A LOW-RISE, MEDIUM DENSITY HOUSING PROJECT, SAPAN KWAI, BANGKOK

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by

Chula Bardhanabeadya

A Thesis submitted to the Faculty of Graduate Studies and Research in partial fulfilment of the requirements for the degree of Master of Architecture

School of Architecture,
McGill University,
Montreal, Canada

April, 1964

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PREFACE

This thesis is concerned with the design of low-cost housing (Low-rise) in particular for people of low income in Bangkok, Thailand. Therefore, for the achievement of the design, it is necessary to study at the outset the factual aspects of Thailand, and especially Bangkok.

The Thesis consists of nine parts.

Part I to Part V, inclusive, are studies of climatic, sociological, economic and housing conditions, building materials, construction methods and housing standards.

Part VI deals with the implications of "high-density," "low-cost" and "low-rise".

Part VII is the general thesis proposal.

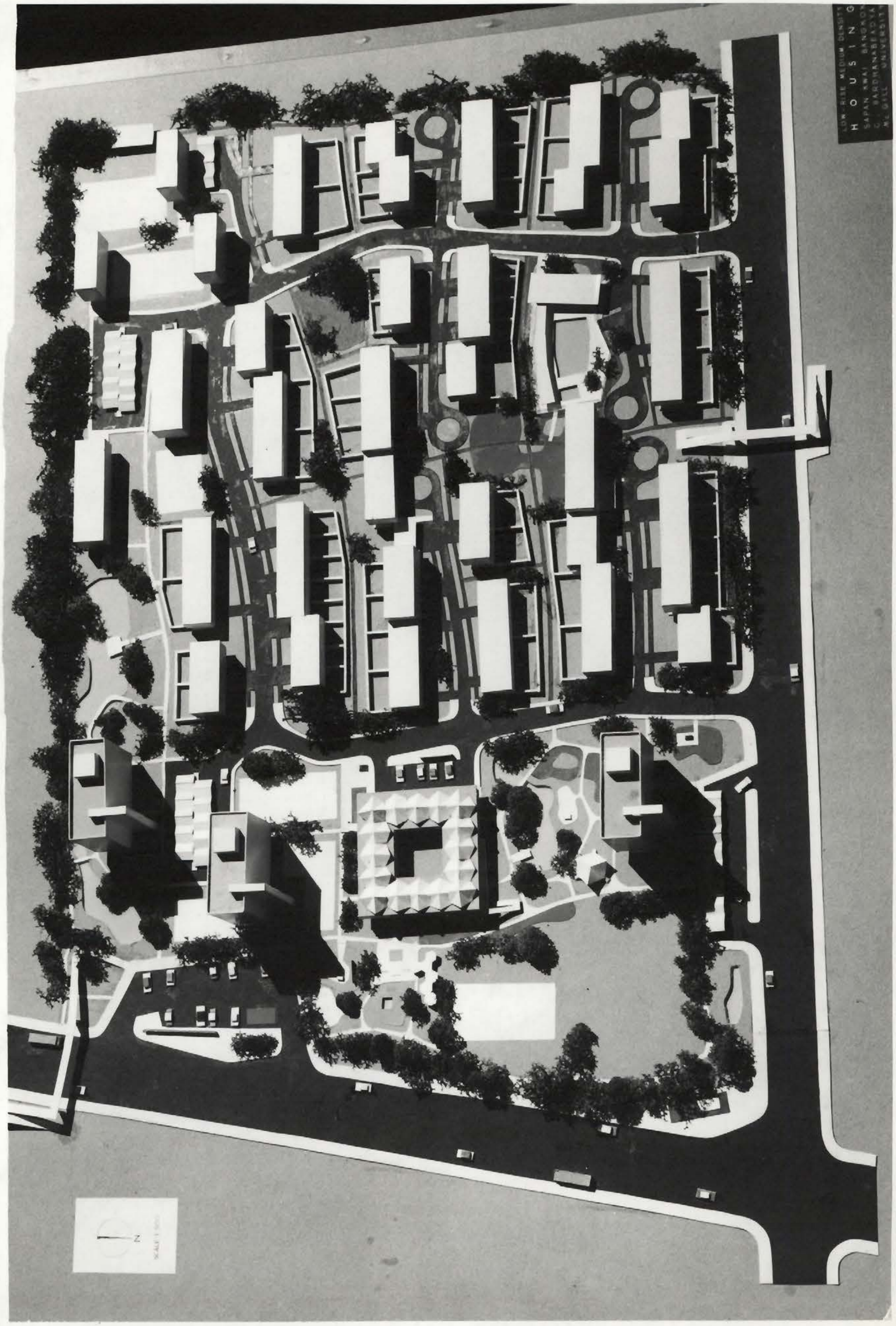
Part VIII is a proposal for a low-cost, low-rise housing project for people of low income (middle-lower class) in Bangkok, Thailand, and a report on the site.

Part IX is the design solution and drawings.

The author is greatly indebted to Professor Jonas Lehrman who has generously given of his advice and help.

The author wishes to thank his friends in Thailand who provided some information and illustrations for this thesis, and also to Mrs. Stewart for her typing.

This thesis would not have been completed without time and co-operation given so willingly by all those concerned.


LOW-RISE MEDIUM DENSITY
HOUSING
SAPAN KWAI BANGKOK
MC GILL UNIVERSITY

INTRODUCTION

Housing is one of the most important basic necessities of human life next to food. The activity in housing does not meet the demands of increasing populations, with the result that today every country is facing a serious housing problem particularly in urban areas.

It is an actual fact that the need for housing, particularly of people of low income in urban areas such as Bangkok, has reached a high level. The significance of this can be seen from the steady growth of housing projects, but most of them are not perfectly suited to satisfy the needs of the people sufficiently. In the country of Thailand as a whole this causes many problems, and especially in Bangkok where the problem has been more serious than in the other provinces.

As the population in Bangkok increases, the number of dwellings must be increased as well. However, a housing project is rarely carried out by private money investment because it costs a lot of money. Therefore the housing problem is one of the most important subjects with which the government must be concerned and on which it can take responsibility and action in the housing field.

In Bangkok, most urban housing developments are sponsored by the government and almost every project is intended for people of low income.

Now that the government is taking action in the housing field, the national housing policy and program are carried out in many schemes, such as the project of slum clearance in the urban area, where there are deteriorated or unsanitary buildings and people are over-crowded, the project for improvement or modernization of existing housing and housing techniques, and the project of building new housing.

The organization of government activity with regard to housing welfare is the responsibility of the Ministry of the Interior which directed the Public Welfare Department to take charge of the works through the Bank of Housing Welfare. All the programs emphasize in particular the welfare of people of low income by means of:

(a) giving mortgage loans to owners for construction or renovation of buildings,

(b) providing land and constructing houses for the hire-purchase system,

(c) constructing houses for rent.

This thesis is mainly concerned with the design solution of housing projects for people of low income in Bangkok. A report of the study of low-cost housing problems in Bangkok, Thailand, is presented in Part I to Part VII.

PART I : CLIMATIC INFLUENCE ON ARCHITECTURE

IN BANGKOK, THAILAND

1. GENERAL CLIMATIC CONDITION OF BANGKOK
   - A. Geographical Situation
   - B. General Climatic Conditions
     - a. The Seasons
     - b. Temperature
     - c. Rainfall
     - d. Relative Humidity
     - e. Cloudiness
     - f. Thunderstorms
     - g. Surface Winds
     - h. Typhoons

2. CLIMATIC FACTORS INFLUENCING THE DESIGN OF BUILDINGS
   - A. Bioclimatic Conditions
   - B. Effect of the Sun on the Earth
     - a. The Sun's Position
     - b. Sun-angle Calculator Device
     - c. Exclusion of Solar Radiation from Buildings
       1. Shading
       2. Reflection
       3. Ventilation
       4. Thermal Capacity
     - d. Note on Glare
   - C. Wind and Ventilation
     - a. Wind Effect
     - b. Stack Effect
       1. Wind Evaporates Moisture, Dries Surfaces
       2. Wind Pressure on Buildings
       3. Cooling Effect of Wind.
   - D. Insulation
   - E. Rainfall
     - a. Flooding
     - b. Soil Erosion
     - c. Variation in Moisture Content of Ground
     - d. Damp Penetration
     - e. Surface Erosions of Building Materials
     - f. Thermal Shock
     - g. Problems Connected with Carrying Capacity of Gutters
   - F. Landscaping
     - a. Shading Effect of Trees and Ventilation
     - b. Air Flow Utilization

I: GENERAL CLIMATIC CONDITION OF BANGKOK

A. Geographical Situation

Bangkok is the capital city of Thailand. It is situated in the tropics between latitude 13 44'N and 13 55'N, and between longitude 100 38'E and 10029'E. The elevation of Bangkok is approximately 2.00 metres above mean sea level, actually situated in the middle plain of Thailand. There are many canals and waterways, which have also served practically as main transportation, drainage and irrigation. The Chao Phraya River is the main waterway, running from north to south, with Bangkok located on the east bank.

Bangkok is located in the "hot wet" tropical humid belt, having a high humidity throughout the year, even in the hot season. The monsoon influences the seasonal variation, bringing in critical amounts of rain and wind. There is a small variation in temperature between day and night. Due to the high temperature and high humidity (mean humidity 85%), air movement is essential for comfort.

B. General Climatic Conditions

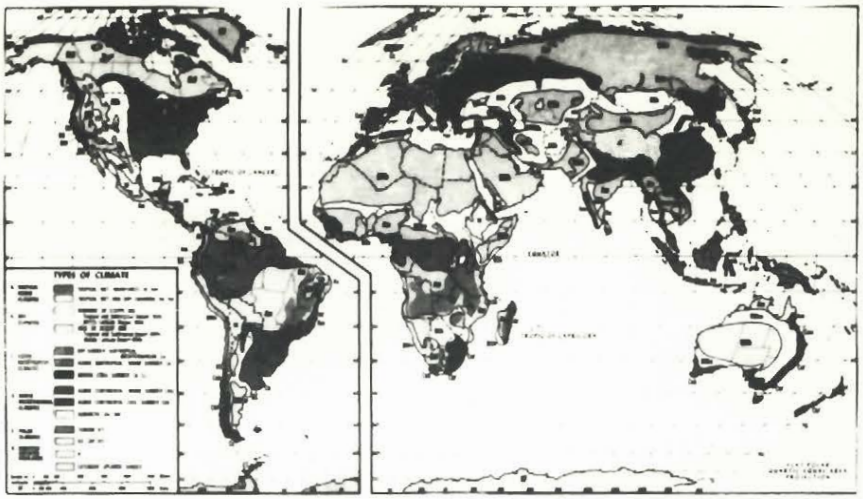
The climate in Bangkok is under the influence of the seasonal monsoon winds. The Northeast Monsoon lasts from November to February, bringing cold, dry air from the China mainland.

The Southwest Monsoon lasts from May to September, carrying warm, moist air from the Indian Ocean, and causing abundant rain over Bangkok.

MAP OF THAILAND

AND

WORLD MAP, SHOWING TYPES OF CLIMATE



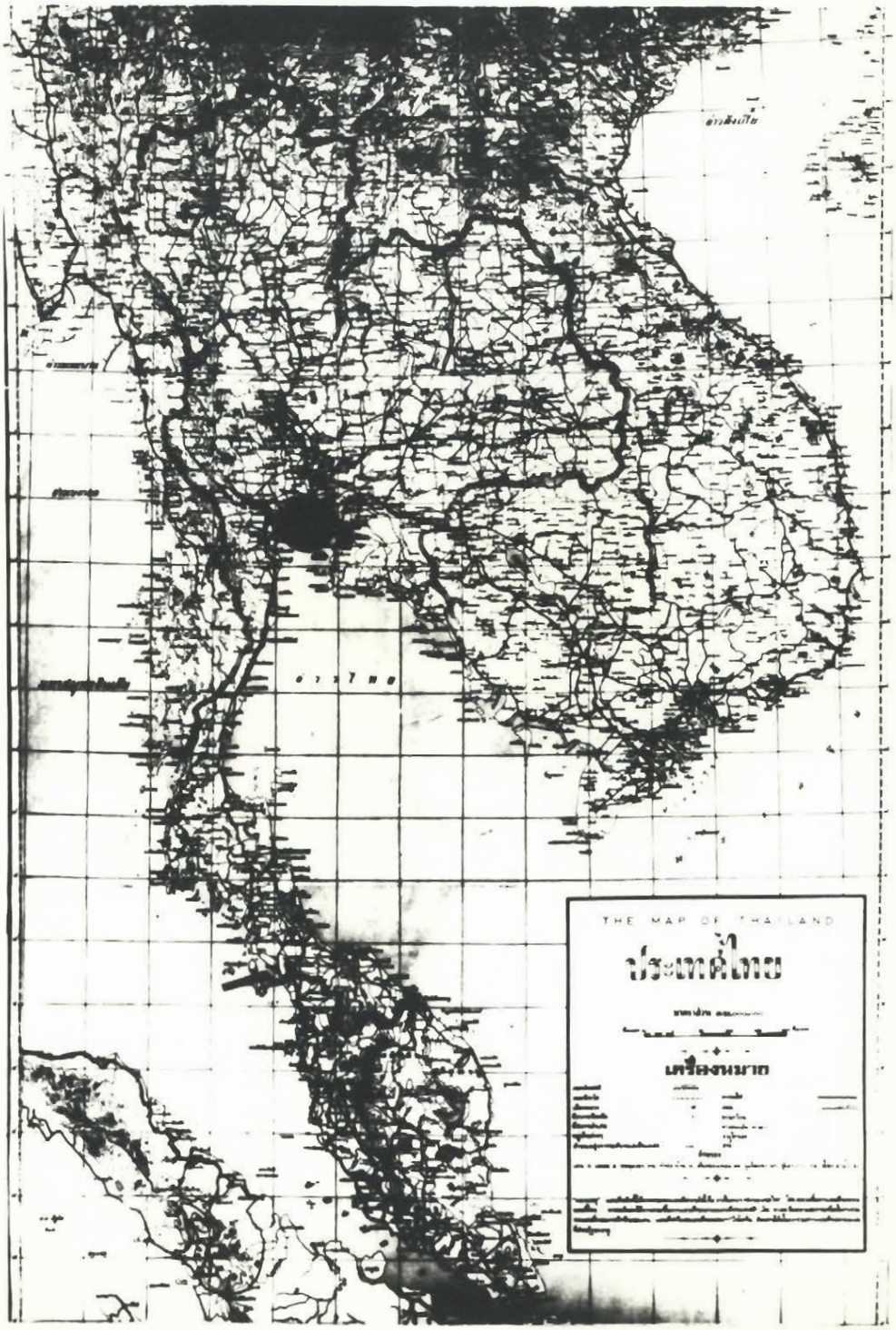


FIGURE 1

a. The Seasons

The climate of Bangkok may be divided into three seasons:

1. Winter, from November to February. This is the mildest period of the year.

2. Summer, in March and April. This is the transitional period from Northeast to Southeast Monsoon.

3. Rainy, from May to September. Abundant rainfall occurs over nearly the whole country.

b. Temperature

This is generally high, sometimes rising to 39.8 C (103.8 F). At night, however, there is a rapid loss of heat by radiation and also by active sea breezes; night temperatures thus become more moderate.

During the winter, temperatures in Bangkok are milder and persons accustomed to a temperate climate will find this season, November to February, delightful. The daily temperature range during this period is quite large, averaging about 15 to 19 C. The influx of cold air from the China Mainland, however, occasionally reduces the temperature to fairly low values. (See Graph 1, Table 1)

c. Rainfall

There is little rainfall in Bangkok in the cold season and throughout the hot season. Bangkok has its maximum rainfall in September. The monsoon rainfall, augmented by that from the tropical depressions is the main cause of floods in Upper Thailand.

(See Graph 2, Table 2)

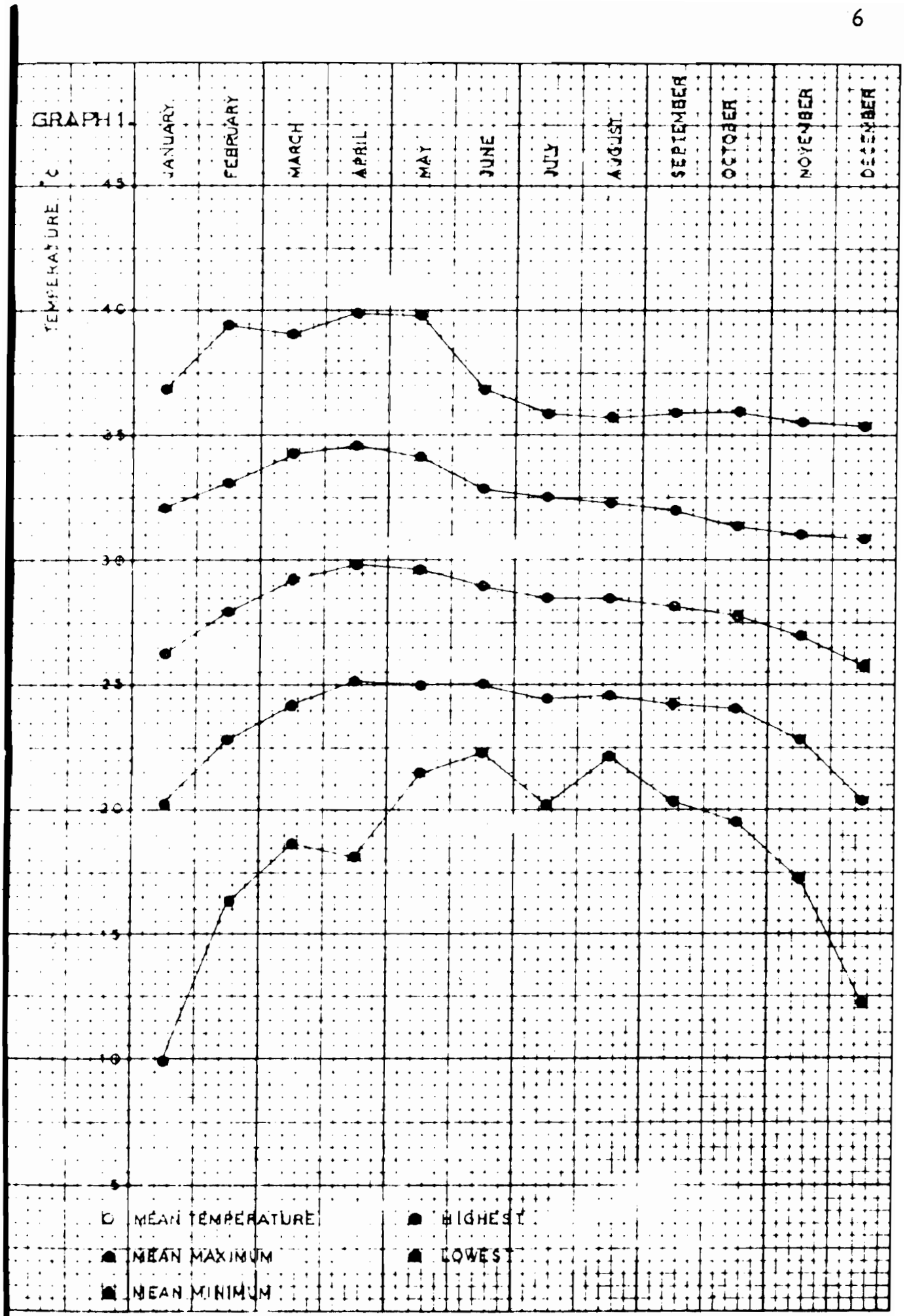

GRAPH 1
TEMPERATURE °C
45
40
35
30
25
20
15
10
5
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
MEAN TEMPERATURE
MEAN MAXIMUM
MEAN MINIMUM
HIGHEST
LOWEST

Table 1. MONTHLY AND SEASONAL TEMPERATURE DATA FOR BANGKOK

1937-1955

Month	Mean	Mean Maximum	Mean Minimum	Highest	Lowest
January	26.2	32.1	20.3	36.9	9.9
February	28.0	33.1	22.8	39.4	16.3
March	29.3	34.3	26.3	39.1	18.7
April	29.9	34.6	29.2	39.9	18.2
May	29.6	24.1	25.0	39.8	21.5
June	29.0	32.6	25.0	36.8	22.3
July	28.5	32.5	24.5	35.8	20.2
August	28.5	32.3	24.6	35.7	22.7
September	28.2	32.0	24.3	35.8	20.4
October	27.8	31.4	24.1	35.9	14.6
November	27.0	31.0	22.9	25.5	17.3
December	25.6	30.8	20.4	35.3	12.3
Year	28.1	32.6	23.6	39.9	9.9
N.E. Monsoon (Nov.-Feb.)	26.7	31.8	21.6	39.4	9.9
1st Transition (March-May)	29.6	34.3	24.8	39.9	18.2
S.E. Monsoon (June-Sept.)	28.6	32.4	26.6	36.8	20.2
2nd Tfansition (Oct.)	27.8	31.4	24.1	35.9	19.6

Abolsute Maximum Temperature 39.9 C. 27/4/41
Absolute Minimum Temperature 9.9 C. 12/1/55

Source: Meteorological Department, Royal Thai Navy, 1957

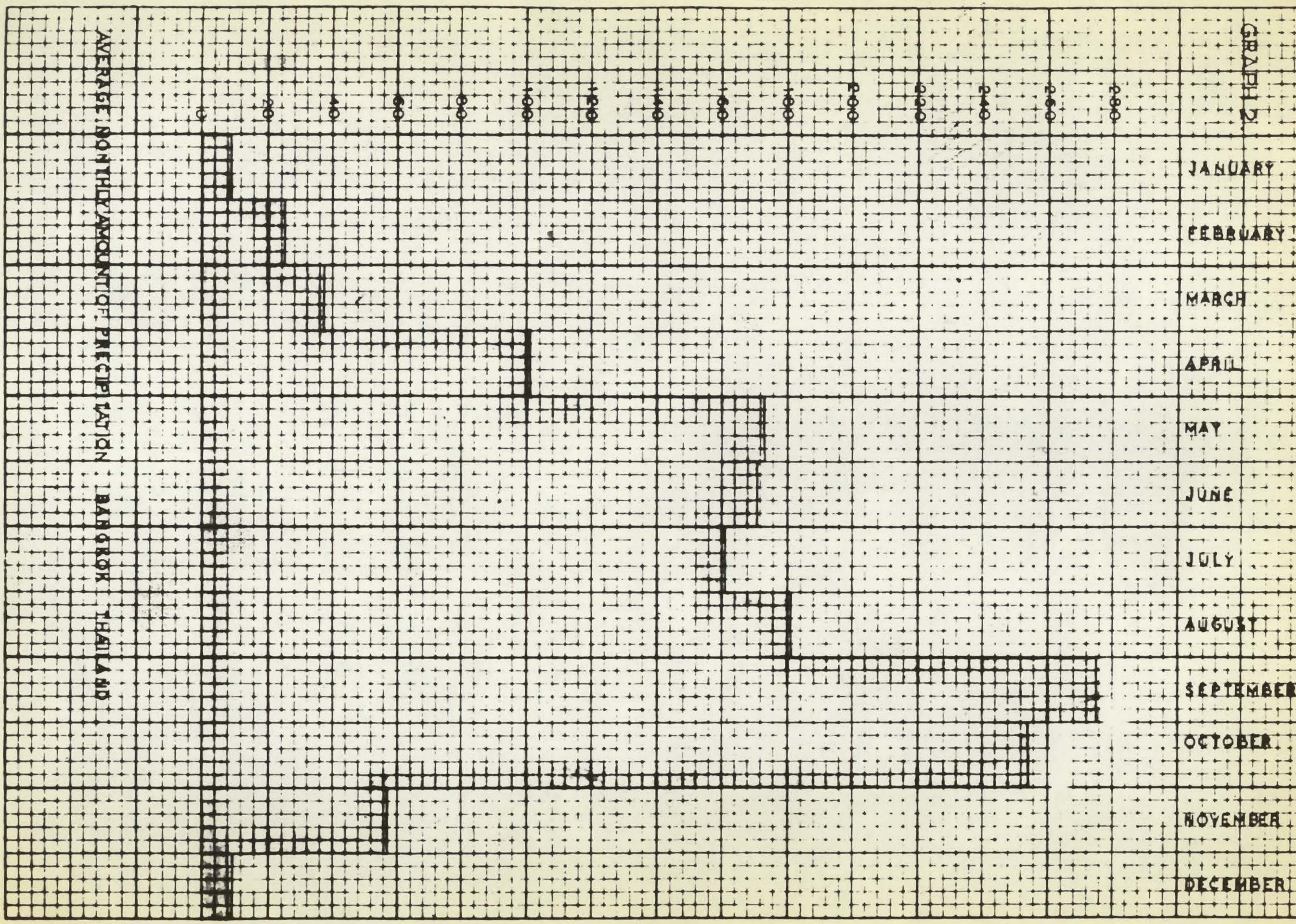

GRAPH 2
AVERAGE MONTHLY AMOUNT OF PRECIPITATION . BANGKOK THAILAND
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER

Table 2 PRECIPITATION DATA FOR BANGKOK 1932-1952

Month	Rainfall in MM. Mean	Mean Rainy Days	Max.in One Day	Mean Evaporation (CC.)	Mean Cloud Amount 1 p.m.
January	9.1	1.2	54.6	195.5	3.4
Februray	25.6	3.0	55.0	178.0	3.8
March	37.1	3.1	53.6	199.8	4.1
April	101.6	6.7	144.2	176.5	4.9
May	175.4	13.9	81.3	149.2	5.9
June	171.6	15.9	97.3	144.3	6.6
July	161.3	17.6	80.4	155.6	6.7
August	180.4	17.2	76.6	144.9	6.7
September	275.1	20.7	121.4	113.7	6.6
October	254.7	15.7	111.0	116.3	5.8
November	57.3	7.4	38.7	131.3	4.9
December	9.2	1.22	8.5	183.9	4.1
Year's Mean	121.53	10.3		157.4	5.3

Source: Meteorological Department, Royal Thai Navy.

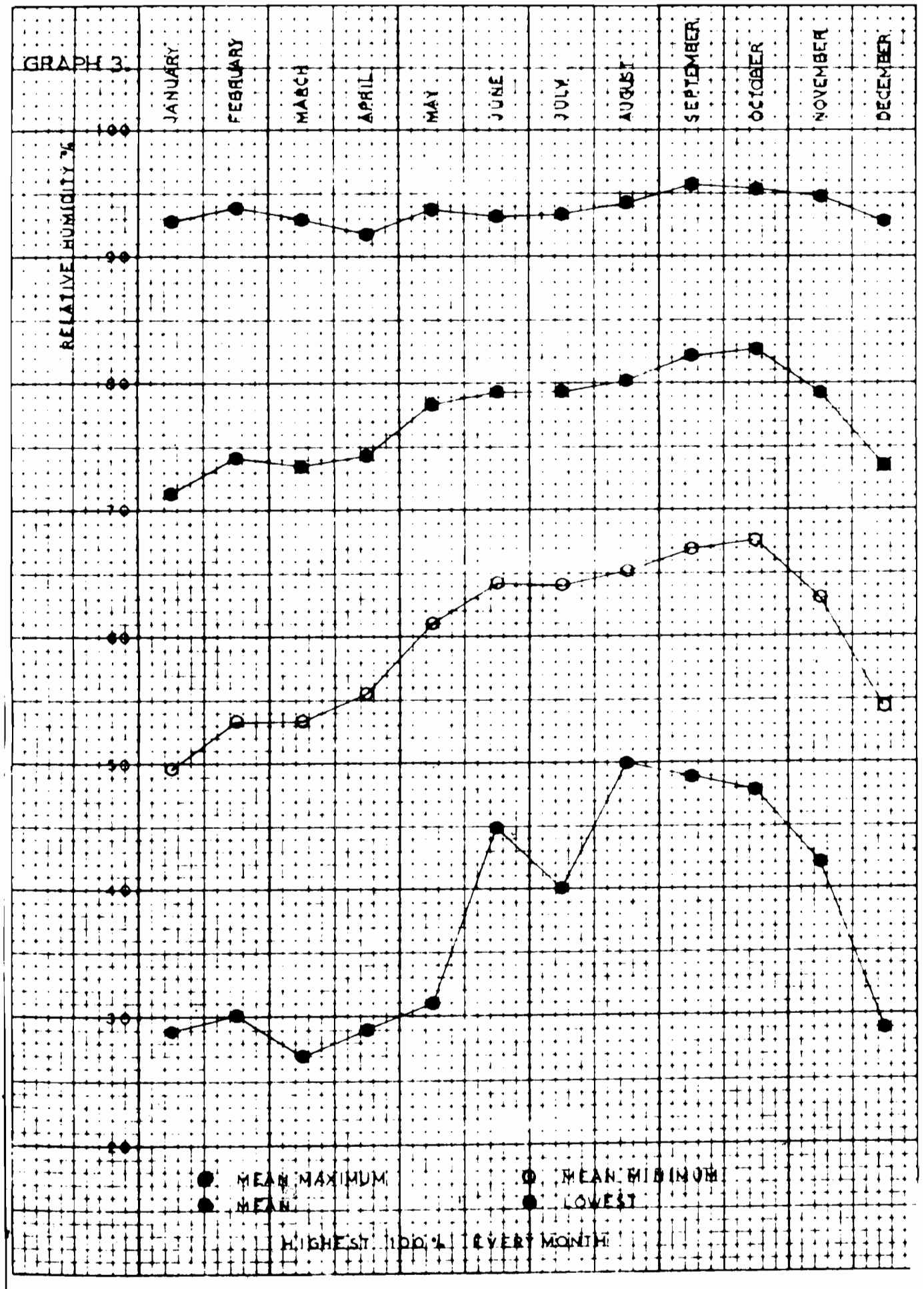

GRAPH 3.
RELATIVE HUMIDITY %
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
MEAN MAXIMUM
MEAN
MEAN MINIMUM
LOWEST
HIGHEST 1000 L EVERY MONTH

Table 3 MONTHLY MEA N RELATIVE HUMIDITY IN PERCENT
BANGKOK, 1937-1955

Month	Mean	Mean Maximum	Mean Minimum	Highest	Lowest
January	71.4	92.6	49.7	100.0	29.0
February	74.1	93.8	53.3	100.0	30.0
March	73.6	93.0	53.3	100.0	27.0
April	74.3	91.9	55.4	100.0	29.0
May	78.6	93.8	61.0	100.0	31.0
June	79.4	93.2	64.1	100.0	45.0
July	79.4	93.4	64.0	100.0	40.0
August	80.1	94.3	65.2	100.0	50.0
September	82.1	95.8	67.2	100.0	49.0
October	82.7	95.4	67.7	100.0	48.0
November	79.3	94.8	63.0	100.0	42.0
December	73.5	92.9	54.5	100.0	27.0
Year	77.4	93.7	59.9	100.0	27.0

Source: Meteorological Department, Royal Thai Navy, 1958

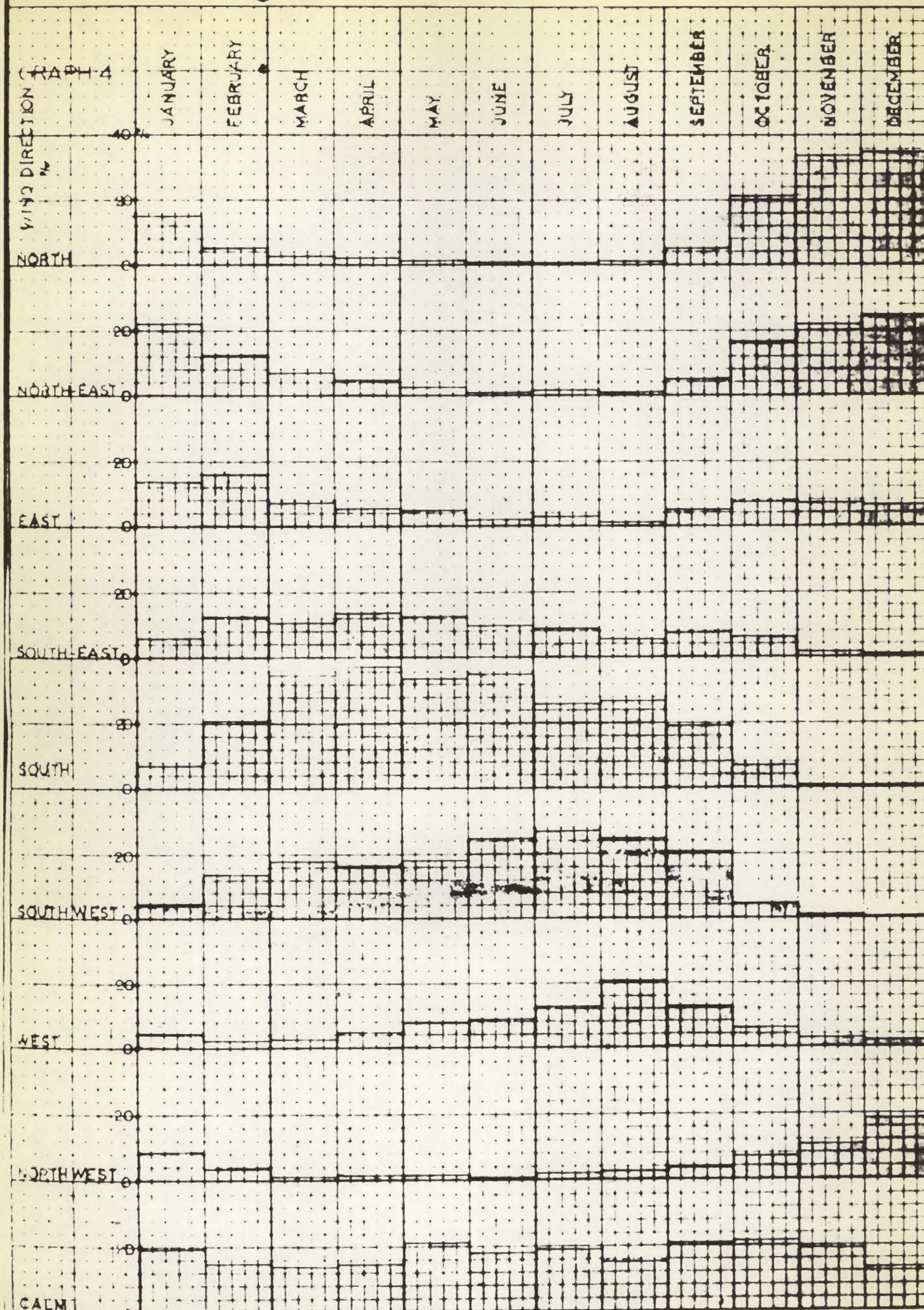

GRAPH 4
WIND DIRECTION
%
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
40
30
NORTH
0
20
NORTH-EAST
0
20
EAST
0
20
SOUTH-EAST
0
20
SOUTH
0
20
SOUTHWEST
0
20
WEST
0
20
NORTHWEST
0
10
CALM
0

Table 4 SUPPLEMENTARY WEATHER DATE FOR BANGKOK

Month	Monthly Frequency of Thunder Storm Days	Monthly Frequency of Lightning & Thunder Days	Mean Number of Days With: Hail	Haze	Fog	Squall
January	0.2	2.5	0	25.0	23.6	0
February	2.2	5.9	0	22.0	20.5	0.1
March	6.0	13.7	0	25.1	24.7	0.3
April	11.2	17.9	0	16.4	17.5	0
May	17.3	27.1	0	7.9	13.2	0.3
June	11.7	19.9	0	7.1	10.2	0
July	12.8	20.8	0	5.7	8.7	0.9
August	11.2	19.8	0	4.6	12.6	0.2
September	14.0	23.8	0	5.2	12.1	0.2
October	12.1	22.6	0	6.8	13.8	0
November	4.4	10.6	0	8.6	16.0	0
December	0.3	0.7	0	18.0	20.7	0
Total	103.4	184.9	0	152.4	193.6	2.0
Period	1948-57	1948-57	1943-52	- - - - - - - - - - -		

Source: Meteorological Department, Royal Thai Navy

Table 5 MONTHLY FREQUENCIES OF WIND DIRECTION, BANGKOK, 1950-1954

Month	Percent from: N	NE	E	SE	S	SW	W	NW	Calm	Average Velocity (B.F.)	Average Maximum Velocity (B.F.)
Jan.	15	23	15	4	8	5	4	8	20	1.2	5.0
Feb.	5	12	17	13	21	14	2	3	14	1.5	5.8
Mar.	3	7	8	11	35	19	3	1	14	1.7	6.4
Apr.	2	5	6	14	35	17	5	1	14	1.9	7.4
May	1	3	5	12	30	18	8	1	22	1.4	7.4
June	1	1	2	10	35	25	8	1	18	1.5	7.8
July	1	1	3	9	26	27	12	2	19	1.5	7.8
Aug.	1	1	2	6	26	26	21	3	16	1.6	7.6
Sept.	5	4	5	8	19	21	13	4	21	1.3	6.2
Oct.	21	17	8	6	7	6	6	7	22	1.2	6.4
Nov.	34	23	7	1	1	2	3	11	20	1.1	6.8
Dec.	35	24	6	1	1	1	2	19	13	1.3	5.2

(percent given to nearest nos.)

Note: Extreme wind velocity observed in the period of 19 years, 1934 - 1959, is 11 Beaufort Scale or 62 to 72 m.p.h. on April 13, 1952.

Source: Meteorological Department, Royal Thai Navy

d. Relative Humidity

The relative humidity is usually at its lowest during December and January, while during the hot season in March and April, the moisture content of the air becomes moderately high. The afternoon humidity usually remains low. During the rainy season, the monthly mean relative humidity rises gr gradually and reaches its peak of about 80 percent between August and October. Then the maximum relative humidity decreases to its lowest point of the year, 66.1 percent, in December or January. (See Graph 3, Table 3)

e. Cloudiness

From November through March, a clear sky is frequent, particularly during the forenoon and at night. Most of the clouds are high clouds, although fine weather cumulus may be seen occasionally.

During the rainy season, the clouds are almost entirely cumulus, cumulanimbus and stratocumulus. A perfectly clear sky is rare during this period, except in June, when fine weather, particularly before noon, may occur for frequent intervals of two to three days. Average cloudiness is about 6 oktas during this season.

f. Thunderstorms

Thunderstorms chiefly occur in May, and secondarily in September. The main causes of these thunderstorms are thermal convection and shear lines moving from the north, which occur in the afternoon or early evening hours. (See Table 4)

Table 6 TROPICAL CYCLONE FREQUENCY
THAILAND, 1947-1955

Month	Upper Thailand	Gulf of Thailand
January		
February		
March		
April	1	
May		
June	1	
July	1	
August	1	
September	6	1
October	3	1
November		2
December	1	1

g. Surface Winds

The weather from November to February is governed by the characteristically cold and dry continental wind system. The prevailing winds are mainly from the south in the afternoon and evening hours. In the early part of the day, the wind is generally variable. Prevailing winds are mainly south, southwest and west. (See Graph 4, Table 5)

h. Typhoons

There are a number of tropical cyclones occuring in September and October. The following summary shows the number of tropical cyclones which entered Thailand from the east during the years 1947 to 1955. (See Table 6)

II : CLIMATIC FACTORS INFLUENCING THE DESIGN OF BUILDINGS

A. Bioclimatic Conditions

The primary factors that make up "climate" in its impact on human beings are physical; the temperature and the humidity of the air, its rate of movement, and the radiation of surrounding surfaces.

The body is in the normal comfort zone when the outside temperature is between 70 -80 F and relative humidity is about 65%. At extremely high temperature and relative humidity, air movement is needed to re-introduce drier air and increase the evaporation rate from the skin.

"The most important aspect of comfort is probably thermal, which is related to the energy balance of an individual in any environment. The economical reduction of thermal stress should, therefore, be a primary objective in building design". (1)

B. Effect of the Sun on the Earth

When the sun's rays reach the earth's atmosphere, about one-third of the sun's energy hits the earth's surface and is promptly turned into other types of energy. Evaporation, convection, heat conduction, reflection and radiation occur.

---

(1) Page, J.K.: "Some Aspects of Architectural Bioclimatology", International Society of Bioclimatology and Biometeorology, --First Bioclimatological Congress, Vienna, September 23-27, 1957 p.6

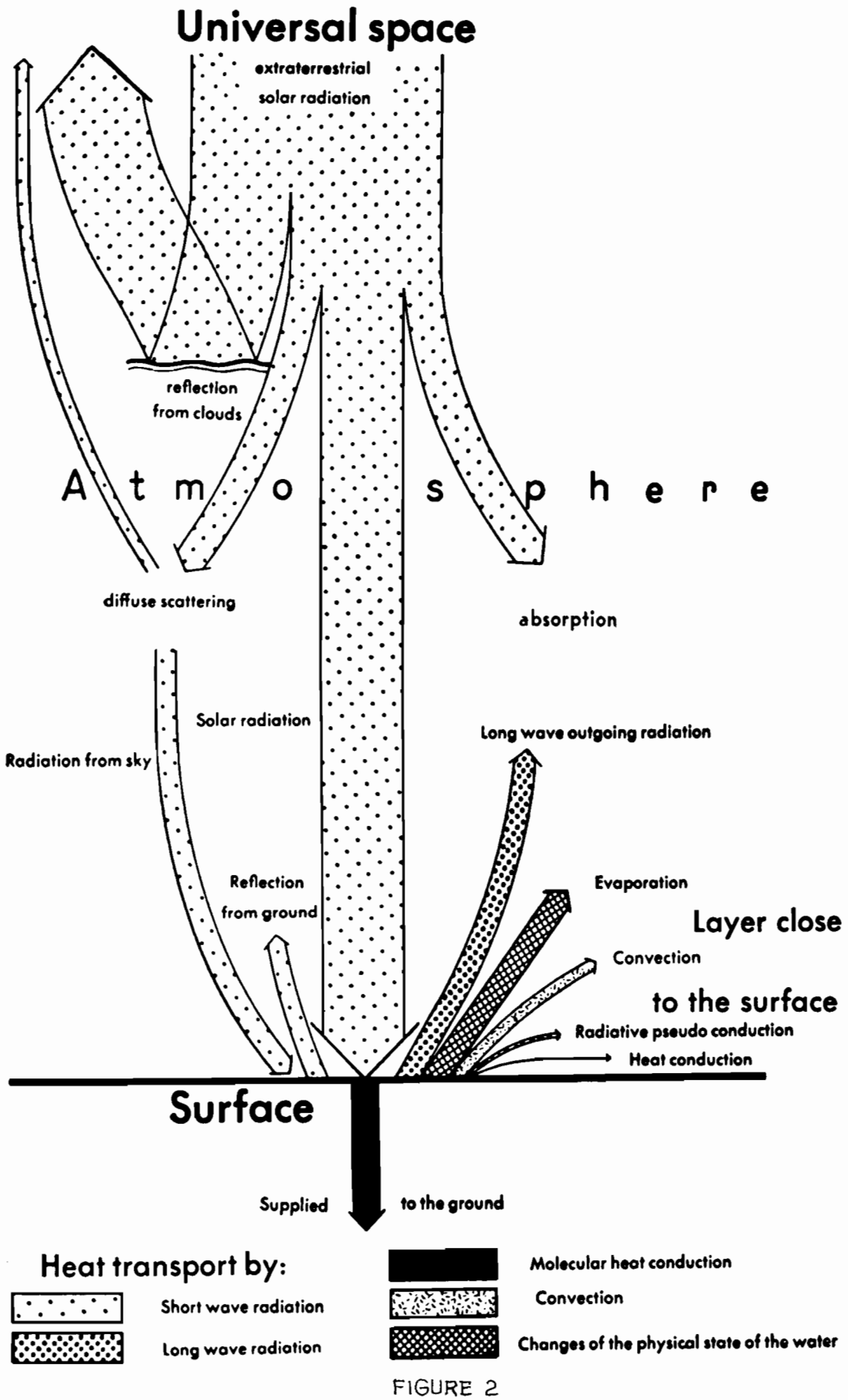

Universal space
extraterrestrial
solar radiation
reflection
from clouds
A t m o s p h e r e
diffuse scattering
absorption
Solar radiation
Radiation from sky
Long wave outgoing radiation
Reflection
from ground
Evaporation
Layer close
Convection
to the surface
Radiative pseudo conduction
Heat conduction
Surface
Supplied
to the ground
Heat transport by:
Short wave radiation
Long wave radiation
Molecular heat conduction
Convection
Changes of the physical state of the water

FIGURE 2

The amount of radiation received depends on seven factors: (2)

1. Position of sun according to the time of day
2. Position of sun according to the season
3. Clouds and other obstruction
4. Direction of slope of station
5. Angle of slope of station
6. Height of station
7. Situation with regard to surroundings

In Bangkok, the cloud amounts are relatively high. The upper surface of thick clouds reflects about three-quarters of the sun's radiation back into space. This means a great loss of heating power which is accentuated by the fact that in cloudy regions the amount of water vapour in the air is relatively great. Bangkok is flat, and has a great river, the Chao Phraya, nearby, with several canals and waterways. The neighbourhood of a small canal or a shallow body of water is in an unfavourable situation during the hot months because of the high temperature since active evaporation makes the lowest layers of air very humid, especially in calm, sunny weather.

The large and deep Chao Phraya River is deep enough to absorb the sun's radiation without warming up, and has an appreciably cooling and moderating effect on the air.

a. The Sun's Position

The path of the sun is definite at different times of the day and the year. There are many methods of determining or recording the sun's position.

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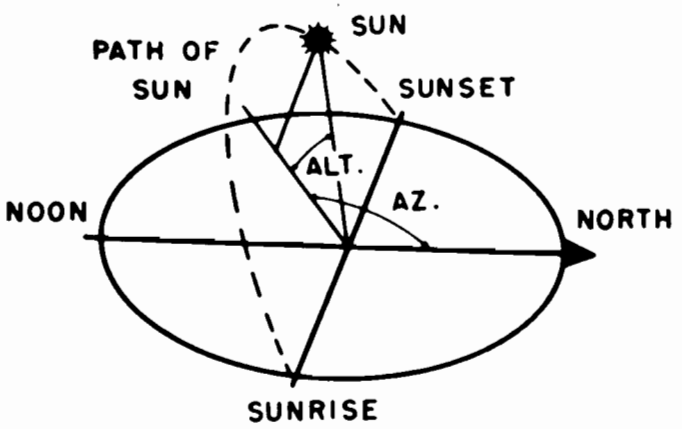
(2) Aronin, Jeffrey Ellis: Climate and Architecture, Progressive Architecture Book: New York Reinhold Publishing Corporation, 1953


SUN
PATH OF
SUN
SUNSET
ALT.
AZ.
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NORTH
SUNRISE

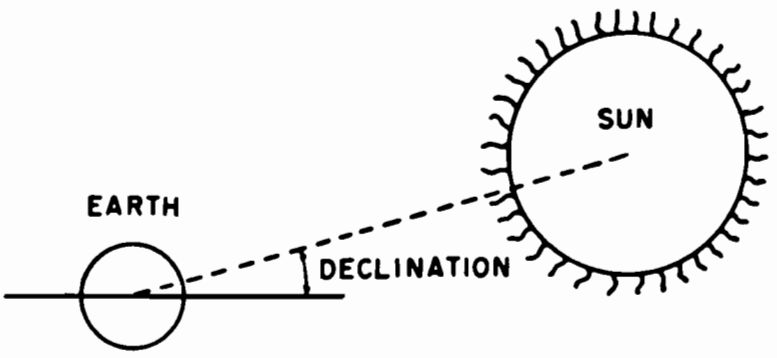
SUN
EARTH
DECLINATION

FIGURE 3

b. Sun-angle Calculator Device

The position of the sun may be determined by the device method, or "Sun-angle Calculator" developed by the Libbey-Owens-Ford Glass Company, Toledo, Ohio, and prepared by Aeronautical Service Inc., Washington, D.C.

From calculation of the altitude and azimuth angles of the sun for Bangkok, a similar device might be developed. The following page shows the "sun-angle calculator" device for Bangkok, Thailand. (Figure 4)

c. Exclusion of Solar Radiation from Buildings

Almost every day of the year, the air in Bangkok is really hot. The exclusion of solar radiation is necessary in building design. There are four main principles which apply in exclusion of solar radiation:

1. Shading ; i.e. preventing direct sunshine from falling on those parts of the building;
2. Reflections; i.e. using the reflective qualities of various surface finishes such as white-washed and white-painted surfaces so that as little as possible of the sun's radiation is absorbed by the building;
3. Ventilation; i.e. providing for full air movement and convection in roof spaces and wall cavities;
4. Thermal capacity; i.e. by using materials which do not store up heat from the sun.

Shading is achieved by using overhanging eaves, sun-break devices according to sun-angle calculations, canopies, pergolas; light slabs or light-weight top roofs to shade

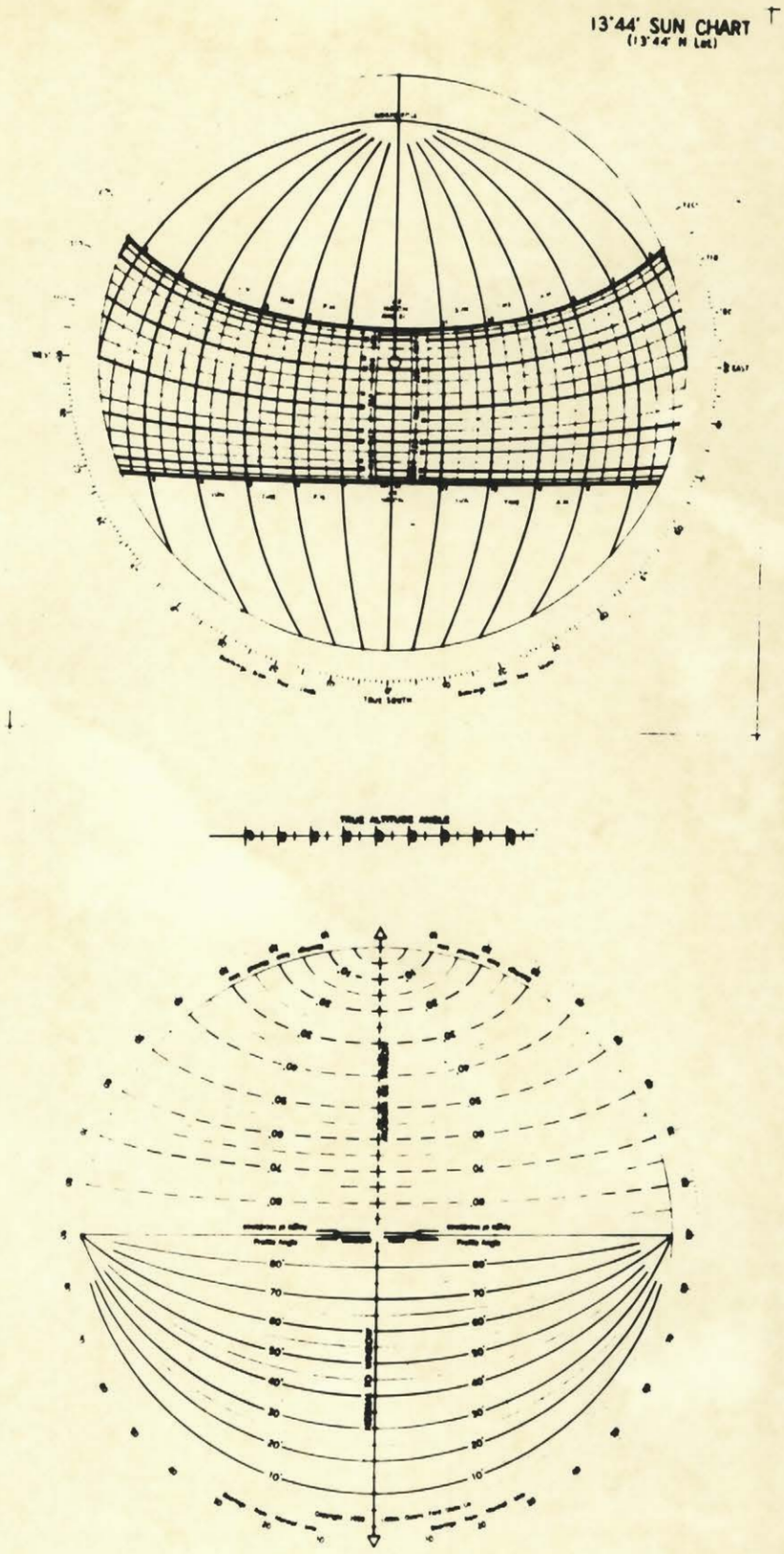

FIGURE 4

HORIZONTAL TYPES

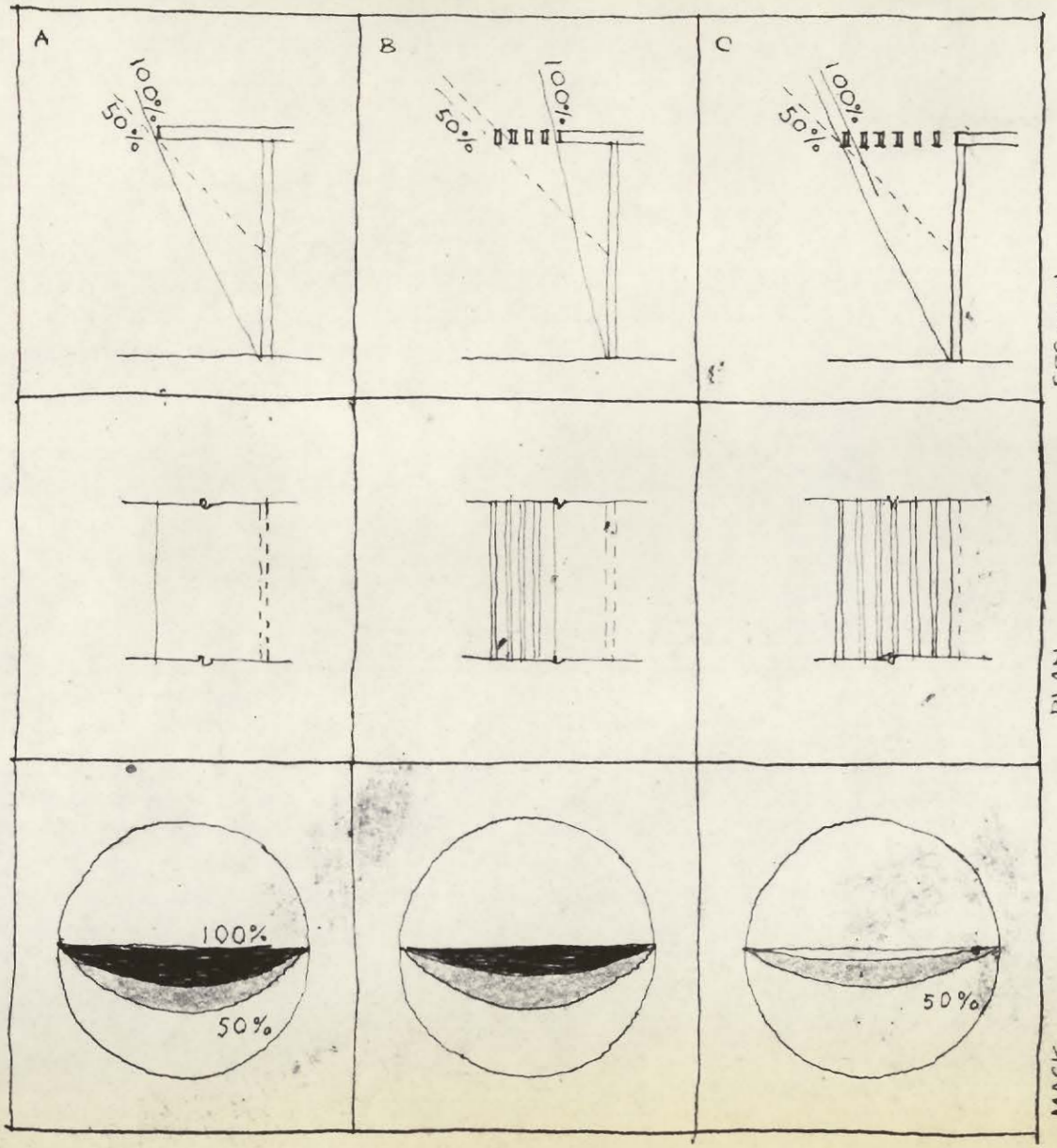

FIGURE 5

HORIZONTAL TYPES

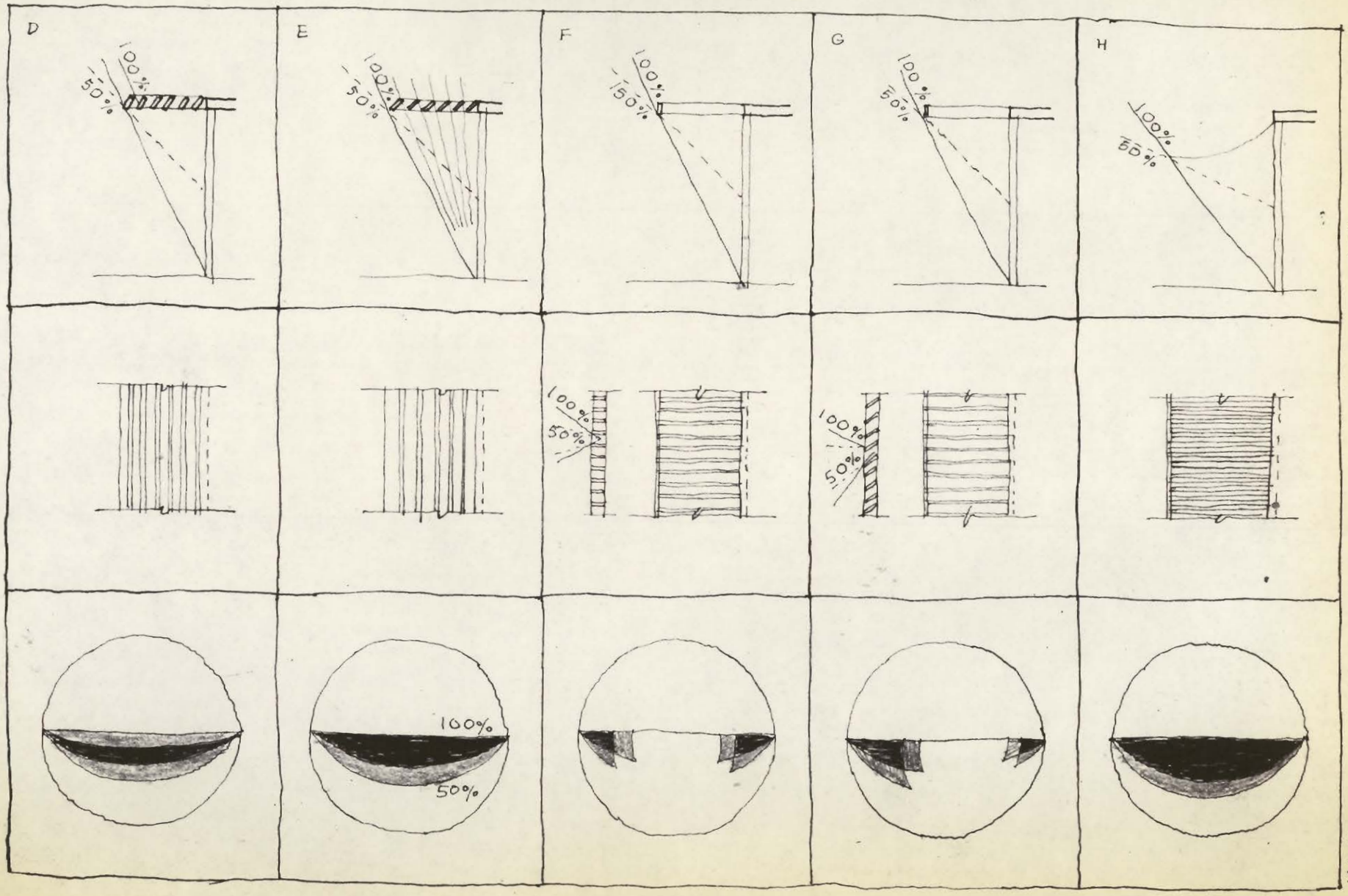

FIGURE 6.

HORIZONTAL TYPES

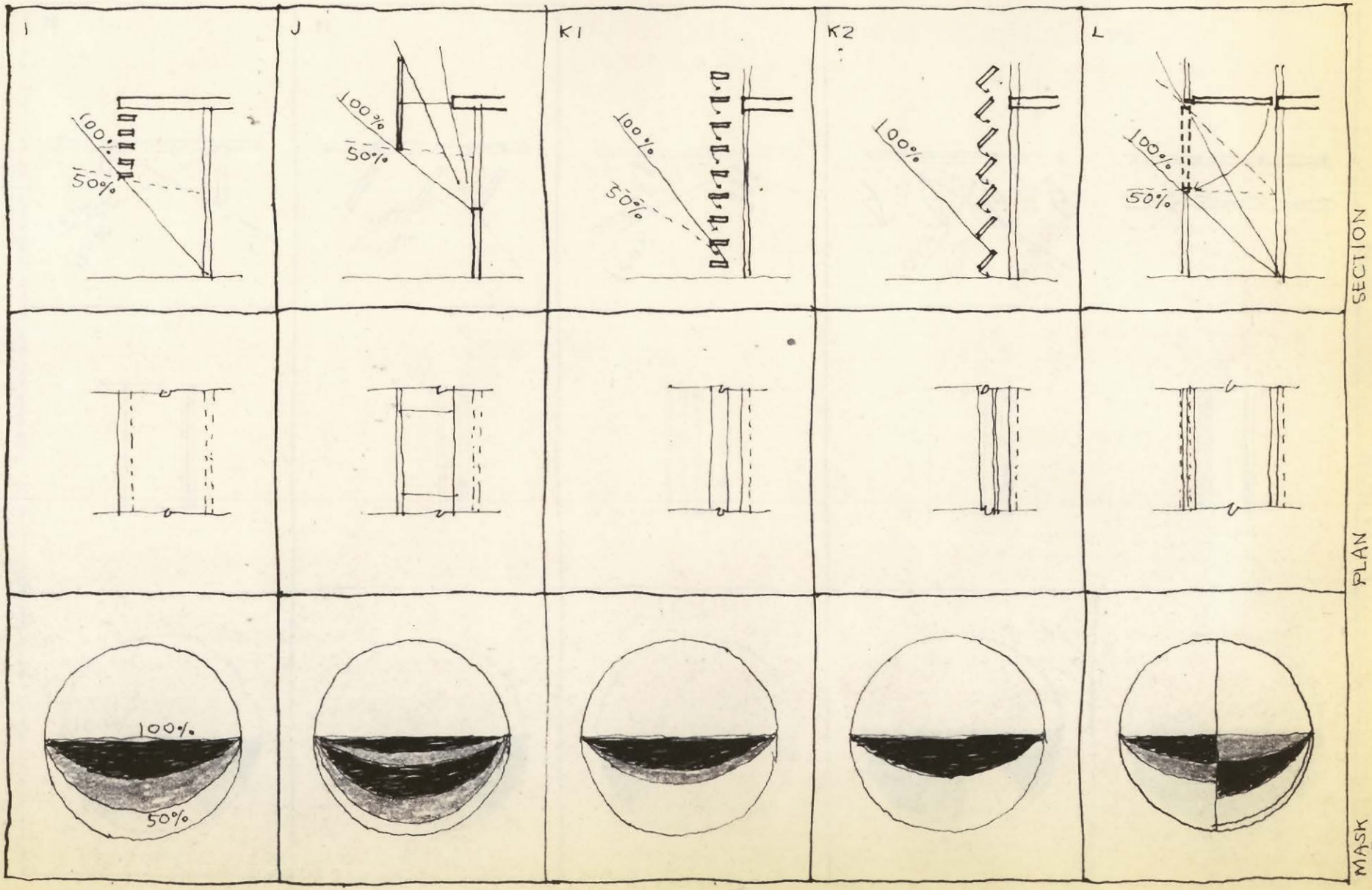

FIGURE 7

VERTICAL TYPES

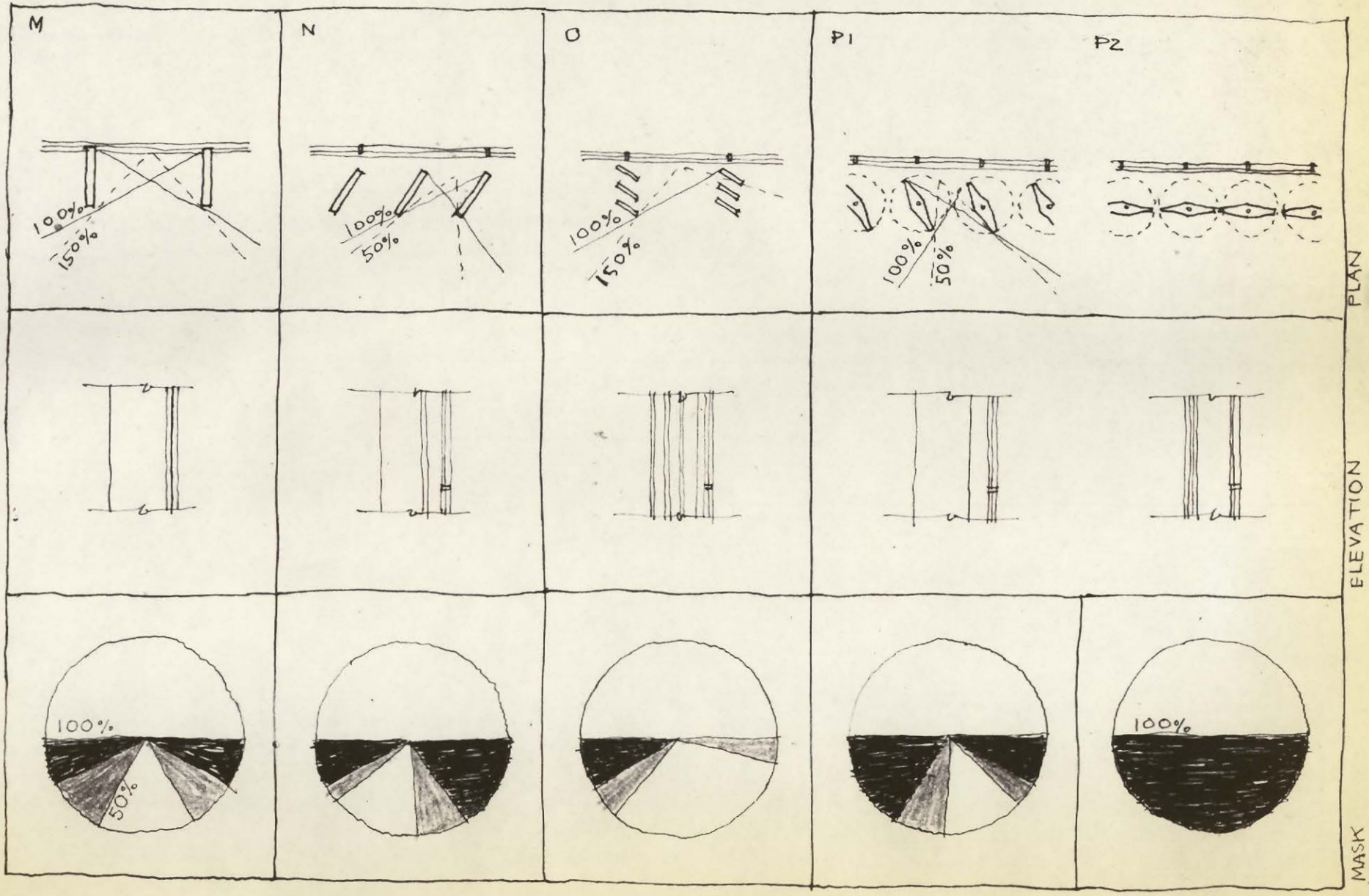

FIGURE 8

EGG CRATE TYPES

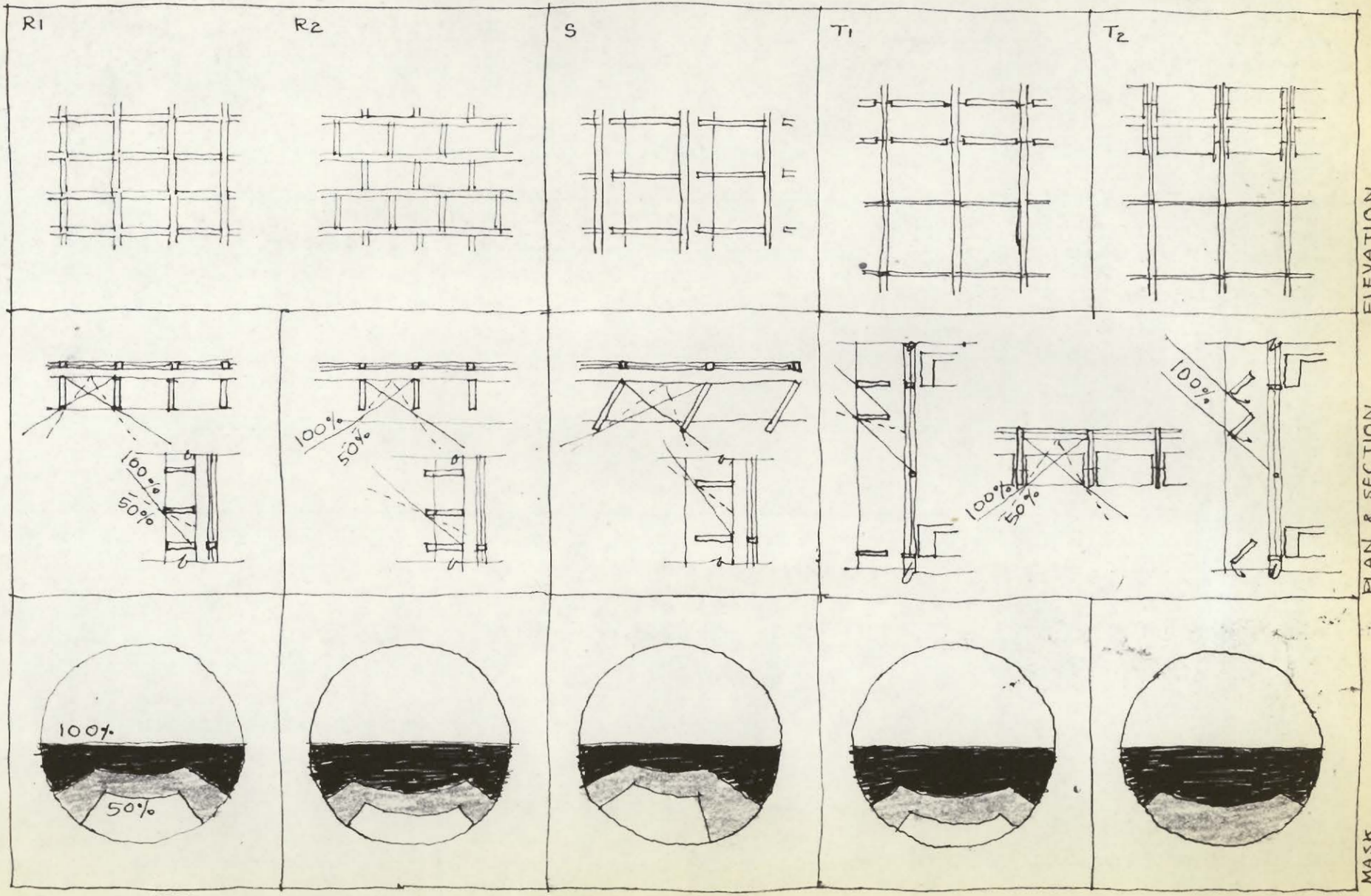

FIGURE 9

a flat roof below. The various types of overhangs and sun-break devices are shown in Figures 5, 6, 7, 8, and 9. (1)

Reflection concerns the reflectivity or diffuse relection co-efficient of a material which determines the fractional quality of radiation from the sun that is reflected from the surface without change of wave length:

1. white-washed or white-painted surfaces are good reflectors;
2. red, green and brown-coloured surfaces are poor reflectors;
3. black surfaces are very poor reflectors.

Whitewash is clearly the best reflector, but since it needs constant renewal, white spar chippings are a good alternative and form a more permanent surface.

Ventilation is discussed under "Wind and Ventilation"

Thermal Capacity -- in humid, tropical climates such as Bangkok there is usually not a great variation between day and night temperature, therefore a heated structure has little chance to cool off rapidly at night.

This fact should be carefully considered in connection with the building concerned: for example, a heavy, reinforced concrete roof over a room to be used at night will prove a considerable disadvantage, which when added to the disadvantages of expansion and contraction, indicates that a light-weight concrete is preferable.

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(1) Olgyay and Olgyay: Solar Control and Shading Devices, Princeton University Press, N.J. 1957

d. Note on Glare

In Bangkok, the sky rather than the sun is the main source of radiation. The sky in the humid tropics is bright and glaring when thinly clouded, but dull when thickly overcast. Where these conditions prevail, it is important to provide a means of cutting off a direct view of the sky from the interior of a building. This end can be achieved by the use of louvers of certain types, tinted glass or similar devices.

Glare in towns often comes from reflection from white buildings. It can be alleviated by the avoidance of white on walls and the subwtitution of other light colors.

Careful planting of trees and shrubs around buildings can also minimize the effect of glare, and climbing plants on loggias outside windows will help to reduce the effect of glare in the interior of a room. Glare from pavements may be avoided by encouraging grass and foliage outside the building not only to avoid glare but also for their soothing effect and because the air near growing things is cooler and therefore better for human consumption and comfort. (See Figure 10)

C. Wind and Ventilation

Wind ventilation is one of the most important factors to be considered in designing buildings in Bangkok. It is needed for human comfort.

It is necessary to consider two separate effects when

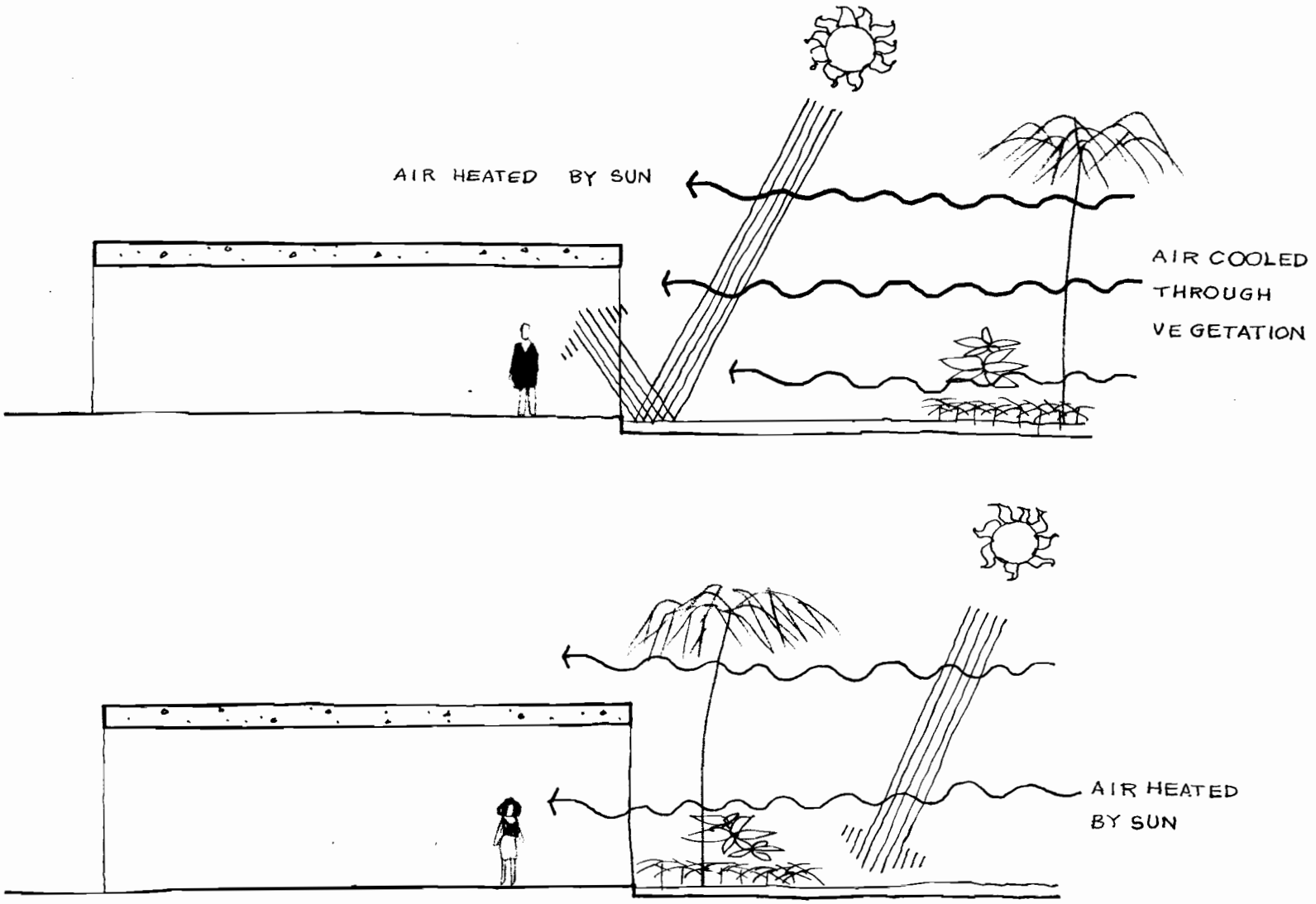

FIGURE 10

EFFECT OF VEGETATION

considering ventilation by natural forces: (See Figures 11, 12) (a) wind effect and (b) stack effect. The first is important for daytime ventilation and the second is important for night-time ventilation, due to the calmness of the wind during early evening.

a. Wind Effect

It is important for architects to be aware of the following facts:

1. "The wind tends to travel inside the building in the same direction as it travels outside, because air has inertia. It is more desirable to place a window to the direction of the wind than to make an angle to the direction of the wind." (1)

2. The success of cooling by ventilation depends on keeping the speed of air relatively high.

3. A small opening should be placed carefully in the pressure wall to admit a small stream of fast-moving air directly on the people to be cooled. A larger opening should be amde in the suction wall to pull air through the room and to widen the stream before it leaves.

4. "An overhang can be used to deflect more air into the room if there is suction to pull it through". (2)

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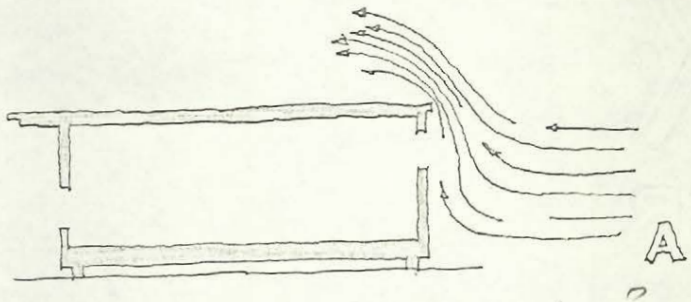
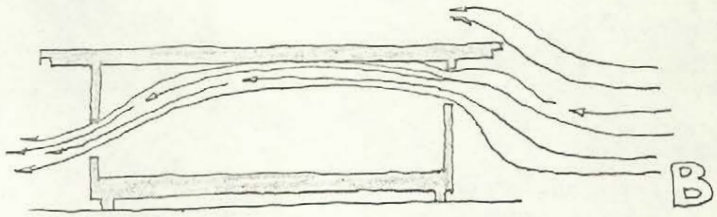
(1) W.W. Candill, S.E.Crits, and E.G.Smith: Some General Considerations in the Natural Ventilation of Buildings, Texas Engineering Experiment Station, 1951 Report 22

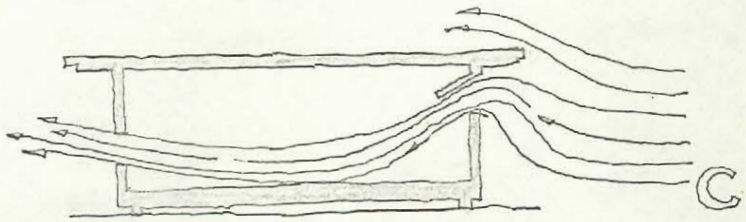
(2) " , Report 33



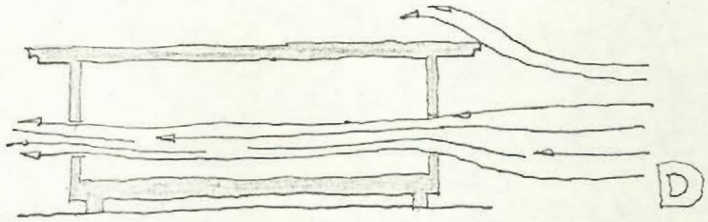
A SHOWS THAT THE BUILDING WITHOUT OVERHANG HAS LESS ?



B. SHOWS THAT THE OVERHANG CAN BE USED TO DEFLECT MORE AIR INTO THE ROOM

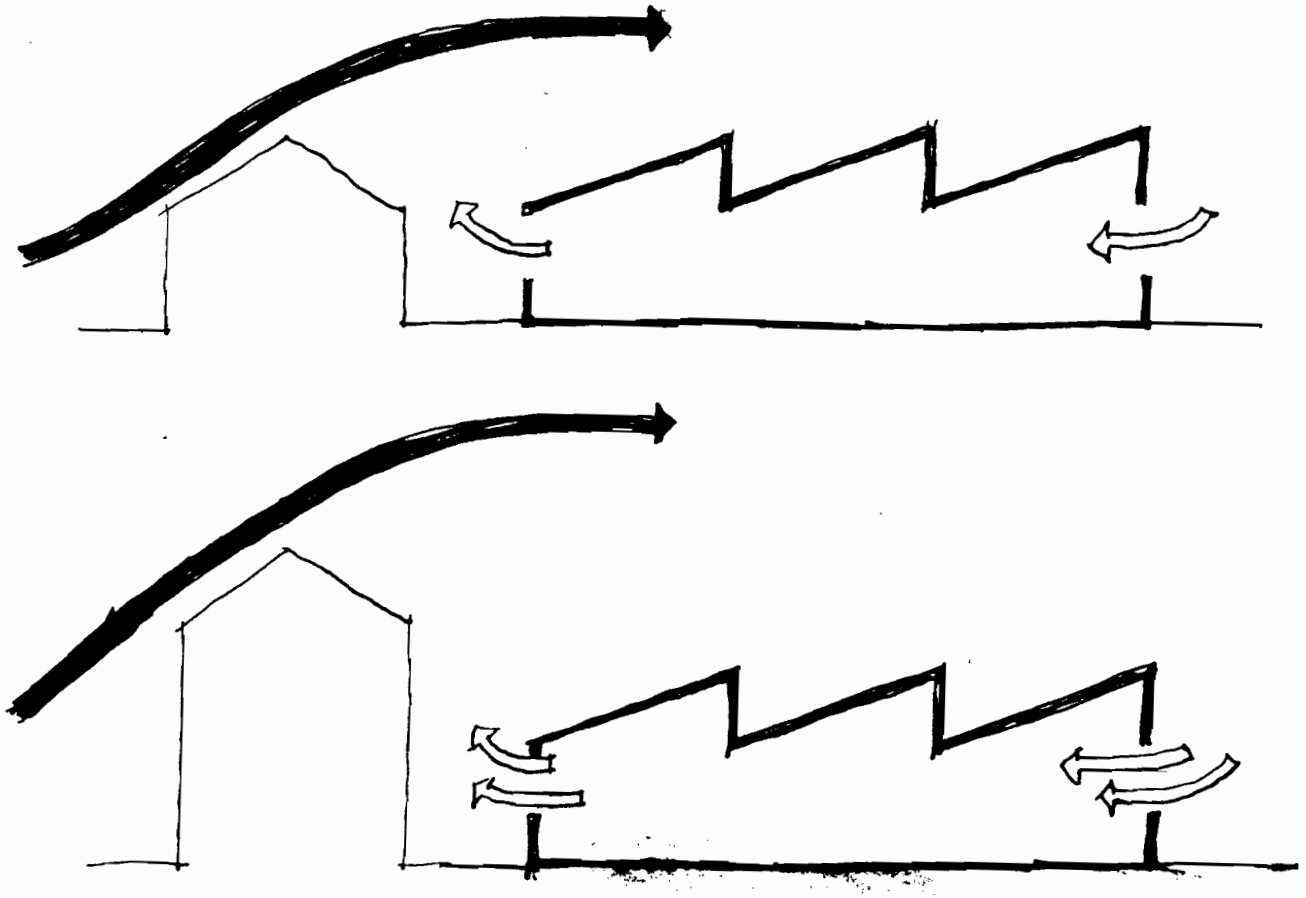


C. SHOWS THAT CAREFULLY ADJUSTMENT OF A LOUVER CAN PUT THE MOVING AIR WHERE IT WILL HAVE THE GREATEST COOLING EFFECT



D SHOWS THAT THE PROPER PLACEMENT OF WINDOW GIVES THE BEST COOLING EFFECT

FIGURE 11



J.C. WESTON HAS SHOWN BY WIND TUNNEL STUDIES THAT OBSTRUCTING BUILDINGS MAY MAKE THE INDOOR AIR MOVE IN THE OPPOSITE DIRECTION TO THE FREE WIND. BETTER VENTILATION MAY RESULT SOMETIMES FROM OBSTRUCTION BY NEARBY HIGH BUILDING (BOTTOM) THAN BY A NEARBY LOW BUILDING (ABOVE). DUE TO THE MORE INTENSE ZONE OF REDUCED PRESSURE IN THE IMMEDIATE LEE OF A HIGH BUILDING.

FIGURE 12

5. Different types of windows have different effects on the direction and the pattern of wind flows.

6. A high building that shields a low building from the effect of direct wind may promote a better internal flow of air in the obstructed building than a low obstructing building, because a high building creates a more intense zone of reduced pressure in its lee.

b. Stack Effect

"The stack effect results from the pressure differential set up by density variation between the indoors and outdoor atmosphere arising from temperature differences.

Significant heating of the air may occur, especially in crowded rooms because of the energy output of the occupants" (1)

1. Wind evaporates moisture and dries surfaces:

Relative humidity increases greatly during the night in Bangkok because the outside air temperature is lower than in the daytime. Important aspects to be considered for building design in Bangkok are:

--An opening for cross-ventilation at the roof such as gable louvers and dormer louvers (See Figure 13)

--Openings in the walls between ground level and floor level so that air can circulate through the crawl space and keep it dry.

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(1) J.K.Page: "Some Aspects of Architectural Bioclimatology" International Society of Biolclimatology and Biometeorology, -- First Bioclimatological Congress, Vienna, Sept.23-27, 1957

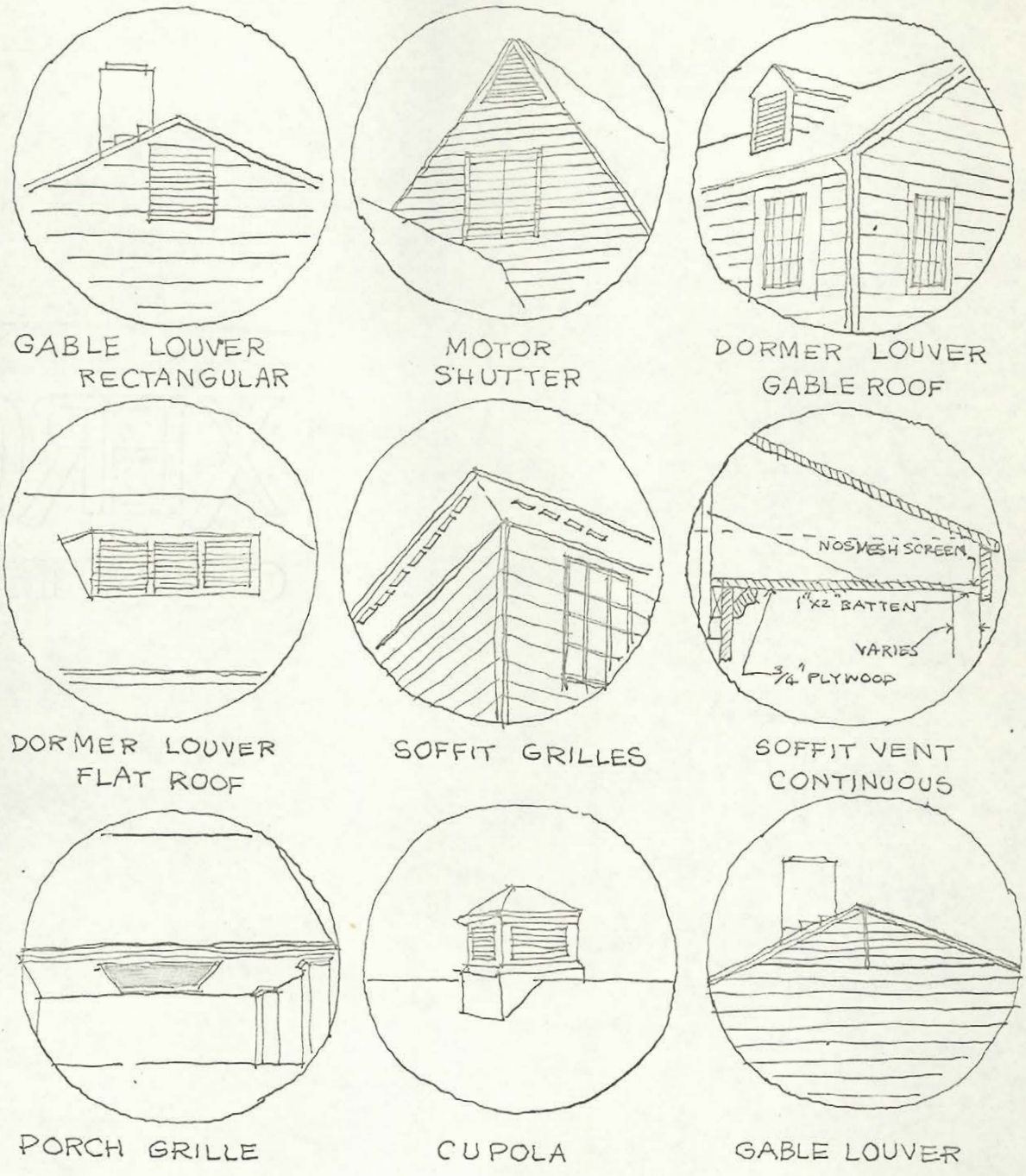
GABLE LOUVER
RECTANGULAR
MOTOR
SHUTTER
DORMER LOUVER
GABLE ROOF
DORMER LOUVER
FLAT ROOF
SOFFIT GRILLES
NOSMESH SCREEN
1"X2" BATTEN
VARIES
3/4" PLYWOOD
SOFFIT VENT
CONTINUOUS
PORCH GRILLE
CUPOLA
GABLE LOUVER

FIGURE 13

The traditional house on stilts in Thailand is a very good example of these aspects.

2. Wind pressure on Buildings:

When the wind encounters a building it presses on the windward face and exerts a force directed toward the interior of the building. On the leeward face, the air is sucked away by the wind currents passing overhead and on each side and a low pressure is formed which exercises a suction effect on this side; therefore, the force on the walls is directed outwards.

The air piled up against the windward faces escapes by passing over the roof. With isolated buildings, the air flows past on either side. Owing to its momentum, the air blowing up the face of the building cannot level out immediately, and there is also a suction or lifting effect on a part or the whole of the roof.

This distribution of pressure causes problems in the construction of walls and roofs of buildings. Dangerous lifting forces on a roof may be minimized by the use of longitudinal openings under the ridge of the roof, such as a louver, which often forms a part of the system of ventilation. (1)

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(1) J.E.Aronin: Climate and Architecture, Progressive Architecture Book (New York: Reinhold Publishing Corporation,) 1953

3. Cooling Effect of Wind:

The problem is one of reducing the penetration of heat from the roof to the interior, and of reducing radiation at night. Flat concrete roofs with or without a false ceiling below are desirable but are, in many cases, subject to cracking due to contraction and expansion. There are many ways to solve these problems.

--Finish in whitened aluminum or whatever corresponds to whitewash;

--Water-cooled roofs. This method has been used by some residents in Bangkok with a flat roof. It is costly and troublesome to apply;

--By spraying water continually over the roof;

--By the double-roof method or by placing lightweight slabs on blocks above concrete roofs. This method seems to be the most desirable method for flat roofs, but it is expensive.

One practical type of roof in Bangkok is the one shown in Figure 14, which has an upper surface of fair reflecting quality (e.g. asbestos) held above a ceiling layer, with an adequate air gap between. This roof, being built of the lightest materials, has practically no reservoir of heat, and cools an hour or two after sundown at night temperature.

D. Insulation

The term "insulation" really covers two types of interference with the passage of heat. The simpler and better-known type conveniently called "resistance insulation"

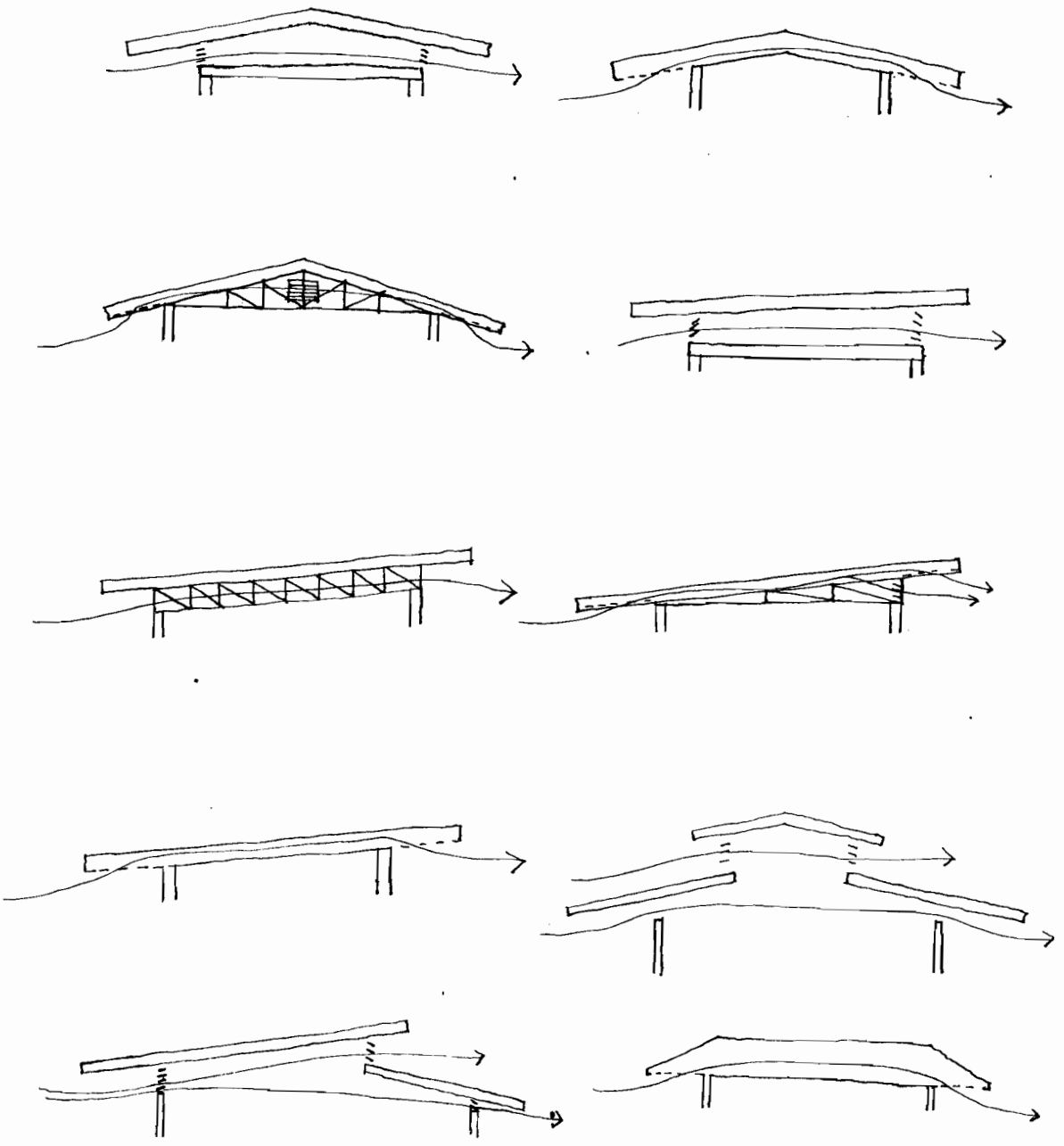

FIGURE 14.

TYPICAL ROOF STYLES USED IN BANGKOK

resists the passage of heat from a place which is continuously warmer to a place which is continuously cooler, and is provided by materials which have a low thermal "conductivity". The better insulator is one which will store up a large quantity of heat during the loading period and give it back again when the load is off. This is conveniently called "capacity insulation" and as is well known, still air has the lowest thermal conductivity, and materials such as dry wood, cork, fibreglass and rock wool, which hold air in their interstices, are among the best insulators under steady heat conditions.

"Outer surfaces exposed to direct sunshine under calm conditions may attain a temperature of 165 or more. Therefore, for this flat zone in order to maintain a comfortable 76 F interior house temperature, insulation and other protection will be required against a thermal gradient inward of approximately 70 F. This stress may be reduced by shading, air movement, insulation or surface evaporative cooling." (1)

Roof: A roof is required for insulation from sun.

Flat roof: Figure 15 shows the practical way of designing this kind of roof.

Double roof: This will aid in preventing accumulation of heat indoors and in sheltered open spaces.

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(1) Dr. Douglas H.K.Lee: Physiological Objectives in Hot Weather Housing

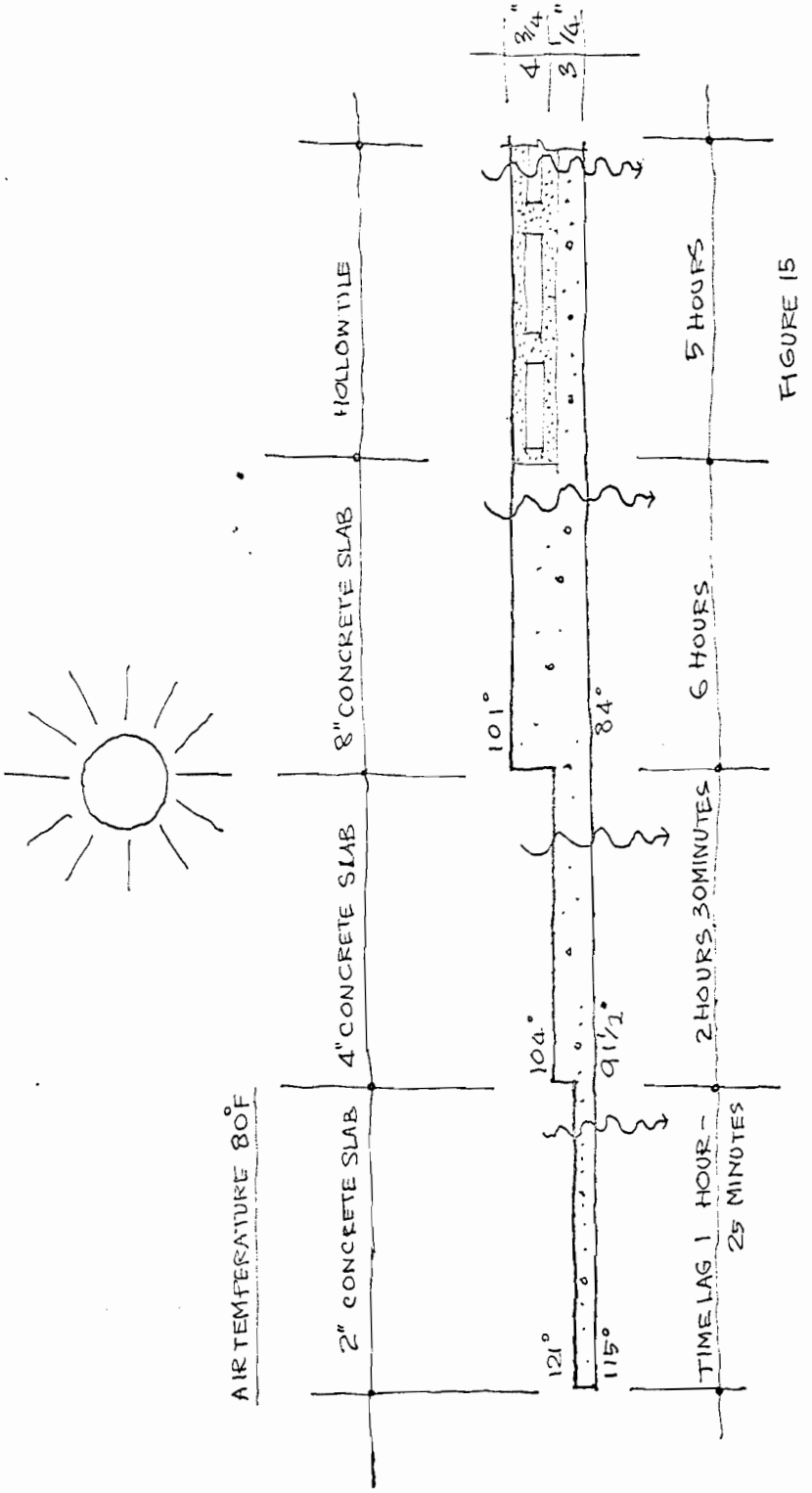
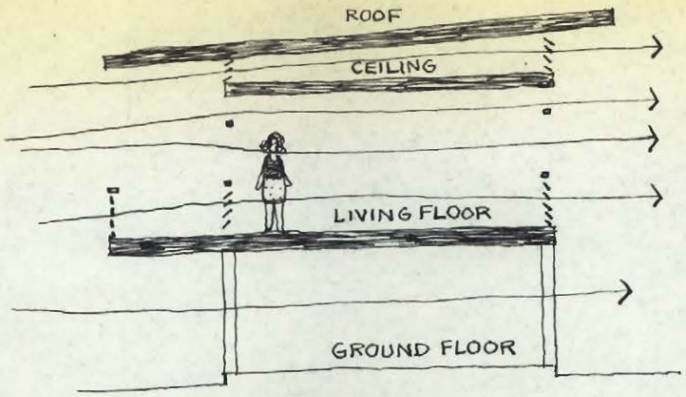
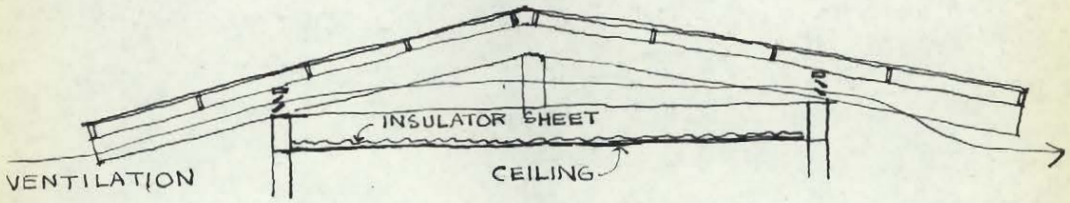

AIR TEMPERATURE 80°F
2" CONCRETE SLAB
4" CONCRETE SLAB
8" CONCRETE SLAB
HOLLOW TILE
4
3 1/4"
1/4"
121°
115°
104°
91 1/2°
101°
84°
TIME LAG 1 HOUR - 25 MINUTES
2 HOURS, 30 MINUTES
6 HOURS
5 HOURS

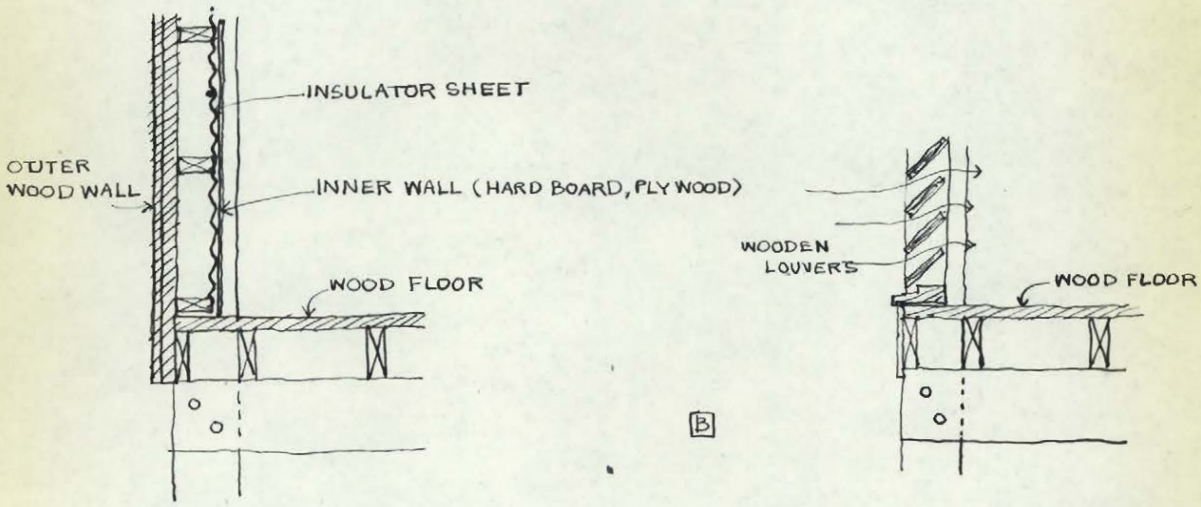
FIGURE 15



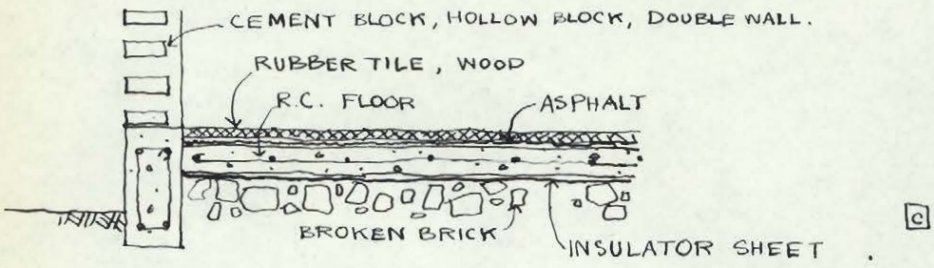
CROSS VENTILATION



A



B



C

FIGURE . 16

INSULATION IN FLOOR AND ROOF DESIGN

One practical roof in Bangkok is the roof in Figures 14 and 16B, which has an upper surface of fair reflecting quality held above a ceiling layer with an adequate air gap between.

Wall: A wall of any material should have a ventilated cavity or space separating inner and outer walls. Solid and massive wall-construction should be avoided to prevent heat conductivity (Figure 16B)

Floor: Openings should be provided in the walls between ground level and first living floor level so that air can circulate through the crawl space and keep it dry (Figure 16C)

E. Rainfall

The effects of rainfall include:

a. Flooding

In some parts of Bangkok, which are low, flooding always occurs after a heavy rain. The only solution is to raise the floor level of the building higher than the highest flood level. However, with the Chao Phraya River Dam at Chai Nart, the damage of flooding from the Chao Phraya River will now be eliminated.

b. Soil Erosion

The level of the water in the public drainage system or nearby waterways has to be considered before designing any drain. The shape and slope of the drain must be sufficient to promote quick drying. Any road or surface to be drained

must be hard enough to withstand erosion effect.

c. Variation in Moisture Content of the Ground

Moisture content of the ground is important for a number of reasons affecting the design, excavation and maintenance of foundations. Precipitation may also affect the stability of the foundations after the building is completed.

A specific type of failure occurs in expansive soil in hot climates, where the avaporation from the regions under the building tends to be lower than the evaporation from the surrounding terrain. The moist soil regions formed under the building swell, forcing the walls outward and producing a very characteristic pattern of cracking. However, this phenomenon is rarely seen in Bangkok.

d. Damp Penetration

The problem of assessing the probability of rain penetrating any particular form of construction is more complex. Heavy masonry walls, for example, are capable of absorbing a considerable amount of moisture, acting like a sponge, holding much of the water as it reaches the surface and releasing it slowly over a considerable period of time afterwards as water vapour to the atmosphere.

The answer to these problems consists in providing a long canopy or eaves to protect the walls from driving rain and also to keep sunshine off the walls. This overhang may do double duty by protecting the wall from the extremes of saturation and rapid drying.

e. Surface Erosion of Building Materials

Rainfall contributes to the weathering of building materials in a number of ways. The only way to obtain reliable information about the effects of rainfall on building materials is by natural exposure tests, though sometimes an indication of relative performance can be obtained by an accelerated weathering test.

f. Thermal Shock

The failure of concrete roofs in Bangkok is probably linked with the incidence of heavy rainfall after a prolonged spell of hot sunny weather.

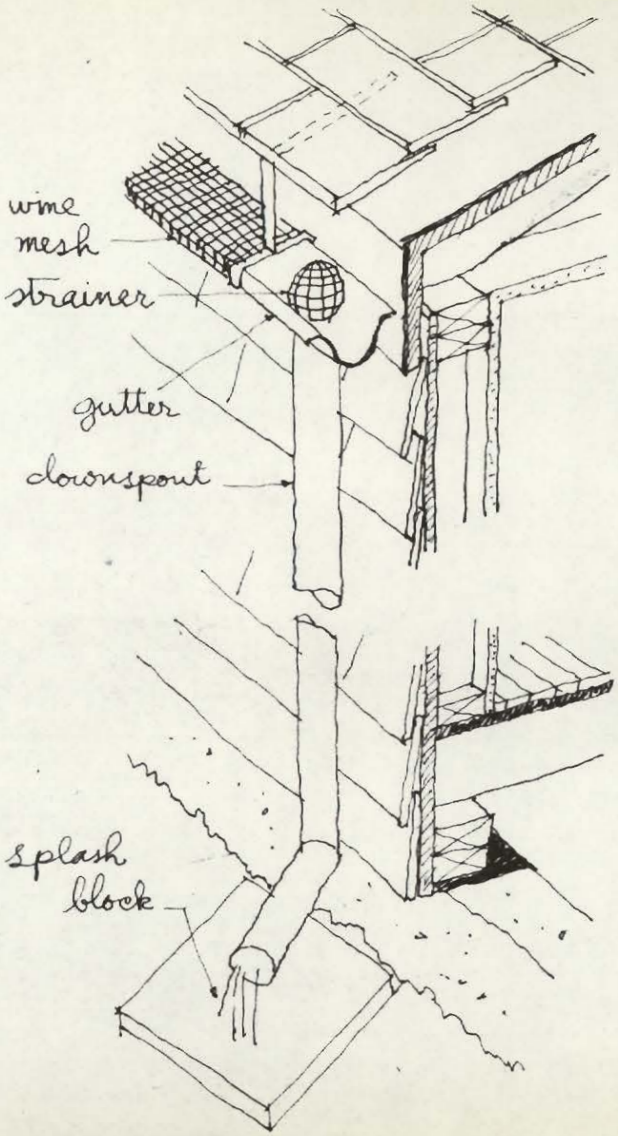
g. Problems Connected with Carrying Capacity of Gutters

The size of gutter should be related to the local peak intensity of rainfall. If for any reason it is not desirable to install gutters, it is necessary to build aprons projecting beyond the eave-drop of brick, stone or concrete. These are usually in conjunction with ground gutters with adequate proportions. Figure 17 shows a well-designed roof gutter and downspout.

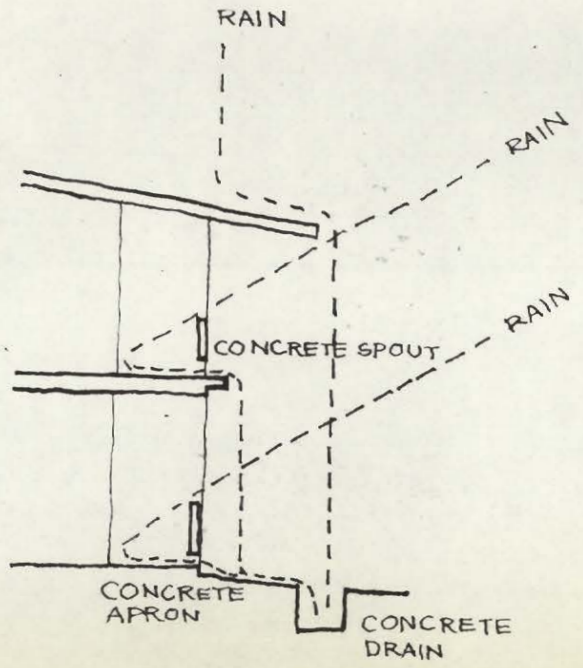
F. Landscaping

a. Shading Effect of Trees and Vegetation

Trees and shrubs, if planted, reduce air-borne sounds with great efficiency. Trees can be utilized to shade the roof and walls and the surrounding ground. Vegetation normally covers the ground under warm humid conditions and full advantage should be taken of reductions in reflection and thermal emission which it causes.



SHIELDED GUTTER AND DOWNSPOUT



RAINWATER COLLECTION

FIGUR 17

Trees, also, should be selected according to their attractiveness and usefulness for shading. To achieve sufficient shading, trees have to be placed strategically. As the sun passes in the morning and late afternoon at a low altitude angle, trees give their best performance on the east, southeast and on the west and southwest; low sun-rays cast long shadows, which can be utilized effectively on those sides, otherwise difficult to protect from the sun's heat. At midday, the sun's path is high and the rays can be intercepted easily with an overhang. At this time of day trees on the south perform poorly, casting their shadows near their trunks. At noon, an overhang shields the building. In the early afternoon, trees on the southwest corner protects the west side. For complete shade coverage there should be further trees to the west. (Figure 18)

b. Air Flow Utilization affecting Trees and Ventilation

"--The foliage mass of a tree serves as a direct block to the passage of air.

-- The speed of air movement directly underneath a tree is measurably increased with respect to speed at stations of the same height on the lee and windward sides of the tree.

-- Planting can materially affect the movement of air through and about a building.

-- Depending on the way it is used, planting may augment or reduce the natural air flow through the building.

--Planting may cause actual change of direction of air flow within the building.

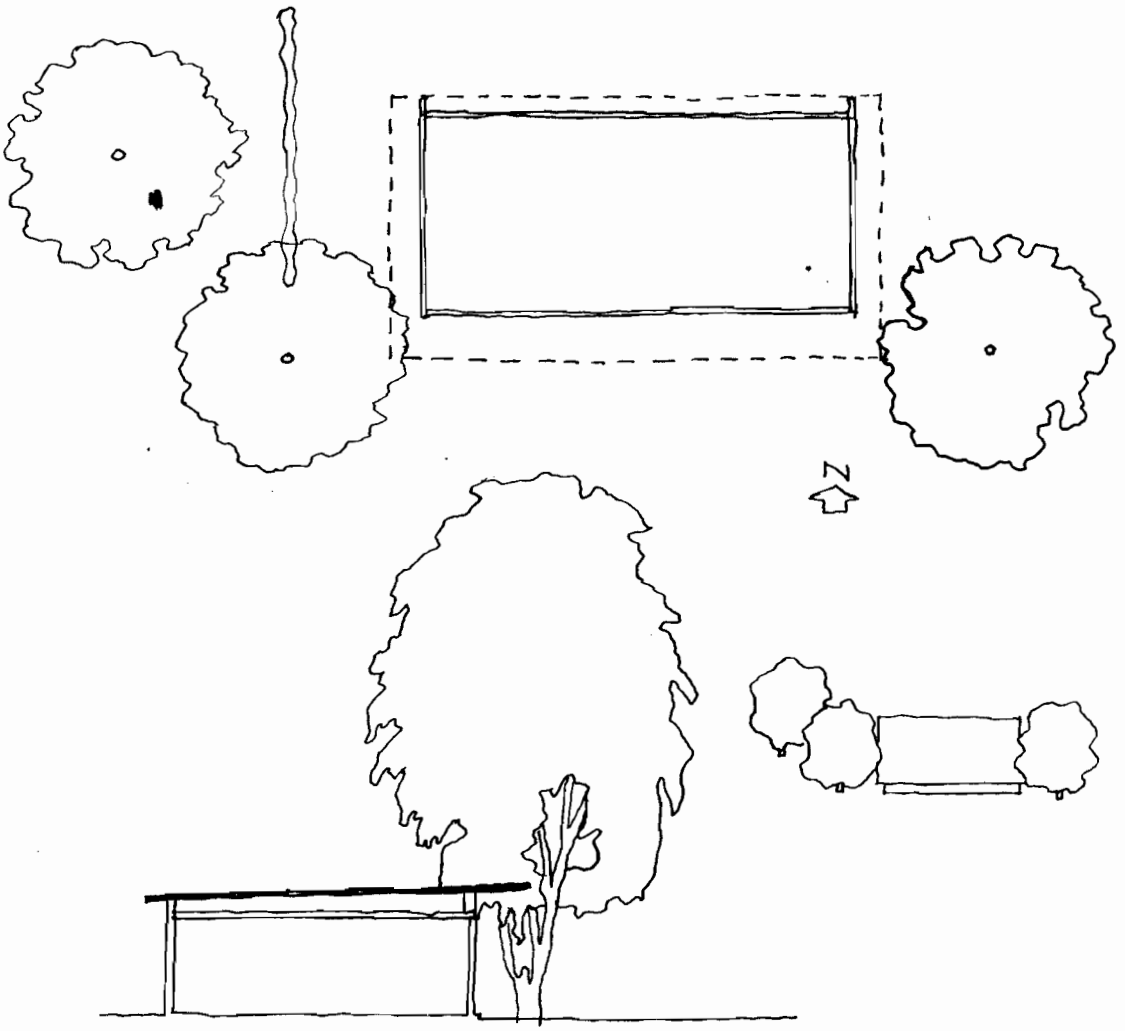
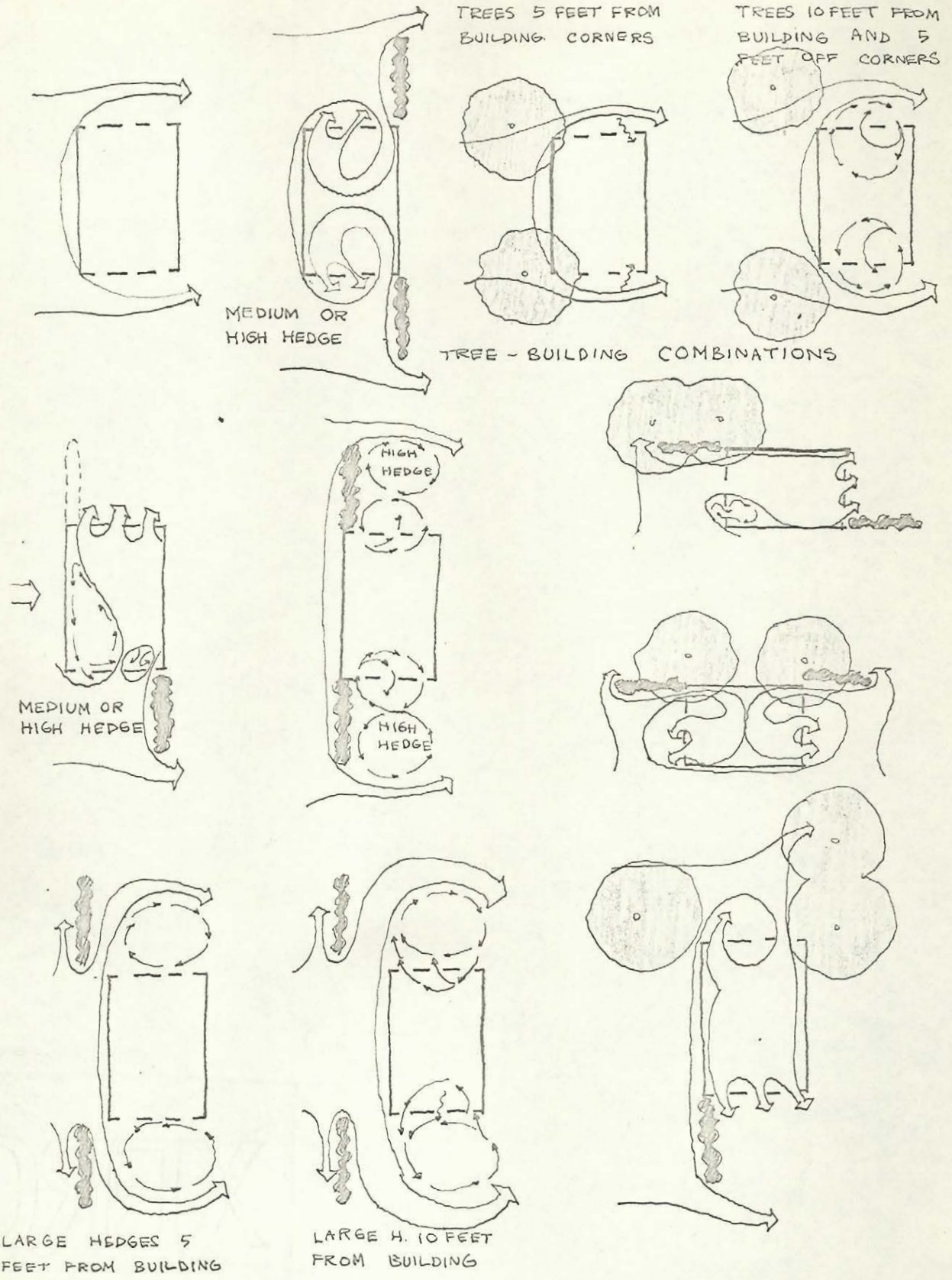


FIGURE 18

SECTION AND PLAN OF HOUSE SHOWING LOCATION OF VEGETATION AND OVERHANG MEASUREMENT.

FIGURE 19


TREES 5 FEET FROM BUILDING CORNERS
TREES 10 FEET FROM BUILDING AND 5 FEET OFF CORNERS
MEDIUM OR HIGH HEDGE
TREE - BUILDING COMBINATIONS
HIGH HEDGE
HIGH HEDGE
MEDIUM OR HIGH HEDGE
LARGE HEDGES 5 FEET FROM BUILDING
LARGE H. 10 FEET FROM BUILDING
HEDGE-BUILDING COMBINATIONS
TREE HEDGE-BUILDING COMBINATIONS

-- Planting on the lee side of buildings has little or no effect on the movement of air through the building unless it is in such a position that it obstructs the outlet openings.

-- Air loses about 50% of its speed on sharp turns."

(1)

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(1) References: "Landscape Architectural Development and Natural Ventilation" Landscape Architecture Quarterly

Dr. Douglas H.K.Lee: Solar Control and Shading Devices

PART II : THE PEOPLE

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1. PEOPLE
    - A. Size and Density of Population
    - B. Occupation
    - C. Wages and Hours
    - D. Standards of Living
2. SOCIAL STRUCTURE
3. CULTURAL AND GENERAL PATTERN OF LIVING

L. PEOPLE

A. Size and Density of the Population

The population of Thailand numbers 21,076,000 according to recent reports based on the 1957 census. Censuses are taken every ten years: the first was taken in 1937, giving a total of 14,464,105. In 1947 the official total was 17,442,689, and increase of 2.9 millions. For the ten-year period of 1957, there was an increase of 3 percent per annum or a total increase of 5.2 million. There has been a consistent increase during this century but no spectacular growth.

The average density is about 44 persons per square kilometre. The Chao Phraya Valley has over 600 persons per square mile of cultivated land and certain sections of the extreme southeast coast have over 3,000. Bangkok, the capital, has the highest density of 1,000 per square kilometre, followed by the sister city of Thonburi with 784. The third city, Ayudhya, has a mere 146, while the rest of the city and towns in the provinces lie far behind.

B. Occupation

Of a total population 1947 of 17.5 million persons, nearly a million were economically active. In Bangkok in the same year out of a total population of about 889,538, there were about 379,394 persons between 15 and 65 in the employable age group. (See Table 1)

Table 7

Occupied Population by Industrial Group 1947
(14 years of age and over)

	Total	Male	Female
Agriculture, Forestry and Fishing	7,683,966	3,882,704	3,801,262
Mining and Quarrying	4,805	4,261	544
Manufacturing	195,875	128,903	66,972
Construction	8,149	7,853	296
Electricity, Gas, Water and Sanitary Services	2,182	2,040	142
Commerce	706,974	352,031	354,943
Transport, Storage and Communication	65,860	61,919	3,941
Government and Personal Services	273,688	225,789	47,911
Activities not otherwise described	114,374	79,059	35,315

Source: Thailand National Economic Council (Central Statistical Office), Statistical Yearbook, 1952

It may be noticed that the government is the largest employer of professional and clerical workers. The vast majority of the better-educated Thai are employed by it to staff the school system and the extensive administrative network. Thai administrators are also employed in the many government-owned or operated industries. Obviously, in Bangkok where the Ministries are located, government employees are found more than in any other area.

C. Wages and Hours

The work week is set by the new labour law at 48 hours. For work beyond this limit, additional wages at 1½ times the usual rate must be paid. Employees are ensured one break during each day, one free day per week

in addition to traditional holidays, six days paid vacation per year. Exceptions in the payment of overtime are made for several important groups of workers. The number of hours usually worked in Thailand varies considerably. The work week of civil servants and of employees in government-owned factories is 33 hours. In the majority of other occupations it is between 48 and 63 hours and watchmen as many as 84.

Estimates of prevailing weekly wages (in Baht; 1 Baht equals 5 cents) in the Bangkok area for various occupations in the first six months of 1954 were as follows:

	Male	Female
Professional	330 baht	169 baht
Managers (proprietors & officials)	420	263
Clerical and related workers	188	172
Salesmen and related workers	140	80
Farmers, fishermen	88	23
Transport operators	174	-
Craftsmen, production process workers	157	85
Manual workers and labourers	134	82
Service workers	132	83

Differences in wages paid to skilled and unskilled lab
labour may be seen from the monthly wages paid in 1956 to workers
workers in various industries.

	Skilled	Unskilled
Highways	500-1,400 baht	400-600 baht
Sawmills	600-1,200	300-800
Factories & rice mills	600-1,600	300-600

At the same time, the prevailing wages of certain other groups were as follows:

Mine Workers	800-2,000 baht
Rubber tappers	900-2,500
Clerks	500-1,500
Elementary teachers	450-1,600
Accountants	1,200-2,400

Wages outside Bangkok are somewhat lower than those in the city. The government employees are differentiated by salary group. The salary group which is under 6,000 baht per annum is selected as the basis for this design solution.

D. Standards of Living

There are two different standards of living in Thailand, urban and rural. Eighty-five percent of the population lives in rural areas.

Most rural Thai are remarkably indifferent about their housing. The climate is so mild that elaborate shelter is not required and heating arrangments are unnecessary except in certain sections of the mountains in the North. Only in the last quarter century has housing become a problem. Materials have become much more scarce; teak is beyond the reach of all save the most wealthy, other hard woods have acquired export value, and bamboo and palm leaves, as the primary building materials cost much more than formerly. Rural families and neighbours co-operate in building houses as they have always done, just as they do in rice harvesting and other activities.

One general type of house is basic to all rural groups. Bamboo and timber are used for the walls; palm leaves, thatches, wood shingles and clay tile for the roof; timber for the floor, and teak for door and window frames. The finest rural houses are entirely of teak, but it is now increasingly rare to find a new house built of this material.

Regardless of the material used, the plan of the house is the same: a large central room as a family room (as in the U.S.) and small, plain bedrooms. The kitchen is usually built away from the main dwelling.

The compound is a family island, attempting to achieve self-sufficiency. The number and variety of out-buildings in a peasant's compound is an indication of his degree of wealth.

Urban housing, especially for lower income groups in Bangkok, is built of timber. The largest rooms are about 10 feet square, which often hous families of five or more.

For the middle class there is virtually no housing problem, although the quality of better housing varies considerably. A typical house for this class in Bangkok is a small timber two-storey residence with wooden walls and cement tile roof. The lower floor is usually concrete, a small room at the entrance is used for receiving general guests and attached is a dining room and a larger general-purpose room. A room nearby serves for bathing. Two or three private bedrooms are upstairs. The kitchen is invariably apart from the house but connected to it by a covered passage. A pantry or kitchenette is quite popular, located close to the dining room.

The houses of the elite are scattered about Bangkok, and in the outskirts. The principles are about the same as in the middle-class house, but on a larger scale and more luxurious. The effort is still made to be completely independent.

2. SOCIAL STRUCTURE

The basic socio-economic unit in Thai society is the family, consisting of a man, his wife and their children, residing either in a single house or in several houses in one compound.

In most areas the community is a village and the surrounding area, all of whose inhabitants attend the same Buddhist temple (Wat).

In the rural Thai community, there are friendship associations based on mutual interest in such activities, recreation or mutual economic aid.

All Thai recognize themselves as belonging to a unified culture, for which the religious, political, social and economic capital is Bangkok. From the point of view of unified national social structure, all Thai would agree that, in general, people who live in Bangkok have higher social status than people of similar wealth who live elsewhere.

The Thai village has a virtually classless society, but the city has a highly stratified class system. A good number of formal associations exist in Bangkok, but virtually none in the village. The purposes served by the few groupings which do exist in village areas are entirely different from those served by Bangkok organizations. Finally, the criteria for assigning people to different status are different in villages and in the city.

Within Bangkok, class status or membership is determined on the basis of an individual's of a family's position or rating in one or more of five categories: economic standing, political power or connections, education, outlook on life, and family background. Members of the nobility, for example, possess superior family background and a good education, but they can hardly compare with the next class below them as far as economic holdings and political standing are concerned.

The use of the term "class" is in itself somewhat misleading. Most Bangkok people are aware of general class distinction and of their own status in relation to others, but by and large, members of a particular class do not have a strong sense of identity with other members of their own class. Present urban society is characterized by an extraordinary amount of status (or class) mobility both up and down the scale; people are constantly changing jobs, changing their prestige and class position, and moving in and out of the city. As a result, class lines tend to become blurred and unclear.

The population size of the class groups is difficult to determine. A very approximate estimate may be made on the basis of occupation, which is a fairly good measure of status in Thailand, usually indicating economic standing, degree of political power and amount of education, though not clearly reflecting the other social valuations involved.

The proportion of the Bangkok population which can be placed within the old elite numbers less than one percent; possibly fifty percent is in the upper-middle class; about twenty percent in the lower-middle class that is selected for the design solution in this thesis; and approximately twenty-five percent is in the lower class.

3. CULTURAL AND GENERAL PATTERN OF LIVING

Thailand is the only country in Southeast Asia that has never known colonialism, either political or cultural. This fact has affected its culture as well as every other aspect of the life of its people.

In former days there were constant raids and wars of conquest among neighbours. The conquered people were removed wholesale from their old homes as prisoners of war and domiciled in various localities within the victorious lands. There came too, every now and then, emigrants from neighbouring countries due to accidents of history. These intermixed with the natives of their adopted land and became assimilated after a few generations into one whole. Such was the case in both Thailand and its neighbouring countries. The ethnic elements of the race in Thailand are more mixed, especially in the central and southern areas, while in other areas they are more nearly of one stock. The culture of Thailand is therefore, due to the above facts, unified but with regional diversities in different proportions due to varying alien elements.

The culture of Thailand as expressed in its religion, arts, literature, social system, habits and customs reveals a unity in a general sense with its neighbours, but with distinctive characteristics.

To study one nation's culture is to study it as a whole. Fundamentally, the culture of Thailand may be summed up in religion. Arts and literature, the social system,

habits and customs developed and clustered around religion. Only in quite recent times has there been some adaptation in the culture due to Western influence. This culture tends to become secular in the progressive parts of the country, but to the people as a whole, religious culture is still a living force.

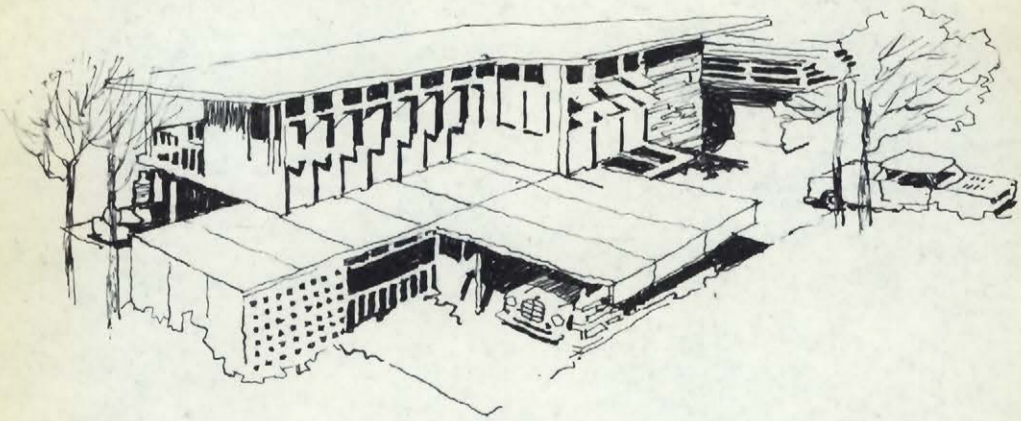
The traditional religion of Thailand is Buddhism, which is derived largely from the ancient Buddhist centre of Ceylon.

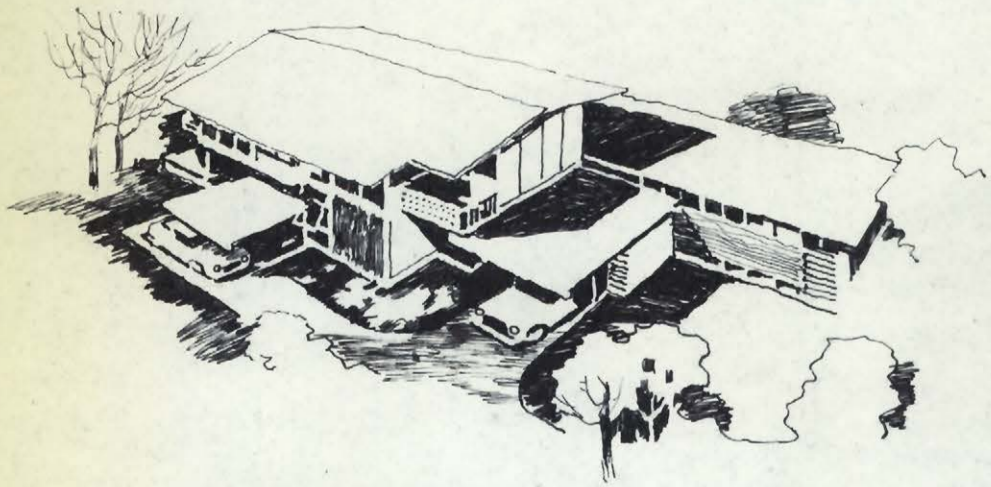
The great emotional attachment all Thai have to the doctrines and rites of the Buddhist order forms an essential base of their lives; Buddhism is constantly woven into their thought and actions. The Wat is the religious and social centre of the Thai community. The Buddhist monastery remains the most respected institution in society and much closer to the heart of the people than is the government. The monks represent the Thai's cultural traits, and can be the most influential, respected and important individuals in the local community. The acquisition of merit is an essential part of life and a great amount of time and energy is expended for this purpose.

Rural Thai are satisfied with their way of life and have no urge or compulsion to change it. Thai rural dwellers live in simple but adequate houses, usually of their own construction, made of teak or bamboo and raised on stilts to avoid flooding. The surrounding small plot of land may be fenced. Part of the land is used for a kitchen garden, and there is usually a threshing ground and place for

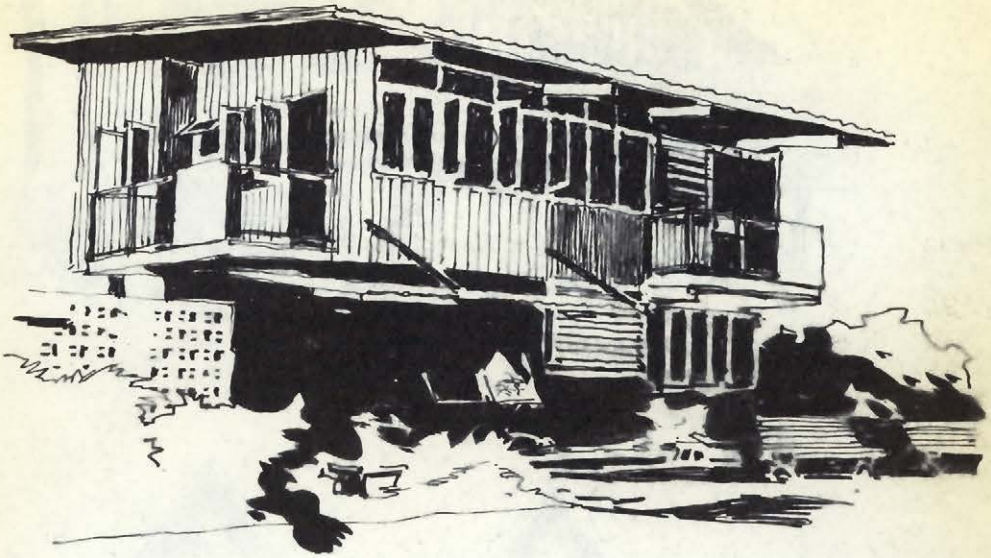
Figure 20

HOUSES OF VARIOUS CLASSES

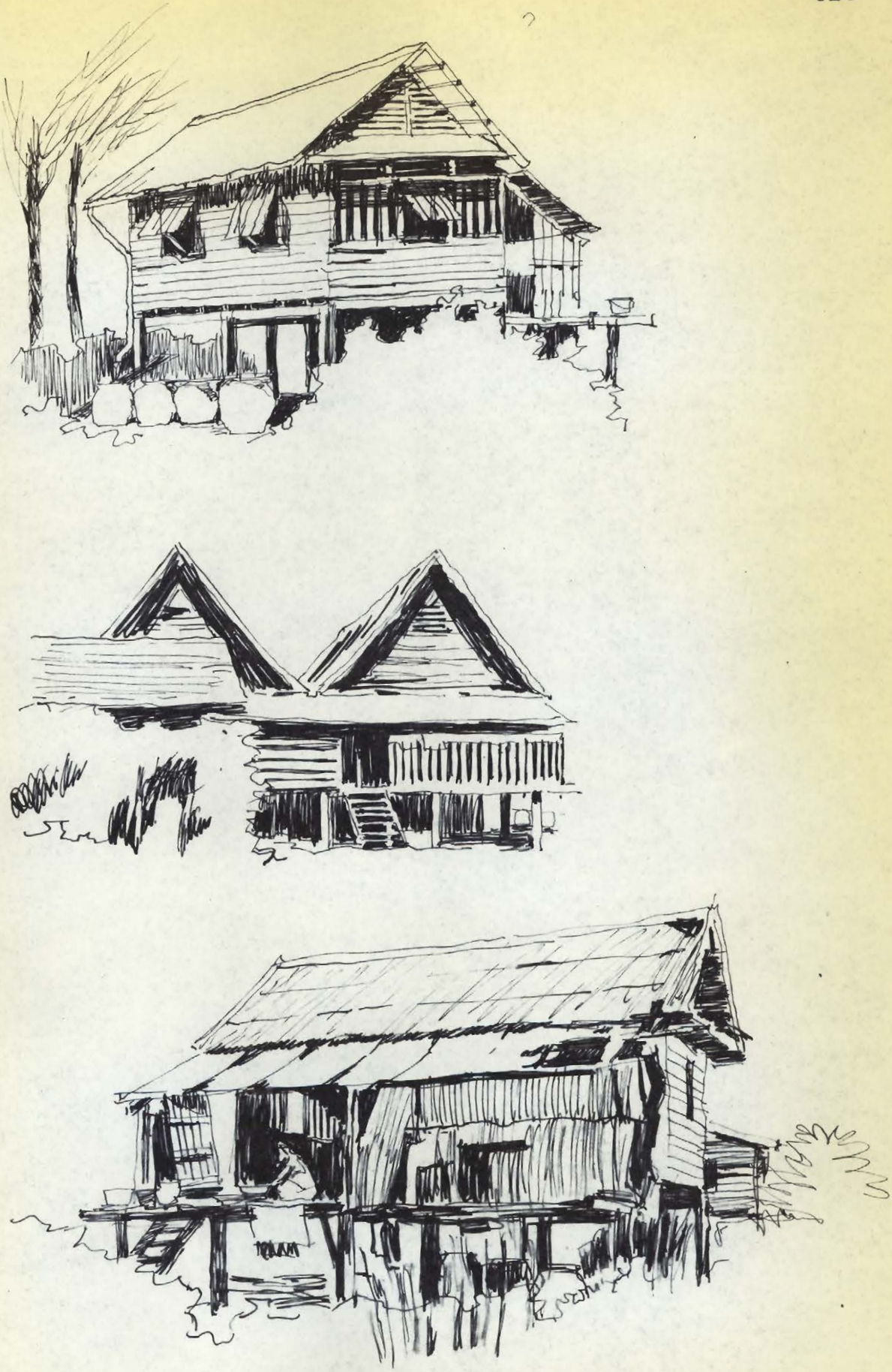




HOUSES OF HIGH CLASS PEOPLE.



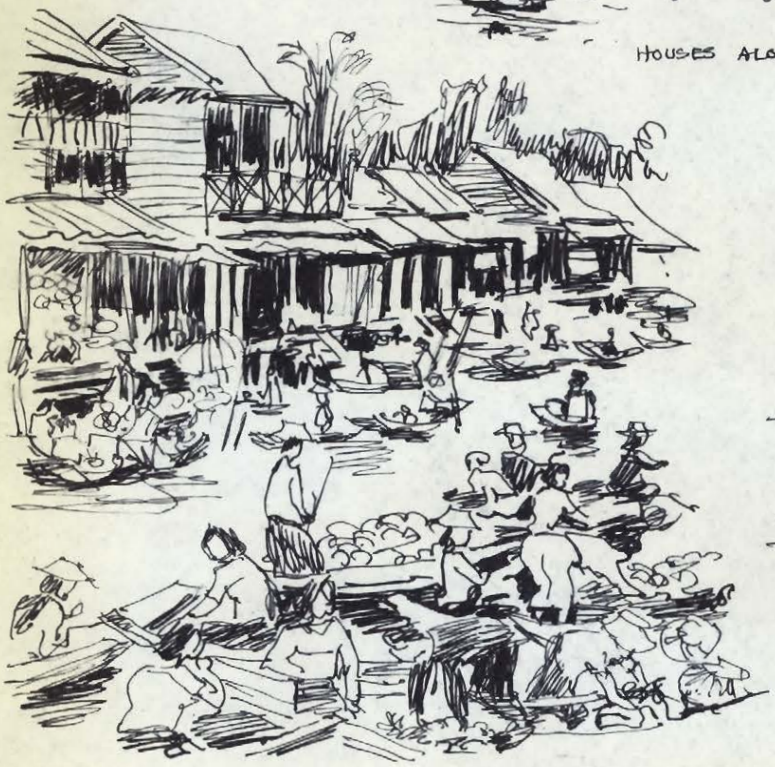
MIDDLE CLASS HOUSES.



HOUSES OF LOW-INCOME PEOPLE

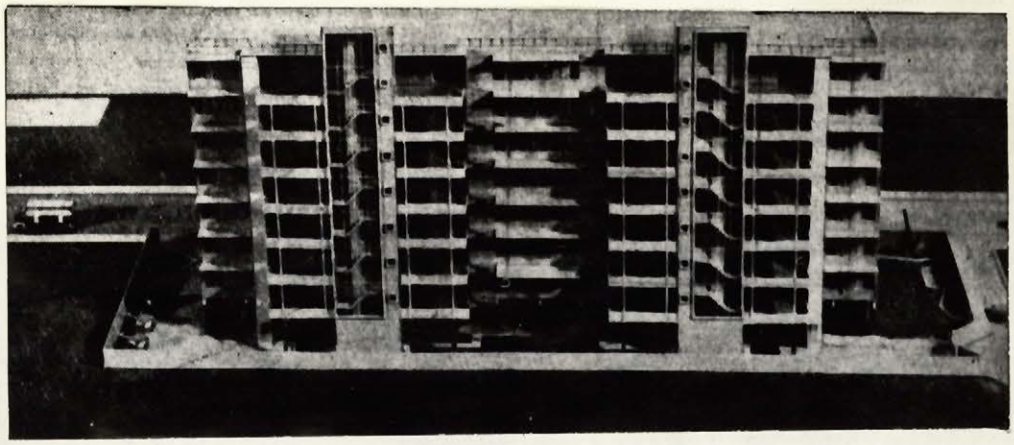
FARMERS' HOUSES

HOUSES ALONG THE CANAL

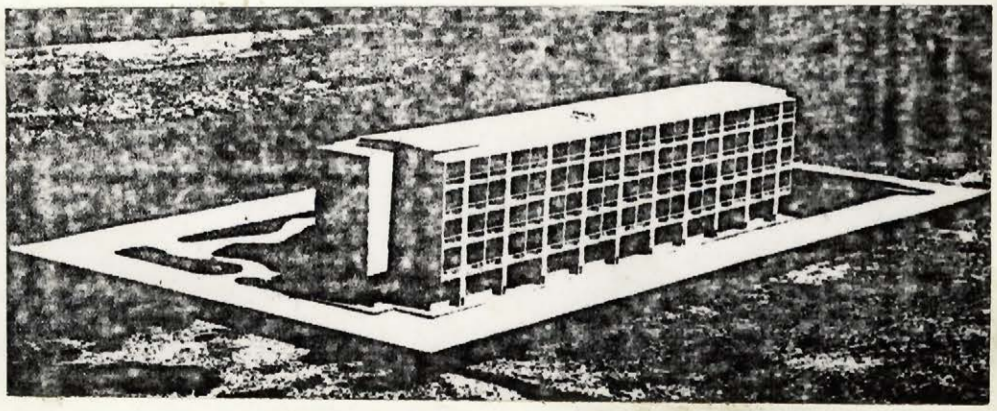


GARDENERS' HOUSES AND FLOATING MARKET.

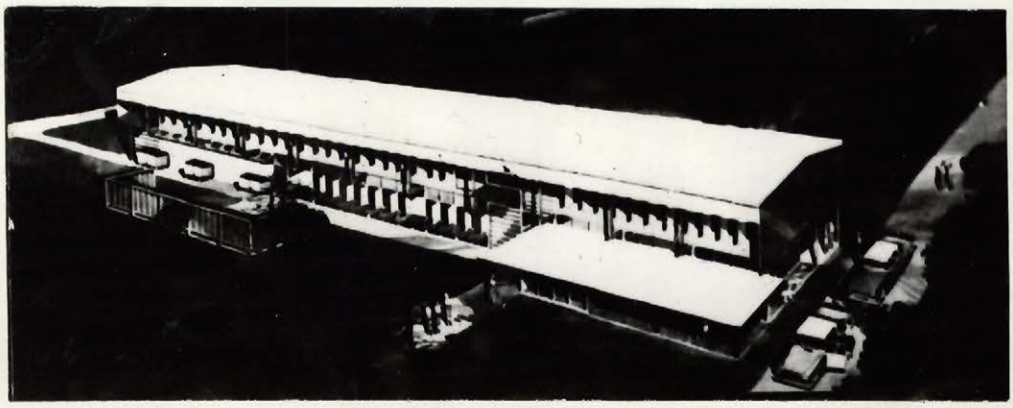
FLOATING HOUSES.



APARTMENT FOR HIGH CLASS PEOPLE



APARTMENT FOR MIDDLE CLASS PEOPLE



APARTMENT FOR LOW-INCOME PEOPLE

rice storage. The family's chickens and ducks live in the compound, the bullock shed is located beside it.

The houses of the Thai lower-middle class and working class are usually small wooden structures with two or three rooms built in a small compound. Lower class groups usually live in slums or house-boats.

As in this country, offices, schools, factories and shops open between eight and nine o'clock; children and adults go to school and to work on crowded buses and streetcars. Schools close between two-thirty and three-thirty; offices close between four-thirty and five. Almost everyone is home by six for the evening meal.

In the upper-class urban type of family, there is a much greater differentiation of sex roles than in rural Thailand. Family income does not depend, as it does in the rural family, on the active working help of wives, and hence women do not participate to any extent in male activities. Differentiation in sex roles also influences the upbringing of the children. Girls become proficient in the home arts required to run a gracious household. Sons are tutored to learn the skills which would fit them for occupations, traditionally government service, in which family wealth, status and prestige would be maintained. In the lower-class groups, occupations tend to become sex-bound, with new fields of specialization, men becoming bus-drivers , for example, and women emerging as hair-dressers.

The Thai are polite and friendly. Manners are an inherent part of their character, inculcated from the earliest years by habits of respect for parents, elders, priests, teachers and others to whom respect is due.

Source: Central Statistics Office, Office of National Economic Development Board, Ministry of Economic Affairs

PART III : THE HOUSING SITUATION IN THAILAND

1. REASONS FOR HOUSING SHORTAGE

2. GOVERNMENT POLICY

1. REASONS FOR HOUSING SHORTAGE

Bangkok is a many-centred capital city: a port, a business centre, a Royal centre and a religious and government centre. Since the war, it has become an international centre.

Cities have been allowed to grow without control, regardless of elementary human needs, until they have become practically unmanageable.

The idea that a planned policy of decentralization of industry should be based on an urban land use policy is the only solution to this problem.

The population of Bangkok, including its straggling suburbs had, according to the census of 1947, reached 691,000. By 1955 it had grown to about 1,089,500. The annual rate of increase is 7.23 %.

It is believed that the present population of the Metropolitan area might normally increase from the present population of less than two million to about seven-and-a-half million by the year 1990.

In the face of this dilemma of a growing population and increasing numbers of new families, it is suggested that strong programs are necessary, aimed at distributing economic development to other sections of Thailand; in this way the Bangkok area may be kept to four-and-a-half million. Even this moderate growth will put a strain on the economy with regard

to decent sanitation, housing and circulation. (1)

The real housing shortage exists only in the city, and especially in Bangkok. The factors are --

1. the rapid increase of the population in the metropolitan area and the growth of the city,
2. the migration of rural people into the cities, especially Bangkok, the capital, in search of permanent and seasonal employment,
3. the obsolescence of houses through lack of repairs, and the rebuilding of existing houses with a loss of a certain relationship,
4. the large number of immigrants to Thailand, especially Chinese; these mostly settle permanently in Bangkok, and the rest are thinly scattered throughout the country,
5. the clearance of slum areas for better living conditions,
6. fire damage.

2

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(1) Estimates from the planning program for the Metropolitan region of Bangkok by Professor R.B.Graeley of the Department of City and Regional Planning, Massachusettes Institute of Technology, Cambridge, Mass.

2. GOVERNMENT POLICY

The government of Thailand has a two-phase program to alleviate the shortage or inadequacy of housing, namely: The Housing Project Office, and the Self-help Settlement Housing. The Housing Project Office was begun as early as 1942 to build new housing and to modernize existing housing.

Arrangements were made to rehouse the displaced families in better houses. In 1948 the government announced its policy to meet the pressure of growing population and industrial expansion by providing the people with adequate shelter.

The Department of Public Welfare of the Ministry of the Interior was responsible for carrying out this program, which constructed 585 apartments and houses in the first four years of its operation.

The major program is the provision of adequate housing to low-income families in Bangkok and Thonburi where the need is greatest. The Department of Public Welfare is planning housing for 1,499 families already registered. The government, in 1956, had plans to grant housing loans to an additional 2,000 families.

The second phase of the government's housing program consists of assistance to residents of self-help settelements who need shelter. This self-help settlement program was started at Saraburi in 1941 and 751 houses have been built

in these settelements by the government.

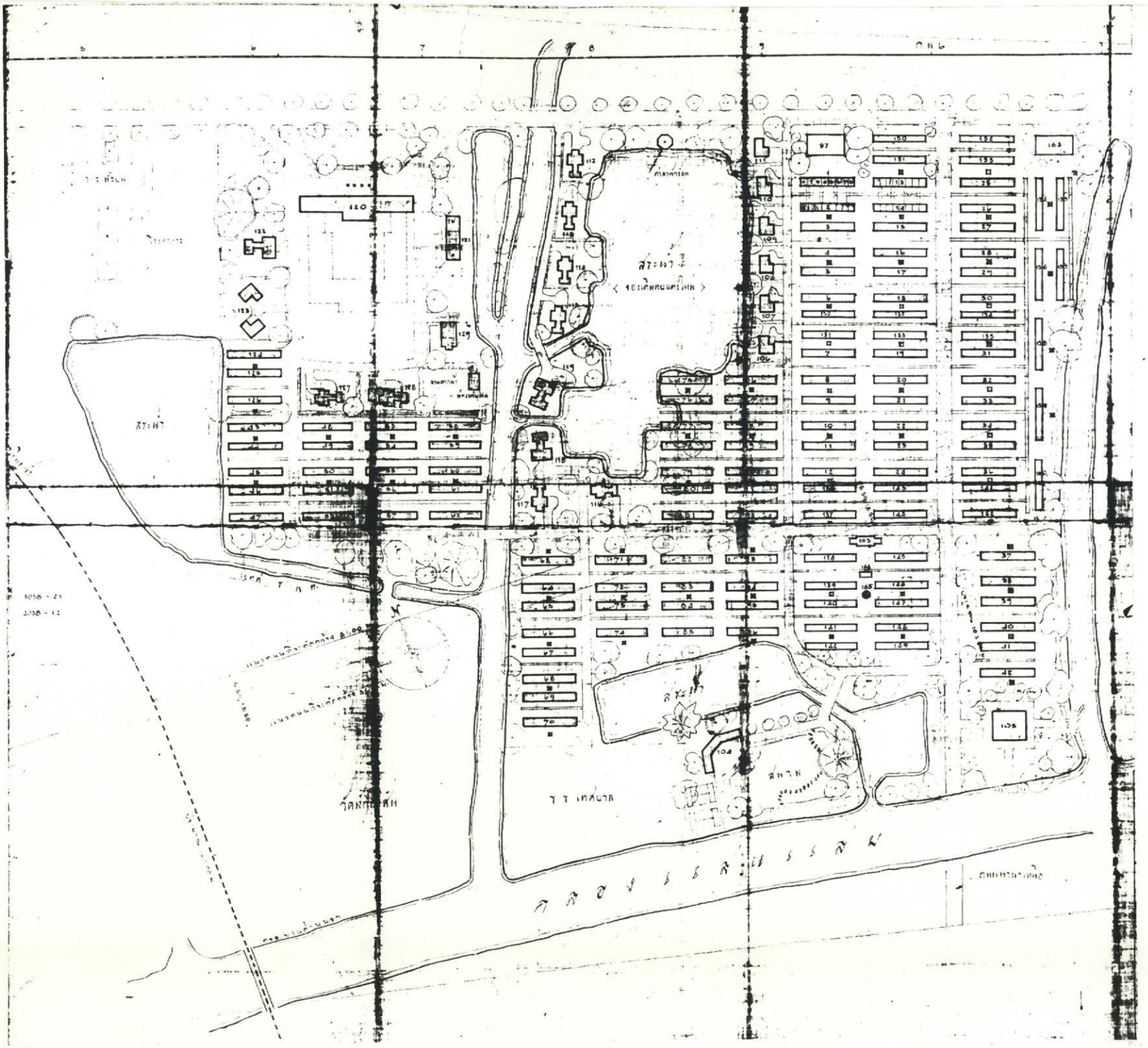
One of the most interesting of the Rural Re-settlement projects which were sponsored by the government is the development and utilization of uncultivated lands of the Bangpakong settlement in 1941-1950. The results have been to draw settlers from the surrounding districts and also from Bangkok and its surrounding townships, to which many rural families migrated during the war.

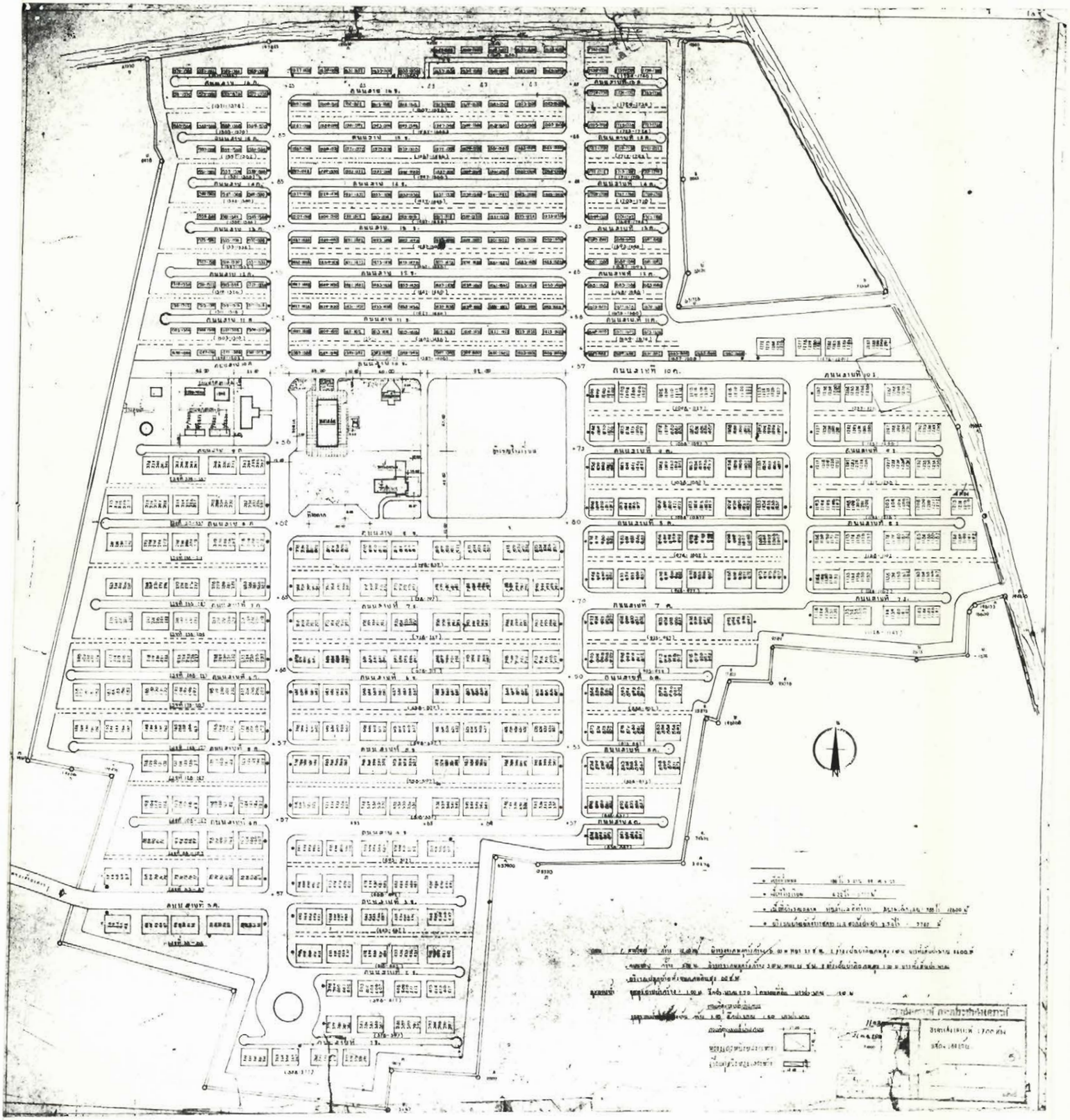
The government program is not only a housing construction program, but it also emphasizes over-all community development. The government also assists needy settlers by the provision of building materials, land clearing machinery, road-building and other heavy equipment.

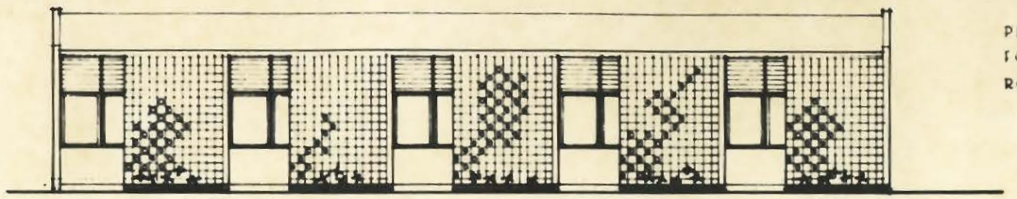
Houses and apartments have been built variously of brick and wood, the structures being designed to meet the requirements of the climate and to fulfil the needs of the residents. Water and electrical facilities are provided and careful attention is paid to the convenience of location and availability of transportation.

Figure 21

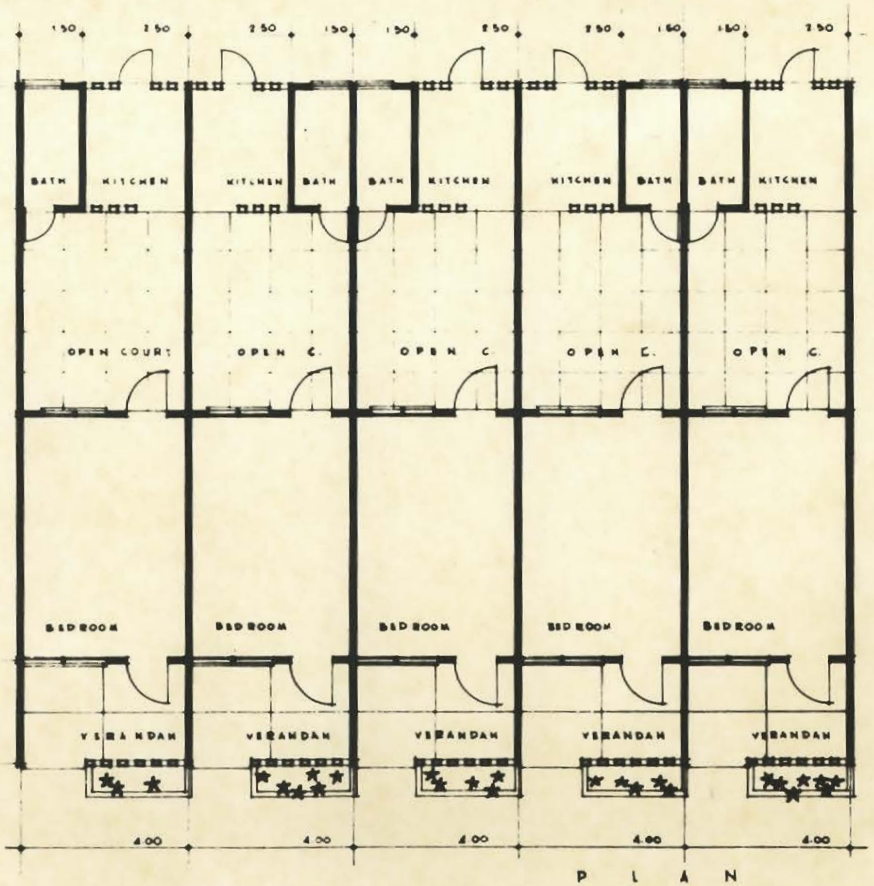
VARIOUS HOUSING PROJECTS







ELEVATION.



P L A N

SCALE 1:100

PLAN OF LOW COST HOUSING
FOR LOW INCOME GROUP
ROW HOUSE . PERMANENT TYPE

DATA

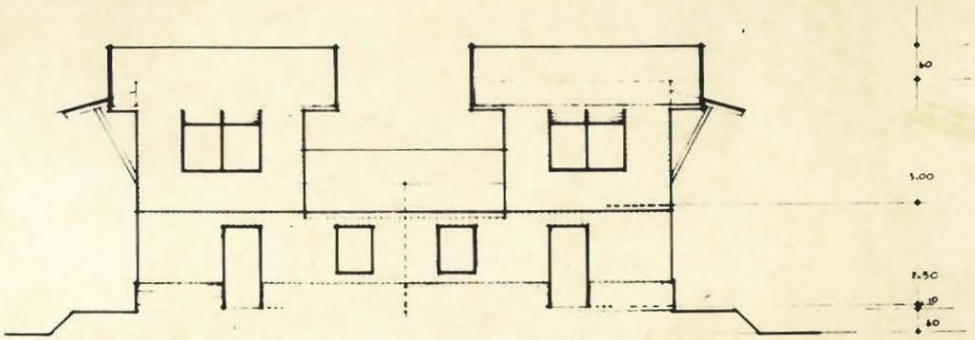
1. AREA PER UNIT
   LIVING AREA 46 m^2
   OPEN COURT 20 m^2
2. TOTAL CONSTRUCTION COST PER UNIT
   71,200 BAHT
3. RENTING NO INFORMATION

BRIEF SPECIFICATION

1. REINFORCED CONCRETE FOUNDATIONS & FRAMES
2. WALLS . BRICKS OR CEMENT BLOCK FILLED IN FRAMES FINISHED THICK. 12 cm
3. FLOORING TERRAZZO OR CLAY TILES ON CONCRETE 3" BASE
4. ROOF TRUSSES . HARD WOOD
5. ROOFING CORRUGATED ASBESTOS
6. DOORS & WINDOWS . TEAK
7. FINISHING BRICK WALL PLASTERED BOTH SIDES . CEMENT PAINT
   WOOD PAINTED
8. CEILING SHAVING BOARD

HOUSING DIVISION . DEPARTMENT OF PUBLIC WELFARE . MINISTRY OF INTERIOR
BANGKOK . THAILAND.

PLAN OF LOW COST HOUSING FOR VERY LOW INCOME GROUP . HUA KWANG . THAILAND . SEMI DETACHED HOUSES TYPE .



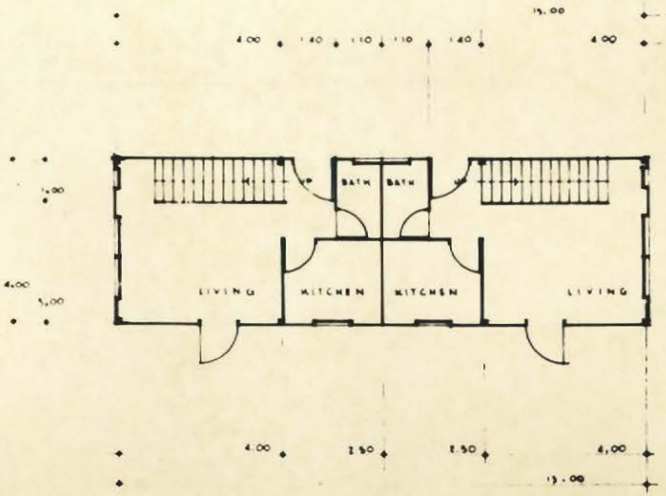
ELEVATION .

DATA

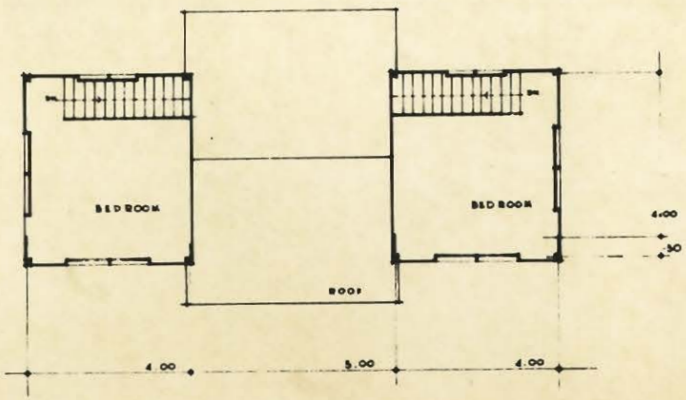
1. TOTAL AREA
   GROUND FLOOR 52 m^2
   FIRST FLOOR 56 m^2
2. TOTAL CONSTRUCTION COST PER UNIT 40,000 B.
3. RENTING PER FAMILY 90 BAHT

BRIEF SPECIFICATION

1. PRE-CAST CONCRETE POST & FOUNDATION
2. GROUND FLOOR . CONCRETE .05 cm ON WELL RAMMED GRAVEL OR CRUSHED BRICK
3. BRICK-WALL 12 cm THICK 60 cm ABOVE FLOOR BY STEP-FOOTING
4. SUPERSTRUCTURE . ALL TIMBER . (AS ROW HOUSE TYPE)
5. ROOFING CORRUGATED ASBESTOS
6. FINISHING BRICK WALL BOTH SIDES PLASTER NO CEMENT PAINT . WOOD . NATURAL .



GROUND FLOOR PLAN

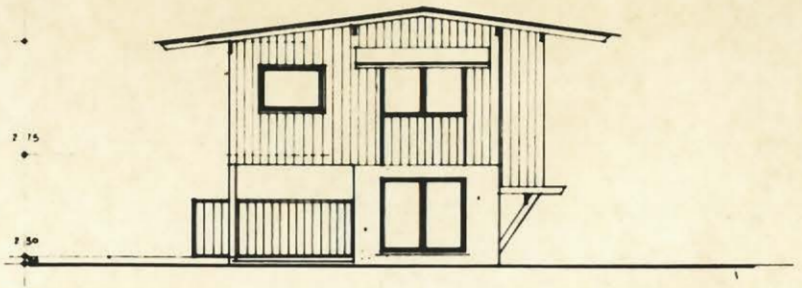


FIRST FLOOR PLAN
SCALE 1 : 100

68D

HOUSING DIVISION . DEPARTMENT OF PUBLIC WELFARE . MINISTRY OF INTERIOR . BANGKOK . THAILAND .

PLAN OF LOW-COST HOUSING FOR [illegible]
PROTECT IN TUNG MAHAMEK, BANGKOK, THAILAND
DETACHED TYPE



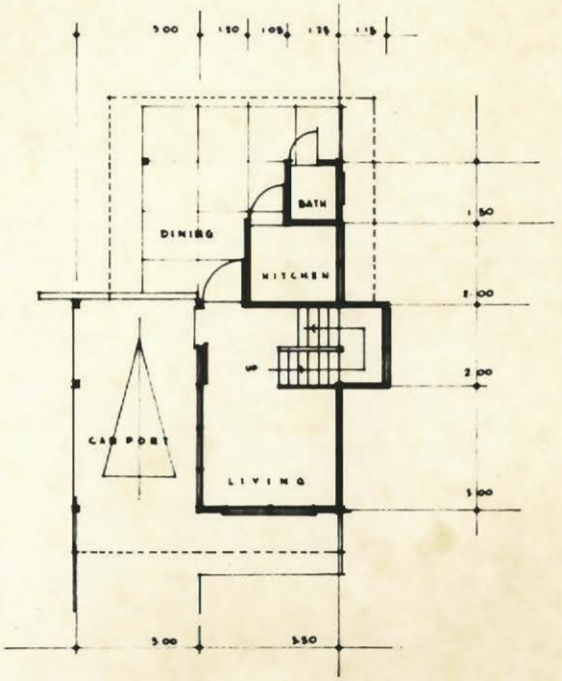
ELEVATION.

DATA

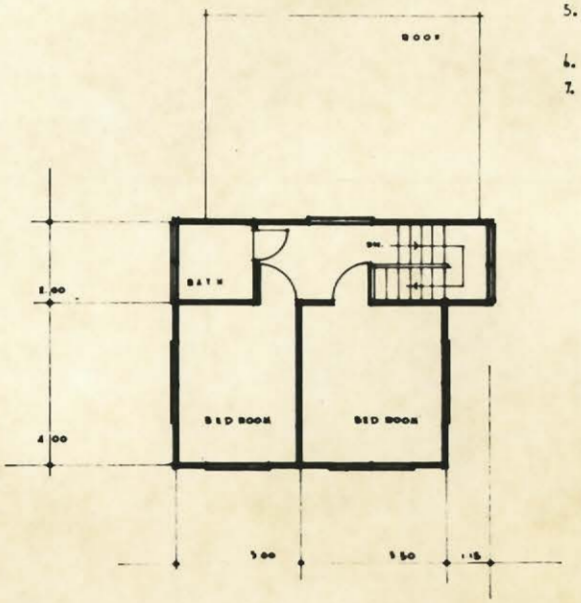
1. AREA PER UNIT GROUND FLOOR 69.5 m²
   FIRST FLOOR 49.00 m²
2. TOTAL CONSTRUCTION COST PER UNIT 90,000 BAHT
3. LEASE-PURCHASE

BRIEF SPECIFICATION

1. REINFORCED CONCRETE FOUNDATIONS & FRAMES
2. WALLS . BRICKS OR CEMENT BLOCKS 12cm THICK
3. SUPERSTRUCTURE ALL TIMBER
   POST . FRAMES . ROOF TRUSSES . FLOORING BOARD
   HARDWOOD . PARTITIONS SOFT WOOD . DOORS & WINDOWS
   & STAIRS TEAK
4. GROUND FLOOR CLAY TILES
   ON 3" CONCRETE BASE
5. ROOFING CORRUGATED
   ASBESTOS
6. CEILING SHAVING BOARD
7. FINISHING BRICK WALL:
   RENDERED BOTH SIDES.
   CEMENT PAINT
   WOOD . PAINTED



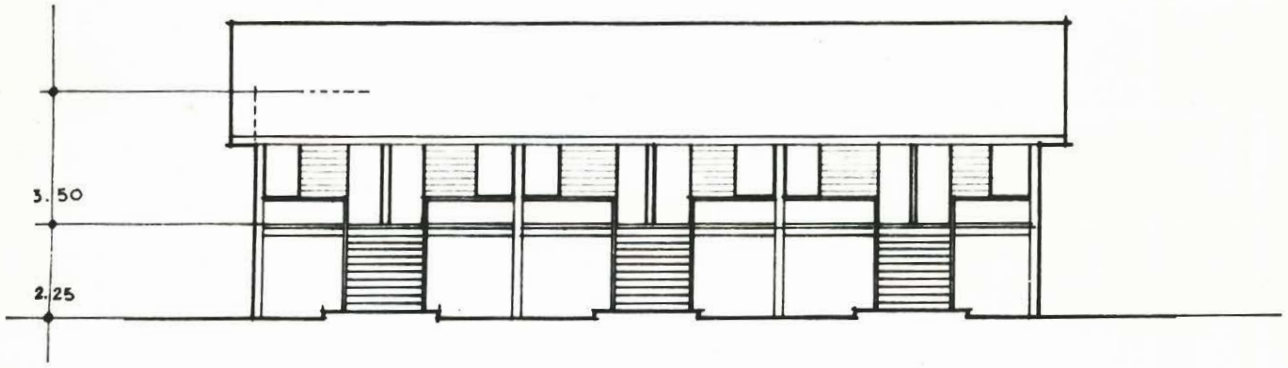
GROUND FLOOR PLAN



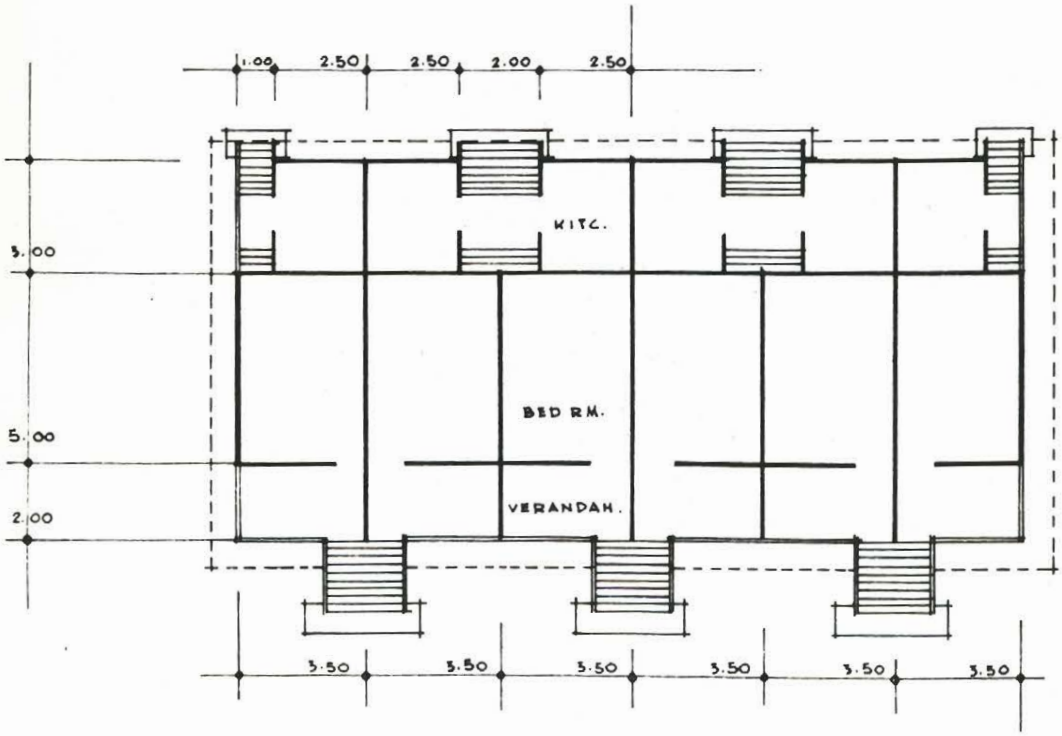
FIRST FLOOR PLAN

SCALE 1:100

PLAN OF STANDARD HOUSING FOR STATE RAILROAD EMPLOYEES
FOR INCOME GROUP 513 BAHT - 827 BAHT
SEMI-PERMANENT TYPE



ELEVATION.

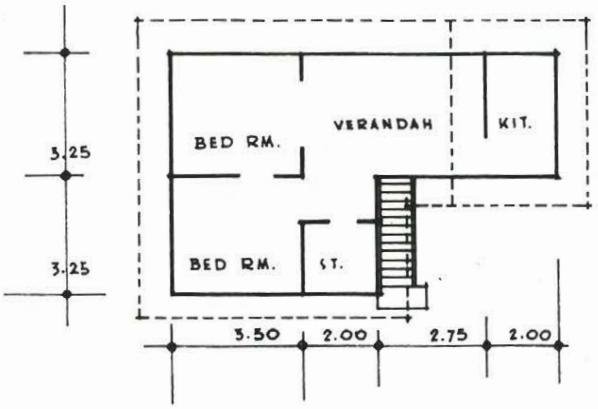


PLAN
1 : 200

TECHNICAL OFFICE . ARCHITURAL SECTION
STATE RAILROAD OF THAILAND . BANGKOK . THAILAND

PLAN OF STANDARD HOUSING FOR STATE RAILROD EMPLOYEES
FOR INCOME GROUP 513 BAHT - 827 BAHT
SEMI-PERMANENT TYPE

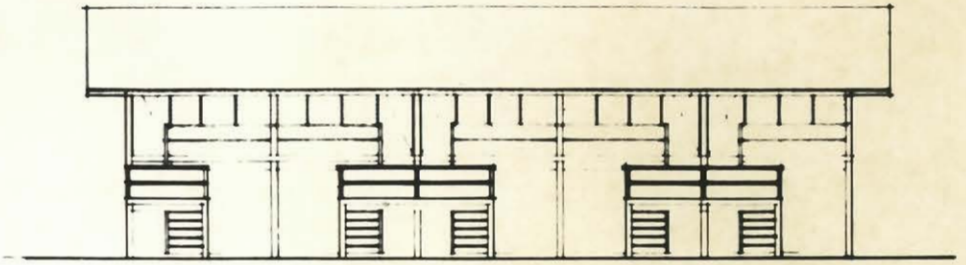
ELEVATION.



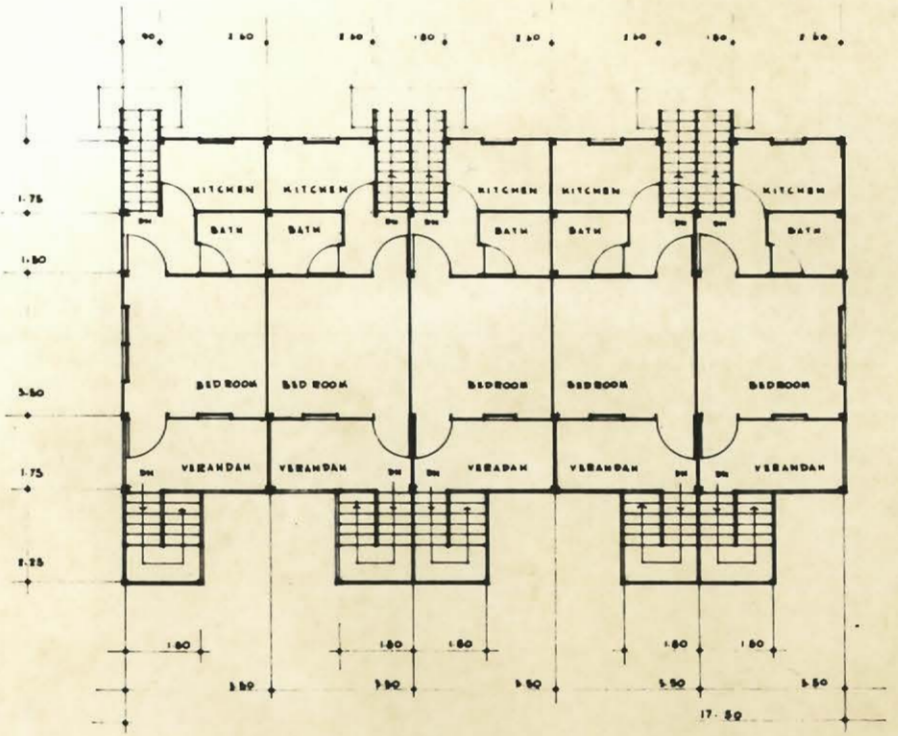
PLAN
1 : 200

TECHNICAL OFFICE . ARCHITECTURAL SECTION
STATE RAILROAD OF THAILAND . BANGKOK . THAILAND

PLAN OF LOW COST HOUSING FOR VERY LOW INCOME GROUP , HAU KWANG , THAILAND . ROW HOUSE TYPE .



ELEVATION



PLAN

SCALE 1:100

DATA

1. AREA PER UNIT 29.75 m^2
2. TOTAL CONSTRUCTION COST PER UNIT [illegible],000 B.
3. RENTING UNIT PER MONTH [illegible].0 BAHT

BRIEF SPECIFICATION

1. PRECAST CONCRETE POST & FOUNDATION
2. SUPERSTRUCTURE . ALL TIMBER .
   POSTS . FRAMES . ROOF TRUSSES
   FLOORING . ALL HARD WOOD
   DOORS & WINDOWS . TEAK .
   PARTITION & CEILING. SOFT WOOD.
3. ROOFING CORRUGATED ASBESTOS
4. FINISHING NATURAL

HOUSING DIVISION. DEPARTMENT OF PUBLIC WELFARE .
MINISTRY OF INTERIOR . BANGKOK . THAILAND .

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PART IV : BUILDING MATERIALS AND CONSTRUCTION METHODS

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1. BUILDING MATERIALS

   A. Cement

   B. Steel

   C. Raw Materials

   D. Electric Power

   E. Clay Products
      a. Bricks
      b. Tiles
      c. Other clay products

   F. Building Stone, Marble, Gravel, Lime and Sand

   G. Imported Materials

   H. Fittings and Furniture

   I. Plywood

   J. Building Boards

   K. Forestry and Timber

2. PREFABRICATION

3. OTHER CONSTRUCTION METHODS

4. COST OF CONSTRUCTION

   A. Land Cost

   B. Materials

   C. Labour Cost

1. BUILDING MATERIALS

There are two groups of low-cost housing according to the area in which the houses are built, either serving the government employees or workers engaged in urban and industrial areas, or the rural population. The materials required for construction of these two distinct groups of houses vary widely. The materials for permanent housing of an urban nature are available in large quantities in both local and imported materials. Rural housing is almost entirely based on indigenous materials. Materials for low-cost urban types of housing are more or less uniform all over the country. But in rural areas, materials vary in different regions according to their availability and the climate.

In Thailand, building materials are predominately organic materials. An approximate estimate of the proportional application of local materials to housing construction throughout Thailand is as follows: (1)

Brick and concrete	12 percent
All timber	35 "
Timber and bamboo	40 "
Bamboo	28 "

All-bamboo dwellings are chiefly found in the Northeast region. Timber, brick and concrete houses are found mostly in cities and towns.

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(1) Royal Thai Forestry Department estimate, April, 1959

A . Cement

Until 1958, there was only one cement factory in Thailand, established in 1913. This factory exported to Singapore, Penang and the Northern Malayan States. Its production was 386,000 metric tons in 1955 and 475,000 tons in 1957. A second plant was constructed in 1958 with a capacity of 300 tons per day, but this is exclusively to provide cement for the large Yan-Hee Dam. Investment has been solicited from the public for an additional cement factory, approved by the government.

Cement Production - The Thai Cement Factory manufactures asbestos cement as follows:

1. Asbestos cement corrugated roofing sheets, of which there are two types -- a. twin corrugated "Lawn Khoo" sheet, 50 cm. wide and in the standard lengths of 90,120,or 150 cm.; these are normally available on the market,
   b. corrugated sheets 100 cm. wide and in lengths of 120,180 or 240 cm., with 5 cm. deep corrugations.
2. Flat boards with wire mesh reinforcing, 90 by 190 cm., and 8 - 10 cm. thick, used as partitioning board or school blackboards. Ceiling boards are 60 by 60 cm., 90 by 90 cm. or 50 by 50 cm., and 4 mm. thick.
3. Venetian screens in various designs.
4. Low-pressure piping in different dimensions which find a ready use for all sanitary installations.

All products listed above are used in increasing quantities. Other cement products, such as concrete circular cess-pits, water-butts and paving slabs, terrazzo floor tiles and roof tiles are made by many private firms. The older traditional roof tiles are of a rectangular interlocking type; these are of fair quality, but with little or no lateral strength, as they are of flat section with lugs but without ribs or corrugations. There are tiles now being manufactured in a variety of finishes and colours, which are stronger and less liable to damage in transit and storage.

Terrazzo work and a type of imitation granite facing, applied by trowel and hand-polished, is much in evidence. Concrete drainage pipes of various diameters are usually cast on the job, in wooden molds. Reinforced concrete design and execution are bold and of a high technical standard.

Concrete blocks at present are a more economical form of construction than clay bricks and they are very widely used. The blocks are locally made in imported machines and are now being produced in Thailand, using both local aggregate and cement. There are many standard sizes. They are produced by numerous private firms and also by the factories of the Department of Industrial Products and State Railroads of Thailand.

B. Steel

Thailand established an iron and steel industry on a small scale only in recent years. The plant is about 150 km. from Bangkok and produces at present some 350 tons per month

of round mild steel bars, from 12 to 15 mm. in diameter, for use as reinforcement in concrete works. The demand for steel products in the country is steadily increasing on account of the expansion of industry, the construction industry in particular.

C. Raw Materials

Present conditions in Thailand, where wood fuel is plentiful and relatively cheap, seem to indicate that iron smelting by charcoal blast furnace will be the most satisfactory method of iron and steel production for some years to come. The development of hydro-electric power resources will, however, radically alter these conditions in the future. Iron ore of fair quality was discovered in 1946. It is now being surveyed and the Thai government is anxiously watching for the final results which are due shortly.

All tin is now exported. Other minerals produced to some degree include lead, gypsum, antimony and salt.

D. Electric Power

The Yan-Hee Dam project undertaken in 1956 by the government will meet the greater part of Thailand's power needs. Electricity peoduction has been gradually increasing in recent years, mainly in and around Bangkok. Electric current consumption in Bangkok increased from 68.5 million kilowatt hours in 1950 to 143.9 million in 1955. Areas outside Bangkok come under the jurisdiction of the provincial Electric Organization which serves 98 towns and villages.

E. Clay Products

a. Bricks

There are two factories for machine-made bricks and tiles, which are B.B.T. at Bangbuathong (16 km. from Bangkok) and B.P.K. at Thonburi. The product is a standard dry pressed brick of good quality, usually used for decorative purposes, exposing their smooth texture and natural colour without rendering. In addition, to the common brick, in wide use throughout the country there is a smaller-sized rural type of product, invariably underburned and very soft.

It is used as infilling panels for reinforced concrete-framed constructions and rendering-finished on both sides.

The Thai Cement Factory manufactures fire brick in standard sizes, 65 x 20 x 20 cm. and 6.5 x 9.8 x 20 cm., also facing bricks in size 5 x 5 x 15 cm. and unglazed tile approximately 1.5 x 15 x 15 cm. for walls and finished floors.

b. Tiles

Burnt clay roofing tiles are not now widely used except for the decorative roofs of the many Buddhist temples. These tiles are hand-made, of rectangular shingle-pattern approximately 30 x 28 x 1.7 cm. with semi-circular ends. The colours range from very light browns through greens and blues to bright reds and yellows. When fixed in patterns on the elaborate pitched gable roofs of the Wat in traditional Thai style, the general effect is most striking and colourful, particularly in the North.

A very fragile shingle type of clay tile is still

to be seen in use in small towns and villages. This is approximately 25 x 12.5 cm. in area and extremely thin (about 4 mm.)

c. Other Clay Products

There is an abundance of good quality clay throughout the delta of the Menam Chao Phraya. The chief sources of brick clay are Bang Bua Thong and Bang Pa Kong. All sorts of pots, jars, water butts, pipe and cooking utensils are made on a cottage industry basis, invariably by hand.

F. Building Stone, Marble, Gravel, Lime and Sand

Good limestone is plentiful throughout most of Thailand, quarried by the government and by private firms at Saraburi and Rajaburi. Bangkok also draws supplies from Ko Sichang. Marble is quarried by the Ministry of Industry and by private firms at Saraburi. Encouraged by the present government, production is in increasing quantities. River gravel or stream gravel is brought to Bangkok by boat from Saraburi and Kanchanaburi. Lime is one of the traditional construction materials, and is produced from natural limstone. The large quantity of local sand which predominates in concrete mixture, plaster and mortar, is brought from Saraburi and Angthong from the bottom of the Chao Phraya. There are two kinds; rough sand is used as a component in concrete mixture and mortars; fine sand is used for plastering.

G. Imported Materials

A variety of building materials are imported. These are mainly steel products, roofing sheets, hardware, plumbing and

electrical fittings, paints and small metal items such as hinges, hasps and staples, etc. A good deal of ornamental wrought-iron work is also imported.

H. Fittings and Furniture

Excellent furniture is made from teak and other high-quality woods. It is exported to the neighbouring countries, while cane is also the basis of a flourishing minor family-type industry producing a great quantity of lounge furniture, basketry, etc.

I. Plywood

The Thai Plywood Factory was established at Phra Khanong, Bangkok, in accordance with the government policy for forestry preservation. It produces teak and other valuable plywood and veneers for the export market, as well as supplying local demand for the common grades. Block board and flush doors are other products of this factory. The great demand for these items has encouraged extension of the plant to increase present quantities.

J. Building Boards

There are good prospects for the manufacture of building boards. To date the valuable secondary product of the sugar factories has customarily been fed back as fuel, in conjunction with fire-wood, to the factory boilers.

Fibre cement board is a new product since 1956, made at a plant located in the outskirts of Bangkok. It is composed of wood fibre, chips from various kinds of cheap soft wood, and

Portland cement. It is well known by the name of "cellocrete". The size is 1 x 2 m., and there are different thicknesses from ½" to 1". The product is insect-proof and water-repellant. It is mostly used for the panelling of a timber house or for plastering, for ceiling materials, for sound-proofing, as good insulation, and as a mold for flat slab construction.

Another new process has been developed in the same period by Sri Maha Raja to manufacture building boards from various kinds of chip woods. This firm is planning to produce 1,400 sheets per day, of a standard size of 1.25 x 2.5 m. It is proposed to manufacture building board (also called "Shaving Board") of .6 to 1.8 m. The product will be insect-proof, water-repellant and fire-retarding. It is usually used as house interior partitions, for ceilings and furniture and on some occasions as flooring material.

Lath and plaster is widely applied to many types of building. Bamboo was used as concrete reinforcement during the war: many private buildings and houses were built by this method although the numbers have been decreasing since the end of the war.

K. Forestry and Timber

Thailand possesses a very rich and greatly diversified flora, with a total of probably 10,000 species. Experimental research is necessarily centered around a comparatively few species of the more important economic types. Among all of them, teak is pre-eminent. 273 forest revenue stations and check stations are maintained in the country, most of them in combination with provincial, township, or range officers.

2. PREFABRICATION

The Thai Cement Factory has attempted to produce a fully prefabricated house in different sizes and prices, approved by the government, but the capital cost is too high. Also numerous private firms have made the same attempt, but the products have been of unsatisfactory quality.

Prestressed concrete products are a new production of the Thai Cement Factory, which is very popular in the construction field, from the point of view of structural efficiency and economy both of production and construction.

3. OTHER CONSTRUCTION METHODS

Construction and design techniques in the past were under the influence of available indigenous materials such as large-scale building in beick masonry. Characteristic roofs of wooden structure were covered with glazed coloured tiles, seen in churches and Royal palaces. Houses mostly are of highly-skilled timber construction, although some have been built in brick masonry. The first reinforced concrete bridge was built in 1923, and later this type of construction spread through the country very rapidly. It is used in different functional buildings, such as office buildings, factories, workshops, houses and for transportation purposes, highways and bridges.

Modern large office-buildings in Bangkok or in rural areas are mostly of reinforced concrete frame construction with hand-made brick walls finished with cement rendering. Wood construction for secondary buildings, particularly for houses, is popularly favoured, because of its light weight, cheapness and suitability to the climate.

The elevation of Bangkok is about 2.00 metres above mean sea-level. This causes constructional and drainage problems on account of the flat, low-lying terrain.

Cheapness does not depend simply on the choice of cheap material, but also on the method of application. In low-cost housing, therefore, the method of construction is also of importance in the reduction of cost.

Foundation design in Thailand, particularly in Bangkok, is complicated and it is one of the factors that increase the price of construction. In Bangkok, foundation soils are of a low bearing capacity, being soft silts or clays which extend to great depth. Heavy buildings must therefore be founded on spread footings or on a raft type of foundation, or more usually on a grid of piles. Roughly estimated, foundations take about one half of the total cost.

4. COST OF CONSTRUCTION

A. Land Cost

Since the war, land cost has increased throughout the country and particularly in Bangkok, due to the increasing dwelling needs of the population. At present, it costs 500-700 baht per square metre (U.S. $23-25) in the area of homes, factories, stores and offices; in central commercial areas, the cost is 15,000-30,000 baht per square metre (U.S. $750-1500); and 1,000 baht per square metre for suburban areas. In recent years, the cost has remained almost constant. There are three types of land ownership according to the land policies in Thailand, -- private land, government land, and Crown land. (1)

B. Materials

Industrial development, particularly in building materials, would greatly help in reducing the cost of construction. On the other hand, need for more transportation of materials would increase the price.

Average costs of construction in Bangkok per square metre of floor area, including material and labour are:

1. one-storey timber house (high quality)	800	baht per m^2
2. two-storey " " " "	1,400	"
3. one-storey timber house (mixed hard and soft wood)	300-400	"
4. two-storey " " "	600-800	"

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(1) Land cost estimates of the Department of Housing, Ministry of Public Welfare, July, 1959

5. one-storey reinforced concrete structure, brick wall 1,800 baht per m^2

6. two-storey " 2,800 "

7. Half-timber type (reinforced concrete structure, wood partition or lathing) 2,000 "

Note: cost is calculated only on ground floor for each type.

C. Labour Cost

Practically, the labour involved in home building in Bangkok is divided into two classes of work, --

a. skilled work:

1. carpentry, including finishing work and roofing,
2. masonry, including concrete work and plastering,
3. tile setting
4. plumbing
5. electrical wiring
6. painting

b. unskilled work.

The labour involved in skilled work is frequently subcontracted and unskilled labour supports this. The total amount of labour employed in construction in Bangkok during 1954 was about 11,480, skilled labour being 50 % of the total. (1) Generally, house building labour is more skilled than labour in general, and higher paid by the same working time, nine hours a day.

The daily wage rates do not mean that the average income of the workers is above others. Because so much of the work is seasonal and dependent upon the weather, income varies. It depends also on the requirements of the job; for example, a timber house needs more carpentry work. On the other hand, the common labourer can work until the construction is complete.

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(1) Number of economically active population 15 yrs. and over

(1) on preceding page:

Number of economically active population 15 years of age and over by principal industries. Source: Statistical Office of the National Economic Development Board, 1954

PART V : HOUSING STANDARDS

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1. STANDARDS FOR COMFORT AND HEALTH

2. DESIGN OF HABITABLE ROOMS

   A. Minimum floor space per person

   B. Number and Size of Rooms

   C. Ceiling Height

   D. Day-lighting

   E. Permanent Ventilation

   F. Kitchen

3. THE COST OF BUILDING CONSTRUCTION

A housing program cannot be successful unless it is related to the economic situation, physical condition and social or cultural background of an area. Standards depend on the way people live, their family organization and economic status. They also depend on the wealth of a country as a whole and on the climate. Standards furthermore will not be static but will depend on social and economic development.

The fundamental relationship between housing and health is widely recognized. In Thailand, public health and social legislation contain a multiplicity of provisions determining standards of living space. These define such things as the design of habitable rooms, the provision of cooking and sanitary facilities and the layout and setting of the house.

In housing standards, thought should be given to:

1. STANDARDS FOR COMFORT AND HEALTH

There should be criteria in fixing standards for low-cost housing which take into account

a. transmission of disease,

b. physiological discomfort and stress,

c. effect of climate on building design,

d. landscape.

2. DESIGN OF HABITABLE ROOMS

A. Minimum Floor Space per Person

Most regulations specify the minimum amount of floor space to be divided per person. This may be in terms of cubic volume of air space or, preferably, floor area. The ceiling height is defined separately. The minimum floor space per person should therefore be based on the space required for sleeping.

The numbers and size of rooms are at least as important as the floor space per person. This is recognized in more advanced housing legislation. Minimum sizes for single and double bedrooms and for living rooms are specified, the actual number of rooms provided depending on the size of the family. The standard of floor area per person should be used only as a basis for assessing overcrowding. This minimum floor space per person is mentioned in Bangkok municipal law.

B. Number and Size of Rooms

A reasonable basis for determining the number of rooms is that of sex segregation. Except for husband and wife, two persons over ten years of age and of different sex should not sleep in the same room. It is generally recommended that not more than four persons should sleep in one room. The minimum sizes of rooms should be determined by their use.

C. Ceiling Height

Two main considerations govern ceiling heights, -- adequate head-room and comfort. For comfort in a warm climate, the ceiling should be cool. Where there is no ceiling under the roof, heights become important. Then the higher the ceiling, the more comfortable the room. Minimum ceiling heights should be related to the kind of roof used, but it will be more economical if the ceiling can be lower, and this is also a saving in material. The required ceiling height is mentioned in Bangkok municipal law.

D. Day Lighting

The amount of daylight entering a room depends on the size of the window opening. It also depends on the brightness of the sky and surrounding unlit surfaces and depends on the amount of water vapour in the atmosphere. In Thailand, a cloudy sky, especially during the middle of the day, can be very bright; it is usually the main source of light and may cause a sensation of glare. This can be reduced by using a canopy of louvres, or cross-lighting. Alternatively, the size of the opening can be increased so that there is more light in the room and the contrast between inside and outside reduced.

Bangkok municipal law requires openings not less than 10 % of the floor area. In the absence of scientific data, a minimum requirement such as this may serve as a reasonable figure for the humid tropics.

E. Permanent Ventilation

Ventilation and daylighting may be obtained through windows. For health reasons there must be a minimum of fresh air entering a room by means of open doors and windows and by permanent ventilation in the form of ventilators and flues. Cross ventilation is extremely important, since a considerable amount of air movement is needed for comfort as well as health. Correct orientation is important to make use of prevailing winds.

Practically the whole window, which should extend to the ceiling, should open.

F. Kitchen

It is obviously desirable that each household should have its own cooking accommodation and it is more convenient for the housewife if the kitchen forms part of her house. Cross-ventilation in the kitchen is very desirable and for this reason, kitchens are usually separated from the living room.

Charcoal is generally used in Thailand for cooking. In Bangkok, this fuel is becoming more and more costly. Now serious consideration may have to be given to the use of simple, sturdy electric appliances for cooking in low-cost housing, since hydro-electric power is being developed from the Yan-Hee Dam. It would be of great help to the housewife and would save space, giving rise to a new standard of living.

3. THE COST OF BUILDING CONSTRUCTION

The cost of building construction is very important for low-cost housing, so great attention should be given to low-cost construction, materials and methods so that the units can be leased at the lowest possible rentals while architectural quality is maintained.

Average costs of construction in Bangkok per square metre of floor area, including material and labour costs in equivalents of U.S.dollars, are of the following order:

a. One-storey timber house (high quality)	800 Baht per sq.m. 80 " per sq.ft. ($4 ")
b. Two-storey timber house (high quality)	1400 Baht per sq.m. 140 " per sq.ft. ($7 ")
c. One-storey timber house (mixing hard and soft wood)	300-400 Baht per sq.m. 30-40 " per sq.ft. ($1.50-2. ")
d. Two-storey timber house (mixing hard and soft wood)	600-800 Baht per sq.m. 60-80 " per sq.ft. ($3-4 ")
e. One-storey building (reinforced concrete structure, brick wall)	1800 Baht per sq.m. 180 " per sq.ft. ($9 ")
f. Two-storey building (reinforced concrete structure, brick wall)	2800 Baht per sq.m. 280 " per sq.ft. ($14 ")
g. Half-timber house (reinforced concrete structure, wood partition or lathing)	2000 Baht per sq.m. 200 " per sq.ft. ($10 ")

Note: The cost is calculated on ground floor only for each type.

Average cost of the materials for construction in Bangkok are of the following order:

Bricks	1000 bricks	70 Baht
	good grade	120
Gravel	1 cubic yard	68
Sand	1 cubic yard	38
Steel	1 ton	2600-2900
Stone	1 cubic yard	84
Concrete	1 cubic metre	250
Hard wood	1 cubic foot	27
Soft wood	1 cubic foot	17
Teak	1 cubic foot	60-100

Partitioning:

1/2 brick wall with plastering both sides	35 Baht m^2
Yang partitioning with yang studs	25
"Shaving board" both sides with Yang studs	70
Thai plywood both sides with Yang studs	30
"Cellocrete" both sides	70
"Shaving board" 1 item (thickness varies)	50-125 (depending on size)
"Cellocrete" 1 item (thickness varies)	25-44 (depending on size)

Roofing:

Corrugated aluminum	7 Baht m^2
Corrugated asbestos sheet	23
Cement tile	15
"Uibulari tiles"(Marseilles type)	21
Glazed clay tile	160

Ceiling:

Timber - soft wood		12 Baht m^2
Hardboard		20
Shaving board		20
Acoustic board		20
Cellocrete		20
Plywood		20
Asbestos sheet		12
Hard board 1.20x2.40m.	1 item	50 Baht
Shaving board 1.25x2.50m.	"	50
Thai plywood 1.20x2.40 m.	"	40
Acoustic tile 1.20x2.40 m.	"	48
Cellocrete 1.00x2.00 m.	"	40
Clay tile 8"x8"		20 Baht m^2
Terrazzo tile 8"x8"		25-30

Prepared by the section of Estimating, Department of Housing, Ministry of Public Welfare

Labour Cost	Baht daily
1. Carpenter	45-100
2. Brick-layer, including concrete work and plastering	60-65
3. Tile-setting	50-60
4. Plumbing	45-50
5. Electrical wiring	35-40
6. Painting	45-60
7. Work inspector and advisor	70-90
8. Common labourer	15-20

PART VI : IMPLICATIONS OF HIGH-DENSITY, LOW-COST, LOW-RISE

1. HIGH-DENSITY
   - A. The Advantages of High-density
   - B. The Disadvantages of High-density
2. LOW-COST
3. LOW-RISE
   - A. The Advantages of Low-rise Apartments
   - B. The Disadvantages of Low-rise Apartments

1. HIGH-DENSITY

In talking about density, we refer to people per acre or to population density. Density is usually defined as the number of units per acre of net lot area, excluding streets and non-residential areas.

It is significant that high-densities are found in the urban more than the suburban areas and found in building for the very rich and the very poor. Sometimes in low-cost housing it is necessary to make low-rents by increasing high-density in order to reduce land cost per dwelling unit. Luxury buildings are frequently built at a high density in order to reduce land cost per unit due to the expensiveness of land encountered in locations having considerable prestige appeal. Sometimes on inexpensive ground, high densities are found as a result of the effort to produce dwelling units at a minimum expense. In a very few extremely high land-cost areas, high-rise densities are, to be sure, inevitable.

A. The Advantages of High-density

1. Higher density development will achieve a greater economy of land use and afford greater opportunity for families to live in the cities.
2. If the location is down-town, quick accessibility to places of work, shopping districts and amusement centres is possible.

B. The Disadvantages of High-density

1. Traffic crowding and confusion.
2. The higher the density of people, the higher the rent, because high density population causes high land-cost.
3. Often implies less light, air and distant view.

2. LOW-COST

In low-cost housing design, it is very important to make the cost of construction low as long as architectural quality does not suffer unduly. The design is made to make every inch work with maximum efficiency for every penny spent. The design is disciplined by standard materials and components and adherence to dimensions which minimize cutting and fitting.(1) Structural systems and building methods are used and developed for exploitation by average trade skills and for fabrication with minimum effort and material. The use of optimum low-cost construction materials and methods is most significant, so that units can be leased at the lowest possible rentals.

Reducing construction costs can be done by taking advantage of volume production of standard components, thereby reducing construction time. Low costs are achieved by cutting site labour and construction time to a minimum, together with maximum use of machine labour and existing facilities, with materials readily available.

Low-cost design implies design economy, since good design achieves compactness by elimination of superfluous space, by planning rooms so that they may be combined or used for several purposes, and by providing proper storage space; good engineering design aims at eliminating unnecessary dead weight, avoiding complicated structural layouts and by developing new formulas and design methods which help

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(1) ?

to achieve this aim. Proper designs for mechanical installations also have possibilities for economy.

Prefabrication is considered suitable for use in low-cost housing design. Prefabrication makes for low costs; its use of machine labour and mass production and large volume of demand aids economy and precision. It is also speedy to erect.

In low-cost housing, the efficient use of materials is one way to favour economy of construction. Here are some of the factors to be considered:

1. minimum of cutting and fitting, use of stock parts and use of standard sizes and standard lengths,
2. lighter materials, panels for exterior and interior walls, salvageable materials which can achieve economy through their re-use and more durable materials which offer economy through reduction in maintenance costs,
3. preference given to precast prestressed concrete material rather than reinforced concrete, in terms of mass production,
4. materials should be simple and readily available locally,
5. use of materials needing little maintenance,
6. use of light-coloured materials in order to reflect as much light as possible in courts and angles,
7. finished materials, including sash, doors and hardware, etc. can be loaded onto trucks.

In other ways it is possible to make low-rents by:

1. reducing as much as possible of the cost of maintenance and utilities,
2. reducing the number and size of rooms per person,
3. increasing density to reduce land cost per dwelling unit,
4. eliminating superfluous ornament,
5. reducing building costs by eliminating or cheapening various items as, for instance, elimination of closet doors, and substituting open shelving in kitchens,
6. reducing the number of electric outlets, etc.

The aforementioned can be usefully applied to the low-cost housing project in Thailand. But practically speaking the prefabrication system cannot be used in every part of the construction because of its high cost for a small project. However, it is reasonable to use it for some parts, for instance, interior walls, ceilings, roof panels, floor, doors, windows, stairs, trim, texture and interior furnishings which can be assembled into various types of houses and which should be standardized.

The prefabrication mentioned above can be performed rapidly, with a minimum of labour, partly with unskilled workers and under any conditions of weather and season.

3. LOW-RISE

In terms of housing, "low-rise" means a dwelling, building or apartment that has no more than four storeys. An elevator is usually not needed for this kind of apartment, so sometimes it is called a walk-up apartment. "A walk-up apartment is a group in which two or more units are entered from a common hall and outside door". (1) Three storeys is the maximum height considered good for low-rise apartments.

Low-rise housing is considered suitable for use in low-cost housing design, because of being more economical in construction. Corridors and elevators are eliminated and maintenance is more economical due to eliminating lobbies, corridors and elevators. Usually, low-rise buildings are found suitable in not too high-density areas such as suburbs.

A. The Advantages of Low-rise Dwellings

1. Through ventilation or cross-ventilation for all units.
2. A desirable type of building through closeness to the ground.
3. Smaller in scale and therefore tend to provide more human environment.
4. Desirable for families with children because children can be more easily supervised and have greater freedom of play.

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(1) Apartments and Dormitories, An Architectural Record Book, published by F.W.Dodge Corporation, 1958

5. More out-door facilities, such as playgrounds and garden spaces.
6. Lower rents, and lower land-costs.
7. Usually lower building and maintenance costs.
8. Many of the advantages of light, air and view.
9. Greater adaptability of plan to individual requirements.

B. The Disadvantages of Low-rise Apartments

1. Reduced densities and therefore less economical land-use.
2. Common open spaces are reduced in size, but probably are increased in utilization.
3. Price of more time spent in travelling to and from work and shopping places because low-rise apartments are more suitably built in the suburbs, unless, of course, these dwellings are built at a high density.

PART VII : GENERAL THESIS PROPOSALS

VII : GENERAL THESIS PROPOSALS

Climate is the great significant factor influencing the design of building. Basically, design for comfort is one of the most important factors for architects. In order to know how to achieve the most desirable comfort, Aronin suggests that "an architect should know about the particular climate he deals with in building design and must know the major scientific facts and understand the physiological ones." (1)

The characteristics of architectural design reflect clearly the local climatic condition. In solving the problems of climatic influence on architecture, at the present time technology has widely developed many mechanical aids which are of assistance, however one should not depend so much upon mechanical aids if one intends to economize.

As is mentioned earlier, the climate of Bangkok is tropical, hot and humid. As a result, greater stress on thorough ventilation is given in the dwellings. This openness in planning and flexibility are essential and desirable for comfort.

Two factors are emphasized by Fello Atkinson: "to achieve a satisfactory level of comfort....it is essential to catch as much breeze as possible and at the same time

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(1) J. E. Aronin: Climate and Architecture, Reinhold Publishing Corp. New York 1953

to exclude direct sunlight. This does present complicated planning problems but it also necessitates openness. " (1)

In relation to the above statement, Albert Mayer writes as follows: "A house in the tropics has three kinds of living areas; indoors, completely outdoor, and indoor-outdoor by verandah or loggia. This is true anywhere, but the two latter are much more basically important than in temperate or cool temperate climates. People live and sleep a great deal out of doors." (2)

The following statements point out that the contemporary approach to design can contribute immeasurably toward solving the problems of design for living in Bangkok.

In site planning, a careful adjustment of the building and circulation to existing ground conditions is essential. The type of ground should be investigated to make sure that it is suitable for building purposes. Thus topography and the orientation of buildings are the important factors in designing the buildings. One must study landscaping which contributes a great deal to the aspect of project design and must be carefully laid out to enhance the appearance of the buildings and grounds. Plantings should be designed to enhance the architecture and groups of trees should be carefully placed.

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(1) Fello Atkinson: Style and Tropical Architecture, Conference on Tropical Architecture, University College, London 1953

(2) Albert Mayer: Architectural Design for Hot Climates, B.R.A.B. Conference Report No. 5, 1952

Bangkok is the selected place for the proposed scheme, hence the climatic study of the tropical humid climate and its influence on architectural design in Bangkok, Thailand (See Part I).

In relation to this study of climate, four principal factors have to be considered:

1. Form of the buildings

In order to achieve air movement very effectively throughout, skeletal frame or light structure, light walls or partitions and sloping parasol roofs are the main features of construction.

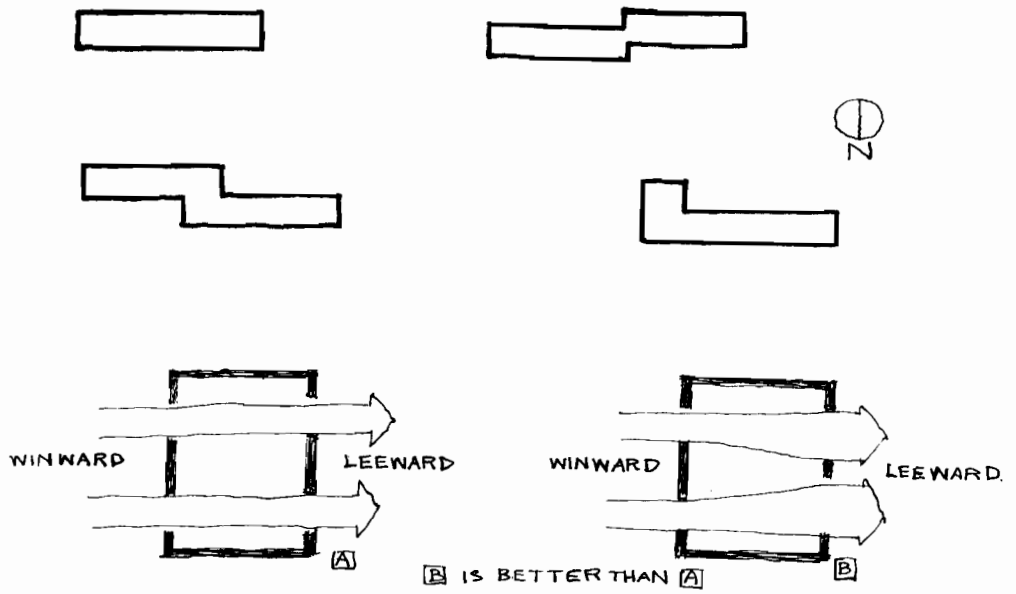
Dealing with orientation, it is essential to locate the building toward the prevailing wind and to avoid strong radiation effect on east and west sides, dictating the shape of the building to a slender elongation. Simple rectangular form, openness, flexible arrangement and spaciousness are the most desirable.

Stilted floors are also essential in order to gain as much breeze as possible and also to prevent high level flooding; good ventilation is gained by permitting the full force of the breezes to move under the house, decreasing heat and dampness and partly preventing the hazard of infestation. Wide overhanging roofs are essential to exclude radiation and tropical monsoon rain.

2. Ventilation

Openness of the buildings provides excellent cross-ventilation which is essential even during the rainy period.

FORM OF BUILDING



GROUP OF BUILDING

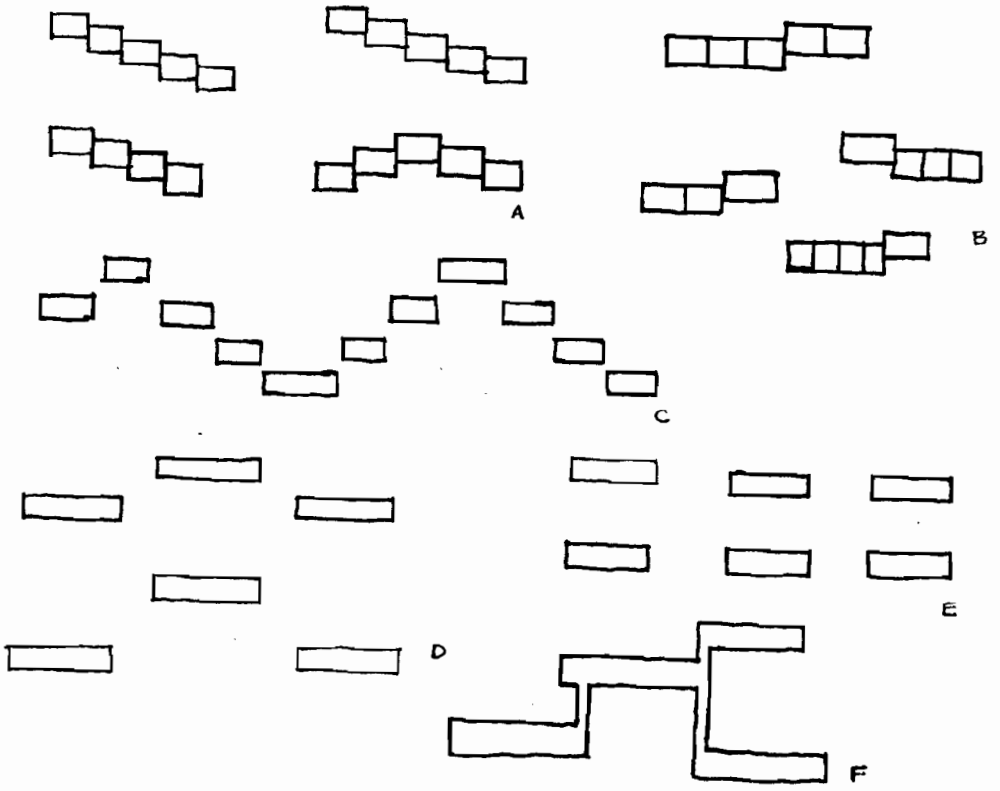


FIGURE 22

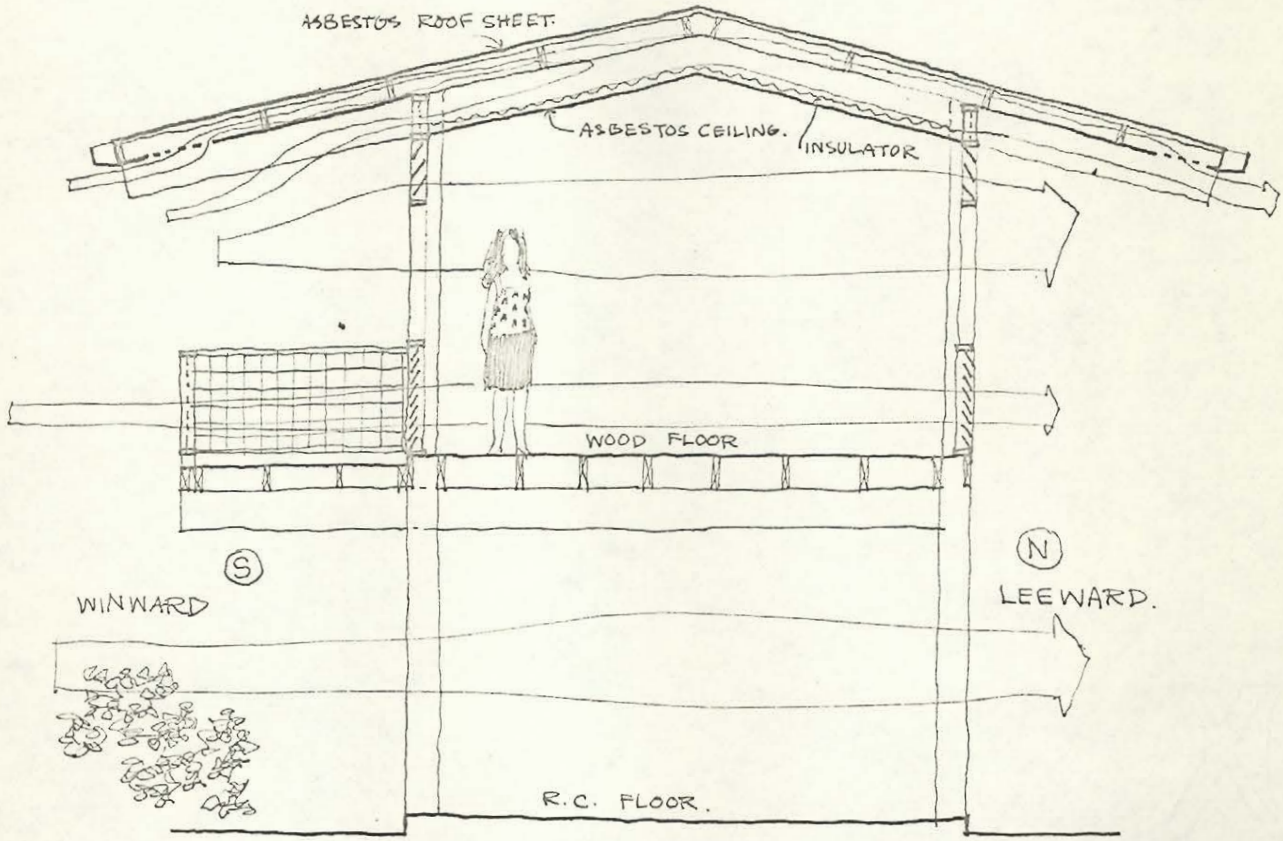


FIGURE 23

CROSS SECTION SHOWING CROSS VENTILATION.

Wall openings should not only be of maximum extent, but also be free of obstruction.

Through ventilation or corner ventilation has been set up in many housing standards as a very desirable or essential requirement; through ventilation is provided when windows are placed in opposite parallel walls of the units, and corner ventilation when within one room of the unit there are windows in walls at right angles.

Roof ventilation must be well considered in order to reduce the heat which will penetrate the lower part of the building. Figure ○ gives an idea for a solution in relation to this problem.

3. Shading

Next to air movement, shading plays an important part both in building and outdoor activity areas.

Building: In some instances where wide overhanging roofs cannot be used successfully, as with tall buildings over two storeys, or to screen off the radiation on the east or west facade, shading devices have to be applied, strategically located.

Landscaping Effect: The cooling effect of trees and shrubs is another factual aspect affecting the building in hot weather.

From this point of view, various types of shade trees and shrubbery should be used. Also, placing grass and other ground-covering near the building allows the heavier cooler air to flow inside. One must remember that even though

shade provided by treees is most desirable, this planting must be strategically located in order to draw appreciable breeze instead of obstructing it. The location of shade trees has to be studied well.

4. Drainage:

In Bangkok, because of its low land and heavy rainfall, dampness and efficient drainage are also critically important. It is practical to fill in land actually on the building location in order to attend to these factors.

Besides the climatic problems, there are many important factors involved with the design, namely economics, materials, cultural patterns and ways of living.

The relationship between people's lives and their housing is paramount. Houses are dwellings; people are dwellers. So in housing design, people's needs must be studied carefully. One must study their way of life, -- their standards of living, standards of health, cleanliness, privacy, cultural, social and family needs in the area and the general background, when dealing with housing problems. One should analyse the problems and find a solution on those conditions.

In order to enjoy a satisfactory minimum housing standard, one must know what the people or family needs. Better housing would improve the health and increase the comfort and privacy of each member of the family as well as provide adequate housing facilities.

The population of the city is an important point considered in relation to this study. One should know the required population density for a given area in order to

provide adequate housing for its population. Therefore, Part II of the report studies the people of Bangkok, Thailand.

In designing a new housing project, especially a low-cost housing project for people of low income, we should consider and study housing in some existing projects in Thailand; as well as the causes of housing shortage, the government's policy concerning housing projects, etc. The new housing project must lead the way to better standards. We must learn from the deficiencies of existing housing when designing the new project.

As the program is for low-cost housing, the cost of building construction must be as low as possible but not lacking in good architectural quality. So the effective use of materials and construction methods are considerable factors. The most readily available local materials, light in weight, durable and easy to handle should be used. The structure should be light and must not be complicated. Prefabrication is suitable for use in low-cost housing because of its contribution to cutting costs (See Part VI). The prefabrication and erection operation should be simple and speedy.

Prestressed, precast concrete is suitable for use for the main structure in terms of prefabrication, because prestressed concrete can cut weight nearly in half, compared to reinforced concrete and can span a much greater distance.

Fire-proof building materials and materials having a low maintenance cost should be used. Concrete is a suitable material for construction because it is strong, fireproof, sound-resistant and available readily in Thailand.

The housing standard is one of the most important points of the design, and relates to living comfort. So the standards for comfort and health, the effects of climate on building design that are concerned with comfort and health, and the design of habitable space are considered relevant factors, as well as the type of building and cost of construction. (Ref. Parts V and VI) Besides these, standards depend very greatly on land cost, location, zoning laws and jurisdiction of various authorities.

Low-rise dwellings are a type of building considered especially suitable for use in low-cost housing in Bangkok, since they are more economical in construction (See Part VI). The soil in Bangkok is soft, and not suitable for high-rise buildings.

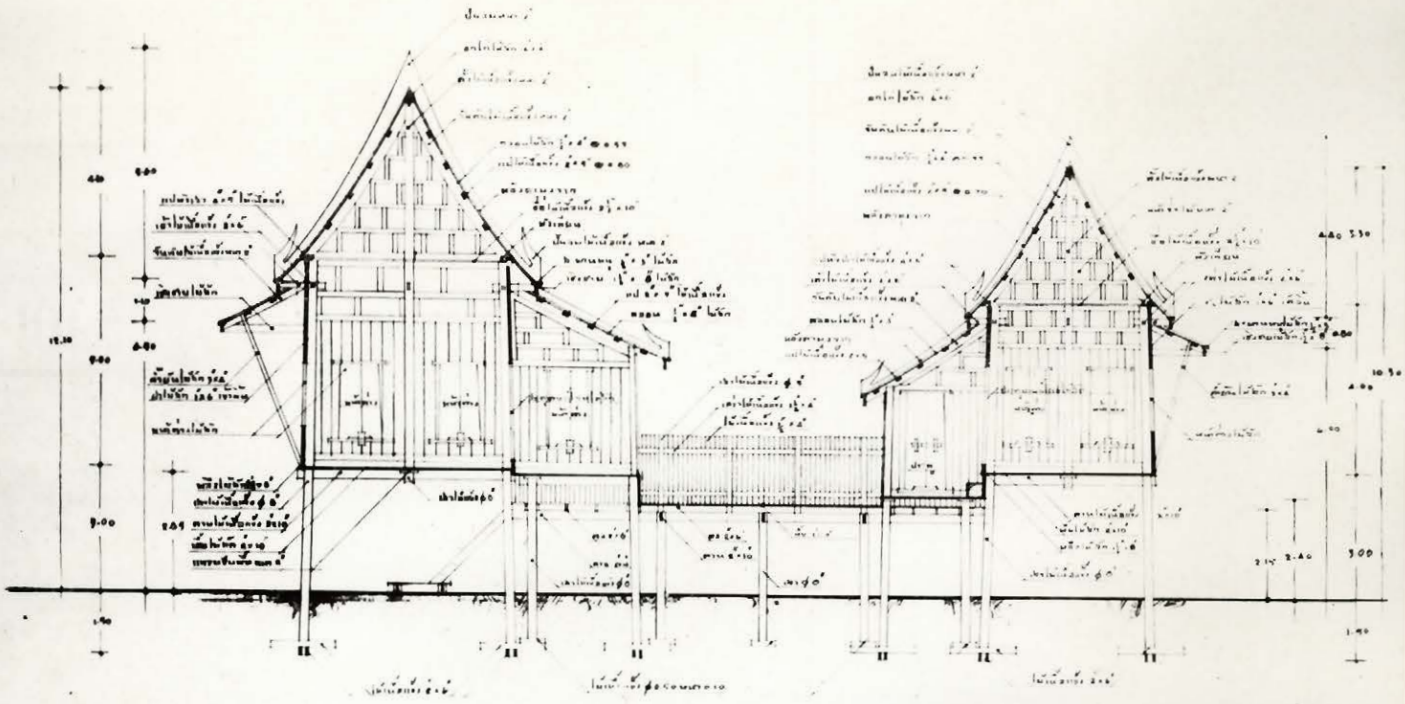
However, many people do not want to live too near the ground in Bangkok. Upper floors are desirable because they give unobstructed views over long distances and many people appreciate these views, and consider that first floor windows are exposed to the view of passers-by, generally lack privacy and give easy access to prowlers.

Dwellings should therefore be raised up from ground level. Further advantages are:

1. through ventilation for each unit,
2. avoidance of rising damp, flooding and vermin infestation,
3. preservation of a characteristic tradition in Thai houses, which are raised on stilts,
4. use of covered ground floor for many purposes and activities, e.g. playing for children, indoor games, sitting, space for storage, etc. When it is rainy or very sunny, sometimes indoor open spaces are needed.

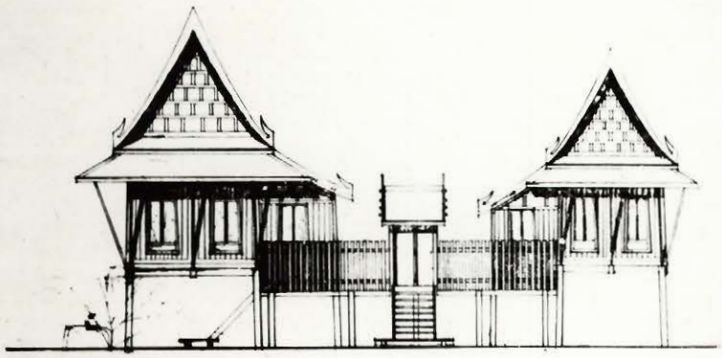
Figure 24

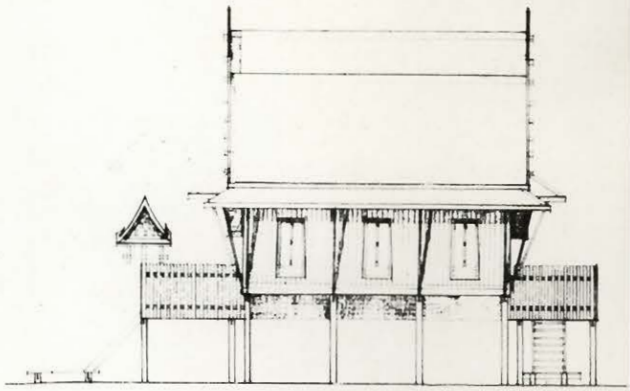
TYPICAL ANCIENT THAI HOUSE

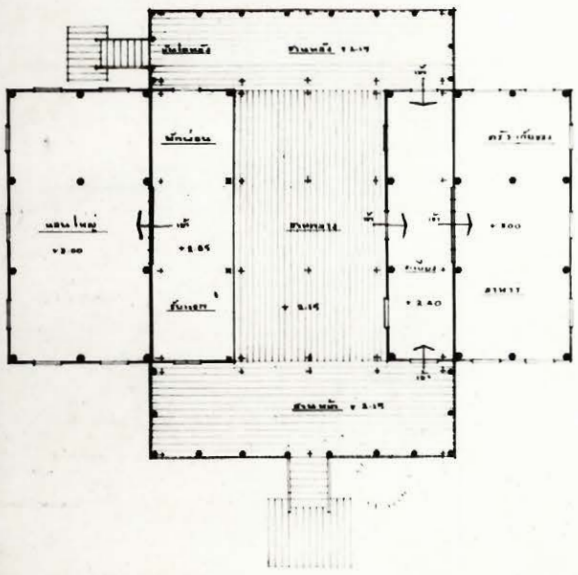


บ้านไทยโบราณ ภาคกลาง

(อีกแบบหนึ่ง)







PART VIII : A PROPOSAL FOR A LOW-RISE, MEDIUM-DENSITY HOUSING PROJECT, SAPAN KWAI, BANGKOK

1. PROPOSAL

2. REPORT -- SITE

   A. Size

   B. Location

   C. Situation of Site at Present

   D. Number of Families

   E. Type of Buildings

1. PROPOSAL

To-day, the density in Bangkok is very high, With a population of 25.5 million and an area of 514,000 square kilometres, Thailand has a population density of 68 persons per square kilometre. In the municipal area of Bangkok, with a population of 2,159,000 and an area of 117 square kilometres, the density is 12,466 persons per square kilometre. The rate of increase in the population of the country is 2.8% per year, and it will increase more in the future. At the present time, both the land value and the cost of living are very high.

Even though construction materials and land are available, it is at a very much higher price than formerly. Houses for rent are very difficult to find; building houses for rent is no longer considered a profitable way of investment.

Most of the houses for rent built many years ago are now in a very poor condition, and are likely to be town down sooner or later. New houses for rent cannot be expected to be built by private persons or private organizations.

Large numbers of the low-income groups, such as labourers, not only cannot afford to buy land of their own, but also cannot pay high rent either. Their houses are almost always in poor condition and over-crowded. In addition, the city is also faced with the problem of immigration from rural areas. These people always search for the cheapest place

to live, mainly in slum areas. They do not mind living crowded into small and unhygienic places.

It is fully realized that the unhealthy living conditions of the people will not contribute to the economic and social development of the country. If this situation is not properly managed, it might be susceptible to communist infiltration, especially among the low-income group.

The reasons mentioned above encouraged the author to study the program of a low-cost, low-rise housing project for low-income people at the highest density, in Bangkok, which will be suitable for application in the serious housing crisis at present. This project can be carried out by the government, and the houses in this project can be built on the government's land in a suburb of Bangkok.

The aims of this thesis would be as follows:

1. to clear slum areas,
2. to prepare to serve increasing population in the future,
3. to provide shelter for people who are unable to provide it for themselves at a standard considered conducive to a decent way of life,
4. to improve their living conditions and set a new suitable standard of living,
5. to encourage people to become familiar with social life in a better community resulting from the housing activity,
6. to design for building at a reasonably low cost, but in a way which will last a long time without deterioration.

2. REPORT -- SITE

A. Size

The size of the land is about 7,200 square metres, equivalent to approximately 17 acres.

B. Location

The location is on the Phaholyothin Road, a main road, and Patipat Road in the Sapan Kuai area, a suburb of Bangkok.

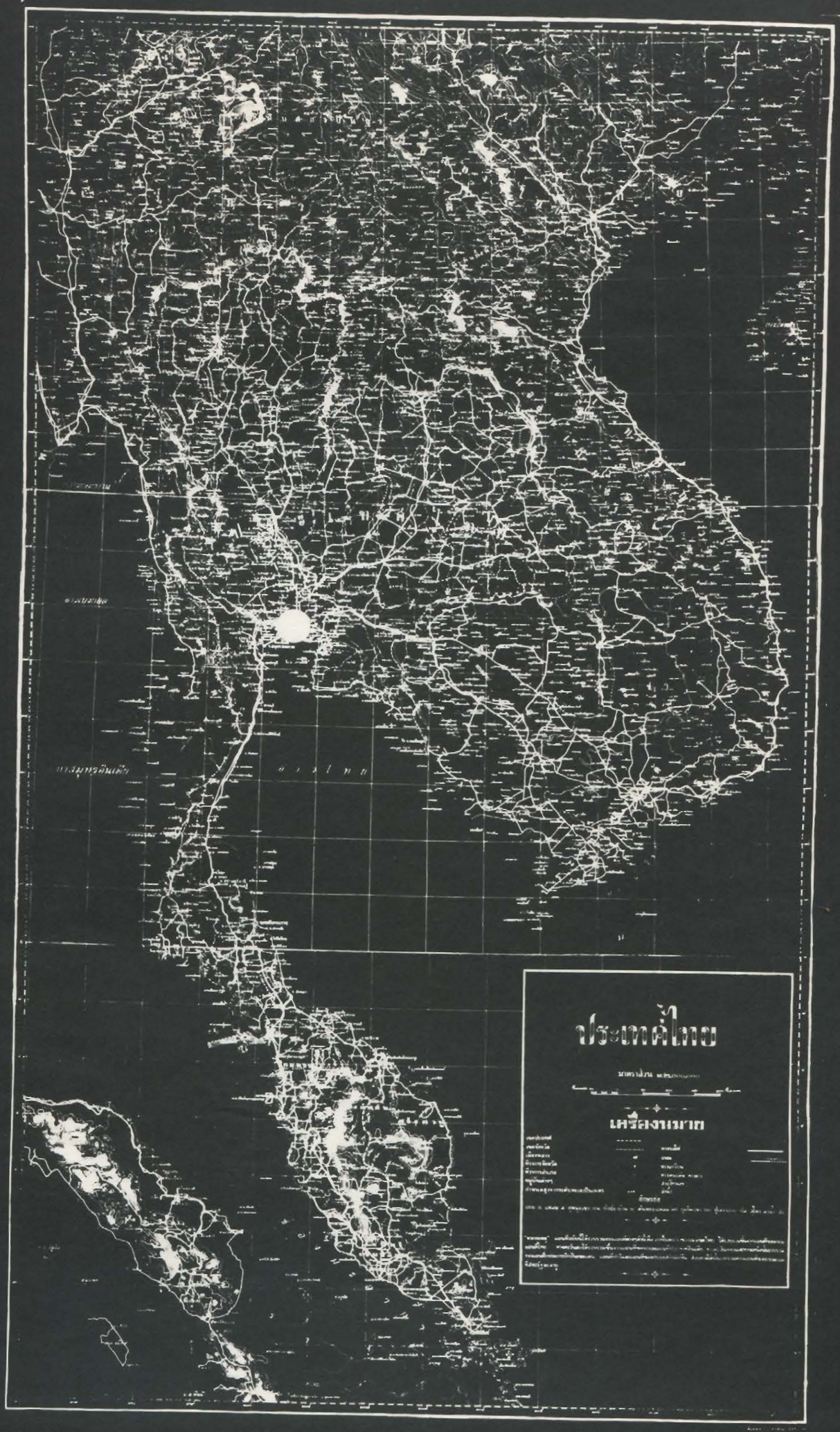
C. Situation of Site at Present

The structures in this area consist of houses, shops and plantation. It is government land, and at the sides of both roads there are shops and houses and behind them there are houses of people of low-income, some built by the government many years ago, and others built by private persons. Almost all the buildings in this area are made of wood and are of one or two storeys. Living conditions are crowded; the land is not developed and is in very poor condition. The area is close to becoming a slum. Since the houses were built many years ago, they are now falling into disrepair and decay. Therefore, they are to be torn down sooner or later.

This area has very suitable surroundings for a housing project, because it is surrounded by markets, shops, theatres, schools, a bank, police station, hospitals, office buildings, factories, a railway station and bus terminal and the Phaholyothin Road leading to Bankok International Airport.

MAP OF THAILAND

SHOWING POSITION OF BANGKOK


ประเทศไทย
เครื่องหมาย

MAP OF BANGKOK


แผนที่เขตเทศบาลนครกรุงเทพ และ ธนบุรี
มาตราส่วน 1 : 20,000
MAP OF BANGKOK

MAP OF BANGKOK

SHOWING POSITION OF THE SITE

MAP SHOWING THE SITE

AND RELATIONSHIP TO THE SURROUNDINGS


SCHOOL
RESIDENTIAL AREA
TELECOMUNICATION BLDG.
NORTHERN BUS TERMINAL
FRUIT GARDENS AND SCATTERED VILLAGES
SCHOOL
CEMENT CO.
SCHOOL
SCHOOL
RAILWAY STATION
POLICE STATION
RESIDENTIAL AREA
COMMERCIAL AREA
FACTORY
PHAHOL YOTHIN RD. TO BANGKOK AIRPORT
SCHOOL
FIELD
TEMPLE
SCHOOL
TROOP AREA
MARKET
TEMPLE
TROOP AREA
RESIDENTIAL AREA
POST OFFICE
PATIPAT RD.
RESIDENTIAL AREA
SHOPS AND MARKET AREA
SCHOOL
RESIDENTIAL AREA
SCHOOL
THEATER-BANK
SITE
RESIDENTIAL AREA
RESIDENTIAL AREA
RESIDENTIAL AREA
SHOPS AND MARKET AREA
KINDERGARTEN
SAVING BANK
TROOP AREA
SCHOOL
GOVT. HOUSING AREA
SCHOOL
POLICE STATION
RADIO BROAD CASTING STATION OF THAILAND
HOSPITAL
TROOP AREA
RESIDENTIAL AREA
NORTHERN RAILWAY LINE
SMALL FACTORY
RESIDENTIAL AREA
RESIDENTIAL AREA
RAILWAY STATION
TEMPLE
TROOP AREA
WATER WORKS
SUPER HIGH-WAY TO BANGKOK INTERNATIONAL AIR PORT
RICE FIELDS
RESIDENTIAL AREA
TROOP AREA
SCHOOL
TROOP AREA
TELEVISION STATION
HOSPITAL
HOSPITAL
SCHOOL
TEMPLE
GOVT. HOUSING PROJECT AREA
KINDERGARTEN
PLANTATION
SCIENCE DEPT.
MINISTRY OF INDUSTRY
HOSPITAL
VICTORY MONUMENT
PARK
MINES DEPT.
HOSPITAL
HOSPITAL
GOVT. HOUSING AREA
RESIDENTIAL AREA
SCHOOL
TEMPLE
SCHOOL
HOSPITAL
POLICE STATION
PLANTATION
SCHOOL
SCHOOL
SCALE 1:10,000

There are four bus routes passing by the area to the centre of the city, and the distance from the site to the down-town area is not too far so that people can go to work conveniently by bus.

C. Number of Families

In this area there are about a hundred families. This thesis is aimed at the construction of low-rise housing to accommodate 200 to 250 families, including open space, playground and parking space.

D. Type of Buildings

The residences in this area are one- and two-storey wooden houses. Most of them are single houses built by private persons, and others are low-rent houses built by the government. Every building has too little space for its tenants. They live in crowded and unhygienic conditions. The decayed buildings are beyond repair. Most houses were built with very cheap and poor construction techniques, so they have not lasted long enough.

The author also realized that the basic human needs, such as for sunlight, air, as well as for privacy and sociability are the first consideration.

The dwellings in this project will be designed to provide adequate ventilation, sunlight, and living space in the building to satisfy the maximum standard of health requirements.

The types of buildings will be row-houses and low-rise apartments, which are more suitable for low-cost design and for people of low income than other types.

"It is considered that single homes are suitable only for the highest income bracket of the working class, while the apartment house is the only reasonable housing type for the bulk of the lower-income groups." (1)

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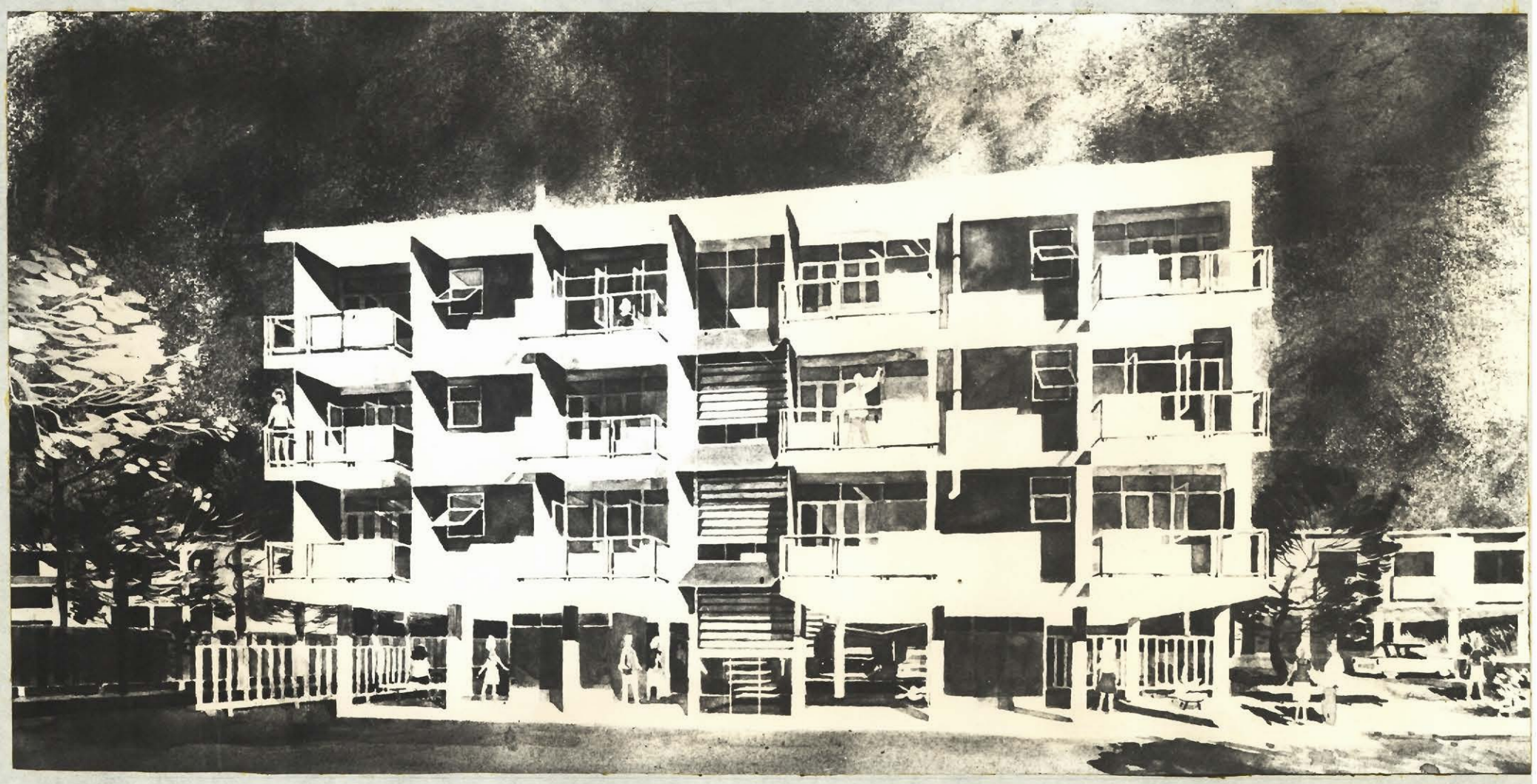
(1) Walter Gropius: Scope of Total Architecture, Collier Books, edition 1962, New York

PART IX : DESIGN AND DRAWING

LIST OF DESIGNS AND DRAWINGS

LIST OF DESIGNS AND DRAWINGS

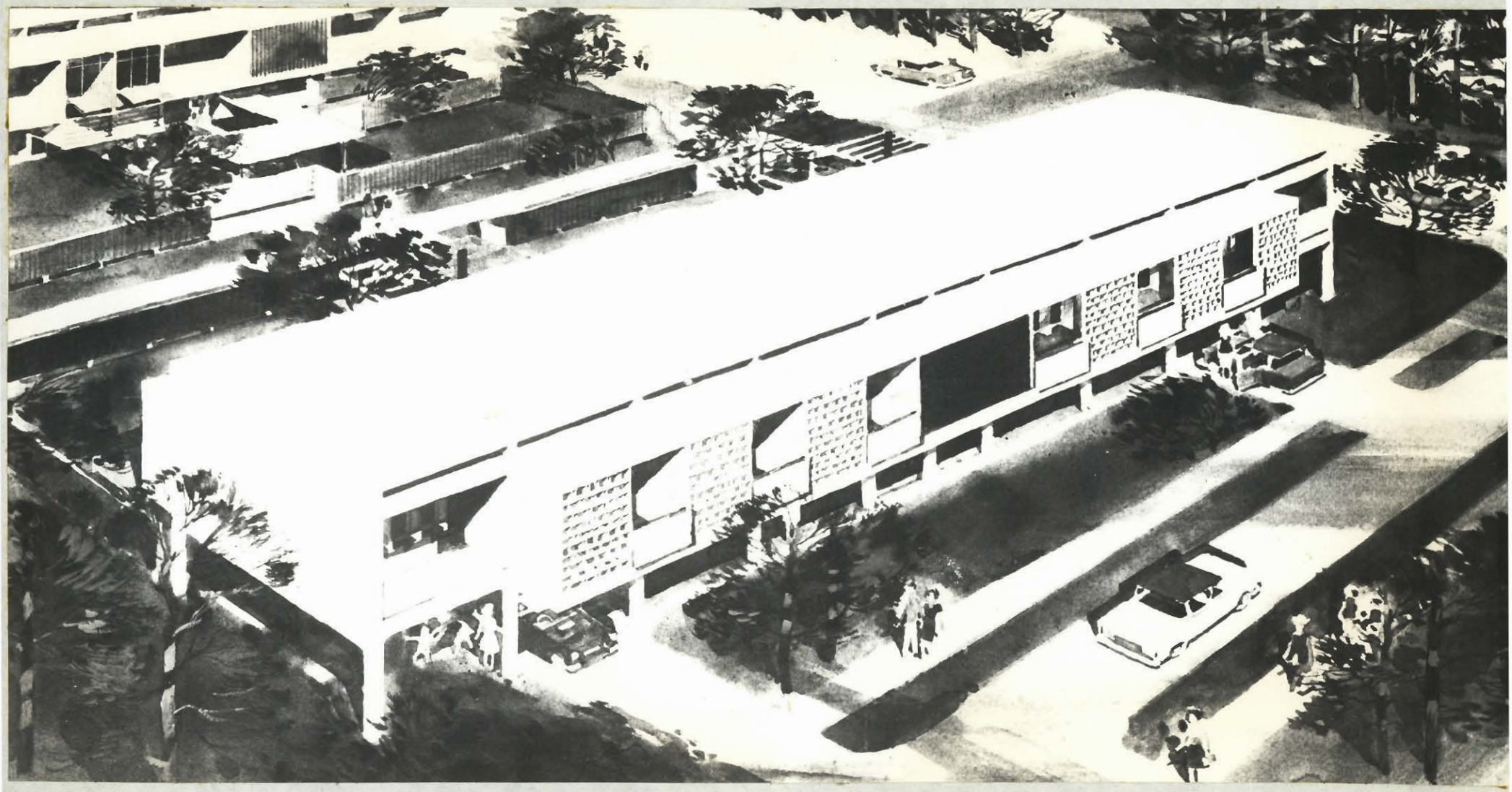
Drawing		Scale	Number of Plates
Map of Thailand Map of Bangkok Map of the Site & relationship to surroundings		1: 10,000	1
Type of Buildings			
threebedroom type A	plan, elevation, section	1:100	2
three bedroom type B	plan, elevation, section	1:100	2
two bedroom type A	plan, elevation, section	1:100	2
twobedroom type B	plan, elevation, section	1:100	2
single bedroom type A	plan, elevation, section	1:100	2
single bedroom type B	plan, elevation, section	1:100	2
high-rise communal building and garden	plan, elevation, section	1:200 & 1:100	5
three bedroom type	typical section	1:50	1
three bedroom type	interior perspective		1
different types of buildings	exterior perspective view		4
Model		1:500	



PERSPECTIVE VEIW OF SINGLE BEDROOM TYPE A

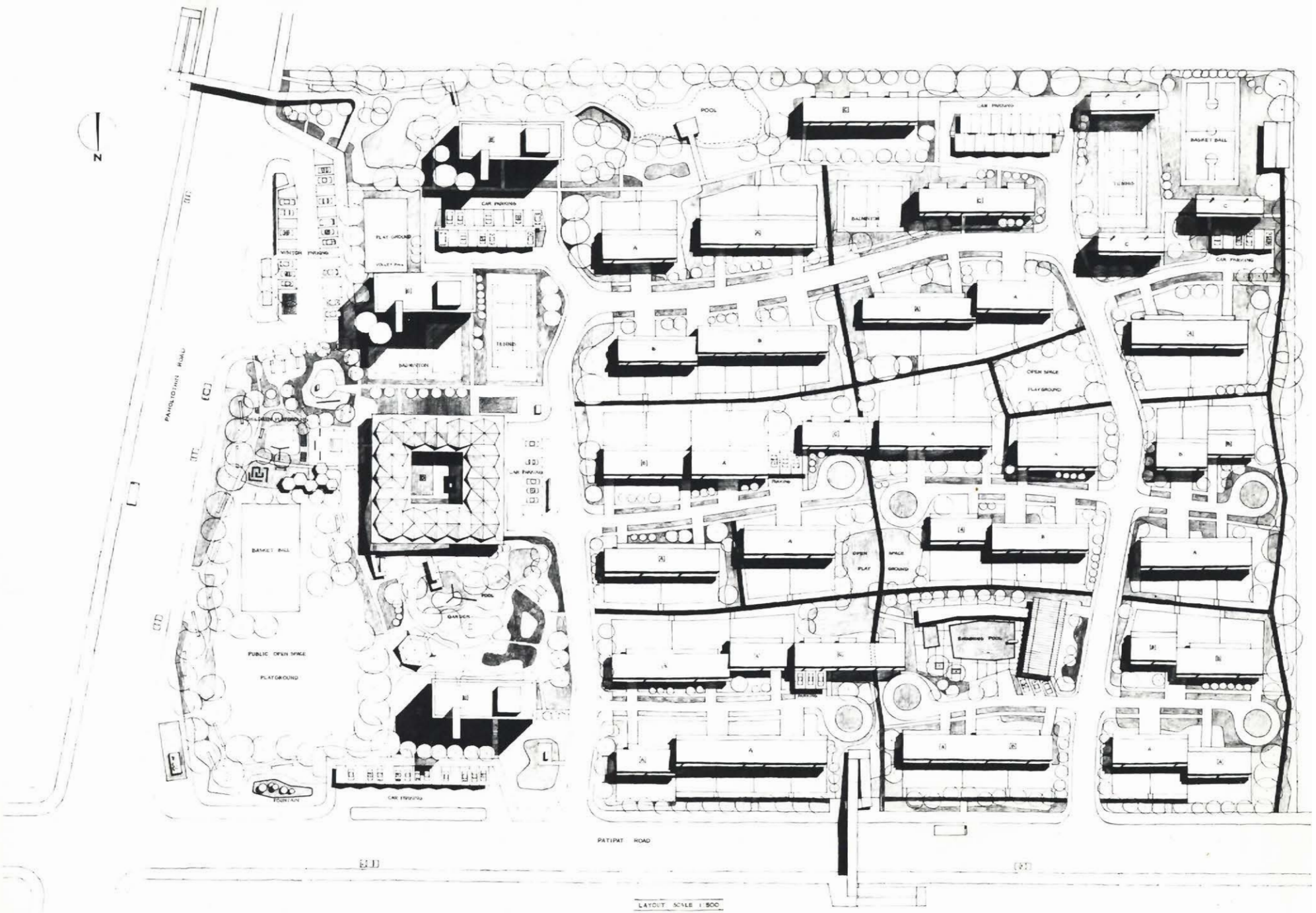
PERSPECTIVE VEIW OF DIFFERENT TYPE BUILDINGS

PERSPECTIVE VEIW OF COMMUNAL BUILDING.

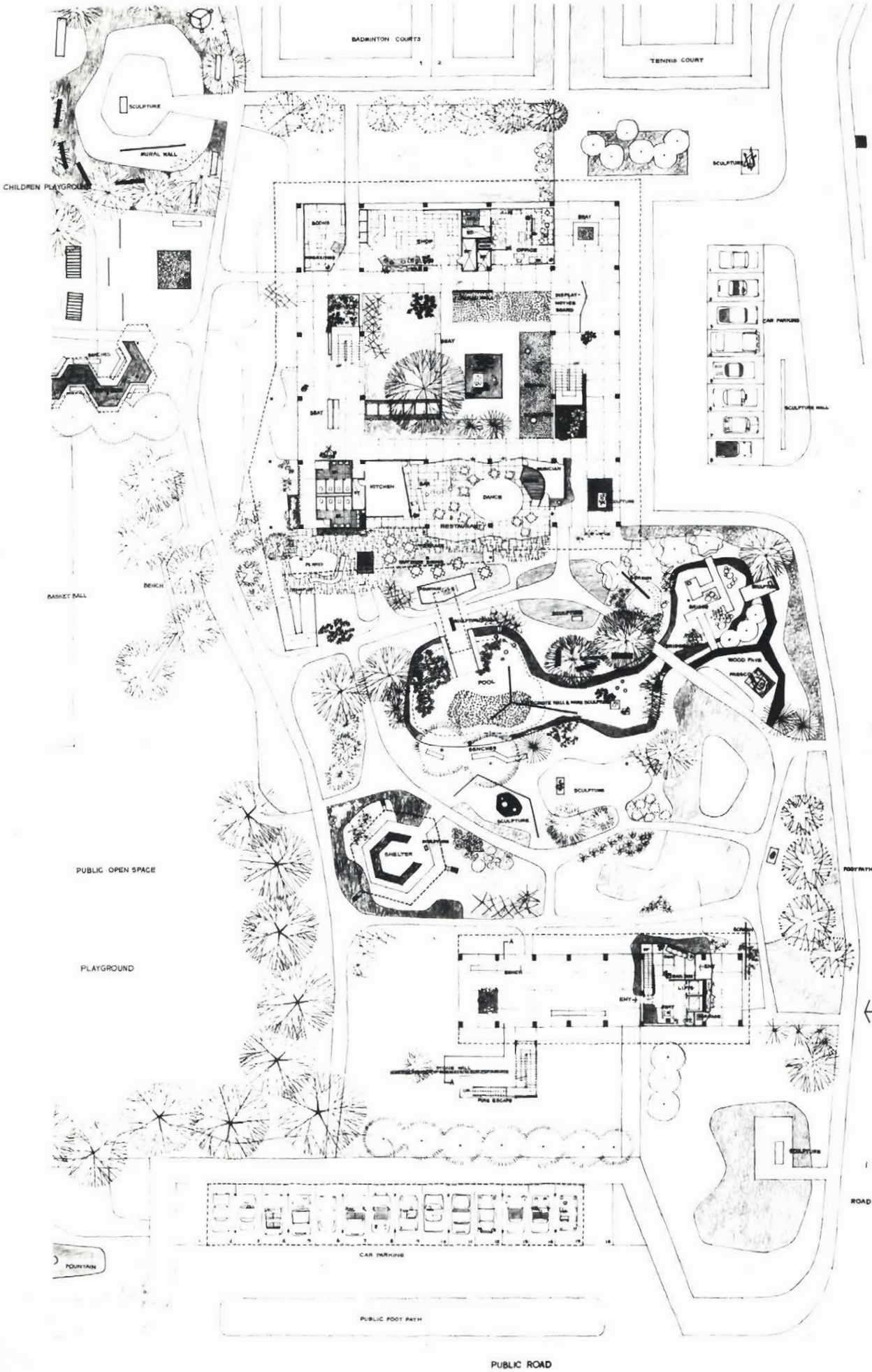


PERSPECTIVE VEIW OF THREE BEDROOM TYPE B.

A - Three-bedroom type A		52 units
A - Three-bedroom type B		
B - Two-bedroom type A		37 units
B - Two-bedroom type B		
C - Single-bedroom type A		50 units
C - Single-bedroom type B		
D - Communal Building		
E.- High-rise		
Parking Spaces (tenants)	130 cars	
Parking Spaces (visitors)	27 cars	
Total Area -	72,000 m^2 (17 acres)	
Total People -	680 persons	
Density -	40 persons per acre.	



LAYOUT SCALE 1:500



GROUND FLOOR PLAN. SCALE 1:200

COMMUNAL BUILDING

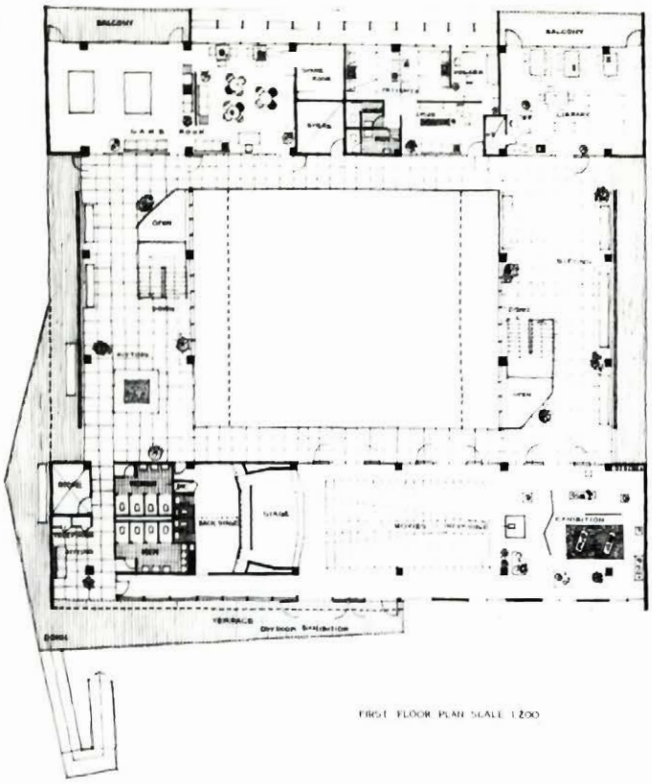
GROUND FLOOR PLAN : SCALE 1:200

GARDEN.

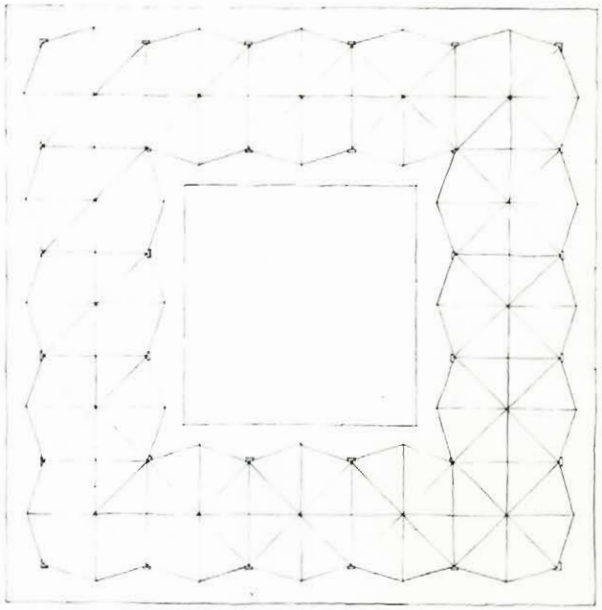
GROUND FLOOR PLAN : SCALE 1:200

HIGH -RISE BUILDING.

SINGLE BEDROOM - TWO AND THREE BEDROOMS.

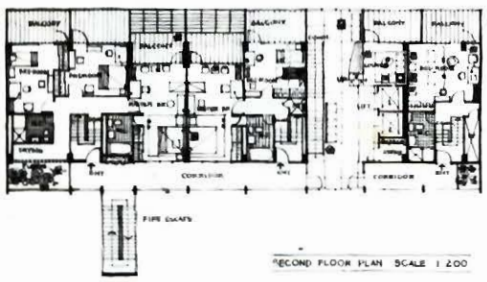


FIRST FLOOR PLAN SCALE 1:200

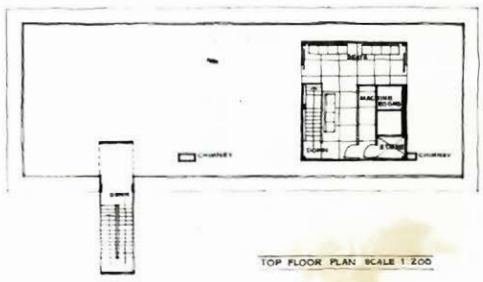


ROOF PLAN SCALE 1:200

COMMUNAL BUILDING



SECOND FLOOR PLAN SCALE 1:200

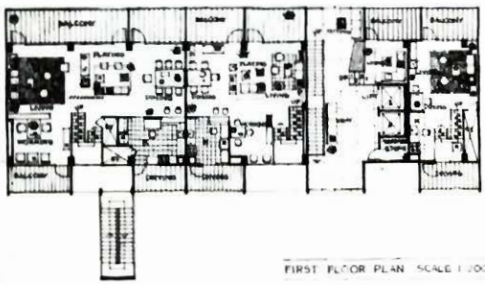


TOP FLOOR PLAN SCALE 1:200

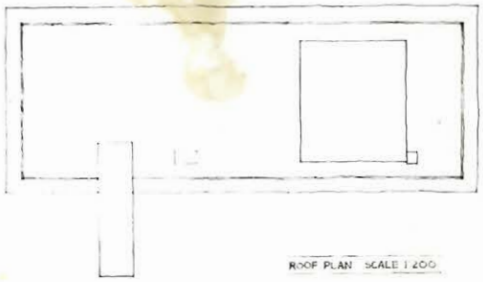
THREE BEDROOM TYPE

TWO BEDROOM TYPE

SINGLE BEDROOM TYPE

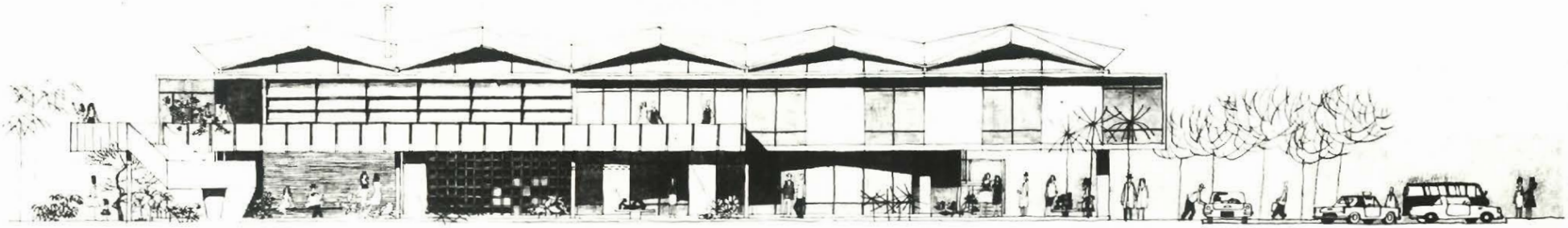


FIRST FLOOR PLAN SCALE 1:200



ROOF PLAN SCALE 1:200

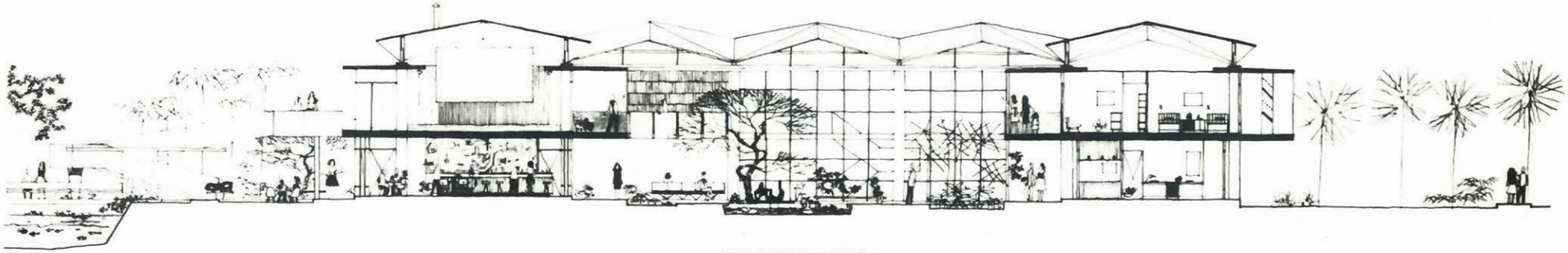
HIGH-RISE BUILDING



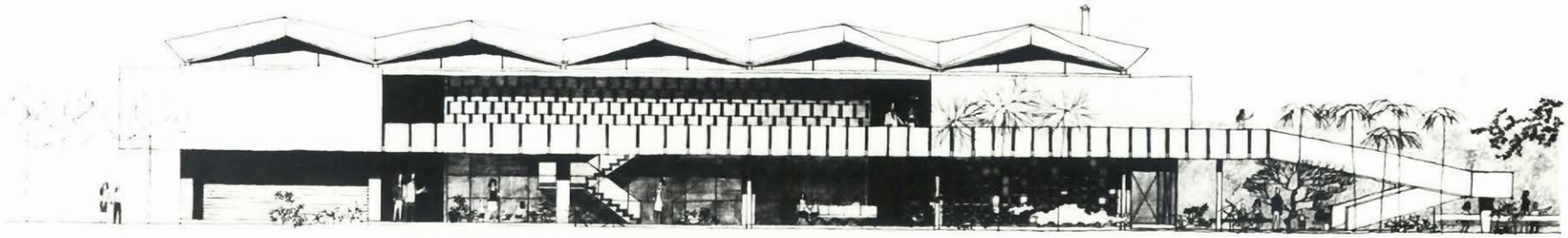
NORTH ELEVATION. SCALE 1:100

WEST ELEVATION. SCALE 1:100

COMMUNAL BUILDING.



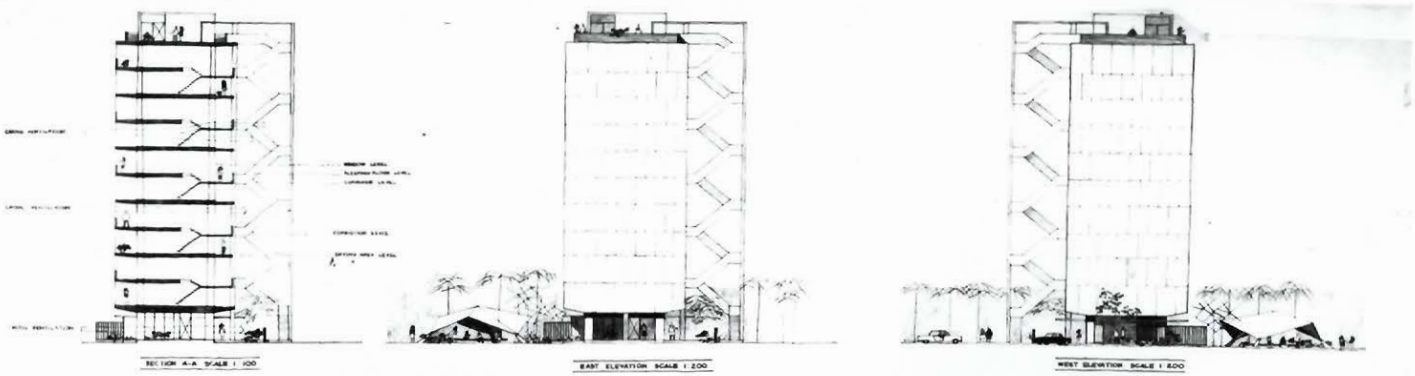
SECTION A-A SCALE 1:100



EAST ELEVATION SCALE 1:100

SOUTH ELEVATION SCALE 1:100

COMMUNAL BUILDING



SECTION A-A SCALE 1:100

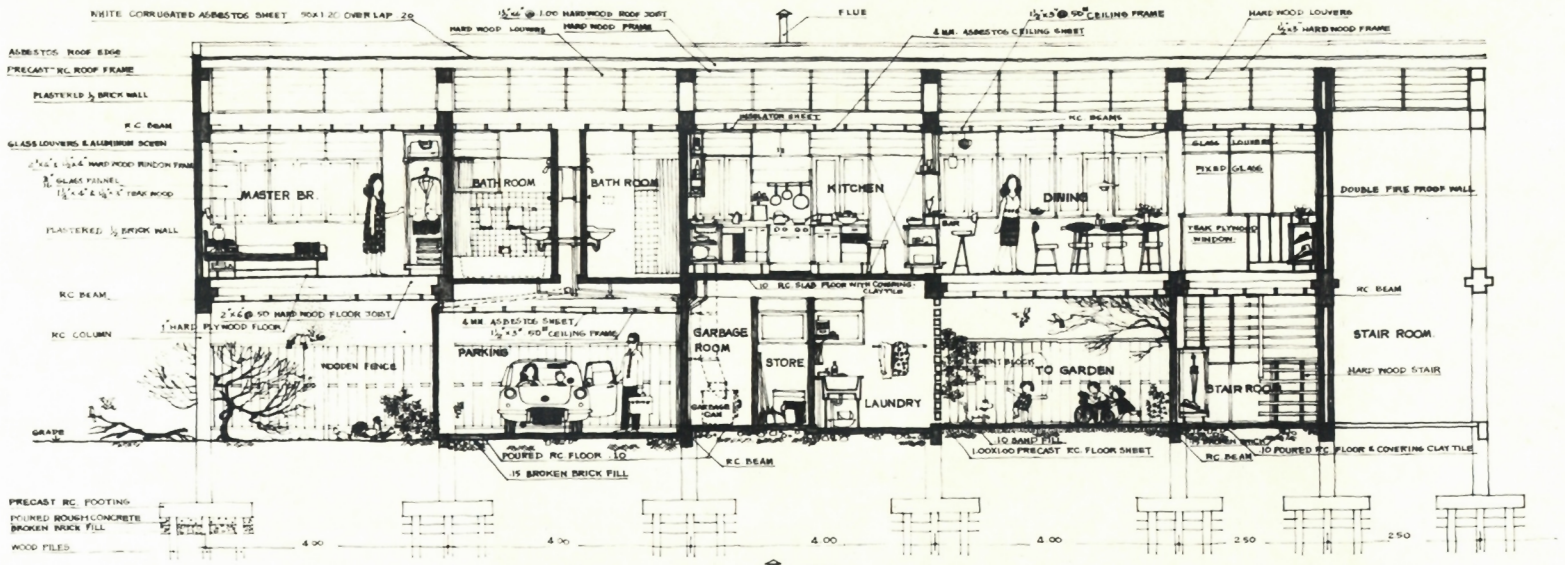
EAST ELEVATION SCALE 1:200

WEST ELEVATION SCALE 1:200

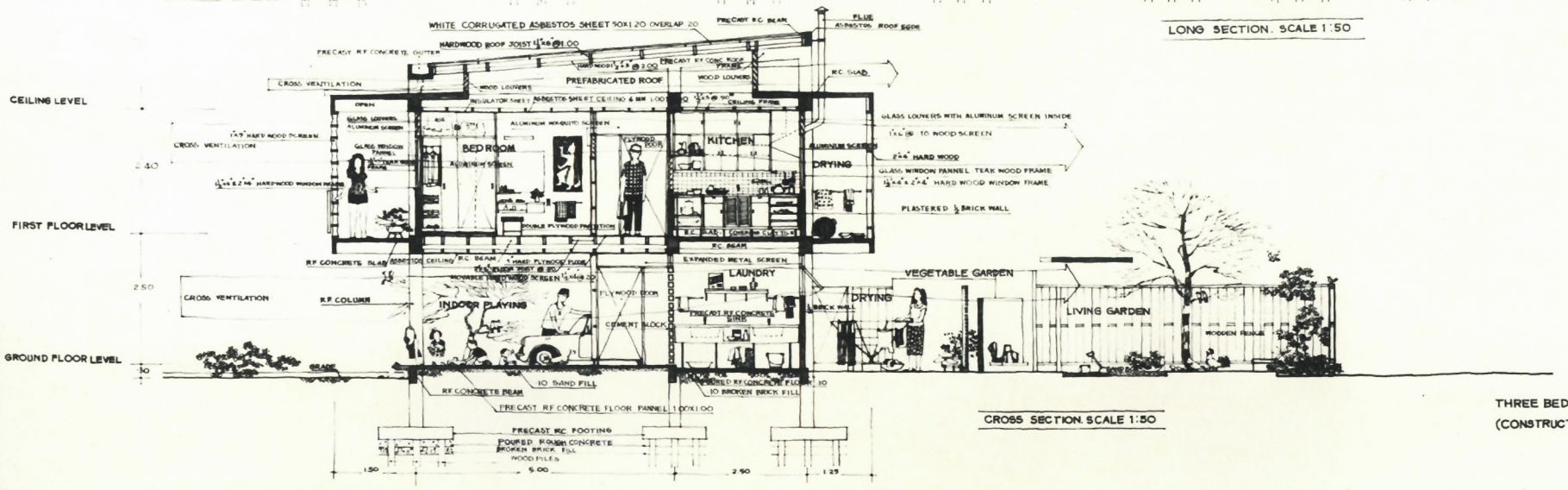
SOUTH ELEVATION SCALE 1:200

NORTH ELEVATION SCALE 1:200

HIGH-RISE BUILDING SINGLE BEDROOM - TWO AND THREE BEDROOMS



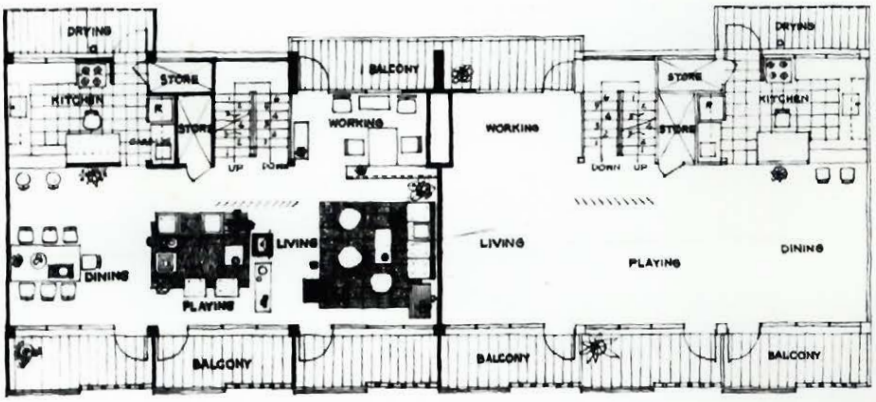
LONG SECTION. SCALE 1:50



CROSS SECTION. SCALE 1:50

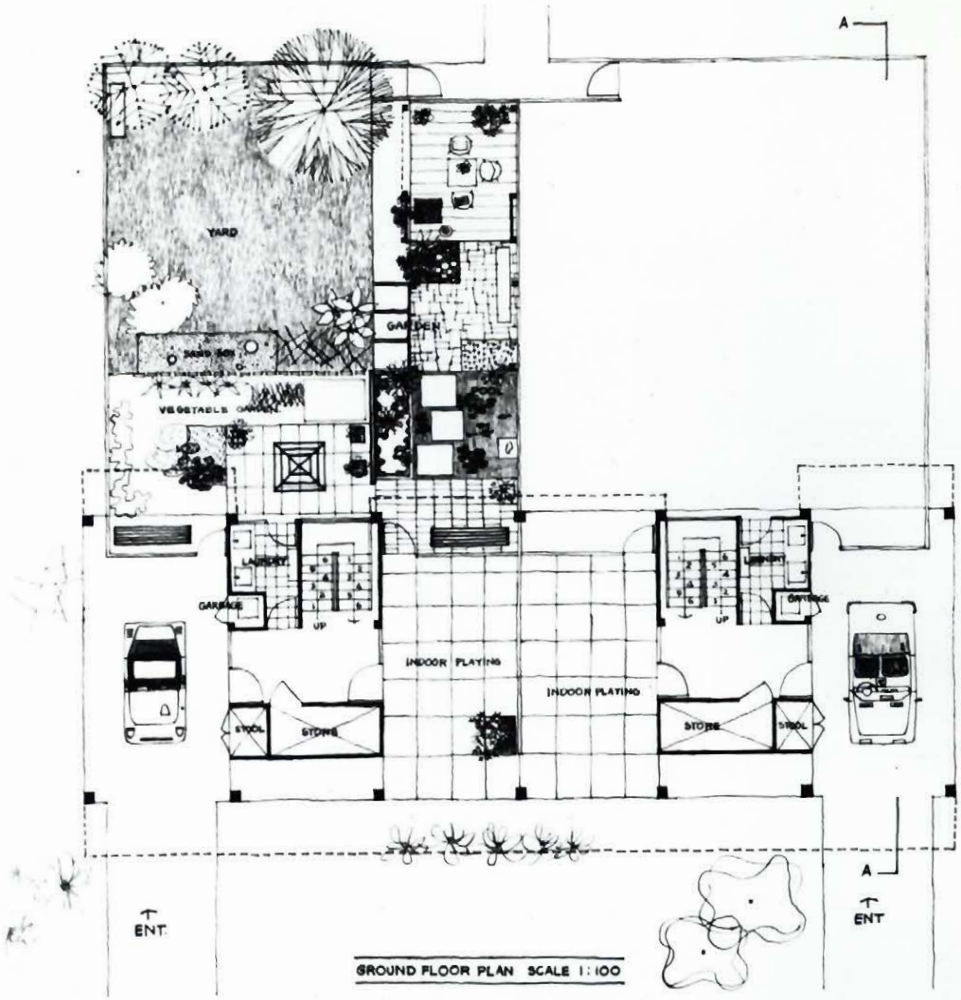
THREE BEDROOM TYPE B.
(CONSTRUCTION DETAIL.)

SECOND FLOOR PLAN, SCALE 1:100

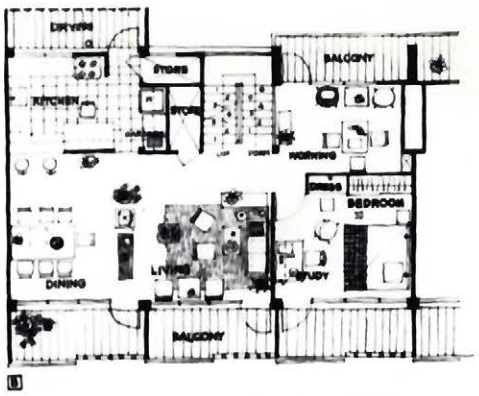


A

FIRST FLOOR PLAN. SCALE 1:100

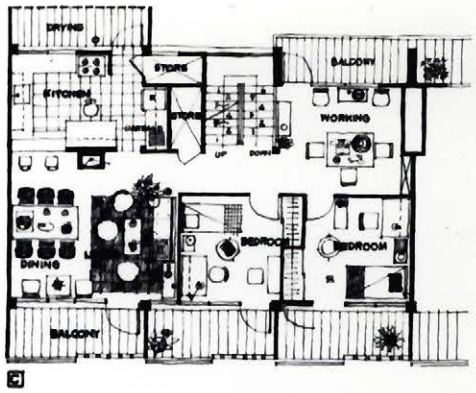


GROUND FLOOR PLAN SCALE 1:100



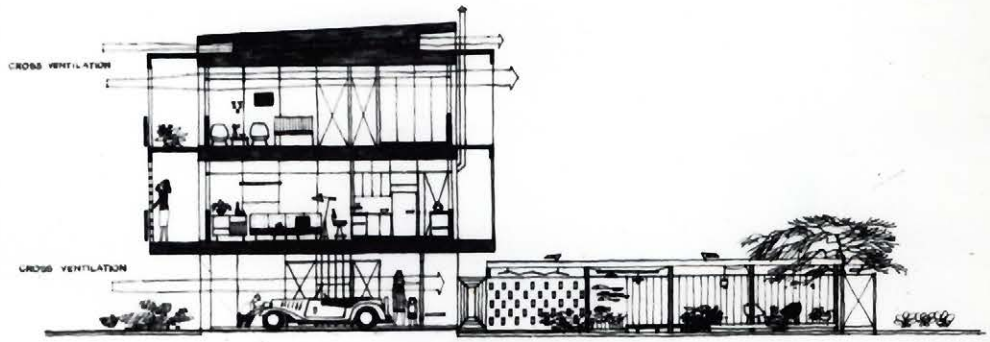
B

FIRST FLOOR PLAN SCALE 1:100



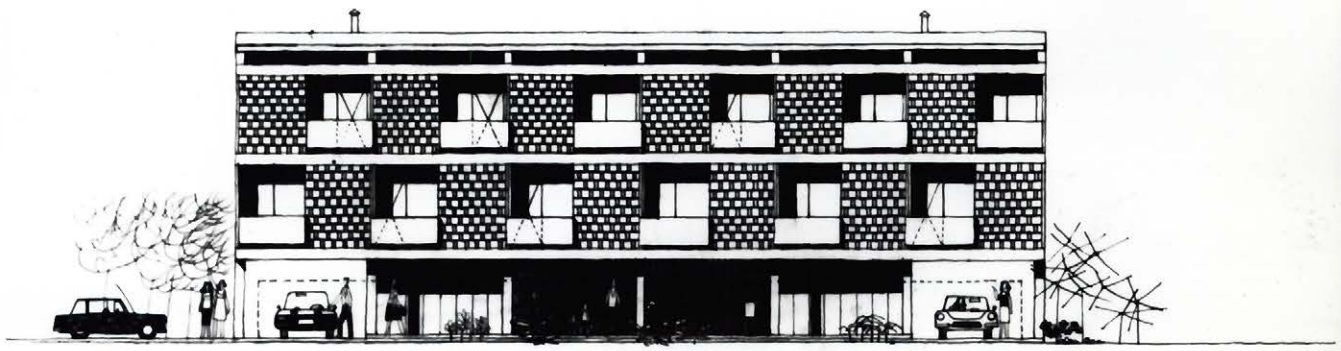
C

FIRST FLOOR PLAN SCALE 1:100

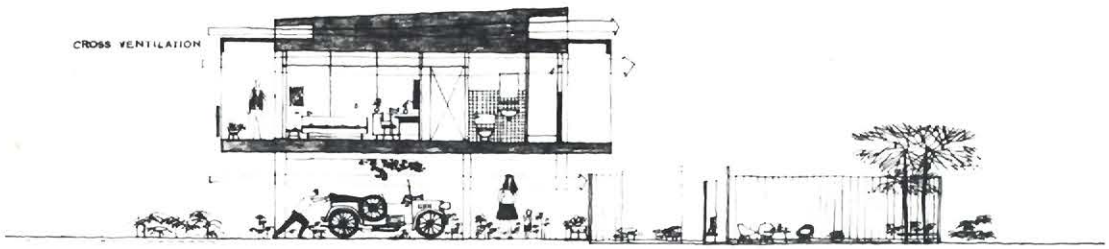


SECTION AA SCALE 1:100

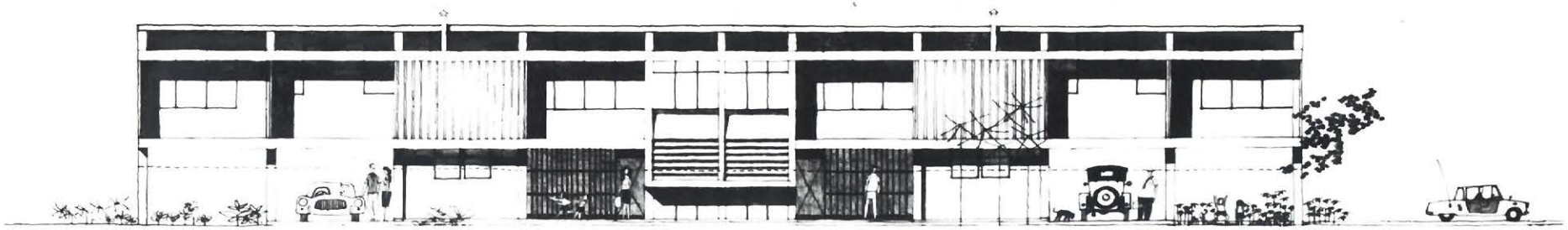
NORTH ELEVATION SCALE 1:100



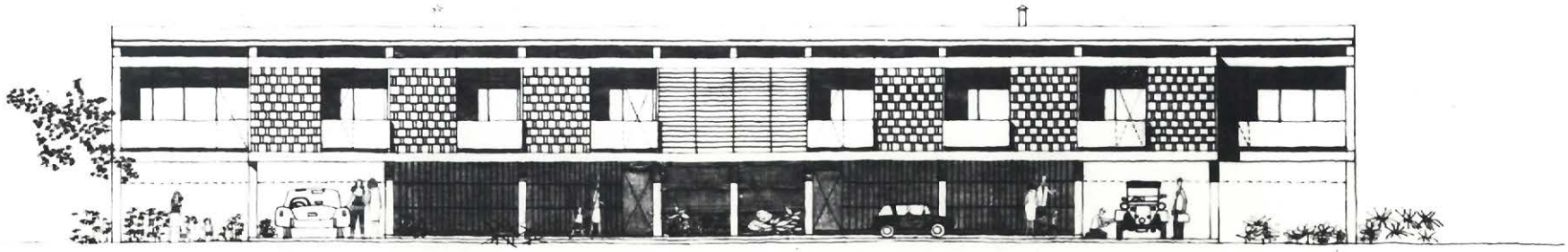
SOUTH ELEVATION. SCALE 1:100



SECTION A-A SCALE 1:100

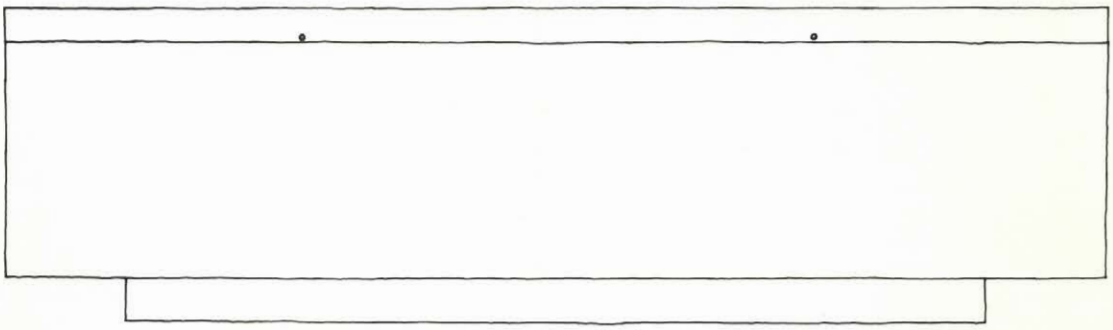


NORTH ELEVATION SCALE 1:100

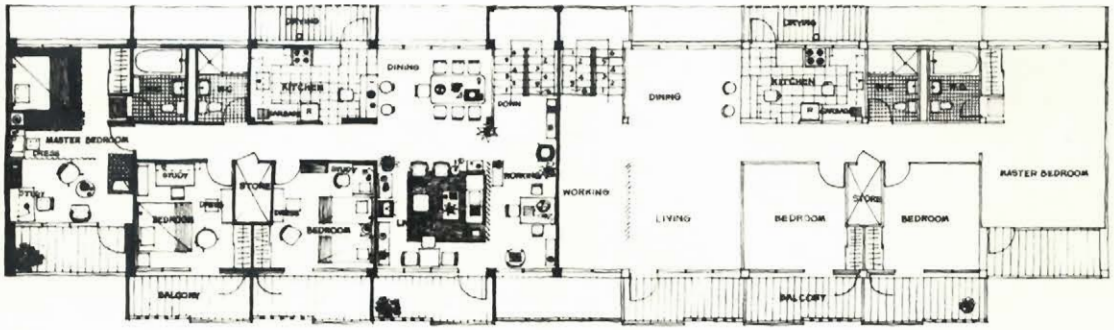


SOUTH ELEVATION SCALE 1:100

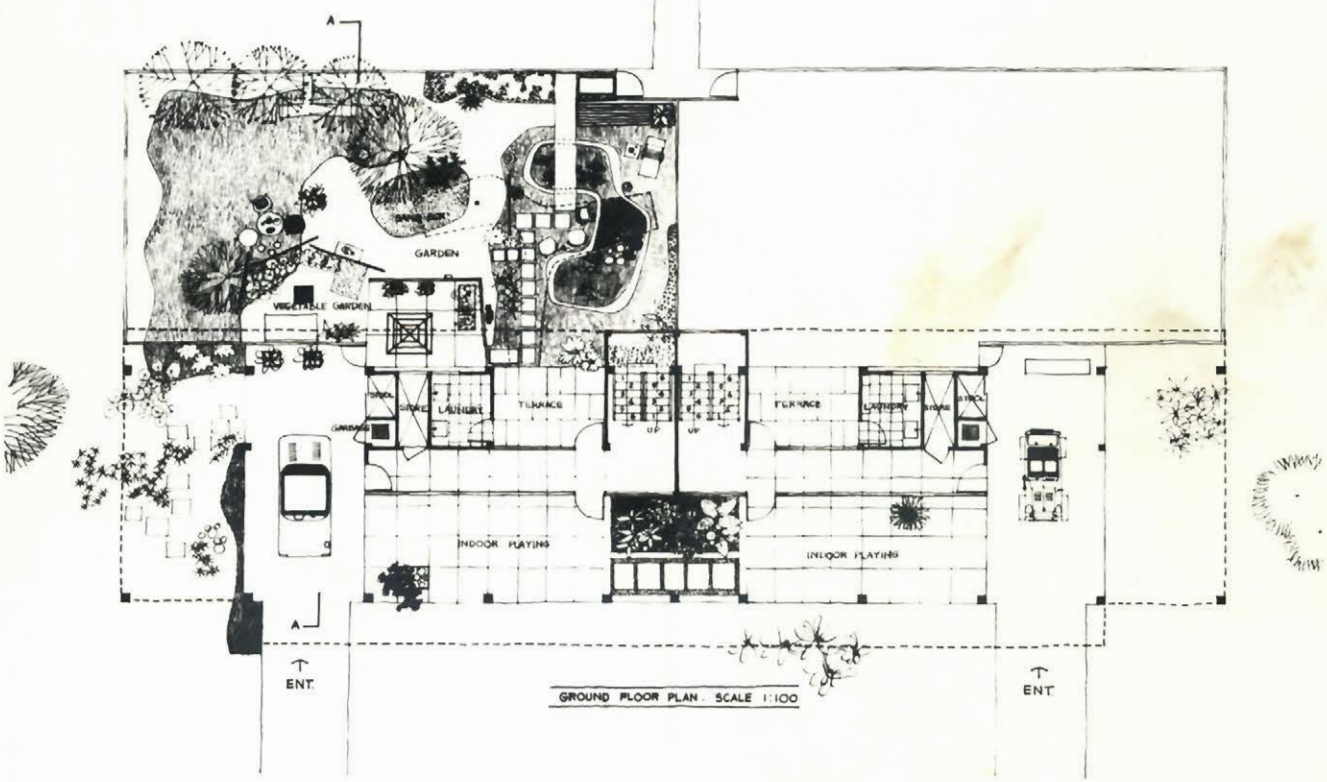
THREE BEDROOMS TYPE B



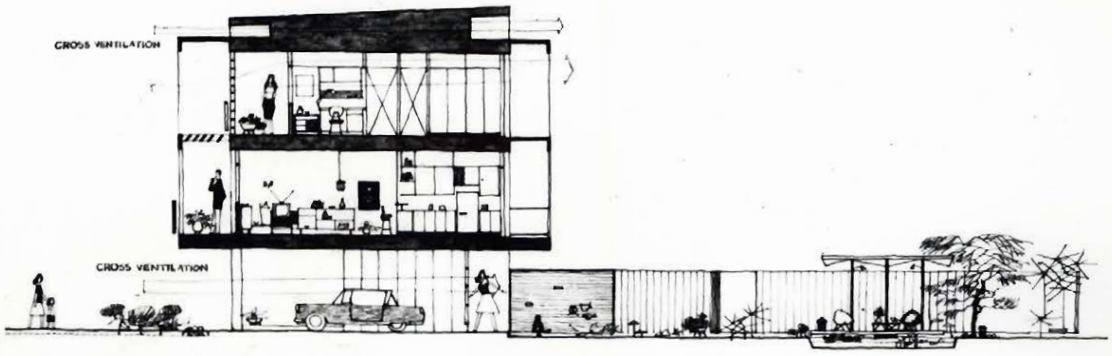
ROOF PLAN SCALE 1:100



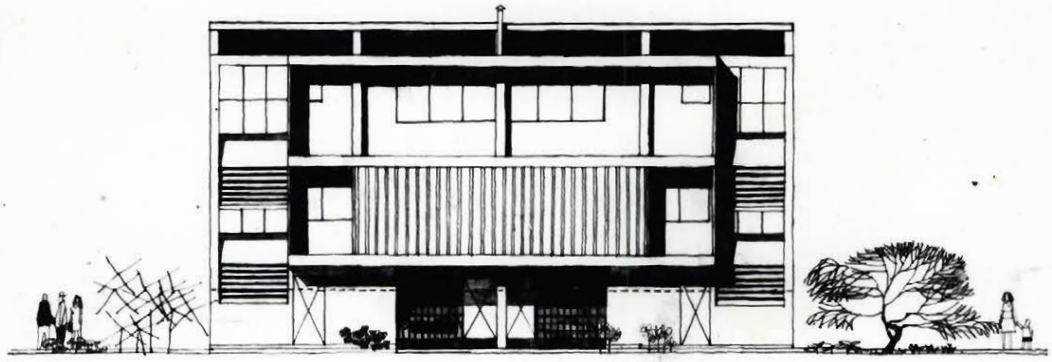
FIRST FLOOR PLAN. SCALE 1:100



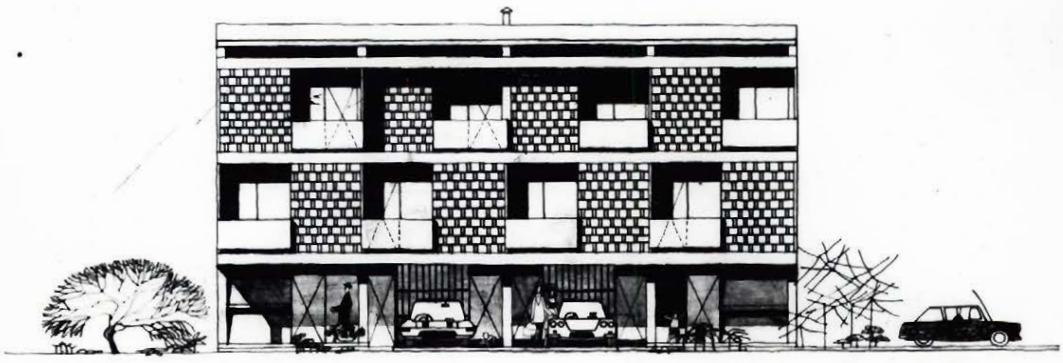
GROUND FLOOR PLAN. SCALE 1:100



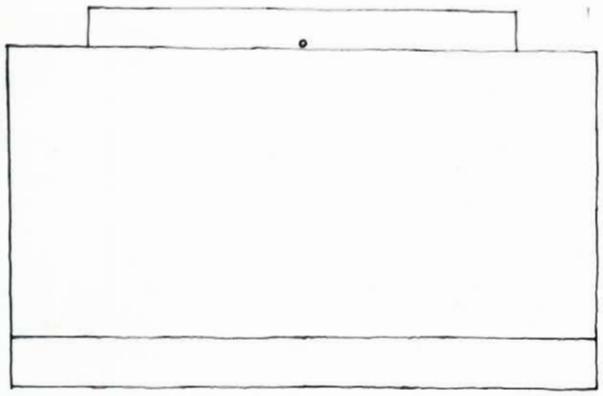
SECTION A-A SCALE 1:100



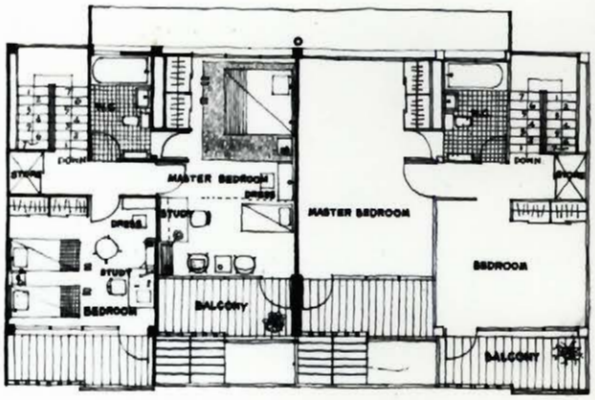
NORTH ELEVATION. SCALE 1:100



SOUTH ELEVATION SCALE 1:100



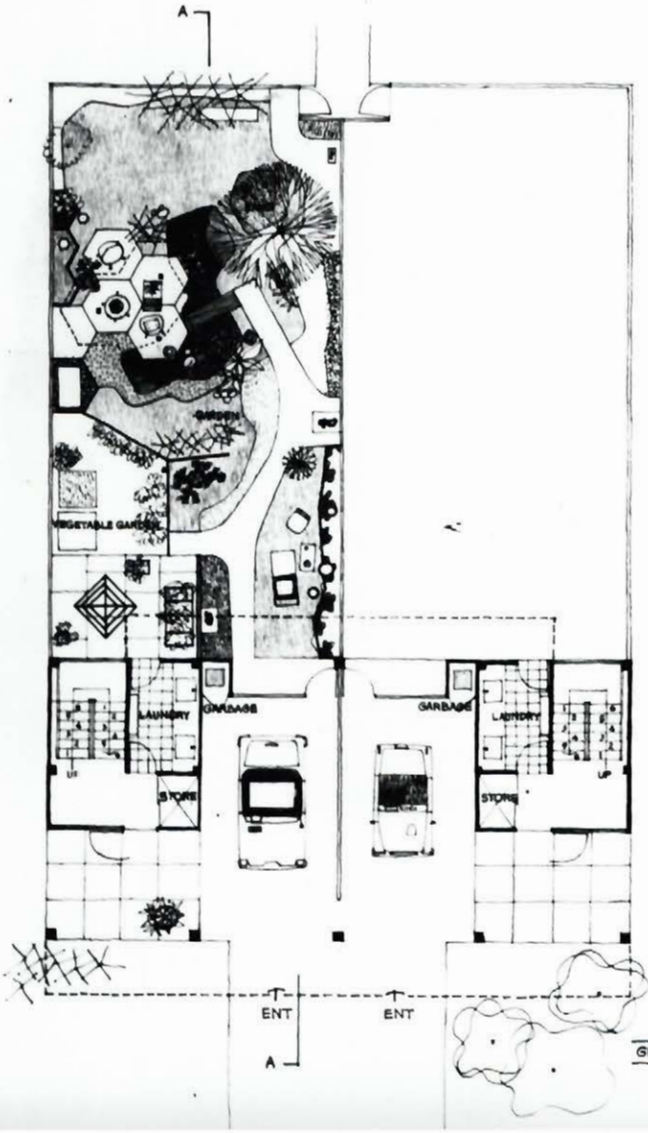
ROOF PLAN SCALE 1:100



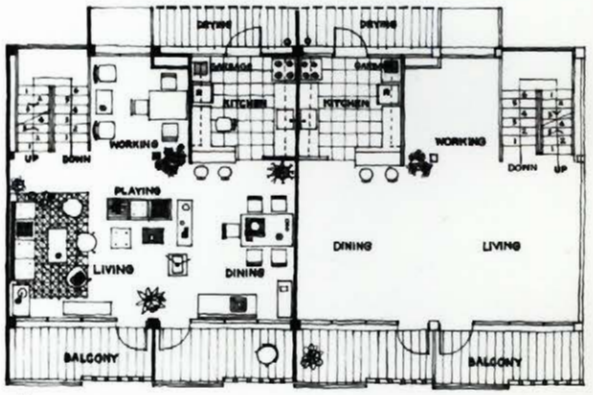
SECOND FLOOR PLAN. SCALE 1:100

[B]

FIRST FLOOR PLAN. SCALE 1:100



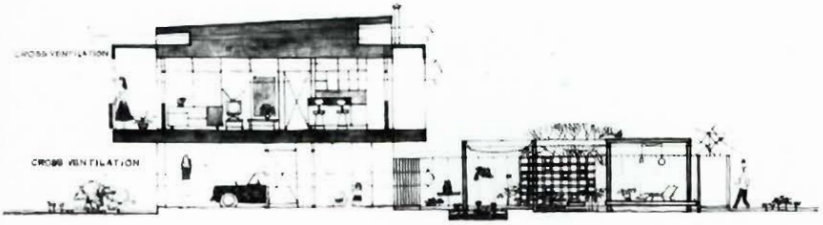
GROUND FLOOR PLAN SCALE 1:100



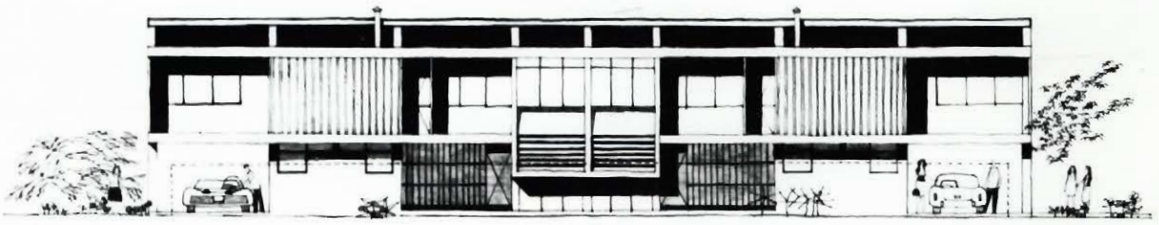
[A]

FIRST FLOOR PLAN. SCALE 1:100

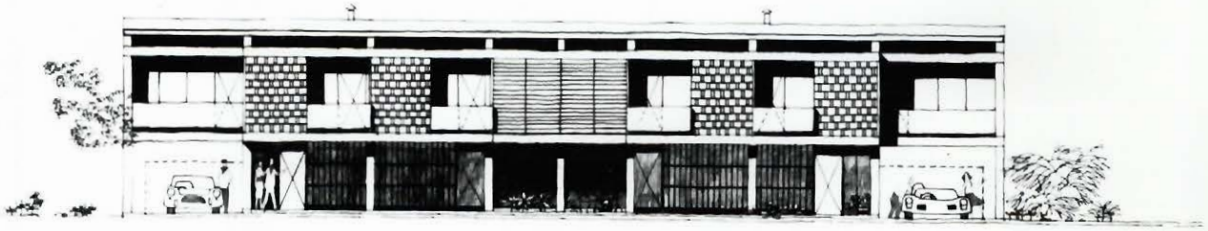
TWO BEDROOMS TYPE A



SECTION A-A SCALE 1:100

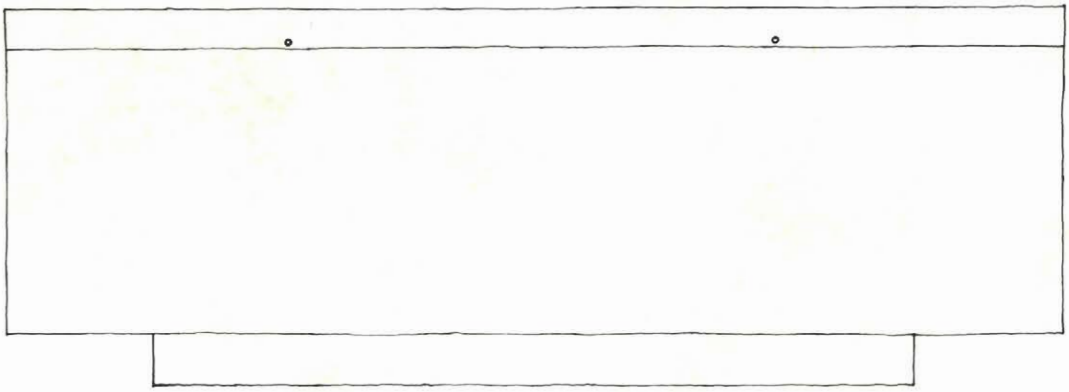


NORTH ELEVATION SCALE 1:100

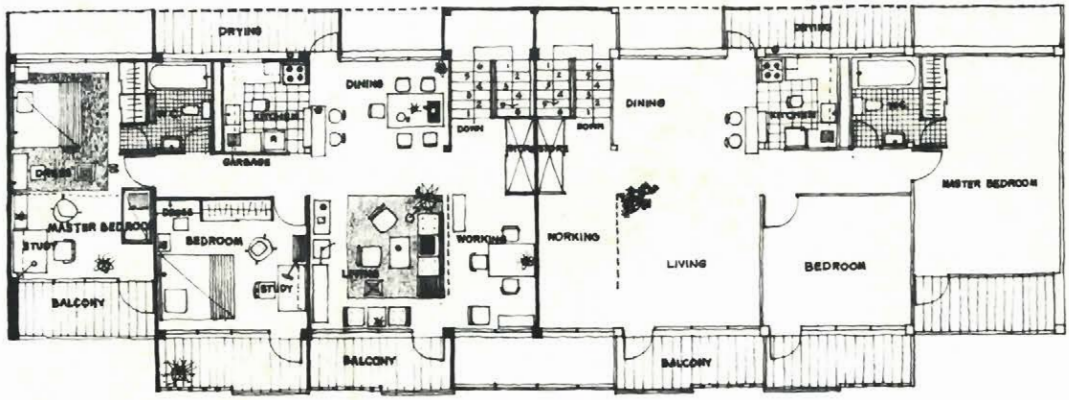


SOUTH ELEVATION SCALE 1:100

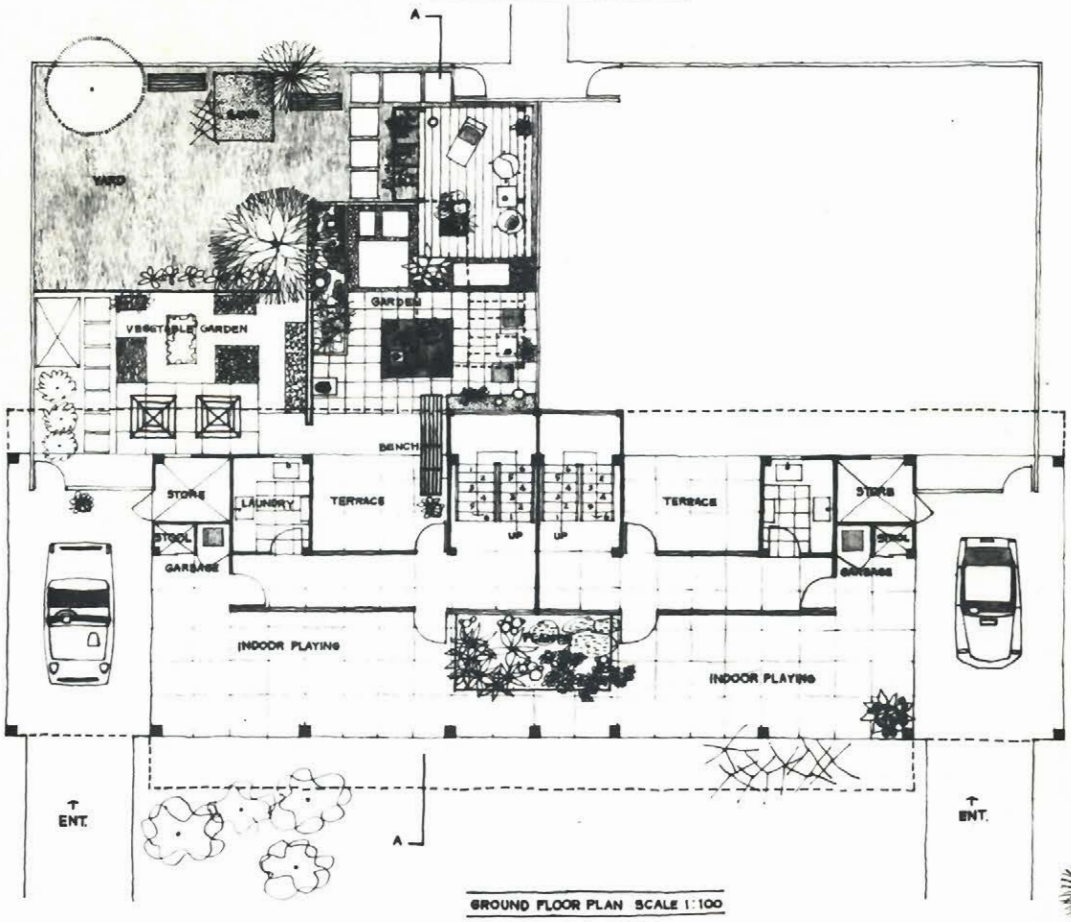
TWO BEDROOMS TYPE B



ROOF PLAN SCALE 1:100

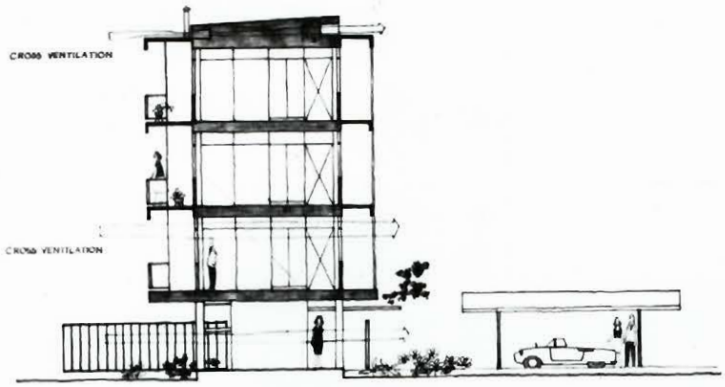


FIRST FLOOR PLAN SCALE 1:100

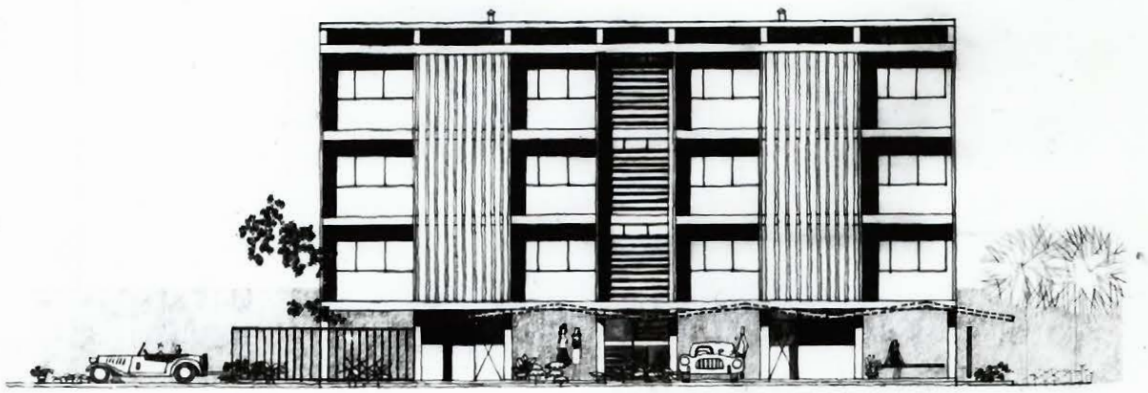


GROUND FLOOR PLAN SCALE 1:100

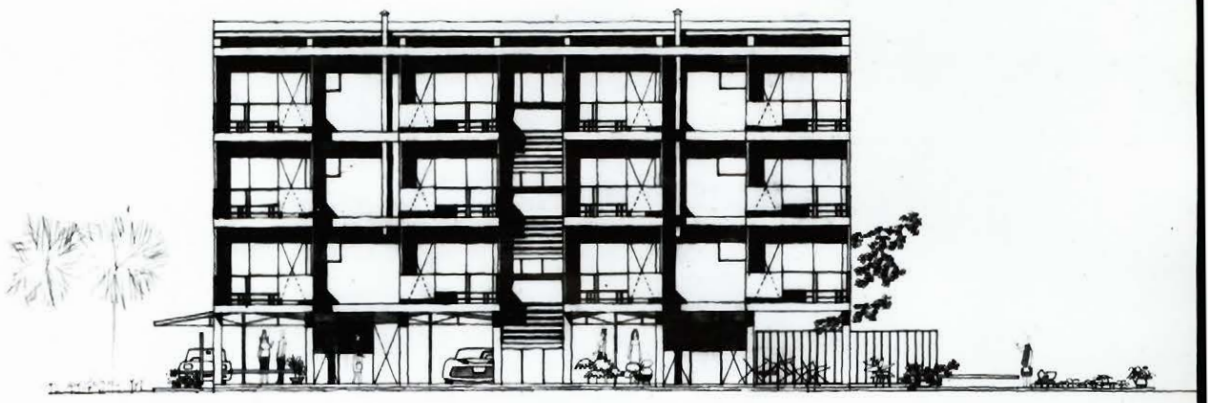
TWO BEDROOMS TYPE B



SECTION A-A SCALE 1:100

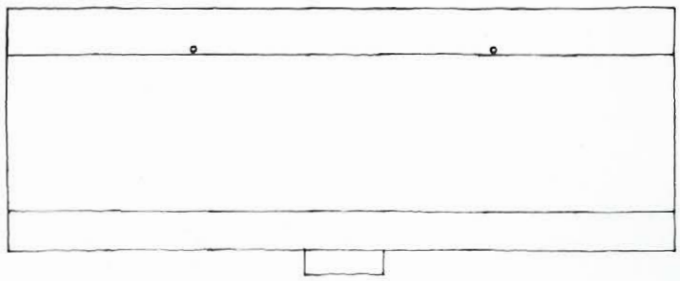


NORTH ELEVATION SCALE 1:100

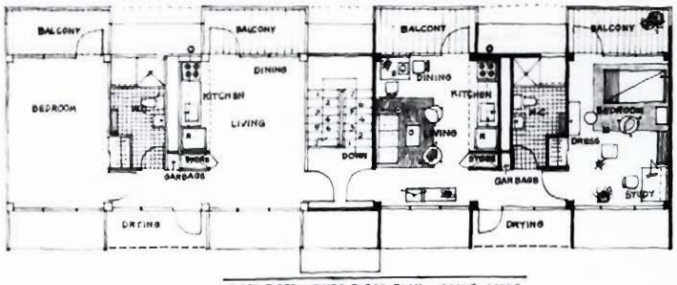


SOUTH ELEVATION SCALE 1:100

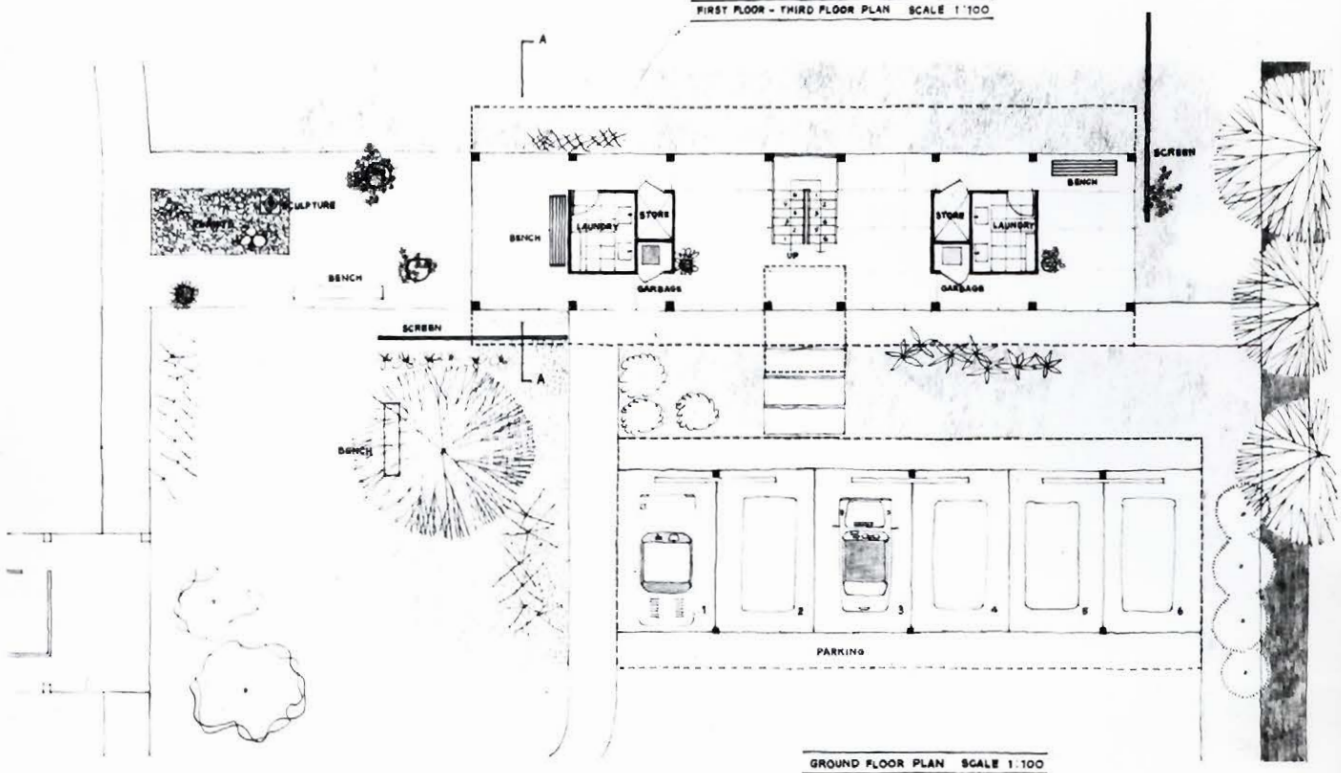
SINGLE BEDROOM TYPE A



ROOF PLAN SCALE 1:100

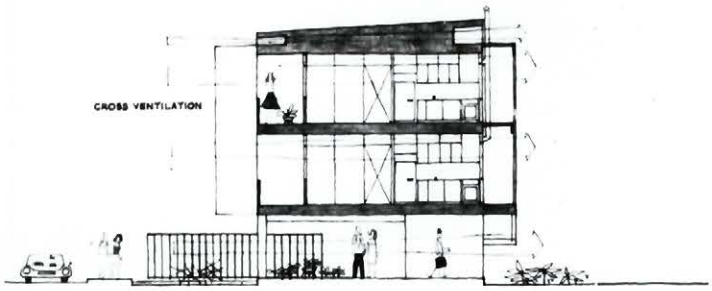


FIRST FLOOR - THIRD FLOOR PLAN SCALE 1:100

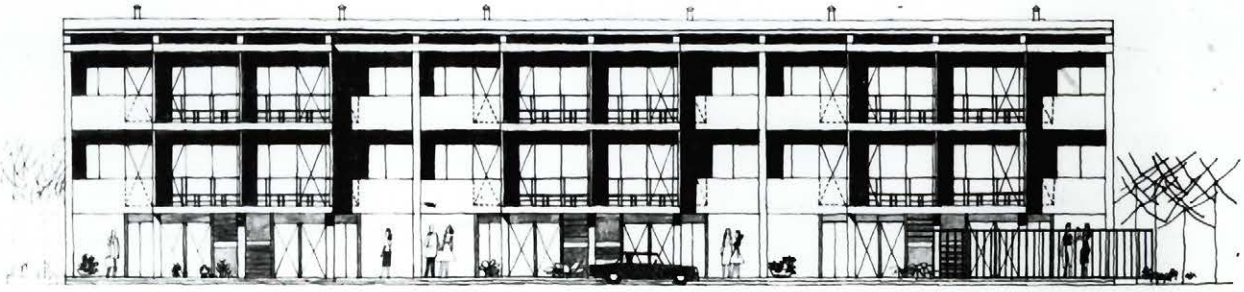


GROUND FLOOR PLAN SCALE 1:100

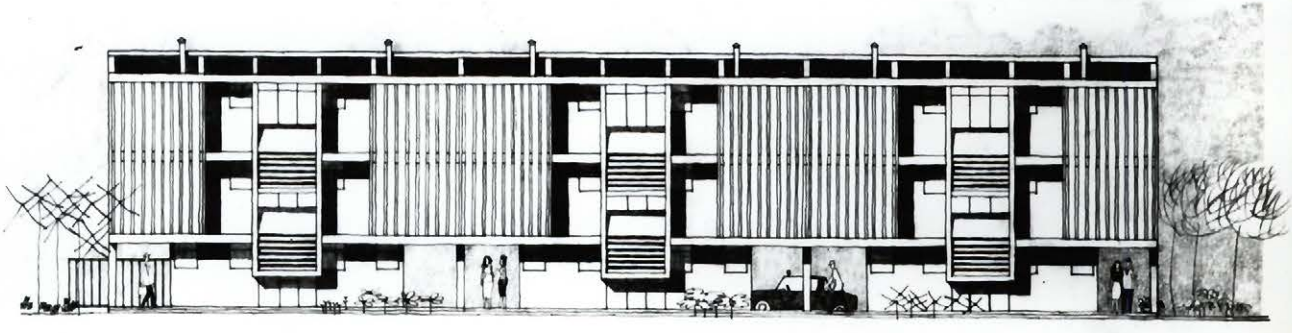
SINGLE BEDROOM TYPE A



SECTION A-A SCALE 1:100

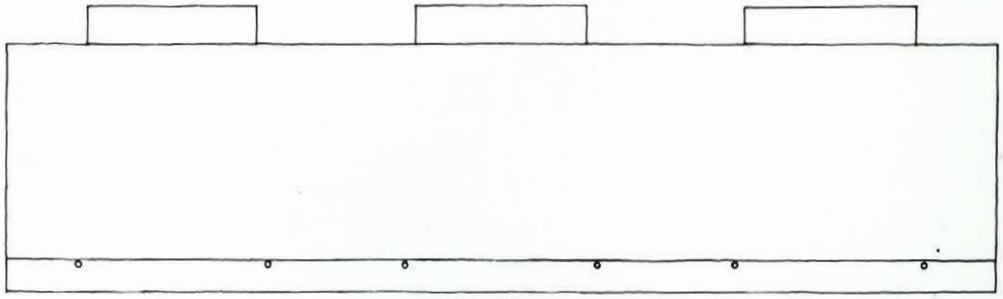


SOUTH ELEVATION SCALE 1:100

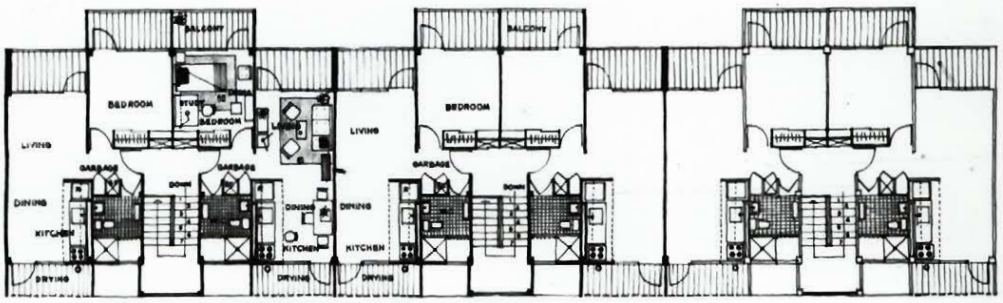


NORTH ELEVATION SCALE 1:100

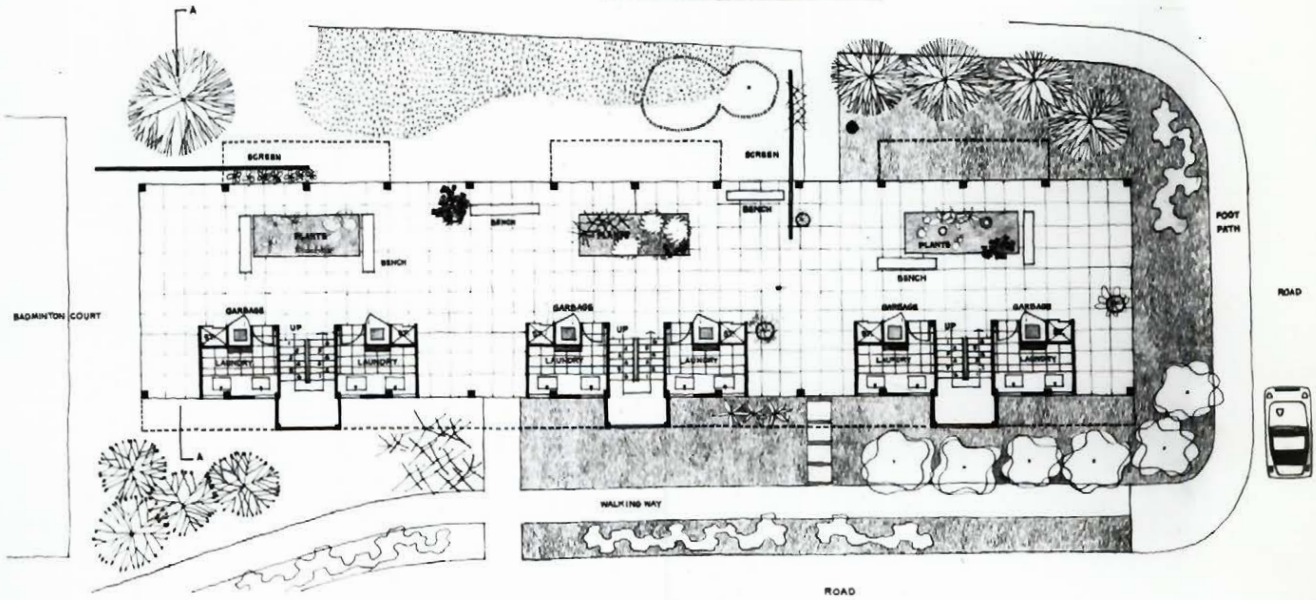
SINGLE BEDROOM TYPE B



ROOF PLAN SCALE 1:100



FIRST FLOOR - SECOND FLOOR PLAN SCALE 1:100



GROUND FLOOR PLAN SCALE 1:100

SINGLE BEDROOM TYPE B

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Among all the sources consulted in the preparation of this thesis, the following are recommended as additional reading on the basis of quality and general availability:

Anuman Rajadhon, Phya: The Cultures of Thailand, "Thailand Culture Series,"No. 1, National Culture Institute, Bangkok, 1953

Anuman Rajadhon, Phya: The Story of Thai Marriage Customs, "Thailand Culture Series", No. 13, National Culture Institute, Bangkok, 1953

Wittsiwasariyanon: Aspects and Facets of Thailand, Siba Phom, Ltd., Bangkok, 1958