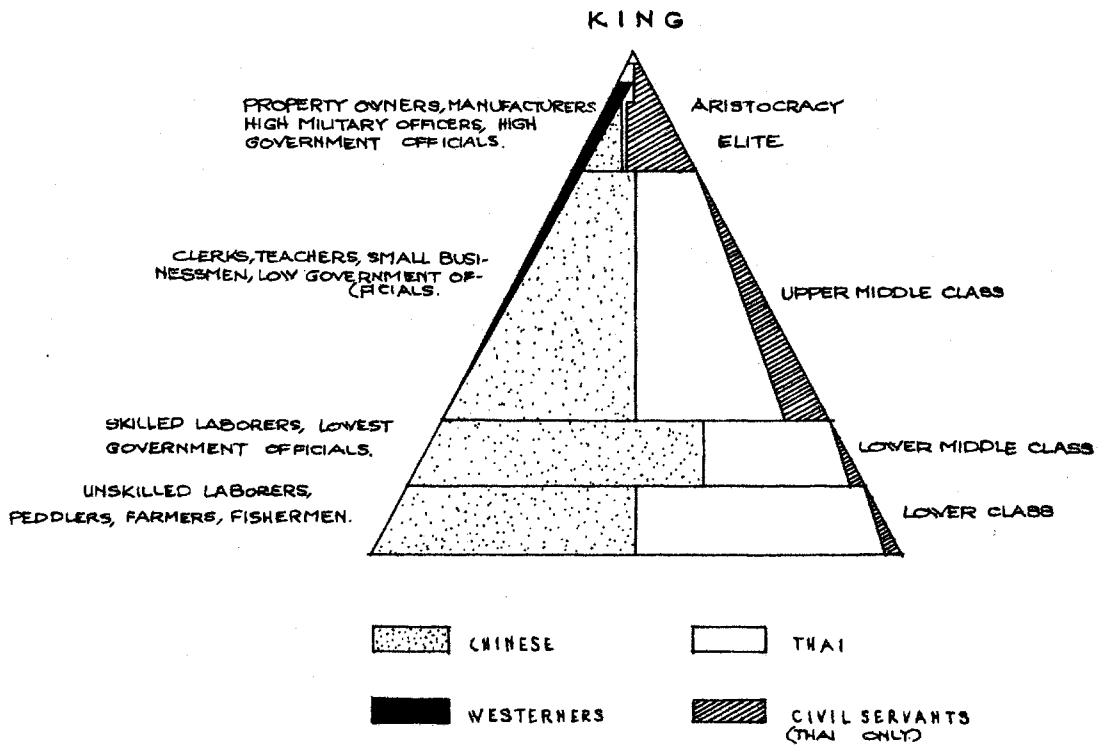
2-7. Social Structure

Bangkok society must be viewed in terms of both classes and ethnic groups. Five "classes" may be identified: an aristocracy,

BANGKOK SOCIAL STRUCTURE

PRINCIPAL OCCUPATION

SOCIAL CLASSES



composed largely of descendants of royalty and the old nobility; an elite, comprising the top political figures, professional, and business leaders, an upper-middle class, made up of merchants, small businessmen, and white-collar workers; a lower-middle class, made up mostly of craftsmen and skilled laborers; a lower class made up of unskilled laborers, domestic servants, peddlers, and the like. There is also the large institution of the Buddhist Order, whose members are on a level with the top ranks of this pyramidal structure but cannot really be fitted into it. The king, above all others in the Social scale, is in a "class" by himself (See plate, Bangkok Social Structure). Within the classes there are two main ethnic divisions: Thai and ethnic Chinese. Ethnic Chinese are defined as those individuals who speak a Chinese dialect and identify themselves as Chinese. These include many Chinese who are Thai nationals.

It may be estimated that less than one percent of the Bangkok population can be placed within the old elite (including the aristocracy and a few others), four percent in the new elite, possibly fifty percent in the upper-middle class, about twenty percent in the lower-middle class, and approximately twenty-five percent in the lower class.

2-8. Standard of Living

In Bangkok and vicinity more vegetables and meat products are eaten per capita than in other regions, perhaps because of the Chinese influence, and it has become fashionable to use canned goods also. Among the old elite, cooking continues to be a traditional art; the women of the family take pride in creating for their guests the sauces,

savories, curries, condiments, sweets, and desserts which are the variants of the Thai rice diet. Most upper-class urban families have adopted the western pattern of three meals a day. The number of restaurants in Bangkok has increased since the end of World War II, probably because of the increase of the middle class, whose members demonstrate a preference for restaurants by eating in them two or three times a week. Thai restaurants are rarely frequented; Chinese, European, and Malayan restaurants are popular, in that order. Urban Chinese people, even those of the lower class, add to the general rice diet, but use an increasing variety of foods -- fish, eggs, greens, other vegetables, meat poultry, sweets, and imported canned goods -- however, rice is still the staple.

More and more of the Thai working class have begun to wear either Chinese or western-type trousers. Middle-class civil officers are now required to wear either a uniform or the trousers, coat, shirt, and tie of acceptable western fashion. Women wear blouses and skirts when working in the offices or shopping. For social occasions modified western dress is worn, often similar to the fashion that Chinese women have made popular in Shanghai -- long slit skirts, high collars and long sleeves. High fashion in Bangkok is that of London, New York, or Paris with local variations.

2-9. Family Types

About thirty percent of all families in Bangkok -- Thanburis Municipal Area live in multi-family households. The most usual type of sub-family is servants, or married children living in the parents' household.

Of all economic families in the Municipal Area, fifteen percent are single persons. Almost three-fourths of these persons receive their housing free as part of their wages but are otherwise financially independent. Twenty-six percent of all families have eight or more members. The average family size is 5.5 persons. About thirty-six percent of all families are composed of father, mother, and their own children with no other persons present. Another twenty-four percent are father, mother and children with other adults included in the family unit. Families with only one parent present represents fourteen percent of the total. In most of these cases, the father is the missing parent; eighty-five percent have the mother as head of the family.

Over one-half of all family heads are between thirty and fifty years of age, twenty percent are below thirty years and twelve percent are sixty years old or over. Forty percent of all family heads have received formal education only through the primary grades or less, twenty percent have some secondary schooling and five percent have completed pre-university training and perhaps some university schooling also. Three percent are university graduates.

About thirty-nine percent of all Bangkok -- Thanburi families own their own homes, twenty-four percent pay rent for their housing, fifteen percent live in rented rooms, and twenty-two percent receive their shelter free or as part of their wage.

POPULATION GROWTH, BANGKOK AND THONBURI
MUNICIPALITIES, A. D. 1937 - 1958

1937	533,104		
1942	674,172		
1946	565,642	168,357	733,999
1950	757,636	205,990	963,626
1954	971,570	259,869	1,231,439
1955	1,024,502	289,457	1,313,959
1956	1,127,923	302,732	1,430,655
1957	1,204,894	321,821	1,526,715
1958	1,286,422	336,039	1,622,461

BIRTHS, BIRTH RATES, AND DEATHS, DEATH RATES
BANGKOK AND THONBURI MUNICIPALITIES (1946-1958)

1946	26,734	36.4	16,842	23.0
1948	36,180	42.0	10,365	12.0
1950	44,241	45.9	11,522	12.0
1952	46,320	43.2	9,243	8.6
1954	56,495	45.9	8,280	6.7
1956	66,654	46.6	8,240	5.8
1957	76,818	50.3	10,774	7.1
1958	74,904	46.2	10,633	6.6

PERCENT OF FAMILIES OWNING DURABLE ITEMS

Radios	55.8%
Television Sets	14.4%
Refrigerators	8.6%
Electric Fans	33.3%
Sewing Machines	33.5%
Dining Room Furniture	34.5%
Motor Scooter	3.9%
Automobile	7.4%
Bicycles	8.3%
Electric Lighting	94.0%
Piped-in Water	70.0%
Installed Toilet Facilities	94.0%

AVERAGE RENT AND SIZE OF HOUSES RENTED BY HOUSEHOLD,
BY INCOME CLASS

Detached Houses	Average Rent	Average Number of Rooms	Average Floor Area (sq. m.)
All Income	209	2.9	43.8
Under Baht 6,000	61	1.8	24.4
6,000 - 11,999	83	2.4	39.0
12,000 - 23,999	228	3.1	46.3
24,000 - 35,999	323	3.8	63.1
36,000 - 59,000	520	3.0	56.1
60,000 -			

AVERAGE INCOME CLASS, FAMILY SIZE AND TENURE OF FAMILY

Family Annual Income Class

Under 6, 000	19.8%
6, 000 - 11, 999	31.8%
12, 000 - 23, 999	27.7%
24, 000 - 35, 999	9.5%
36, 000 - 59, 999	5.9%
60, 000 - and over	5.3%

Family Size

1 person	14.6%
2 - 3 persons	14.5%
4 - 5 persons	23.2%
6 - 7 persons	21.3%
8 - and over	26.0%

Tenure

Owner of house and land	16.0%
Owner of house, renter of land	22.7%
Renter of house and land	24.5%
Renter of room or rooms	15.1%
Receive rent free	21.7%

AVERAGE MONTHLY FAMILY EXPENDITURES
FOR FOOD AND BEVERAGES

Cereals and Flour Products	15.2%
Meats	14.2%
Fish and Sea Food	9.6%
Poultry (duck, hen)	4.1%
Vegetables	7.2%
Fruits	4.6%
Eggs	4.0%
Spices and Condiments	2.5%
Sugar and Sweets	1.0%
Non-Alcoholic Beverages and Ice	5.1%
Prepared Meals Consumed at Home	4.6%
Milk Products, Oils and Fats	2.9%
Food and Beverages Away from Home	4.6%

VEHICLE REGISTRATIONS BY TYPES AND ABSOLUTE
1947 AND 1958 BANGKOK AND THONBURI

<u>Motorized Vehicles</u>	<u>1947</u>	<u>1958</u>
Passenger Cars	3, 259	26, 913
Taxis	100	6, 109
Buses	191	1, 841
Trucks	1, 282	9, 581
Motorcycles	693	10, 883
Motor Tricycles	---	1, 618
Trams	201	156
	<hr/>	<hr/>
Total	5, 726	57, 101
<u>Non-Motorized Vehicles</u>		
Tricycles	3, 300	3, 712
Tricycles, Taxi	8, 800	10, 504
Hand Carts	5, 700	1, 546
Carts, Animal Drawn	200	31
Bicycles	33, 000	36, 344
	<hr/>	<hr/>
Total	51, 000	52, 137

On May 26, 1959, the Government announced that all Tri-cycles, Tricycle Taxis, Hand Carts, Carts, and Animal Drawn Carts would be banned in Bangkok on December 31, 1959. If implemented, this order would have significant repercussions on the public transportation patterns of the area.

CHAPTER III

PRINCIPLES OF DESIGN IN THE TROPICAL CLIMATE

In the tropical zone, the most important factors concerned are the climatic conditions: humidity, wind, rainfall, temperature, sunshine, with the addition of minor additions such as dangerous insects, termites, etc. The character of the houses in different parts of the tropical zone depend on the following postulates:

Orientation towards the sun. The greatest extension of the building must be to the east and west in order to avoid sun exposure, and a wide area on the south and east sides.

Orientation towards the wind. The longest side of the building must be placed against the direction of the wind in order to create air movement and natural ventilation.

The roof as shelter against the sun. A big roof is necessary in this region for protection against the heat radiation and the sun in different seasons.

Sun sheltering of the walls. To avoid direct exposure of the walls to sun, the building is surrounded by verandas.

Airing. The living room can get good natural airing by having a north or south veranda or perforated partitions.

Rain. Good drains must be provided for the great amount of rainfall.

Building Materials. The best building materials for the tropical zone should be good insulators such as brick and wood, using

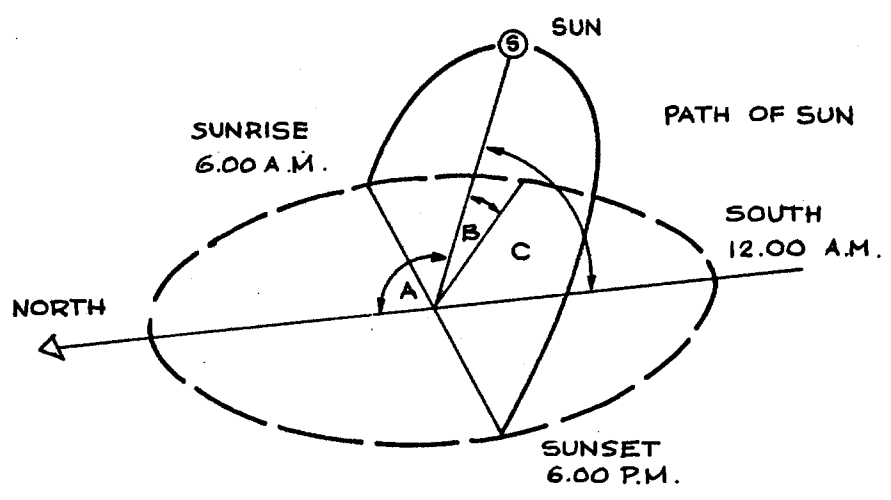
only those kinds of hard woods that are resistant to decay, rot, termites, vermin, etc., or treated to be resistant to the above.

The one thing that no one can control is temperature. Few people install air conditioning, which is a luxury in such areas. The sun is usually strong during the day and we can collect the sun's radiation to heat water, and to operate heaters and air-conditioning machinery. By doing this, we reduce the cost of heating; for example, the owners of a home on the shores of Lake Michigan report that they save \$250.00 per heating season over conventional methods.

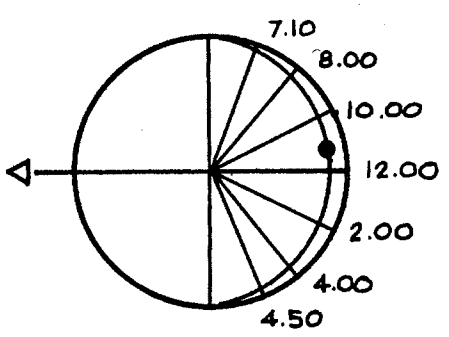
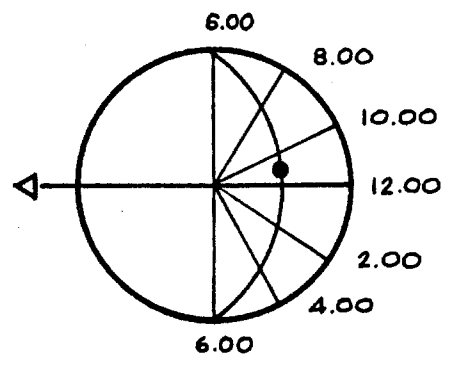
The solar water heaters are good for a region in strong sunshine. They can receive enough solar radiation throughout the year to yield impressive results. The solar water heaters are composed of nothing more than a copper coil in an air-tight, black colored glass topped can. These heaters are fixed in a position for maximum exposure to the sun on the roof, on the wall, or sometimes on the window where they can act as awnings. A heater will supply a family of six with 130° F. per 64 sq. ft. of heater capacity. The yield is, of course, much higher in mid-summer.

3-1. Design for the Sun

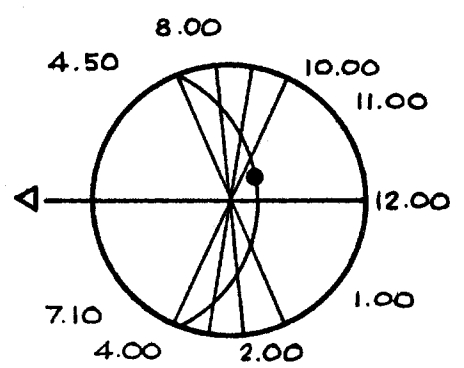
When the sun's rays reach the earth's atmosphere, some are reflected by the clouds and the ground, some are absorbed, and some are diffused. The sun's energy which is reflected by the surface of the clouds is ineffective concerning the heat of the air and the ground. This amount is 33% of all radiation as an average for the



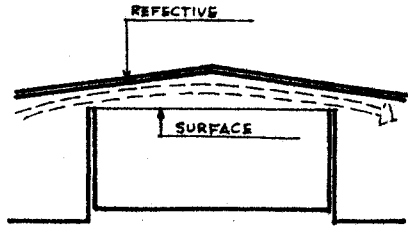
EQUINOX



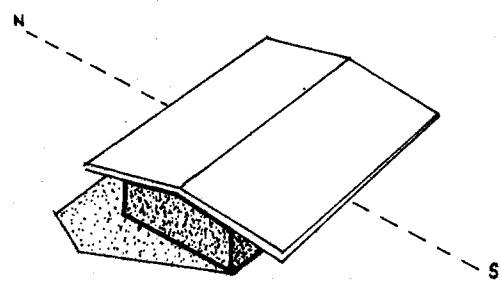
WINTER SOLSTICE
DECEMBER 21



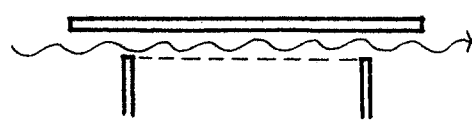
SUMMER SOLSTICE
JUNE 21



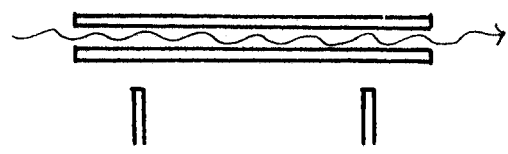
A ROOF SPACE OPEN TO THE HOUSE WILL HELP KEEP THE UNDERSIDE OF CEILING COOL.



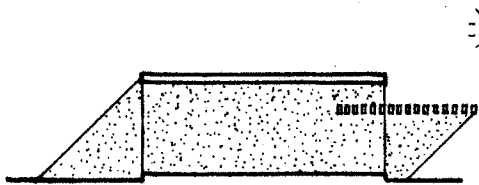
OVERHANGING EAVES PROJECTION. BUILDINGS SITED WITH THEIR LONG AXES EAST-WEST SIMPLIFY THE SHADING PROBLEM.



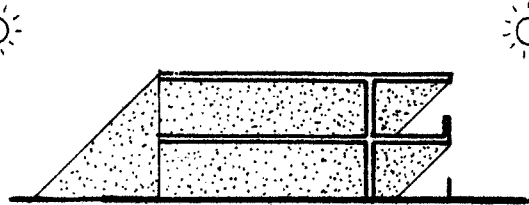
MINIMUM



DOUBLE-ROOF



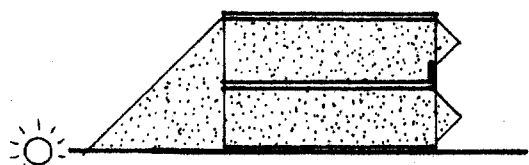
PIERCED BALCONIES



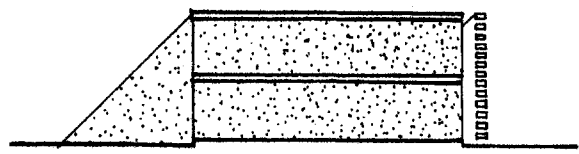
BALCONIES



ADJUSTABLE LOUVRES



EXTERNAL BLIND



HORIZONTAL SCREENS

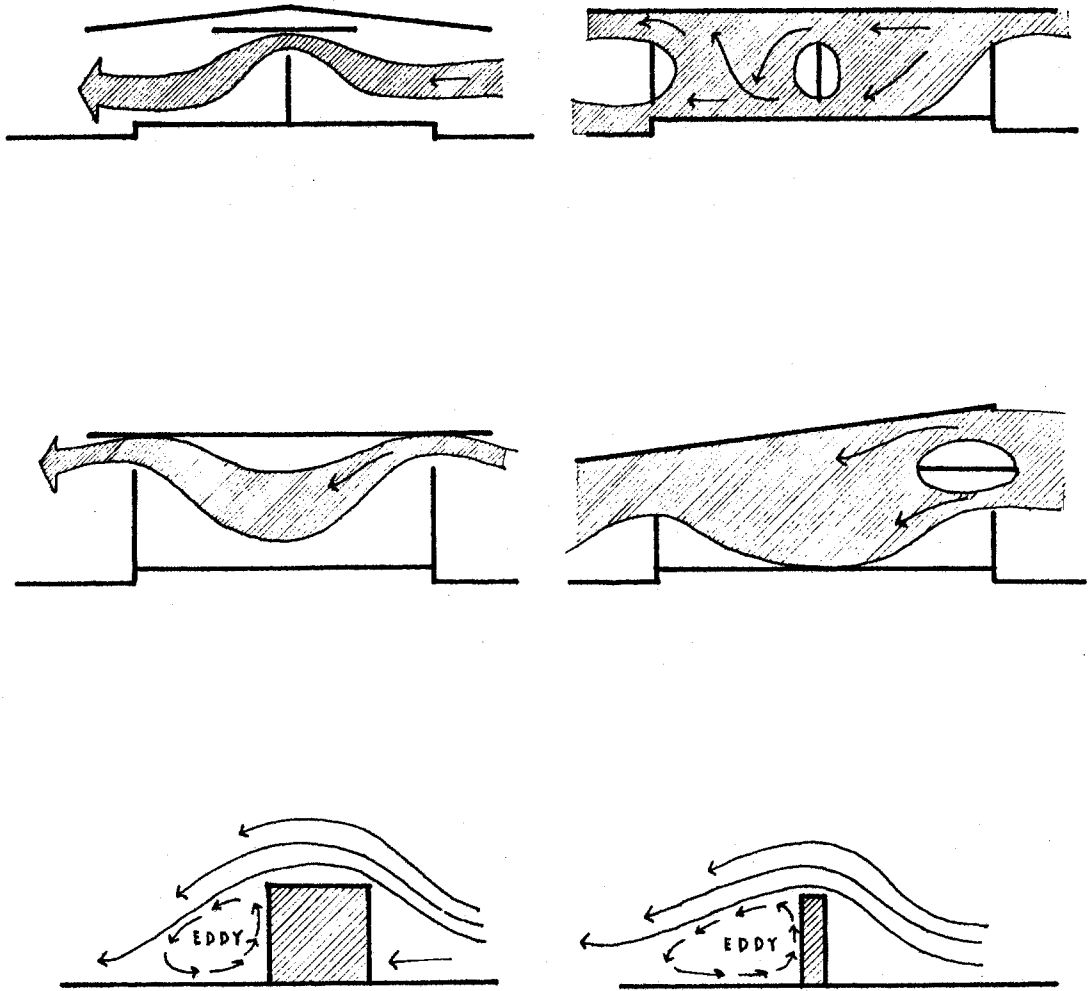
northern hemisphere. As we know, one-third of the sun's rays reach the surface of the earth and are transformed to other types of energy. Evaporation, convection, and radiation occur.

When louvers are used, it is necessary to check the angle of the sun at a certain area in order to get the best effect. We can check the angle of the sun at noon in every position on the surface of the world by calculation, or by the sun machine when we can observe the shadow on the model at any time during the day. The desirable design temperature (depending on the use of the building) is 70° to 72° F., and the various structure members such as the roof, ceiling, walls, and floors are designed to provide this desirable temperature.

3-2. Design for the Wind

Two natural phenomena cause the movement of air. The first is pressure difference, and the second is temperature difference, which really results in pressure differences. Air flow from high pressure to low pressure regions causes hot air to rise. Air can flow through a low structure alone by the difference of temperature, but in hot weather its cooling effect is negligible compared to that caused by even a very light breeze.

It is desirable to have the air-flow in the living area of the building during the summer. Therefore, we should consider the effect of the geometry of our buildings on the air flow pattern within them. The two main factors which determine the air pattern are location and type of inlets.



DETERMINANT OF AIR FLOW PATTERN AND EDDIES.

3-3. Design for Temperature

As we know, the sun is our source of heat. Any region which is exposed full-face to the sun for a large part of the year is hot. Those which receive sunshine only at a low angle and for small portions of the year are cold. Therefore, the equatorial regions must be hottest. The temperature may vary in each part of this area depending on the effects of the environment, such as latitude and season, atmospheric impurities, land and water, wind and air-mass movement, and altitude.

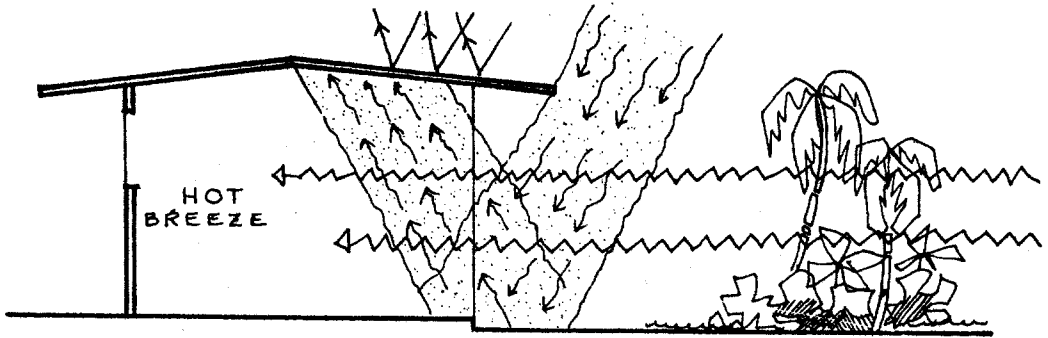
3-4. Technology of the Cooling Effect

Plants: Grass or some other ground cover can reduce the solar heat reflected from the ground.

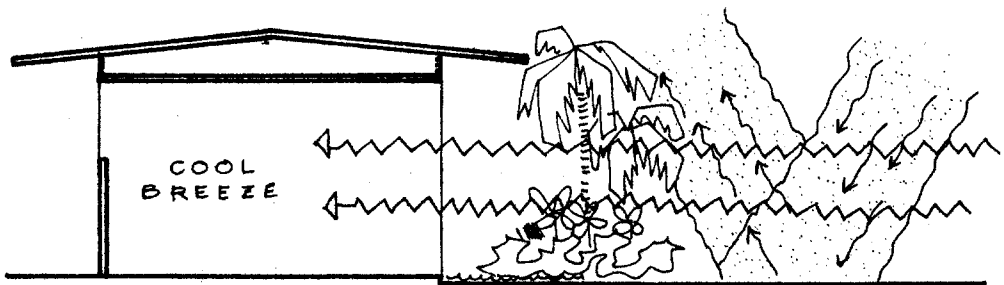
Eternal shade: Trees can be used to intercept the solar radiation.

Attached shade: Blinds, shades, or shutters will prevent the sunlight from getting into the room and also will reflect and absorb heat.

Water Cooling: Spraying roof or wall structures which are exposed to the sun can be quite effective in reducing the heat because of the evaporation on the surface. By passing the air through the water absorbent material screen on which the evaporation takes place, the temperature will be reduced as much as 15° F.



IMPROPER PLACEMENT OF VEGETATION.: THIS SKETCH SHOWS HOW THE SUN IS ALLOWED TO HEAT THE COOLING BREEZE AS IT ENTERS THE ENCLOSURE NEGLECTING THE BENEFITS OF VEGETATION. ALSO THE USE OF DOUBLE ROOFS WILL AID IN DEFLECTING THE SUN'S RAYS, PARTICULARLY IN HOT HUMID CLIMATES.



PROPER PLACEMENT OF VEGETATION.: THIS SKETCH SHOWS A MORE SATISFACTORY PLACEMENT OF VEGETATION AS IT ALLOWS THE BREEZE TO COOL DOWN BEFORE ENTERING THE ENCLOSURE.

3-5. Servicing of the House

Servicing of the house is very essential in the design of the house. Sewer pipes, kitchen flues, bathroom pipe runs, electrical wiring, water closet flushing cisterns, etc., can be unsightly unless their space requirements (and access requirements) are borne in mind from an early stage in the design. For both aesthetic reasons and economy, rooms requiring plumbing and drainage runs are best grouped together on one wall of the house, or at a corner, so that both water supply in and drainage out, can be simplified and kept to the minimum. Other services which require early consideration in the design process are refuse disposal, obtaining hot water, and the planning of the kitchen in relation to method of cooking and type of fuel.

3-6. Kitchen and Cooking Methods

Kitchens in the past were frequently detached from the main part of the more substantial homes of the tropical world. This was partly because of the character of the fuels available and partly because of the social status of the person doing the cooking. With changing circumstances, the increasing shortage of good domestic servants in many areas and the availability of improved fuels and stoves, the attaching of the kitchen to the house is becoming increasingly popular. Whether or not it is entered from a veranda or a back porch, across a courtyard, or directly from the main body of the house will depend upon the wishes of the client and is moulded by the local elements, social customs and the nature of the cooking

fuel used. The kitchen will be a hot place in any warm climate and therefore a shady location is preferable and in humid climates one also open to the breeze. Kitchen heat should not be allowed to pass back into the living areas of the house.

Fuels in use for cooking in tropic areas include: wood, charcoal, kerosene, or paraffin, gas, (either town supply or bottle (cylinder)) and electricity. In Thailand cooking in the rural areas is done by wood or charcoal and in urban areas they use charcoal or gas.

3-7. Bedrooms, Bathrooms, Storage and Furniture

Bedrooms. Bedrooms should have protected south and west walls and low-cross-ventillation secured by louvers and/or doors opening on to verandahs, but offering both security and privacy, which with the necessity to maintain ventillation is not so easy as it sounds.

Bathrooms. In a humid climate frequent washing or cleaning of the skin is a necessity and is a pleasure as well, whether the operation should be performed in a shower or a bath tub. Unless very ample sanitary provision is made the toilet should be kept separate and if not water-borne, screened. Always provide a medicine cabinet of greater capacity than elsewhere in the world to contain the host of medicines, unguents, salves and pills.

Storage. Clothes in storage are attacked by moths and in the rainy season by mildew, which is difficult to remove. Cupboards should open completely, with no dark and inaccessible corners, and should be ventilated top and bottom. In bad situations it may be

necessary to install some form of low-intensity heating as a protection during the wet season, and it used to be the habit to fix a low-voltage lamp for this purpose. In any case, occasional airing and exposure to the sun of the stored clothes is necessary and at times it may become necessary to hang them out on racks on the open room. Ample storage for the trunks, boxes and in some places tinned and bottled food should be provided.

Furniture. The furniture in the tropics should be cool, clean and easy to maintain. Hard surfaces such as smooth concrete, marble or terrazzo, which are used only in places of public assembly where hard wear is expected in the west, are here suitable floor surfaces in both private dwelling and public buildings. The open air character of living makes surfaces which are used only externally in the west, more suited to internal use in the tropics.

Woods tend to crack owing to shrinking and swelling caused by the variation in the climate in the tropics and where large flat surfaces are required such as on wardrobes or tables, plywood is a better answer, or, sometimes a more expensive durable plastic finish. Table tops should be of hard shiny durable materials such as terrazzo, Warerite or well varnished timber.

3-8. Housing Layout

In planning the housing layout, these factors must be carefully considered.

1. Is the majority of the housing, where not air-conditioned, so arranged that a through breeze is maintained?

2. Is the housing so arranged that the mid-day sun follows the length of the roof tops?

3. Are houses planned on contour lines so that erosion is prevented, but at the same time so that road drainage is secured without scouring?

4. Is pedestrian traffic separated from vehicular traffic?

5. What roads and pedestrian way should be shaded with trees?

6. Have you made provision for future expansion?

7. Have sufficient "lungs" of open growing vegetation to reduce temperature and sweeten air been provided?

8. Where housing is of inflammable material, has fire protection been provided?

9. Does the grouping of the houses give a feeling of local unity, both social and physical?

10. Is the types of houses varied to suit different orientations?

11. See that inflections are provided where required such as at ends of streets and junctions.

12. Have both services and structure been considered together so that a coherent unity with a minimum of "street furniture" is achieved, such as street light fittings and overhead wiring, which can often be carried on the housing itself?

13. Are the vehicular roads so arranged that the evening sun will not dazzle?

14. If the housing is on an existing site, are the worthwhile features of the existing site, whether architectural or landscape preserved?

15. Are all good existing trees being preserved?

16. Are the planting and building programs planned together so that tree planting can follow house building as soon as possible after the road levels have been established and have irrigation for them been provided?

17. Have all the impediments of housing such as sign-posts public latrines, fire hydrants, police posts, electrical sub-stations, telephone poles, etc., been designed with the housing so that they are not installed later as extras to ruin the original intended appearance?

18. Is a sufficient "green belt" in the form of market garden, fuel wood supply, farmland, etc., been preserved around the edges of town, and is demand for fuel wood etc., in accordance with the availability of local electric power and is greenery around the houses planned to help keep the temperature down?

19. Have maintenance costs been considered as well as the original investment cost?

3-9. Foundation Requirements In and Near Bangkok

The subsoils of Bangkok have already been dealt with by Dr. Chai and we can all appreciate the foundation problems in this city.

1. Spread footings and shallow foundations

For light buildings it is possible to use spread footings supported by short piles. These piles are generally of wood which is cheap and therefore economical for Bangkok. (Bangkok soil can carry a safe load of 2500 kg/sq. m. of surface.)

2. Foundations on medium length piles

Where the load for the column of the building is too large for the above method, recourse has to be made to piles which will carry the load due to cohesion of the pile and clay.

3. Long piles

Where the load on each footing is large it is necessary to use long piles reaching at least 20 m. or more below M.S. L. The hard clay in Bangkok extends to a depth varying from 20 to 22 m. below M.S. L. Beneath the clay, sand is found. Piles in the range of 20 m. length may be reckoned to give safe carrying capacity of from 25 to 30 tons depending on their sizes.

CHAPTER IV
EXISTING URBAN HOUSING IN BANGKOK

Urban housing, especially in Bangkok, offers great extremes of squalor and luxury. Thousands of families live in the restricted quarters of houseboats. Bangkok housing for the poorest families on land is called hang too (the equivalent of the western urban tenement); these structures, resembling rows of animal sheds are built of bamboo, oil cans, scrap lumber, or packing boxes. The largest rooms are about ten feet square and many house families of five or more persons. (Fires occasionally sweep these areas.)

(1) Laboring and lower-class Chinese in Bangkok live in houseboats, hang toos, or mat dwellings. Chinese merchants and shopkeepers usually live above their establishments. Their homes are Chinese in style but increasingly modified by Thai and western influence.

(2) A typical middle-class Thai house in Bangkok is a small two-story structure with wooden walls and tile roof. The lower floor is usually of concrete. A large veranda or room at the entrance, generally western in style, is used for receiving general guests; it may contain a hat tree of deer antlers (evidently acquired from Victorian England), a table, chairs, framed pictures of friends, a cane rack and a raised platform with mat and pillows for those who prefer lounging to sitting. A room nearby serves for bathing. There may be one or two private rooms on the ground floor. The kitchen

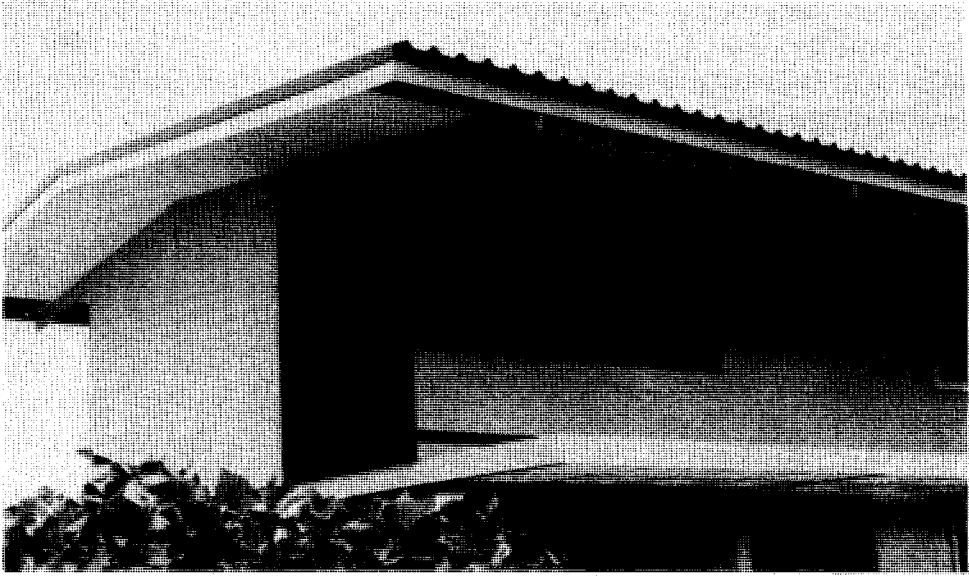
is invariably apart from the house but connected to it by a covered passage. The family rooms and a room for receiving intimate guests are upstairs. They are generally Thai in style with a low table, mats, porcelain, chests, and so on.

(3) The houses of the elite are scattered about Bangkok and in the outskirts. They are surrounded by walled compounds in which the attached building known as the servants quarters is located. If at all possible the family has within its compound a water well, a septic tank and power generator. An effort is still made to be completely independent, even of the meager services offered by the municipality of Bangkok.

4-1. Residential Areas

The total land area devoted to residential use in Bangkok is 27% (22,221 rai) while in Thanburi only 16% (4,287 rai) of the municipality is in this use. It is interesting to note, for comparative purposes that 39% of the total land area of a highly industrialized city in the United States (Philadelphia, Pennsylvania) is devoted to residential land use. In the following paragraphs the residential areas of Bangkok municipalities are broken down by residential area classification -

Farmer's Housing	11,554 rai	1.9%
Compound Housing	8,564 rai	10.6%
Small Lot Housing	4,345 rai	5.4%
Attached Apartment Housing	187 rai	0.2%
Condensed Housing	7,571 rai	9.4%



Modern Compound Housing



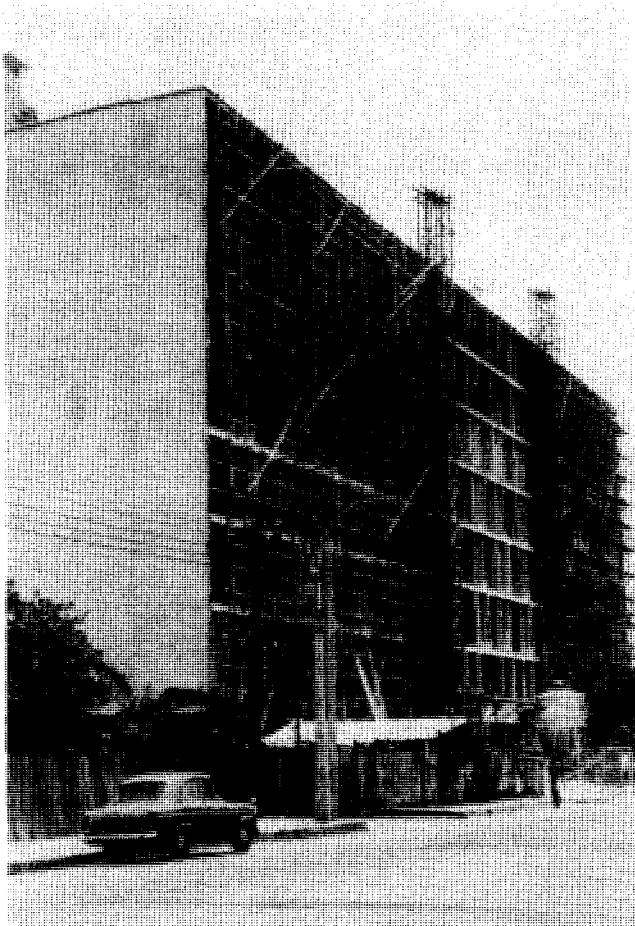
Modern Compound Housing, South Elevation

Farmers housing is usually built on piles and raised high enough above the ground to avoid flooding. The structure has walls of woven bamboo and palm-thatch and a palm-thatch roof. These farmer's houses are usually found strung out or in clusters along the banks of the klongs (canals).

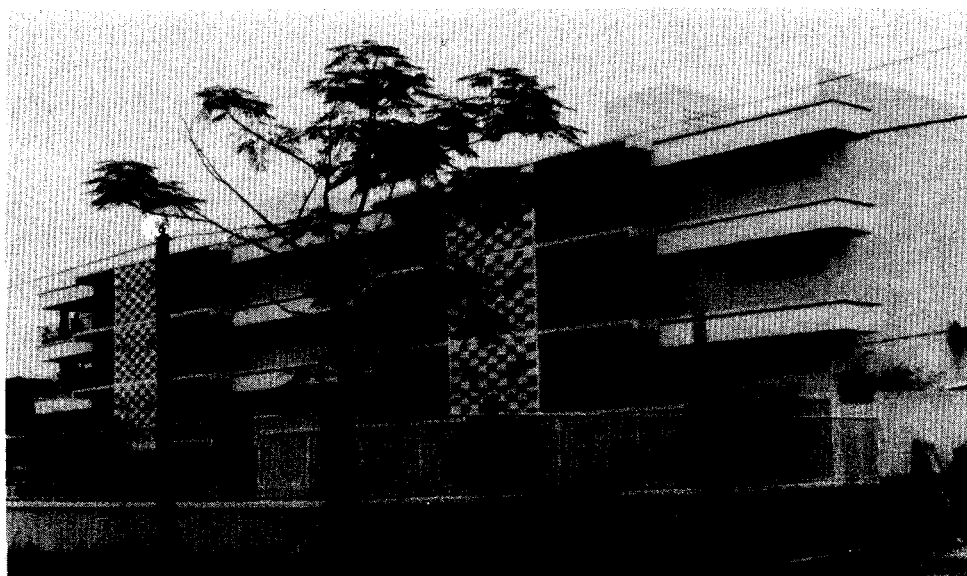
Compound type housing is practically limited to the middle and upper classes and to foreigners. A strong fence or wall for the dual purpose of security and privacy encloses these western-influenced houses and forms a compound. In addition to the principal dwelling unit, the compound includes a kitchen, either as part of the main house or seaprate, servants' quarters, garages, and other auxiliary buildings. The size of the lot ranges from 600 square meters to two or more rai.

Small lot housing is generally an improved wooden variation of the native indigenous housing described above under "Farmer's housing". Improvements consist of the use of innumerable variations constructed of more lasting construction meterials, concrete piling, shuttered windows, etc.

Attached apartment housing. The attached housing type as it is called in the United States, and the apartment type have had little acceptance as evidenced by the above land area findings. Most of the attached housing is found in government housing projects, sponsored by the Welfare Department (Ministry of Interior), the Department of Railways (Ministry of Communications), or the Tobacco Monopoly, the Siam Cement Co., etc. These housing projects are discussed in greater detail in the Housing Monograph.



Highrise Apartment



Apartment House

It should be noted that there is considerable variation in the quality of housing provided in these projects. Some units are for relatively high government officials and are quite luxurious, while other projects are for the low-income day laborers and could be considered minimum housing. Supplemental income is obtained by some of the tenants from small businesses that are allowed to develop under the houses which are usually on stilts.

Condensed housing. This land use classification is based more on residential area conditions than on housing types since the housing most prevalent in these areas seems to be substandard, overcrowded, and in many cases, blighted. Other uses such as commercial, industrial, and even agricultural are found in the areas that fall within this land use classification, however, the primary use is residential.

4-2. Housing Characteristics

In March, 1962, over one-half (54.0 percent) of all dwellings in the Bangkok-Thanburi Municipal Area occupied by private households were detached houses; over one-third (35.5 percent) were row houses, and the rest were in commercial structures, above or in shops. About 47 percent were owned by the occupant; 44 percent were rented and 9 percent were occupied rent free. Only about one-third of all residential property owned by the occupant included the land on which the dwelling was built; two-thirds were built on rented land.

The average market value of detached house and land, as estimated by owners, was about 100,000 baht. These dwellings had

an average of almost five rooms and an average floor area of 73 sq. m. The average value varies considerably with the size of the dwelling and the income of the owner, ranging from less than 10,000 baht in the lowest income class to about 270,000 baht in the highest income class.

Houses built on rented land were considerably less valuable, averaging about 16,500 baht in the lowest income class to 42,500 baht in the highest income class. The average size of houses built on rented land was much smaller in the number of rooms and floor area than those built on owned land; but it appears that the difference in value is due primarily to the value of land.

The average rent paid for detached houses in March 1962 was 209 baht per month, and this ranged from 61 baht to 520 baht according to the income class of the tenant. The average rent for row houses was 62 baht. Unlike detached houses, the variation in average rents paid for row houses by tenants at different income levels, did not appear to be significant. About five percent of all tenant households lived in rented dwellings above retail shops. They reported an average monthly rent of 175 baht; however, it is not clear as to whether or not reported rents included the business premises.

Seventy percent of all dwellings in the Municipal Area were of wood construction, twenty-eight percent were of brick and cement, and only two percent were made of bamboo, mat and other materials.

4-3. Industrial Area

Industrial areas include all manufacturing industries, both privately and publicly owned in addition to home industry. Since

industry on the first floor in residential structures is considered the dominant use, it is included in this classification. Total industrial land in Bangkok amounts to about 2,193 rai, which is almost three percent of the area of the municipality.

Even though home industry represents a small land area in most cases, this land is intensively used. The industrial area is usually restricted to the first floor of a building similar to the shop house which employs anywhere from five to fifteen workers, and in many instances these are boys. To expand a home industry in these row-type units, the same procedure described under commercial shop-houses is used.

Industry in Thailand at the present time is of minor importance to the economy. Manufacturing accounts for no more than twelve percent of the national income and employs less than one percent of the population - approximately 200,000 workers. It is all on a small scale and is confined largely to processing agricultural commodities (mainly rice), fabricating a few consumer products (playing cards, jewelry, toys, furniture, etc.), and manufacturing building materials (cement, lumber, bricks). Except for a small steel mill, there is no important heavy industry.

4-4. Commercial Area (2,472 rai = 3.1% of Bangkok Municipality)

Commercial land use is dominated by the commercial residential classification which consists mainly of the shop-house type of building evident everywhere in Bangkok. Pure commercial uses such as retail stores, gas and auto repairs, offices, hotels, restaurants,

movies, and community markets are also included. It should be noted, however, that the minor commercial uses in condensed housing areas and all minor retail and service establishments related to residential districts, are included in this respective land use classification.

The shop-house type is located primarily along the major roads, but is dominant also in the Central Business District. It is an attached row of stores with each unit between 3.50 and 5.00 meters wide and 10 meters deep. One or two residential floors are almost invariably built over the shops and provide the shopkeepers living quarters. The shop-house has a variety of uses besides the commercial one. The lower floor can be used as a garage, warehouse, workshop, or as a living room. The limits of its flexibility seem to be restricted to the physical dimensions. As business grows and expansion is horizontal into adjacent units the walls can either be removed or left in place. Fortunately the present lack of automobile-oriented shopping has kept traffic congestion at a minimum, however, many store owners permit streethawkers to operate in front of their stores, causing sidewalk congestion, and in many instances the commercial activity spills over into the street.

4-5. Open Spaces (1,493 rai = 1.9% of Bangkok Municipality)

This land classification includes parks, playgrounds, historical areas, such as the wall and forts along klong Ong Ang, golf courses, sports areas of all kinds, clubs and all large areas used for open air recreation or land used for landscaped areas.

4-6. Bangkok Observations

The Bangkok-Thanburi Metropolitan Area is unique in many respects and some of the observations made during the land use survey are recorded here. Through these general observations the reader can gain a clearer understanding and visualization of the city.

Alluvial deposits of fine silt, many hundred feet in depth, give the city poor foundation conditions and make the development of high-rise buildings expensive. This has caused the growth of a "flat" city with vertical punctuations achieved chiefly by pagodas, temples, occasional modern buildings (four to ten floors in height), etc.

By Asian standards, Bangkok is a sprawling city, however, to a person accustomed to western sprawl, the city is remarkable for its compactness. A vigorous walker can traverse it from north to south in three hours or less.

The internal structure of Bangkok lacks the zones or sectors which characterize most western cities. There are the old city areas and the Chinese quarters, a western type residential area and formal administrative districts. Bangkok is known for the many canals that have been dug for defense, transportation, irrigation and drainage purposes. In the past practically all transportation was by foot and water, so it is not surprising that paralleling the waterfront a dense complex of urban development occurred crisscrossed by footpaths. Streets, as they were superimposed on this pattern tended to form great superblocks containing residential, commercial and industrial areas. These internal areas are served by sois (lanes) varying in quality and width, which penetrate into the blocks but which generally

lack connections with road and soils.

The absence of a comprehensive plan and of the necessary development control, such as zoning, subdivision control, mapped streets, etc., to assure orderly growth, is apparent everywhere in the urban areas. The land use patterns are heterogeneous or even chaotic, and to record and analyze them presents a very complex problem.

CHAPTER V

PROJECT PLANNING

The Public Welfare Department is planning to build new flats for low income and medium income people that can be bought on an installment basis. The flats, to be constructed at Bangna District (Sukumvit Road), will cost between 40,000 to 70,000 Baht. The cost will be repayable by the tenant over a period of ten to twenty years.

The project is designed to fit a 906 rais (362 acres). This project is planned to provide for the following:

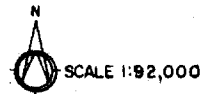
- (1) A balanced community, covering a full range of family size units.
- (2) Proposed population of 7000 to 8000 people (20 persons per acre).
- (3) Adequate facilities of elementary school, high school, nursery, a variety of recreational opportunities, a temple (Buddhist Temple), shopping centers and other commercial facilities required by this community.
- (4) Building design to fit the climatic conditions of the area so that occupants live comfortably the year around without applied heating or cooling.

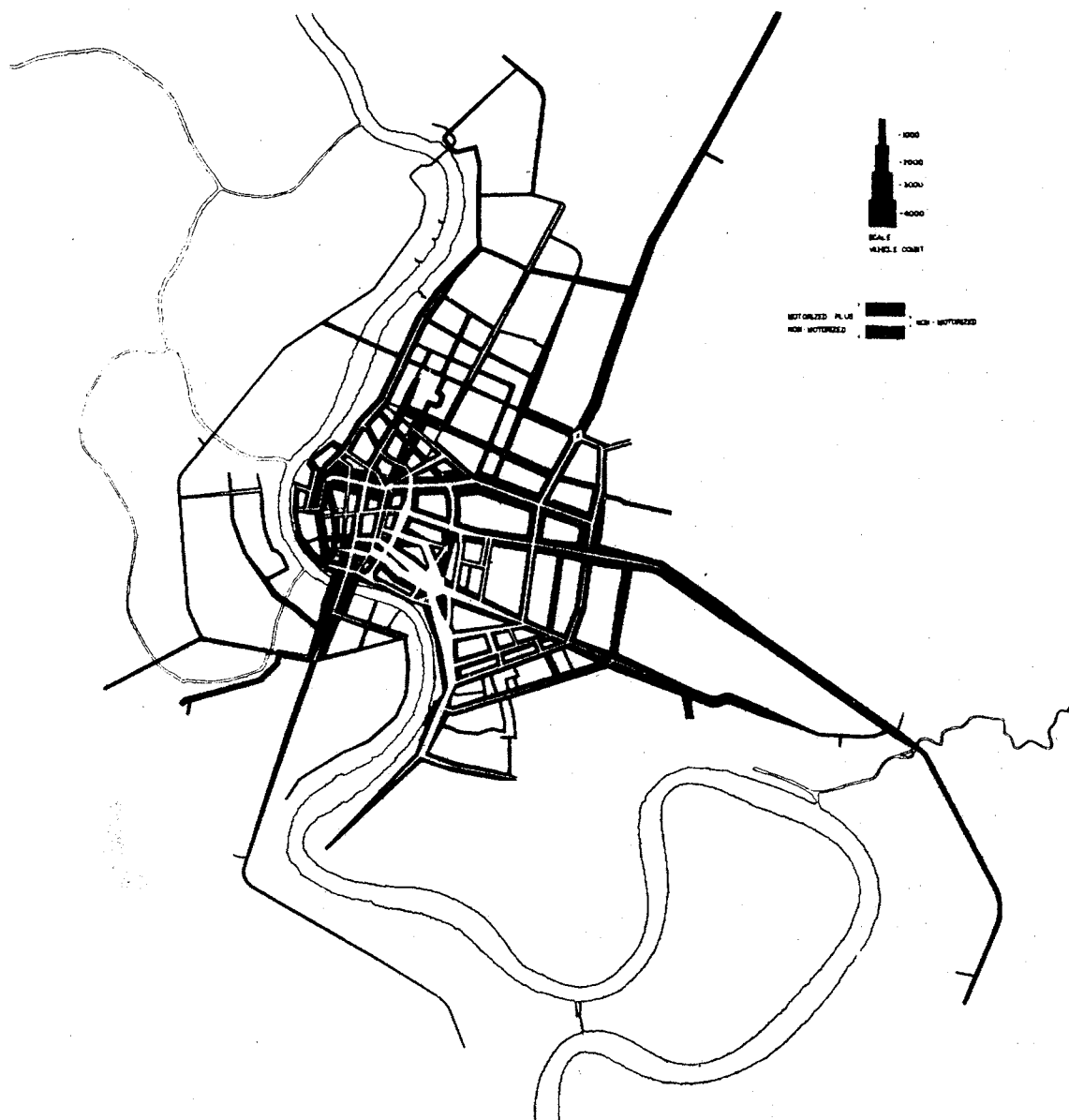
5-1. Location

The Public Welfare Department selected a site in Bangna District. The size of the site selected is 906 rais (362 acres). The

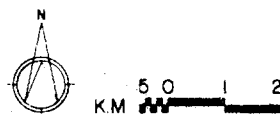


THE URBANIZED AREA OF BANGKOK — THONBURI
FOR THE YEAR 2501 BE. (1958 AD.) WAS
APPROXIMATELY 60,230 RAI OR 23,805 ACRES
NOTE: MAP SHOWN IS 2501 ROAD & LANE BASE MAP





BANGKOK THONBURI
TOTAL TRAFFIC PEAK HOUR 1959



location is approximately 15 kms (9.5 miles) from Bangkok. (Monument of Victory)

Boundaries

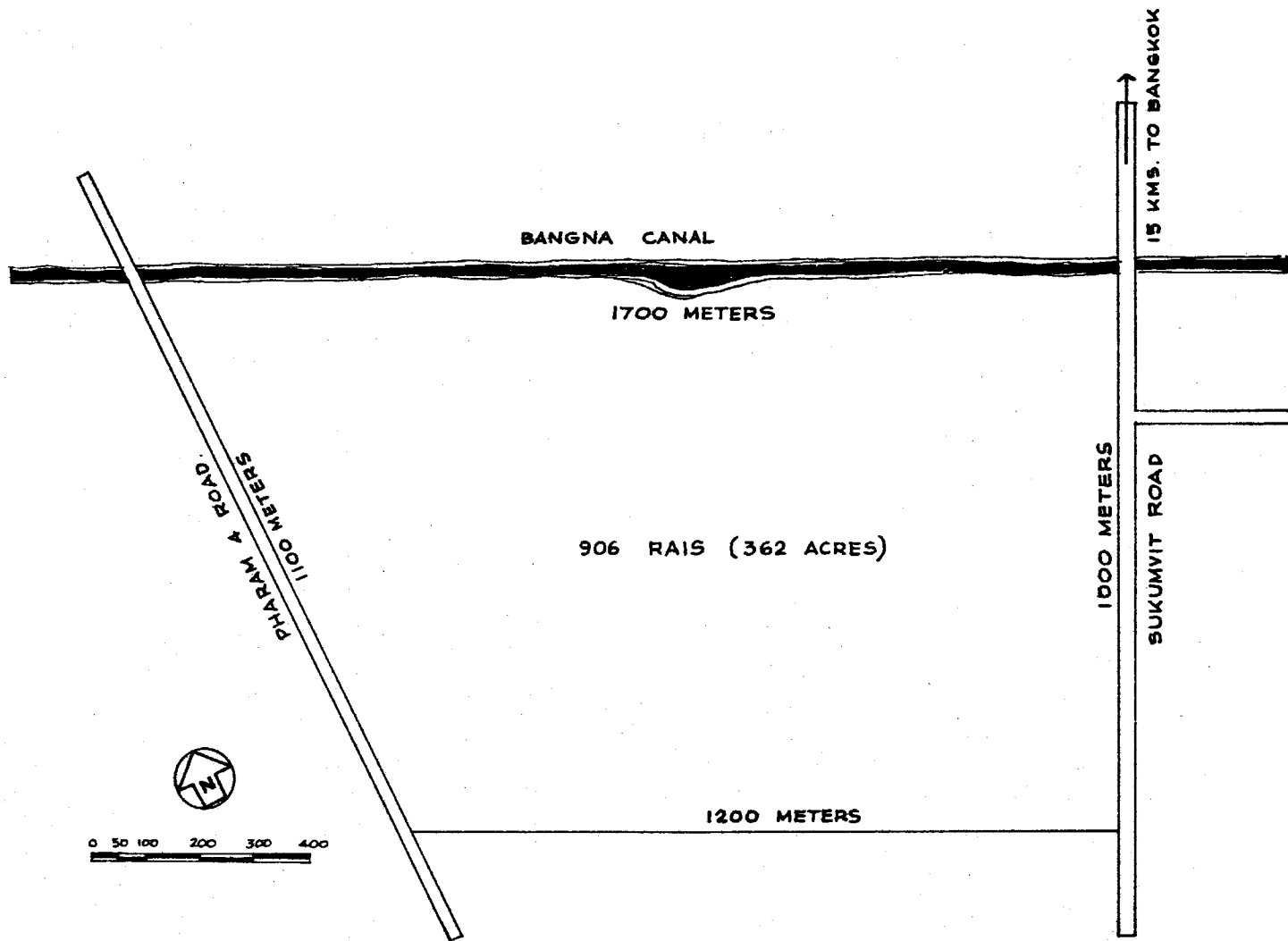
SE	Sukumvit
NE	Bangna Canal
NW	Pharam 4 Road
SW	Boundary

Existing Condition

The site is flat. The water table is about 1.50 meters (4.5 feet) below the existing ground. The wind blows from the south approximately 75%. The soil is dark gray clay. There are few families living in this area. The area is almost waste area containing only a rice field and coconut grove.

Advantages of Site

This location is not far from Bangkok. There is bus service along Sukumvit Road (20 minutes to Bangkok). The site is accessible from two parts of Bangkok, by Sukumvit Road and Pharam 4 Road. The initial cost of the land is low and very little demolition of existing structures will be necessary prior to construction of the project. A minimum of site grading will be necessary because of the flatness of the land. The project can be expanded in the future.



SITE PLAN 1 : 10000

5-2. Concept

The three major points of emphasis in this solution are the housing lay-out concept, the shelter-design and the building elements.

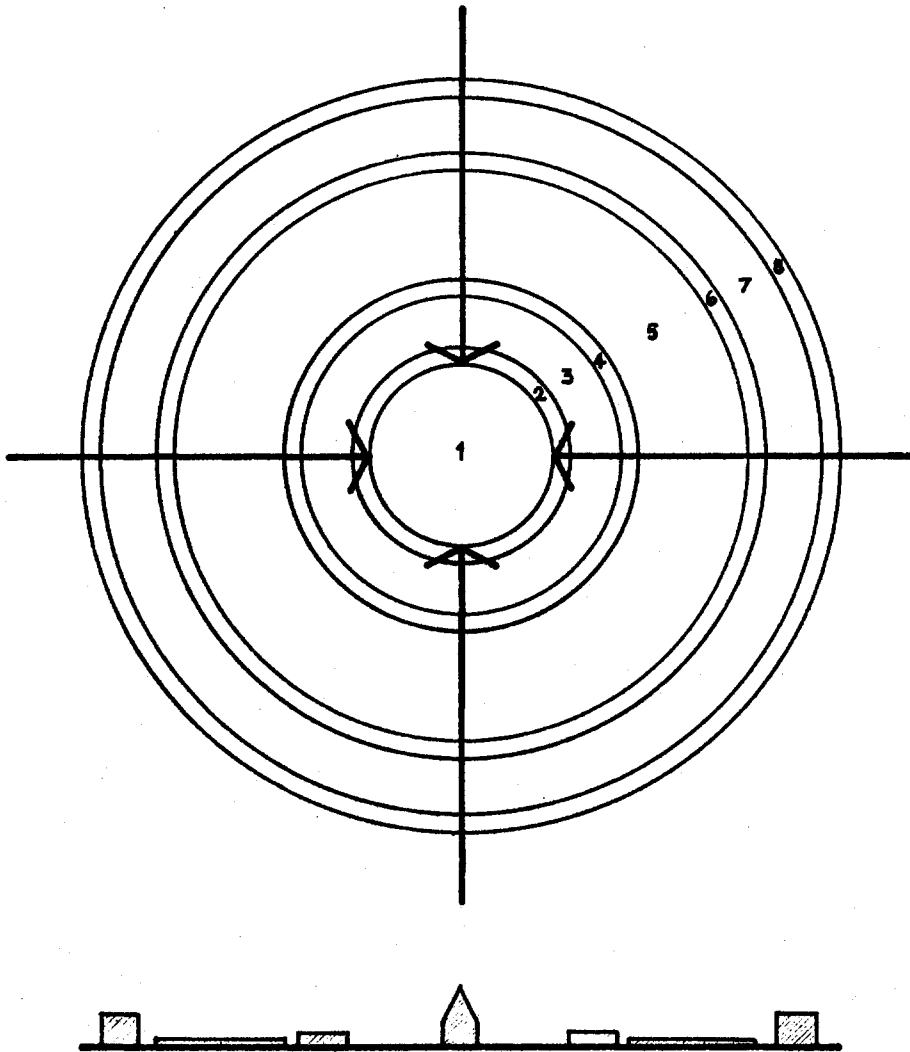
(1) The basic concepts of housing lay-out emphasised in this solution are community considerations, circulation and housing, with emphasis on a community center and extensive pedestrian traffic. The center consists of a temple enclosed by business area, market, shopping center, fire security station, theatre, recreation, ect.

The location is devided into various zones, as follows:

Temple	12%
Business Area	7%
Schools	6%
Hospital	2%
Residence	40%
Road and Parking Area	17%
Park	16%

There are two entrances to the general area in this solution, Sukumvit Road and Pharam 4 Road to ring road around the site to serve the buildings. Pedestrians are separated from the road and walk under shade provided by the trees. Parking garages are on the ground. Every residence zone is enclosed by a greenbelt.

(2) Concept of shelter-design, the buildings should be such as to encourage cooling air movements. Shade protection should be provided by the roof on the E and W exposures. Strong radiation effects on the E and W sides should dictate the shape of the building

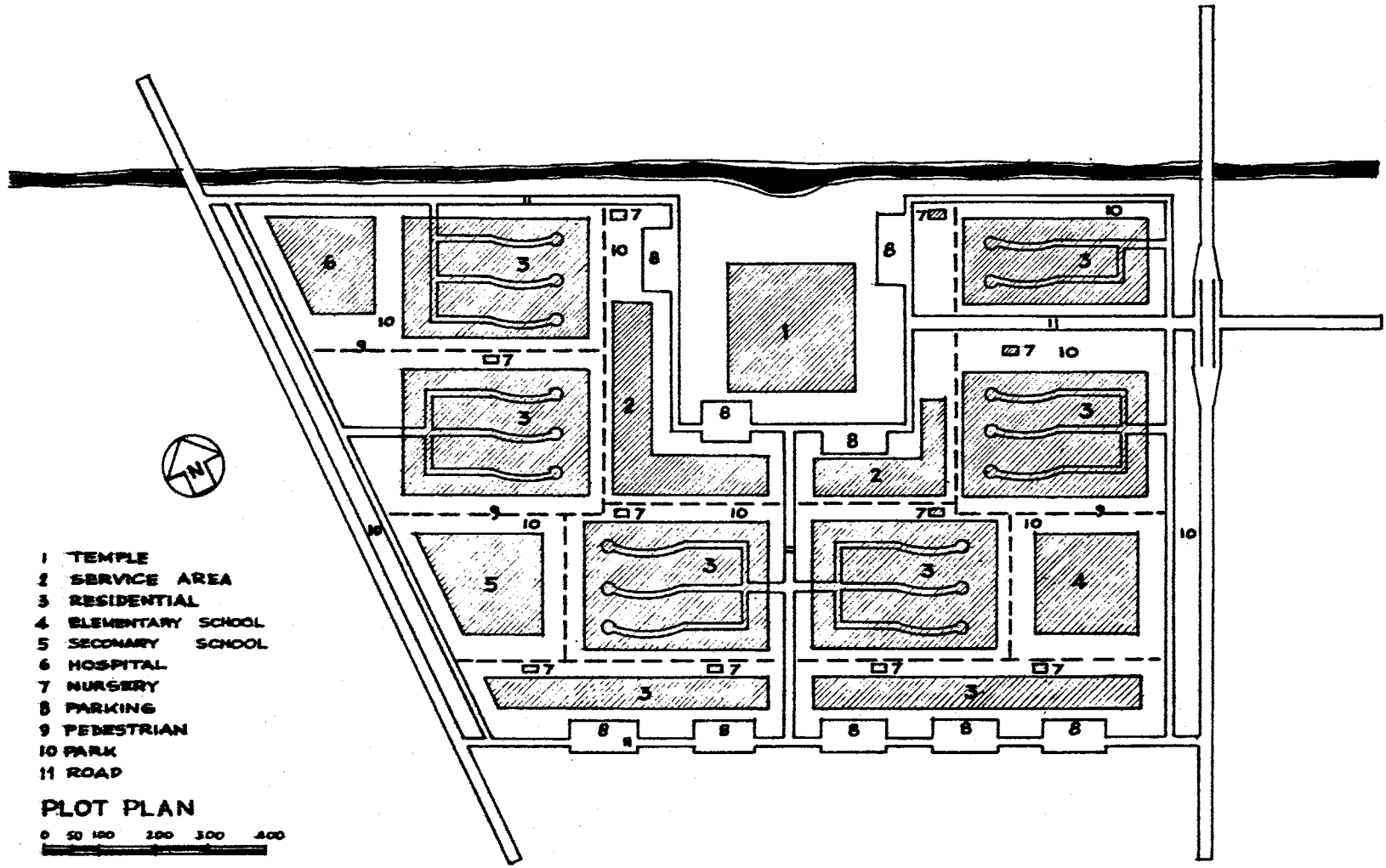


- | | |
|-------------------------|---|
| 1 TEMPLE | 5 RESIDENTIAL , SCHOOL |
| 2 PARK , ROAD | 6 PARK , ROAD, NURSERY |
| 3 SERVICE AREA | 7 RESIDENTIAL, SCHOOL, HOSPITAL, SHOPS. |
| 4 PARK , ROAD , NURSERY | 8 PARK , ROAD |

INTERRELATIONSHIP AMONG VARIOUS ZONES

to a slender elongation. The optimum shape is from about 1:1.5 up to 1:5. Orientation with long side toward differing wind direction is acceptable only under shaded conditions. Interior space must be shaded and well ventilated. Flexible spaces, by the use of screened, movable, or low partitions, are desirable. Floor materials must be impervious to moisture. Reflective light colors in the pastel range are the best, in order to avoid glare both inside and outside the building.

(3) Building elements: Housing in this solution is provided with no air-conditioning or heating, so the buildings should face S and N for natural ventilation. Ventilation is needed 85% of the year and E - W cross ventilation is essential. Elements such as screening, louvres, jalousies, and grills are useful to admit air flow and for protection from the sun. The structure must be sheltered from sun and rain. Walls have less importance in this region. They are used primarily for screening from insects and for their flexible wind penetration qualities, rather than as thermal barriers. Folding window-wall excellently, the upper roof functioning as sun protection. A wide overhang is necessary for rain protection and for a reduction of sky glare (the rain often is inclined at 45° angles). Sunbreakers are important because of powerful radiation mainly on E and W sides. Basement is impractical because of constant high humidity. Foundation must be protected from moisture, mold, fungus, termites and other gnawing insects and animals.



- 1 TEMPLE
- 2 SERVICE AREA
- 3 RESIDENTIAL
- 4 ELEMENTARY SCHOOL
- 5 SECONDARY SCHOOL
- 6 HOSPITAL
- 7 NURSERY
- 8 PARKING
- 9 PEDESTRIAN
- 10 PARK
- 11 ROAD

PLOT PLAN



SCALE 1 : 10000

5-3. Temple

In this solution the temple is at the center of the district. The Temple area occupies about 12% of the whole area of the solution. There are a variety of buildings connected to the temple such as, Bot, Vihara, Phra Chedi, Haw Trai, Sala, Kuti, Haw Rakang, etc. The Thai Wat is an enclosure surrounded by a colonnade and a number of buildings, small and large. Its principle axis runs east to west with entrances on the east, south, and north (except the west), surrounded by coconut palms, Phro trees, and fruit trees, etc. These are dictated by thai culture. A brief description of the temple element is as follows:

BOT. The principle structure of the wat is the Bot. The location of the Bot is at the center of the Wat compound. The Bot is used for the monks assembled for prayer.

VIHARA. Vihara has the same architectural characteristics as the Bot and is used to enshrine Buddha images, and on some occasions, is also used to teach the Buddhist doctrine. Bot or Vihara is enclosed in a square verandah walled outside, covered by the typical Thai roof, having four gateways.

PHRA CHEDI. Phra Chedi has the same characteristics as the Indian stupa.

HAW TRAI. The Haw Trai is the Monk library where sacred books are preserved.

SALA. In the Wat compound there are four Salas which are either open or walled pavilions. The former serve as resting places, while the latter, more properly called Kanparian, serve to teach

Buddhist Monks and people.

KUTI. Attached to the Wat near by the canal, the Kuti is the residence for the Buddhist Monks. The Kuti is separated from the Wat by a colonnade. There are twelve Kutis.

HAW RAKANG. The bell tower (Drum Tower) and Haw Rakang is used also for proclamations and drummings.

5-4. Service Area

The business area occupies about six percent of the solution. It is located in the central region surrounding the temple. There are a variety of businesses such as retail stores, shop houses, markets (fruit market, fish market, cloth market), theatres, police station, aumthur (district office), storage facilities, offices, etc. Careful attention is paid to traffic and parking considerations in this area.

The central business area is located for maximum convenience and accessibility for the greatest number of people in the urban community. The business area is located close to two major arteries tributary to trade areas. The site is adequate for peak parking and complete lines of shops and store types, eating and entertainment facilities, branch business and financial services sufficient to fill several hours of shopper's time.

SCHOOL. There are three kinds of schools in this solution; kindergarten, elementary school, secondary school. The average kindergarten serves pupils, elementary school pupils, and secondary school serves pupils. The kindergarten covers three grade levels, the elementary school covers seven grade levels and the secondary

school covers five grade levels. Maximum walking distance would be approximately one-half kms. (Kindergarten 100-200 meters). The site is adequate for main buildings, recreational facilities, landscaping, and is located with considerations for safety of children and amenity of surroundings.

HOSPITAL. There are no hospitals surrounding the general area of the project and it is proposed to provide for one within the area. Its location is shown in Figure and provides for calm and pleasant surroundings nearby the water tributary. Separation from the main areas is highly desirable.

RECREATION AND PARK. Ample recreational and park areas are provided around the residential areas with trees and greeneries which stay green throughout the year to insure a healthy atmosphere. The main indoor recreational building is located in the general north-western area to the rear of the temple mall. It houses adequate facilities for ball rooms, filliards, and other indoor recreation.

5-5. Residential Area

This constitutes about forty percent of the project. Residential areas are provided in different zones. There are six zones for low density population (single-family apartments and two-family apartments) and one zone for multiple family (one-room apartments for low income people) with enclosure by greenbelts for reduction of heat in the tropic region and for recreation area.

The area to be assigned is determined by the character of the occupation of community and family income. A pattern of homes linked by quiet streets, and centered around an elementary school, kindergarten, a meeting place, a park, etc.

The major considerations are close proximity to major thoroughfares and transit systems and direct connections to work and leisure time areas, and internally served by a system of collector and service streets fitted to the terrain with due consideration to drainage, sunlight, and views. Suitability for integrated design of residential areas and their related shopping facilities, schools, the temple and recreational facilities, including the community serving and the neighborhood serving facilities.

5-6. Housing Types

To consider detailed standards and patterns we must separate the general types of site planning, such as residential, commercial, industrial, and institutional. As the most common and fundamental kind of development, we will consider the plan of housing layouts in some detail. There are a number of common residential building types.

(1) One-story apartment (two bedrooms). The single family house: Each dwelling unit in its own isolated structure. (67 units)

(2) Two-story apartment (three bedrooms). The single family house. (150 units)

(3) Two-story attached apartment (two bedrooms). The two family house: Two units attached side by side. (304 units, 152 buildings.)

(4) Nine-story apartment house (one room apartment).

Elevated apartments for low income people. (880 units in 11 buildings.)

One-story apartment	67 units	5%
Two-story apartment	150 units	11%
Two-story apartment	304 units	22%
One-room apartment	880 units	62%

One-Story Apartment (Medium-Income Apartment)

There are 67 units located as shown in Figure . Each unit per one family total area 45.60 m^2 (490.66 ft^2). There are living-dining rooms, kitchens, toilets, and two bedrooms. Parking garage: one car per one apartment on the ground. Two staircases at the front and the side. The floor is raised one meter (three feet) over the ground.

Structure: Hard wood frame

Roof: Corrugated asbestos sheet $50 \times 1.50 \text{ m}$ overlap $.20 \text{ m}$. White roof is desirable, aluminum sheet for insulation. Overhang approximately 2.00 meters (6.6 feet).

Ceiling: Plywood $.4 \text{ m.m}$ inside the building, corrugated asbestos $.4 \text{ m.m}$ outside.

Wall: Corrugated asbestos 6 m.m or soft wood.

Toilet: Shower, sink, and water closet. (Obtainable from Japan at a very low cost.)

Floor: Special plywood or hard wood.

Foundation: Pile footing 1.50 deep, wood pile four meters.

Area of the building:

Bedroom 1	12.30 m ²	(132.35 ft ²)
Bedroom 2	9.30 m ²	(100.07 ft ²)
Living-dining room	15.00 m ²	(161.40 ft ²)
Toilet	4.00 m ²	(43.04 ft ²)
Kitchen	5.00 m ²	(53.80 ft ²)
Terrace	7.70 m ²	(82.85 ft ²)
Total	45.60 m ²	(490.66 ft ²)
(Terrace	7.70 m ²	(82.85 ft ²)

Two-Story Apartment (Medium Income Apartment)

There are 150 apartment units located as shown in Figure . Each unit per one family total area 114.93 m² (1236.65 ft²). There are living-dining rooms, kitchen, toilet on the first floor and three bedrooms, one toilet on the second floor. Parking garage: one car per apartment on the ground. Two balconies for the two bedrooms are provided.

Structure: Reinforced concrete on the first floor and hardwood frame in the second floor.

Roof: Corrugated asbestos sheet .50 x 1.20 overlap .20 m 10° angle, white roof is desirable, aluminum sheet for insulation. Overhang approximately 2.00 meters (6.6 feet).

Ceiling: Plywood 4 m.m inside the building, corrugated asbestos 4 m.m outside.

Wall: Light weight concrete block; on the first floor and corrugated asbestos sheet 6 m.m or softwood on the second floor.

Toilet: White terrazzo floor, tub, water closet, sink (obtainable from Japan at a very low cost).

Floor: Hardwood or redwood for second floor, and terrazzo, asphalt tile or vinyl tile, terra cotta, or hardwood on slab concrete, in the first floor.

Foundation: Pile footing 1.50 m deep (4.5 feet) wood pile or concrete pile six meters (20 feet).

Area of the building:

First Floor

Living-dining room	40.95 m ²	(440.62 ft ²)
Toilet	2.60 m ²	(27.98 ft ²)
Kitchen	8.40 m ²	(90.38 ft ²)
Terrace	12.00 m ²	(129.12 ft ²)

Second Floor

Bedroom 1	23.40 m ²	(251.18 ft ²)
Bedroom 2	15.92 m ²	(171.30 ft ²)
Bedroom 3	11.70 m ²	(125.89 ft ²)
Toilet	5.00 m ²	(53.80 ft ²)
Hall	3.00 m ²	(32.28 ft ²)
Staircase	3.96 m ²	(42.61 ft ²)
Veranda	9.00 m ²	(96.84 ft ²)
Sunshade	16.50 m ²	(177.54 ft ²)
Total	114.93 m ²	(1236.65 ft ²)

(Terrace, Veranda, Sunshade, 37.50 m² (403.50 ft²))

Two-Story Attached Apartments (Medium Income Apartment)

There are 152 buildings located as shown in Figure . Each apartment contains two units (95.07 m^2 per unit). One staircase serves each apartment. Each apartment contains a living and dining room, kitchen on the first floor and two bedrooms, one toilet, two closets on the second floor, no heating or air-conditioning. Parking garage: One car per unit on the ground. A balcony for each bedroom is provided.

Structure: Reinforced concrete frame in the first floor, hardwood frame in the second floor, with six inch light weight concrete block on the first floor wall, corrugated asbestos sheet (6 m.m) for second floor wall. Plywood is used for partitions.

Roof: Corrugated asbestos sheet .50 x 1.50 m overlap .20 m 10° angle. White roof is desirable. Aluminum sheet for insulation. Overhang approximately 2.00 meters (6.6 feet).

Ceiling: Plywood 4 m.m inside corrugated asbestos sheet outside.

Wall: Light weight concrete block for the first floor, corrugated asbestos sheet 6 m.m or soft wood on the first floor.

Toilet: White terrazzo for floor, tub, water closet, sink (obtainable from Japan at a very low cost).

Floor: Terrazzo, asphalt or vinyl tile, terrz cotta or hardwood on slab concrete for the first floor, hardwood or special plywood for second floor.

Foundation: Pile footing 1.50 m (4.5 feet) wood pile or concrete pile six meters (20 feet).

Area of the building:

First Floor

Living room	22.71 m ²	(244.36 ft ²)
Dining room	10.50 m ²	(112.98 ft ²)
Staircase	3.96 m ²	(42.61 ft ²)
Kitchen	6.60 m ²	(71.02 ft ²)
Terrace	8.80 m ²	(94.69 ft ²)

Second Floor

Bedroom 1	17.10 m ²	(183.99 ft ²)
Bedroom 2	17.10 m ²	(183.99 ft ²)
Hall	3.60 m ²	(38.74 ft ²)
Staircase	3.48 m ²	(37.45 ft ²)
Closet	4.80 m ²	(51.65 ft ²)
Toilet	5.22 m ²	(56.17 ft ²)
Veranda	9.00 m ²	(96.84 ft ²)
Sunshade	4.50 m ²	(48.42 ft ²)
Total	95.07 m ²	(1022.95 ft ²)
(Terrace, Veranda, Sunshade	22.30 m ²	(239.95 ft ²)

Nine-Story Apartments (Low Income Apartments)

There are eleven buildings located at the southwest road of the solution. Each building contains eighty one-room apartments. (36.9 m² and 27.67 m² 6:4). There are two staircases and two elevators serve the ten apartments in each floor. No heating or air-conditioning is proposed. Parking garage: One car per two apartments on the ground (proposed as a future addition as at present the

low income families seldom use cars.) A balcony for each apartment.

Structure: Reinforced concrete frame, with six inch light weight concrete block for exterior wall, between apartment four and one-half inch.

Roof: Corrugated asbestos sheet (.50 x 1.20 m overlap .20 m 10° angle), white roof is desirable, aluminum sheet for insulation approximately overhang 2.50 meters (8 feet).

Ceiling: Plywood 4 m.m for interior, corrugated asbestos sheet 4 m.m for exterior for the ninth floor. First floor through the eighth floor, have no ceiling, use slab concrete floor for the ceiling.

Wall: Six inch light weight concrete block for exterior wall, four and one-half inch for interior wall.

Toilet: White terrazzo floor, indigenous water closet.

Floor: Asphalt or vinyl tile, terra cotta, or hard wood cover on slab concrete.

Foundation: Pile footing 3.00 meter (10 feet deep) 20 meters (66 feet) concrete pile.

Area of the building:

First Floor

Children's play room	60.00 m ²	(645.60 ft ²)
Laundry	55.35 m ²	(595.57 ft ²)
Janitor storage	18.45 m ²	(198.52 ft ²)
Public toilet	14.80 m ²	(159.25 ft ²)

Second - Ninth Floor (each floor)

Corridor	78.60 m ²	(845.73 ft ²)
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Staircase	18.48 m ²	(198.85 ft ²)
Verandah	60.00 m ²	(645.60 ft ²)
Apartment A (6 units)	221.00 m ²	(2377.96 ft ²)
Apartment B (4 units)	110.68 m ²	(1190.92 ft ²)
Elevator	12.50 m ²	(134.50 ft ²)
Garbage	1.50 m ²	(16.14 ft ²)
Duct	2.50 m ²	(26.90 ft ²)

Apartment Area for Each Unit

<u>Unit A</u>	36.90 m ²	(397.04 ft ²)
Living, dining, bed, area	27.90 m ²	(300.20 ft ²)
Kitchen	5.15 m ²	(55.41 ft ²)
Toilet	2.28 m ²	(24.53 ft ²)
Hall	1.32 m ²	(14.20 ft ²)
Duct	.25 m ²	(2.69 ft ²)
<u>Unit B</u>	27.67 m ²	(297.73 ft ²)
Living, dining, bed, area	21.97 m ²	(236.40 ft ²)
Kitchen	3.17 m ²	(34.11 ft ²)
Toilet	2.28 m ²	(24.53 ft ²)
Duct	.25 m ²	(2.69 ft ²)

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VITA

Chatchai Gadavanij

Candidate for the Degree of
Master of Architecture

Report: PROPOSED BANGNA HOUSING PROJECT, BANGKOK
THAILAND

Major Field: Architecture

Biographical

Personal Data: Born in Nakorn Phathom Province, Thailand,
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Institution: Oklahoma State University Location: Stillwater, Oklahoma

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Pages in Study: 74 Candidate for Degree of Master of Architecture

Major Field: Architecture

Purpose and Scope of Study: The development of housing in Bangkok and the influence of climatic and sociological conditions on the design.

Findings and Conclusions: In the design of housing in Bangkok, principal of major influence includes provisions for free air movements and effective insulation from the heat outside. These considerations may influence the design of openings in the wall and the thickness of the exterior walls. Careful consideration of such factors affecting the buildings is needed for their successful function in the tropical zones.

ADVISER'S APPROVAL _____