

TERRACE HOUSING:
Providing Quality in Higher-density Housing

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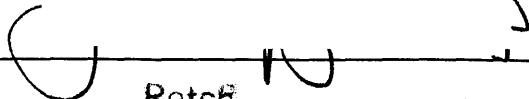
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by
Songpol Atthakor

Submitted in the Department of Architecture on May 8, 1992
in partial fulfillment of the requirements for the Degree of
Master of Science in Architecture Studies

ABSTRACT

The higher demand of higher-density housing in Bangkok due to the rapid growth of the economy and the use of high-performance materials and modern construction methods has changed the forms of housing from low-rise buildings to multi-storey apartments. During the last two decades, people in Bangkok have faced problems of living in high-density housing and lack of open space, which limit the quality of living space. Providing better quality of living space above ground must therefore be considered.

Terrace housing, that is multi-storey housing with open spaces on each level, is a building type which has the advantage of providing the qualities of private open spaces to each unit of building. Terrace building types have been a popular solution to modern housing design for quality in multi-storey apartment buildings. There is a great variety of this building type: roof top, hillside, on ground free standing terrace, vertical stack, courtyard terrace, artificial hill terrace and cluster terrace. The main purpose is to provide compensation of living quality on the ground to individual units and common area in the air. Terrace buildings also respond well to their environment. However, terrace buildings require many special architectural and technical considerations.

A study of this building type will help to clarify the design and technical considerations of terrace housing design and provide design alternatives for better living conditions in the city. The work deals with terrace houses on flat sites in the city of Bangkok on two main contextual levels.

1. General level; Guidelines for off-ground terrace buildings are described by means of the specific components of the building types which are generated by internal requirements and external conditions (such as spatial requirements, climates and urban contexts).

2. Specific level; This level is based on practical considerations of the process of representing a terrace building. Prototypical forms of terrace housing will be matched with quality of housing and technological systems. The results provide suggestions for the design of this building type and a selected design alternative.

Thesis Supervisor: Dr. Eric Dluhosch
Title: Associate Professor of Building Technology

To my parents with love

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1. HOUSING IN BANGKOK

1.1 Introduction

The demand for higher-density housing in Bangkok due to the rapid growth of economy and the uses of higher-performance materials and modern methods of construction has changed the forms of housing from two-storey detached houses to 4 storey townhouses and to multi-storey apartment building. During the last two decades, people in Bangkok have faced problems of living in high-density housing and lack of open space, which limit the quality of living space. Into the 90's with the economy booming and with limited open space on the ground, providing better quality of living space above the ground is to be considered.

How to achieve both density and quality of housing are the major challenges of new development. It is difficult to provide every household with an ownership on the ground because parking spaces take most of the ground area of the site. Higher density housing tends to take the form of multi-storey apartment buildings raised above ground level parking lots, rather than low-rise townhouses. However, possible projects can be developed in suburban areas of Bangkok where the land cost is more reasonable. The housing in this area can be in the form of medium-rise, instead of high-rise buildings, since lower cost can be made with shorter time of construction. Providing terraces may increase a building cost but it is worthy.



The landscape of Bangkok is beginning to be dotted with high-rises. During 1988, constructions of condominiums accounted for eight per cent of the total projects.

BUSINESS REVIEW FEB MARCH, 1989

Fig.1-1 The new development and the existing landscape of Bangkok

1.2 Development of Thai Housing

Physical Description of the Bangkok Metropolitan Area

Bangkok is Thailand's major administrative, economic and cultural center. Bangkok, as its major port, is located on both sides of the Chao Phraya river at a point 33 kilometers north of the Gulf of Thailand. It sits on the flat fertile plains of the Chao Phraya delta. The city was established on the edges of the river to make it easier to defend against attacks from invaders, and the central urban area is surrounded by canals. Until the last few decades, most of the existing buildings and developments in Bangkok were low-rises. Detached houses, townhouses, shop houses and other residential structures rarely exceeded five stories in height. Today new high-density developments, especially high-rise condominiums, have changed the city form, due to the booming economy.

Development of Thai Housing before the 20th Century

Before the 19th century, most Thai men were considered to be naturally skilled traditional crafts, particularly in carpentry; most Thais had the basic skills and knowledge to build a house or dwelling which reflected a common traditional style of Thai architecture.

The beginning of the 19th century was a turning point when Thailand experienced an increasing influence of western architecture. A number of



Fig.1-2 The Chao Phraya river, Bangkok

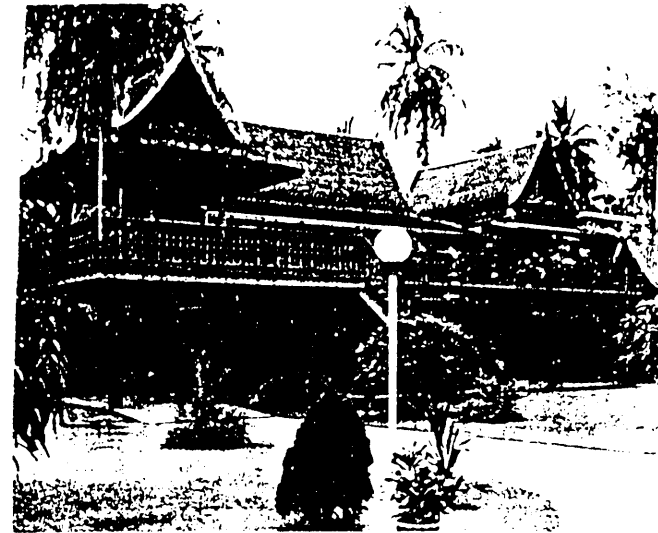


Fig.1-3 The traditional Thai house

Chinese and European craftsmen began to be involved. Since Thailand started communicating and doing business with other countries, influence of foreign architecture has changed the forms of housing in Thailand.

During the 19th century, Bangkok faced the beginning of increased construction activity; however, skilled labor was in short supply. As a result, it was necessary to begin training new construction craftsmen to meet the growing demand. At that time, Chinese immigrants, skilled in masonry construction, cooperated with Thai craftsmen who were skilled in woodworking. Many houses of this period had the appearance of a wooden house on top of the masonry base giving the structure a more permanent character. Stronger construction was also used instead of traditional wooden construction. Thai architectural construction also modified and adapted itself toward western concepts, similar to other models of colonial architecture. Brick construction and elements of the colonial style were the most influential to the development of a new type of Thai house. The uses of hip roofs, louvered windows and decorated screens were widely accepted. However, these houses were rarely higher than 2 stories.

Development of Thai Housing in the 20th Century

In the early 20th century, industrial products, such as corrugated roofs, metal nails and alloy hinges were started to be used. Reinforced concrete, grass and finishing materials became major elements in construction. Terraces made out of concrete, sometimes with ceramic or marble finishing, were introduced to increase durability. Wood construction was only used as standard economically



Fig.1-4 A Thai Colonial Style House



Fig.1-5 A Thai house built during 1940-1960



Fig.1-6 A Thai house built during 1960-1980

sized elements. During this period terraces existed both on the ground floor and the second floor, often covered with verandahs and loggias. Most buildings were built to occupy space horizontally, no more than 4 storeys, since land was relatively plentiful.

After the middle of the 20th century, wood became rare and concrete construction and other industrial products, such as particle boards and roof tiles, were often used. The wide use of industrial products has made a significant change to Thai housing forms. Wood is combustible, expensive and has limits of height for multi-storey construction, the uses of other materials had to be explored. Concrete and new prefabricated components, such as prefabricated floors, roof tiles, plywood and gypsum boards, and ready-made windows and doors, are now freely available.

New building systems, such as plumbing, elevators and fire protection make multi-storey buildings possible. A great demand for housing, a better economic situation and new technology of construction caused significant changes in housing types for higher densities in the city. Townhouses and multi-storey apartment building are such new types.

In the 60's, the government started to build walk-up apartments for low-income people. The construction of a multi-storey apartment building of concrete structure, masonry or block walls and wood-frame or aluminum-frame openings has been used in such construction until now. In the 70's, Thailand's economy continued to grow and the numbers of multi-storey housing, typically



Fig.1-7 Typical Three-storey townhouse

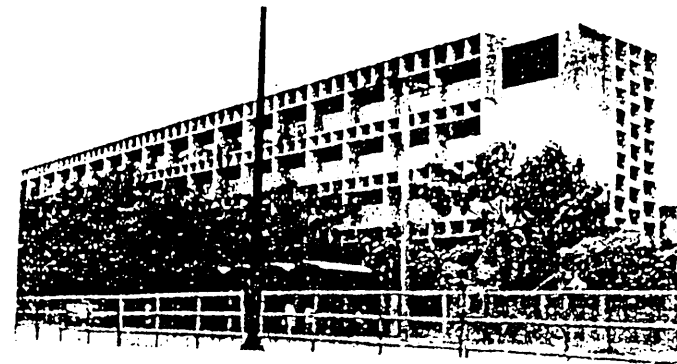


Fig.1-8 A Walk-up apartment building built by the government in the 60's

about ten storeys, increased significantly. Steel-reinforced concrete walls, prefabricated concrete floors, were widely used.

Developments in the 80's

From the middle of the 80's until now, the economy has significantly changed, and construction of multi-storey buildings has become fashionable among local contractors who are more familiar with buildings with 4-10 floors. The increasing demand of housing leads to finding better ways of construction within a short period of time. Also, total cost of a building construction may not be as important as a shorter period of construction, in order to meet urgent market demands. Labor has changed from skilled workers to working under supervision. Industrial or ready-made products are increasingly being used. Thai contractors are familiar with larger elements of materials and intensive construction process, such as using cranes, installing large wall panels and systems for high-rises. Now in Bangkok, a 44 storey-height condominiums can be found and over 200 high-rise condominiums are under construction, including 96 storey-height condominium project, the 6th tallest building in the world. More than 500 condominium projects are planed to be built in the early 90's. Thai architects, engineers and contractors are exploring other alternative methods of construction, beside conventional methods.



BUSINESS REVIEW FEB-MARCH, 1989

Construction of multi-storey buildings has become a new fashion among Thailand's contractors who are more familiar with buildings with 4-10 floors.

Fig.1-9 High-rise residential condominiums in the city center

1.3 Housing Investment in Bangkok

Housing Production Trends 1974 to 1988

Since the mid of 70's housing stock has grown rapidly responding to the need of an increasing population. The total housing stock is estimated to have increased from 585,163 units in 1974 to 1,256,382 units, an absolute increase of 617,219 dwelling units. This translates into an annual increase of 5.7 percent. About 44 percent of the increase took place in the past five years, with the housing stock increasing from 959,775 to 1,265,382 dwelling units. During the late of 80's Bangkok's housing stock increased by an annual compound rate of 7 percent.¹

First Period (1984-1988)

During the 1974 and 1984 period, developer-built housing accounted for one-fourth of the total housing stock increase. During the 1984-88, the share of developer housing production increased to nearly 31 percent as the stock of housing production increased to nearly 31 percent. The tabulation of multi-storey condominium projects and developer-built housing stock had increased to 270,800 units, accounting for 49.6 percent of Bangkok's 1984-88 housing stock increase.²

¹ National Housing Authority Aerial Photographic Survey, 1987 and 1990

² PADCO (Planning and Development Collaborative International) and LIF (Lnad Institute Foundation), Bangkok land and housing market assessment, September 1990.

REVISED HOUSING STUDY TABULATIONS REFLECTING ADDITION
OF CONDOMINIUMS AND RECLASSIFICATION OF
LARGE-SCALE DEVELOPER-BUILT AND HOUSING

TYPE OF HOUSING	1974	1984	1988	ANNUAL		
				ABSOLUTE INCREASE 1984-88	SHARE OF INCREASE 1984-88	COMPOUND INCREASE 1984-88
Large-scale Developer-built	20,193	113,755	270,800*	157,045	49.6%	24.2%
Shophouses	134,766	247,552	257,266	9,714	3.1	1.0
Small-scale/ Independently-blt.	262,345	363,323	479,995	116,672	36.9	7.2
Slum Housing	139,326	160,145	170,638	10,493	3.3	1.6
Public Housing	28,533	74,708	85,000	10,292	3.3	3.3
Other Housing	N.A.	38,951	51,323**	12,372	3.9	7.1
TOTAL	585,163	998,436	1,315,022***	316,586	100.0%	7.1%

* Based on estimates from building permits information tabulated by the Government Housing Bank including condominium units.
** Assumes other housing grew at 7.1% per year 1984-88.
*** Revised total is increased to account for 58,640 condominium units tabulated by the NHA in 1988.

Source: Tabulations of National Housing Authority Aerial Photographic Surveys 1987 and 1990; Government Housing Bank building permit tabulations, 1987-90.

Table 1-1 Tabulation reflecting addition of housing

Although regulation of large residential buildings has been promulgated by law since 1980, the investments before this period were aimed mainly towards townhouses and detached houses. Investment in larger scale buildings such as apartments and condominiums had seriously started in 1982-1986 for middle and lower-middle income, 200,000-300,000 Bath/Unit (about 8,000-12,000 U.S.\$/Unit). Most of the condominiums in this period faced problems of management after sale and turned into 'slums in the air'. Many of them had to be changed to rental apartments. Therefore, the investments were not profitable and banks had comprehensive policy of giving funds. After this first period, there had been some recovery of large scale residential investment but people were still interested in living in townhouses and detached house communities.

Second Period (1987-1989)

Since the boom of economy of Thailand in 1986, the principal factors, such as reduction of available land together with an increase of land prices and construction expenses, caused vertical development. Apartments and condominiums became popular. It was so successful that everyone called this 'the golden period'. There were two target groups in this period. One was high and higher-middle income, 500,000-8,000,000 Baht/Unit (20,000-320,000 U.S.\$/unit) in the city and the other was lower-middle income, 120,000-400,000 Bath/unit (4,800-16,000 U.S.\$/unit) in the outskirts of the city. The business of large apartment and condominium buildings has rapidly grown. The increase of large scale developments of housings were successful and 'living in the air' has become common. Although low-income users were not used to the new environment of multi-storey buildings, they preferred to live in large and tall buildings having image like high-income high-rises.

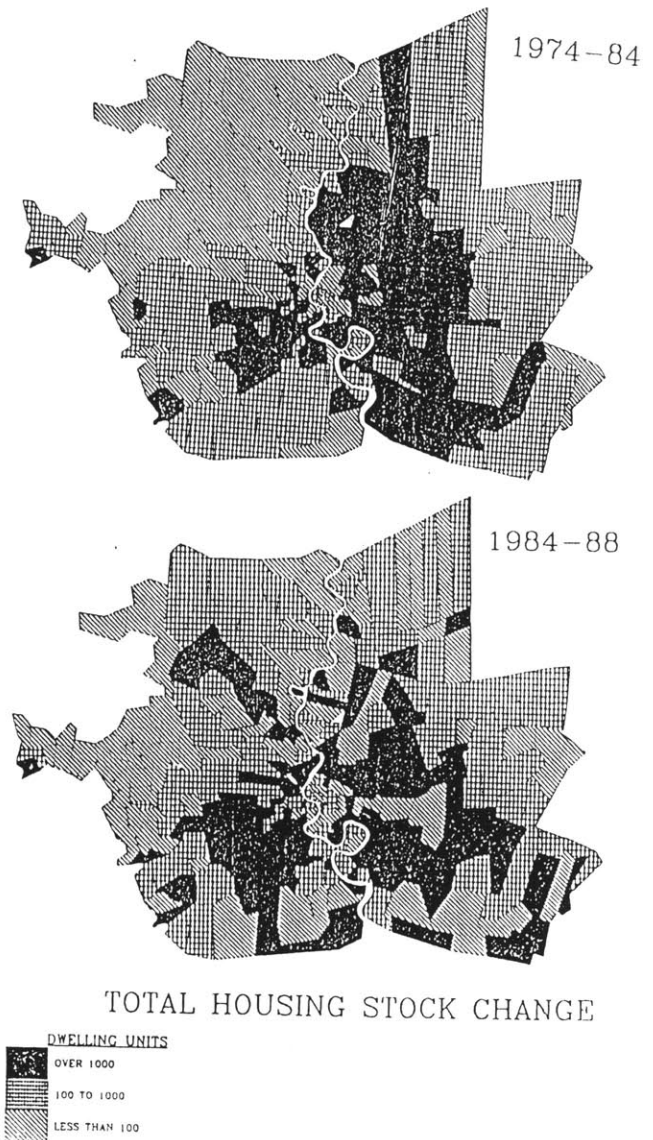


Fig. 1-10 Total Housing stock change during 1974-1988

Present Situation

Since 1989 large scale housing is still in great demand, according to rapid growth of the economy and because of a wider range of market. For example, the new law for ownerships in condominiums gives opportunities to foreigners to own up to 40 percents of a condominium. As the city grows, there are more people coming to live closer to their work places in the city.

The mushrooming pattern of high-rise projects have caused tremendous traffic congestion on Bangkok. The pattern of circulation is poor with only limited options for cross-town travel, and the limited roadway widths are incapable of handling peak travel demands at acceptable levels. As a result average travel time is quite low. For example, it usually takes about an hour to travel 5 kilometers in the city center on a working day. Traffic problems are likely to worsen as more development comes into the city center. The traffic congestion has started to generate the decentralization of development outside of the city. There has been considerable urban development in the edge of Bangkok, outside the city center. This pattern is the result of high land prices.

Residential Land Prices

Land prices have skyrocketed in Bangkok in recent years. Rarely a week passes when there is not a major news article discussing land inflation, speculation or foreign land-grabbing. During 1987-1988, land prices in Thailand increased generally by 200-300 percent. But for some specific areas like the Eastern

	1972-1976	1978-1981	1982-1986	1987-1989	1989
1. Construction (%increase)	25,814 (16.8)	70,387 (20.9)	118,189 (6.1)	178,465 (20.4)	221,000 (23.4)
1.1 Private sector	15,517 (15.8)	37,066 (17.8)	58,193 (8.5)	115,470 (31.9)	150,700 (30.5)
1.2 Governmental	10,297 (18.1)	33,321 (23.9)	59,996 (3.9)	62,995 (5.0)	70,300 (11.6)
2. GDP	264,245 (17.7)	573,864 (17.0)	962,509 (7.6)	1,450,540 (15.1)	1,668,900 (10.5)
3. Construction/GDP %	9.8	12.3	12.3	12.3	13.2

Year	Residential	Large Apartments & Condominiums*	Comercial	Industrial	Total
1986	4.0 (25.8)	1.3	2.4 (17.1)	0.4 (37.5)	6.8 (0.8)
1987	5.0 (24.2)	1.2	4.2 (24.8)	1.2 (17.0)	13.6 (24.0)
1988	8.2 (65.3)	3.4 (183.3)	4.2 (38.4)	1.2 (139.6)	13.6 (60.3)
1989	12.2 (49.0)	6.8 (100)	6.5 (53.8)	1.1 (43.1)	19.8 (60.2)

*Buildings which are higher than 15 m (4 storeys) or more than 2,000 sq m

	in Bangkok	Others Cities	Total	Units	Total Amount
Large buildings	292	142	288	50,000	120,000
Small buildings	44	18	62	25,000	5,000
Total	190	160	350	750,000	125,000

Source: Tabulations of National Housing Authority Aerial Photographic Surveys 1987-1990; Government Housing Bank building permit tabulations, 1987-90.

Table 1-2 Increase of housing in Bangkok

Seaboard which is the core area in the industrial development plan, prices have risen as much as 300-1000 percent. In Bangkok Metropolitan Area (BMA), the land prices for major commercial and residential areas have also risen many times: from 70,000 Bath/square Wah to 170,000 Baht/square Wah (700-1,700 U.S./sq.m) in Surawongse commercial area; from 25,000 Bath/square Wah to 75,000 Baht/square Wah (250-750 U.S./sq.m) in Sukumvit residential area.³

Rising land cost push up housing costs and higher development

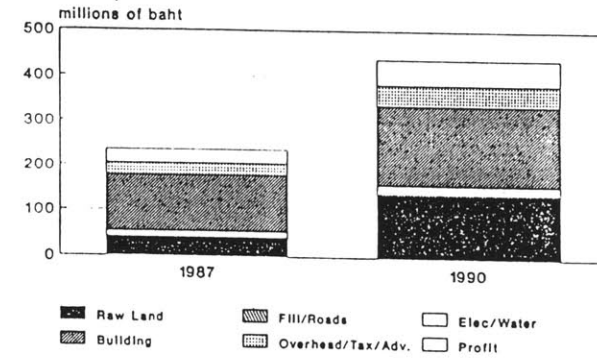
The major cause for the increase in housing development costs is rising land costs. Real, inflation-adjusted land cost increased by 375 percent between 1987 and 1990, an annual compound increase of 67 percent. Rising land costs are making land the key determining factor for housing costs. Land costs in 1987 ranged from 1,173 Bath per square Wah for a townhouse project to 44,980 Baht per square Wah for a high-income condominium project. The increase of land prices depends on the location of the project. Projects located on the suburban fringe areas had the greatest relative increases, where land prices have been increasing the most. The portion of total housing costs represented by land costs as increased from an overall average of 26 percent in 1987 to nearly 46 percent in 1990.² These rising costs are forcing developers to either shift to

³ Asvabhokin, Anant. Property Market in Thailand. Business review, February-March 1989, Bangkok, Thailand.

Notes: 1 Wah = 2 meters, 400 square Wah = 1 rai, and 4.4 rai = 1 acre
25 Baht is about 1 Dallar

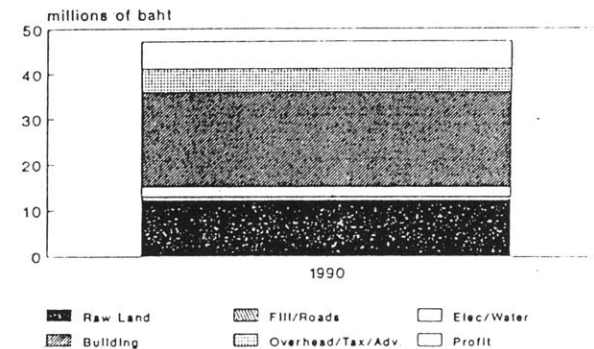
² PADCO(Planning and Development Collaborative International) and LIF (Land Institute Foundation), Bangkok land and housing market assessment, September 1990.

HIGH INCOME CONDOMINIUM
COST AND PRICE ANALYSIS



PADCO-LIF LAND MARKET ASSESSMENT, 1990

LOW INCOME CONDOMINIUM
COST AND PRICE ANALYSIS



PADCO-LIF LAND MARKET ASSESSMENT, 1990

Table 1-3 Development cost analysis

either shift to sites located on the fringe of Bangkok for lower-income market or provide better quality for the upper-income market.

"Rising land and housing costs and prices, rising interest rates and a growing supply of units are likely to dampen housing demand in the future. Housing stock increases over the past three years have been substantial, and are currently increasing at an annual rate of 90,000 units. Based on population and household data, the actual increase in households averages 40,000 to 50,000 per year. It is quite likely that inventories of housing stocks will continue increasing, especially in the upper-middle- and high-income price ranges."⁴

Stronger Purchasing Power

Over the past fifteen years, the growth trend has substantially increased, especially during the past five years. The pace of urban development during the past four years has equaled the total urban growth in the region over the preceding ten years. Unlike other large cities in Asia, Bangkok's growth is not fueled by massive population immigration but by economic growth and rising household incomes.

"Fueled by a booming economy, Bangkok's land and housing markets have soared. Robust business expansion, rising domestic and foreign investment, and the rapid growth of household incomes have spurred the demand for all

⁴ Business Review magazine. Condominiums '89, Thailand's Mushrooming Phenomenon. February-March 1989.



Fig.1-11 A luxury condominium project with 9 meter terraces

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KEY INDICATORS OF THE THAI ECONOMY
1986-1989

INDICATOR	1986	1987	1988	1989	ANNUAL COMPOUND GROWTH RATE
GDP (1977=100) (a)	413.81	446.36	499.80	554.00	10.34
Per Capita GDP (1986=100)	20,790	22,438	25,009	26,998	9.0
Gross Domestic Investment (1986=100) (a)	241.28	310.39	375.31	442.76	22.2
Total Commercial Bank Deposits (1986=100) (a)	627.15	733.50	838.89	1,002.66	16.8
Total Commercial Bank Loans (1986=100) (a)	543.73	655.85	801.50	981.04	21.5
Index of Manufacturing Activity (1987=100)	88.04	100.00	115.33	132.68	14.5
Population	52,960,000	53,870,000	54,960,000	56,006,000	1.9
Labor Force	28,040,000	28,860,000	29,920,000	30,870,000	3.2
Employment	26,140,000	26,928,000	28,457,000	29,440,000	4.0

(a) = billions of baht

Source: Department of Economic Research, Bank of Thailand, Thailand Key Economic Indicators, March 1990.

Table 1-4 Key indicator of the Thai economy

⁴ Business Review magazine. Condominiums '89, Thailand's Mushrooming Phenomenon. February-March 1989.

is spreading to other areas as well as land prices make low-rise residential development uneconomical.

Housing types by distance to city center

Responding to rising land and construction costs, the housing density in the city has dramatically changed over the past five years. Housing projects have moved farther into the suburbs and consume of less land with larger size. The average density of housing development is now much greater, despite the fact that projects are now even farther from the city center. The higher densities are the result of considerable condominium development now taking place in the city region, as developers seek ways of cutting the impacts of rising land prices. In 1986, nearly 50 percent of the housing production was in single-family housing units. Almost all the remainder, 49 percent, is comprised of townhouses and duplexes. The rest were condos, less than 2 percent. In 1990, the market had shifted dramatically and condominiums now comprise 43 percent of the market. Single-family housing has fallen to 36 percent of production and townhouses now stand at 21 percent.⁶

In 1990, the multi-storey condominium market had broadened to include projects all across the city. This, in contrast to 1986, when condo projects were concentrated within 10 kilometers of the city. Now approximately two-thirds of the planned units are located more than 20 kilometers from the city center, These will be targeted to low- and middle-income buyers.

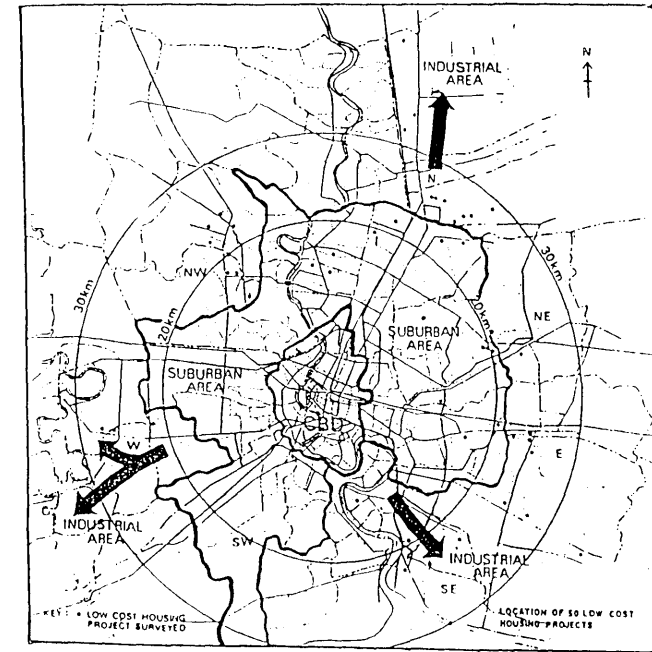


Fig.1-12 Building types and distance from the city center

CHARACTERISTICS	CONDOMINIUMS		SINGLE FAMILY		TOWNHOUSES	
	1986	1990	1986	1990	1986	1990
Distance From City Center, Km	3.5	15.5	18.4	28.0	17.7	24.7
House Size M2	72.5	180.9	97.2	149.0	93.1	118.5
Plot size Mx2	N.A.	N.A.	50.9	73.5	22.9	27.0
Price (1990 Constant Baht)	888,893	5,501,179	774,320	1,845,549	479,020	1,013,794
Price/Sq. Mt. Of Housing	14,960	28,072	8,300	15,111	5,311	8,954
Sales/Per Month	1.8	20.1	2.9	6.4	3.7	12.9
Percent of Units Sold	N.A.	60.1%	N.A.	64.4%	N.A.	81.8%
Total Number of Units	398	12,156	13,975	10,089	13,310	5,938
Total Number Sold	N.A.	7,311	N.A.	6,496	N.A.	4,859

Source: PADCO-Land Institute Foundation Housing Projects Survey, 1990; Bangkok Land Management Study 1986, Household Survey.

⁶PADCO(Planning and Development Collaborative International) and LIF (Land Institute Foundation), Bangkok land and housing market assessment. September 1990.

Development Possibility

High land prices mean that the density of urban development must increase. Housing development for middle and upper income located within 20 kilometers to the center will need to be multi-storey, with an FAR in the 1.5 to 3.0 range if housing is to remain affordable. Such high density development is required to make a project feasible for acceptable market price ranges.

Townhouse projects are mostly located outside the suburban area for low-income group. Because of their maximum FAR of 1.5, townhouse projects are difficult to make even due to the high cost of land, with the exception of high-income groups.

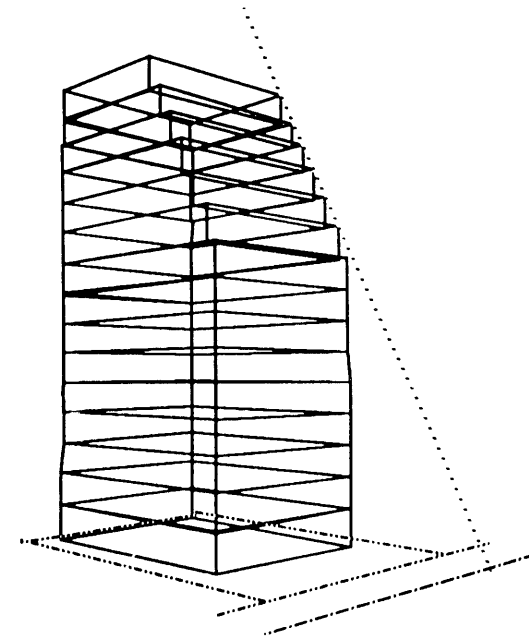


Fig.1-13 An analysis of maximum built form by building codes on a typical lot of 800 sq.m (FAR 1:7)

Estimate of Development Costs and Density in Bangkok, in 1989 (about 25 Baht = 1 U.S.\$)

Development Costs:	Baht/Sq.m
-Land costs in Bangkok	<u>5,000</u> -40,000
-Site works and Contractor's overhead (include Demolition, Sewer and drains, Electrical service, Landscaping, Site furniture, Road and Parking lots)	<u>2,500</u> -5,000
-Building construction cost	<u>5,000</u> -12,000
-Fees:- Consultant, Insurance, Permits and financing of land & Construction about 25% of Construction cost	<u>1,250</u> -3,000
-Marketing and Management about 20% of Construction cost	<u>1,000</u> -2,400

Selling Price:

Average Bangkok	<u>20,000</u> -25,000
-----------------	-----------------------

Saleable Areas:

70% of Gross building area (exclude circulation and public spaces)	0.7 Sq.m
--	----------

Density:

Density of a development is minimized at the break even point. Following is a process of finding the density at that point:

Assumes: $X = \text{Density (FAR, floor area ratio)}$
 $X = \text{Gross building area / Land area}$

Total Expenditure = Total Revenue

Land & Site work costs + [X(Construction cost+Fees+Marketing & profit)] = (Saleable area) X (Selling price)

$$5,000 + 2,500 + [X(5,000+1,250+1,000)] = (0.7 X) (20,000)$$

$$7,500 + 7,250 X = 14,000 X$$

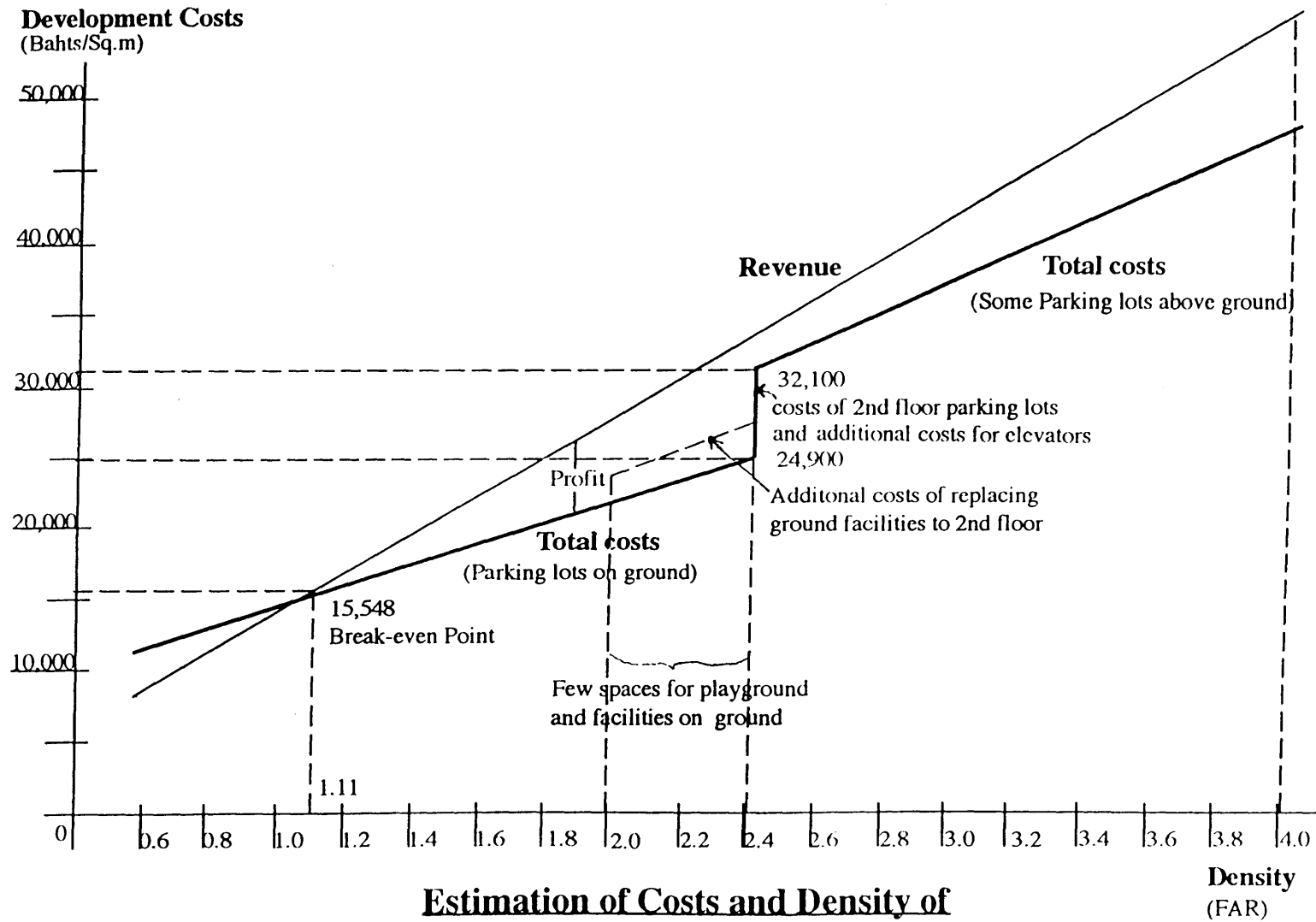
$$X = 1.11$$

Therefore, in order to break even in an investment, density (FAR) of a building must not be less than 1.11.

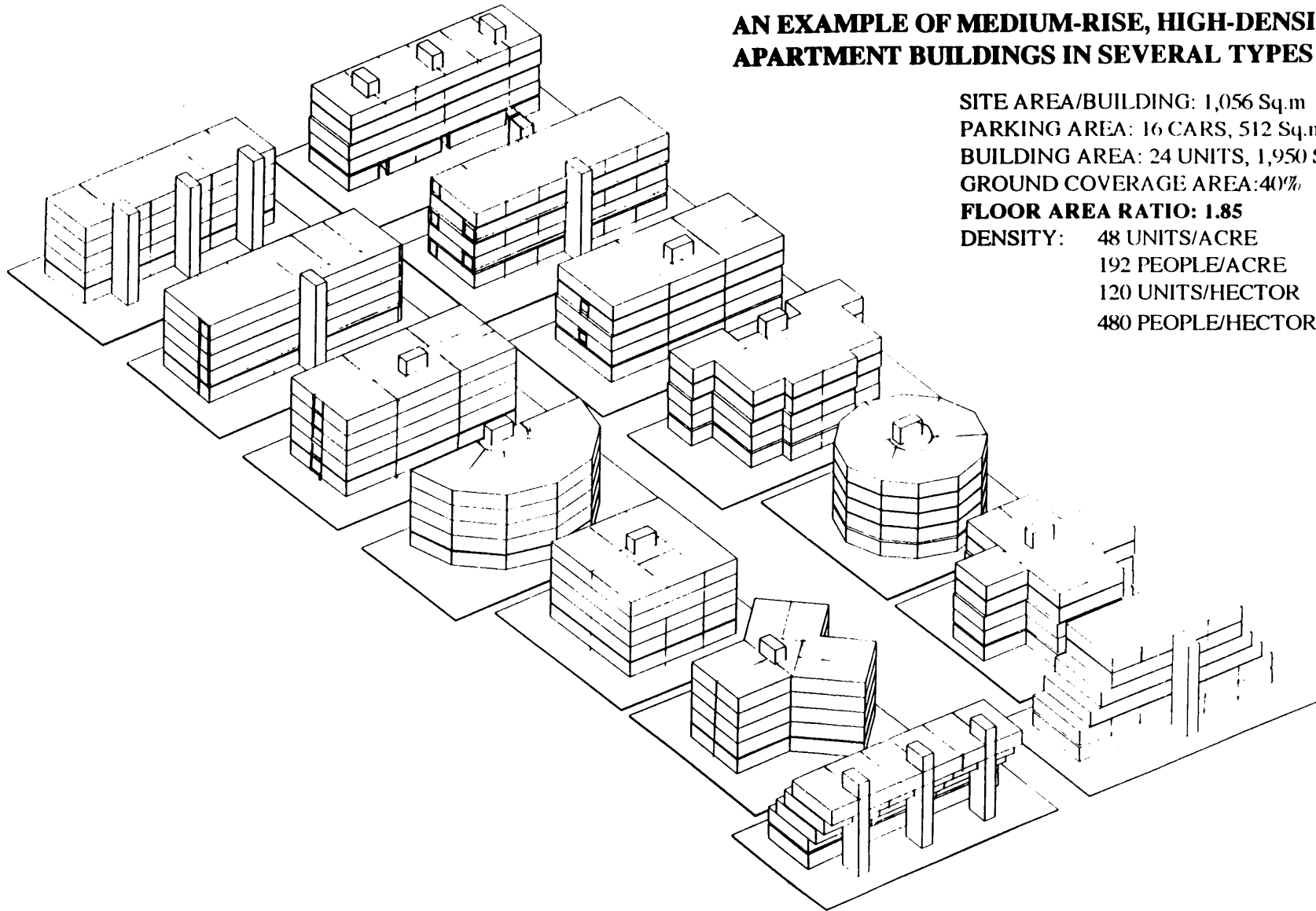
If build-up area = 30% of Site, the building height will be about 4 storeys above parking lots on ground level.

Notes: Development Costs to be added 800-1,000 Bath/Sq.m if parking lots require more areas than parking on ground level.

Buildings, higher than 7 floors, are considered to be high-rise buildings, which add additional costs for elevators and fire proofing, according to code and perhaps additional costs for the structure due to wind resistance as well as interest for a longer period of construction.



Estimation of Costs and Density of Developments in Bangkok, Thailand



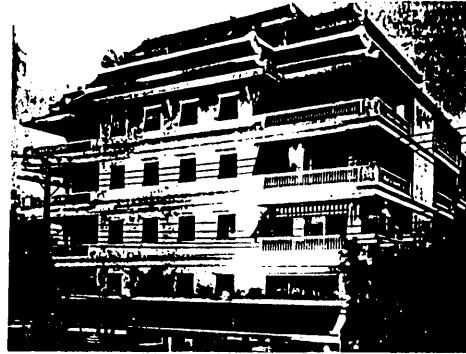
**AN EXAMPLE OF MEDIUM-RISE, HIGH-DENSITY
APARTMENT BUILDINGS IN SEVERAL TYPES**

SITE AREA/BUILDING: 1,056 Sq.m
PARKING AREA: 16 CARS, 512 Sq.m
BUILDING AREA: 24 UNITS, 1,950 Sq.m
GROUND COVERAGE AREA: 40%
FLOOR AREA RATIO: 1.85
DENSITY: 48 UNITS/ACRE
192 PEOPLE/ACRE
120 UNITS/HECTOR
480 PEOPLE/HECTOR

CONTEMPORARY DEVELOPMENTS



Suan Pharichat 2 (Baan Krongjai): 1985
North Rachasima Rd. Dusit, Bangkok



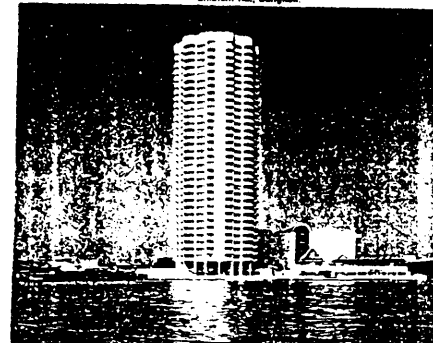
Baan Itthikamol: 1988
Sai Thang Lar Sukhumvit 55, Bangkok



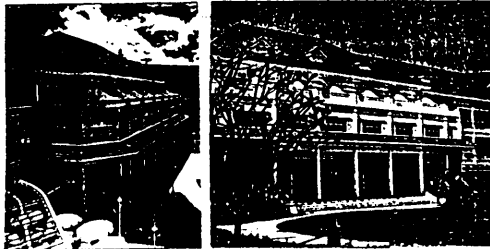
**Charimart
Apartment: 1986**
Ph 2 Soi 1 Samit, Suan Bangkok



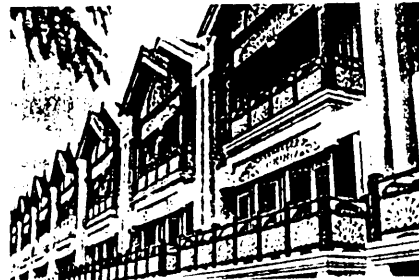
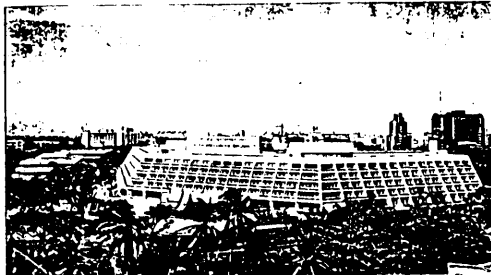
Sithakorn Condominium: 1984
Chidlom Rd., Bangkok



Bangkok Riverfront Commercial/Condominium Complex:
Taksin Bridge, Charoennakorn Rd., Bangkok



Hua Hin: 1988
Hua Hin



1.4 The Need of Quality Housing

Changing Lifestyle

The change of life-style from the past has caused a significant change in the form of housing. Because of social change from agricultural activities and handicrafts to working in the offices, housing tends to provide lesser spaces and is more compact. Users spend less time during the day in their house. Most rooms in a house are joined together for economic reason. A bathroom, which used to be outside the house for easy access to water and separated from living and sleeping area, is combined in the interior because of access and better quality of plumbing and fixture. Living areas that used to be outside the building are now inside because of the need for security and privacy. The underside of the house that used to be a multi-purpose space for activities during the day has become a parking lot for cars.

Today walk-up apartments for low- and middle- income housing, or multi-storey building with elevators mostly for medium and high income, are more likely to be developed in Bangkok instead of low-rise detached houses and townhouses, mainly due to higher land costs. This significant change has led people to a new way of living, caused by living in the air and remote from the ground. Since there is no relation between the new type of housing and Thai existing housing, the forms of multi-storey housing are often copied from the western architecture. The image of elegant living of Classical styles are popularly used. Many forms of housing are inappropriately designed with local climate in Bangkok. Provision of basic comforts and needs, such as protection

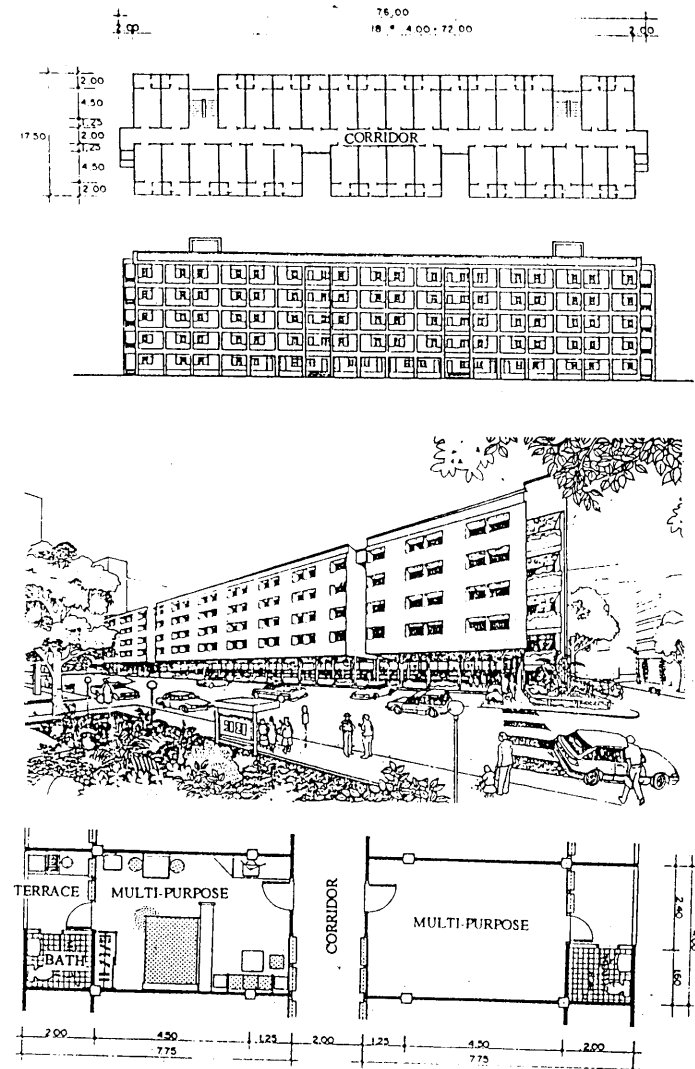


Fig. 1-14 TYPICAL FIVE-STORY,
DOUBLE-LOADED CORRIDOR,
LOW-COST PUBLIC HOUSING

of sunlight and providing ventilation and open spaces are often ignored. Later the costly electrical accommodation, such as air-conditioning systems, are used to solve the problems. The lack of open spaces in multi-storey housing are also to be considered.

The Need of Outdoor living Space in Low-income Housing

Compact units in a typical double-loaded apartment building for low- and middle- income causes problems for the life-style of people who mostly immigrated from the rural area. In the compact plan, problems, such as lack of cross ventilation and outdoor space, are created. The kitchen which used to be outside the building, in order to get good ventilation, may cause problems of smell and smoke from a western-style pantry in the house. To cook Thai food needs a lot of space both indoor and outside. Laundry is another problem for most Thai housewives who still need sunlit outdoor space for drying cooking materials and clothes. Access to the natural landscape for leisure activities is very difficult since people in the units above the third floor have little contact with the ground and leisure areas suffer from a lack of maintenance. Users need to have a private outdoor open space providing fresh air, sunlight and shade for these activities.

The Demand of Outdoor Space in Higher-income Housing

Many luxurious high-rise condominiums provide larger open spaces for private units because of increased density. Luxury, wealth, and status can be expressed by having the means to achieve privacy and solitude. The penthouse is one such

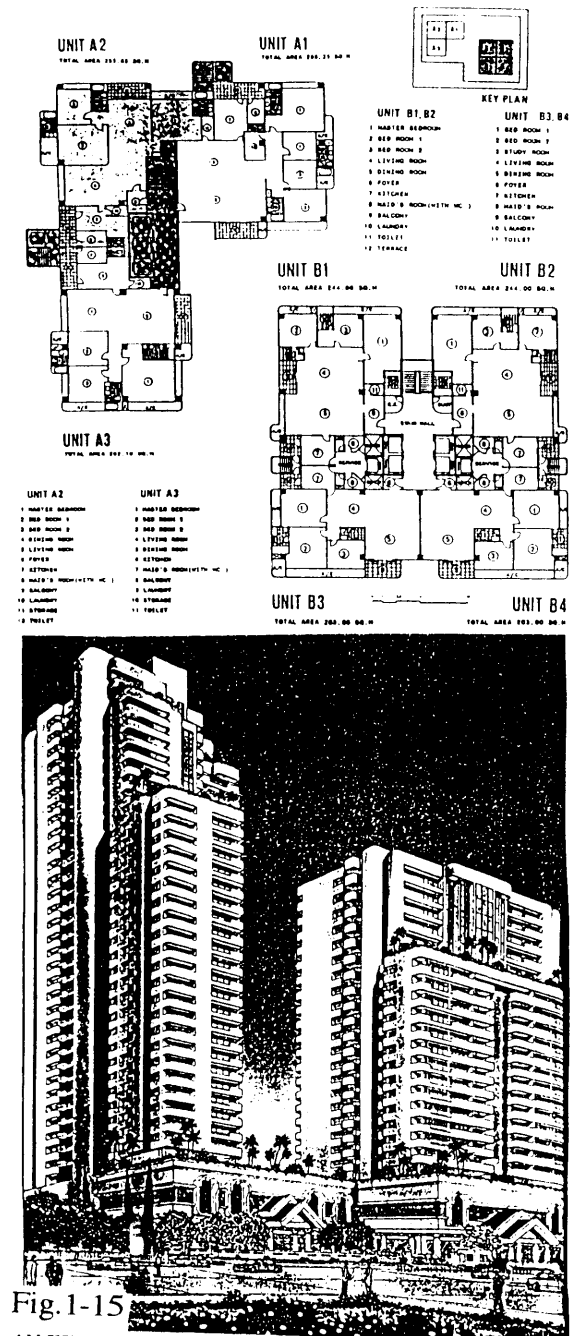
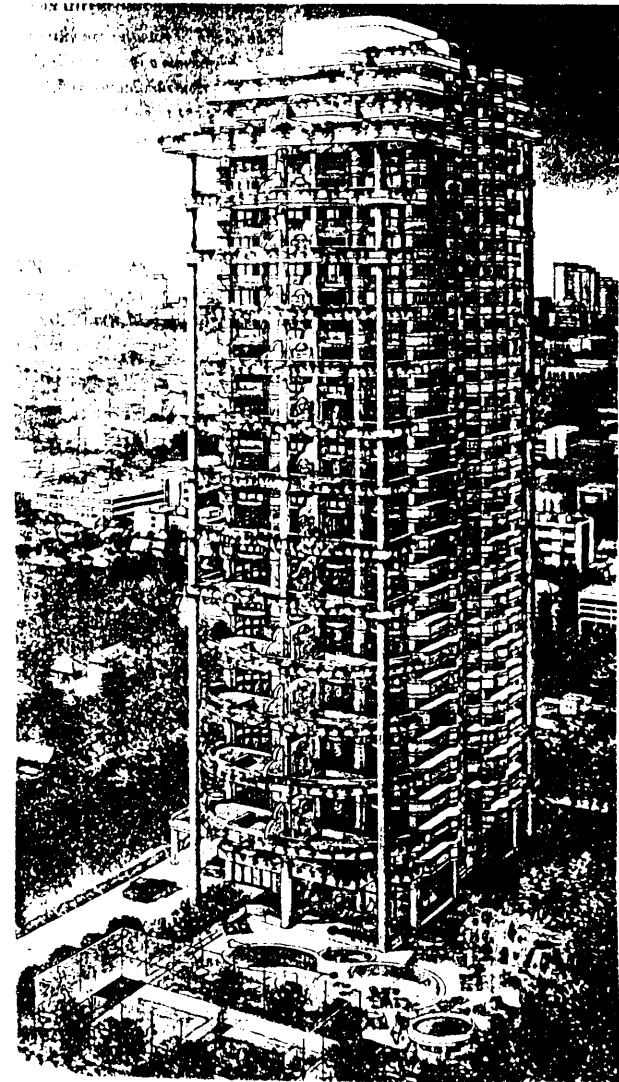


Fig. 1-15
AN EXAMPLE OF HIGH-RISE HIGH-INCOME HOUSING

logical means, and has become an accepted type of luxury living. Terrace gardens, swimming pools or outdoor pavilions are some possible other features of private terraces. Once multi-storey condominiums began to be designed intentionally with high-rent penthouses, these might be formed by series of setbacks or double-height units that make for ample views and open spaces.



*MAGNIFICENT VIEWS,
LUXURIOUS PRIVATE POOL*

Fig.1-16 A luxury condominium project with a swimming pool for each unit.

2. FORMS OF TERRACE HOUSING

2.1 Indigenous forms of Terrace Housing

The appearance of terrace architecture has been known as the architectural inheritance from ancient times which have, in fact, shown an exceptional richness in creation of open space above the ground. Examples of of terrace housing are the hanging garden of Babylon, the traditional habitat of numerous mountainous land where the houses are grouped at the sloping side, and other indigenous housing with specific needs of outdoor terrace space.

The hanging garden of Babylon, known as one of the seven Wonders of the world, has been described as a 'built paradise' which provided the largest garden built on terraces more than 3000 year ago with amazing ancient technology. The platform was built on the two-meter width brick column and covered with one to two meters of plant earth which allow the implantation of big trees. The terrace of paving tile of 4.50 by 1.30 meters. These blocks were covered by a bed of reed mixed with a great quantity of asphalt for water proofing. The terraces has plenty of vegetation maintained by irrigation system, and various kinds of animal lives. (Barret 1988)

Nuristan village houses, clustered along the steep slope of the Hindu Kush mountains in Afghanistan, show the unity of housing that depending on each other. There are a couple of hundred dwellings, which are packed closely together, terraced against the mountain sides. A Nuristan house will have a ground floor for keeping goats or cattle, and an upper floor used for main living



Majorca, Spain

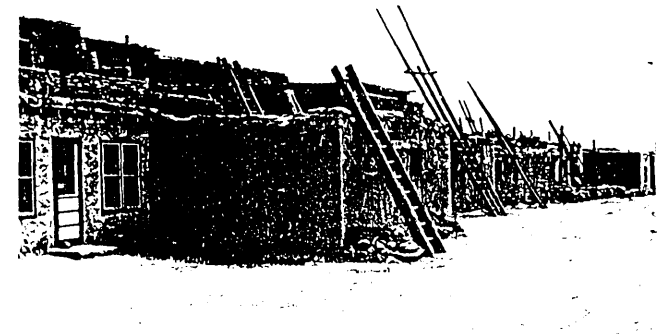


Nuristan village houses, Afghanistan

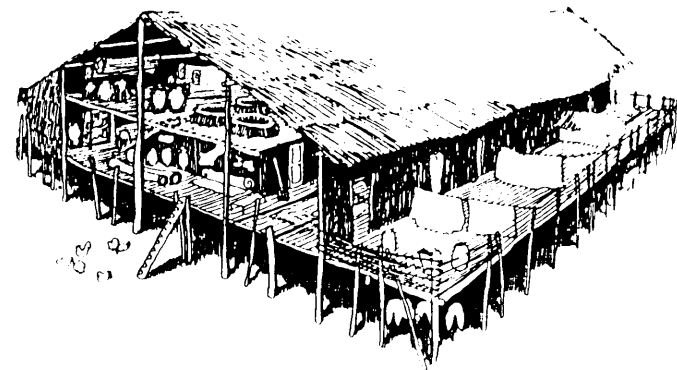
space, with private rooms dug into the hillside at the rear. The flat roof of a unit serves as a social space and access to the upper unit. These built terraces are the important daily working spaces for the Nuristanis who are the skilled craftsmen. The base of the house attached to the hillside is usually of stone and the upper parts are built with timber frames filling with rock and earth. In some parts of a terrace a verandah, supported by long forest of poles projecting from the living area, provides a roof for the working area. (Oliver 1987)

Acoma, the terrace houses in the Arizona desert, are lined on long terraces with dividing walls between the dwellings, which are stepped back to upper storeys at the rear of each block. The houses were built of mesa stone bonded with a cement of sagebrush ash mixed with earth and water. Access to most houses is by ladder of the front storey where a trapdoor led to the interior. The purpose of providing the stepped terrace is to give privacy to each dwelling and to define territory by individual access.

One example of an indigenous apartment building in tropical climate is the Iban longhouse in Sarawak. It has the tropical character of rising platform above the ground to avoid sudden flooding, and provide ventilation and sometimes usable space below. The long pitched roof over the sleeping and living verandah gives protection from rain and hot sun during the day. The outdoor space on the platform linking with other sections, is used for common work and social place gathering in the cool of the evening. The two-storey living space over the platform of the whole long-house can accommodate 160 families. (Oliver, 1987)



Acoma, the terrace houses in the Arizona desert



Iban longhouse in Sarawak

From the second half of the last century, many cities whose historic center was located in low-lying areas, extended up to the surrounding hillside. In these areas terraced construction happened by means of the rise of the hill. Since open space on the flat ground are limited, terraces can provide usable open space on the slope.

The above examples of housing with above-ground outdoor space show that some are constrained by having space on ground, such as housing on steep slopes, and some provide terraces for specific needs of space above ground, such as privacy, view or ventilation. These creations of environment above the ground are, to the author, an important application to the quality of housing in development of multi-storey apartment building today.

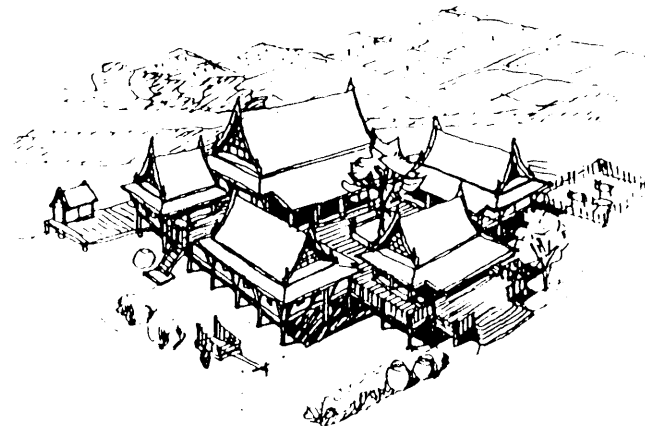
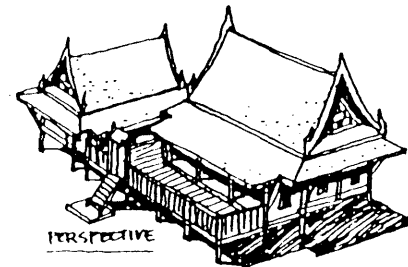
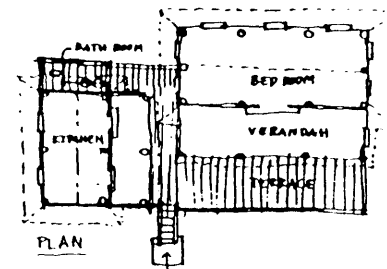
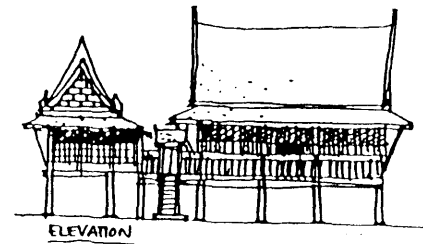
2.2 Terrace of the Traditional Thai House

Description of the Traditional Thai House

In the first decade of the present century, an English painter named P.A. Thompson passed a pleasant day touring Bangkok by boat, then still the most convenient way to explore Thailand' capital. On one suburban Klong, or canal, he came across a number of houses "of the typical, low country type," which he described as follows:

"A platform of teak planks is supported on piles, six or seven feet above the level of the ground, and approached by a ladder leading down into the klong. Opening on to two sides of the platform are little houses, also built of teak, with graceful gable ends curving upward to a sharp point. In the city the roofs are tiled, but here they are generally thatched with attap. If the people are very poor, perhaps they will only have a platform of bamboos, and the walls of the house will also be split bamboo and attap interlaced. The platform is often gay with flowering shrubs, amongst which brilliant butterflies flit about. It forms the courtyard, from which it is only a step up to the floors of the houses. The sleeping-rooms are at the back, but in front and open to the platform are deep verandahs, in which the family live during the day". (Warren 1988)

Providing an ideal solution in the environmental sense, traditional buildings show various techniques in coping with local climate and reflecting Thai ways of life. The traditional Thai house has various qualities due to the creation of an above-ground environment.



Characteristic of the Traditional Thai House

Elevated floor

The floors of Thai house are elevated for several reasons:

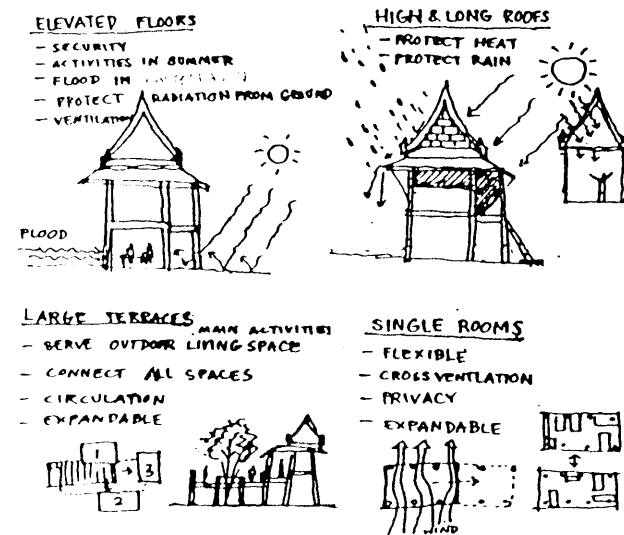
- Escaping from flood and the wet land during the rainy season
- Safety from dangerous animal and thieves during the night
- Keeping the underside of the building dry and clean by lifting it above ground
- Reducing heat gain by the wind blowing underneath and less radiation of heat from the ground
- Providing spaces for storage, weaving, handicrafts and keeping family animals

Many levels of elevated floors are stepped, usually 40 cm different, from terraces to verandahs to bedrooms for ventilation, surveillance space underneath, seating.

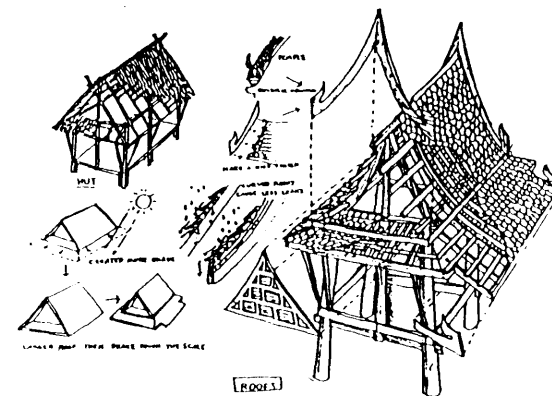
High and long roof

Gable and hip roofs of the Thai house have a lot of advantages for its hot and humid climate:

- A high roof keeps the roof tiles, such as ceramic, palm or coconut leaves, from leakage by fast draining. A high gable roof keeps hot air raising high and provides ventilation on both side of the gable facades.
- The long cantilever roof provides ample shade and rain protection.



FORMS & FUNCTIONS



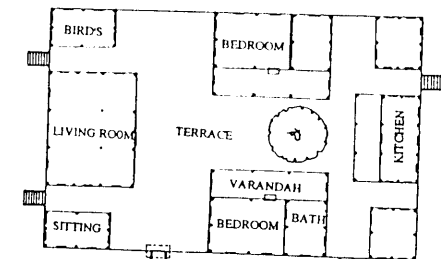
Terrace

The terrace, or open platform, usually takes 40 percents of the total area (rooms, verandahs and terrace). If the terrace is included with verandah areas, total outdoor living will be about 60 percents of the total area. The reason of the great amount of outdoor space is need for open space for various activities as well as response to the hot and humid climate. Therefore, the terrace has become as important for living as the internal spaces, such as the bedrooms and kitchen. The dining and living areas are usually placed under verandahs or pavilions outside the building, which are shaded and get wind breezes. These spaces are the ideal place for living activities. The terrace, which is open to the sky, may still get some shade from surrounding trees and from nearby buildings, is the ideal place of more active functions, such as enjoying fresh air and cold wind, as a play area for children, getting sunlight for planting, cloth drying, preparing food and handicrafts. Most social activities normally take place on the terrace in the evening.

A terrace surrounded by a group of houses is like a community plaza, or "street in the sky" to serve as a common meeting place. For special events, such as marriage and religious ceremonies, the terrace is the place for these activities. The terrace connects all spaces (bedrooms, kitchen, children room, family room, verandahs and pavilions). Thus, several units of an extended family can be accommodated by sharing facilities, such as kitchen and bath. The continuity of the terrace space allows numerous variations of housing arrangements and expansion.



View of a terrace of Thai house



Plan of a courtyard terrace of a single-family house

2.3 Terrace Housing Developments in the 20th Century

The pioneering movement in modern architecture has experimented with the use of diagonal elements of composition as a direction of development in Architecture. One of the earliest ideas of stepped-section building was the project of the industrial city by Tony Garnier in 1901.

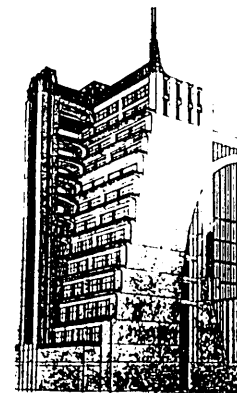
In multi-family housing, It was found in 1914 in the project "city of the future" by Antonio Sant'Elia, Italian futurist. The design of stepped form by the German expressionist is shown in the project "Haus der Freundschaft" in Istanbul in 1917 and the project "Festival Hall" in Salzburg, Austria in 1920, both by Hans Poelzig. In 1917, J.J.P. Oud's project for stepped and staggered houses along the beach at Scheveningen followed the progressive De Stijl movement by breaking down the elements.

Adolf Loos's plans for Hotel Babylon in 1923 used the stepped profile of 'set-back' houses, but seems to lack discipline, and again his group of twenty houses on the Côte d'Azur designed in the same year, share the roofs of each lower house to become a succession of terraces and gardens. He was always anxious to recover 'lost' space for children's play areas, private open space, etc. Then in Paris, in Sauvage's social housing, a rigorous view of a modern terraced city enclosing a swimming pool, became a reality in 1925.

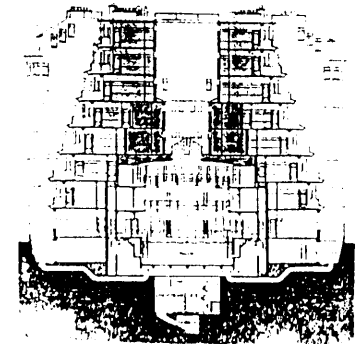
Le Corbusier's drawings for an art school (1910) had found a solution to the pyramid with terrace studios each opening up to a small garden for working outside. In 1933, Le Corbusier planned a series of terrace building, as for



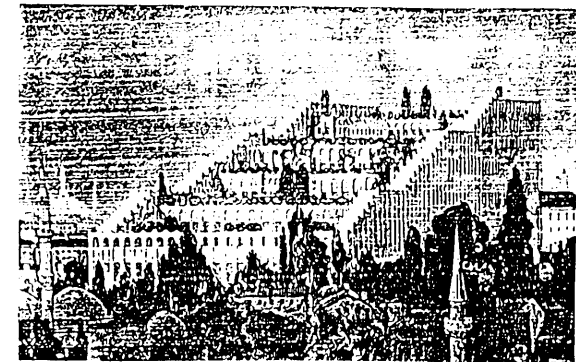
Tony Garnier. Project of an industrial city. 1901.



Antonio Sant'Elia. "City of the future". 1917.



Henri Sauvage. House in Rue des Amiraux.



Hans Poelzig. "Festival Hall" in Salzburg, Austria. 1920.

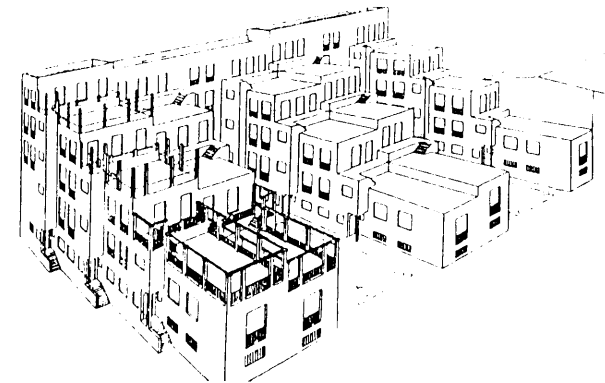
example, the Durand apartment project in Algiers (1933-34). But, these were never constructed.

In the 30's many projects of terraced houses and urban buildings were published of which some are worthy to be mentioned in the ideal plan of the "new city with hillside homes" by Guiseppe Vaccaro (1936). There was also the Kauttua complex of terrace houses (1938) by Alvar Aalto in which the ceiling of the lower unit becomes the terrace of the upper unit and which can be seen as a classical prototype of a series of successive analogous constructions.

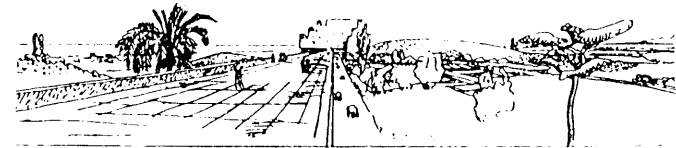
Terrace Housing in Switzerland (Chiaia 1979)

Immediately after World War II, sporadic construction of this type occurred mostly in Switzerland due to the persistence of the rationalist credo, the interest in the cube, and the composition of enclosed and level facades. This can be seen in a large amount of the projects and constructions on hillside.

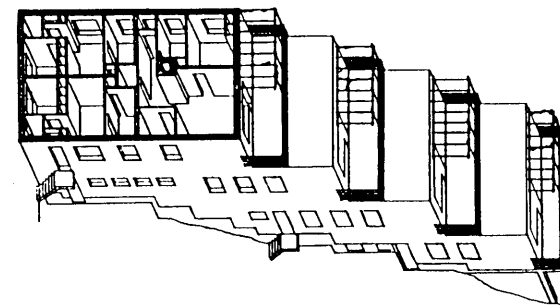
There are many reason for which the first construction of houses and terraces came together in Switzerland. In Switzerland, due to the need for new housing because of a rapidly growing population and immigration to the cities, and due to an already high level of income, a construction boom of large proportions occurred in the 60's. This situation was made difficult by a scarcity of available land traditionally suited for flat site construction. This produced an obvious, large increase in the costs of land and the resulting need to use sloping land. In many communities, flat land suitable for construction became rare so that the more important housing complexes could only be constructed in hillside areas.



Adolf Loos. Group of 20 houses with roof garden. 1923.



Le Corbusier. Durand apartment project, Algiers. 1933-34.



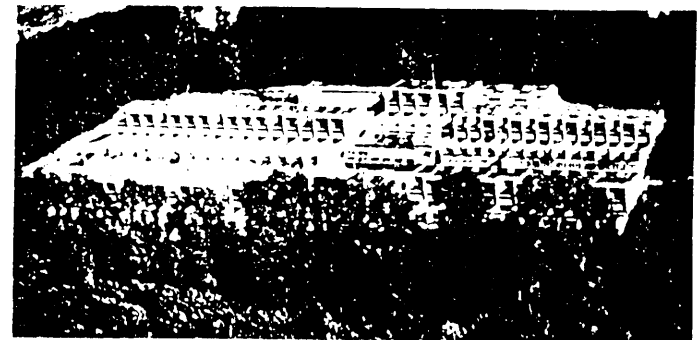
Alvar Aalto. Kauttua complex of terrace houses. 1938.

It is in these areas that the first terraced houses and the first large terrace complexes were built experimenting with new structural and construction methods suitable for such a terrain.

Moreover, in Switzerland, the high level of technical construction skills in construction produced buildings of great perfection which favored the continuation of this process and confirmed the obvious advantages of this type of construction. This corresponded to the persisting ideal of the Swiss that each person should have his own, separate unit. These new systems quickly spread to almost every part of the country.

Also it must be remembered that in Switzerland the principle of ownership, in other words multi-storeyed condominium building, is almost unknown (in the type of building, the units are usually rented and not owned) and that ownership of a house and land are as a rule related).

In many areas, where it was forbidden to build a massively vertical structure, stepped buildings along the slope were not prohibited. Some of the first terrace houses were constructed according to the idea of 'hiding' or harmonizing with the landscape. These are projects of widening partially open space yet respecting the existing single-family units sitting directly on the sloping terrain. These could be considered as ground-covered structures or 'carpet housing'. In various cases, this device remained legally valid and their constructions was regularly authorized. The concept of "carpet housing" was transformed from a stepped form of a hill side to the built environment, which early conceived by



Atelier 5. Siedlung Halen complex, Switzerland. 1961.

Tony Garnier in 1901. The most famous built application is the Siedlung Halen complex in Switzerland (1961) by Atelier 5.

Determined to develop terraced constructions in Switzerland, the local authorities devised non-conventional methods for dealing with housing problems taking into consideration the lack of available land and the need to prevent the deterioration of the terrain and countryside which would be inevitable with the spreading out of single family, detached units. It was the great number of steep, sloping hills and mountains in Switzerland which were the true inspiration for a large number of terraced projects constructed up until today.

The influence of the specific geographic conditions were evidenced during the rationalist period of the 30's: it is important to remember the neighborhood of Neubühl: of great architectural interest, constructed in 1930-32 in La Werkbund, Switzerland. The design through a graduation of the hill pointed already to the possibility of terraced housing. Also the construction at Lebustrasse in S. Gallo (1954) by Dauzeisen and Voser, follow the slope of the hill with relation to the existing housing scale, and the complex at Biserhof also at S. Gallo (1956-57) and by the same architects not being a true and actual terraced, sloped construction, are clear examples of the Swiss appreciation for construction design and for organized insertion of local countryside hill constructions.

Some well known hillside terraced constructions in the 60's are: (in addition to those already mentioned at Zug by Stuky and Meuli (1954-60), the complex in



Dauzeisen and Voser. Lebustrasse , S. Gallo. 1954.

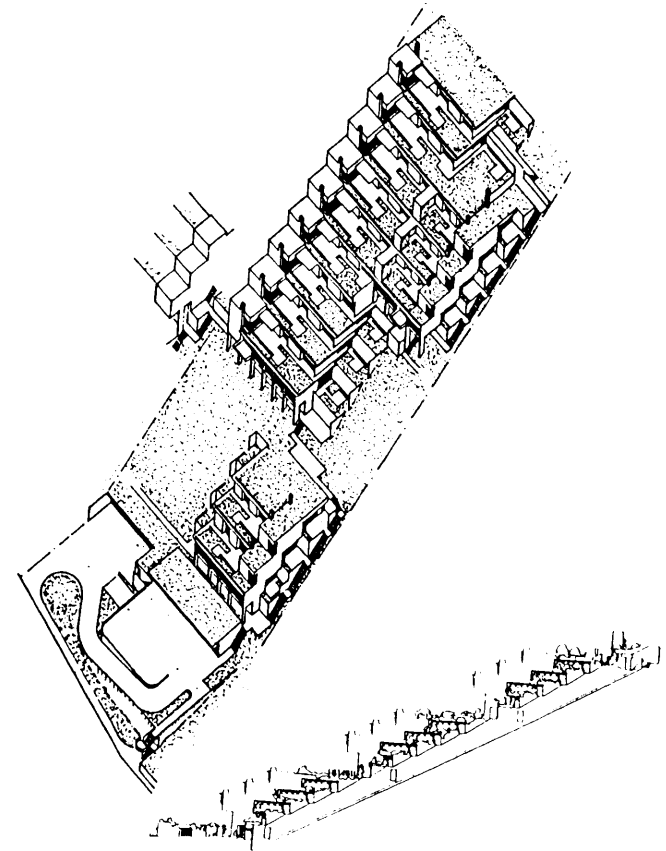


Stuky and Meuli. Zug. 1954-60.

Eirbrectstrasse of Witikan (1959) by Cramer, Jaray, and Paillard, the most well known terraced house at Witikan, Zurich (1959-60) by Paillard and Leemann, the installation at Unterziggenthal by Frei (1962-63), the residential installation at Orselina (1962-65) by Muhlstein constructed using prefabricated elements and the one of Corsier on Lake Geneva (1965) by the same architect, the three groups of terraced houses in Oberengstringen near Zurich (1964) by Bonalli, the complex of housing units in the Via Caselle in Orselina (1964-65) by Studer, characterized by the distribution of the units inside as well as outside the construction; the large complex in Zollikeberg (1965-68) by Monti and Kast. Often terrace buildings are being planned to harmonize with the profile of the surrounding hills and mountainscapes with rather advanced building technology. (Terrassenhauser 1974)

The most successful constructions of the 60's in this area, however, are probably those of Scherer, at Burghalde in Klingnau (1959-69) and the Muhlehalde in Umiken Brugg (1963-65). This last one is part of a vast plain (Brugg 2000) of tower buildings in a valley and stepped terraced construction on the lateral slopes served by an inclined elevator connected to a horizontal pedestal.

In addition to Swiss examples, other foreign examples are noteworthy, such as the terraced houses at Skoustanik near Stockholm (1957-60) by Kandell; the residential complex in Ullernaasen near Oslo by Friis, terraced hotel in Eboltof, Denmark by Friis and Nielsen; residential complex in London (Camden and Thamesmead), the most well known student housing structures in England.



Scherer. Muhlehalde, Umiken Brugg. 1963-65.



Friis. The residential complex in Ullernaasen, near Oslo.

It must be underscored that terrace complexes are not bound to a specific, formal orientation. Therefore this kind of solution can take on rather different shapes and be adapted to various functional scopes. In fact, terrace construction does not necessarily constitute an exclusively residential typology. It may also be applied to buildings such as schools, hospitals, hotels, etc. particularly in construction of academic buildings.

From Switzerland comes an efficient idea which is significant to modern, sensible housing and construction possibilities, which combines harmonious new ideas of private living and the need to take into consideration the aspects of higher-density housing forms and environment.

Terrace Housing and Development

The general requirement of dealing with this type of project which takes into consideration the needs of modern life, manifests itself in a renunciation of the flat facade, and the promotion of the three-dimensional elements and the rebirth of exterior space. This is the definitive modern affirmation of the general architectural principle valid above all as a definite direction of development for an integrated architecture of the city.

However, in housing, everything comes into play: form and function of a dwelling and of complexes, organization of community life related to the life of the individual, the relationship between city and countryside, city legislation and building codes, the concept of ownership, the relationship between the street, traffic and housing, and existing visions of the cityscape.

The problems remain naturally open to many solutions. It is undeniable that terraced houses, hill-side housing, pyramid residences and cluster terrace housing represent a present ideal for housing in the city and are based on concrete solutions which are becoming ever more interesting in the experimentation and planning of new conceptual and technical ideas in architecture and urban design

the diagonal can also be artificially created in the form of superimposed platforms.

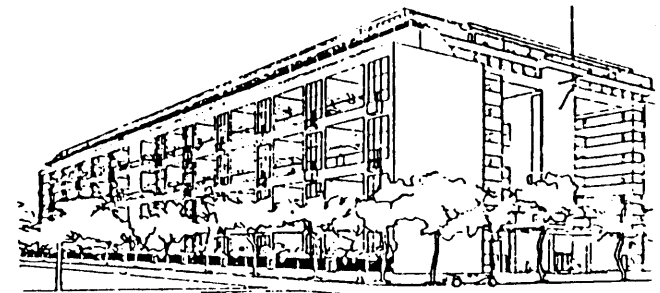
If the angle is steep enough, the houses must be stepped up on top of the lower unit; the free space is on the roof of the house below. The steeper the slope, the shorter the necessary distance between buildings, which means the density is also increased.

Vertically Stacked Terraces

It has been remarked that terrace housing is not always a stepped form or a pyramid architecture. Terraces could be provided vertically as well. When the demand for outdoor living space has become general, provision of efficient balconies is to be considered. Projecting large balconies off the building facade is another way of providing individual private open space. This idea can be seen in many modern housing blocks.

In Siemensstadt housing development, Berlin (1930), planned by Walter Gropius, a building designed by Otto Bartning gave an alternative building by extending terraces from the facade of the linear building. This is the solution of providing terraces for a linear block that was strictly planned by Gropius.

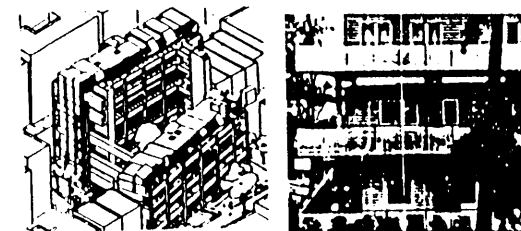
In Le Corbusier Work, Immeuble-Villas (1922) and the Proposal for New Algiers Viaduct Block (1934) showed the attempt of providing each apartment with a private suspended garden, double-storey height terrace, but the building



Le Corbusier. Immeuble-Villas. 1922.



Walter Gropius and Otto Bartning. Siemensstadt, Berlin. 1930.



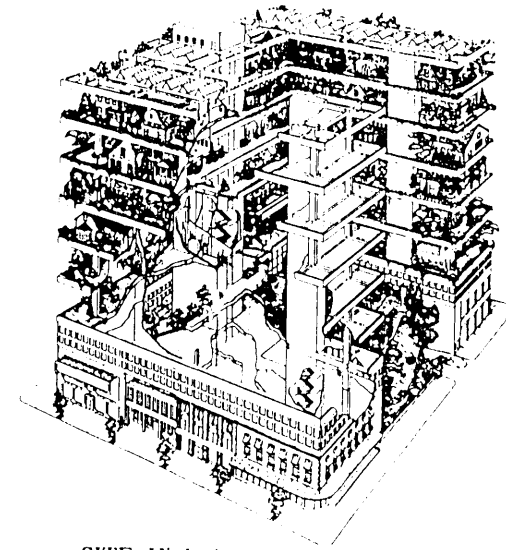
Werner, Barnes, Toan, Lunde and the Keene Corporation. "Adaptation of Townland Housing System" in the 70's.

elements were all based on the super-block. The idea of the 'free plan' by Le Corbusier called for a high degree of freedom of flexibility in layout in his designs.

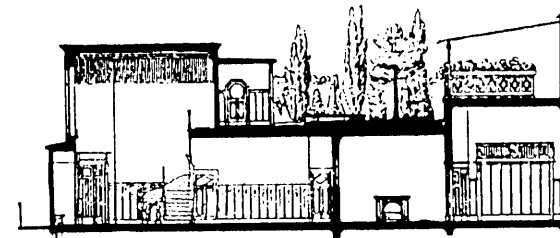
In the 60's Friberger's Gothenburg experiment in Sweden presents multi-storey housing blocks with the separation of the structural system and the removable dwelling units. Each unit has the opportunity to remodel its spaces on a "land in the sky". With the same idea in the 70's, Warner, Barns, Toan, Lunde and the Keene Corporation created the "Adaptation of the Town Land Housing System" ("Operation Breakthrough") for housing in Seattle. The latest experimental condominium by SITE, called the High-rise of Homes, is a prototype of stacked terrace housing intended for construction in major cities. The building, composed of eight to ten stories supported by steel and concrete matrix, will allow life-style choices for the individual houses and gardens in the mega-structure. It is based on the premise that "people need the personal affirmation and territorial definition associated with the detached 'house' even though living in the compressed environment of a multi-storied structure."

Roof terraces

Roofs of buildings in the city are a simple way to provide livable open space, since most spaces below are too tight. Roof gardens have developed for a long time in most European cities. Most of the rooftop units or artist lofts, are a preferable place for privacy, view and a private open space. A roof garden in Wilmersdorf, Berlin (1910) created by a private owner, built on top of an office



SITE. High-rise of homes. in the 80's.



A roof garden in Wilmersdorf, Berlin. 1910.

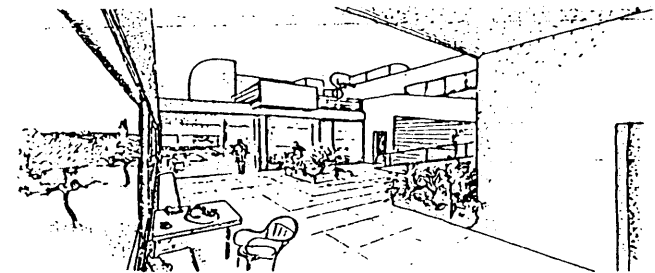
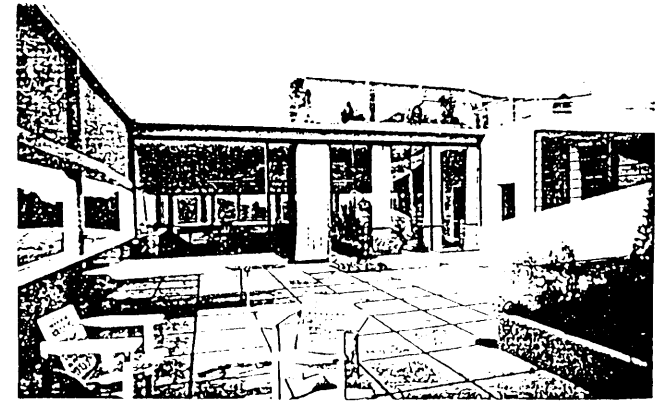
block, give a natural quality to the living environment by integrating open spaces and garden.

One of the most impressive example of the constructed exterior space on top of a building is the large enclosed outdoor living room of the Villa Savoye of Le Corbusier. This roofscape is situated in the enclosed volume with horizontal window arrangement of the adjoining living areas. This terrace offers a spatial entity of an outdoor living room.

A communal roof deck may also be developed on top of a housing block or on the flat roof of a garage building to provide for useful communal activities for the residents in a convenient and pleasant environment. To learn how to produce roof terraces at a reasonable costs, it took builders several decades before theoretical knowledge became general practice. Today the uses of roof terraces have become fairly general due to the lack of green area.

Artificial Hill Terraces

While hillside terraces often lack openings for cross ventilation when placed against a hill and create difficult access for parking, they have a lot of advantages in terms of private outdoor space. The decline of individual units has encouraged some architects to try the same form in an urban context (without hill).



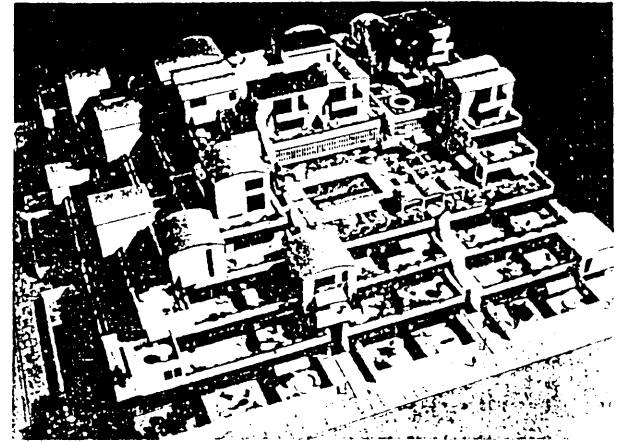
Le Corbusier. Villa Savoye. 1929-32.



Combining two terraced buildings on a flat land, connecting shoulder to shoulder, the "hill-like terrace" ensues. Their stacked units provide large terrace gardens in the front, like hillside terraces, but instead of working on a natural slope they imitate a artificial one. The hill-like terrace sections have almost triangular or trapezoid shapes. The rear side of the terrace units are given an internal space for various purposes or can be filled with more unit spaces.

The underside of the space of a terrace structure or 'belly', which can be more or less large according to the number of floors, the angle of stepped forms and the distance between the two opposing structures, can be used in part as a common area for the residential units and as well as a space for commerce. The ground floor can be designed for stores as well as garages. The central space can be either open-air or enclosed and also can be designed with skylights and air-conditioning. The internal space of this type of structure lends itself to more various and articulated solutions and allows very dramatic architectural solution.

In the early 1960's, DeMars and Reay suggested such a structure for Santa Monica, California. By utilizing the space under the terraced housing, one of the advantages is that the parking is at the same level as the house entrance, which is common in single-family housing but rare at higher densities. In addition to the private yards, a stepped structure was used for communal and semi-private outdoor spaces in a manner similar to that of walk-up housing. Although this project was never built, it was widely publicized and had its affect on subsequent developments.



DeMars and Reay. Structure for Santa Monica, California. 1960's.



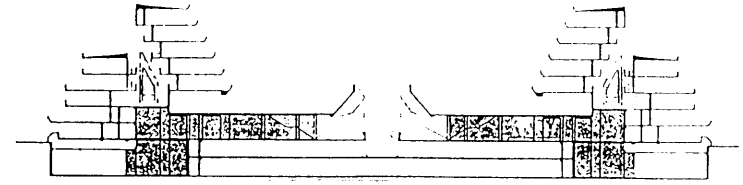
Faller and Schroder.. Weststadt, Frankfurt.

In Europe a more concrete hill-like housing solution is the one by Faller and Schröder. The architects had their first success with a proposal for a "hill" of terraced houses in a competition for "Weststadt," Frankfurt-on-Main. In principle, a "housing hill" of this type combines a number of different housing types in a single unit which also provides indoor parking space, community premises, and shops. This housing not only provides spacious rooms with the outdoor garden opened to sky, but is also a new housing prototype avoiding a major drawback of conventional blocks of flats.

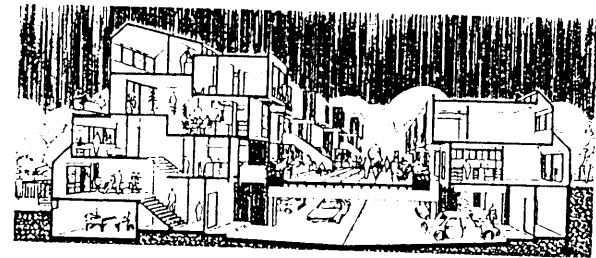
Courtyard Terraces

It is difficult for higher-density housing to provide open space of recreational space on ground level, since most area on ground are garages and other service areas. In many solutions, the elevated space in between two parallel building structures is planned for greenery or for pedestrian walkways. This occur very widespread in many urban plazas.

The courtyard terrace of the two housing blocks in Bloomsbury, London (1970-71), by Patrick Hodgkinson, retained the character of the neighborhood by providing open space for pedestrians, including town facilities such as shops, supermarkets, cinema, restaurants, cafes, etc. Coldspring housing (1972-81), a low-rise, high-density development designed by Moshe Safdie, gives every unit a garden on the ground or on a roof. The typical maisonnettes and townhouses are jointed by a pedestrian mall with parking area underneath.



Patrick Hodgkinson. Bloomberry, London. 1970-71.



Moshe Safdie and Association. Coldspring Newtown, Baltimore. 1972-81.

These 'deck houses' succeeded in combining the qualities of communal and private space.

Clustered Terrace

The idea of breaking the monotony by aggregated elements of housing was explored after the failure of providing mass housing with over-repetitive and bureaucratic ways. Many approaches to the design of cluster terraces in the modern period have played with technological systems, such as kit of parts. Expo '67 Habitat by Moshe Safdie is the most famous of the terraced building prototypes in clustered forms. Variation of unit arrangements was explored. Prefabricated units were possible to be arranged in various compositions.

A similar approach of planning and construction of a terraced structure is the one of Candilis, Woods and Josics based on a progressive pattern of both twisted space in plan and stepping forms of the lower and upper floors. The areas of the twisting and setting back of rooms make up the terrace of the adjacent units.

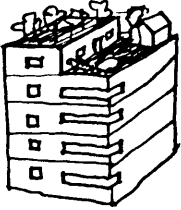
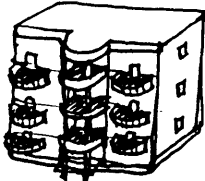
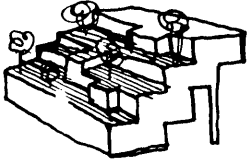
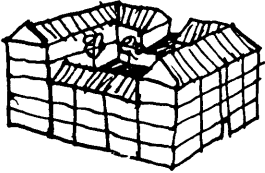
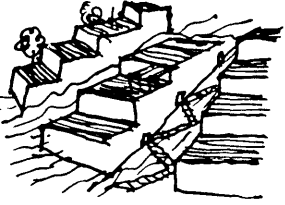
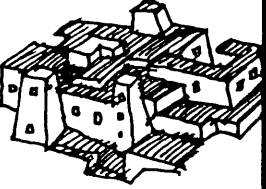
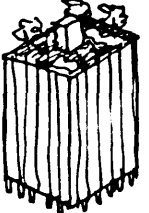
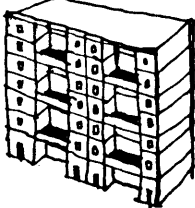
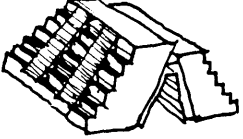
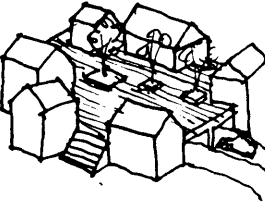
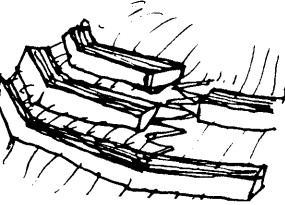
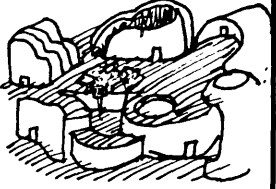
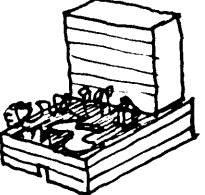
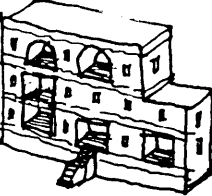

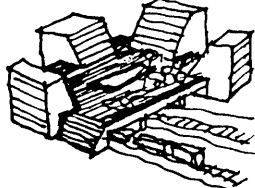
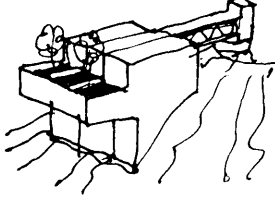
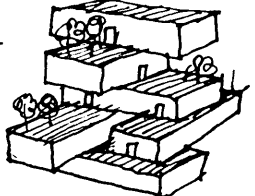
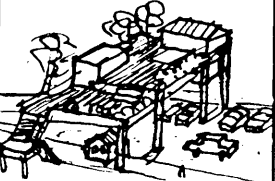
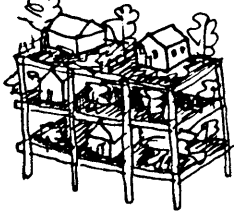
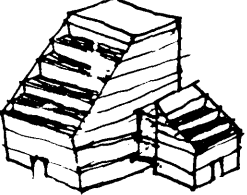
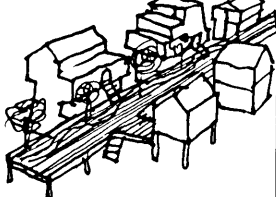

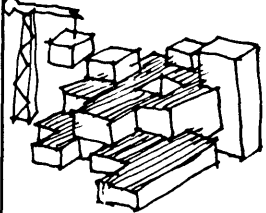


Moshe Safdie. Expo'67 Habitat.

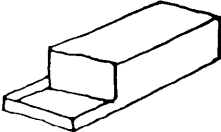
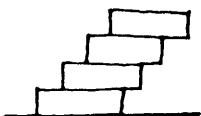
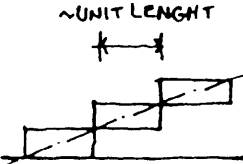

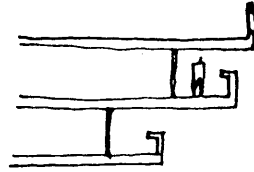
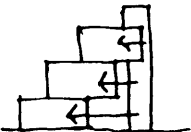
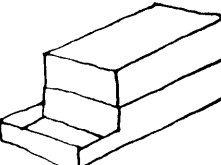
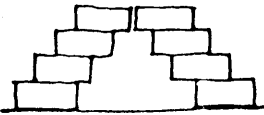
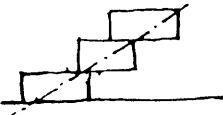

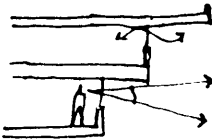
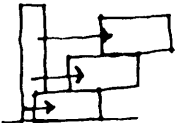
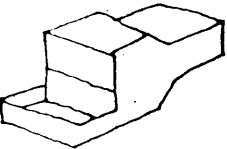
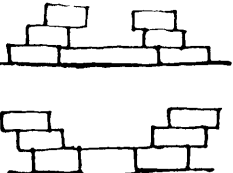
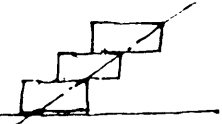
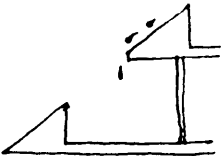
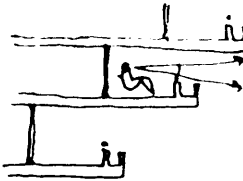
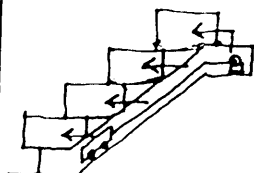
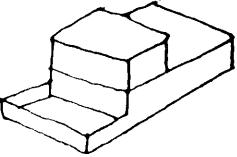
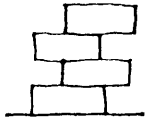
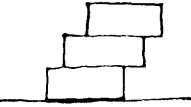

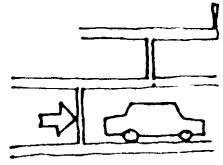
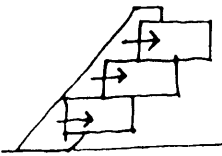


Candilis, Woods and Jessica. Residential Building in Gran du Roi

FORMS OF BUILT TERRACE TYPES

ROOF TOP	VERTICAL STACK	STEPS ON GROUND	COURTYARD	HILLSIDE	CLUSTER
 PENTHOUSE	 EXTENDED FACADE	 FREE STANDING	 ENCLOSED SPACE	 ALONG THE SLOPE	 RANDOM SETTLEMENT
 TOWER TOP	 TWO-STOREY HEIGHT	 ARTIFICIAL HILL	 OPEN COURTYARD	 ALONG THE EDGE	 ORGANIC FORM
 PODIUM TOP	 BUILDING HOLE	 PYRAMID	 PLAZA	 EXTENDED FORM	 SHIFT STACK
 ELEVATED SLAB	 EMPTY FLOOR	 SET BACK	 PROMENADE	 BRIDGE	 ADDING/SUBTRACTING

TYPOLOGY OF TERRACE BUILDING

UNIT TYPES	TERRACE TYPES	SLOPE ANGLES	PARAPETS	REAR SIDE	CIRCULATION
 SINGLE FLOOR	 FREE STANDING	 SLOPE < 50%	 DIAGONAL WALLS	 CORRIDOR	 VERTICAL / REAR
 DOUBLE FLOOR	 ARTIFICIAL FILL	 SLOPE 50-75 %	 HORIZONTAL / VERTICAL WALLS	 WINDOWS	 VERTICAL / FRONT
 SPLIT LEVEL	 COURT YARD	 SLOPE 75-120 %	 ROOFS	 TERRACE	 DIAGONAL / REAR
 ONE AND A HALF FLOOR HEIGHT	 CLUSTER	 SLOPE > 120 %	 PLANT BOXES	 SOLID	 DIAGONAL / FRONT OR INSIDE

3. FUNCTION AND QUALITY OF TERRACE

3.1. Spatial Requirements

Activity Requirements

Families need private and communal exterior space to accommodate daily and leisure activities of both adults and children.

"In the physical environment fit for man to live in, in the fullest sense, humanity must be able to see, touch, smell and scent of plants, and the songs of birds and insects, cannot be enjoyed expect through unhurried contact ... All this demands dwellings close to the ground with easy access to outdoors, an organic whole in which indoors and outdoors are integrated in a single comprehensive shelter".¹

Many daily activities often occur outside the dwelling. For example, children's play, adult socializing and various forms of outdoor recreation. In higher-density housing where exterior facilities on ground cannot be provided, or is difficult to access, because most spaces on ground are used for parking and covered by the building structure, these activities often happen in parking areas, corridors or on roof decks.

¹ Chermayeff & Alexander, Community and Privacy, Doubleday & Co., P. 62

While terraces in lower-income housing are mainly used for basic needs only, such as drying clothes or cooking, outdoor terraces in higher-income housing may have additional special features, such as serving recreational activities. To have a similar quality as in nature, like in detached houses, luxurious units are usually located on top of the building such as penthouses, or units near the swimming pool, garden, or large outdoor open spaces. A large private terrace can create a special atmosphere of extended space to the living or dining room that gives a feeling of being in more open and flexible space, and also the possibility to move readily in or outside the interior space. A well designed terrace can provide an outdoor environment that may have features similar to those found at the ground level, such as lawn, garden and leisure area, with more privacy, views and ventilation.

3.1.1 Private outdoor space

The Need of Open Space in Multi-storey Housing

Many private activities often take place outside the dwelling. For example, children's play, exercising, cooking, home maintenance and various forms of leisure. In higher-density housing most units cannot have open space on the ground. These activities often occur on corridors, along the well ventilated windows, balconies or roof decks. Unsuitable space can even limit activities and uses of space. In order to achieve quality outdoor living spaces, size, form, location and details must be defined by activity and environment.

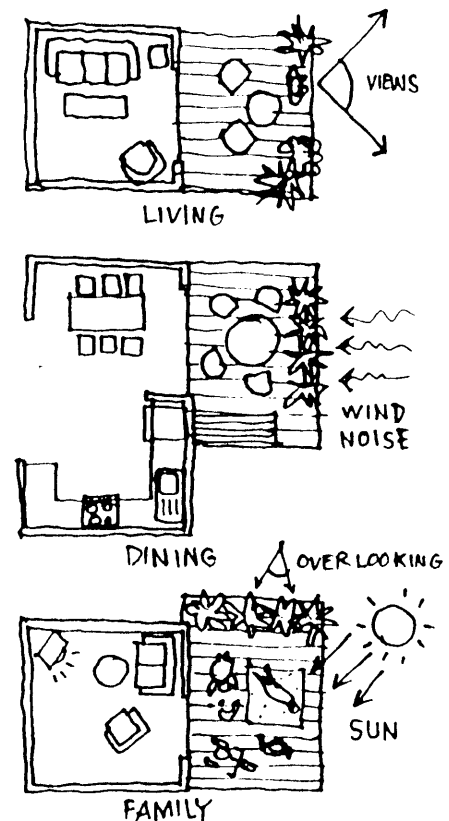
Design Criteria

The purposes of providing outdoor space are

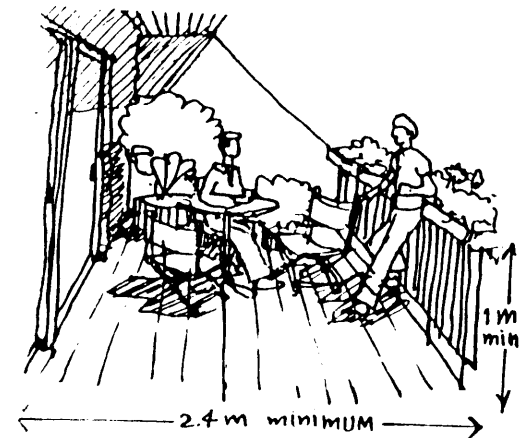
- To provide quality dwelling open space
- To improve privacy within units.
- To improve physical comfort within units
- To increase space flexibility in response to the need of indoor and outdoor use
- To improve the performance of buildings in terms of response to the climate

Criteria for suitability of outdoor private space include:

- Direct accessibility from the unit
- Spaces big enough for outdoor activities
- Orientation to the best view



- Privacy in terms of noise and overlooking other units
- Safety for children's play
- Response to the local climate; sun, wind, rain, etc.
- If possible, provision for direct access to the ground.



Activities on the Terrace

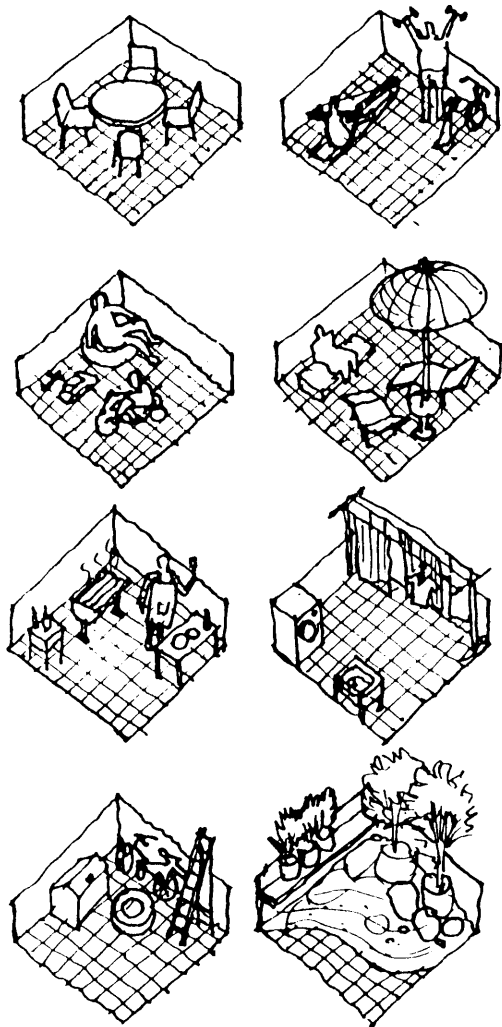
Activities	Examples	Users	Period of time
• Living and relaxing	viewing, sitting, lying down	all family members and guests	in the morning, evening, night
• Growing plants	growing, irrigation and maintenance	all family members	in the morning, evening
• Exercising	jogging, jumping, toddling	all family members	in the morning, evening
• Children's play	crawling, toddling, playing toys	children	in the evening
• Pet keeping	dogs, cats, birds, etc.	all family members and pets	24 hours
• Having snacks, meals	eating	all family members	in the morning, evening
• Playing games	cards, golf putting, Thai games	all family members	in the evening and night
• Cooking activities	grills, fry, drying under the sun	housewife and maid	during the daytime
• Laundry	washing and drying cloths and linen	housewife and maid	during the daytime
• Special occasions	parties, ceremonies, religious activities	all family members and guests	during the day, in the evening
• Emergency	fire escape	all family members	anytime

Size of Private Outdoor Space

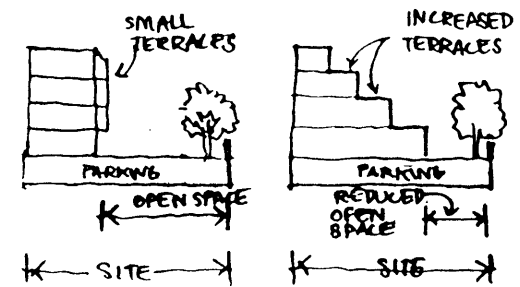
To accommodate most activities, the minimum personal outdoor space for families with children should be no less than an internal living space (the aggregated living, dining and kitchen space). When a balcony is larger and becomes a part of a living place, it is more likely to be called a 'terrace'. Generally, the terrace having a depth of 6 to 8 meters is almost the maximum reasonable depth since the reasonable span of residential building is usually no more than about 8 meters. Yet, a depth less than 2.4 meters will cancel out the functionality of the terrace, reducing it to a simple balcony. The reason is that activities on terraces will be limited if less than a size of a small room. However, any private open space is better small than none at all.

With a width of the terrace equal to 2.4 meters it is possible to eat outdoors, rest and play etc. but this type of terrace would have no room for any plants or flowers, etc. The width of the terrace is more crucial than its length; for example, A square shape of outdoor living area, minimum space of 2.4 x 2.4 m, can accommodate more activities than long and narrow one having the same area.

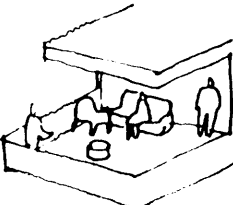
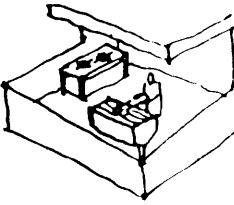
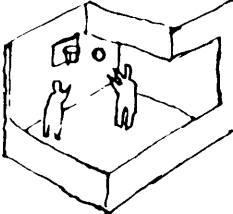
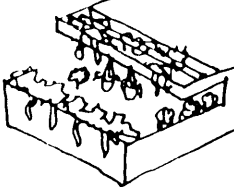
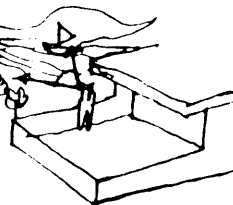
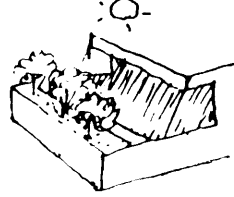
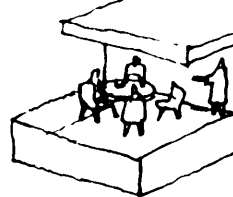
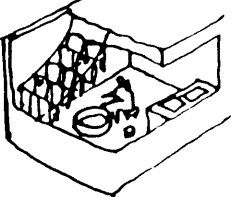
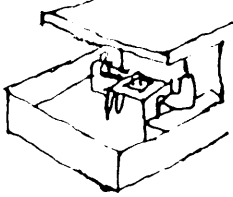
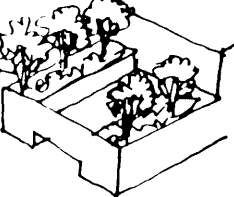
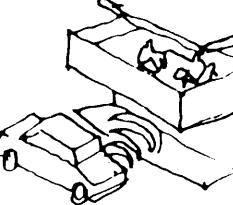
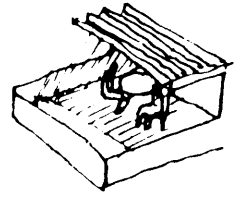
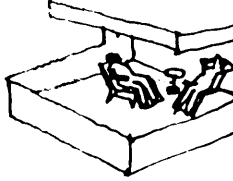
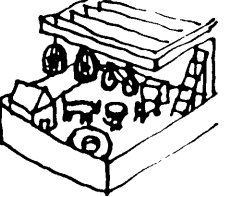
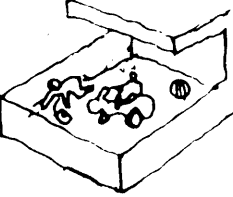
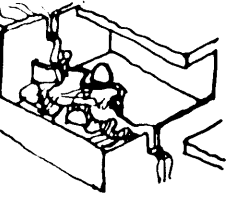
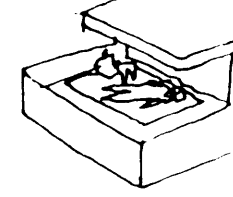
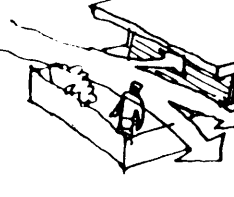
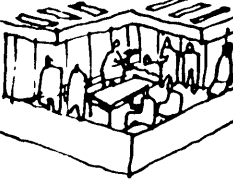
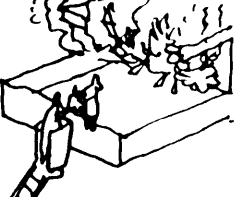
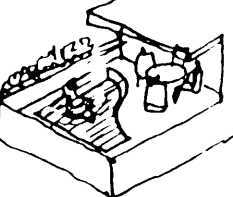
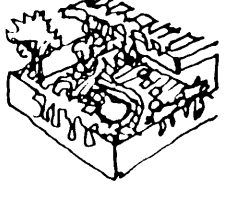
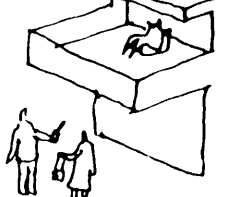
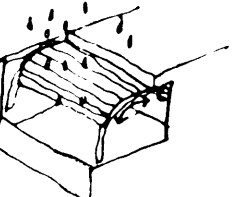
A recent study by the GVRD (Greater Vancouver Regional District) on privacy requirements recommended that each home on the second and third floor have attached private outdoor space, the total area of which should not be less than 40% of the floor area of the home. Outdoor space should be big enough for daily activities. An outdoor terrace should be designed as an out door room (approx. 8' x 12') or minimum 90 sq. ft (about 9 sq.m). (Vancouver 1978)



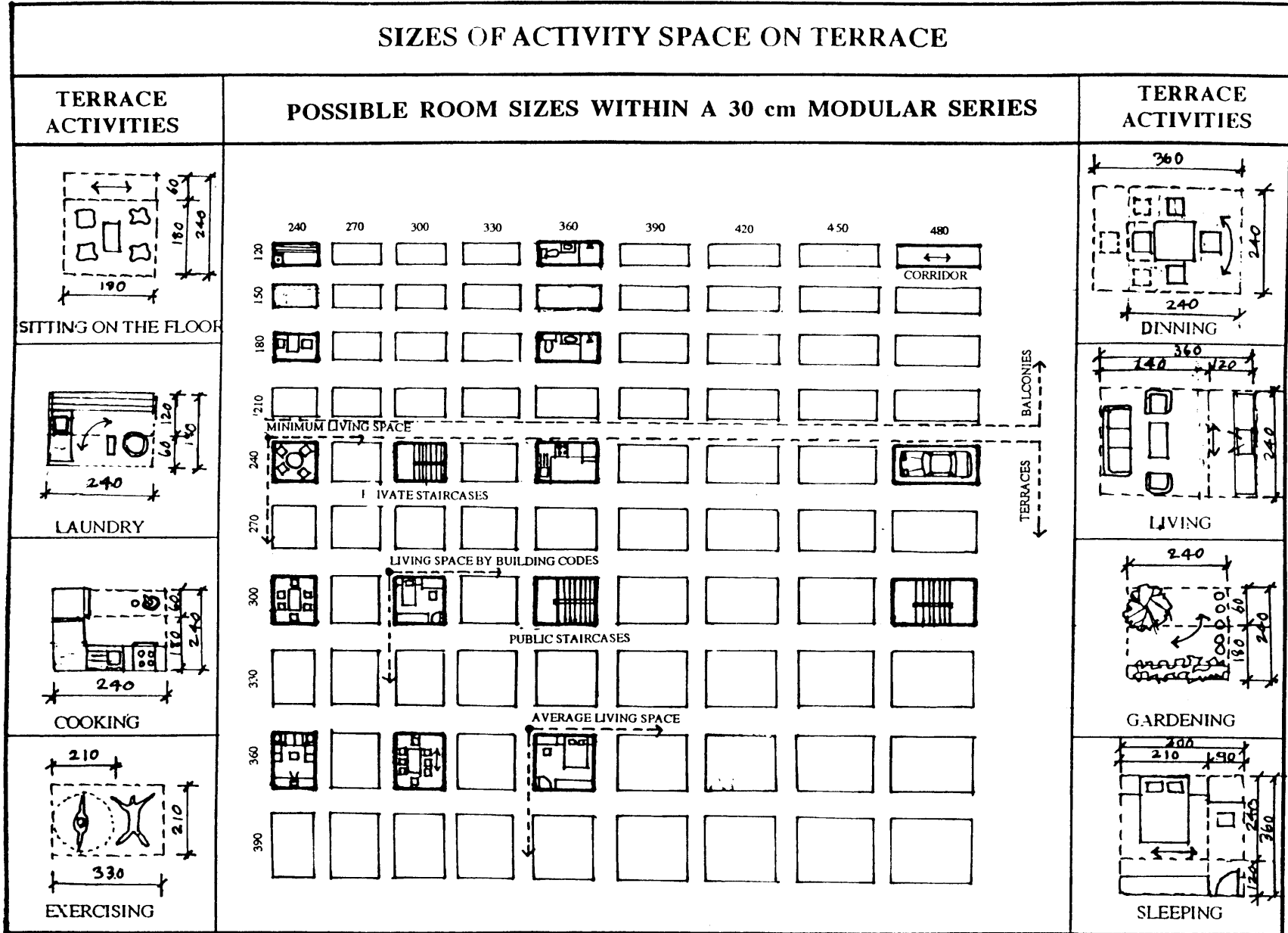
In terms of outdoor activities, the amount of private outdoor space should be scaled against amount of communal outdoor space provided. The lower the unit/acre density, the more active open space can be provided at a private rather than communal level. At higher-densities (>40 unit/acre), communal open space must compensate for small and off grade private open spaces. (Vancouver 1978)



FUNCTIONS OF TERRACES

LIVING AREA	SERVICE AREA	LEISURE AREA	GREEN AREA	GIVING PRIVACY	CLIMATIC RESPONSE
 <p>LIVING</p>	 <p>COOKING</p>	 <p>ACTIVE RECREATION</p>	 <p>SMALL PLANTS</p>	 <p>VIEW</p>	 <p>SUNLIGHT</p>
 <p>DINING</p>	 <p>LAUNDRY</p>	 <p>PASSIVE RECREATION</p>	 <p>LARGER PLANTS</p>	 <p>LOW NOISE</p>	 <p>SHADES</p>
 <p>SLEEPING</p>	 <p>PET KEEPING/STORAGE</p>	 <p>CHILDREN'S PLAY</p>	 <p>WATER FEATURES</p>	 <p>PRIVATE AREA</p>	 <p>VENTILATION</p>
 <p>MEETING PLACE</p>	 <p>FIRE ESCAPE</p>	 <p>SWIMMING POOL</p>	 <p>LAWN / GARDEN</p>	 <p>SAFTY FROM OUTSIDE</p>	 <p>MULTIPLE SHELTERS</p>

SIZES OF ACTIVITY SPACE ON TERRACE



3.1.2 Public Outdoor Space

Public outdoor space can be provided above ground in the form of communal terraces. In order to achieve quality of uses on top of the building structure, a study of providing activity spaces is important. There are different types of potential users of public outdoor terraces and each requires a different type of terrace environment.

User Types on Communal Terrace (Source: Utermann 1977)

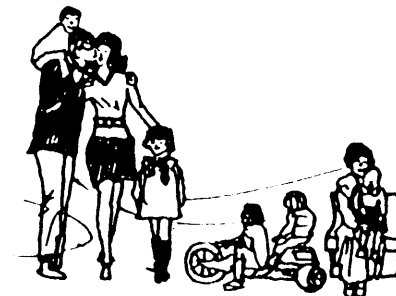
Adult without children (single or married couples)

This group is likely to use the terrace for relaxation after work and on weekends. Singles and couples will use available facilities, although they prefer to relax in the place without children. They need a public terrace with as much isolation and privacy as its location on the building allows.



Families with preschool and school-age children

A communal terrace is a place where families with children are likely to meet one another. Preschool children with their parents (or a responsible adult) usually use a common terrace together. The space should accommodate a playground for both groups. Recreational equipment should be provided and hold their interest. However, most courtyard, garage and promenade terraces may well be used by school-age children unaccompanied by an adult.



The terrace should be well maintained and secure. It should have good accessibility, both visual and functional, from the units but should be

acoustically shielded or separated from building. Some shade and wind control should be provided.

Teenagers

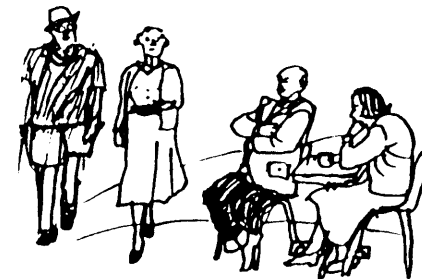
This is a difficult group to satisfy because teenagers are highly active but also like to sit and socialize. Their requirements are similar to those of adults, but careful attention must be given to the balance between their need for privacy and the adults' desire to keep an eye on them. It is important that terrace be planned in such a manner that teenagers and adults can both share facilities.



This group needs a communal terrace which has relative accessibility from other parts of the building, where sound does not travel easily from terrace to other parts of the building. The terrace should have a relatively exclusive place where teenagers may meet and socialize with one another. A context for teenagers is a variety of games and sports which may take place safely.

Senior citizens.

The activities of most senior citizens are relatively passive as they prefer peace and quiet on roof decks. However, some may prefer a more active and a public terrace and may not like a strictly sedentary place. Some senior citizens will use the terrace to exercise as well as to relax; some will want to just watch others exercise. Their general mobility or some of their perceptual skills may be limited. This group needs special care in the design of their environment.



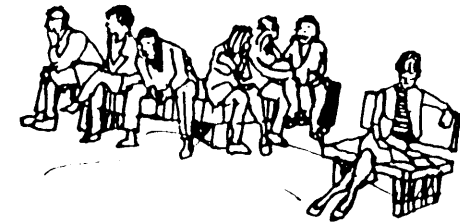
General factors should be considered in ensuring that potential users are sympathetic to various terrace environments:

- The visual, noise and accessibility relationships between public terrace(s) and the building.
- The activities that are likely to take place on the terrace and the type of space which is required
- The degree of social communality and privacy
- The degree of security and maintenance of each user type

Activities on Public Terrace (Source: Beck 1979)

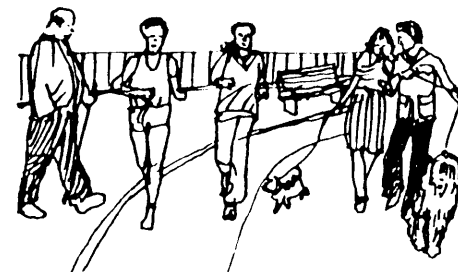
Sitting

Roof terraces are often used by residents who simply want to sit outdoors. They can be encouraged to do so if suitable seating is provided. Comfortable seating should provide some back support with some recline. Some seating should face view or provide for small group activities or conversation, and be protected from unpleasant climate extremes. Seating should be placed to give the user the choice of social mingling or privacy, both with sun exposure and shade. Users with wheelchairs should be accommodated.



Strolling and Jogging

Communal terraces may be used as a place for strolling and jogging. A pathway should be provided to have a nice loop around the terrace or along the

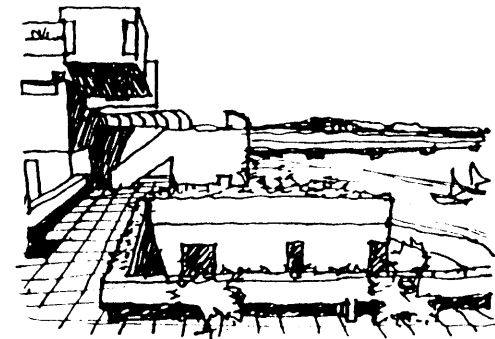
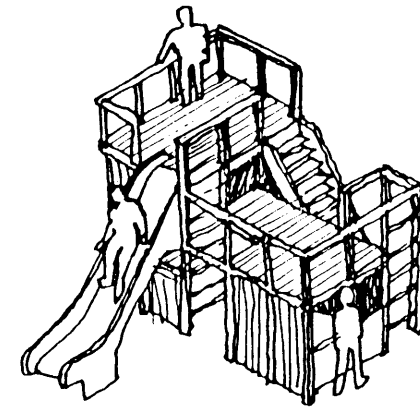


promenade. It is desirable to modulate size, shape and materials of the pathway with some seats or play area along the pathway. It should be screened from more passive activities and separated from vehicle ways.

Children's play

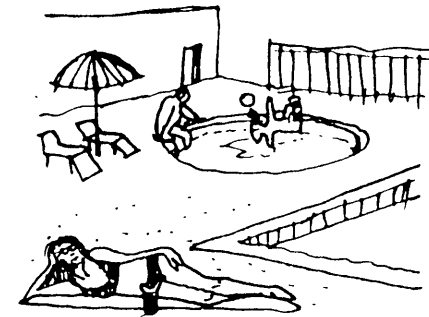
Children of different age-groups are expected to use a communal terrace so that playgrounds should provide a supportive environment for their mental and physical development. As children grow, the facilities they need change and expand. Opportunities should be provided for preschoolers to engage in diverse forms of play: physical play, social play, creative/cognitive play, quiet play and retreat. Children's play areas should be on terraces located on lower floors. Enough space should be provided for normal activities having the same standards as at grade. Children's play areas should be separated from other terrace areas that may be used by adults. Safe, durable surface and equipment materials should be considered.

For preschool children, there should be imaginative climbing and building equipment, places to explore and enough space for tricycles, carts and games. Seating for supervision by adults should be placed adjacent to all play areas used by preschool children. Suitable outdoor games for school-aged children are miniature golf, volleyball, basketball, badminton and sports in shading area such as table tennis and table games. Surveillance of parents from dwelling units to playground is recommended.



Swimming

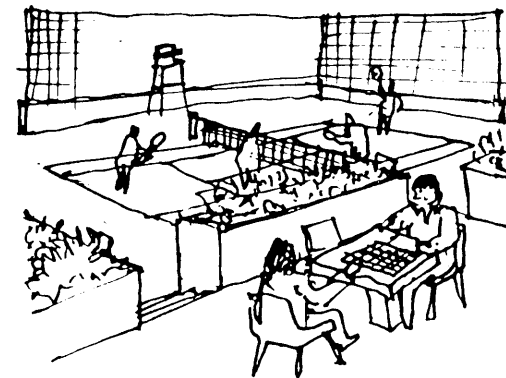
The pool and sunbathing area are interrelated: the former is used to cool off after sunbathing, and the latter to dry off and warm up after swimming. All user types may be expected to use the swimming area. Design of the swimming pool should ensure that senior citizens can use the pool safely and children have an adequate shallow area. Precaution signs are necessary. Both pool and terrace should be positioned to provide both sun exposure and shade, and control wind speed. Seating should allow views of the pool and the surveillance of children. Screening from other area of terrace for privacy and sound buffer might be required. Changing room and toilet facilities is also required.



Games and Sports

In considering which terrace games and sports are appropriate, the designer might well compare the roof terrace to the deck of a ship. High action sports equipment, such as games using balls, can be provided on a very large terrace or in an enclosed or fenced area. Several games and sports should be provided for all age-groups with areas for people who want to watch games.

On large terraces with appropriate controls, many terrace games and sports could be accommodated including tennis, volleyball, badminton, basketball, shuffleboard, croquet, and golf putting. Areas for active games should be provided but separated from passive activities, such as sunbathing and sitting. Passive games, such as cards and chess, should also be provided. Safety, maintenance and storage are required, especially for high-action games.



In the housing market of Bangkok today, the main theme in competitive marketing in higher-income housing is to provide attractive outdoor features to the developments. Special features, in addition to normal facilities, make marketing much easier. Following are some public outdoor facilities on communal terraces.

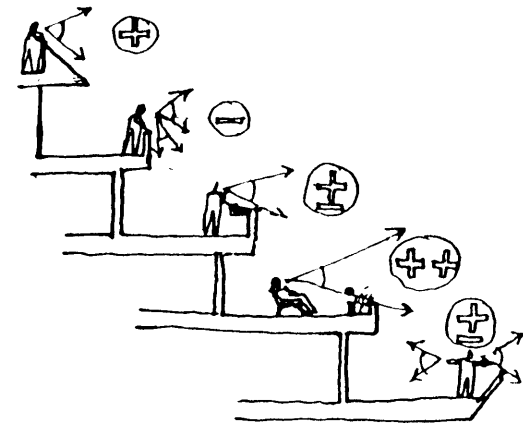
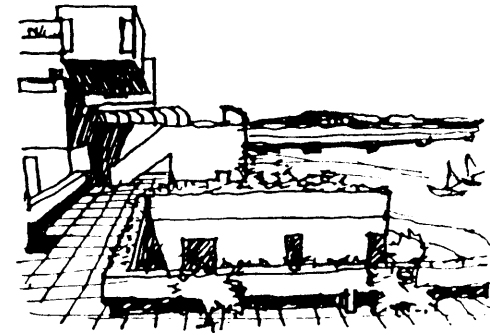
- Large free form or Olympic-sized swimming pool
- Tennis courts
- Jogging track
- Water garden
- Fancy playground
- Roof garden
- Barbecue corner
- Outdoor bar and restaurant
- Heliports
- Amphi-theater
- Golf putting green, etc.

3.2 View

The fundamental characteristics of private, external space of a terrace house is that the terrace be usable, that is an open-spaced highly utilized space. This terrace should be connected to other living spaces of the apartment allowing a sense of privacy. The space of a terrace extends out from the interior and covers part or all of the lower unit. Terracing assures a 'softening' of the surrounding environment which offers three things, an unobstructed view, and visual and auditory isolation.

Residents often go to their outdoor areas to enjoy the views. Outdoor terrace should take advantage of looking out on the surroundings and face pleasant views. Viewing will be best from a deck on the highest floor possible. If there is no attractive surrounding, terraces can be pleasant places for the residents to look at. Residents may wish to view at night; therefore unobtrusive downward lighting may interfere with the effect of city lights. Unit windows and doors should be separated from public or semi-public areas by a passive activity area or semi-private zone, or visual screening.

Part of outdoor living space should allow viewing while standing and sitting. Parapets should be provided that do not block views when users are standing or sitting, unless they are intended to hide something unsightly. Parapets should look strong and have substantial physical security from falling. Fear of heights can be reduced by restricting views over the edge using a variety of guardrail designs. (CMHC 1980)



3.3 Noise Control

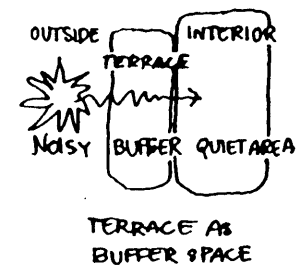
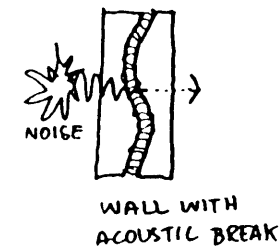
Design criteria

Noise comes from many sources; busy streets and adjacent public areas, sound reflected between facing multi-storey buildings and among dwelling units. This noise can disturb the quiet enjoyment of an indoor living area.

The design of an outdoor space should consider the noise characteristics of adjacent areas. Traffic noise is the loudest source. On the street, noise has a loudness range of 60-100 dB. A measure of the acceptable acoustical quality of a living area should be about the range of a normal conversation. Therefore, the general maximum ambient sound pressure level in any living area should not exceed 55 dB. (CMHC 1980)

Sound travels more easily down and sideways than up. Sounds made by people are more disturbing than sounds made by equipment (e.g., washers). Common walls between units, and public areas should have a Sound Transmission Class of at least 50. Floors between units should have an Impact Isolation Class of at least 50. (Vancouver 1978)

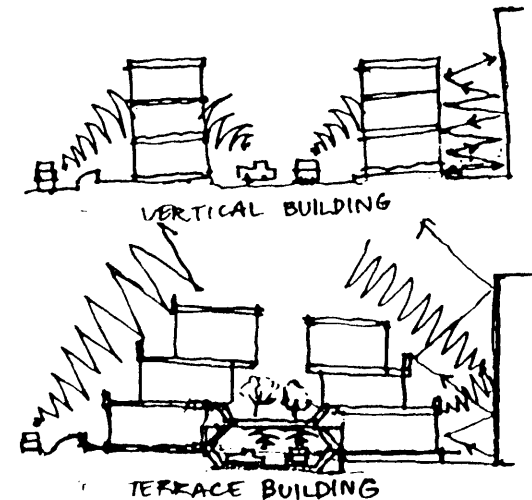
To reduce noise level into living units, zoning 'sound-compatible' areas within or between dwellings should be provided to assist in effective noise privacy. Private area of units should be separated from public or semi-public areas by a semi-private zone. Distance, building and plant can be used to reduce the impact of adjacent noise sources. The outdoor living areas located between unit and noise source can be a buffer for the dwelling units. To prevent the build-up of



sound pressure levels, multi-storey buildings should not be facing or parallel to each other.

Building performance

An outdoor terrace provides a transitional space which reduces the sound pressure level from outside. A stepped terrace building has advantages of reducing the level of disturbing sounds, especially on the upper units. A stepping back of the upper units provides indirect intrusion of noise to the dwelling units and reduces reflected sound between facing buildings. Plants and screen on terraces also reduce penetration of noise from the outside. In the model of courtyard terrace with garage below, hiding the garage below a common terraces will also create the quiet open space for a housing group.



3.4 Privacy

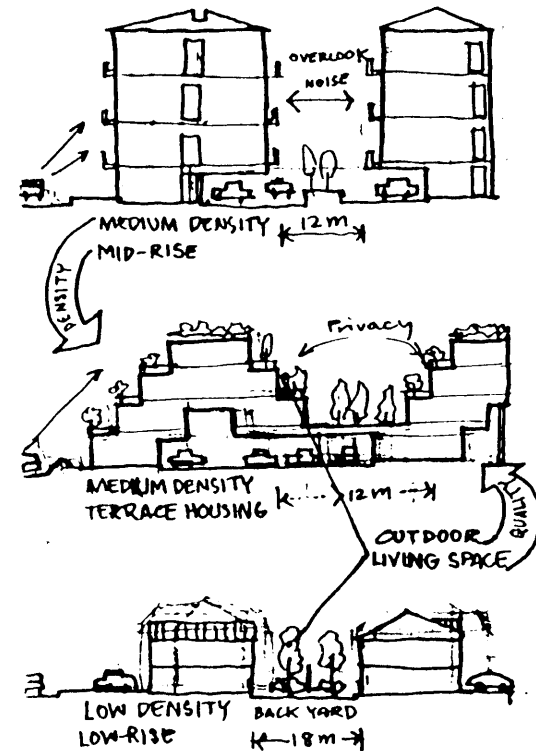
Guidelines

In the design of dwellings, arrangements for privacy are very important. Residents want to have the ability of individual living within their own properties and carry on everyday activities without unwanted intrusion and observation by others. They require space that is free of the unpleasant sights, sounds and smells from outside. They also want control over conditions and have the right to obtain privacy whenever they want. Various private areas can be defined in individual dwelling units by barriers and spatial arrangements. An ideal space of a home should have both indoor and outdoor private space.

A part of each outdoor living area should be visually private or capable of easily being made private by the occupant. "A direct distance of 18 m between the living area and other areas should be adequate because at this distance, most people can no longer distinguish facial expressions or understand speech carried on at a conversational level." (CMHC 1980)

Screening should be provided for privacy in terms of overlooking other units and hiding unpleasant activities, such as laundry, or storage. Private outdoor space should be arranged and located to make it as private and as secure against intrusion as possible.

Although care has naturally been taken to ensure adequate privacy on the terraces, neighboring families should not be fully insulated from one another. Condition for privacy and conditions for maintaining social contacts with other



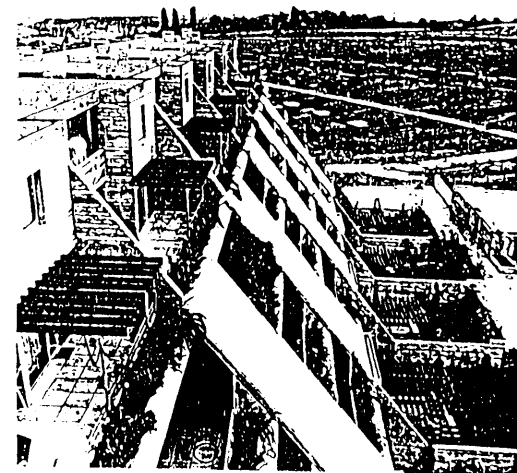
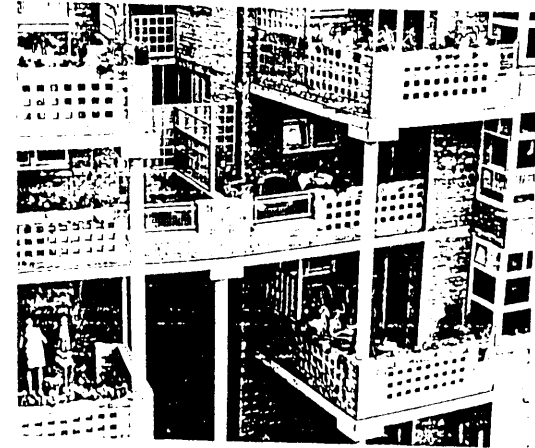
are necessary. The works of Herzberger, such as Documenta Urbana Housing or Lima Housing, Berlin, have aimed at designing the exterior spaces in such a way that necessary screening detracts as little as possible from the spatial condition for contact between neighbors.(Hertzberger 1986)

Building performance

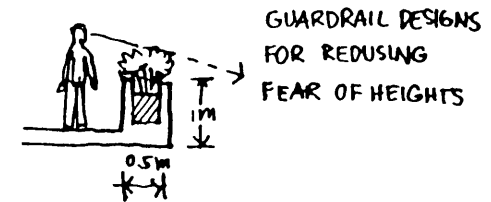
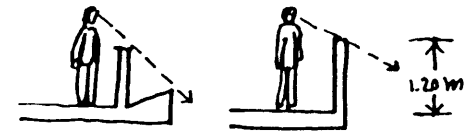
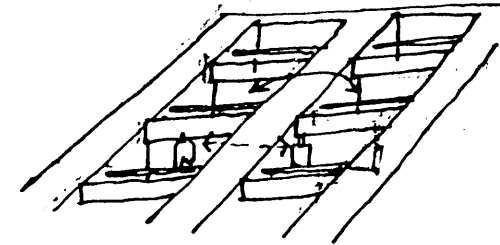
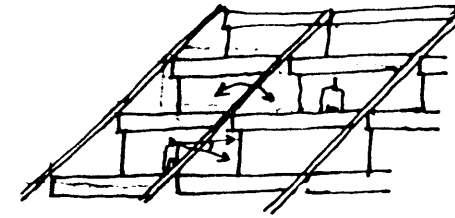
Interaction among units can be reduced by providing indirect interaction among units or by screening. Dwelling units screened by outdoor terrace can have closer distant among units but still retain privacy and a feeling of open space. Stepped forms, courtyards or cluster arrangement also provide privacy in denser housing. On a terrace, plants can be used as effective screens and to orient views, which give privacy to the unit.

The problem of preserving privacy of the terrace gets complicated, particularly if the unit is joined to adjacent terraces. The wall of the side barrier must be tall enough, at least 1.80 m, to avoid intrusion and this brings up the problem of shadow acceptable in the afternoon (CMHC 1979). However, there are a lot of ways to separate terraces lying in the same row.

The design of parapet at the edge of terrace to prevent noise and overlooking other units while having view and greenery is one possibility. To get rid of intrusions into the privacy of each units is a technical problem which has a lot to do with detail design. To construct a protection, which is not only essential visually, but also for controlling the noise level from the upper floor, it is



possible that the parapet be high, and have a certain width to permit the view from the lower unit and to allow the construction of flower boxes which creates a background of plants and flowers. The shape of the parapet is, whether curve upward or sloped, to reflect the sound coming from below.



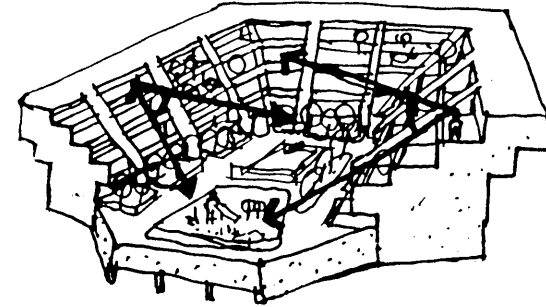
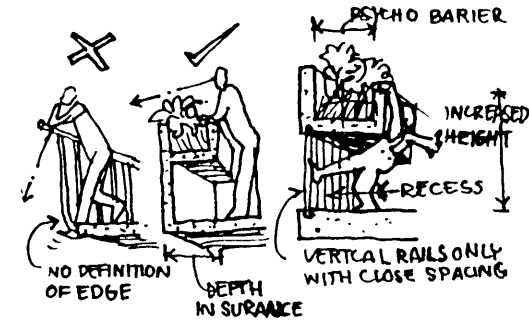
3.5 Safety and security

Safety railing

Railings should be made safe against climbing by children. One meter-railings with vertical bars set 12 cm apart and a horizontal bar at the bottom set close to the floor are recommended. Avoid horizontal bars or projections, which might encourage climbing. (Beck 1978).

Surveillance

An outdoor living terrace should be immediately adjacent to the living, dining or family room of the dwelling. In developments where most households have families with children the off-grade private open space might overlook the central court or children's play area.



3.6 Territoriality

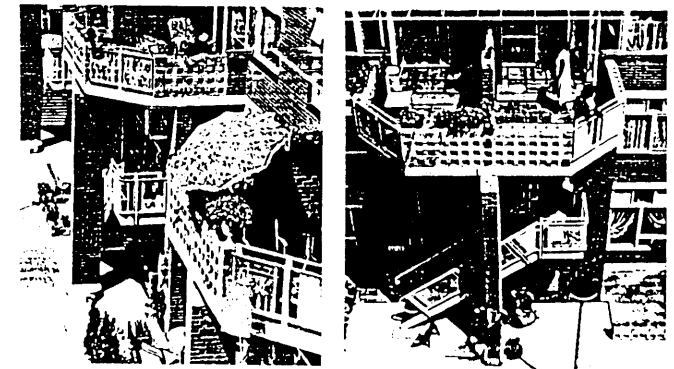
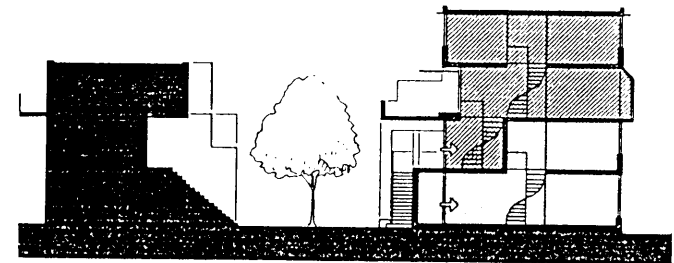
Design criteria

Territorial needs of residents require a clear indication of what areas are "ours" or "theirs". The sense of belonging of a house is much more impressive when they own their land and private open spaces. The impression is that of an exterior private space and garden of an individual house.

Residents often want their home to reflect their own individuality and to have freedom of creating their own environment. They plant flowers and shrubs, add decorative elements to facades and open space, paint doors and other surfaces, and develop specific activity areas, such as terraces. Personalization can disrupt the design of a housing environment, but it often provides a visual richness to the exterior. Architects should stimulate personalization by providing residents the opportunity to express their own individuality.

Building performance

Having an exterior space, units with terraces can provide a many opportunities to create a territorial space in multi-storey housing. Providing good access by individual staircase led to the exterior terrace of a unit above can reflect clear responsibility of ownership to the upper-unit inhabitants. Articulation of terraces of upper units indicates their properties and gives them a sense of place, which can be recognized from the ground. Terraces allow people to have their



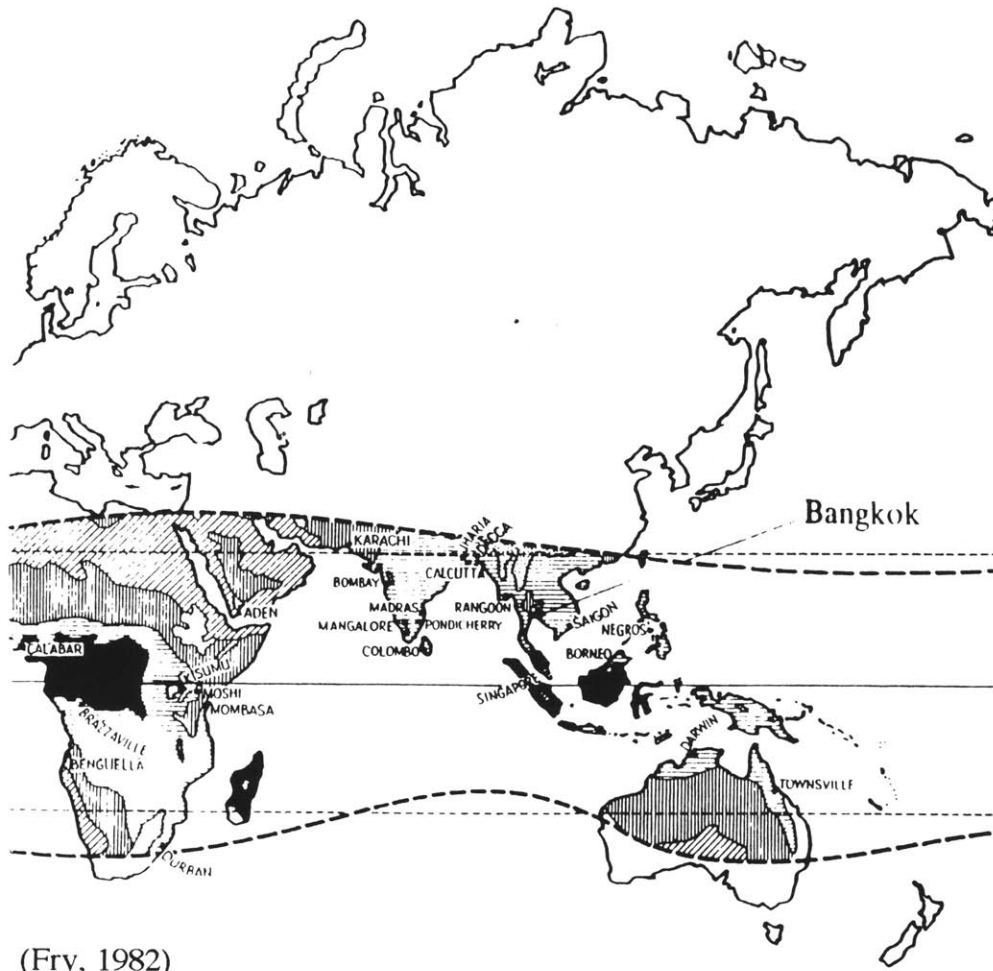
Herman Hertzberger. Harlemmer Houttuinen, Amsterdam, Netherland

personal touches on their environment. By providing terraces, users will have freedom to decorate their properties and unit facades.

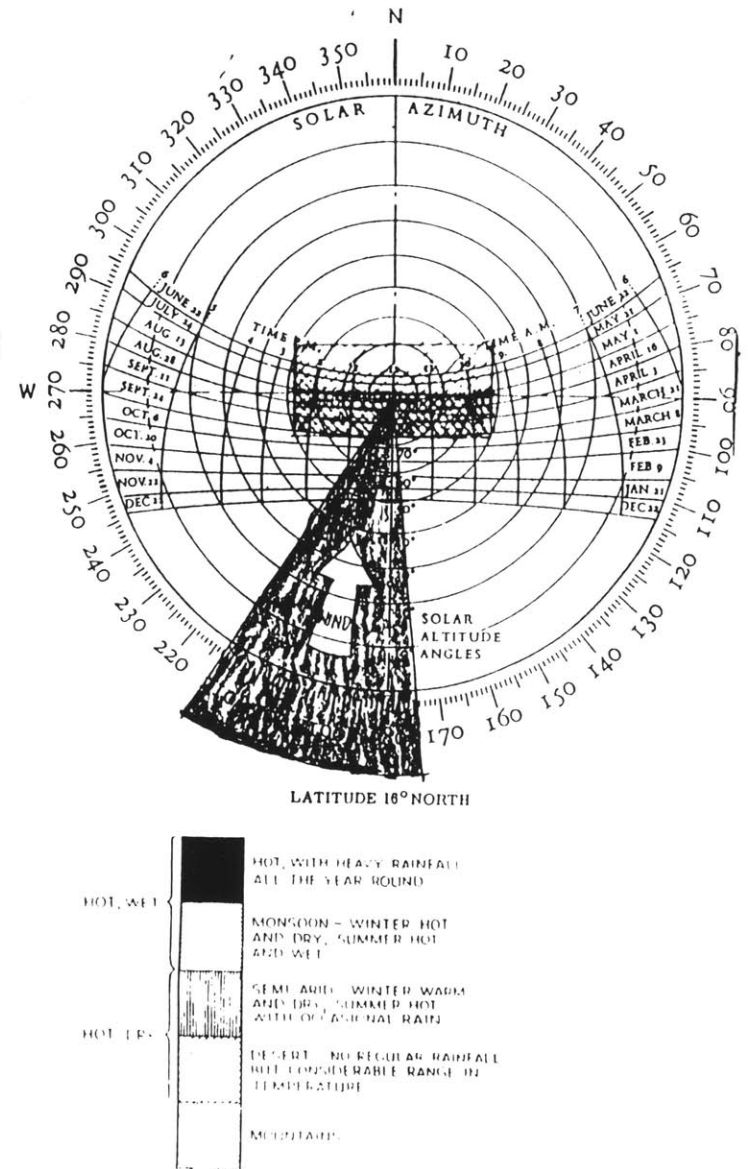


4. CLIMATIC CONSIDERATION

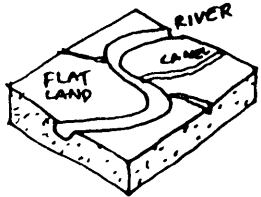



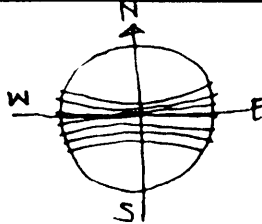
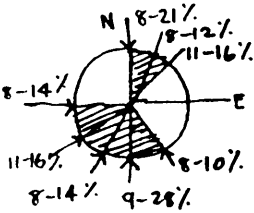
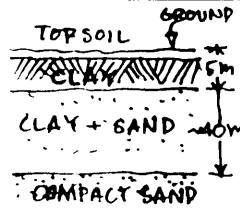



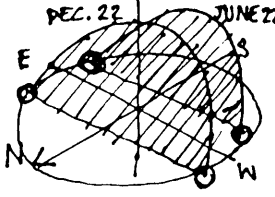
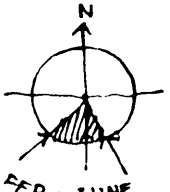
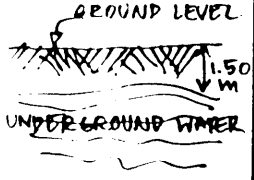
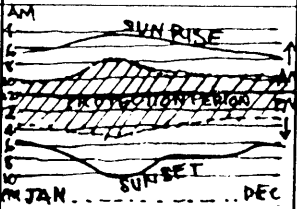



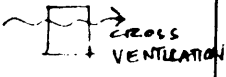
4.1 Topography of Bangkok



(Fry, 1982)



TOPOGRAPHY OF BANGKOK

GEOGRAPHY	TEMPERATURE	HUMIDITY	RAIN	SUN	WIND
 <p>LAND PROFILE</p>	 <p>25.1°C (77°F) IN JANUARY</p> <p>AVERAGE LOWEST</p>	 <p>63.9% IN JANUARY</p> <p>AVERAGE LOWEST</p>	 <p>5.2 mm IN DECEMBER</p> <p>AVERAGE LOWEST</p>	 <p>LATTITUDE 14° N</p>	 <p>WIND DIRECTION</p>
 <p>SOIL CONDITION</p>	 <p>30.6°C (87°F) IN APRIL</p> <p>AVERAGE HIGHEST</p>	 <p>80.9% IN SEPTEMBER</p> <p>AVERAGE HIGHEST</p>	 <p>281 mm IN SEPTEMBER</p> <p>AVERAGE HIGHEST</p>	 <p>DAYLIGHT</p>	 <p>FEB - JUNE WIND IN SUMMER</p>
 <p>UNDERGROUND WATER</p>	<p>HOT: 23-28°C (73-82°F) (PREFERED COMFORT: 17-25°C OR 70 - 82°F)</p> <p>AVE. TEMPERATURE</p>	<p>HUMID: 60-70% (PREFERED COMFORT: 30-60%)</p> <p>AVERAGE HUMIDITY</p>	<p>RAINY: 117 mm</p> <p>INFLUENT OF MONSOON FROM THE SOUTH-WEST</p> <p>RAINY SEASON</p>	 <p>PROTECTION PERIOD</p>	<p>WIND IN WINTER WINTER OCT - JAN.</p>  <p>WIND IN RAINY SEASON</p>
<ul style="list-style-type: none"> • NEED STABILITY OF FOUNDATION  <p>REQUIRMENTS</p>	<ul style="list-style-type: none"> • REDUCE HEAT GAIN INTO THE BUILDING  <p>REQUIREMENTS</p>	<ul style="list-style-type: none"> • REDUCE HUMIDITY BY AIR MOVEMENT  <p>REQUIREMENTS</p>	<ul style="list-style-type: none"> • BE CAREFUL OF SUDDEN FLOOD • PROVIDE RAIN PROTECTION AND DRAINAGE <p>REQUIREMENTS</p>	<ul style="list-style-type: none"> • PROVIDE PROTECTION FROM DIRECT SUN TO THE BUILDING BUT BALANCE SUN-LIGHT AND SHADE FOR OUTDOOR SPACE <p>REQUIRMENTS</p>	<ul style="list-style-type: none"> • MAXIMIZED CROSS VENTILATION ESPECIALLY DURING THE SUMMER <p>REQUIREMENT</p>

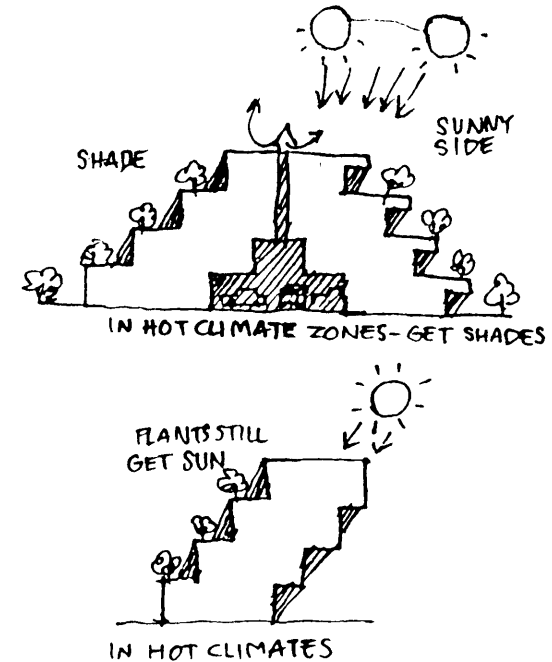
4.2 Sunlight and Shade

Design criteria

An outdoor living area may be considered as well balanced and attractive if sunlight and shade is in balance. The orientation of a building is important for providing an appropriate amount of sunlight. Too much sun can cause problems of heat build-up and glare. Too little sun limits activities and growth of plants. Private outdoor space should be oriented to receive sun at least part of the day.

To maximize the opportunities for sunlight and shade, an outdoor living space should be located in such a way that a part of a terrace should receive sunlight for special purposes, such as drying clothes and growing plants, and shaded for leisure activities. Parts of outdoor living terraces should provide opportunities for occupants to be screened from unwanted sunlight.

Solar heat gain is an element in a warm humid climate that must be controlled to maintain physical comfort. Control of the effects of the sun on a building will influence the inside temperature. A decrease in the radiant heat gain will consequently reduce the amount of heat that must be removed. By providing devices for shading, the solar heat gain can be drastically reduced. The uses of building elements such as screen walls, protecting canopies and landscaping to modify climatic conditions can provide sun protection.

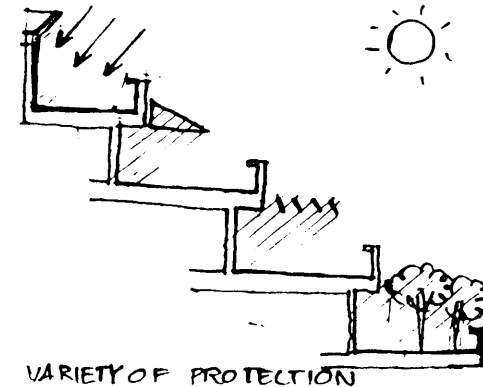


Building Performance

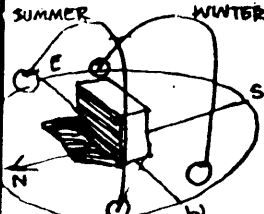
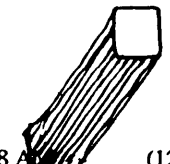
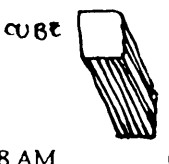
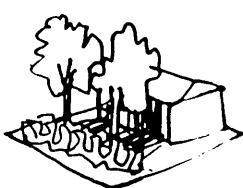

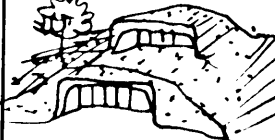
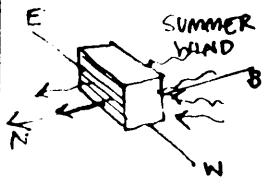

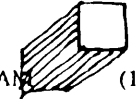








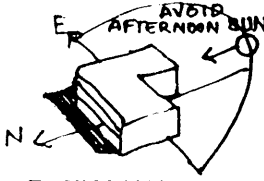








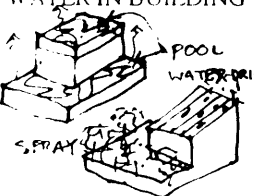
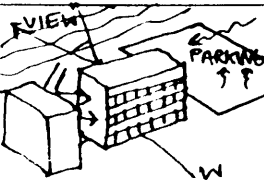




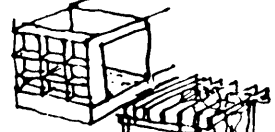
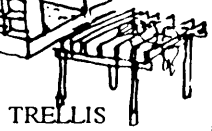



Terrace buildings provide opportunities to get sunlight for outdoor activities and has the capability to respond to different climates. Connecting indoor to outdoor, a terrace acts as a transitional space having plants and building elements to modify climatic conditions. For example, a fence or screen may stop cold or dusty winds but still allow winter sun onto a terrace; pergolas with deciduous vines may block summer sun, yet allow winter sun to penetrate.

In such tropical climates of Thailand, the orientation ideally faces north in order to have shade. Shading devices should allow wind to pass into the interior. A private terrace of a unit gives opportunities for occupants to build and adjust their environments to suit their needs. Adjustable awnings, shutters, blinds, screening or enclosed room may be used for individual activities or occasional protection of sunlight. Using landscape and vegetation can also reduce effects from sun.

A free standing terrace building has a advantage of shading from the cantilever of units above at the other side of terraces. An artificial-hill terrace building provides shade for the large internal space to modify air temperature.



DESIGN FOR NATURAL COOLING

ORIENTATION FOR TERRACE	SOLAR ANGLE WINTER EQUINOX	SOLAR ANGLE SUMMER SOLTICE	OUTDOOR SHADING	BUILDING ELEMENTS	REDUCTION OF RADIATION
 <p>SUN PATHS</p>	<p>TIME ON DEC. 22 (AZIMUTH/ALTITUDE)</p> <p>CUBE</p>  <p>8 AM (120°/22°)</p>	<p>TIME ON JUNE 22 (AZIMUTH/ALTITUDE)</p> <p>CUBE</p>  <p>8 AM (70°/34°)</p>	 <p>VEGETATION</p>	 <p>VEGETATION</p>	<p>LAWN COVERED BUILDING</p>  <p>VEGETATION</p>
 <p>SUMMER WIND</p>	<p>9 AM (128°/33°)</p>  <p>10 AM (140°/43°)</p> 	<p>9 AM (68°/46°)</p>  <p>10 AM (64°/46°)</p> 	<p>BUILDING SHADE</p>  <p>ROOFED TERRACE</p> 	<p>STEPPING BACK</p>  <p>LONG ROOF</p> 	<p>COLOR & TEXTURE</p>  <p>MATERIALS & FORMS</p> 
 <p>FACING NORTH OR EAST</p>	<p>12 PM (180°/54°)</p>  <p>2 PM (220°/43°)</p> 	<p>12 PM (0°/80°)</p>  <p>2 PM (296°/60°)</p> 	<p>VERANDAH</p>  <p>LOGGIA</p> 	<p>AWNING</p>  <p>SCREEN</p> 	<p>WATER IN BUILDING</p>  <p>EVAPORATION</p>
 <p>SITE CONSTRAINT PROVIDE PROTECTION</p>	<p>3 PM (132°/33°)</p>  <p>4 PM (240°/22°)</p> 	<p>3 PM (292°/46°)</p>  <p>4 PM (290°/34°)</p> 	<p>SCREEN</p>  <p>TRELLIS</p> 	<p>FIN</p>  <p>TRELLIS</p> 	<p>ELEVATED FLOOR</p>  <p>REDUCING REFLECTION</p>

4.3 Wind and Ventilation

Design criteria

In tropical regions, ventilation is a major requirement for the design of dwelling units. Outdoor living spaces provide the opportunity to enjoy the benefits of natural breezes. A major approach to providing comfort in a residence while achieving energy saving is to employ the techniques of natural ventilation. People in summer clothing, with 85°F (29.4°C) and 70% humidity, can be quite comfortable when there is a 2-3 mile per hour breeze. Psychologically, in warm weather, the movement of air relative to people is a pleasant sensation and greatly increases the feeling of comfort. (Jones 1983)

Ventilation is necessary to keep the interior temperature and humidity from increasing due to heat output associated with various activities. Building large opening, louvered, vented and windowed walls that are planned for natural ventilation should be oriented to take full advantage of prevailing breezes. Bay windows are a common opening in Bangkok. Where the velocity of wind is low, a building designed for 'stack effect' or 'chimney effect' can provide air movement.

A terrace should be located for the best exposure to ventilation and be a transitional space to provide good air quality for the interior space. A part of private outdoor space should be sheltered against rain coming from the same direction as the wind. Control of hot wind, rainstorm and dusty breezes is important for extended use of the living area. Higher units may have some

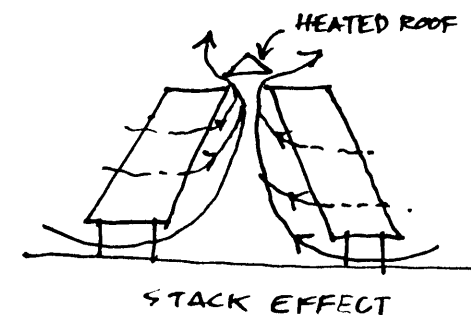
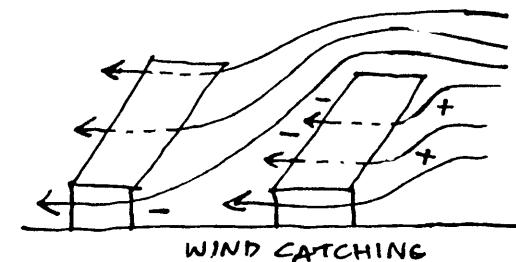
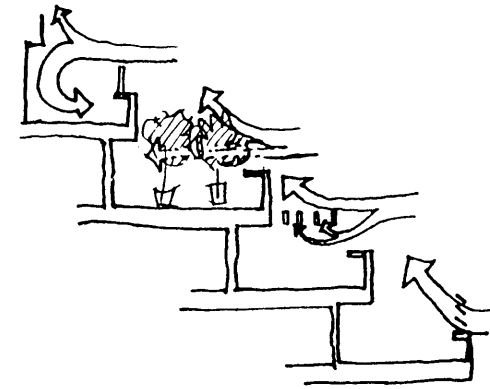
problems with wind turbulence. Tall and slender plants should be protected from high wind.

Building performance

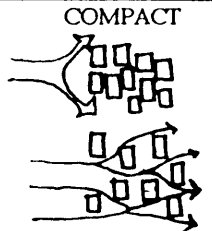
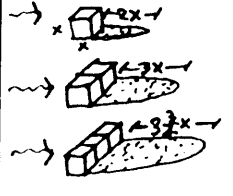
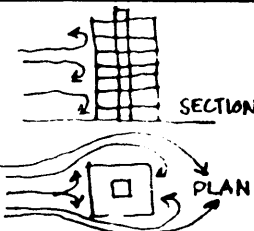

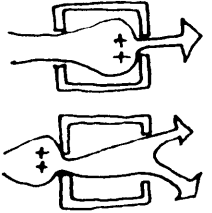
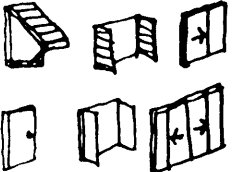
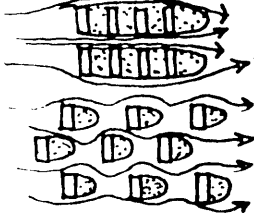
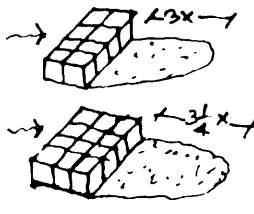
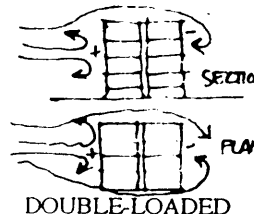

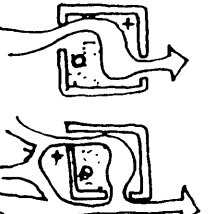
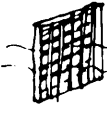

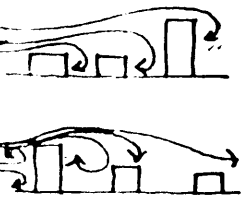
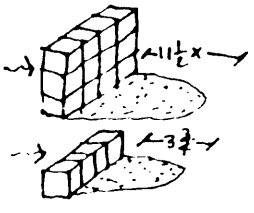
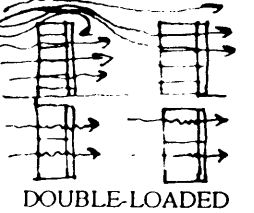
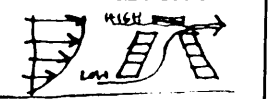
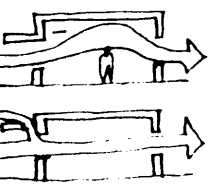
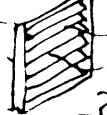
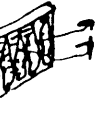
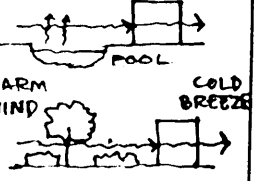
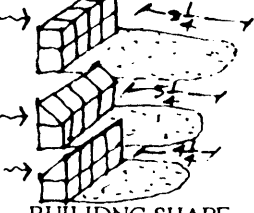
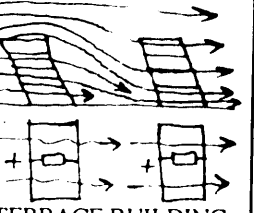
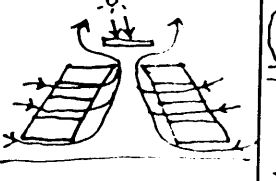
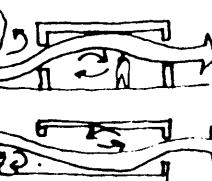

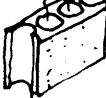
Outdoor terraces are transitional space giving occupants a closer relationship between inside and outside. With wind controlling devices, an outdoor terrace can become a pleasant 'room' for living.

High winds, which disturb terrace activities and small plants, can be intercepted or slowed down by parapets, screens and landscape arrangements. Adjustable screens that either slide or rotate can allow cooling breezes to pass through on hot days and provide protection on windy or rainy days.

In Bangkok, the wind speed at lower than 4-storey height is relatively low because of the close distance between the buildings in the city. Wind speed increases when higher. The diagonal form of free standing terrace can catch the wind at higher level above the building to the lower units. An artificial hill terrace building can provide air movement through dwelling units by heating up the air at the top of the internal space. When the heated air lifts up, the cooler air will blow past the units into the internal space. These two types of terrace buildings can provide better natural ventilation to the housing blocks especially for lower-income housing in the Bangkok because the spacing between the buildings is very tight and the residents cannot afford air-conditioning.



DESIGN FOR VENTILATION

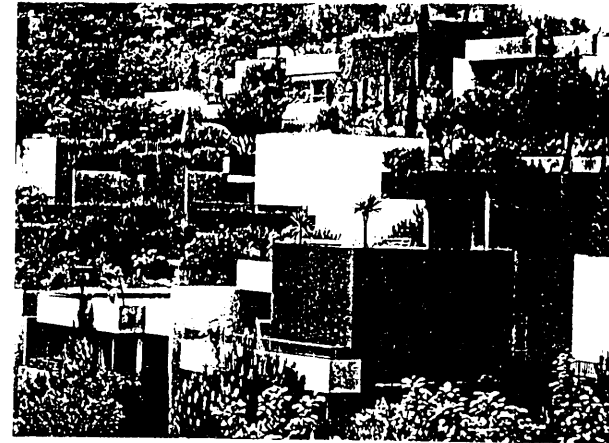
PLANNING	WIND SHADOW	BUILDING TYPES	BERNOULLI AND STACK EFFECTS	WIND CHARACTORS	OPENING
<p>COMPACT</p>  <p>LOOSE</p>	 <p>LENGTH</p>	 <p>SECTION</p> <p>PLAN</p> <p>PIN-WHEEL TOWER</p>	<p>AIR PRESSURE DIFFERENCE</p>  <p>BERNOULLI EFFECT</p>	 <p>IN-LET AND OUT-LET</p>	<p>WINDOWS</p>  <p>DOORS</p>
 <p>GROUPING</p>	 <p>WIDTH</p>	 <p>SECTION</p> <p>PLAN</p> <p>DOUBLE-LOADED CORRIDOR</p>	<p>TEMPERATURE DIFFERENCE</p>  <p>STACK EFFECT</p>	 <p>AIR POCKET</p>	<p>BREATHING WALL</p>  <p>BREATHING FLOOR</p> 
 <p>SEQUENCE</p>	 <p>HEIGHT</p>	 <p>SECTION</p> <p>PLAN</p> <p>DOUBLE-LOADED CORRIDOR</p>	<p>AIR VILOCITY</p>  <p>HIGH</p> <p>LOW</p> <p>HOT</p> <p>BLACK PAINT</p> <p>METAL</p> <p>COOL</p> <p>SOLAR CHIMNEY</p>	 <p>EFFECT OF AWNING</p>	<p>LOUVERS</p>  <p>LATTICED SCREEN</p> 
 <p>WARM WIND</p> <p>POOL</p> <p>COLD BREEZE</p> <p>LANDSCAPE</p>	 <p>BUILDING SHAPE</p>	 <p>SECTION</p> <p>PLAN</p> <p>TERRACE BUILDING</p>	 <p>ARTIFICIAL-HILL</p>	 <p>TERRACE SCAPE</p>	<p>VENTILATOR</p>  <p>AIR IN THE WALL</p> 

4.4 Landscaping and Vegetation

In the tropical cities, landscaping and housings should not be regarded as separate elements, but rather integrated as much as possible. Planting on terraces can provide natural quality and comfort to the units and the city. Water and vegetation can be used in conjunction with the prevailing wind to provide cool breezes for interiors and communal areas.

Landscaping can have a significant cooling effect, and can be an energy saver through proper terrace landscape design and the selection of plant materials. Proper design of landscaping will help control solar heat gain, humidity, direct breezes and increase rain protection.

Selection of plant types and locations must consider what effect a particular plant or tree will have on the prevailing breezes as well as what effects it will have on shading, humidity and heat radiation. The rough dark leaf texture and volume of a small tree or shrub on a terrace can diffuse and absorb solar radiation and provide shade. The terrace covered by lawn and low growing vegetation can absorb the heat that would be reflected into the air, or onto walls and into windows. The temperature of grassed areas on sunny days are 10 to 15 degrees cooler than those over bare ground or paved surface (Jones 1983). Dense plant material on a trellis will provide shade which will be cooler than a space exposed to full, direct sun, and still allow breezes. Some trees provide daytime shade but close leaflets thus minimizing humidity build-up.



A terrace housing in France
(Barret, p. 135, 1988)

5. TERRACE ELEMENTS

5.1 Floor Surfacing System

In the traditional Thai house, terraces are made of teak wood, and have the ability of resisting heat and providing ventilation and drainage through the wooden floor spacing. On a solid structure, ceramic tiles are commonly used. In new developments, most terraces of multi-storey housing are built on concrete slabs. There are many choices of surfaces having different qualities to suit particular uses.

Terrace surfacing should not only be aesthetically pleasing, but also capable of tolerating intended traffic and protecting the waterproof membrane from physical damage. They should be able to withstand effects of hot and rainy climate, protect the structural membrane, and be of a reasonable price. To obtain suitable materials for terraces, the properties of materials and the structural, moisture and thermal consideration should be considered.

Most hard surfaces used on the ground are appropriate for outdoor terraces, although each material has its advantages and limitations. The following guidelines are general requirements of surface materials found on terraces.

Performance Criteria

- Floor surface should prevent heat radiation and provide good drainage
- Hard materials with smooth surfaces and few joints are recommended for cleaning and dust removal.



- For private outdoor or pool areas, materials with low heat conductivity and retention are recommended, since users may walk with bare feet.
- Loose materials should be avoided on all actively used surfaces since some children may be tempted to throw loose materials from the roof.
- Materials should provide appropriate amount of light reflection. Where high natural illumination is desired, light colored paving material can be used; conversely dark or rough surfaces will tend to reduce glare and brilliance.

Surfacing Materials (Source: Beck 1976)

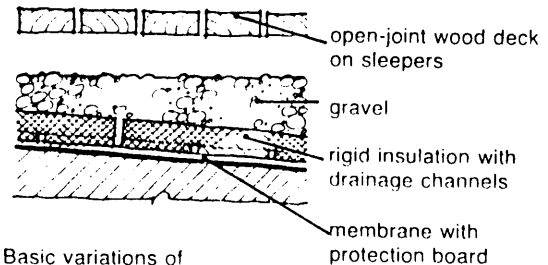
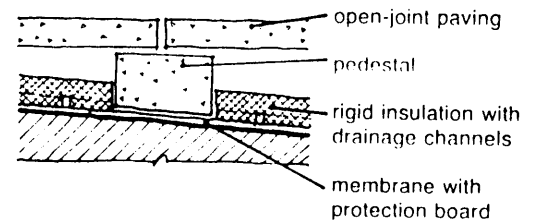
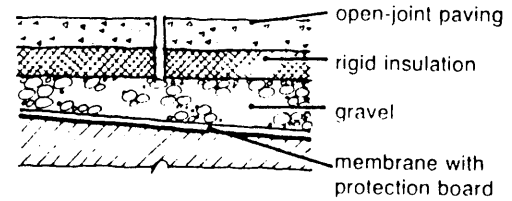
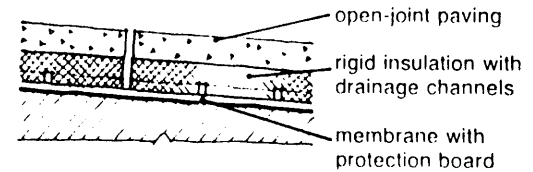
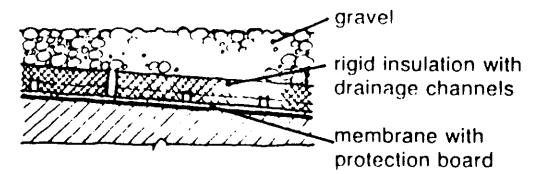
Poured Concrete

Advantages

- variety of texture and colors
- can be placed in any shape
- most durable surface
- least expensive material

Disadvantages

- heavy weight
- becomes too hot in summer sun for bare feet
- must be drained on surface, cannot be concealed (minimum slope 2 %)
- access to membrane, insulation, or structure below require breaking up
- produces glare in bright sunlight, if surface is smooth or white
- poured concrete must have well-located expansion joints



Basic variations of protected membrane roofs and surfacing systems (Source: Beck 1976)

Precast Concrete

Advantages

- variety of color, texture and size
- easy maintenance by hose
- easy access to membrane and drains below the surface
- high durability; greater strength than poured concrete
- no exposed drains and no slope needed on paving surface

Notes: The open joint system, using precast concrete paving on roof decks, has become general practice and is highly recommended over an impermeable top surface. Water disappears immediately into the space below the paving.

Disadvantages

- heavy weight -although lightweight concrete can be used, it becomes very hot in summer
- creates heat radiation and reflects to the room

Asphalt and Synthetic Materials

Advantages

- many synthetic materials, including artificial turf, are available to fit a particular use, such as running tracks or tennis courts
- easy to patch if broken
- surface and is not prone to cracking
- available in many colors

Disadvantages

- must be drained on surface (slope 2% min.)
- asphalt is very hot in summer and becomes soft
- access to subsurface elements can be gained only by breaking up surface
- patch repairs are difficult to hide
- not as durable as concrete

Brick and Tile Pavers

Advantages

- open joint system, good for drainage
- interesting effects in light and shadow when wet
- available in many shapes and colors
- presents a warm appearance
- cool down fast after heated

Disadvantages

- some pavers are highly susceptible to discoloration

Note: If pedestrian surfaces paved with brick are to be used when wet, a rough, hand-burned brick should be employed to avoid the danger of walkers' slipping.

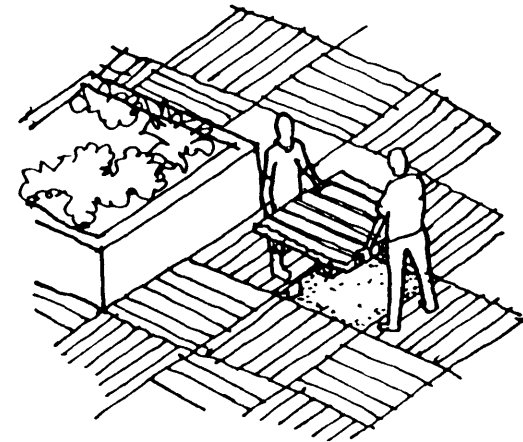
Wood

Advantages

- light weight
- low heat conductivity -good for sun decks and poolside
- easily cleaned
- "warm" appearance feels right on a roof
- relatively skid resistant
- same material as terrace of traditional Thai house

Disadvantages

- affected by natural conditions -drying by sun, rotting or becoming mossy from too much moisture termites
- easily damaged
- spaces between boards clog with leaves and other debris
- access to drains, membrane, sub-deck elements are a problem unless wooden "palettes" are used
- tends to be noisy when actively used
- potential fire hazard, so should not be used for outdoor cooking



Outdoor Carpet

Advantages

- visually interpreted as an extension of interior space
- available in many colors
- good for defining circulation and around pools or sunbathing areas, since bare-foot people will naturally prefer to walk on a carpeted

Disadvantages

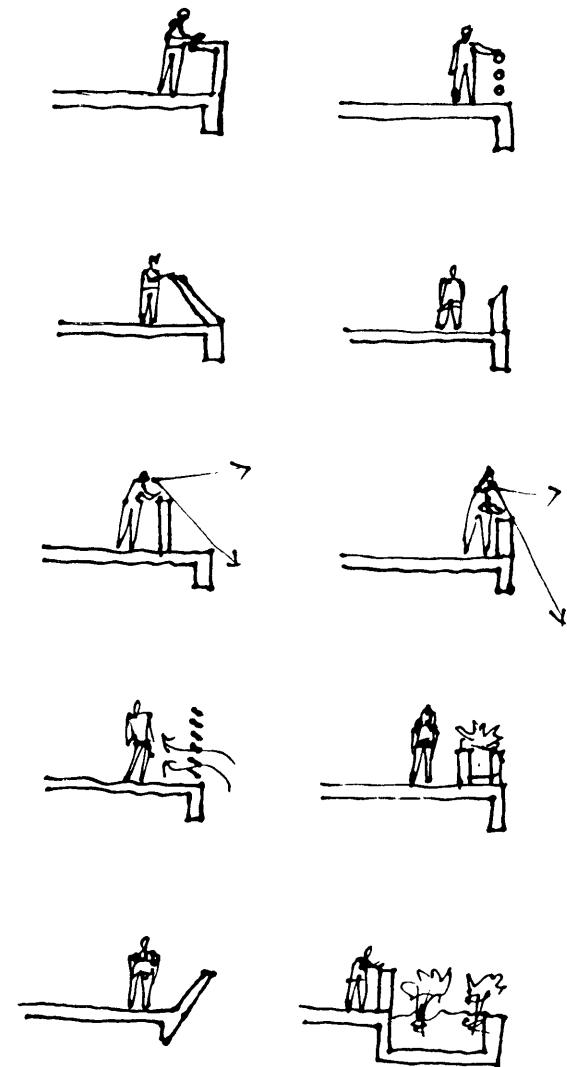
- normally applied over solid surfaces such as poured concrete or asphalt, and therefore subject to the same disadvantage as these materials
- becomes dirty in urban air and must be hosed and vacuumed regularly

5.2 Enclosures

Parapets, walls and screens are built primarily for the safety of roof deck users. Parapets are usually required by law. A minimum height of 90 cm is required in Thailand but higher may be necessary where unsupervised children are to use decks. Horizontal spacing of balusters should prevent small children from squeezing through. Enclosures should not block the wind and may let air movement breathing through the walls. Enclosures may be there for many other reasons:

To prevent objects falling from the deck

To keep children and other users from falling off the roof deck, and to make parents more confident concerning the safety of their children, the parapet walls or handrails should be decisively higher than the person they protect, although they should not exceed adult height. Higher enclosures are necessary where active games are played. Some games require very high walls or netting, and in some cases a complete cage. Care should also be taken to prevent objects from falling off roof edges. An upstanding, solid wall or plant box is useful to prevent rolling objects and blown surface water from going off edges. Spacing of balusters will control the size of objects than can pass through. (CMHC 1978)



A VARIETY OF PARAPETS

To prevent people from experiencing vertigo

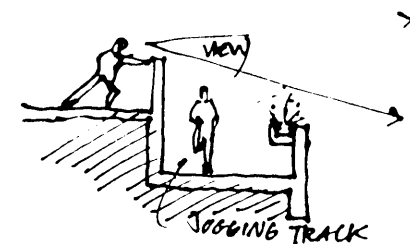
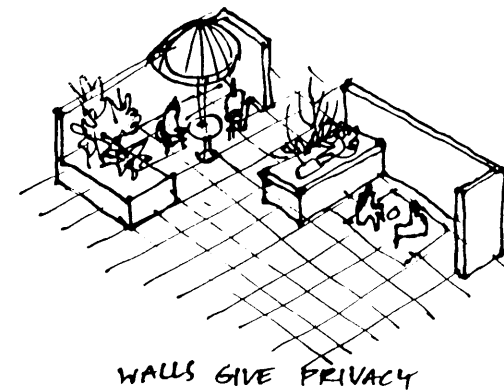
To reduce the fear of heights should be seriously considered in the design of the parapet. Those who suffer from vertigo should not be forced to walk close to the roof edges. Higher guardrails or plant boxes, which keep residents from the edges, are helpful. Parapets must be provided to have both appearance and strength of physical security from falling (The use of solid panels can increase the sense of security). Narrow paving adjacent to perimeter parapets should be avoided. (CMHC 1980)

To give people privacy

Problems of lack of privacy on the roof terraces are similar to that of open space at ground level, but privacy on a roof terrace can be achieved with a more limited number of landscape elements. The degree of enclosure depends on level of privacy needed.

Private activities may need solid wal's or heavily planted trellises while semi-private spaces can be indicated by loose planting or open fences. Because space on roof decks is usually tighter, a compact method of combination (integration of walls and planters) may be necessary. Unwanted views from overhead, adjacent buildings or floor above of the same building, may be blocked by higher walls or by trellises. (Beck 1976)

For people to lean against while looking at the view.



The appropriate handrails or bar counters for people to lean against should be provided by considering human scale and safety. Parapet along the edges of building should be provided for people sitting or children to be able to enjoy the view.

To contain plants or conceal mechanical equipment.

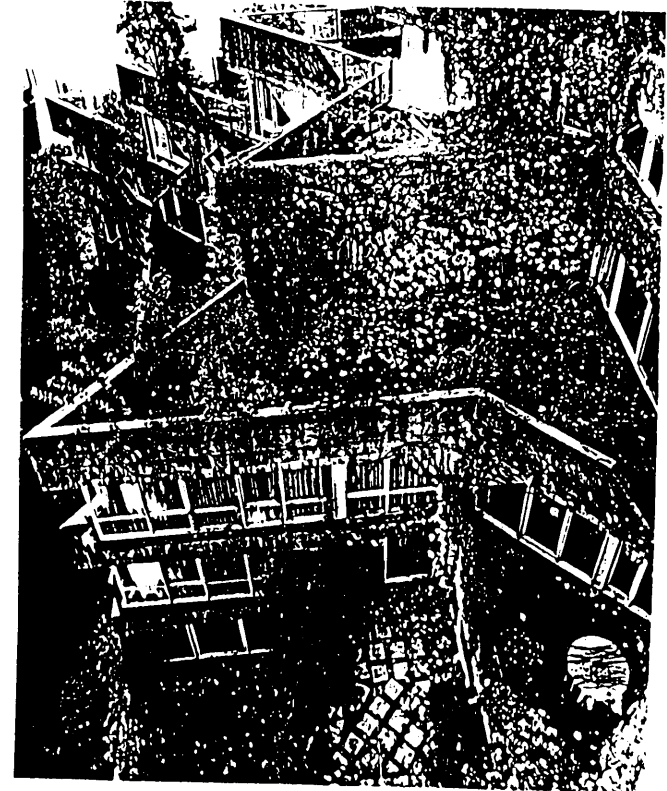
Mechanical equipment or unwanted elements on terraces can be effectively hidden by integrating them with plants. The advantages of widening the parapets in order to avoid the problem of vertigo have been mentioned previously.

To provide a surface for plants to grow against

Parapets, walls and screens may serve the additional function of providing support for certain plants such as vines. The material use for support must be chosen carefully. For instance, a metal trellis may burn and kill certain vines when heated by direct sunlight on a hot summer day; for such vines a wooden trellis is preferable. (Robinette 1977)

Materials for walls and screens

The most commonly used materials are metal, wood, combined metal and wood, concrete (precast and poured-in-place), and stretched canvas in a frame. Durability and maintenance of elements on terraces is a major consideration. All materials must be treated for using outdoors and have enough strength to resist in all climatic influences.



Anchoring Systems for Walls and Screens

There are four factors influencing the need of providing anchoring systems for vertical elements such as walls and screens on a terrace; light weight materials that are used to construct walls in order to reduce loading on the roof terrace, vertical panels that may be considered to be blown over by strong winds, and the need of maintaining the waterproof membrane without penetrating. (Beck 1979)

Stability related to shape of wall

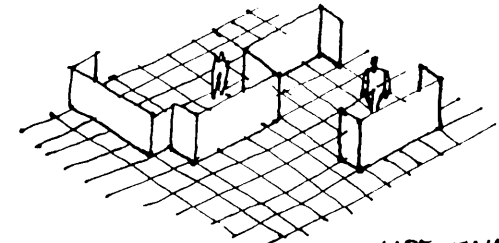
The classic way of providing rigidity to a thin or poorly anchored wall is by frequently changing its direction. This method can be applied on a roof deck. The change of direction increases the wall's rigidity and can take several forms, depending on the design of the deck.

Stability achieved by attaching wall to heavy objects on roof deck

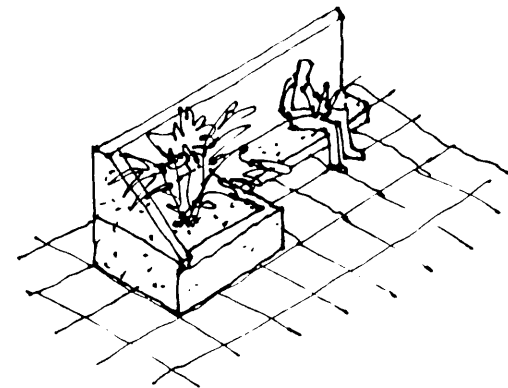
Walls and screens can be where ever possible, attached to, or built as extensions of immovable objects such as planter boxes, building walls or steps.

Stability related to weight of material

Where walls or screens must be strong for a long distance, the wall may be built of a heavy material such as precast concrete blocks, bricks, or a combination of similar materials.



STABILITY RELATED TO SHAPE OF WALL



STABILITY ACHIEVED BY ATTACHING WALL TO HEAVY OBJECTS

5.3 Shelter Elements

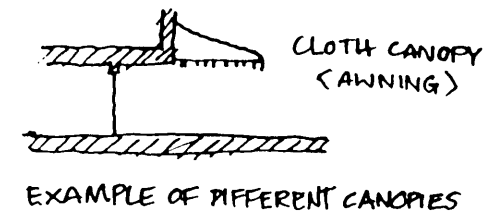
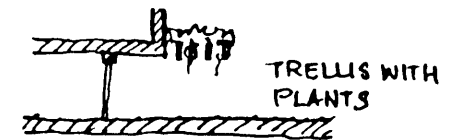
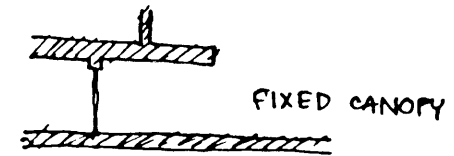
Canopies, trellises and pavilions have long been favorite landscape elements, and have considerable potential for use on roof terraces. In addition to applications which control climate, these shelters give a feeling of intimacy which is often missing on a roof deck. Shelter elements on a roof may be closely connected with adjacent interior space, such as canopies and awnings, or stand freely in the roovescape, such as trellises, pavilions and pergolas.

Canopies

Canopies on roof terraces are mainly used as transitional elements between indoor and outdoor space. They give the sense of protection and entry by their physical and psychological image. Materials used for canopies can be the same as those used for the building facade, i.e., mostly are concrete or wood. Canopies can be solid or transparent such as glass. Awnings are a kind of canopy which is usually made of canvas stretched on a metal frame. Canvas is not durable but easy to adjust, repaired or replaced. Canvas offers the most variety in terms of style and color.

Trellises

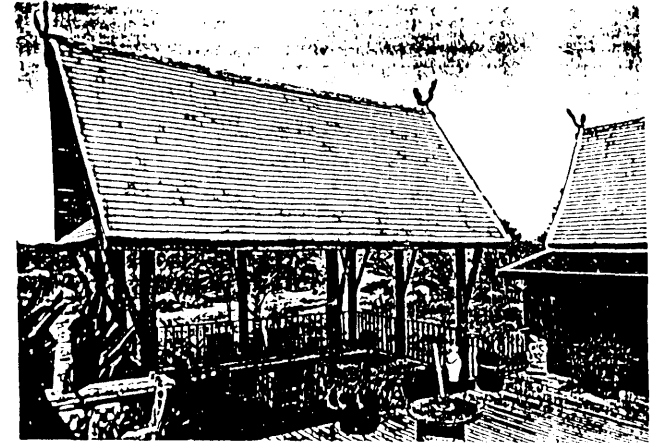
Trellises are structures of crossed strips having a semi-transparent quality. Shades are created while ventilation can blow past the structure. They are often used as covered ways, vertical barriers, screens for opening or a roof for certain terrace activities. Trellises are usually made of wood since it is sympathetic to



the light feeling of trellis and easy to cling to by vines. Vine-covered trellises must be located adjacent to planting boxes.

Pavilions or 'Sala'

Pavilions, common shelters in Thailand, are small shelters, usually open on all sides and solid roofs, standing free from larger enclosed structures. They may be used as protected sitting places on roof terraces. Pavilions may encourage people to use the terrace in the hot and humid climate of Bangkok, since a shaded area with breeze is provided. Their size will depend on the expected use, but should be kept fairly small. Seating should be integrated with the pavilion's structure. Wood is commonly used to build pavilions.



5.4 Furniture

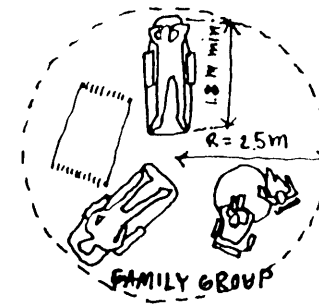
The form of furniture should be considered to respond properly to functions. Durability of furniture should be considered to resist effects of climate, and the likelihood of vandalism or theft. The numbers of people with access to the terrace, the type of user, and the length of time people use the terrace should be observed to provide a suitable amount of furniture. Maintenance cost is an important criterion in selecting both materials and design for roof deck furniture. Furniture can be designed to be fixed or removable according to need.

Furniture that is fixed

Serving multiple functions, fixed furniture is often integrated with other landscape elements such as benches or plants. It may provide for special purposes in terms of function, such as social interaction or privacy, and in terms of art, such as sculptural form. It also is more permanent which saves building management cost in the long run.

Movable furniture

In order to give residents more control over their environment, movable furniture provides more flexible uses for individual and group activities. It can be rearranged according to the prevailing micro climate; sunny, rainy or windy. Movable furniture may easily be stolen and be damaged by being blown over or the weak of lighter materials.

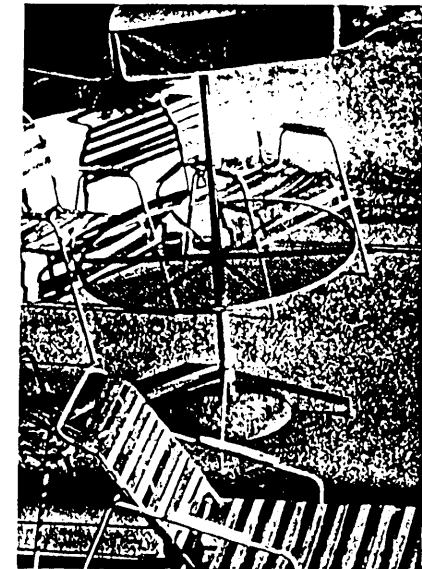
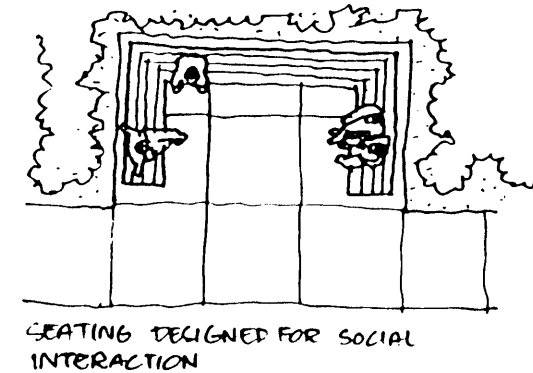
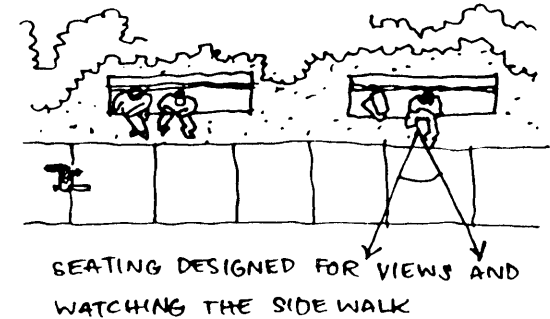


Seating

The form of seating should be arranged by the activities accommodated on the deck, the type of user and by the general combination of forms and materials. Benches should always be as comfortable as possible. Particular attention should be paid to seat height (normally 450 mm for adults) and to proper back support but sometimes older Thais like to sit on flat wooden plate. Permanent seating should correspond to the proper degree of social interaction. For long period activities, using informal and small-scale furniture such as upright terrace chairs with tables should be considered. For relaxation, furniture should allow people to recline, stretch or lie down. Folding chairs are popularly used by residents.

Materials

Suitable for terrace furniture are hardwoods, precast concrete, fiberglass, and metal. Cast iron is seldom used because of its cost and heat gain. Seating may have the same materials as plant containers when combined together. Moldings and decorative elements used in furniture should be designed not to retain water.



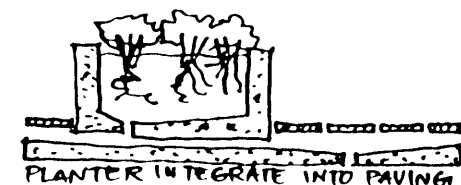
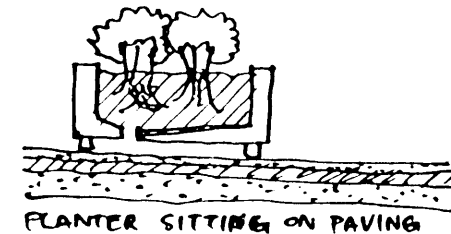
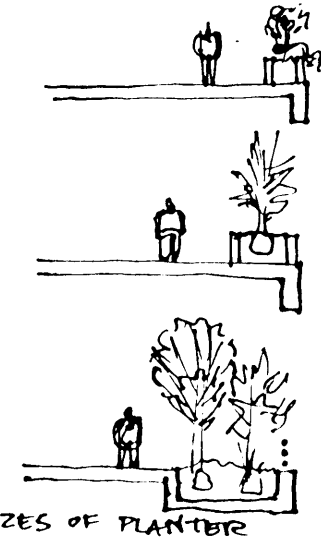
5.5 Plant Containers

Growing plants is one of the most appealing features of terraces. It gives a feeling of being on the ground. The natural forms and the shadow effect cast by plants offer visual relief to the architectural setting of the urban terraces. In order to have plants survive and thrive, the technique for designing plant boxes should have proper space for holding soil and drainage systems. Plant containers may be either movable or fixed.

There are many functions of plant containers: define space, help create or hide changes in level, provide a barrier between incompatible activities of user groups, be integrated with other elements -furniture, lighting, screens, parapets.

Movable plant containers

Movable plant containers, which are usually small and light, allow plants to be moved into the proper shade, wind or rain in different seasons. They are easy to be added and readjusted after the original terrace is built. They are commercially available and can be prefabricated in a variety of colors, shapes, sizes and materials (precast concrete, china, wood, plastic, fiberglass, metal). Movable plant containers prevent plants from reaching their mature size because of their sizes, but may blow over if they are not heavy enough or properly anchored.

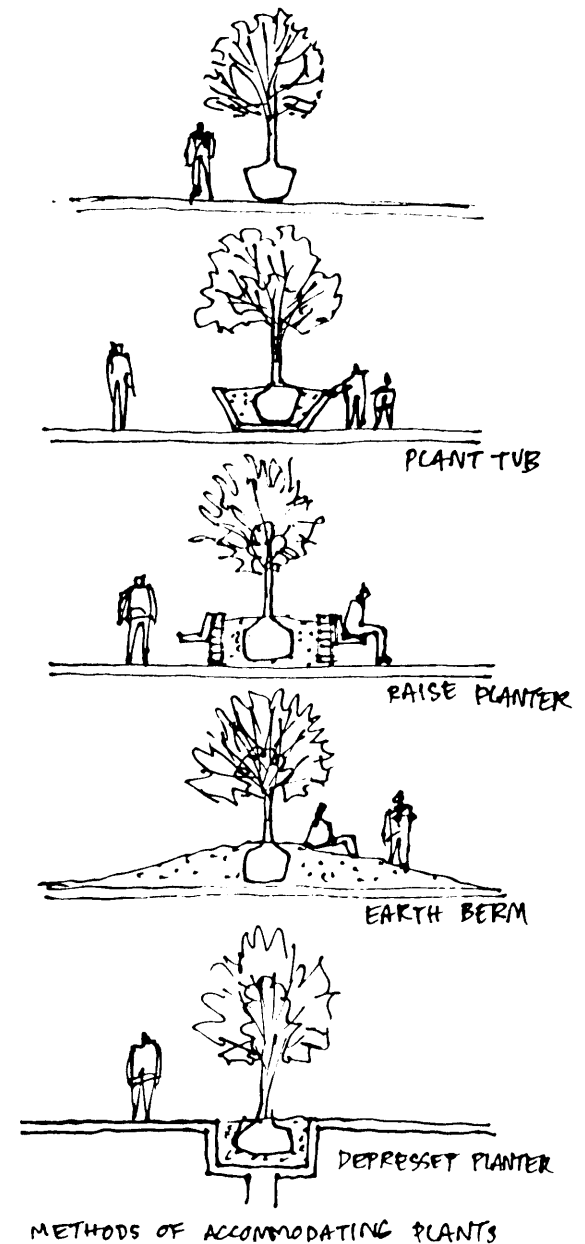


Fixed plant containers

Fixed plant containers can hold a greater volume of soil which allow various selection of plants to fully grow. They are easy to integrate with other permanent landscape elements, such as seating. Containers with deep soil or large plants may cause structural loading problems. Integration of fixed plant containers with the structural building systems is to be considered since most materials (precast or cast-in-place concrete, asbestos cement, brick or timber) are heavy and closely connected to the terrace surface. In larger planting boxes, the stability of the walls from internal pressure due to soil and water must be considered. (Beck 1976)

Drainage

Plants in containers need adequate amounts of water so it is necessary to prevent standing water from accumulating in root zones, especially in the surface topsoil layer. Once water passes through the topsoil, gravel should be placed underneath for removal of water from the root zone. Drains may be located under the plants boxes or flows under the planter wall to a main terrace drain of open-joint surface of a terrace. (Zion 1960)



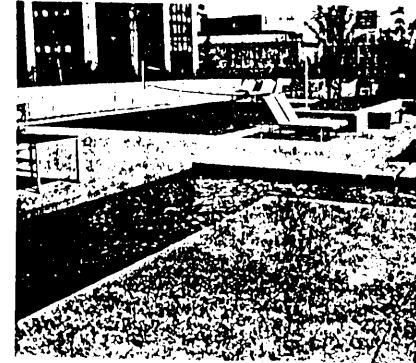
5.6 Pool and Water Features

In the past, most communities in Thailand were located on rivers or canals and many of the houses were literally in the water, either floating or anchored on posts. The old custom is still followed in many parts of the country. There were many canals in Bangkok, but now they are filled up for road ways. Although the modern life style of Thai people does not depend on canals anymore, creating water features are most desirable on terrace landscape.

Water may be used in various forms on terraces. A number of considerations must be evaluated in order to produce maximum impact and minimum damage either to the terrace or the building.

To provide water features on terraces, the structure of the building must be carefully analyzed. Water should be minimized as to its weight as much as possible when used. Some means of movement or recirculation of water for more visual effects requires additional equipment and weight on the terrace structure itself.

Pools and fountains on roof terraces are not only attractive but act as humidifiers and cooling devices. To maximize reflection from clear water, a 50-70 mm deep pool with a black bottom and no organic life is best. This black paint effect distorts the depth perception of the viewer, causing the water to appear much deeper than it actually is. This is also shallow enough to ensure child safety. Pools with organic life (fish or plants) should be provided with adequate depth of water (45 cm minimum). (Robinette 1976)



Water in any situation, especially on a terrace, needs more maintenance both for the recirculation systems, maintenance of the water container, and controlling the areas where the water body meets other design elements on the rooftop. Still, water sets dirty and thus should be filtered and recirculated by a pump. The area under the pools should also be equipped with drains for occasionally repairs.

6. TECHNICAL CONSIDERATION

6.1 Structural Consideration

6.1.1 Alternative Structural Systems

Conventional System

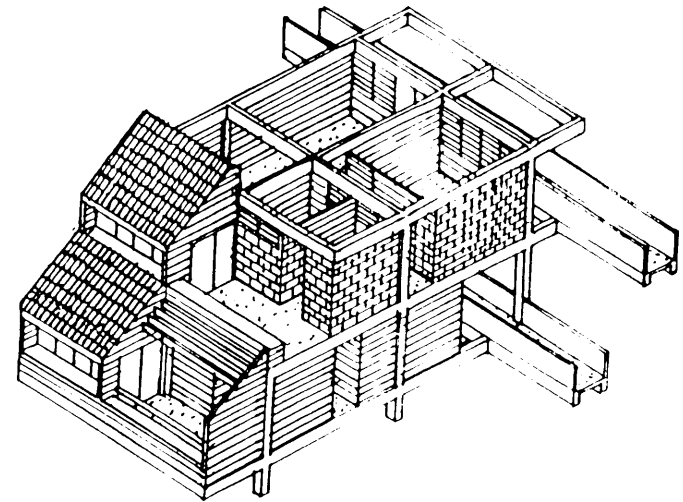
Conventional structures in Bangkok are composed of cast-in-place columns, beams and floors. The walls and partitions are masonry or concrete blocks plastered with a smooth concrete surface. Window and Door are wooden or aluminum. The roofs are tiles supported by wooden frames.

Advantages:

- The method of construction requires low cost equipment
- Intensive labor is available at low expense
- Rigidity of the structure is fairly high.
- Conventional method are more competitive bidding
- The basic method is easy to repair and expand by users.

Disadvantages:

- The construction which is mainly cast-in-place concrete work and laying bricks and carpentry need long periods of construction time.
- Skilled carpenters and masons are required, which they now lack of skills and need training.
- A great amount of concrete form work is required.



CONVENTIONAL SYSTEM

Supporting Frame and Small Prefabricated Component System

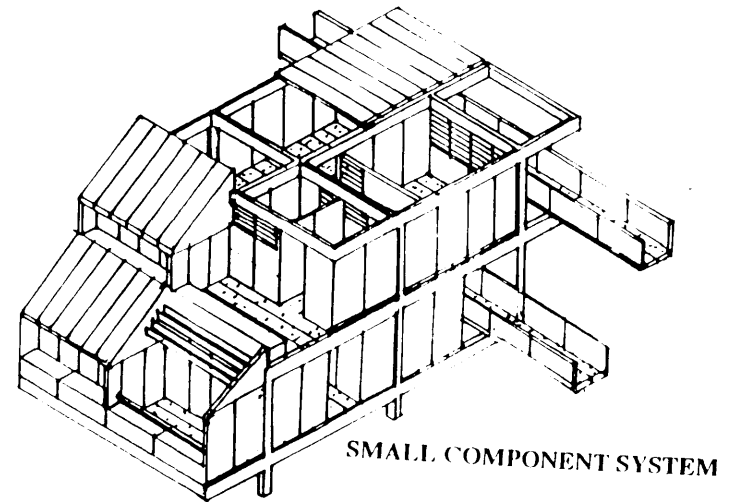
The use of small precast elements, movable by men, is the purpose of this system. The main structure, which are beams and columns, is cast-in-place concrete. All elements of the system are light and small enough to be carried by 2-4 worker, or less than 200 kg. Later prefabricated floor planks and standard walls are used. Doors and windows are standard from the factory. Finishing of the floor and wall still need to be done by hand.

Advantages:

- The construction is simple and can be finished in a short time.
- The work needs fewer skilled labors than the conventional one.
- Products of high quality are made in the factory and are easy to transport and fabricate
- Most process are independent from weather conditions.

Disadvantages:

- The investment in plant and equipment is relatively higher than for the conventional method.
- Uniformity of the structure element is poor, different bending of elements may cause problem of cracking.
- Standard walls and partition may have problems of jointing and noise transmission.



Panel System

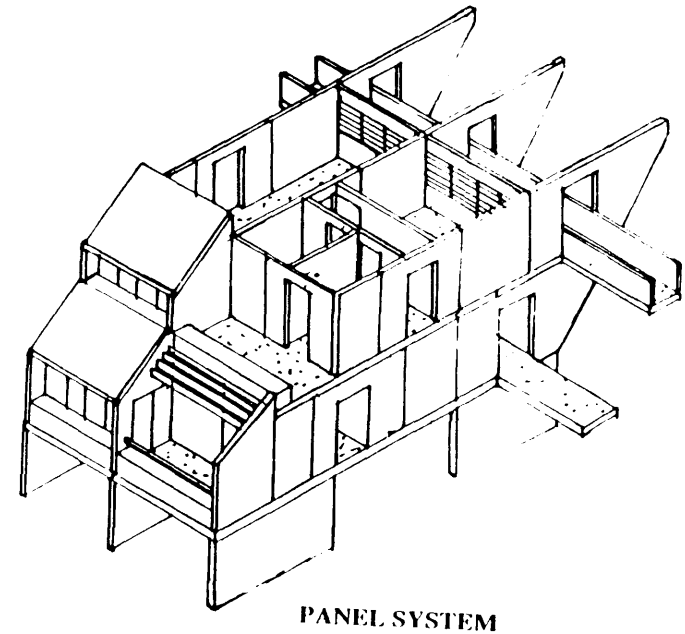
The system consists of load-bearing cross-walls and floor panels. The prefabricated panels are transported from a factory and assembled in place by special instructions. The panel walls are provided by specific design of each element.

Advantages:

- Speed of assembly in site is high.
- Products from factory have high quality
- Most process are independent of weather conditions.
- Thick concrete panels provide excellent sound insulation and possess heavy thermal mass.
- No need for skilled labors, but rather need to follow instruction.

Disadvantages:

- Investment capital for panel production plant and equipment is high.
- Twisting of equipment for installation of heavy panels is required.
- Close inspection and supervision are required since most workers are not familiar with the system.
- Transportation of large elements is difficult.
- Difficult joint details create difficulty for modification, expansion and repair.



- Structural and joint characteristics of the structure may cause a risk of progressive collapse resulting from local structure failure.
- Step arrangement and long cantilevers are difficult, since characteristic of wall panels requires vertical load transfer.

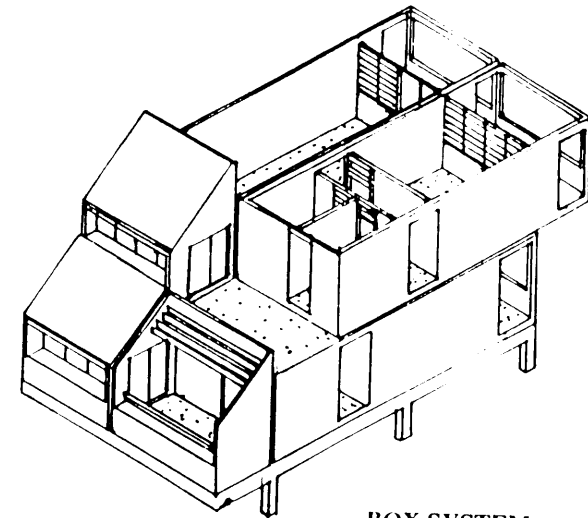
Box System

Box system is a design which takes full advantage of reducing construction time, especially on site. A unit is a combination of several boxes. During the construction, users may choose a suitable combination of boxes having several arrangements to suit their needs. They can choose their own unit facade.

The box unit comes delivered ready-made from the factory. When boxes come to the site, cranes are used to place boxes. Boxes are fixed and concrete is poured into the space in between the boxes

Advantages:

- Speed of assembly on site is high.
- Products from factory are of high quality (if well made)
- Most processes are independent of weather condition.
- Double walls provide excellent sound insulation
- The box system is easy to arrange in stepped form because the structure of each box is self sustaining.

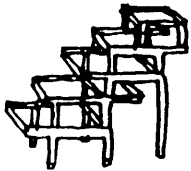
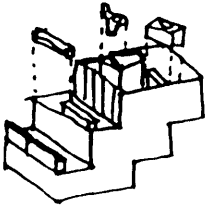
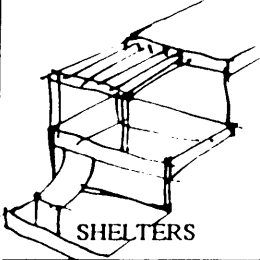
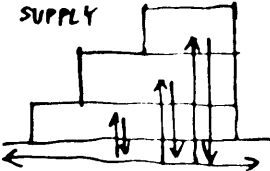
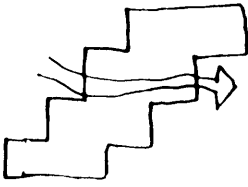
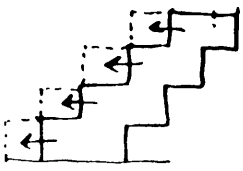
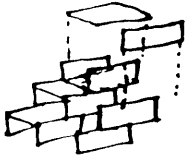
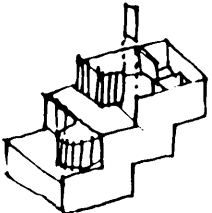
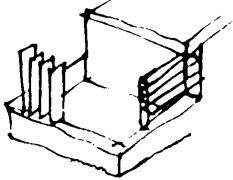
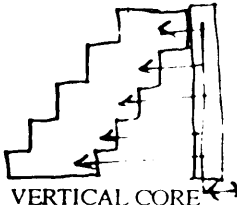
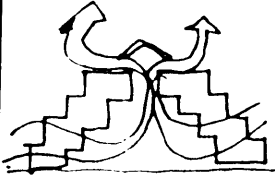

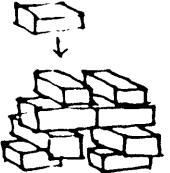
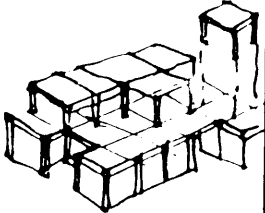
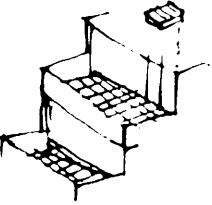
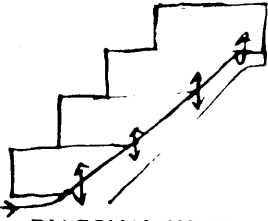
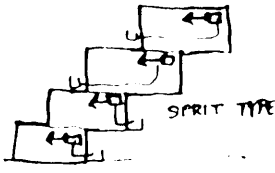
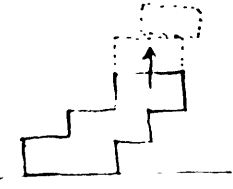
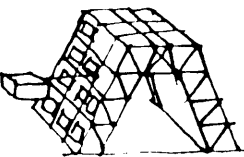
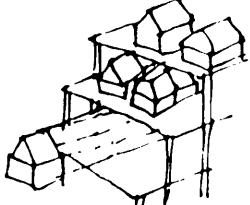
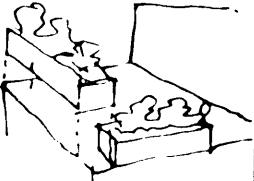
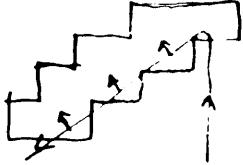
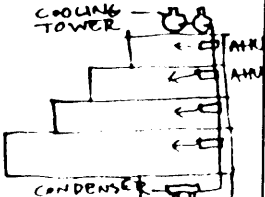
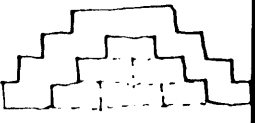


BOX SYSTEM

Disadvantages:

- The system has limitation of size and openings.
- Both weight and volume cause problems of transportation (due to road weight, height and width limitations)
- In order to make the production pay off, a large production is required
- Heavy equipment for installation of heavy boxes is required.
- Close inspection and supervision are required since most workers are not familiar with the system.
- Difficult joint details create difficulty for modification, expansion and repair.

BUILDING SYSTEMS

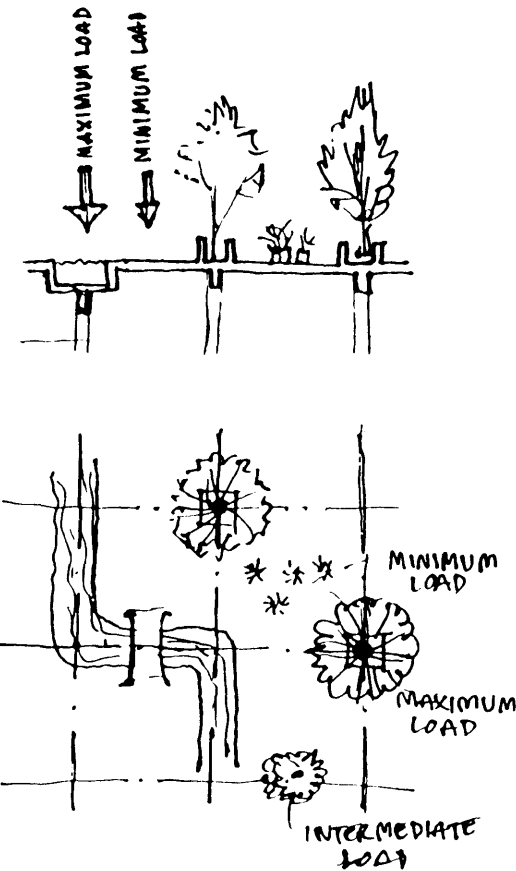
STRUCTURE SYSTEMS	SUPPORT/INFILL	TERRACE ELEMENTS	INFRASTRUCTURE	VENTILATION	EXPANSION
 <p>SKELETON / FRAMES</p>	 <p>FURNITURE</p>	 <p>SHELTERS</p>	<p>DIRECT SUPPLY</p>  <p>VERTICAL SHAFT</p>	 <p>NATURAL WIND</p>	 <p>EXPAND TO TERRACES</p>
 <p>PANELS</p>	 <p>OPENING / WALLS</p>	 <p>SCREENS</p>	 <p>VERTICAL CORE</p>	 <p>STACK EFFECT</p>	 <p>EXPAND TO THE REAR</p>
 <p>STACKED BOXES</p>	 <p>ROOMS</p>	 <p>FLOOR SURFACES</p>	 <p>DIAGONAL SHAFT</p>	 <p>INDIVIDUAL A/C</p>	 <p>ADDING ON TOP</p>
 <p>SUPPORTING FRAMES</p>	 <p>WHOLE UNITS</p>	 <p>PLANT BOXES</p>	 <p>COMBINATION</p>	 <p>COOLING TOWER CONDENSE CENTRAL A/C</p>	 <p>FILL THE 'BELLY'</p>

6.1.2 Terrace Structure consideration

In general, pavements impose the least load upon the structure, and planting has the most load because of the weight of soil. Elements such as sculptures or pools can also be heavy. Although some items such as flagpoles are not heavy, it is often difficult for these to withstand the forces produced by wind.

The structural accommodation of outdoor terraces is properly the responsibility of the structural engineer. It is important that he be consulted early in the project and the structure be developed parallel with the design.

The designer will be required to exercise great discipline in the placement of weight-producing elements on the rooftop. Sometimes accommodation can take the form of weight saving design such as shallow pools or spray heads instead of standing water; light weight sculptures such as metal instead of stone or concrete; light and open architectural features instead of massive constructions; avoid the use of large plant material that requires large quantities of soil; and careful location of heavy objects in relation to the structure below. (Robinette 1976)



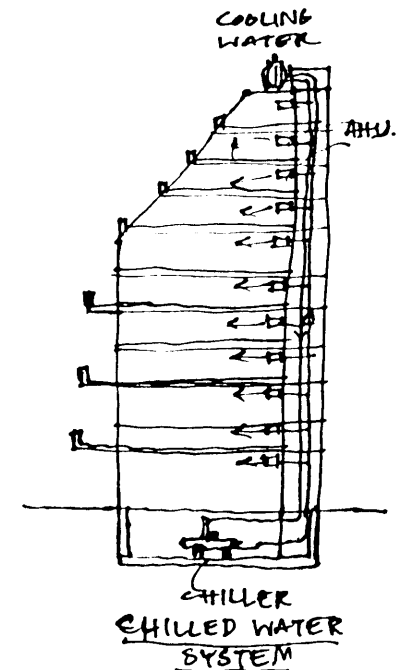
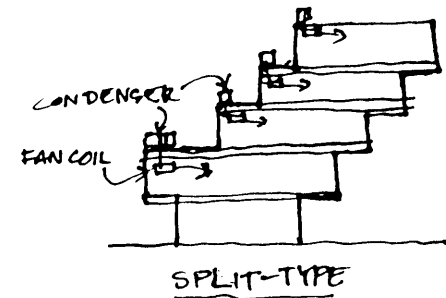
6.2 Mechanical systems

In multi-storey high-income housing, the climate solution is usually achieved by installing air-conditioning. This makes the design of a building much easier, without caring about ventilation or direct sunlight. Cooking and laundry are often done by maids in a separate zone of the apartment. Outdoor space for some activities such as washing and drying cloths are made redundant by introducing mechanical appliances. However, waste of energy should be considered for this type of building. If air-conditioning is really needed, it can be more efficient by being protected from heat gains which may be caused by wrong orientation or using improper facade materials.

Air-Conditioning System

Many people find that their personal lifestyle comfort requirements, or their specific site requires mechanical air conditioning. Air conditioning of a unit will increase the operating costs by insulating against the heat gain and by limiting outside air infiltration.

An air-conditioning system is the assembly of equipment for the purpose of controlling the interior climate to meet the requirements as desired for a given conditioned space. For the tropics, the main functions are cooling, ventilation, filtering, exhausting and recirculation of air. Systems that are commonly in use include direct expansion systems, chilled water systems, split type systems and window air conditioners.



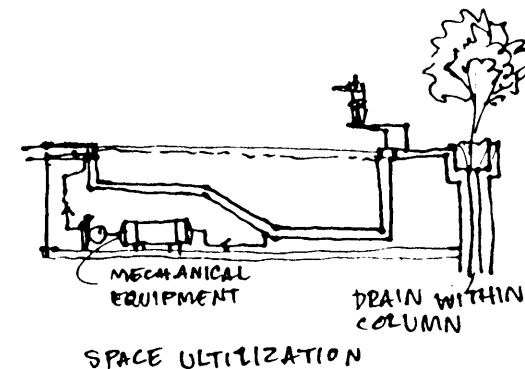
For energy conscious and economical design of air-conditioned units, the building envelope must minimize heat gain from the outside and decrease infiltration of hot-humid air. Compact arrangements of rooms of an air-conditioned unit can decrease exterior walls and reduce solar heat gain and infiltration. In order to minimize air-conditioning costs, partial use of air conditioning in a unit is recommend, such as in bedrooms only where provision of full ventilation is difficult and privacy is needed.

A terrace can provide space for the installation of condenser of a split-type system which require ventilation. A condenser should be located without disturbing terrace activities. For example putting a condenser along the edge with screening and pointing blowing fan out from the terrace can be help.

Landscaping on a terrace of an air-conditioned unit should be dense to provide shade and to reduce heat gain. Vegetation should be close to the air-conditioning room to avoid breezes heating the building through convection or disturbing the surface air films. Hedges and vines will even provide some insulation from the still air between their leaves. (Jones 1983)

Mechanical System for plumbing

In an at grade project, the design of systems to remove water and waste, or deliver water and energy is the responsibility of the civil engineer. However, on an off-ground terrace, where outdoor elements are integral to the building, the architect and his mechanical engineer have the responsibility for providing the mechanical space. It is important that the architect have a clear understanding of

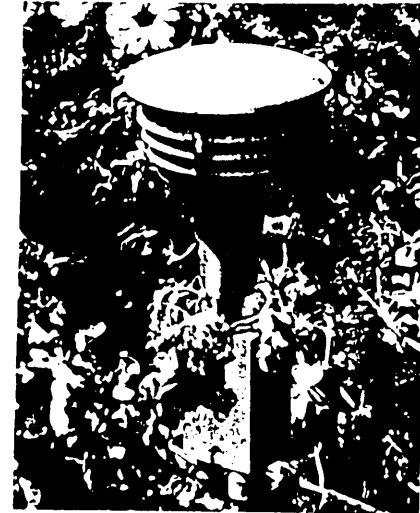


6.3 Lighting

Lighting is used to increase the hours of activities on terraces. The important factors to be considered in lighting are appearance, safety, design integration with various features, etc. Lighting should have good appearance and located without interfering views in the day and not so bright as to distract from night-time viewing.

Lighting fixtures should be accessible to maintenance but not to vandals. They should be safe from water and over heating. Careful placing of lighting and the use of low voltage lighting can prevent accidents and security problems.

Trees are best illuminated by lighting that reaches their branches and leaves directly from concealed sources. Flower beds may be lighted by low "mushroom" units set in the beds, screened so that the light source is not directly visible. Floodlights may be directed across beds and to light taller shrubs which cannot be illuminated by "mushroom" units. The best lighting effects for fountains, waterfalls and pools may be produced by submerged equipment. (Beck 1979)



6.4 Waterproofing

Waterproofing is of the responsibility of the architect. In a large terrace development, the architect is responsible for providing a waterproof condition and the landscape architect develops his work above the waterproofing. Problems may occur in constructing and maintaining a waterproof condition if one does not have prime responsibility.

Problems of waterproofing, which require special attention, are sub-systems penetrating the terrace membrane. Often structural walls, bases for light fixtures, foundations for accessory, expansion joints, etc., have to be integrated with the slab structure. Other items which may disturb continuity of roof membrane are drainpipe, electrical conduit, water pipe, fountain mechanical equipment, etc. To complete the waterproofing, it must encompass these items. Therefore, such items must be identified and defined into the waterproofing plan.

The membrane must be protected against puncture during the construction. Thin concrete placed over the waterproofing is an example of protection against damage. The entire waterproofed surface should be protected for the life of the terrace. Since problems of leaking may occur, accessibility for maintenance of the waterproofing is required. (Richard 1977)

Access to waterproofing under planted areas can be made by removal of the plant material and soil. The pool surface should be accessible when drained. It is more difficult to access the waterproofing under the pavement such as poured



concrete or asphalt. Pavement such as bricks or concrete blocks can be set with butt joints on sand or asphalt so they can then be removed if certain areas have to be repaired. The open joints system, using precast elements supported at each corner, allow water to pass through these spaces and is drained over the deck below. When the waterproofing needs to be worked on, the pavers are relatively easily removed and replaced.(Beck 1979)

Waterproofing has much influence on the design of terraces, the choice of materials, the division of professional responsibility, and the work of other professionals.

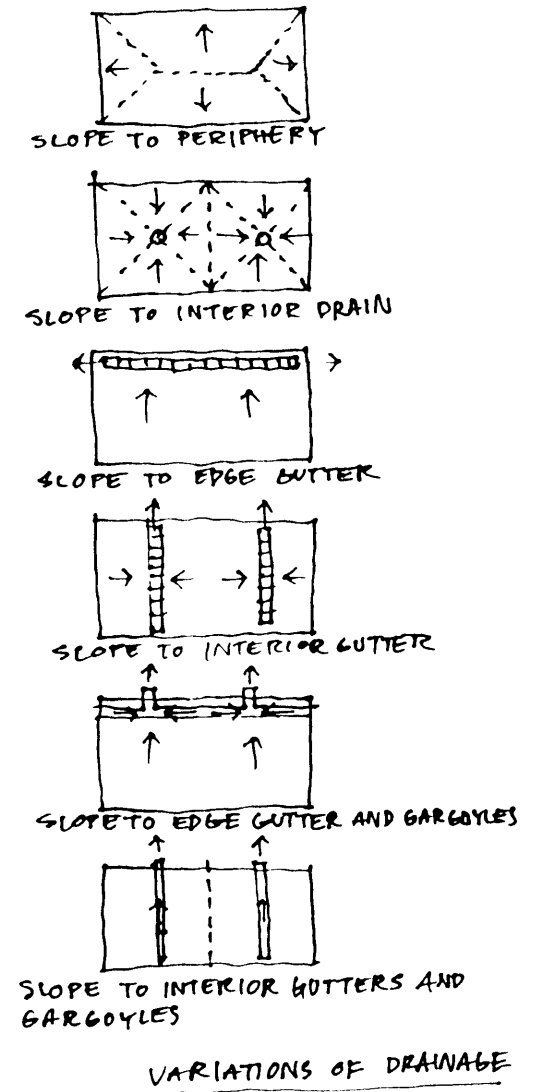
6.5 Drainage

Storm water can be either drained off by natural gravity, or disposed of by mechanical systems, as discussed before. Pitching the paved portions of the roof terrace surface in order that water can be directed to the drains sometimes causes problem. If a roof terrace, which is flat, remain that way because of activities and aesthetic reasons. Surface drainage can be a bothersome problem if not planned for in advance. Several basic techniques for pitching paved surfaces are illustrated.

Drainage under paving

A subsurface drainage system, where water can run freely on a sloping membrane under the open-joint surface, is highly recommended. In this system, dirt is easily washed away from the upper surface and ventilation under the pavement can also accelerate the removal of water and the drying of surface materials. The subsurface drainage layer above the water proof membrane should be continuous under plants and paved areas, pools, fountains, stairways, and even under garden walls or other non structural surface constructions.

Stone or precast surfacing units can be supported by beams, pedestals, or sleepers to provide the require of drain space. It is also possible to groove, corrugate or contour the bottoms of such units to produce a network of voids.



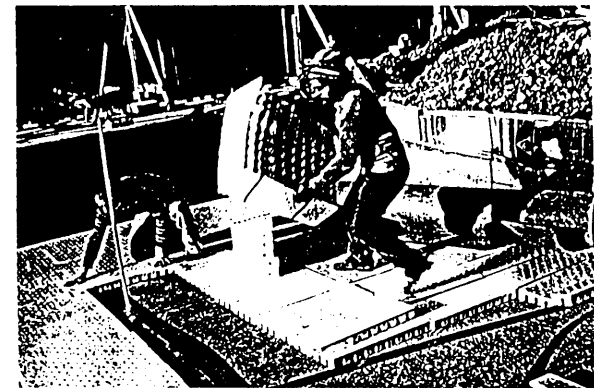
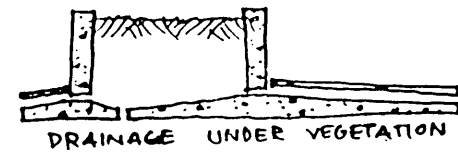
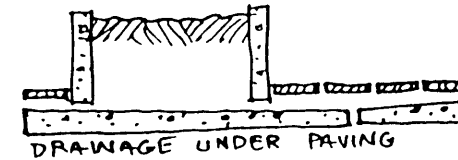
Roof drains at the subsurface drainage level are essential whether there are openings through the roof deck surface or not. Catch-basins, which can be removed for cleaning, should be incorporated in the drainage system to intercept dirt that will be washed from the deck surface. In general, the best drainage will be obtained by placing drains at points of greatest structural deflection.

Drainage under vegetation

Water below the plant roots must be drained, or plants cannot survive. Water on a terrace garden should seep down below the root zone of plants. Water must be removed artificially by sloping the slab and providing frequent drainage. Failure to do so will result in saturation of the root zone. Since plants gain oxygen through roots, so much water will kill them.

A layer of gravel is usually provided over the slab to allow the horizontal movement of water. A cross section that will eliminate problems with both temperature and water is illustrated. If surface drainage is not planned in advance, it can be a serious problem.

One method of avoiding problems is to tilt the support slab 2% and run a strip drain along the lower edge. The entire deck should then be waterproofed with a permanent membrane and covered with a minimum of 100 mm of clean gravel. A soil separator should be placed over this to prevent the topsoil from flowing into the gravel. The depth of gravel depends on volumes of water anticipated. A granular base is normally used under planting areas to provide the required soil



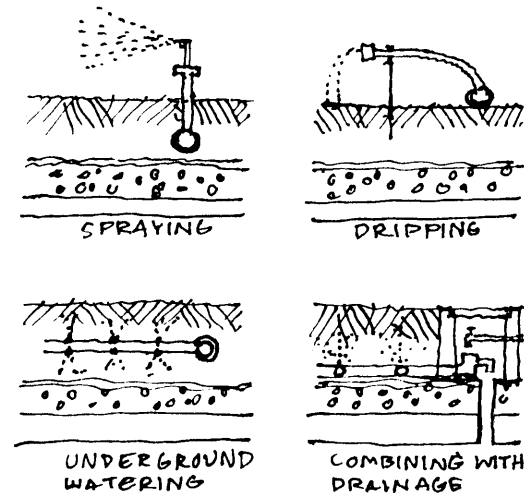
drainage. Another alternative method of drainage is to provide a network of tile drains leading to the edge of the roof.

6.6 Irrigation

Plants on terraces require an irregular amount of moisture since plant roots have no access to the water table. They generally require more watering than if they were planted on a grade. With better drainage and the shallower containers, plants on terraces require more watering. Very shallow soils may need watering twice a day in hot, dry weather. In addition, terrace plants are often surrounded by buildings and pavement which reflect a great deal of heat causing the plants to transpire large quantities of water.

As a minimum, frequent hose bibs should be supplied for irrigation. However, an in-ground irrigation system tied to a control panel with timers is far more preferable. This system is more reliable because it does not depend on as much day-to-day attention from the maintenance staff.

Electrically operated automatic sprinkler and water dripper systems can take care of irrigation of lawns, ground cover areas, flower bed, or hanging plant boxes. Irrigation system can save not only labor costs but also be programmed to operate during the night when wasteful evaporation is at a minimum, and during the time when winds are normally at their lowest levels. Watering is best applied by pop-up sprinklers which can water either full or partial circles. Fixed free-standing sprinklers are simpler but disturb the smoothness of plant scape. Where parts of building overhang the plants soffit sprinklers may be used. Direction and distribution of watering should be careful designed to maximize results and not to spray passers-by.



7. DESIGN ALTERNATIVE

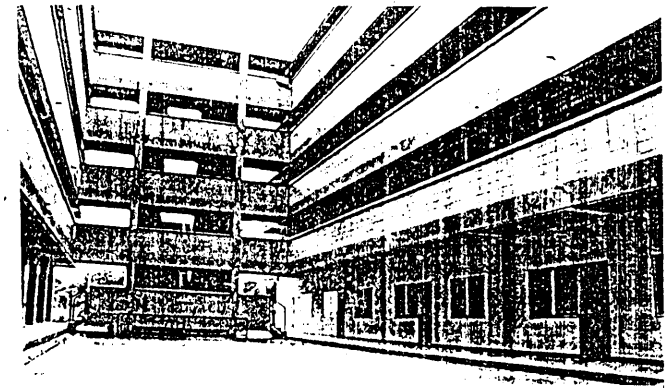
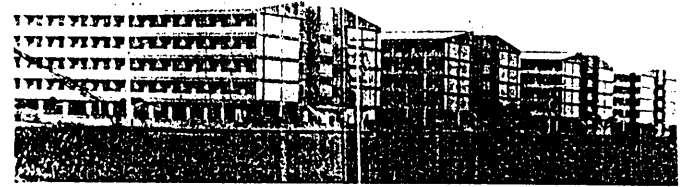
7.1 Medium-density Terrace Housing

In the outskirts of Bangkok, hundreds of medium-density apartment building are built. The existing models of multi-storey housing for lower-income should improve the quality of outdoor space and provide alternative methods of construction. The objective for developing a new prototype are:

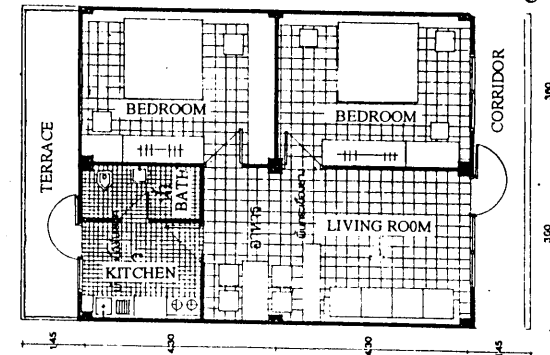
- To provide good, usable and user-friendly open space
- To improve privacy within the unit.
- To improve physical comfort within the unit
- To increase space flexibility in response to the need of outdoor
- To improve the performance of buildings in terms of response to climate
- To provide possible rationalized new building systems

7.2 An Example of Proposed prototype

The prototype is a five-storey terraced apartment building. The ground floor is provides for parking which is required by the building code. The upper floors are stepped back in order to provide terrace open space and the leeward side is to get shade. The corridor at the leeward side is separated from the units for privacy and ventilation.



A typical suburban public housing



TYPICAL FIVE-STOREY,
SINGLE-LOADED CORRIDOR
LOW- AND MIDDLE-INCOME PUBLIC HOUSING

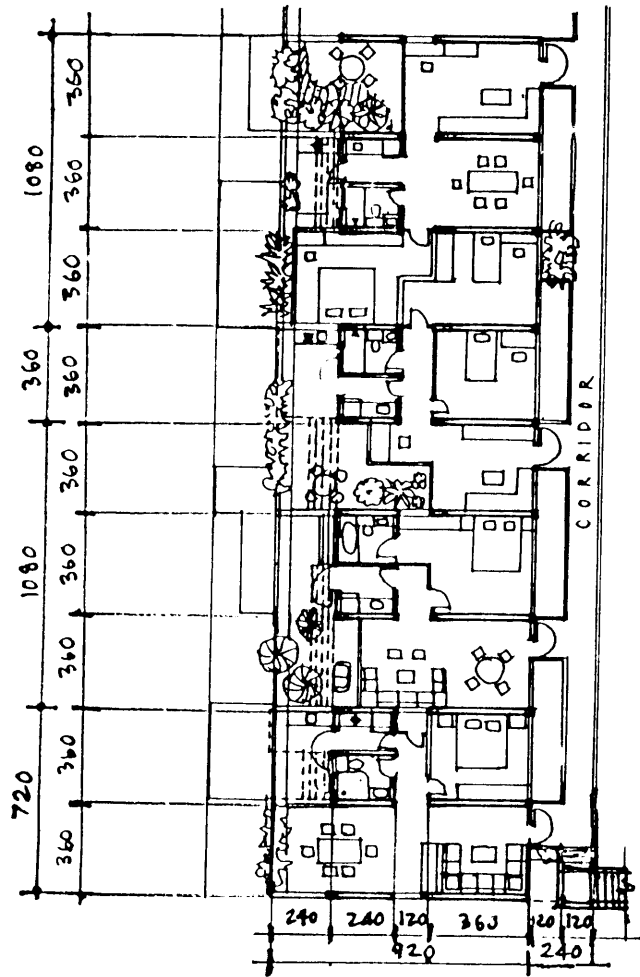
A terrace provides full shade for the opening and a part of the terrace area. Another part of the terrace may get semi-transparency shaded by trellis. Plant boxes along the edge of the terrace and some parts of the terrace have access of sunlight. The quality of shade can make a livable space during the day.

The terraces can provide a flexible use of outdoor activities with the removable terrace elements and exterior partitions. By the system provided, units can be arranged to have 1,2,3 or more bedrooms or bath rooms. Users can add their preferred elements to their unit facade, such as awning or canvas, within the terrace space. Planting and facade decoration are allowed on the terraces. Expansion of a unit can be made by an extending the exterior walls to be covered by an extended roof on the existing structure, and trellises.

Two of the building prototypes can be combined together and create an indoor public space with shared staircases and elevators. In a dwelling unit partitions in the unit are designed to be removable beside the kitchens and bathrooms and parts of common walls.

Fig.7-1 TYPICAL PLAN OF PROPOSED TERRACE BUILDING

TYPICAL FLOOR PLAN



SECTION

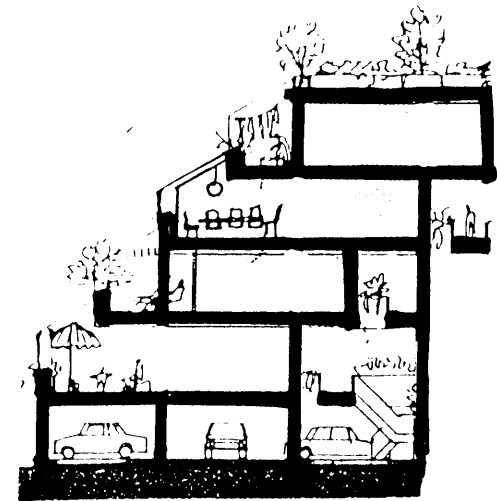
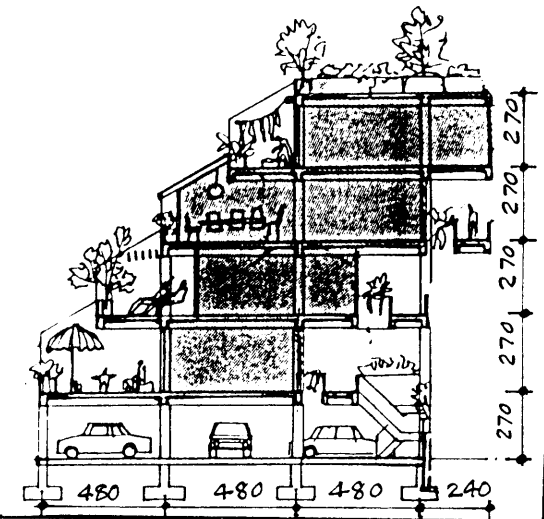
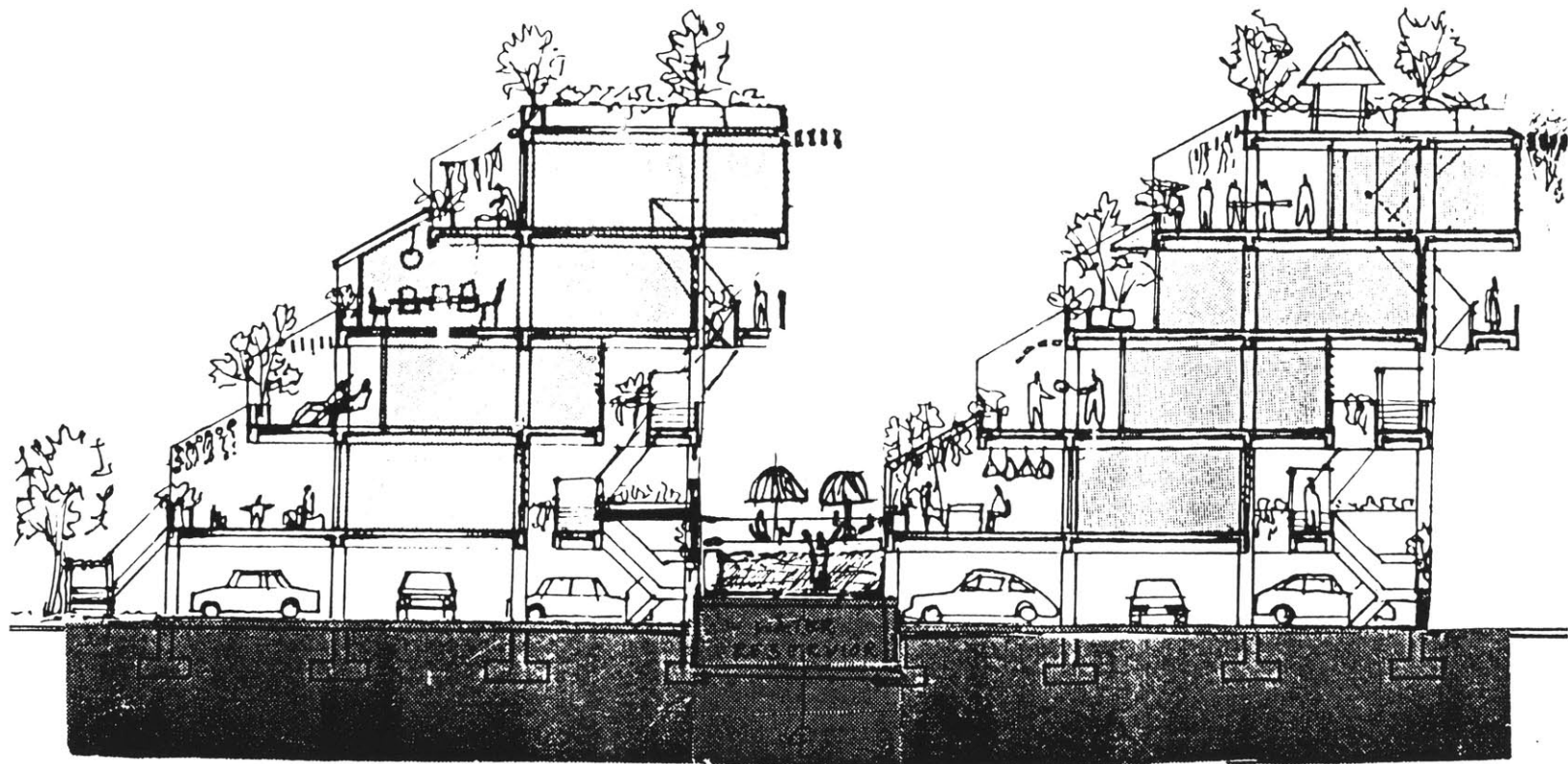


Fig.7-2 ALTERNATIVE CONFIGURATION

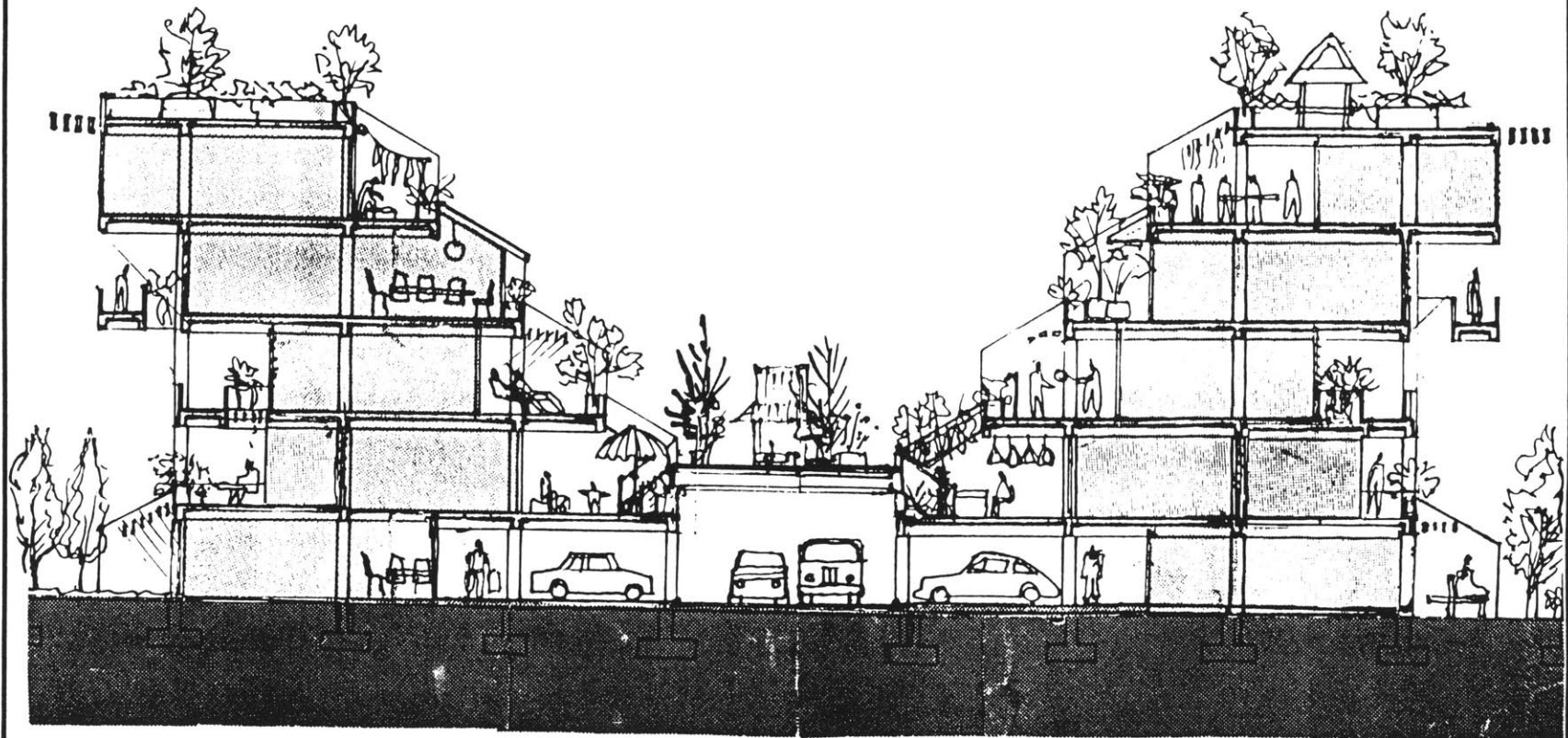
FREE STANDING TERRACE BUILDING



SECTION

Fig.7-3 ALTERNATIVE CONFIGURATION

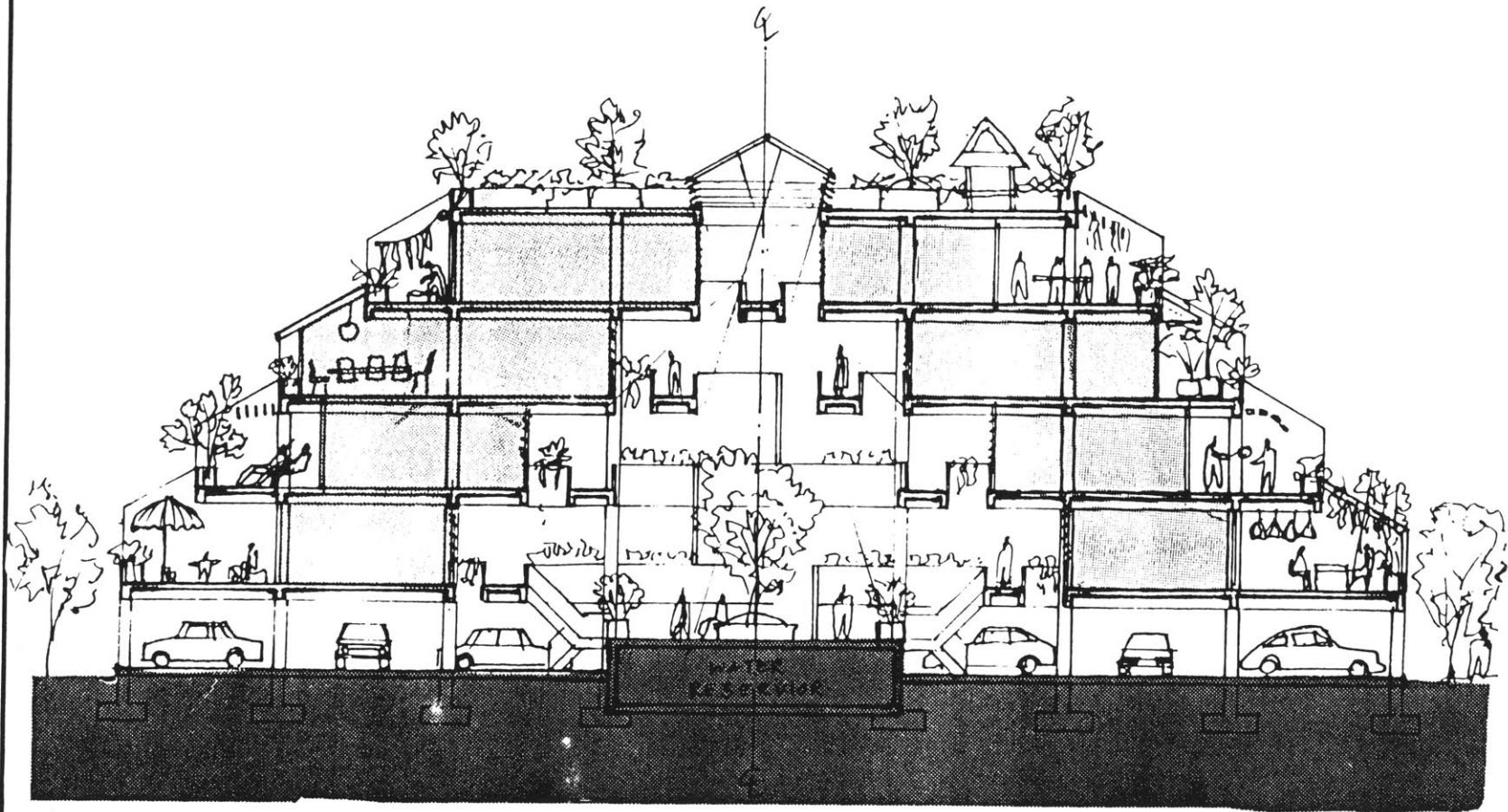
COURTYARD TERRACE BUILDING



SECTION

Fig.7-4 ALTERNATIVE CONFIGURATION

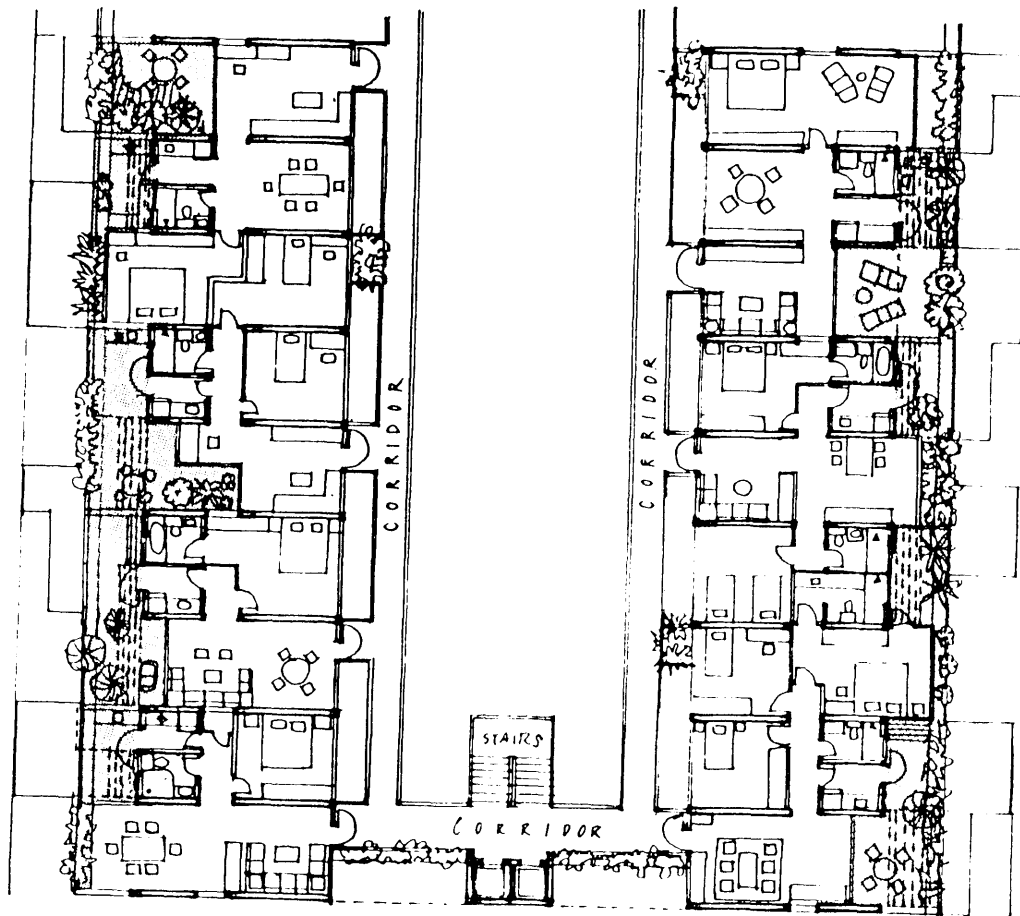
ARTIFICIAL HILL TERRACE BUILDING



SECTION

Fig.7-5 FLEXIBILITY OF INDOOR AND OUTDOOR SPACE

TYPICAL FLOOR PLAN



SECTION

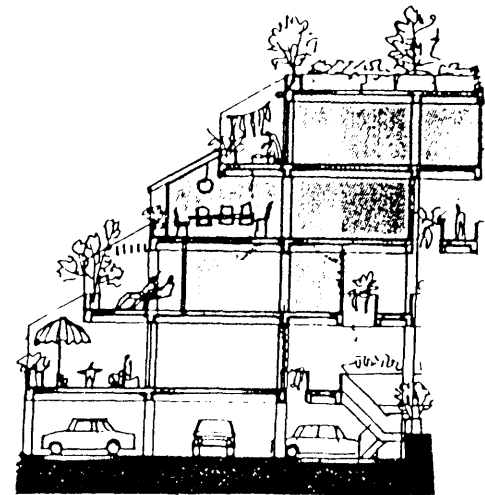
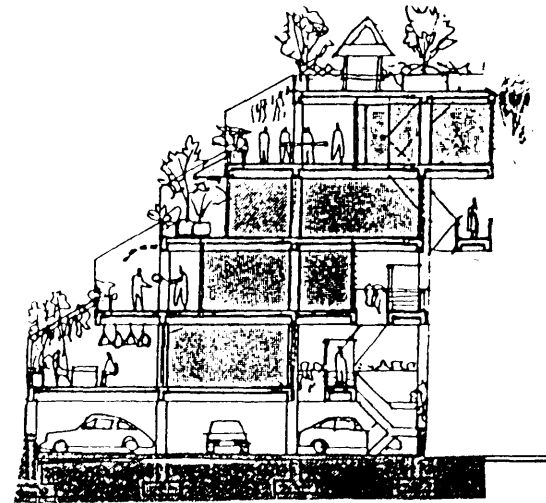
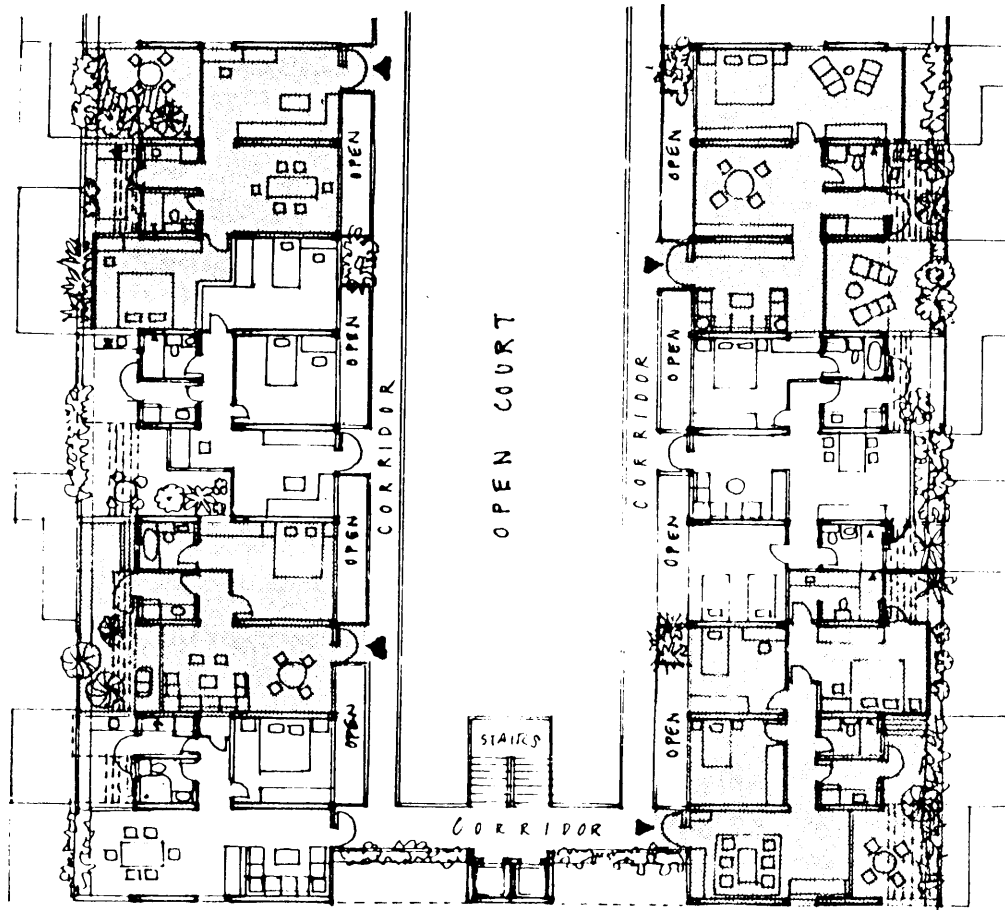


Fig.7-6 FLEXIBILITY OF UNIT SIZE

TYPICAL FLOOR PLAN



SECTION

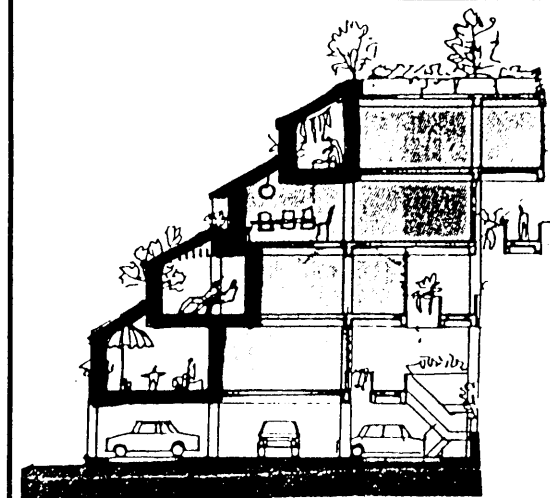
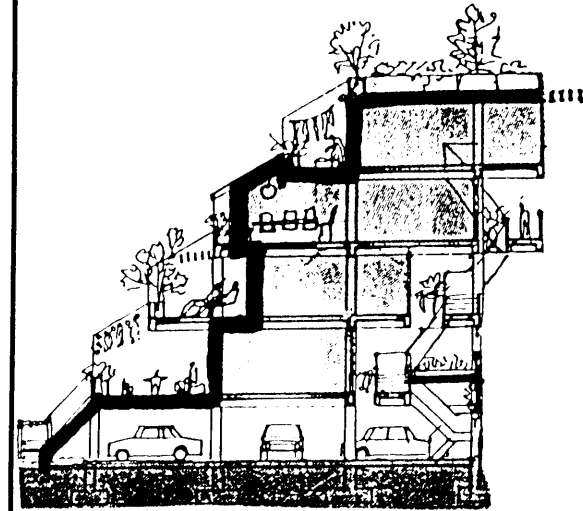
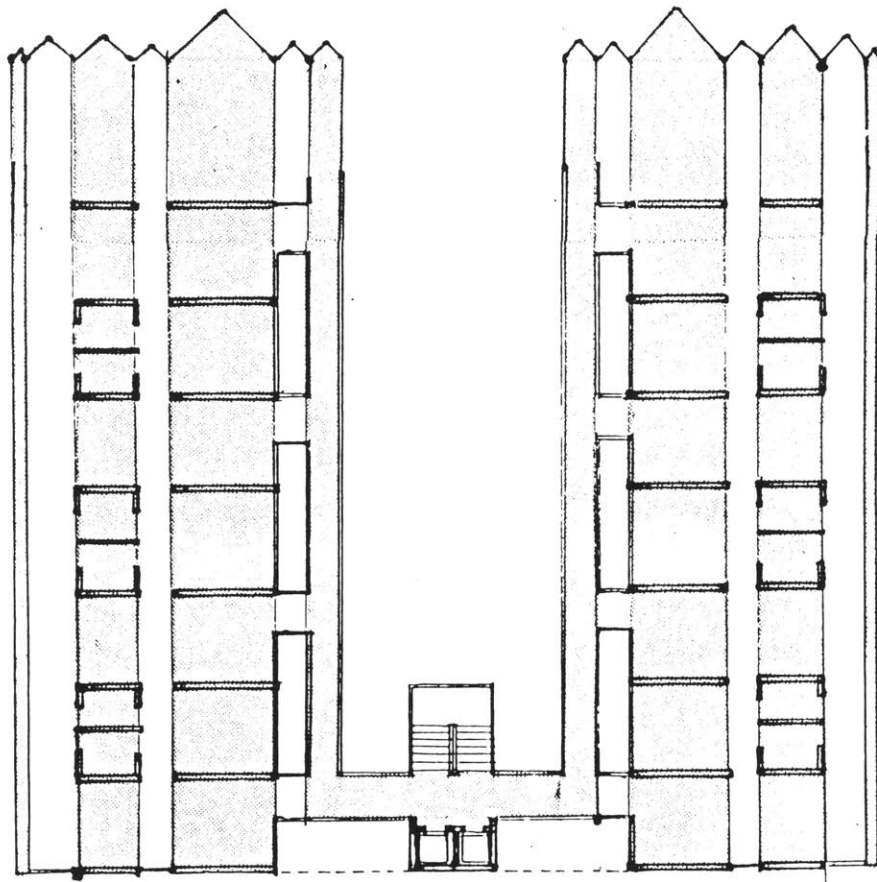


Fig.7-7 SUPPORTING ZONE

TYPICAL FLOOR PLAN



SECTION

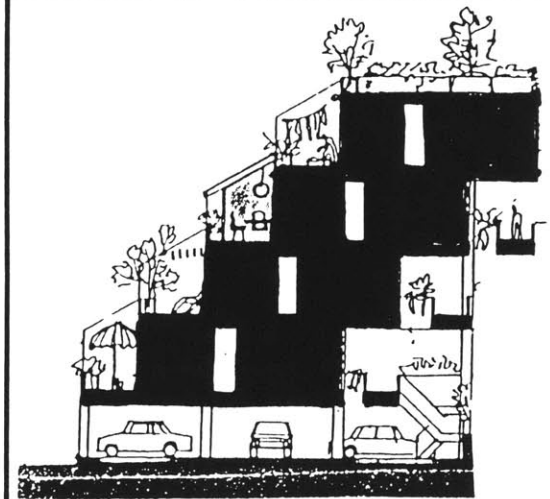
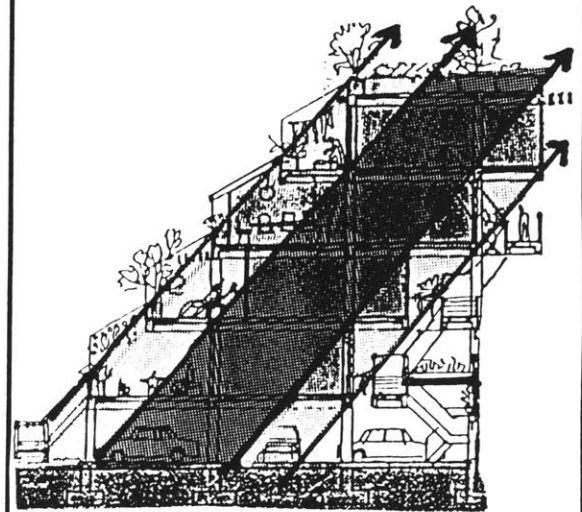
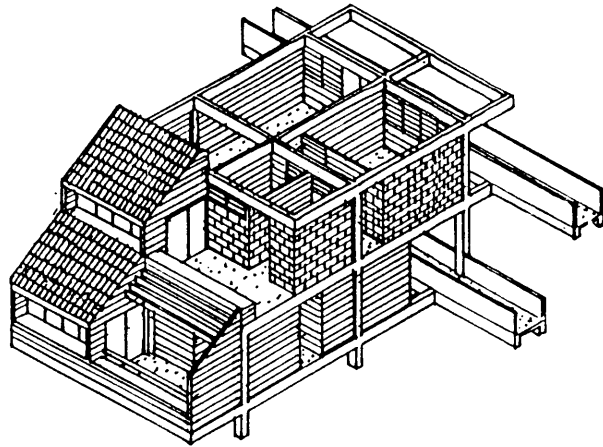
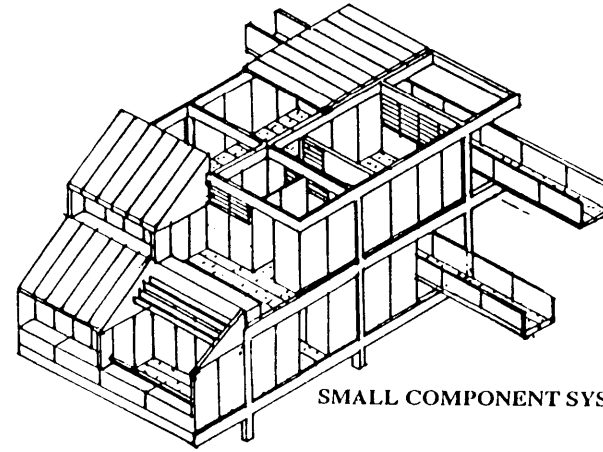


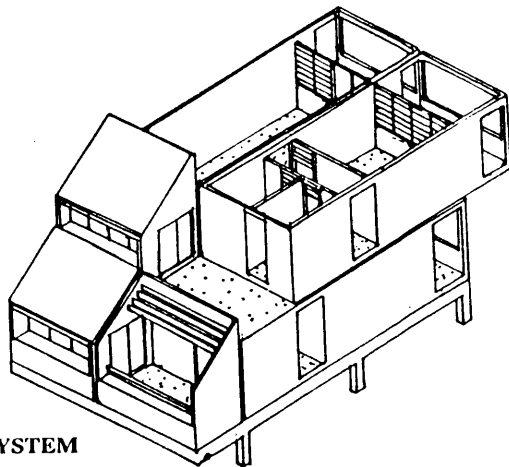
Fig.7-8 ALTERNATIVE CONSTRUCTION SYSTEMS



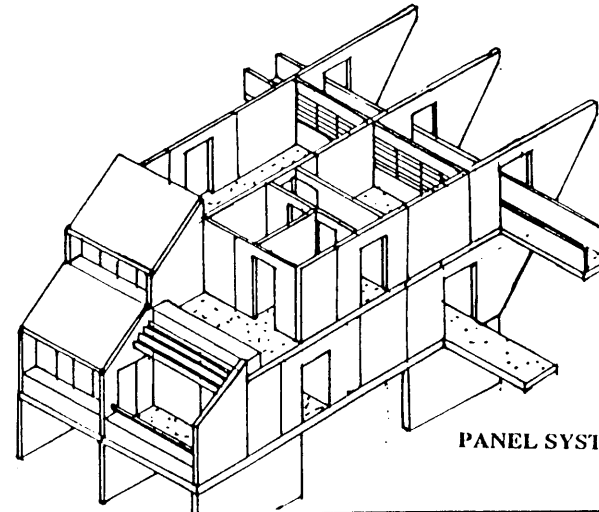
CONVENTIONAL SYSTEM



SMALL COMPONENT SYSTEM



BOX SYSTEM



PANEL SYSTEM

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