

THE TRADITIONAL HOUSE OF JEDDAH:  
A STUDY OF THE INTERACTION BETWEEN  
CLIMATE, FORM AND LIVING PATTERNS

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This thesis has been composed by myself and is my original work.

14/9/1990

SAMEER MAHMOUD Z. AL-LYALY

TO MY PARENTS

## ABSTRACT

The traditional house of Jeddah evolved out of a deep understanding and respect for climate. The thesis describes an investigation of the dynamic interaction between the climate, the form of the traditional house of Jeddah and the living patterns of its occupants. The hypothesis behind the study was that the use of space in the traditional house was closely related to, if not dominated by, a need to maximise thermal comfort. To test the hypothesis, thermal measurements have been carried out in one of the few remaining traditional houses of Jeddah in order to compare and evaluate the thermal conditions in different levels and spaces, and to relate them to the occupants' space-use patterns obtained through interviews conducted by the author with elderly men who had lived in traditional houses. The results provide strong support for the initial hypothesis.

In order to set the research in context, some essential background is given on the development of the old town of Jeddah, its socio-spatial structure, and the nature of its traditional houses. The house is viewed in relation to the whole town, quarters, and the way public urban spaces were distributed and used in residential and civic parts of the town.

The study ends with a brief review of the modern residential environment of Jeddah offered by private villas, and an evaluation of the modern villa in the light of what has been learnt about the traditional house. This enables some suggestions to be offered about the development of a new attitude in designing private houses in Jeddah.

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## SYSTEM OF TRANSLITERATION

The system of transliteration from Arabic used here is the one described in Bulletin 49, (Nov. 1958) issued by the Cataloging service of the Library of Congress.

English quotations are left the way they are even if they do not follow this system.

### Arabic Letter    Transliteration    Short Vowels

	’	اَ	a
ب	b	اُ	u
ت	t	اِ	i
ث	th		
ج	j		Long Vowels
ح	ḥ		
خ	kh	اَ	ā
د	d	اُو	ū
ذ	dh	اِ	ī
ر	r		
ز	z		Diphthongs
س	s		
ش	sh	اَو	aw
ص	ṣ	اِ	ay
ض	ḍ	اِ	iyy
ط	ṭ	اُو	uww
ظ	ẓ		
ع	‘		
غ	gh		
ف	f		
ق	q		
ك	k		
ل	l		
م	m		
ن	n		
و	w		
ه	h		
ت	t		
ي	y		

## INTRODUCTION

### 0.1 PROBLEM STATEMENT

Traditional and vernacular dwellings represented the result of many centuries of optimisation in relation to the climate, technology and resources of materials. Their forms reflect the life style and culture of their inhabitants as well as their understanding of comfort within the natural means available in the environment. However, the traditional dwelling was not built as an isolated object. It was an integral part of the morphology of urban structure. The dwelling unit found its place within the larger habitat ordered within a coherent socio-spatial structure.

The form of the traditional building and settlement evolved not through the direct implementation of planning and design principles as to what and how they should be, but through rules prohibiting what and how they should not be. The governing factor was tradition which acted as a discipline upon all aspects of the built environment and the lives of its inhabitants. Therefore the vernacular environment was not specially created for each dwelling and settlement, it was traditional and handed down through the generations and allowed to evolve through the process of elimination and adaptation.

The traditional house of Jeddah is a remarkable example of the architecture of the Arab world. It had developed over many years into a highly sophisticated and expressive response to the needs of habitation within a social structure and a physical climate that placed very high demands upon the town and buildings.

While there have been various studies made on the old town of Jeddah and its traditional houses, the information they present is rather descriptive and often centred around the influence of socio-cultural factors upon the formation of the old town and its houses. This narrow concern has overshadowed the consideration of climate and its effects on form, and in all the available studies the influence of climate on Jeddah's traditional built form has been discussed superficially and without deep analysis.

The behaviour of the traditional house as a modifier between the exterior and interior climates, and the response of occupants to the modified environment has been of great interest to the author since he was an architectural student. The present thesis is a study of the dynamics of this interrelationship (fig. 0.1).

## 0.2 AIM OF THE STUDY

The main purpose of the study is to investigate and understand the nature of the interaction between the climate of Jeddah, the traditional house form and the occupants' living patterns. The basic hypothesis behind this study is that the use of the space in the traditional house of Jeddah was closely related to, if not dominated by, a need to maximise thermal comfort.

The thesis also contains a brief review of the modern residential environment of Jeddah as offered by the private villas. It is a task beyond the scope of the present thesis to provide a comprehensive study of the modern residential environment in Jeddah. Instead, the general characteristics of the modern private villa are

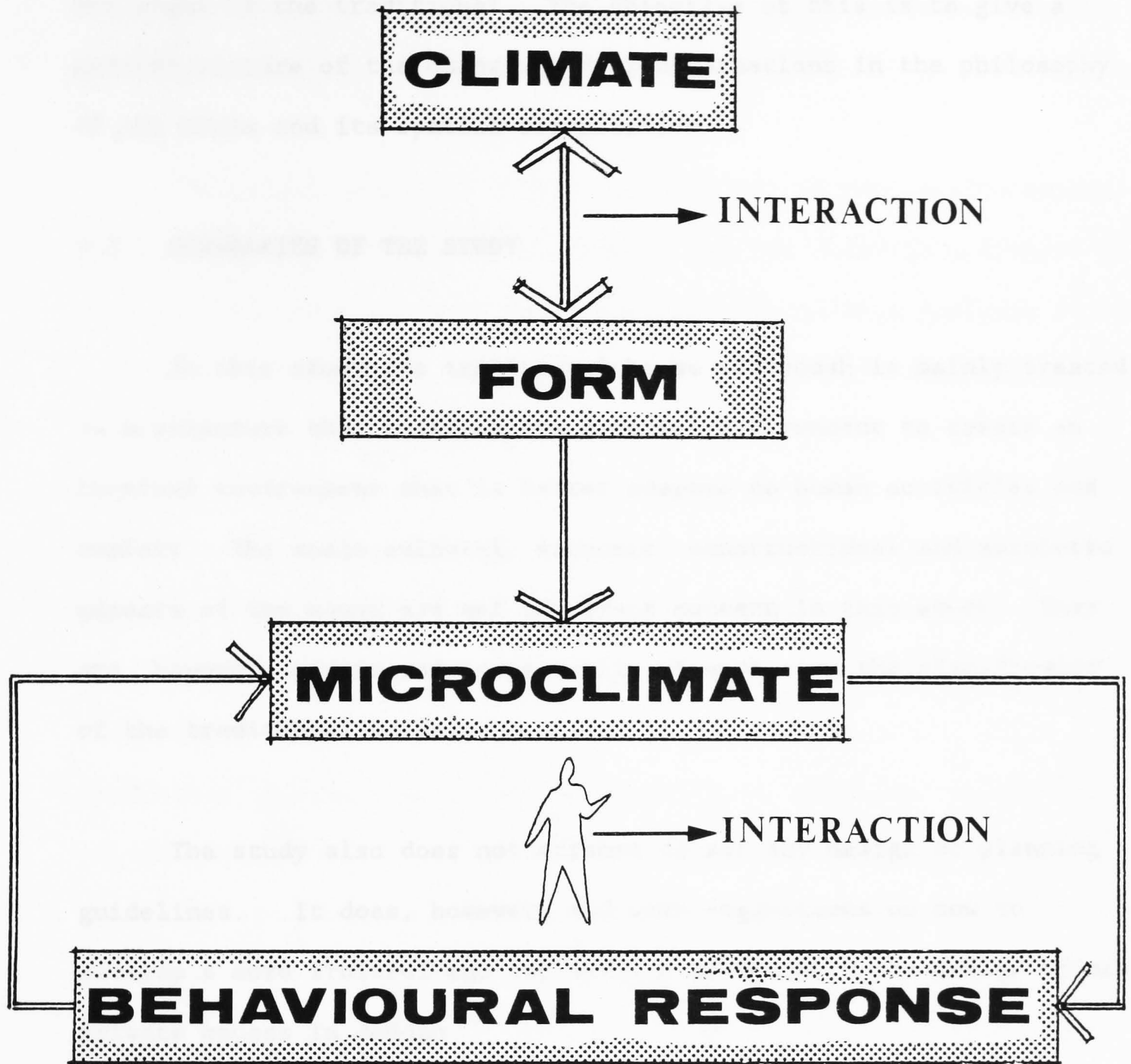


Fig. (0.1) The interrelationship between climate, form and behaviour.

presented as a basis for an assessment of this new housing pattern in the light of the traditional. The objective of this is to give a general picture of the changes and transformations in the philosophy of the house and its spatial organization.

### 0.3 BOUNDARIES OF THE STUDY

In this study the traditional house of Jeddah is mainly treated as a structure that modifies the external environment to create an internal environment that is better adapted to human activities and comfort. The socio-cultural, economic, constructional and aesthetic aspects of the house are not of direct concern in this study. They are, however, considered contextually to emphasize the significance of the traditional house.

The study also does not attempt to set any design or planning guidelines. It does, however, end with suggestions on how to develop a more fruitful and appropriate approach to the design of new private houses in Jeddah.

### 0.4 METHODOLOGY OF THE STUDY

This study is the first contribution on this scale of analysis to an understanding of the interaction between Jeddah's climate, the form of the traditional house, and the activities of its occupants. It has been conducted in three stages as follows:

The first stage was concerned with the preparation of a brief background material on two main topics: the old town structure, and the characteristics of the traditional house.

The second stage was a detailed analysis of two related issues: the climatic characteristics of Jeddah, and the climatic responses of the town and traditional house. The objective of this analysis is to provide knowledge about the influence of climate upon the old town formation and house building.

The third stage was to test the hypothesis that the use of the space in the traditional house was closely related to a need to maximise thermal comfort. Two complementary tools were used. The first was interviews conducted with elderly men who had lived in traditional houses. Available information on occupants' actual use of the house is very sparse and it was necessary to conduct such interviews to obtain a clear picture of the occupants' space-use patterns. The second tool was thermal field measurements carried out in one of the traditional houses of Jeddah in order to compare and evaluate the thermal qualities obtaining in different levels and spaces, and to relate them to the occupants' space use patterns as established on the basis of the interviews.

## 0.5 ORGANIZATION OF THE THESIS

This thesis has eight chapters. Chapter One deals with town of Jeddah. It describes the geographical setting of Jeddah and the general characteristics of its climate. It provides a brief account of the socio-spatial structure of the old town.

Chapter Two traces the evolution and development of the traditional tower house of Jeddah. It describes the common features and elements of the house and gives a short account of its socio-cultural significance.

Chapter Three deals with the climatic response of the traditional house. It provides an analysis of Jeddah's climatic variables and thermal comfort and discomfort conditions. It describes and analyses the urban pattern and morphological character of the old town as well as the traditional house form in terms of their climatic response.

Chapter Four is concerned with occupants' response to climate. It begins with a discussion of the clothing traditions and the social context of thermal adaptation, and proceeds to an account of the interviews conducted on occupants' space-use habits.

Chapter Five describes the thermal measurements conducted in one of the traditional houses of Jeddah. It explains the measuring techniques and shows the type, place and period of measurements. It also presents a discussion of the results and summarizes the thermal qualities obtaining in different levels and spaces. To test the hypothesis established for the study, the results are correlated with the occupants' space-use patterns.

Chapter Six presents a general discussion and evaluation of the traditional house qualities.

Chapter Seven is concerned with the modern villa. It reviews the causes and circumstances which contributed to the decline of traditional house building and the emergence of the modern villa in Jeddah. It describes the general characteristics of the villa, and provides a comparative evaluation of this new housing pattern in the light of the traditional. The opportunity is taken within the context of this chapter to offer some personal views on the possibilities of developing a new attitude towards designing modern private houses in Jeddah.

Chapter Eight is the conclusion of the thesis. It summarizes the study, points out its shortcomings and suggests further studies that will contribute to a better understanding of the thermal adaptation of the traditional house.

## CHAPTER ONE

### THE TOWN OF JEDDAH

A study of the traditional house of Jeddah requires first of all analyses of the overall form of the town, its role within the traditional society and its specific morphology. This chapter starts by giving a brief account of the setting of the town and its historical growth, and then continues with an analytical study of the town's socio-spatial structure.

#### 1.1 GEOGRAPHICAL SETTING AND CLIMATE

Jeddah is located at 21°29' north and 39°12' east on the Tihama coastal plain of the Red Sea in the Western Region of Saudi Arabia (fig. 1.1).<sup>1</sup> The Tihama plain is approximately 12 kilometres wide in the proximity of Jeddah, bounded on the east by a continuous line of foothills, which are a series of outliers from the great Arabian Massif. Further east, another more formidable line of mountain ridges intervenes before the holy city Mekkah can be reached.<sup>2</sup>

Jeddah owes its existence as a town and as a major harbour on the Eastern Coast of the Red Sea to the presence of a gap in this natural barrier (marking the erosional path of Ghalil Valley) which allows ease of communications between Mekkah and the seacoast, and to another gap in the triple line of coral reefs fringing the Red Sea shore.<sup>3</sup>

The area where Jeddah is located is relatively flat, rising eastward gradually from sea level to an elevation of about 12 meters,

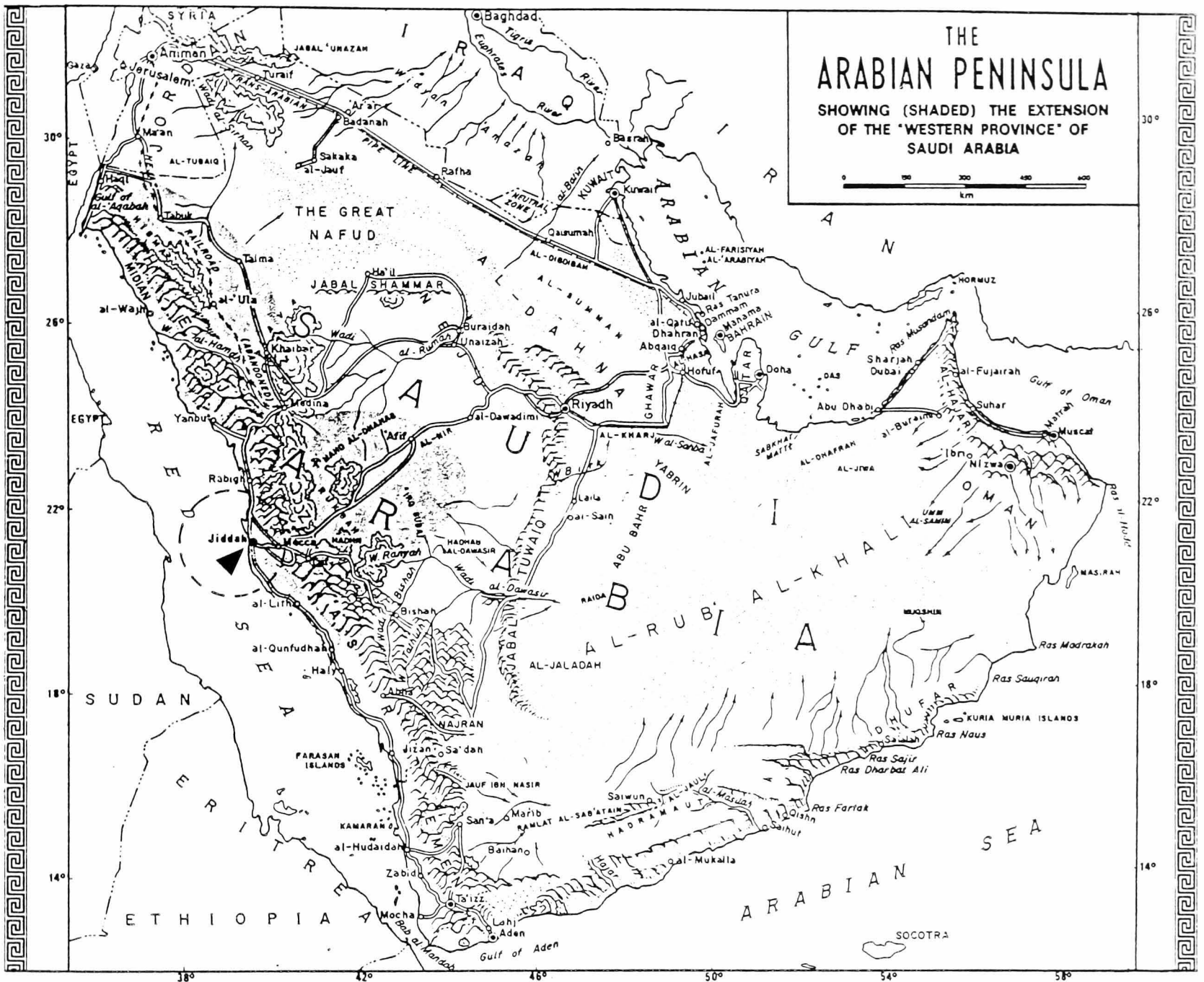


Fig. (1.1) Map of the Arabian Peninsula. The arrow indicates the location of Jeddah

Source: A. Pesce, Jiddah, Portrait of an Arabian City, Falcon Press, London, 1974, p. 101.

with slight changes in elevation towards south and north in some places and for a limited distance.<sup>4</sup> There is no significant topographic relief. Only gentle swells occur, and coral rock shows up where erosion or man-made cuts affect the topographic surface.<sup>5</sup> The area is almost free of vegetation except in the plain north and south of Jeddah where there might be some patches with a fairly thick cover of vegetation, tussocks of grass and thorny scrub, following heavy winter rains.<sup>6</sup>

The climate of Jeddah as well as thermal comfort and discomfort conditions will be discussed later in detail in Chapter Three. However, a short general description of the climate is given here. Being a coastal town, Jeddah suffers from high relative humidity most days of the year, and especially during the summer.<sup>7</sup> The highest levels of humidity are reached at the end of the summer (late August to early October), when the sea temperature reaches its maximum.<sup>8</sup>

The relative humidity is generally lower in winter with a mean daily maximum in December and January is about 90%, while the mean daily minimum ranges from 50% to 60%, the corresponding July and August figures being 93% to 98% and 45% to 50% respectively (fig 1.2).<sup>9</sup>

The mean daily maximum temperature in December and January is about 28°C and the mean daily minimum is about 19°C. In summer, however, the conditions are oppressive during the day with little relief at night. The mean daily maximum temperature in June and July is about 37°C and the mean daily minimum is around 26°C (fig 1.3). Such temperatures coupled with high humidities are the greatest

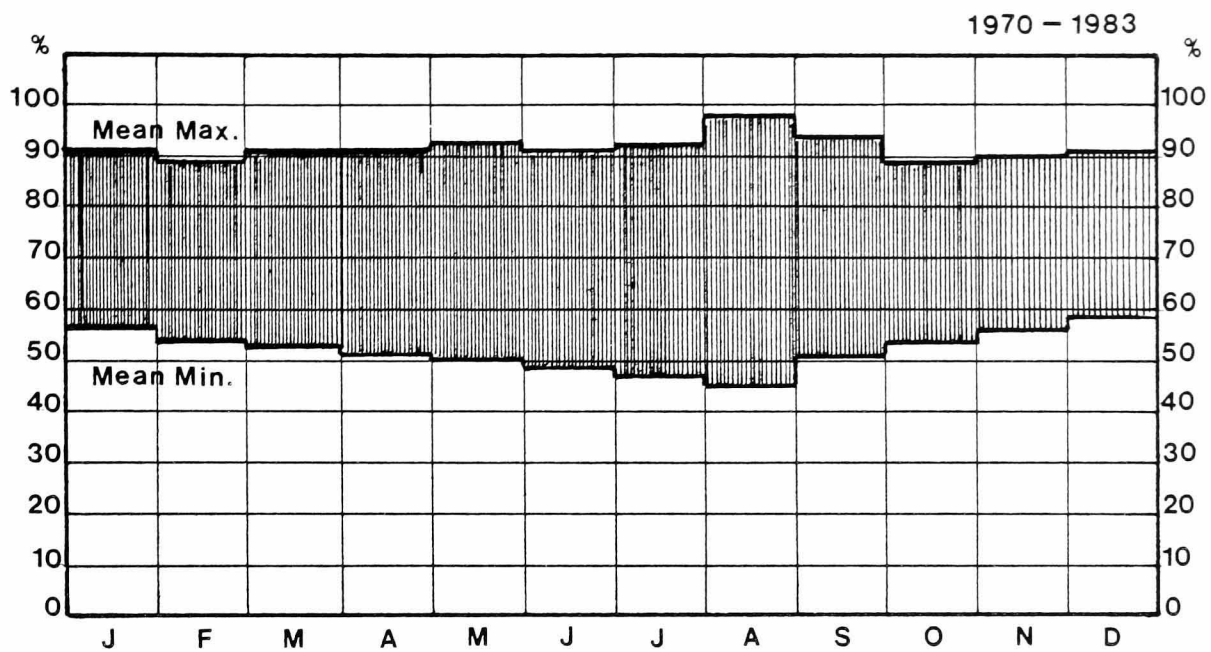


Fig. (1.2) Mean monthly relative humidity in Jeddah .

Source: Weather Records 1970-1983, General Directorate of Meteorology, Western Region, Jiddah, Saudi Arabia.

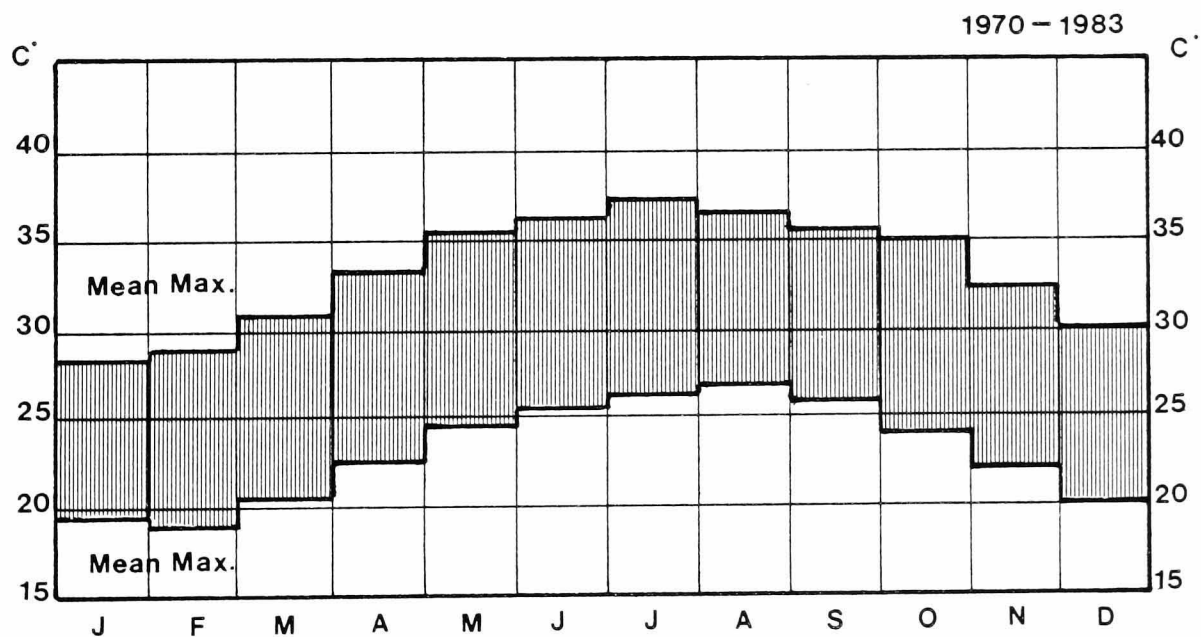


Fig. (1.3) Mean Monthly air temperature in Jeddah .

Source: Weather Records 1970-1983, General Directorate of Meteorology, Western Region, Jiddah, Saudi Arabia.

source of discomfort and annoyance to the residents of Jeddah during the summer.<sup>10</sup>

The prevailing winds (as shown in fig 1.4), are from the north-northwest (330° - 360°) and are very persistent throughout the year. They are usually light to moderate most days of the year.<sup>11</sup> Because of its location on the Red Sea, Jeddah experiences diurnal wind changes commonly referred to as land and sea breezes. The prevailing winds are modified by sea-land breezes during the day and to a much lesser extent, by land-sea breezes at night.<sup>12</sup>

Southerly winds which sometimes occur at any time of year are usually accompanied by rises in temperature and humidity.<sup>13</sup> Sometimes they blow up suddenly causing sand and dust storms; and they are occasionally accompanied by thunderstorms and rainfall.<sup>14</sup> Eastern winds which blow during June are accompanied by the "samūm" which develops into sand and dust storms.<sup>15</sup> The visibility on some days is less than one kilometre, but these unusual conditions do not exceed seven days a year.<sup>16</sup>

As shown in fig (1.5), rainfall in Jeddah, although highly irregular, usually occurs in winter and autumn. It can happen that a few consecutive years may pass without one drop of rain.<sup>17</sup>

## 1.2 HISTORY AND DEVELOPMENT OF THE TOWN

Whilst many scholars have studied the history of Jeddah in detail, our emphasis here is primarily to review the major historic

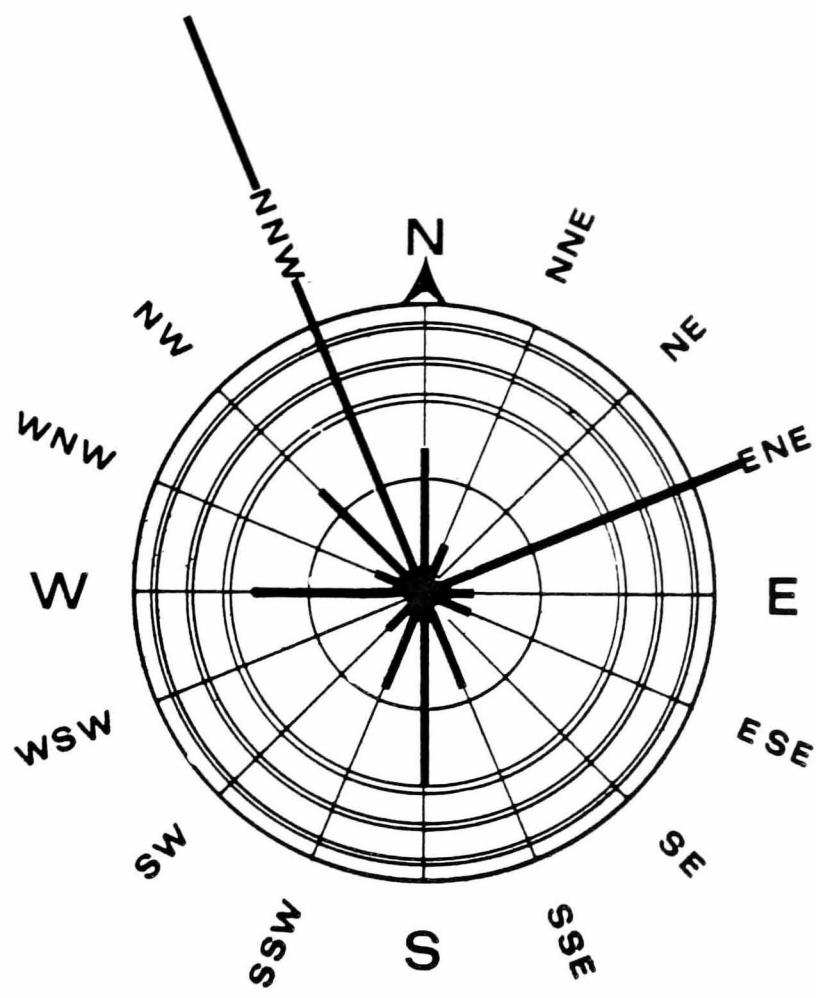


Fig. (1.4) Wind rose of Jeddah.

Source: Ibid.

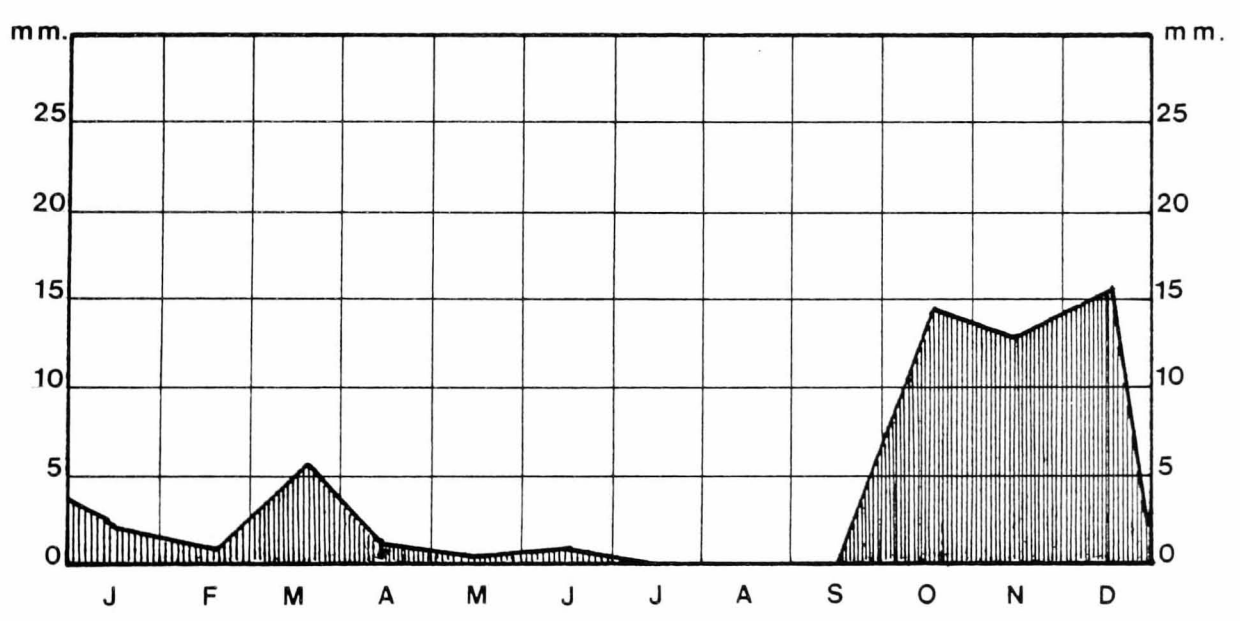


Fig. (1.5) Mean Monthly rainfall in Jeddah

Source: Ibid.

periods of its growth and their impacts on urban formation; as well as architecture.

The historic stages of change in Jeddah can be considered in terms of four eras: Pre-Islamic, early Islamic, Mamlūk and Ottoman. However, historical accounts of the first era make it clear that there was an ancient coastal settlement in the area at least 2,000 years ago, long before the birth of Islam.<sup>18</sup> Although these accounts lack more specific information about the settlement, its particular characteristics and social structure, they show the long established importance of Jeddah as a settlement.

At the end of the Pre-Islamic era, the Port of Mekkah was transferred from Jeddah to al-Shuáibah, about 15 kilometres south of Jeddah.<sup>19</sup> It is thought that al-Shuáibah was exposed to raids from the sea and that is why the inhabitants of Mekkah petitioned the third Khalīfah 'Uthmān to restore Jeddah to its former supremacy as Mekkah's sea outlet. In 646 CE Jeddah's prosperous era began when it again became the Port of Mekkah.<sup>20</sup>

Historical descriptions of Jeddah show that the physical pattern of the town and its architectural character underwent several transformations since it was revived by the third Khalīfah 'Uthmān. The earliest traveller's account describing the townscape of Jeddah is that of Naşir-i Khusraw, the famous persian poet and philosopher (1004 - 1007 CE) who visited Jeddah in 1050 CE. In his famous work Safar Namih<sup>21</sup> he describes the town:

"Jeddah is a great town situated on the coast and surrounded by a wall.... The bazaars are beautiful; the giblah of the great mosque faces the east. There are no buildings to be seen outside the town, except a mosque which is called Masjid ar-Rassoul. The town has two gates: one, to the east, opens on to the Mekkah road; the other, to the west opens on the sea.... There are no trees nor any vegetation in Jeddah; all that is necessary for everyday life is brought in from nearby villages."

The observations of Khusraw that the town was walled and fortified and that there were no houses outside the wall of the town is indicative of the town's opulence and the need for protection against any external threat. This prosperity might be explained by the overall stability and development which the entire Islamic world enjoyed in the ninth and tenth centuries. Prior to and during this period, the town gradually became a major Islamic seaport and trading centre where ships from Egypt met those from India and East Africa and exchanged their merchandise.<sup>22</sup>

Eventually, in the twelfth century, Jeddah's commercial prosperity declined.<sup>23</sup> Within a century or so the deterioration of the town was observed by travellers. In an account of his pilgrimage to Mekkah in 1183 CE, Ibn Jubair, an Arab traveller from Valencia describes Jeddah in his Rihlah,<sup>24</sup> and from this we can derive an impression of the changes which had occurred. He notes:

"Jeddah is a village on the seacoast. Most of its houses are of reeds, but it has inns built of stone and mud, on top of which are reed structures serving as upper chambers, and having roofs where at night rest can be had from the ravages of the heat. In this village are ancient remains which show that it is old. Traces of the walls that encompassed it remain to this day".

Compared to Khusraw's account, this shows Jeddah in a dismal condition. The wealth of the town's inhabitants had faded away. The great fortified commercial town had apparently diminished to an unwallled village with reed houses and primitive structures. However, Ibn Jubair's account of the existence of the inns built of stone and mud (unlike the reeds houses) is indicative of Jeddah's past as a prosperous town.

Jeddah's decline during the twelfth century paralleled the general weakening of Islamic political economic strength which accompanied the fragmentation of the Abbasid Empire.<sup>25</sup> The wealthy merchants of Jeddah were forced to leave the town after the mid twelfth century for political and economic reasons, leaving behind only the fishermen and workers. This led to the town's social and economic degeneration.

About half a century later, the geographer Ibn al-Mujāwir (1204 - 1291 CE) visited Jeddah. He not only wrote extensively about the town on his book Tārīkh al-Mustabṣir,<sup>26</sup> but he was also the first traveller to draw a sketch map of Jeddah (fig 1.6). According to his description, the town was well fortified by a thick wall constructed of coral blocks, and a great moat surrounding the wall into which the seawater flowed. Regarding the inhabitants and their buildings, Ibn al-Mujawir notes: "The people of Jeddah are descendants of the Persians. They build with coral stones and palm fronds, and the town is mostly composed of inns." After mentioning a few of the famous inns, he continues:

# JIDDAH

## ITS CONFIGURATION AS TO PLACE AND POSITION

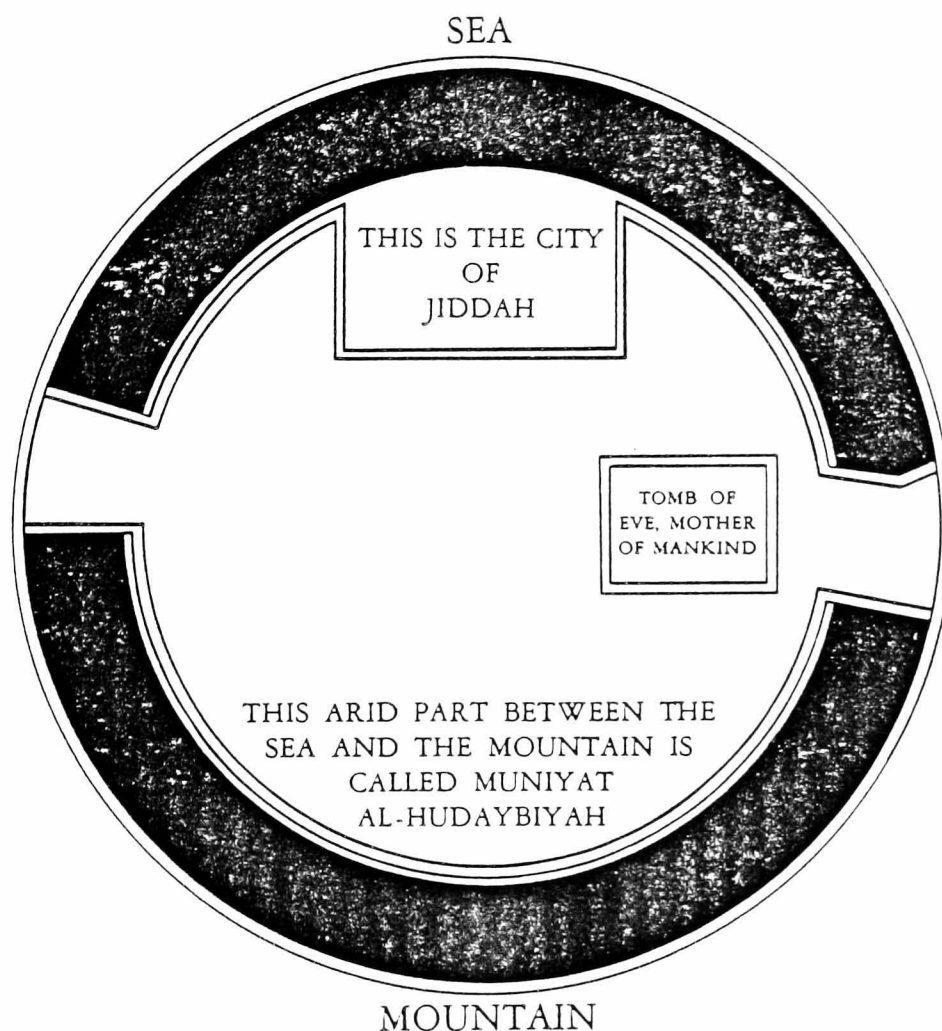


Fig. (1.6) Plan of Jeddah in the early 13th century according to Ibn al-Mujawir (redrawn from the manuscript of Tarīkh al-Mustabsir edited by O. Löfgren). Fanciful and sketchy as it is, this is the oldest Plan of the town and its surroundings.

Source: Reproduced in A. Pesce, op.cit., p. 18.

"Whoever builds in the town a palm-fronds hut, pays the Sultan a yearly tribute of three royal dirhams; conversely, there is nothing to be paid for houses built with stones and gypsum, as these are for the ownership and enjoyment of their landlords."

From Ibn al-Mujāwir's account one can deduce some interesting information about the town. First, it seems the town has regained some of its early prosperity since the visit of Ibn Jubair, about fifty years ago. This is shown by Ibn al-Mujawir's report of the wall built around the town, the stone residences, and the existence of many inns in the town. Secondly, Ibn al-Mujāwir points out that the inhabitants of the town are of Persian descent. Thus one is led to assume that merchants of Persian descent had arrived and settled in Jeddah when it started to regain some of its earlier prosperity and played a major economic role in its development. And finally, Ibn al-Mujawir's report on the coral-built houses suggests that coral had become the major construction material of the area.

Until the fifteenth century the town of Jeddah, and the whole Hejaz region had been usually under the control of the Ashrāf of Mekkah, although Egypt, under the Mamlūk, from the middle of the thirteenth century onwards, took an increasing interest in the town until they actually garrisoned the Hejaz region in 1425, placing Jeddah under Egyptian political and economical superintendence.<sup>27</sup>

Unfortunately, information left from this era is not enough to judge the urban pattern of the town and its houses. However Lodovico di Varthema, an Italian traveller who visited Jeddah in 1503, gave a short description of the town in his book. In Chapter II (Concerning Arabia Deserta)<sup>28</sup>, he describes Jeddah: "This town is not surrounded

by walls, but by very beautiful houses, as is the custom in Italy, we will, therefore, not dwell long on a description of it." He then adds: "It is a town of very extensive traffic;...." His observation that the town was unwalled assumes that the wall which surrounded the town in the thirteenth century had fallen into ruins, and the town became unprotected and subject to attack.

The Portuguese coveted the riches and economic resources of the East, and their frequent attacks on Muslim shipping at the beginning of the sixteenth century presented a new menace to the Port of Jeddah. This threat was perceived by the Mamlūk Qānsuah al-Ghūri, Sultan of Egypt and lord of Hejaz. He ordered the appointed Governor of Jeddah to secure the town by a strong protective wall, which was completed in 1511 CE, making it a strong base for assault against the Portuguese maritime fleet (fig 1.7).<sup>29</sup>

The fall of Cairo to the Ottomans in 1517 CE saw the Sharīfs of Mekkah confirmed in their position and with the extinction of the Mamlūks they appointed governors of the Hejaz region.<sup>30</sup> The Ottomans period ushered in a lengthy era of relative stability during which much of the town of Jeddah was developed.

In 1701 CE Charles Poncet, a French doctor visited Jeddah. Writing about the houses of Jeddah, Poncet notes: "The greatest part of the houses are built of stone, and are flat-roofed after the eastern manner."<sup>31</sup>

During the nineteenth century are seen developing the strands of commercial life which were responsible for the wealth of the town

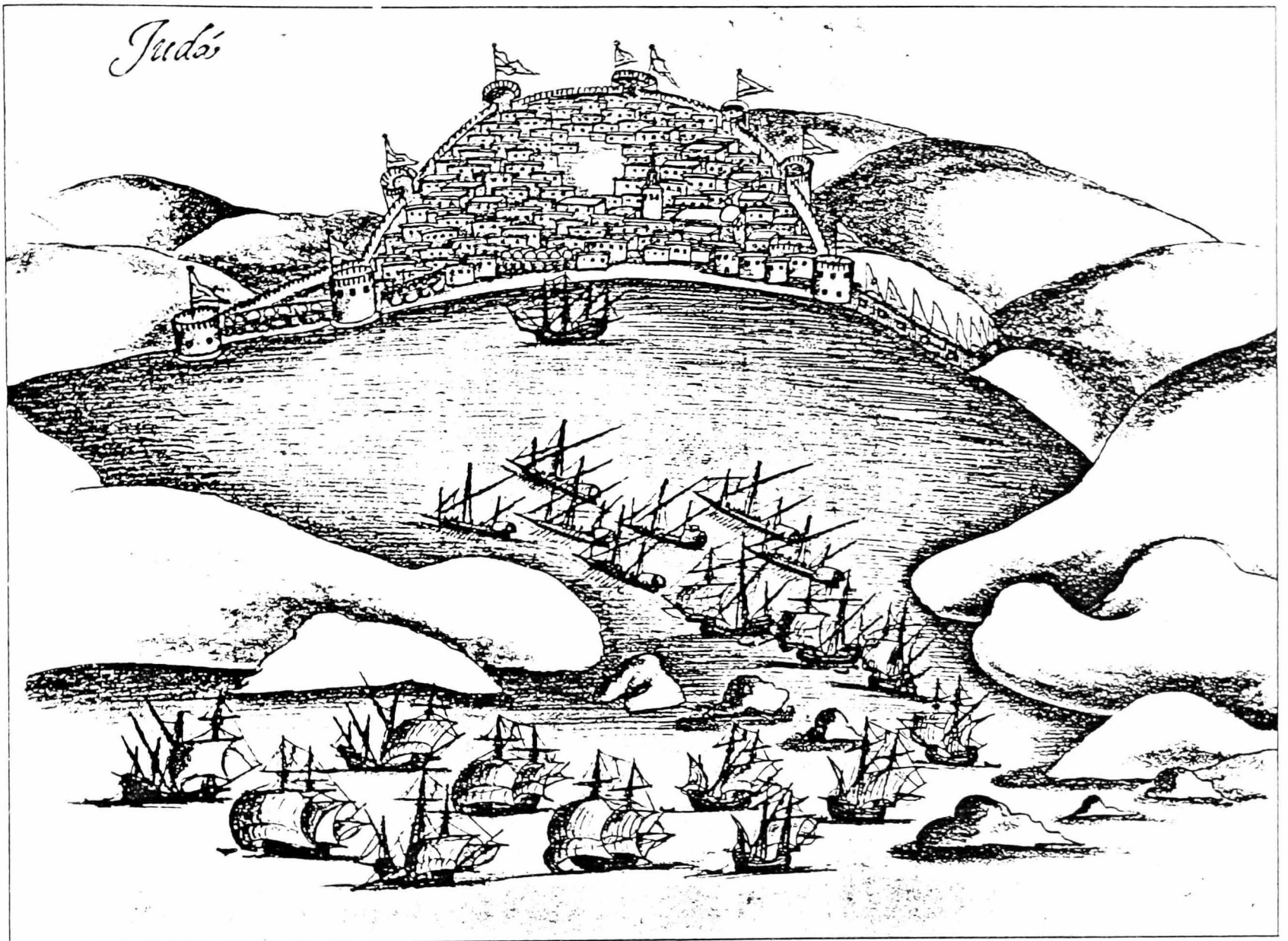


Fig. (1.7) The Town of Jeddah in 1517.

Source: From a drawing by Gaspar Correa in the Museum of the Lisbon Geographical Society. Reproduced in A. Pesce, op.cit., p. 86.

and its development. In 1814 CE Johann Burckhardt, a Swiss traveller, visited Jeddah and gave a detailed description of the town in his book Travels in Arabia,<sup>32</sup> he wrote:

"The town is built upon a slightly rising ground, the lowest side of which is washed by sea. Along the shore it extends in its greatest length for about fifteen hundred paces, while the breadth is no more than half that space. It is surrounded on the land-side by a wall,.... A narrow ditch was also carried along its whole extent, to increase the means of defence; and thus Djiddah enjoys, in Arabia, the reputation of being an impregnable fortress. On the sea-shore, in front of the town, the ancient wall remains, but in state of decay."

Next he proceeds to describe the town layout and its houses:

"The interior of Djidda is divided into different districts.... The most respectable inhabitants have their quarters near the sea, where a long street, running parallel to the shore, appears lined with shops, and affords many Khans constantly and exclusively frequented by merchants. Djidda is well built; indeed, better than any Turkish town of equal size that I had hitherto seen. The streets are unpaved, but spacious and airy;.... Almost every house has two stories, with many small windows and wooden shutters. Some have bow-windows, which exhibit a great display of joiners' or carpenters' work."

He then adds:

"There is, generally a spacious hall at the entrance, where strangers are received, and which, during the heat of the day, is cooler than any other part of the house, as its floors is kept almost constantly wet. The distribution of rooms is nearly the same as in the houses of Egypt and Syria; with this difference, however, that in Djidda there are not so many large and lofty apartments as in those countries, where but few houses, at least of the natives, have two stories, whilst the rooms on the ground-floor are sometimes of a considerable height."

Burckhardt also noted:

"Uniformity in architecture is not observed at Djidda. Some houses are built with small, others with large square stones, the smooth side outwards, and the interior filled up with mud. Sometimes the walls are entirely of stone; many have, at intervals of about three feet, thin layers of planks placed in the wall, and these, the Arabs imagine, tend to increase its strength. When the walls are plastered, the wood is left natural colour, which gives to the whole a gay and pleasing appearance, as if the building had been ornamented with so many bands;.... No buildings of ancient date are observed in Djiddah, the madrepora being of such a nature that it rapidly decays when exposed to the rain and moist atmosphere prevalent here."

Burckhardt suggests that Jeddah derived its wealth not only from being the Port of Mekkah, but also because it could be considered the port of Egypt, India and of Arabia, where all the exports destined for Egypt pass first through the hands of the Jeddah merchants. Hence he adds: "It is probably richer than any town of the same size in Turkish dominions."

The opening of the Suez Canal in 1869 augmented Jeddah's commercial position.<sup>33</sup> The Red Sea, instead of being a side-road for maritime commerce, became the highway to the east. Consequently, Jeddah became a thriving centre of mercantile activity. By the turn of the century, the wealthy merchants of Jeddah were handling a regular volume of commerce with other Arabian ports, India, Egypt and Africa and even Liverpool and Marseilles.<sup>34</sup>

In 1916 CE, T.E Lawrence, (Lawrence of Arabia), visited Jeddah and wrote about the town in his widely read book Seven Pillars of

Wisdom.<sup>35</sup> Describing his approach to Jeddah from the Red Sea,

Lawrence wrote:

"But when at last we anchored in the outer harbour, off the white town hung between the blazing sky and its reflection in the mirage which swept and rolled over the wide lagoon, then the heat of Arabia came out like a drawn sword and struck us speechless."

Next Lawrence describes the town and its houses:

"It was indeed a remarkable town. The streets were alleys, wood roofed in the main bazaar, but elsewhere open to the sky in the little gap between the tops of the lofty white-walled houses. These were built four or five stories high, the coral rag tied with square beams and decorated by wide bow-windows running from ground to floor in grey wooden panels. There was no glass in Jidda, but a profusion of good lattices, and some very delicate shallow chiselling on the panels of the window casings.... House-fronts were fretted, pierced and pargeted till they looked as though cut out of cardboard for a romantic stage-setting."

A number of interesting points can be deduced from Lawrence's account. First, the houses he observed were lofty - four to five stories high - while Burckhardt had noted a century before that almost every house was two stories high. This indicates the splendid development of houses in the late part of the nineteenth and early twentieth centuries. Secondly, the overall character of the town seemed to have changed but little since Burckhardt saw it. It still gave the impression of being well built. The houses were white-washed, and the facades almost covered with a patchwork of timber compounded of projecting bay-windows, screens and shutters. And finally, Lawrence, unlike Burckhardt who noted that the streets were

spacious, pointed out that the streets were alleys. Thus one is led to assume that Burckhardt was impressed by the major arteries, running parallel to the sea and perpendicular to it, and therefore described them as spacious and airy, while Lawrence was referring in his account to the close relatively regular texture of the residential streets which were narrow unlike the major arteries (see fig 1.9).

The eruption of World War I compelled the British to assist the Hashemite Sharif of Mekkah, Hussain Ibn Ali, who had become disturbed by the intolerably increased Turkish control over the Hejaz. Sharif Hussain proclaimed his independence from the Turks and, assisted by the British, attacked Jeddah in June 1916. After one week of the attack the Turks surrendered the town in June 17, 1916, ending the Ottoman domination of the Jeddah which had lasted for four centuries.<sup>36</sup>

At the beginning of 1925, Abdul-Aziz Ibn Saūd's army surrounded the town of Jeddah which was protected by strong walls and fortifications. The siege of Jeddah lasted for almost a year. In December 23, 1925, Abdul-Aziz entered Jeddah and proclaimed himself "King of Hejaz, Sultan of Najd and its Dependencies." It was only in September 1932 that the country was named Kingdom of Saudi Arabia, with Abdul-Aziz Ibn Saūd as its first king.<sup>37</sup>

Immediately after World War II, Jeddah witnessed a commercial and financial boom, aided by the substantially increasing number of pilgrims arriving at its port as well as by the large oil revenues.

The town's rapid expansion and physical growth required the demolition of the walls in 1947.<sup>38</sup>

### 1.3 SOCIO-SPATIAL STRUCTURE OF THE OLD TOWN

#### 1.3.1 Traditional Family and the Social Structure of the Town

In the traditional society of Jeddah, the family provided the primary and basic unit of the social structure of the society. The traditional family in Jeddah was patrilineal, extended, endogamous and the primary locus of allegiance and responsibility. It was the basic agency for mutual aid and protection, the teaching of Islam to the young, the management of private property, and the regulation of social intercourse in the society.<sup>39</sup>

Family life revolved around the Islamic religious teaching which consolidated loyalty and ties among family members. The need to co-operate and co-ordinate their activities in the interest of the domestic unit, and their concern to maintain the good name and honour of the family in the eyes of the society, brought all of its members together, thus keeping the family intact and preventing the rise of disputes. Indeed, this was one of the main characteristics of the traditional family of Jeddah.<sup>40</sup>

The absolute power of the head of the family, in the sense of the subordination of all family members under one person, was another characteristic of the traditional family. The head of the family was not primarily regarded as an individual with a distinct personality, nor was he viewed by the household as a symbolic head. Instead he

constituted the absolute functional and authoritative head of the family, granting and securing existence, and referred to as the Patriarch.<sup>41</sup>

In case of the death of the head of a family, the oldest son became responsible for managing the family business and its public affairs, while his widow assumed final authority inside the house, often assisted by the eldest son and the eldest daughter. The strong ties among the family members have been always respected and cherished even after the death of the Patriarch.<sup>42</sup>

Thus, social cohesion of the society and a sense of belonging were established first of all at the primary unit, the extended family. But Islamic culture does not restrict strong ties and good relations solely to the immediate family; it also encourages good relations with neighbours.<sup>43</sup> This is reflected in the social relations between the family-houses of a single residential quarter, or even between the various quarters in the old town of Jeddah. For example any celebration of one family (such as a wedding, birth, homecoming from a long journey, etc.) as well as its crises (death, sickness, etc.) were collectively shared by the houses of the various quarters.<sup>44</sup>

The traditional social life took thus the form of a family life, governed by religion, tradition and customs. Indeed the various residential quarters of old Jeddah can be seen as nothing more than parts of a still larger family.

Similar to other Islamic societies during the Ottoman era, such as Damascus, the traditional society of Jeddah was cosmopolitan, diversified, and with heterogenous ethnic backgrounds.<sup>45</sup> Many of the great trading families who lived in the old town of Jeddah had come from other parts of the Arab and Islamic world; from Hadramaut, Pakistan, Turkey, Iran and elsewhere. They settled down side by side and gave the town a cosmopolitan atmosphere rather different from the rest of the Hejaz region.

The town's economic prosperity also attracted a floating population of immigrants from other parts of the Arab and Islamic world. Many were skilled craftsmen who came to Mekkah for pilgrimage and afterwards settled in Jeddah for work and found a place in the urban society.<sup>46</sup>

Given the range of ethnic groups, one might well ask how such groups were integrated harmoniously into urban social life without discord, how the town achieved a sufficient cohesiveness to maintain itself as an entity and fulfil the needs of the whole. There were many factors contributing to the social tranquillity of the town. First, the town as a whole was organised and administered according to the Shari'ah (Islamic law).<sup>47</sup> The acceptance of the Shari'ah which is an integral part of the Muslim faith into such a heterogeneous cosmopolitan society as that of Jeddah was an effective vital step towards establishing overall social unity in the old town.

Second, though Jeddah's population was so diverse, it was never organised into tight parochial communities.<sup>48</sup> Social segregation was not practised in Jeddah's urban society. Ethnic grouping (Yamani,

Hadrami, Indian, Turkmen, Bukharys, and Persians, etc.) was more social than physical in the strong communal bonds existed among the members of each ethnic group in that they did not necessarily live in close proximity to one another.<sup>49</sup>

In addition, there was a relative absence of spatial grouping by social status.<sup>50</sup> Economic, religious, and social life were not so differentiated from each other as to create the basis for any radical separation of social classes by quarter. Each quarter can be seen as a microcosm, where all classes (merchant, teachers, scholars, craftsmen and workers) lived together as neighbours. Certain quarters, however, were favoured by the wealthy because of their salubrity or proximity to the sūq, and this gave them somewhat an "upper" class character (see Section 1.3.3).

### 1.3.2 Islamic Law Influence on Building Tradition

Many scholars have attempted to define the effects of Islamic culture on the formation of urban settlements in the Muslim world, and some have tried to isolate the effects of Sharīah (Islamic law) in particular in order to account for the similarities found in the urban process in most medieval Muslim cities. It is generally acknowledged that a set of relatively uniform legislative guidelines was developed through interpretations of the Qur'ān, Hadīth (the Prophet's sayings), ijtihād (scholarly opinion) and traditions; these guidelines had a strong influence on the homogeneity of urban formation and architecture.<sup>51</sup>

Besim Hakim has examined these issues in more depth in his book, "Arabic-Islamic Cities: Building and Planning Principles,"<sup>52</sup> and Al-hathloul's unpublished thesis, "Tradition, Continuity and Change in the Physical Environment: The Arab-Muslim City" offers a helpful framework for the present study.<sup>53</sup> Al-hathloul, working from documents of Qudāh (Judges) and from ahkām (verdicts) manuscripts cited by Muslim scholars such as Malik, (712 - 795 CE) has extracted a number of guidelines which affected the conduct of building activity in al-Madīnah. His findings are useful because they are based on written documentation of the urban formation of al-Madīnah; no such documentation exists to tell us how the town of Jeddah developed, and yet the town's urban pattern and habitats suggest that the same Islamic legislative principles must have been applied.

Malik spent most of his life in al-Medīna, thus his experience was deeply rooted in al-Sunnah (the Prophet's traditions) and by experience and knowledge gained in the town.<sup>54</sup> The guidelines in the Maliki Fiqh manuscripts were continuously recycled and used, with minor alterations, up to the early years of this century. What reinforced and spread the guidelines was the extensive travels of Islamic jurisprudence scholars between the various regions.<sup>55</sup> In addition, within the region of Hejaz the traditional towns of Mekkah, Jeddah and al-Madīnah shared a common cultural tradition rooted in the history of the region and therefore were similar in most respects.<sup>56</sup> There were, however, some local differences due to the factors of physical setting, climate, and available building materials. Also, the formation of Mekkah's and al-Madīnah's town cores was different from that of Jeddah due the existance of the Holy Mosques in them.

Al-hathloul identifies four main building and planning principles: a) the right of way; b) the avoidance of harming others; c) the respect of privacy; and d) the right of ownership and usage.<sup>57</sup> His sources show that in the matter of the right of way, such questions as these were raised: What width is appropriate in relation to main streets, alleys and cul-de-sacs? What activities are permitted in these streets, taking into account problems of privacy? Where do the responsibilities and restraints lie in the maintenance and cleaning of these streets and how is identification made of what is private, semi-private, and public in them?<sup>58</sup>

Locational restriction of usage that might cause public harm, such as noise or smoke, show that Islamic principles placed emphasis on protecting the public from environmental harm. Al-hathloul remarks that the fundamental principle of Islamic law behind this issue was that harmful acts against the public good were strictly prohibited.<sup>59</sup>

Islamic law drew on the Qur'ān and Hadīth in resolving issues of privacy, the right to it and the respect due it. In the context of dwellings, the main concern of the family was for visual privacy, particularly for shielding female members from the eyes of male strangers; building heights, rooftops and the location of doors and windows, which involved air rights, were important factors, but the right not to be overlooked was primary.<sup>60</sup>

The right of ownership and use covered individual usage and the right of joint usage in diverse urban architectural spaces. For example, the significance of a wall between neighbours was sensitive,

because it involved such issues as ownership of the wall, the right of its use, and the right to demolish or rebuild it, all issues which could affect the lives, protection and privacy of either neighbour.<sup>61</sup>

These building and planning principles, therefore, interacted with local traditions and generated a certain building language which could be described as 'patterns'. It developed primarily as a communication tool for identifying locally used traditional elements. It encompassed various aspects of building and construction, such as building materials and construction details, building spaces/configurations, and surface treatment. This language tended to be operative locally and understood by users and builders.

### 1.3.3 Spatial Structure of the Town

In the old town of Jeddah, the tightly-knit urban fabric with integrated commercial and residential quarters had the characteristic patterns of the traditional Islamic town. What made the old town of Jeddah significantly different from the other traditional Islamic towns was its lack of a central space allocated to governmental and religious institutions. Instead, the core of the town emerged around the central sūq (market) surrounded by the residential quarters themselves (fig 1.8). The lack of a governmental institution might be attributed to the fact that Jeddah's origin and subsequent wealth was closely related to its proximity to the holy city of Mekkah: it acted primarily as Mekkah's treasury and trading outlet. The proximity to Mekkah was also the probable reason for the lack of a grand mosque.<sup>62</sup>

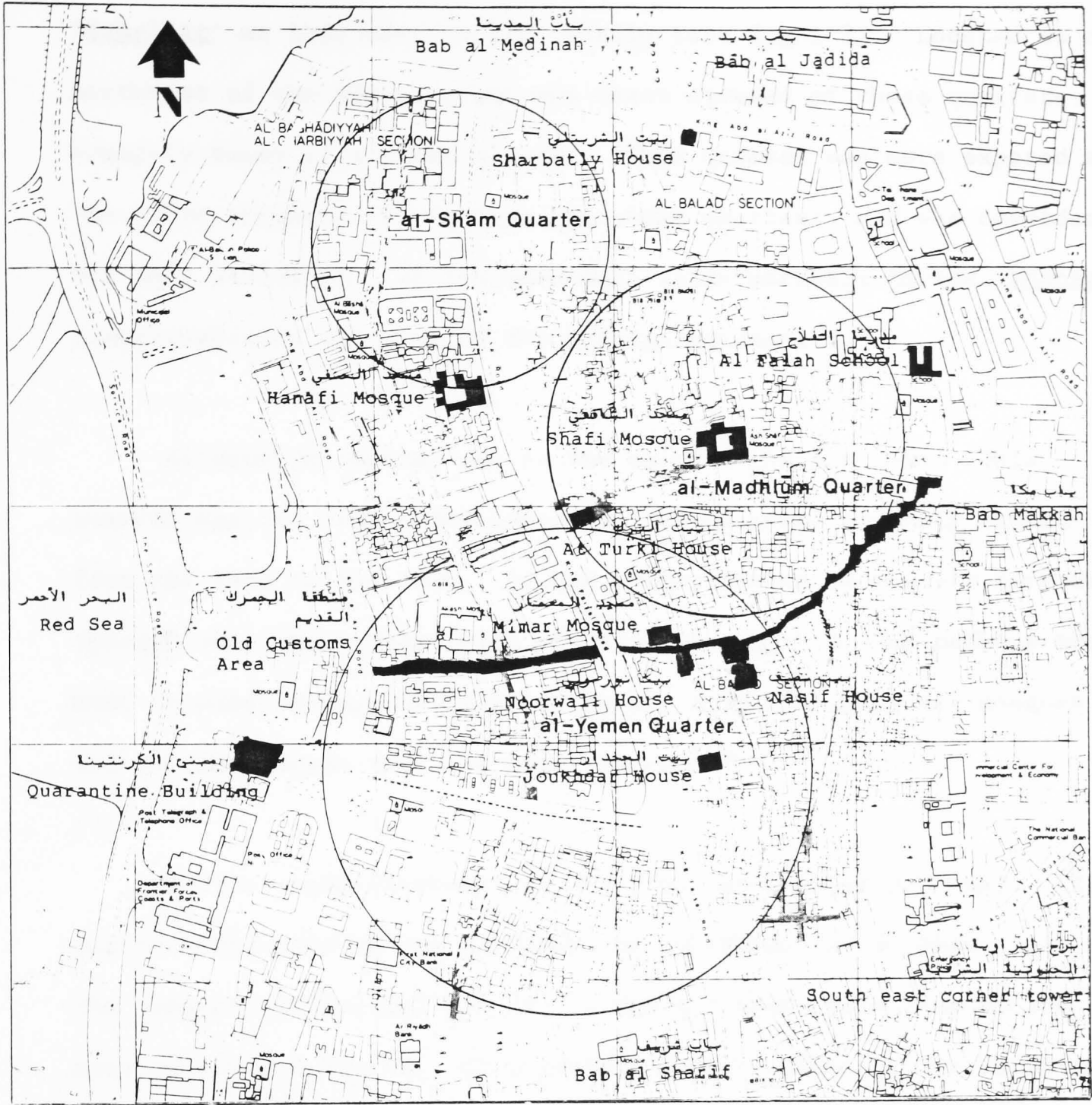


Fig. (1.8) The old town of Jeddah and its residential quarters.

Source: Ministry of Municipal and Rural Affairs, Jeddah Historical Area, Unpublished Technical Report No. 5, Vol. 1, p. 5.

The old town comprised three residential quarters 'Hārāt' or 'Mahallāt' as they were called locally (see fig 1.8). Located to the northwest of the old town was the least crowded of these quarters, commonly known as al-Shām quarter. This quarter was more exposed to the north-northwest winds than the other quarters, and was considered the most wholesome. It included many large merchant houses, khānāt (caravanserais) and most of the foreign emissaries.<sup>63</sup>

Al-Madhlūm quarter was to the east of the old town. This quarter was the oldest developed one in the town, slightly raised from the rest of the town. It had direct access to the old harbour through one long street (part of the main sūq). It was perhaps the most crowded residential quarter in the town with more old mosques and shopping areas than the other quarter.<sup>64</sup>

To the south-southwest of the town was located al-Yemen. This quarter consisted of two sub-quarters: al-Bahar and al-Alawi. It was the largest residential quarter in the old town, with some of the most attractive houses. It enjoyed a direct access to the waterfront as well as the main old sūq.<sup>65</sup>

In spite of the town's division into quarters, it is difficult to identify the demarcation lines between them. Indeed, socially and physically the entire town had a sense of one large, expansive residential quarter.

The social and communal activity of the old town was centred around its most important institution, the mosque. Each residential quarter had one relatively large mosque, and several smaller ones.<sup>66</sup>

The smaller mosques were called zawāyah (Sing., zāwyah). The zāwyah played a very important role in bringing together the heads of the families in its immediate proximity, while the larger one provided a larger meeting place for the men of the quarter. Often the position of Imām (prayers leader) in a zāwyah was granted to the oldest among the heads of the families nearest to it.<sup>67</sup> According to historical records, by the middle of the nineteenth century Jeddah had five large mosques and thirty smaller ones.<sup>68</sup>

Functionally, the old town was tied to the activities of the harbour, which was very much evident in its physical structure. The old harbour not only served as a link with the outside world, but also as an extension of the main sūq with the same colourful atmosphere of business. It was also a shipping centre, an alighting platform for pilgrims, and a centre for dhow building and repair.<sup>69</sup>

The street pattern in the old town obviously did not conform to any rigid geometric pattern. It developed naturally and in stages according to specific needs.<sup>70</sup> The width of the streets varied according to function and location. The narrower cool and shaded alleys mostly located within the residential quarters were called aziqqah (sing., zuqāq), and were sometimes as narrow as two and a half metres.<sup>71</sup> The basic spatial character is strongly related to the vertical organization of the house facades. The alleys possessed visual interest and aroused expectancy as they meandered through the quarters.

Another feature unique to the street pattern of the old town is the common area. The narrow alleys of the residential quarters

usually lead to a series of semi-private tiny squares. Most often the common area is a simple widening of the alley as it turns a corner, or sometimes no more than a setback in the alley or the junction of two alleys (fig 1.9). Thus the narrow alleys and common areas blended with the feeling of sociability, creating an interplay of spatial tension and release.<sup>72</sup>

The wider streets, sometimes as wide as fourteen metres, were generally called shwāri' (sing., shāri').<sup>73</sup> These streets were the major links between town gates and the central part of the town. Most of the commercial activities were concentrated on these streets. Diversity of functions and major movement created intense activity in them.<sup>74</sup>

#### 1.3.4 House/Town System

In the Moslem society, men and women move in two separate circles. The market place and the mosque formed the man's world while the women's activities clearly centred around the house which served the private life of the family (fig 1.10).<sup>75</sup> The immediate result of such practices was a clear separation of public from private life by a hierarchical sequence of progressively more private transitions. In the old town of Jeddah, major streets led from active public areas to a second echelon of social spaces where local streets intersected to narrower streets which led to small common areas and finally to restricted approaches to houses (fig 1.11). This meant that the male resident was protected by two envelopes before he entered the public world of the sūq and his behaviour was adjusted according to the sequences he experienced.

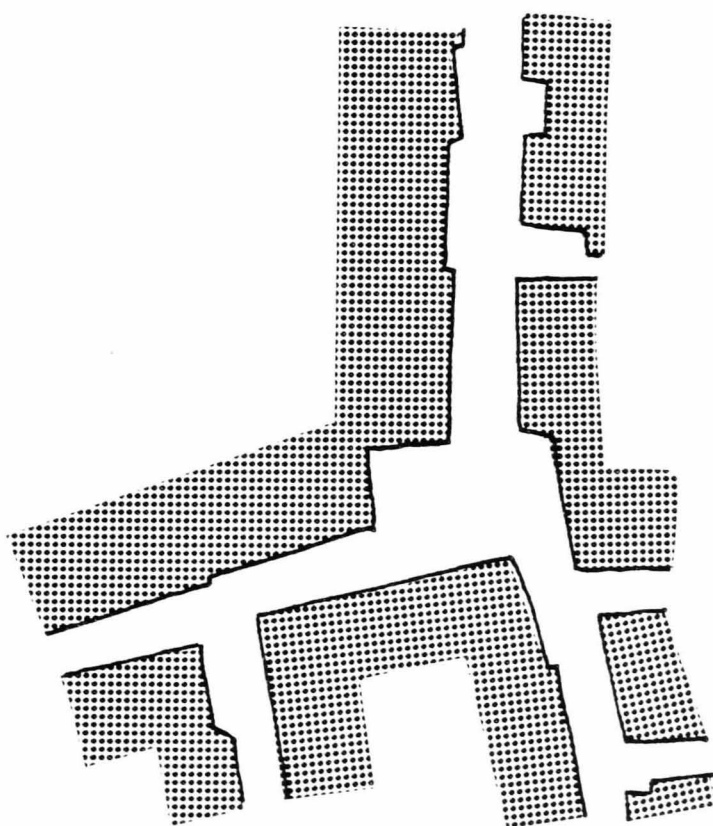
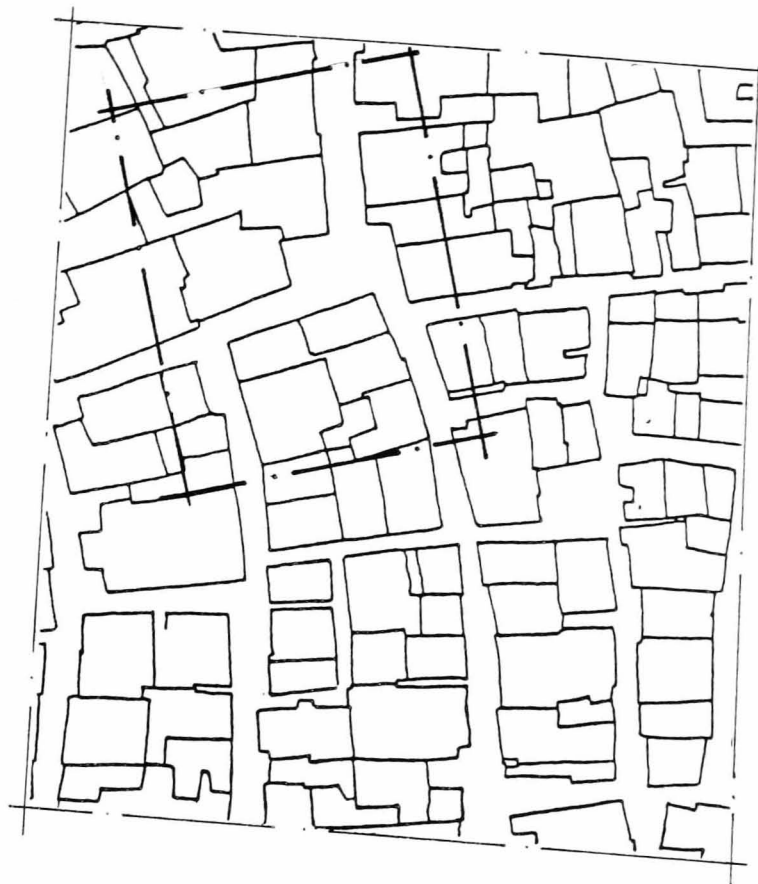


Fig. (1.9) The narrow streets of the residential quarters usually lead to series of semi-private tiny squares.

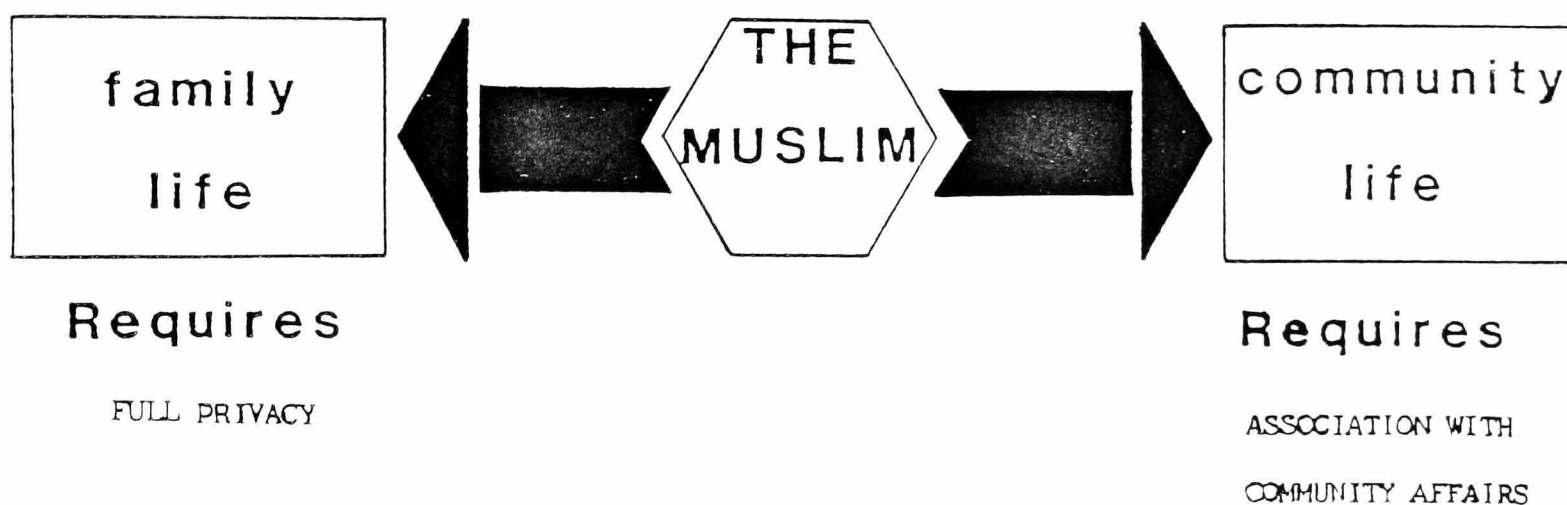


Fig. (1.10) The complex balance between homogeneity and heterogeneity of the Islamic social cultural system.

Source: T. Shalaby, "Behavioral Patterns and the Arab House", in The Arab House, Proceedings of the Colloquium held in the University of Newcastle upon Tyne, 15/16 Mar., 1984, ed. A. Hyland, A. Shahi, Cardo, 1986, p. 75.

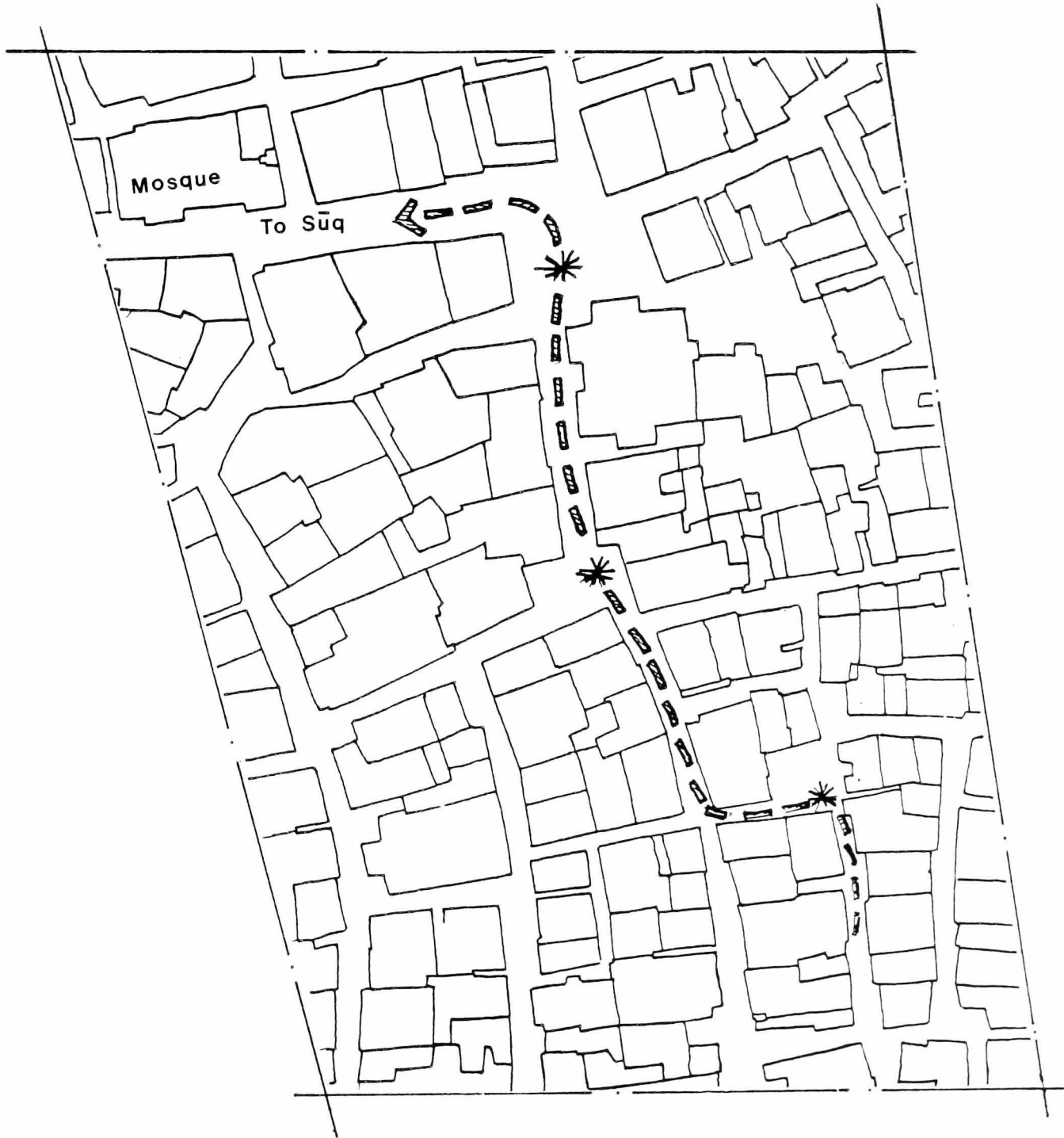
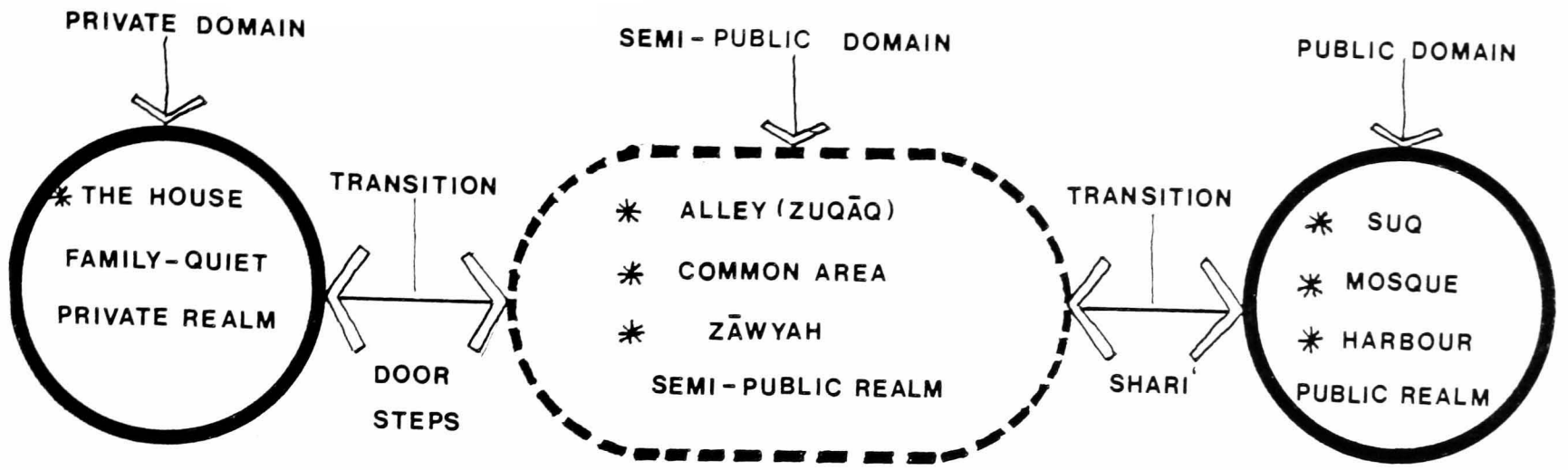


Fig. (1.11) The hierarchy of spaces in the old town of Jeddah.

The first degree of privacy was his house. Leaving the entrance hall of the house, he entered a lesser degree of privacy in the narrow dimly lit alley outside, moving then into the places which belonged to the inhabitants of the immediate neighbourhood. There was progressive loss of privacy and increase of public identity as he travelled along the alley and entered the communal streets of the quarter, where he came out of seclusion into openness of public spaces. Arriving at the sūq he reached the maximum extent of public exposure. On the way back to his house he retrieved his privacy in a reverse order. Returning to the quarter, at first he found sights familiar to him, then faces he could remember, and finally he encountered people who greeted him, then who invited him to join them for a cup of tea or to smoke shīshah (hubble-bubble).<sup>76</sup>

Thus, the hierarchical organization of spaces from the most public to the most private and the sequences between different levels of privacy gave an introverted character to open spaces. The town can be viewed as a sequence of spatial elements where the sūq and the mosque were the focus of social interaction among men, and the houses were the more private, sheltered part of the living realm.

#### 1.3.5 Relationship Between House and Street

The narrow street (zuqāq) was nothing else but an extension of the house frontage. Thus the family houses in the quarter were never physically or visually isolated from one another. As a result, there was always a sense of shared territoriality among the neighbouring family-houses, which in turn led to the enhancement of social integration and the sense of community.<sup>77</sup>

The narrow shady streets and the tiny semi-private squares accommodated various activities and patterns of behaviour that influenced social interaction and enriched the traditional way of life of the inhabitants. For example, older men of each group of neighbouring houses would gather after sunset in front of one of the large houses, listen to the recitations from the Quran, or converse and enjoy sweet tea and aromatic Arabian coffee.<sup>78</sup> It was an amicable gathering arranged in front of the house, with a few long, raised wooden benches covered with expensive rugs and furnished with cushions for sitting. Any familiar and friendly passer-by was welcomed in as soon as he uttered the Islamic greeting.

The entrance door of the house signalled the private world behind it and the change of level by the use of steps and high thresholds stressed transition between inside and outside (fig 1.12).

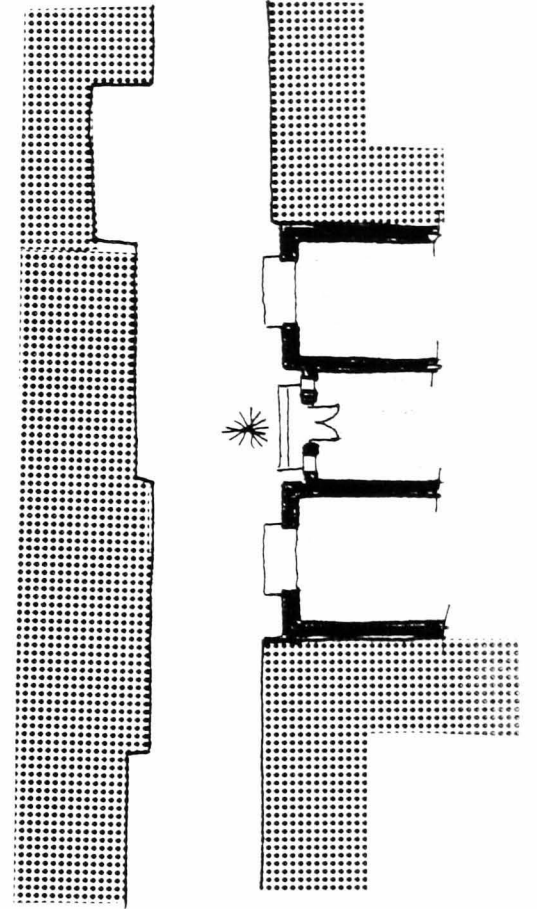
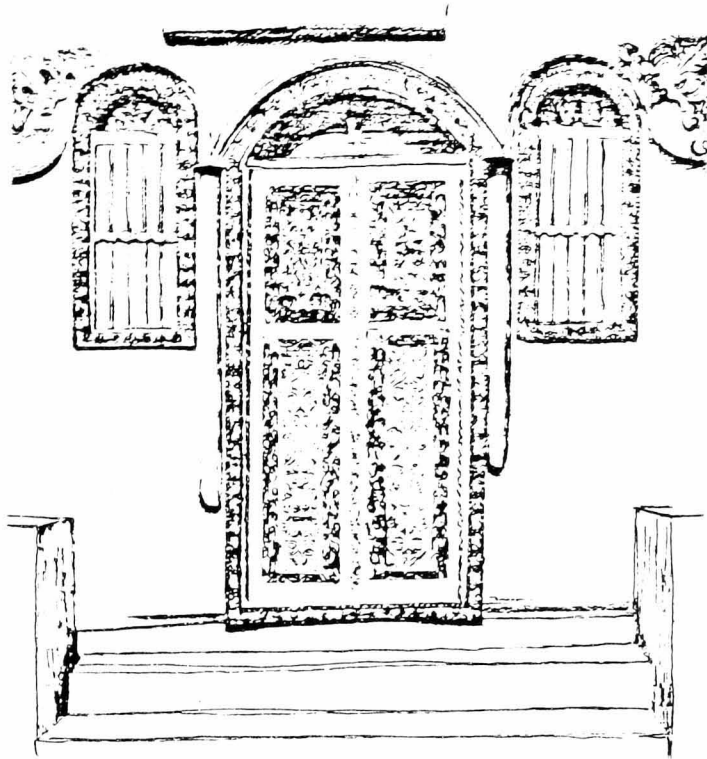


Fig. (1.12) The entrance door of the house formed the transition between the semi-public and private worlds.

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## CHAPTER TWO

### THE TRADITIONAL HOUSE OF JEDDAH

#### 2.1 EVOLUTION OF THE TRADITIONAL TOWER HOUSE: A HYPOTHETICAL RECONSTRUCTION

It seems fairly certain that the tall coral houses of Jeddah of four, five and even six stories emerged in the late nineteenth century and spread in the early twentieth. Travellers' accounts from the seventeenth century and later confirm the fact that the houses of the old town of Jeddah were only of two to three stories. The reason for the late emergence of the tower house, however, may be sought in an economic upturn in the fortunes of the town associated with the opening of the Suez Canal in 1869.

This flourishing trade had its direct effects on the availability and quality of wood used in the construction of houses. The traditional builder relied on materials found in the nearby environment except for wood which had to be imported from India and Java due to the lack of good timber in the region.<sup>1</sup>

Coral stone, locally called hajar manqaby or kashūr, was dug from al-Manqabah lagoon located north-west of the town and then cut on the construction site into roughly 25 to 30 cm. cubes. A dark-brown clay obtained from the bottom of the lagoon served as a cementing material to bind the coral blocks.<sup>2</sup> But since coral rag is extremely porous and quite soft as a construction material, the coral stone walls had to be reinforced.<sup>3</sup> The traditional building

technique followed a system whereby wooden courses known as tajlītāt were used to reinforce horizontally the coral block walls at regular intervals (fig. 2.1) (see Section 2.2.4). These wooden beams apparently spread the weight on the weak coral, and since they tied to the cross-beams they had a reinforcing effect laterally.<sup>4</sup> Timber boarding laid on wooden joists were also used to form the supporting structure of floors and roof. The type of wood used for reinforcement and flooring purposes was called qandal and was imported from India.<sup>5</sup> It is possible that the increase in qandal wood importation after the opening of the Suez Canal was the basic impetus of the change as enough timber existed to permit the construction of tall houses with solid and abiding structures.

Teak wood importation from Java was also increased during this period.<sup>6</sup> This type of wood was called jāwī by the local craftsmen. It was of a higher quality than qandal and much prized for its resistance to insects and humidity.<sup>7</sup> Though it was difficult to work, craftsmen favoured this tough material because, in most cases their handiwork had to brave the elements without benefit of varnish or paint.<sup>8</sup> It was usually used for front-doors, rawāshīn (bay windows) and tāqaat (casement windows).<sup>9</sup> The craftsmen and owner, guided only by the enthusiasm of the former to display his skill and the latter to display his wealth and social status, produced a rich and fine woodwork which presents at once a dazzling display of the craftsman's virtuosity.

Although the prestigious tower house (referred to in this study as 'the traditional house of Jeddah') maintained many characteristics of the early house described by Burckhardt who visited Jeddah in 1814

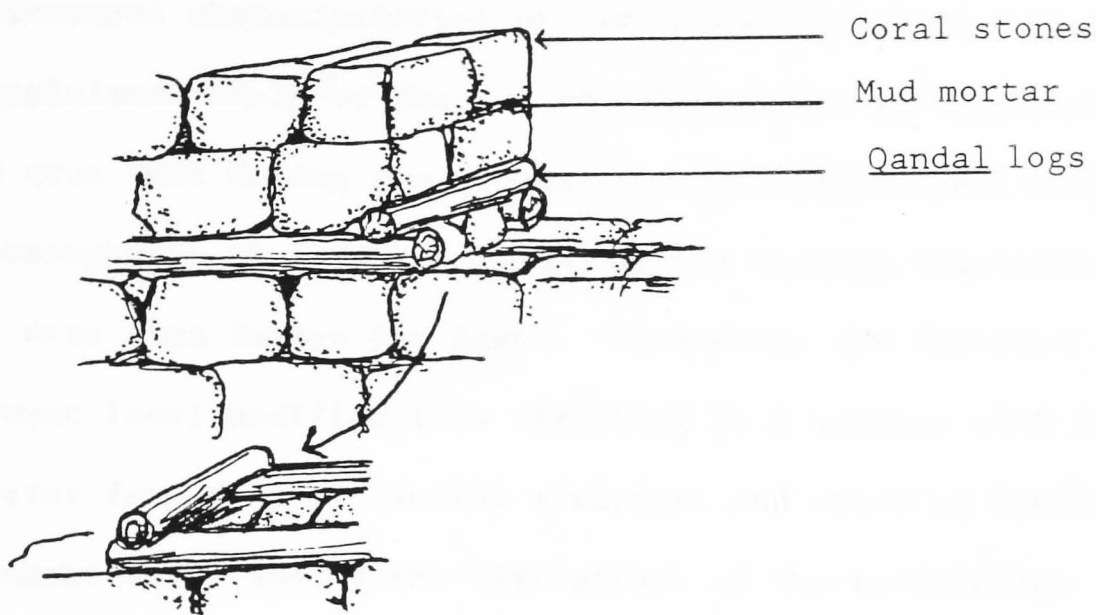


Fig. (2.1) Due to the softness and porosity of the coral stones the walls had to be augmented by tiered qandal beams inserted horizontally (tajlītāt). This is not only provided additional strength and resilience but also prevented uneven settling.

(Chapter One, Section 1.2), it emphasized two basic features: solidity of structure and richness in facade texture. To what extent had the traditional house been influenced by other architectural styles? This essential question has unfortunately hardly been examined scientifically.

In a report prepared by Jeddah Municipality on the architectural characteristics of Old Jeddah,<sup>10</sup> the traditional houses are explained simply by the use of a Turkish or an Egyptian model. It is true that during the Ottoman era many skills and techniques were brought to the town of Jeddah mainly through migrations, some of which were from Turkey and Egypt. Gradually, the imported impulses underwent local modifications resulting in a culture with its own character formed by the social structure and state of knowledge of the inhabitants, and by the limitations of the environment.

Thus, it is difficult to interpret the traditional house of Jeddah as outrightly and definitely derivative of a Turkish or Egyptian model. Traditional houses all over the world are replete with examples of the influence exerted by one style upon another; but this is not to deny that every style has its own individual character. It seems much more satisfactory to think of the style of Jeddah's traditional house as an outcome of an amalgam of local traditions, together with Turkish and Egyptian influences. This hypothesis might have been strengthened if we could have made comparison between the traditional house of Jeddah and the Turkish and Egyptian houses during the Ottoman era in order to define the characteristic features that distinguish it from the others; but this lies beyond the scope of the thesis.

## 2.2 GENERAL CHARACTERISTICS OF THE TRADITIONAL HOUSE

The traditional houses of Jeddah shared many features in common, yet no two can be found that were identical. Individuality was expressed within an overall harmony. Therefore, when describing or discussing the traditional houses of Jeddah one should not speak of a 'typical' traditional house, but of the 'typical' characteristics of Jeddah's traditional houses. These can be broadly grouped under the following headings: main plan elements, elevational treatment, architectural decoration, and constructional techniques.

### 2.2.1 Main Plan Elements

Typical of Jeddah's traditional houses was the vertical distribution of rooms around a stairwell or airshaft (figs 2.2, 2.3). At the ground level, there were usually two entrances to the house, one for the male visitors, the other for the family. Some manner of connection between the two entrances was provided, and this formed a kind of central circulation axis. This axis sometimes took the form of a winding narrow corridor; on other occasions, it passed through a series of central room-like spaces. The staircase, at the ground floor, was mostly situated at the back of the house near the rear entrance.<sup>11</sup>

The front entrance led immediately into al-dahleez, a spacious entrance hall where male guests were received. It was paved with flag stones and furnished with long wooden benches which ran the length of each wall. The floor was usually sprinkled with water to keep it clean and create a cool environment.<sup>12</sup>

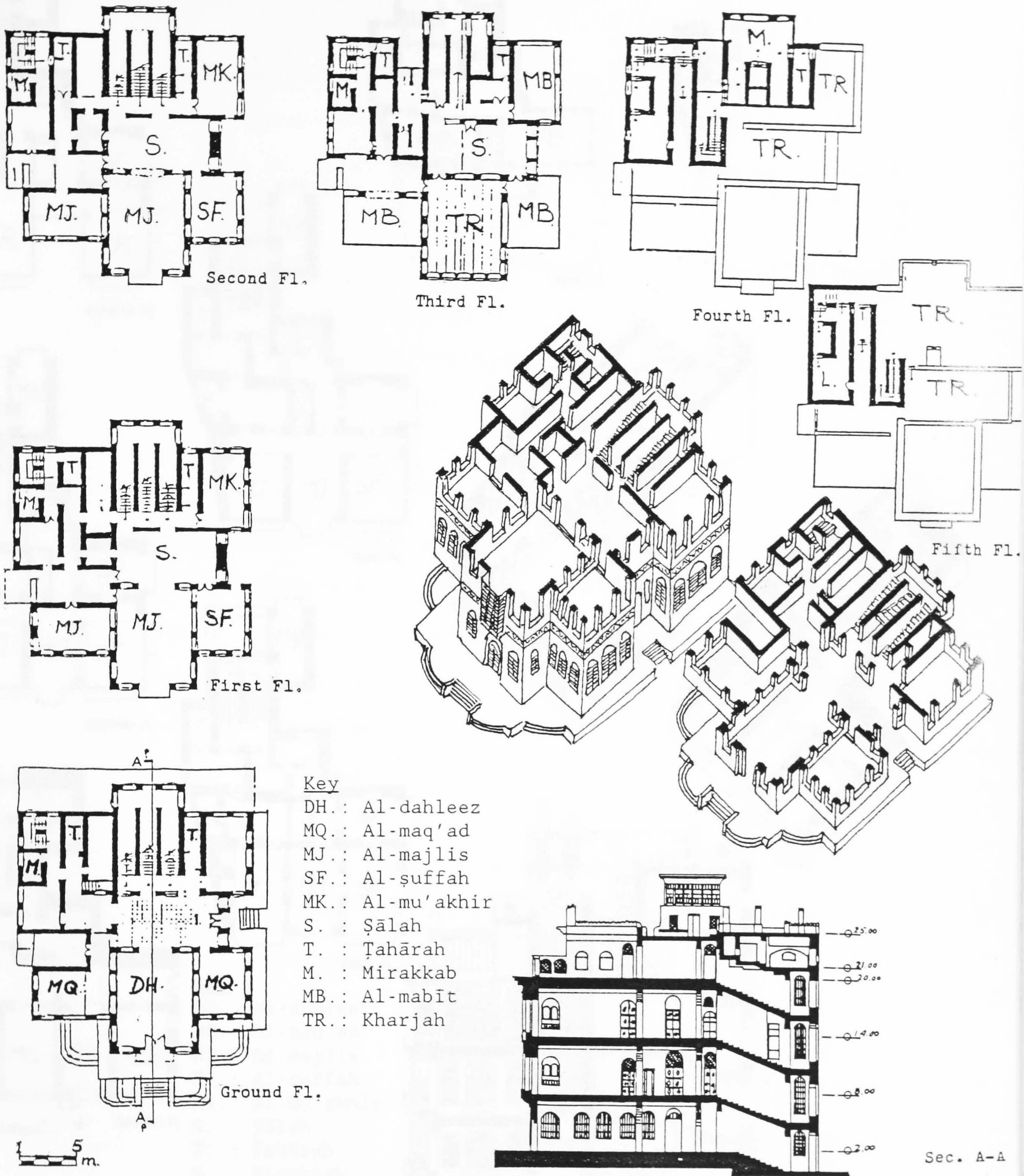


Fig. (2.2) Naşif house

Source: S. Khan, *Jeddah Old Houses*, Saudi Arabian Natural Centre for Science and Technology, Grant No. AR1038, 1981, pp. 22-32.



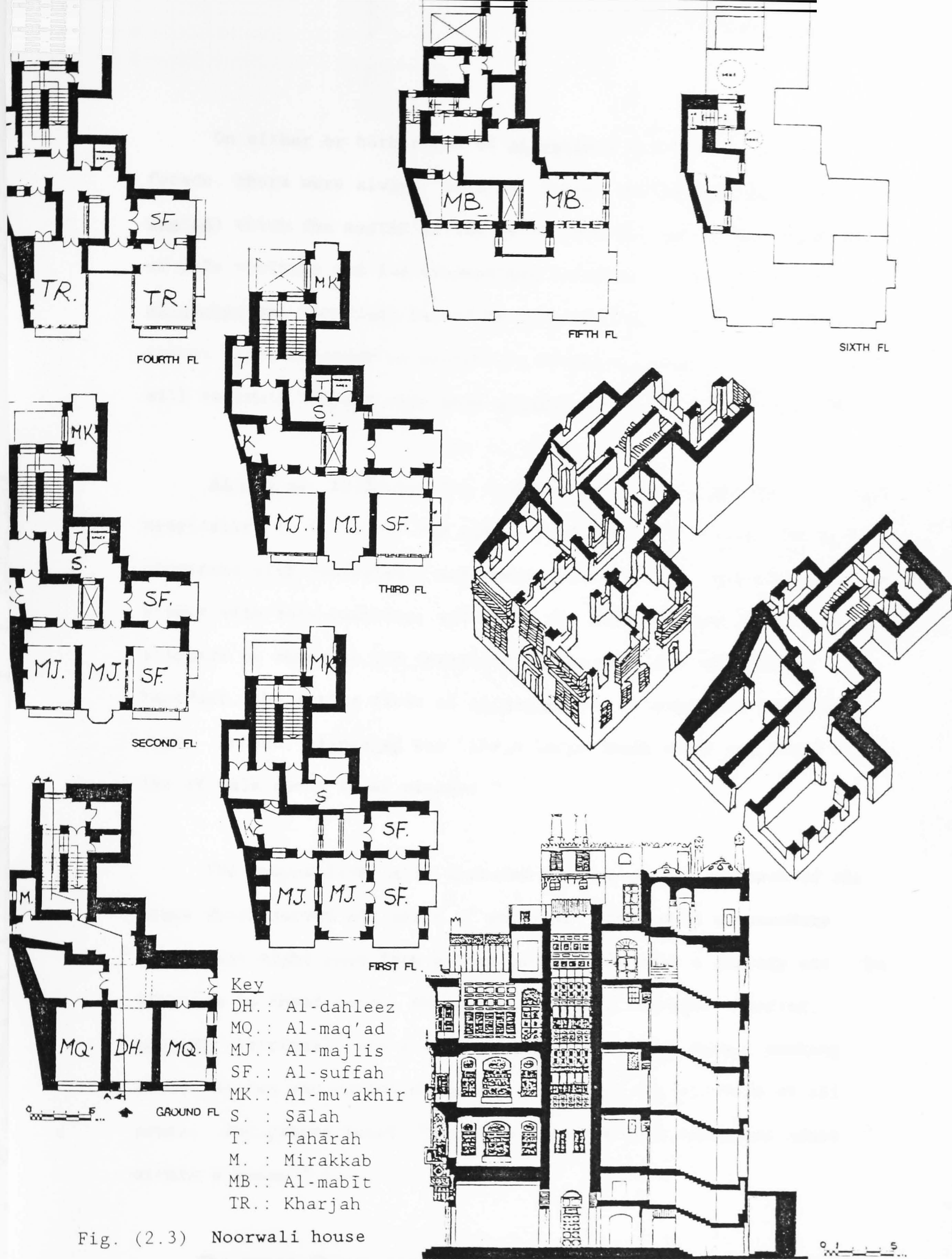


Fig. (2.3) Noorwali house

Source: Ibid., pp. 34-38.

On either or both sides of al-dahleez and toward the main facade, there were always 'sitting' rooms, called maqā'id (sing., maq'ad) which the master of the house used for day-to-day reception of male visitors and for transacting business.<sup>13</sup> The ground level of al-maq'ad was sometimes raised by approximately 1.2 metres above the street level in order to provide an adequate height for the window sill to avoid a clear view into al-maq'ad from the street (fig 2.4).

Al-maq'ad, following the Arab traditions of offering the utmost hospitality to visitors, was always furnished with wooden benches appointed with comfortable mattresses covered with colourful rugs and strewn with soft cushions; and since the Arabic custom is to take off slippers or shoes at the threshold of the door and walk about barefoot, the entire floor of al-maq'ad was covered with handsome rugs. Indeed, al-maq'ad was like a large couch where one could sit, lie or walk about it as pleased.<sup>14</sup>

The ground level also included small rooms at the back of the house which served all sorts of purposes. One could accommodate guests who might come from a long journey, or have a library etc. In addition to these rooms, there were always a servants' quarter, tahārāt (latrines), and a small mirakkab (kitchen) with a cooking stove for tea and coffee which was kept ready for visitors at all hours. The ground level, therefore formed a self-contained house within a house.<sup>15</sup>

The upper floors provided the living quarters for the family. A carved door usually opened from the staircase landing at each upper level to give access to a generous hall (ṣālah), around which the

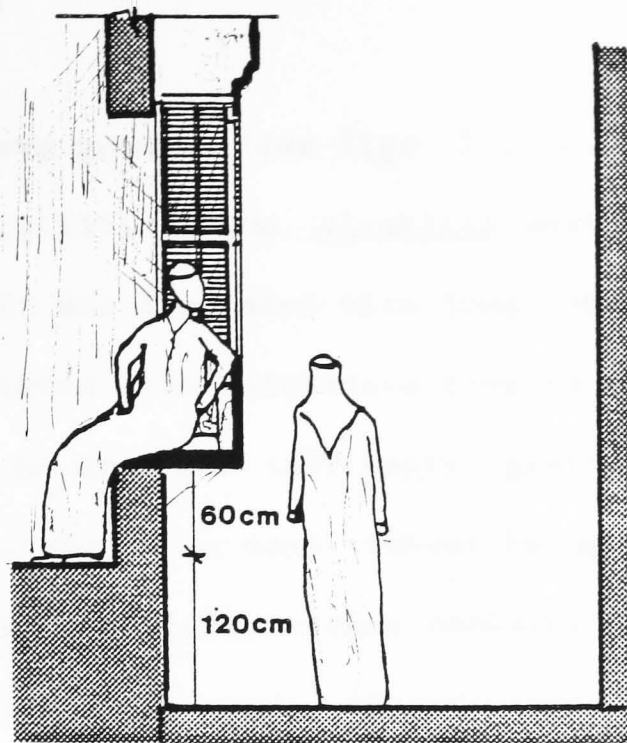


Fig. (2.4) The ground level of al-mag'ad or sometimes the whole ground floor was raised by approximately 1.2 m.

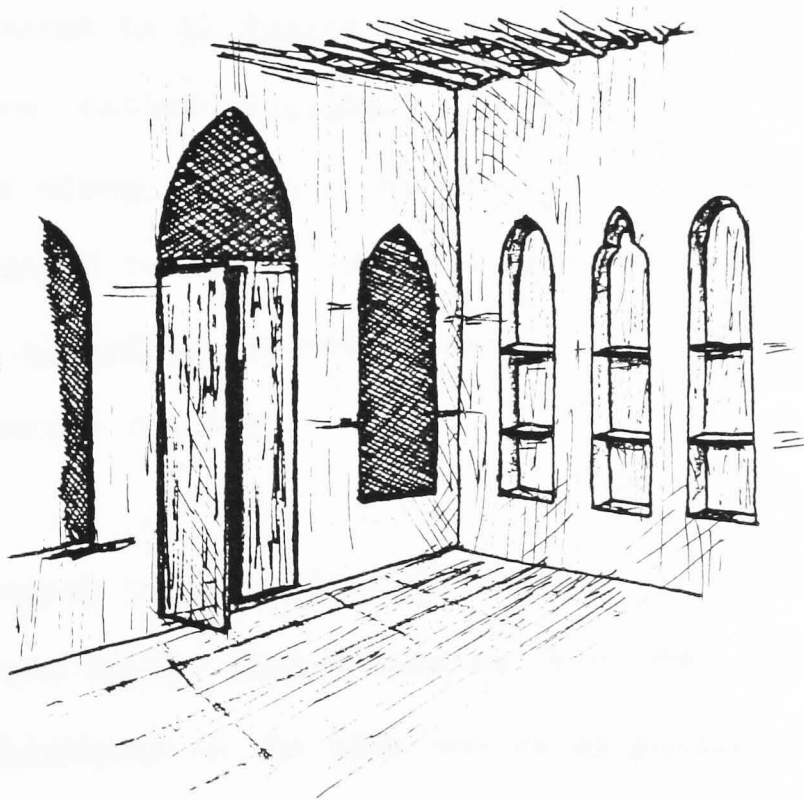


Fig. (2.5) Open niches of varying sizes built into the walls were characteristic of Jeddah's traditional houses.

living rooms were grouped (see figs. 2.2, 2.3). Each floor included one large family living-room, al-majlis usually located towards the main facade. It was furnished with long wooden benches running all round and appointed with mattresses covered with rugs and cushions. The centre of the room was left empty, giving a feeling of space and allowing the carpet to be seen without being cluttered up with furniture. There were also niches containing shelves, usually with small decorative arches over. Storage cupboards and open niches of varying sizes built into the walls, often decorated, were characteristic of Jeddah's traditional houses. They were provided in almost every family living-room in the house (fig. 2.5).<sup>16</sup>

Adjacent to al-majlis at the front, there was another family living-room, called al-ṣuffah. It was usually furnished with floor mattresses along the walls and hard cushions for the back with arm rests arranged to denote separate seats. A small room, khazānah, adjoining al-ṣuffah, served as storage for mattresses, cushions and pillows during the day.<sup>17</sup>

Opposite to al-majlis and towards the rear of the house, a medium sized family living-room was provided, called al-mu'akhir usually furnished in the same way as al-ṣuffah. However, the traditional house had no rooms which were used solely for one purpose. The entire family quarter served as multi-functional living space with rooms used as living, sitting, eating and sleeping areas.<sup>18</sup>

In addition to the habitable rooms, each floor included one or two latrines (ṭahārāt) and a kitchen (mirakkab) located at the rear of the house in order to keep the living-rooms free of odours.

The difference between circulation zones (where slippers or shoes could be worn) and living-rooms (where slippers or shoes should be taken off) was often emphasized by the raising of door thresholds.

On the uppermost floor level, usually the third or fourth, the area of the floor diminished in order to provide the necessary kharijāt (sing., kharijah) (terraces). It included family living-rooms, called al-mabîṭ often with two or three sides built of panelled woodwork with movable louvres, in addition to mirakkab, small storage rooms, ṭahārāt, and a laundry room. The terraces (kharijāt) were private open spaces surrounded with high parapet walls. They provided a direct horizontal extension of the adjacent interior space and served as places for family gatherings after sunset in summer. They were also used as service areas where mattresses and rugs were dusted and cleaned, and clothes were dried.<sup>19</sup>

### 2.2.2 Elevational Treatment

The distinguishing external features of the traditional houses of Jeddah were revealed in their wooden fixtures, front-doors, rawāshīn (bay windows) and tāqaat (casement windows). They have been admired and described by many travellers and visitors who were enchanted by their charm and gracefulness. Not only did these fixtures give an inkling of the artistic taste and appreciation of the owner of the house, but also reflected a degree of eminence and wealth (fig. 2.6).

Most of the front-doors were solidly built of Java teak, from 75 to 100 mm. thick. They were always double and pivoted about their

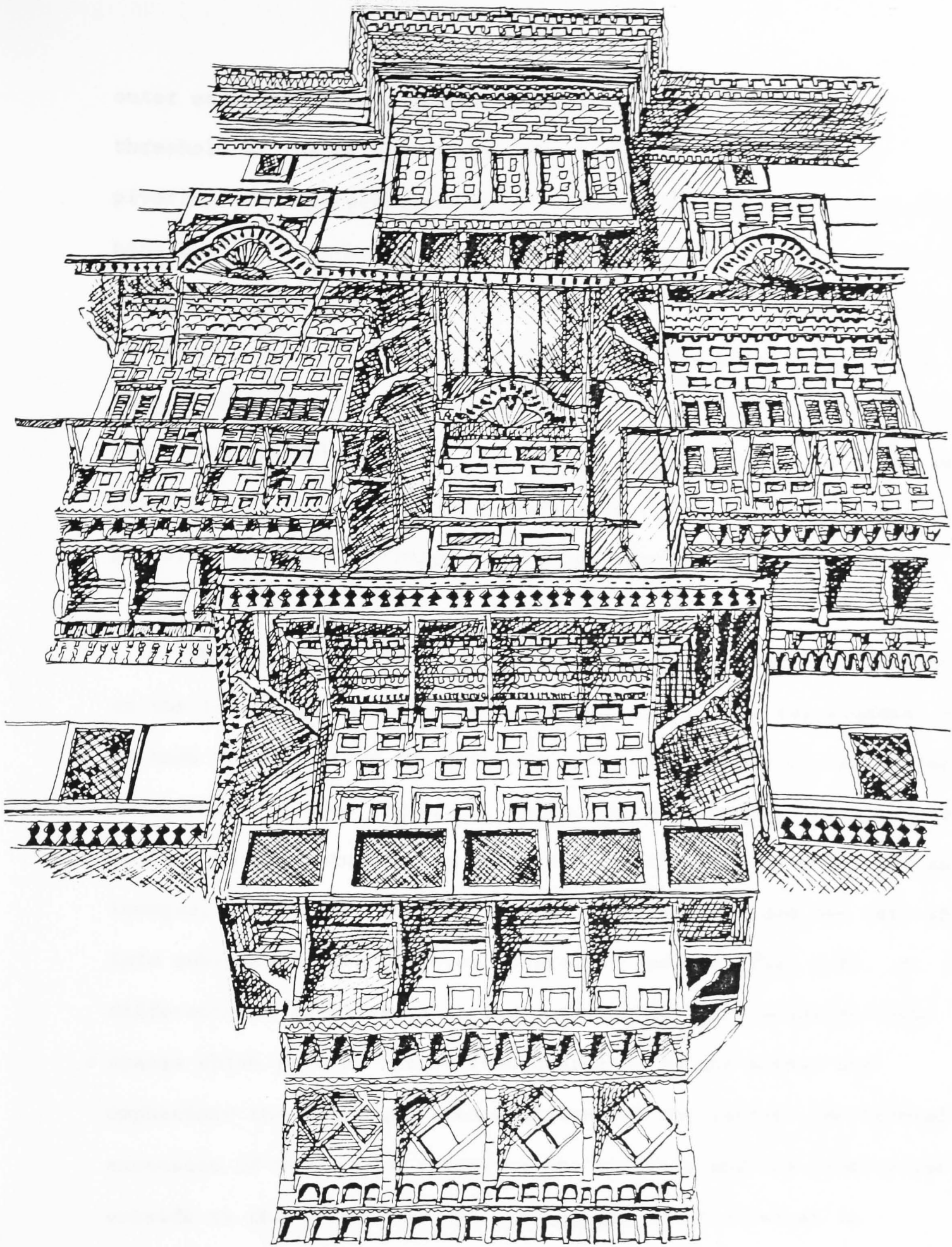


Fig. (2.6) Highly decorative rawashin projecting out from a facade of a traditional house.

Source: K. Talib, Shelter in Saudi Arabia, Academy Editions, London, 1984, p. 69.

outer edge which was extended to form lugs let into the stone threshold at the bottom, and wooden lintel at the top. This pivoting-edge was protected by a rebate in the masonry.<sup>20</sup> The right-hand leaf of most house doors had a smaller door let into it called a khūkhah. It was through this that access to the house was normally obtained. The main portion was also opened to admit large loads. This little door was surrounded by its own carved, arch-shaped fillet and a twin was placed round the corresponding part of the other leaf (fig. 2.7). Front-doors were usually carved in elaborate geometric patterns and had rich hinges and ring-knockers of wrought iron.<sup>21</sup>

The rawāshīn (sing., rawshān) were the most striking feature on the facade of the traditional house. These were bay windows, all of teak wood, jutting out from the walls and resting on cantilevered wooden corbels (see fig. 2.6). Although they stepped out of the main body of the structure, they were still in the private realm and an integral part of the interior space. They sub-divided the main space into sub-spaces with different character and use (fig. 2.8). A difference in level was also made between the main space and sub-spaces which gave an introverted character to the former and emphasized the differentiated character of the latter. Horizontal extension of the indoor spaces to the outdoors and the penetration of outside to the inside through the rawshān which acted as an intermediary zone offered an excellent solution to the problem of both the social and climatic interaction.<sup>22</sup>

The rawāshīn varied in quality and size according to the owner's means and taste.<sup>23</sup> They were used singly, linked vertically

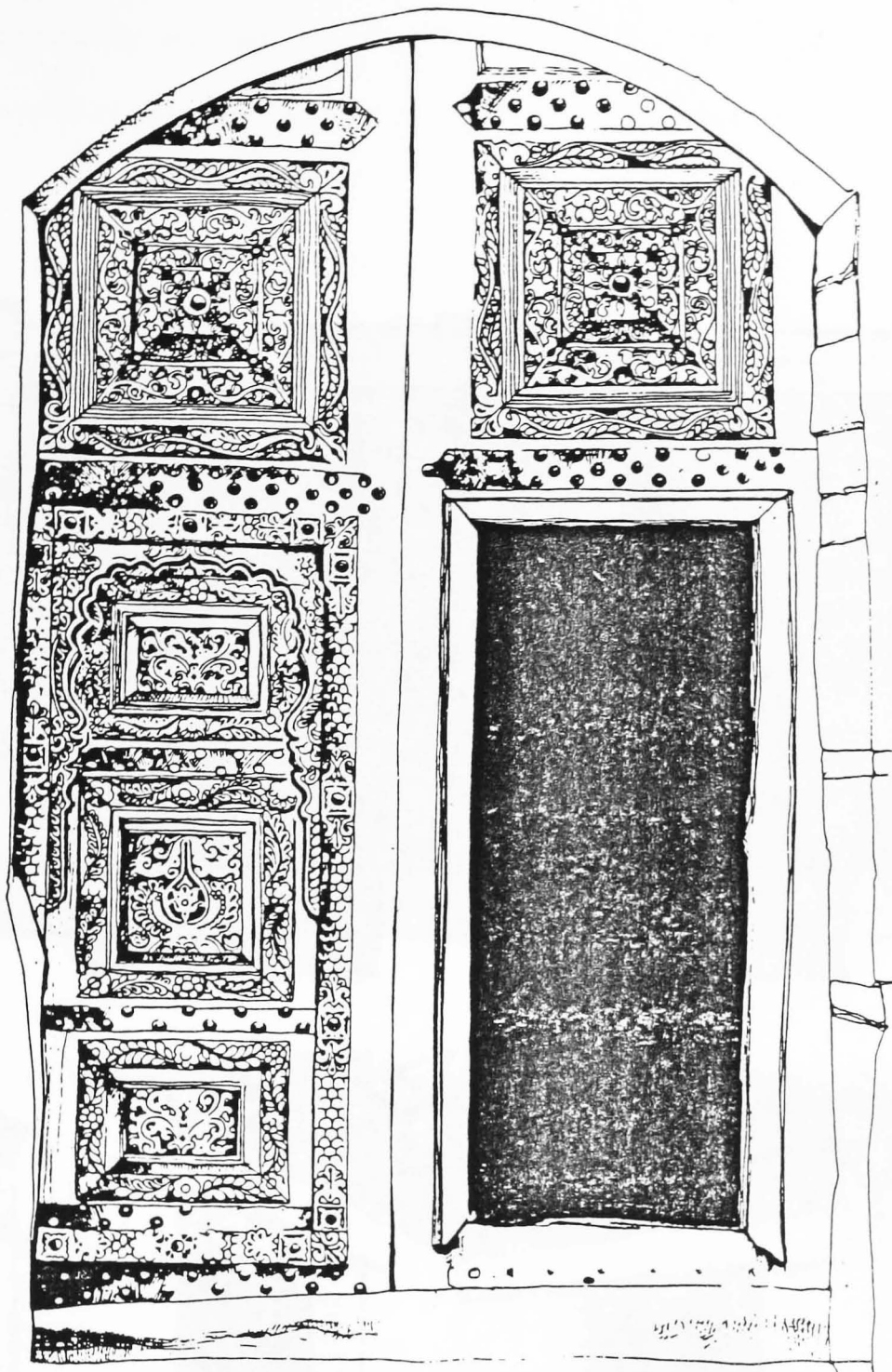


Fig. (2.7) A carved door in a traditional house.

Source: Drawing by Williams, P., of Aramco World Magazine.  
Reproduced in A. Pesce, Jiddah, Portrait of an  
Arabian City, Falcon Press, London, 1974, p. 53.

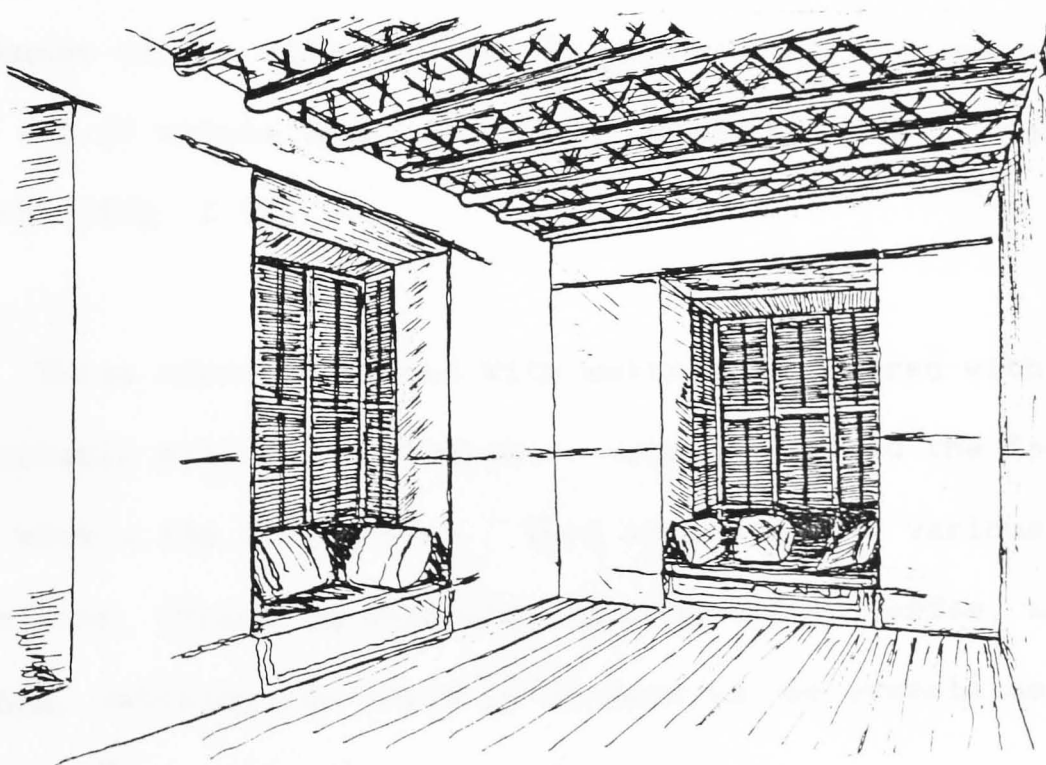
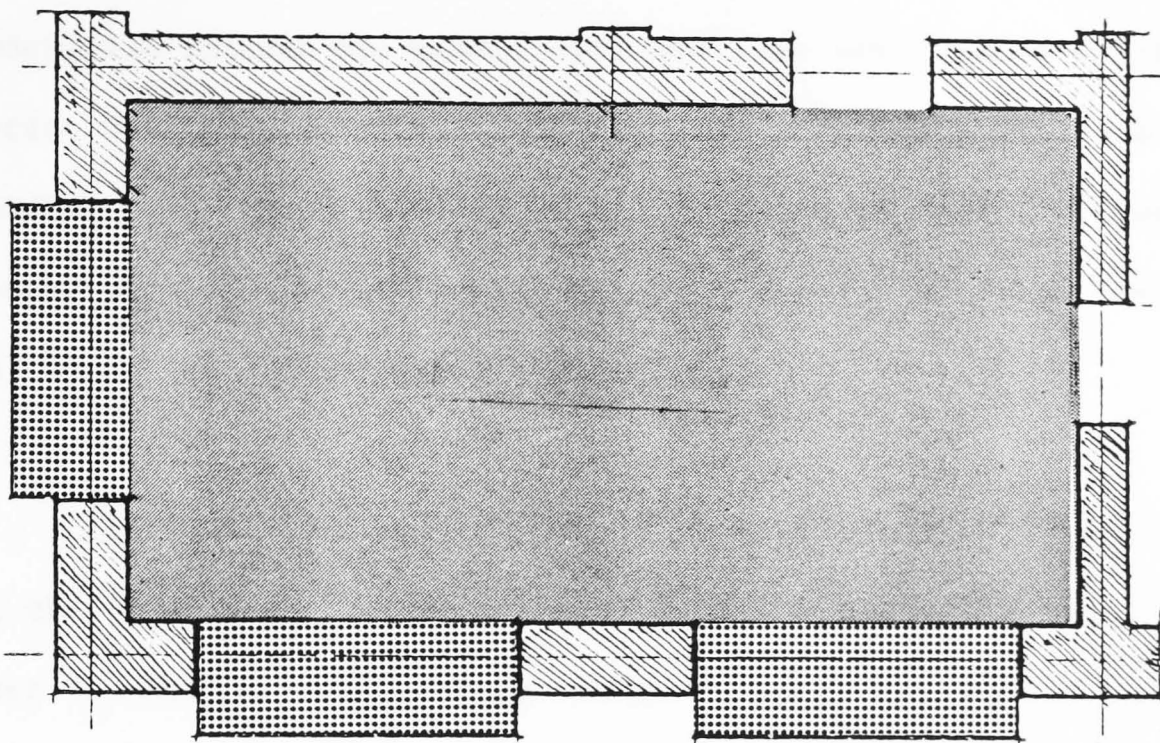


Fig. (2.8) The projecting rawāshīn created sub-spaces within the main space.

or horizontally or less commonly both ways, to create a giant rawshān of spectacular appearance and workmanship (fig. 2.9).

It may be mentioned here that the use of wooden bay windows was widespread around the middle east and some other parts of the Islamic world, but that their size and style varied from place to place. However, the unique quality of the rawāshīn of Jeddah's traditional houses lay in their stateliness, and the large openings they created in the facade of the house.<sup>24</sup>

The size of a single rawshān type was related to the dimensions of the human body; it was wide enough to lie down in comfort - just over 2.3 metres - often high enough to stand in, and projected about 60 centimetres into the street. Adding 50 to 60 centimetres for the thickness of the wall, it made an alcove about 2.3 metres wide by 1.10 - 1.20 metres deep, a space in which two people could sit in comfort (fig. 2.10).

These alcoves, fitted with mattresses covered with rugs, and comfortable pillows and cushions, were considered the focal point of life within the living-room. They were used for various social activities, including chatting, sipping tea or coffee, smoking shīshah, watching the world go by down in the streets as well as sleeping.<sup>25</sup>

The rawshān was usually constructed of louvred panels sliding up and down in grooved frames divided into two sections by a horizontal cross member thus making openable louvred panels above and below the line.

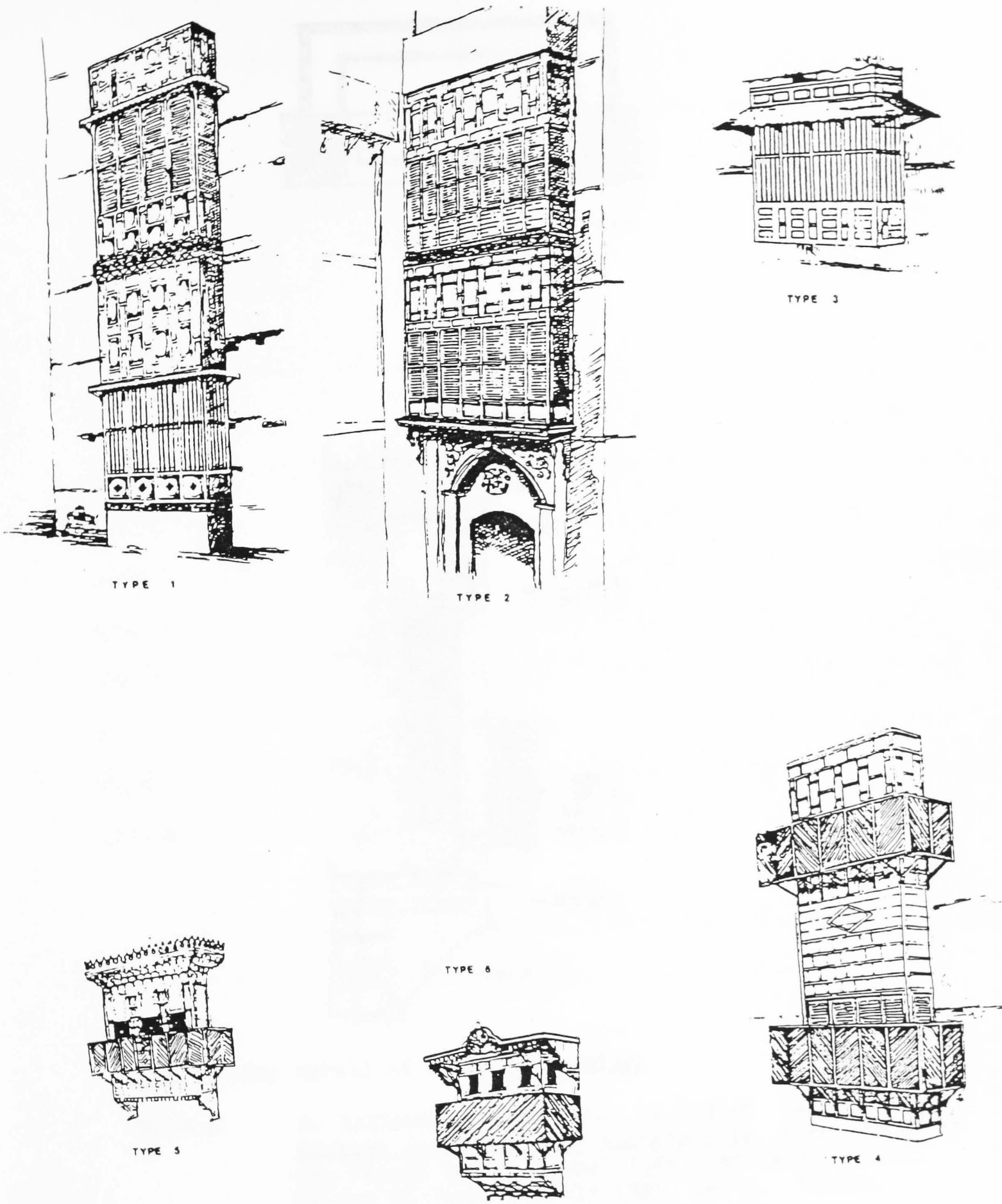


Fig. (2.9) Rawshān types.

Source: S. Khan, op.cit., p. 14.

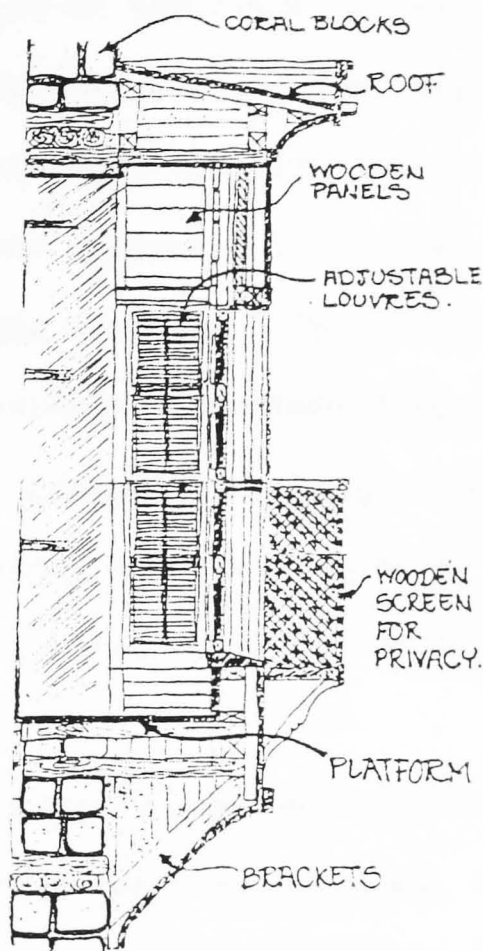
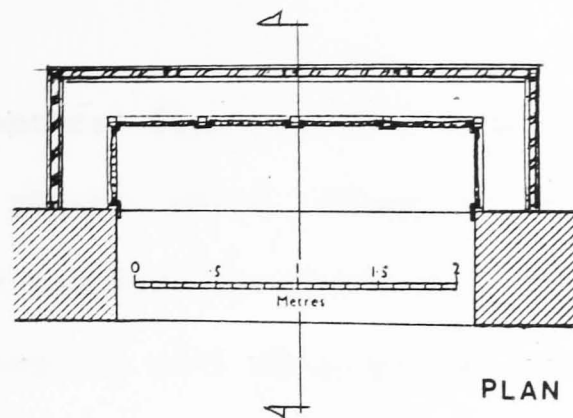


Fig. (2.10) Detail of a single rawshān.

Source: A. Salloum, "El Rawashin of Jeddah, Saudi Arabia", Passive and Low Energy Architecture, Proceedings of the Second International PLEA Conference, Crete, Greece 28 June - 1 July 1983, ed. S., Yannas, Pergamon Press, Oxford, 1983, p. 249.

The carpenters' fine craftsmanship was also expressed in the tāqaat (sing., tāqah), which, though not protruding from the wall, often displayed equally fine woodwork. These were usually set into arched or rectangular wall openings and were also constructed of louvered sliding panels (fig. 2.11).

The rawāshīn and tāqaat located on the upper floors were sometimes made with an additional screen of trellis work, called shīsh helped to further seclude the rawshān particularly when facing another rawshān or tāqah opposite (see fig. 2.10) The Shīsh was an external attachment supported by brackets fixed to the lower panelled area of the rawshān or tāqah. The lattice work of the shīsh was a simple diagonal pattern, sometimes forming a diamond shape. At the ground level, the rawāshīn or tāqaat were usually constructed of hinged panels opening inwards instead of the sliding panels, and were always provided with iron bars for security (fig. 2.12).<sup>26</sup>

The house terraces and roof were sometimes surrounded along the edges by high lattice-work balustrades, or more commonly by high parapet walls, pierced by arched openings with wooden grill-work (fig. 2.13).

### 2.2.3 Architectural Decoration

The symbolic importance of the main entrance of the house, as the transition between the semi-public and the private world, was customarily emphasized by a centrally placed monumental decorated doorway, sometimes in the shape of a pointed arch, sometimes flanked by arched niches forming the trifoliated arch common in Islamic

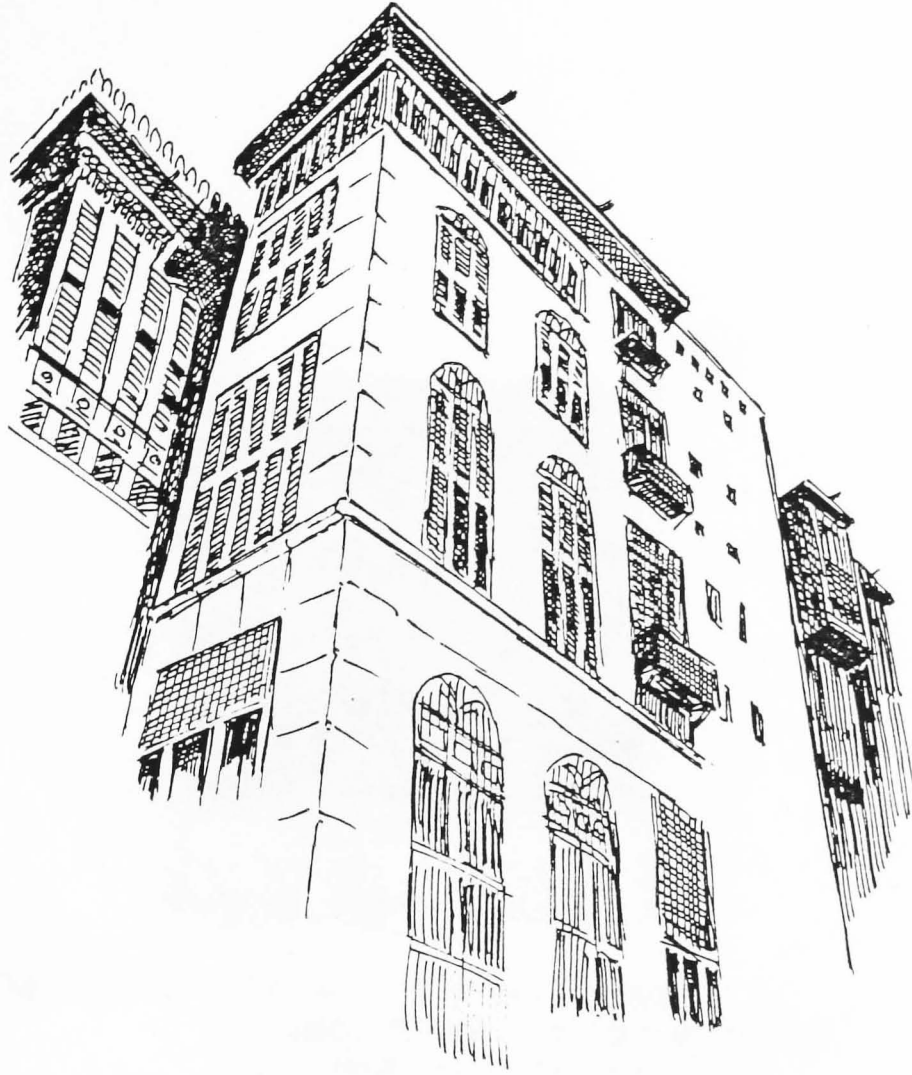


Fig. (2.11) Tāqaat were set into or flush with arched or rectangular wall openings.

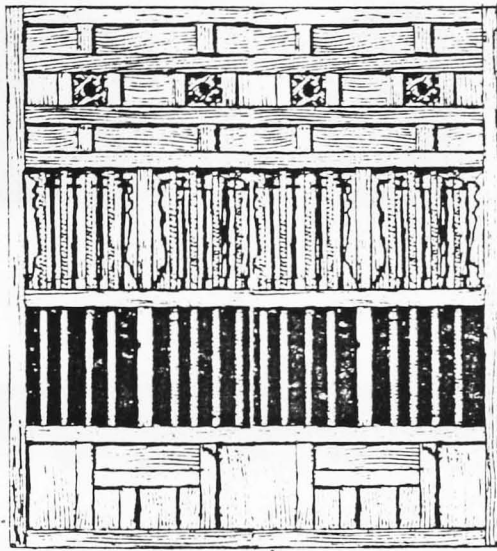


Fig. (2.12) The ground floor rawāshīn or tāqaat were always provided with iron bars for security.

Source: S. Khan, op.cit., p. 48.

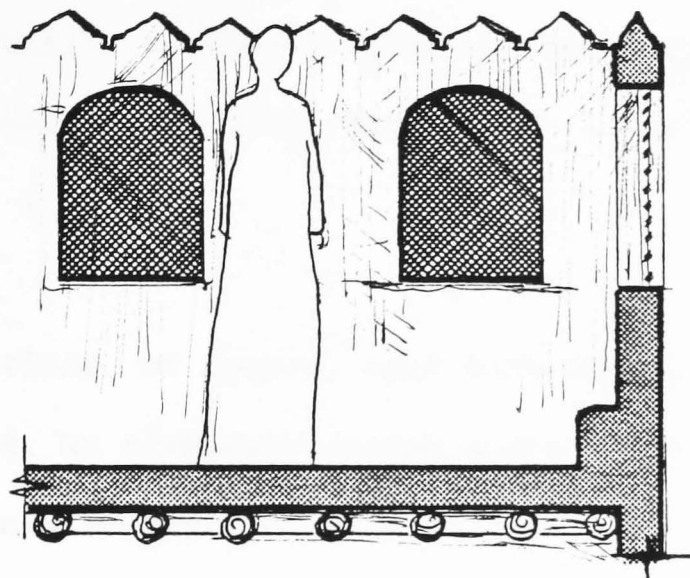


Fig. (2.13) House terraces were surrounded by high parapet walls pierced by arched openings with wooden grill-work.

architecture (fig. 2.14). An arched doorway usually displayed a small square lattice-window or semi-circular window with ornamental spoke-like radiants over the teak door (fig. 2.15). Calligraphy, words from the Quran, incised in the transom or door head, occurred frequently. Sometimes floor levels were marked by small decorative bands of geometric patterns or arabesques. The terraces and roof parapets were often denticulated. These denticulations were a simple but highly effective aesthetic device. The rawāshīn were often adorned with intricately patterned panels, eaves cornices and brackets (fig. 2.16).<sup>27</sup>

The interiors, of course, were enriched by painted carved ceiling members, by elaborate wooden screens and by carved wooden cabinets set into the walls.<sup>28</sup>

On the whole, the exteriors of Jeddah's traditional houses were not heavily decorated, and in fact without the elaborate rawāshīn the facades were rather featureless (fig. 2.17).

#### 2.2.4 Constructional Techniques

Excavation for the footing and wall foundation was usually made one metre deep.<sup>29</sup> The foundation was constructed of compact, firmly bound coral stone and clay layers.<sup>30</sup> Load-bearing walls were constructed approximately 50 to 60 centimetres thick and were reinforced with horizontal wooden members (tajlīlāt) spaced vertically at about one metre intervals (fig. 2.18).<sup>31</sup> In practice, the last and uppermost tier of such wooden reinforcement was then

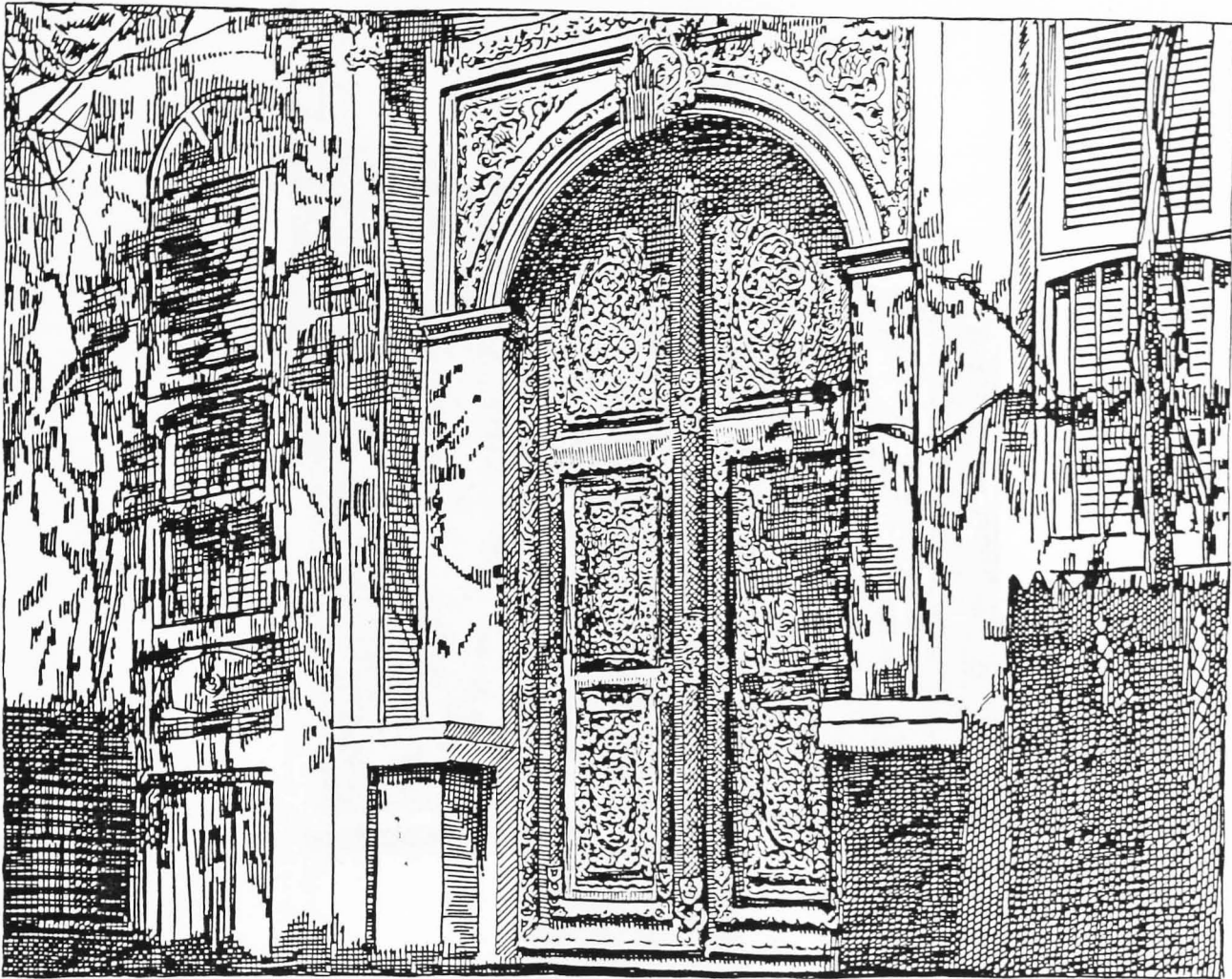


Fig. (2.14) A beautifully carved doorway in a traditional house.

Source: Drawing by Saccardo, G., from an old photograph.  
Reproduced in A. Pesce, *op.cit.*, p. 119.

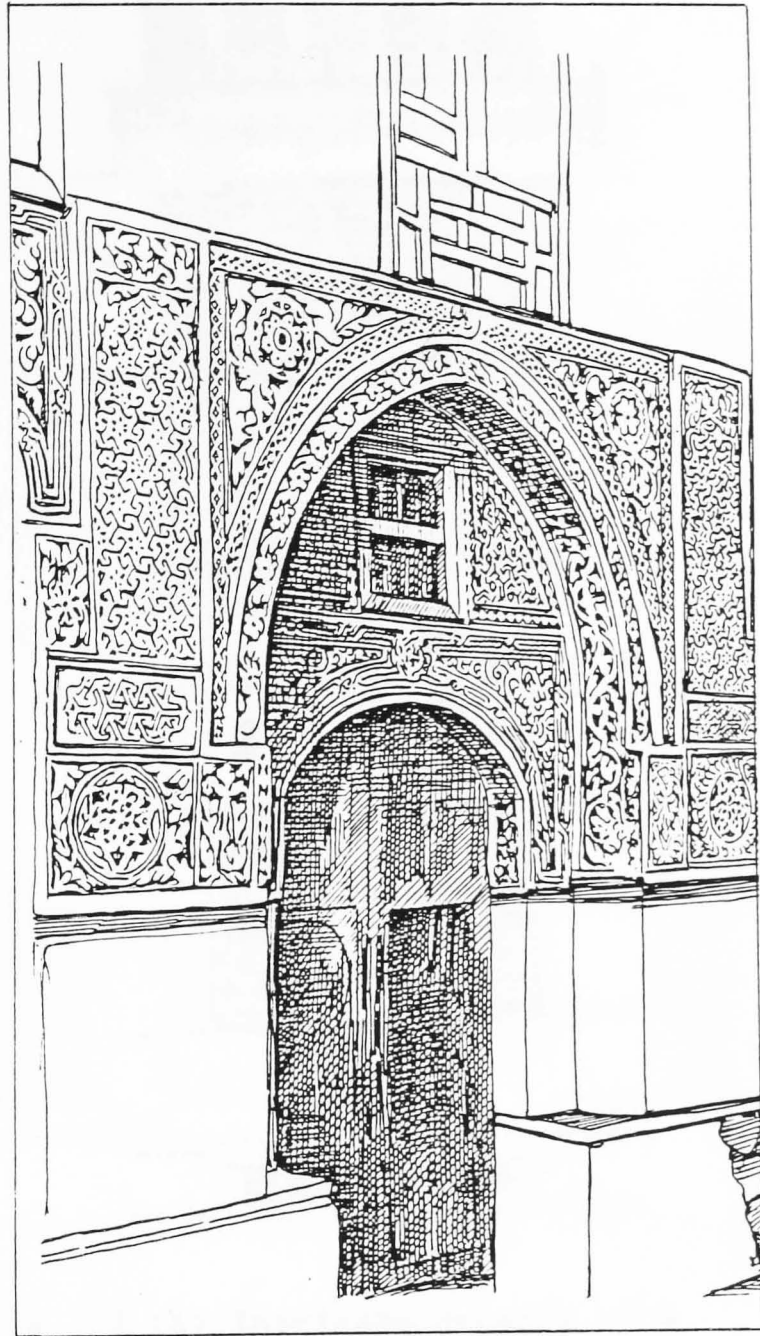


Fig. (2.15) An example of an arched doorway with small square lattice-window over the teak door.

Source: Ibid., p. 118.

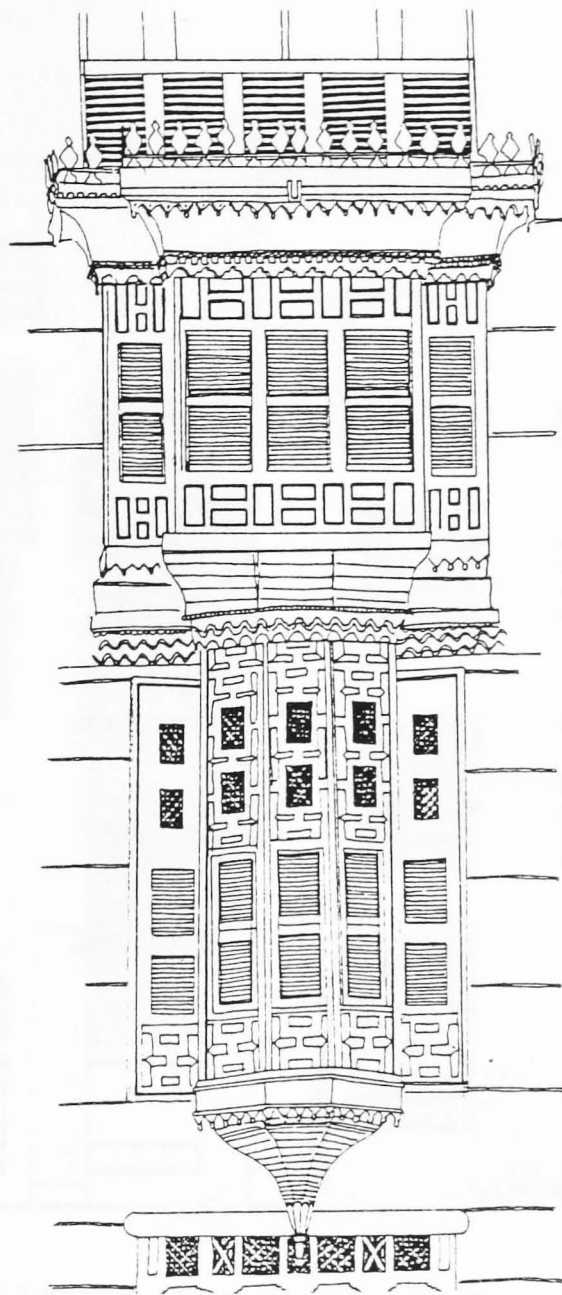


Fig. (2.16) Intricate details of a rawshān.

Source: K. Talib , op.cit., , p. 77.

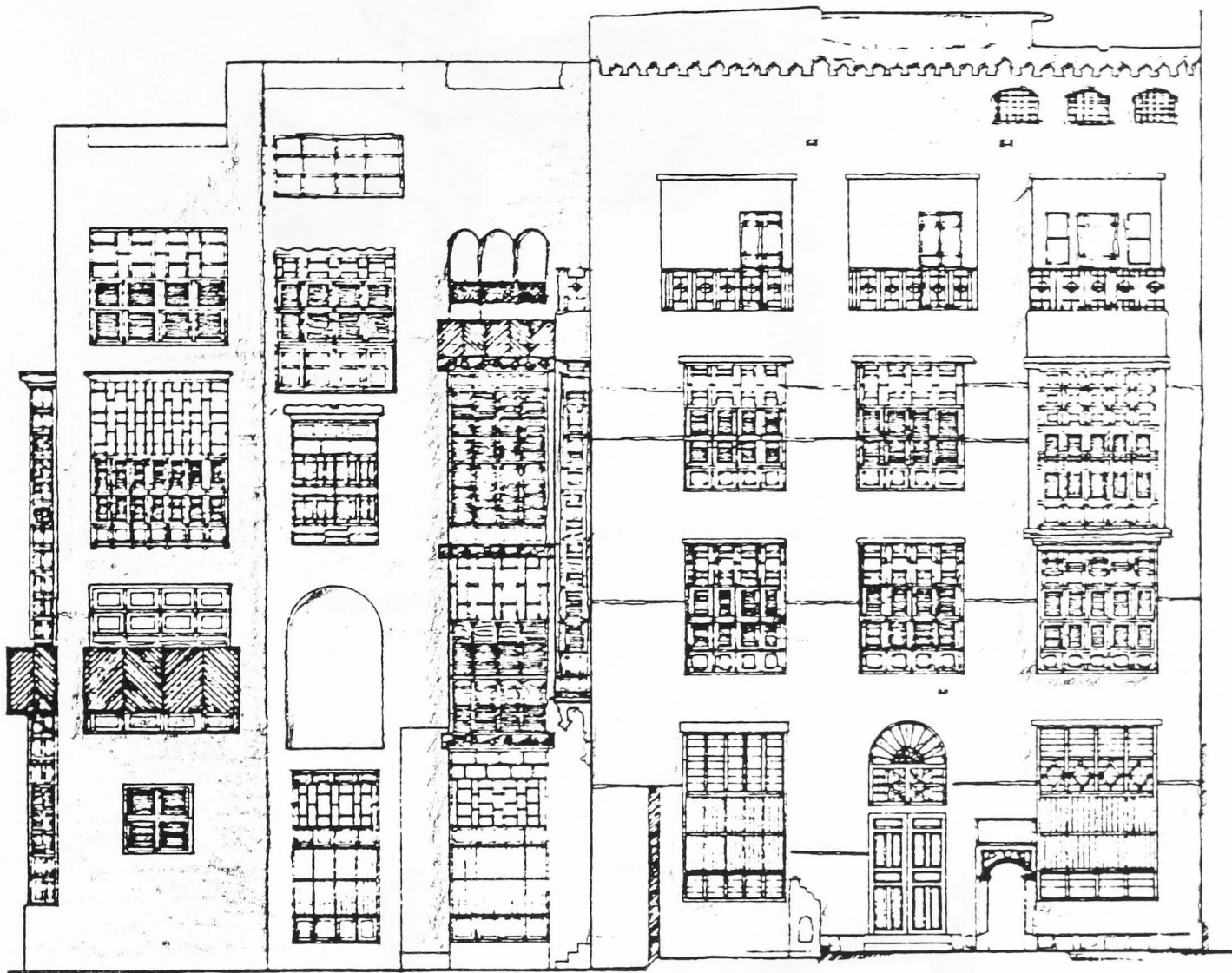


Fig. (2.17) The west facade of Ba-ashin house

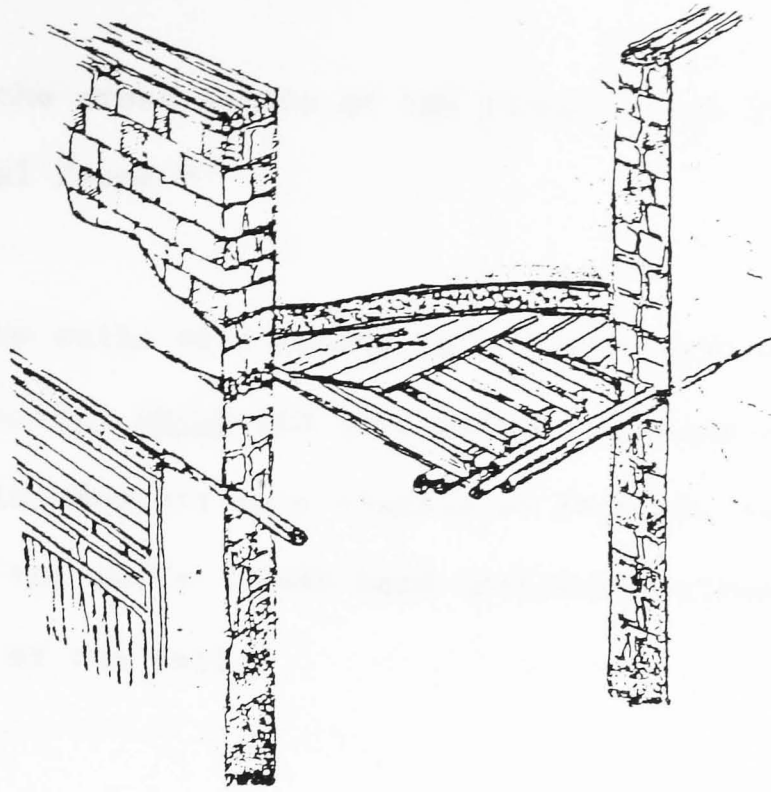


Fig. (2.18) Structural detail (partial)

Source: S. Khan, op.cit., p. 48.

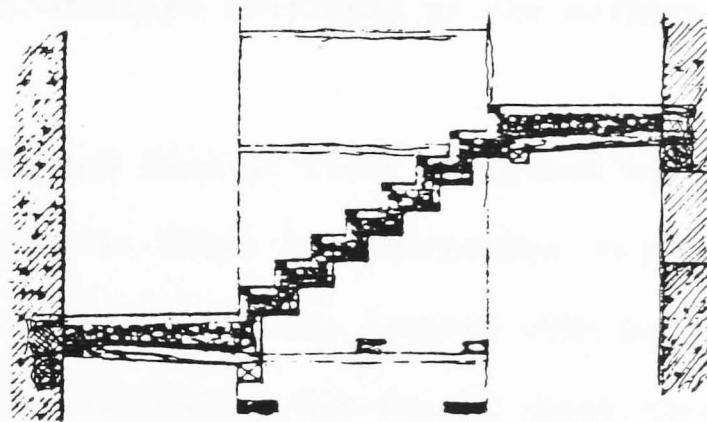


Fig. (2.19) Detail of stairs

Source: Ibid.

tied to the cross joists of the floors, thus forming a stable structural frame.<sup>32</sup>

The walls were coated by a thick layer of lime based plaster, called locally nūrah and then painted by lime wash.<sup>33</sup> The reinforcing members were visible on both the external and internal faces of the walls, clear hard horizontal lines in the smooth white surfaces of the wall.

Depending on span and load conditions, openings had either timber lintels or masonry arches. The general practice was to use lintels made up of stout parallel timbers spread across the full thickness of the wall, tied into the masonry on either side of the opening for a good length. This worked well, distributing the high concentration of stresses developed at the corners of the opening.<sup>34</sup>

The most common form of floor structure was timber boarding laid on timber joists, about 15 centimetres in diameter. This supporting structure was usually covered with straw mats, followed by layers of about 4 centimetres wet earth, three centimetres dry earth, three centimetres mixture of pulverized pebbles and lime bonded with lime mortar, and finally floor tiles.<sup>35</sup> Roofs were similarly constructed but with an addition of a thick bed of limestone below the wet earth layer, and water-resistant lime plaster on top of the roof structure.<sup>36</sup>

The staircase was usually wound around a central pier and was enclosed throughout its height by thick walls. This was one of the reasons for the strength of the traditional tower house of Jeddah,

for the staircase acted as a kind of massive hollow column. The stairs were also constructed of coral blocks. Every step was plastered and protected at the front edge by a long five by five centimetres wooden log, laid on top of three long wooden sticks (fig. 2.19).<sup>37</sup>

The latrines (tahārāt) were situated in identical positions on each floor. Each latrine emptied into a vertical, smoothly plastered sewage duct which extended from the roof to the ground level and received the waste from each floor. This duct was opened at the roof level for the purpose of ventilation. The contents of the duct were deposited into an unplastered subterranean stone septic tank which was cleaned yearly.<sup>38</sup>

### 2.3 SOCIO-CULTURAL SIGNIFICANCE OF THE TRADITIONAL HOUSE

The right of the family to live in maximum privacy and its obligations to offer hospitality resulted in the vertical division of the house into two distinct zones: the semi-private zone for the male visitors on the ground floor and the private zone for the family on the upper floors (fig. 2.20).

Such a practice has led many scholars to use the terms 'segregation of women' and 'seclusion of women' when talking about the traditions and the social customs of the Arabs. The use of either of the two expressions, implies their confinement to special quarters of their own or to particular rooms reserved exclusively for them and for their own use.

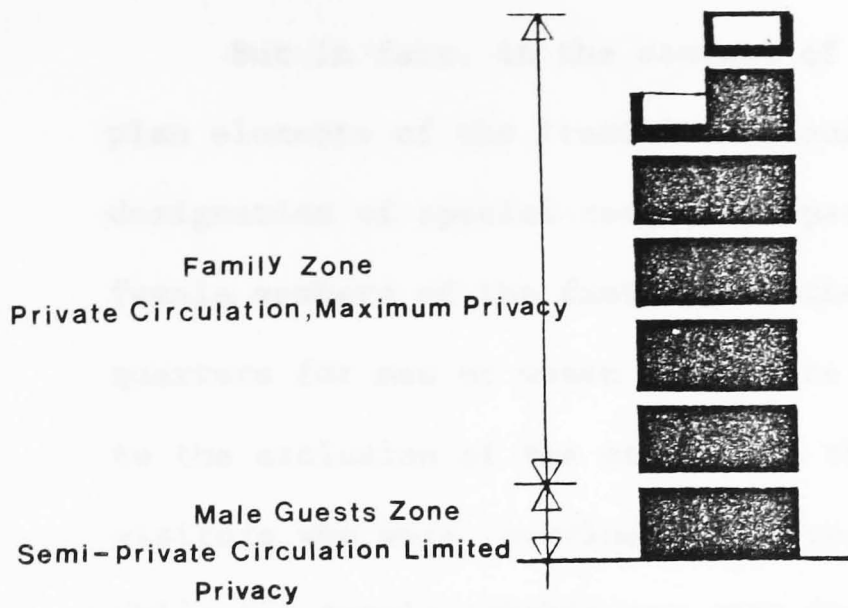


Fig. (2.20) The traditional houses of Jeddah shared the same system of dividing the house into a male guests zone on the ground floor, and a family zone on the upper floors.

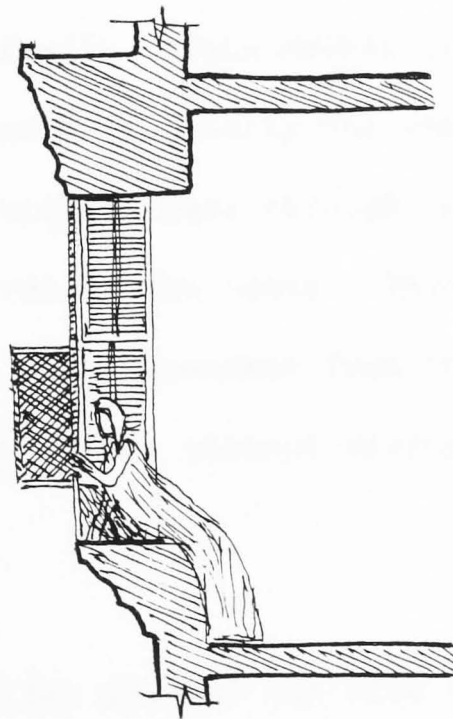


Fig. (2.21) The rawshān allowed the inhabitants to see the outside world while maintaining their privacy.

But in fact, in the context of the arrangement of the various plan elements of the traditional house of Jeddah , there was no designation of special rooms and spaces to be used only by male or female members of the family; in other words, there were no separate quarters for men or women which were used exclusively by either sex to the exclusion of the other. On the contrary, it was the male visitors who were 'confined' and 'restricted' to the ground floor while the female inhabitants were free to move anywhere in the upper floors. Therefore it was the male visitors who were 'segregated', 'isolated' or 'secluded' from the rest of the house, and not the female inhabitants.<sup>39</sup>

This sharp social division was also reflected in the provision of two entrances, a front entrance for male visitors and a rear entrance for the family. This double circulation system enabled the family members, and particularly the women, to go to the upper floor levels without having to pass through the men's 'sitting' rooms located at the front of the house. Thus the semi-private zone was arranged so as to be independent from the rest of the house, allowing male visitors easy access without disrupting the privacy of the family.

The respect for privacy was also clear in the use of the rawāshīn, tāqaat and shīsh. These lattice screens emphasized the strong social character of a defensive and private nature and were part of the transition between inside and outside worlds. They allowed the inhabitants to see the outside world while maintaining the privacy and enclosed character of the indoor space (fig. 2.21).

On the house terraces (kharjāt), privacy was maintained by the high parapet walls (up to 1.8 metres), and this privacy was respected by a social and moral agreement between neighbours to refrain from inflicting any damage to the privacy of these terraces (see fig. 2.13).<sup>40</sup>

The socio-cultural significance of the traditional house was also evidenced in its size, which reflected the large size of the extended family. The family private zone provided the living quarters of the master of the house and the rest of the extended family. Though every married son dwelt in a separate living area, the whole family used to gather daily, and domestic tasks were shared by the female members of the family.<sup>41</sup>

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## CHAPTER THREE

### THE INFLUENCE OF CLIMATE UPON THE TRADITIONAL HOUSE

To appreciate the climatic adaption of the house and its performance in providing comfortable conditions for occupants, one must first characterize in some detail both the climatic conditions in which the house is set and the effects of urban form on the microclimate.

Examination of the climatic variables of Jeddah will allow a clear understanding of its micro-climatic characteristics. It is essential to determine the nature and degree of comfort and discomfort generated by these variables, consequently allowing a better understanding of the bioclimatic needs and human thermal requirements.

#### 3.1 ANALYSIS OF JEDDAH'S CLIMATE

##### 3.1.1 Regularities Associated with Latitude

Owing to the latitude where Jeddah lies ( $21^{\circ}29'N$ ), the sun travels only a  $130^{\circ}$  azimuth, or plan arc, from sunrise to sunset on December 21, the winter solstice day (fig. 3.1). The solar altitude at noon is  $46^{\circ}$ . On June 21, the summer solstice day, the sun's azimuth arc totals  $230^{\circ}$ . The noon altitude of the sun is  $88^{\circ}$ . The difference between the maximum solar altitude in the summer and the minimum solar altitude in the winter is  $42^{\circ}$ . Daylight in December 21 extends from 06:36 a.m. until 17:24 p.m. (solar time). While in June

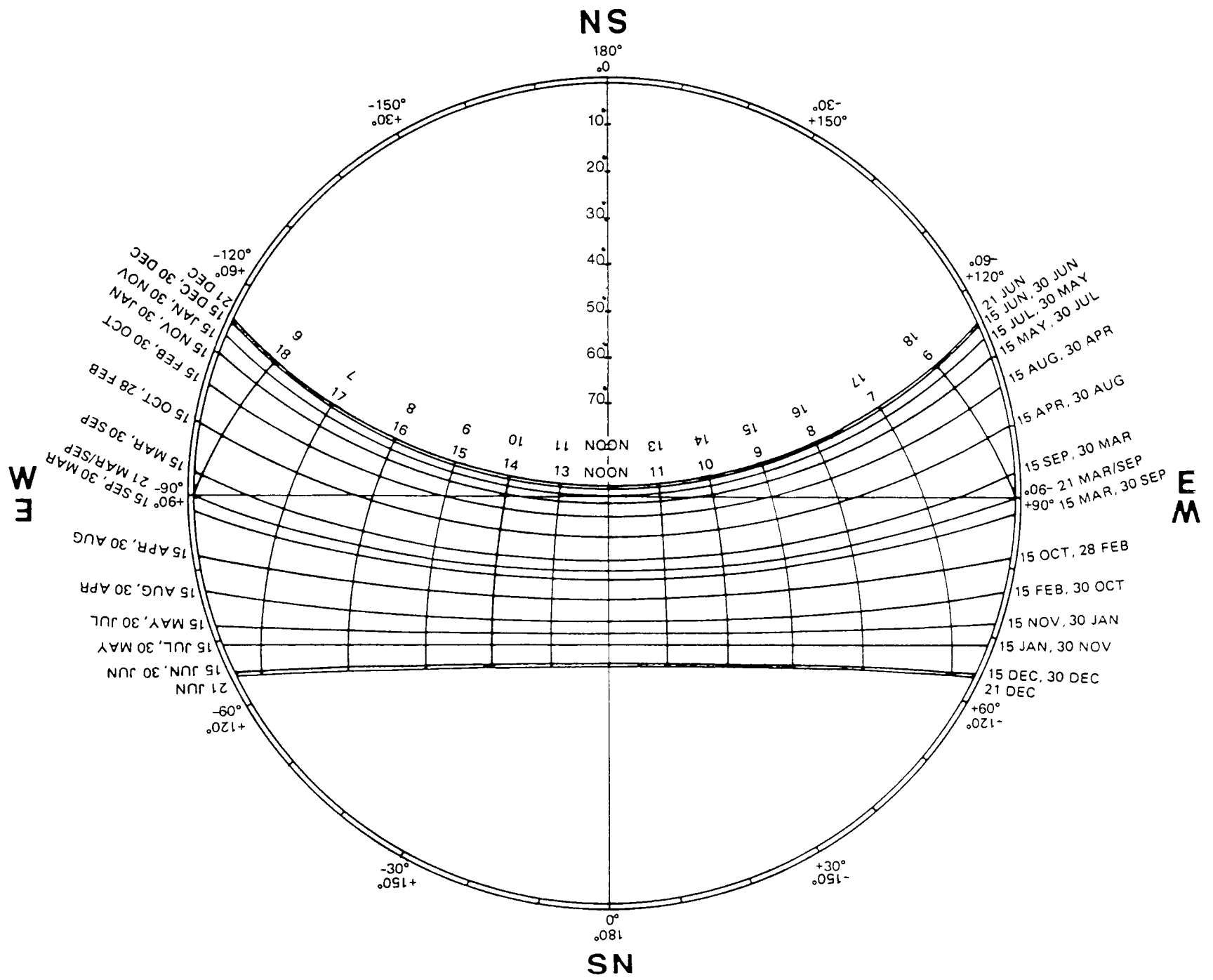


Fig. (3.1) Sunpath Diagram for 21°N. Latitude.

Source: C. Kukreja, *Tropical Architecture*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1978, p. 26.

21 it extends from 05:18 a.m. until 18:42 p.m. Thus, the length of the shortest day is approximately 10 hours 48 minutes and the longest day 13 hours 18 minutes - a difference of 2 hours 30 minutes.<sup>1</sup>

### 3.1.2 Climatic Variables

The analysis of numerical data is always a tedious undertaking. Not only is it quite baffling to try to visualize the spatial-temporal behaviour of variables from tables of numbers, but it is often difficult to extract the patterns hidden in them unless the data are transformed and presented in a different format.

A method of describing the climate through isopleth charts derived from long-term weather data was found by the author to be comprehensive enough for describing the climate data of Jeddah and a valuable means of transforming numerical data of climate variables into visual form.<sup>2</sup>

In the construction of Jeddah's isopleths of dry bulb air temperature, relative humidity and wind speed and direction, hour-by-hour weather data for 13 years recorded by the General Directorate of Meteorology were used.<sup>3</sup> The data cover 1970-1975 and 1977-1983. No data for 1976 were available. The data over 24 hours at each month were averaged to obtain the 13 year monthly mean. The wind direction shown by the wind speed isopleths was the predominant direction at each hour in a month.

No reliable recorded solar radiation data were available at the General Directorate of Meteorology. However, solar radiation data

were calculated on the 21st day of each month for a typical year at the College of Meteorology and Environmental Science.<sup>4</sup> A degree of error was inevitable and was accepted. On later comparison of the estimated values to those published in the SANCST Saudi Arabian Solar Radiation Atlas<sup>5</sup> for a nearby station (al-Sayl al-Kabir), the results over the whole year were found to be within 5%.<sup>6</sup>

#### 3.1.2.1 Dry Bulb Air Temperature Isopleth

The dry bulb air temperature isopleth for Jeddah (fig. 3.2) shows that the mean maximum dry bulb air temperature occurs during the months of June and July and that it can be as high as 38°C. The mean minimum temperature during this period is found to be about 28°C and this occurs between 3:00 and 6:00 a.m., thus giving a diurnal range of 10°C. In all months, a fairly rapid rise in temperature takes place during the first six or seven hours of daylight. After reaching the maximum sometime between 2:00 and 3:00 p.m. the temperature falls again, fairly slowly through the late afternoon and night. The coldest month is January and the mean lowest temperature is 18°C.

The magnitude of the diurnal range is influenced by several factors. The sea breeze, for example, when well developed, tempers the afternoon heat by several degrees.<sup>7</sup> On days when the sea breeze is weak therefore, a larger diurnal range of temperature is to be expected, assuming no difference from other factors, for example, cloud cover or hot winds.<sup>8</sup>

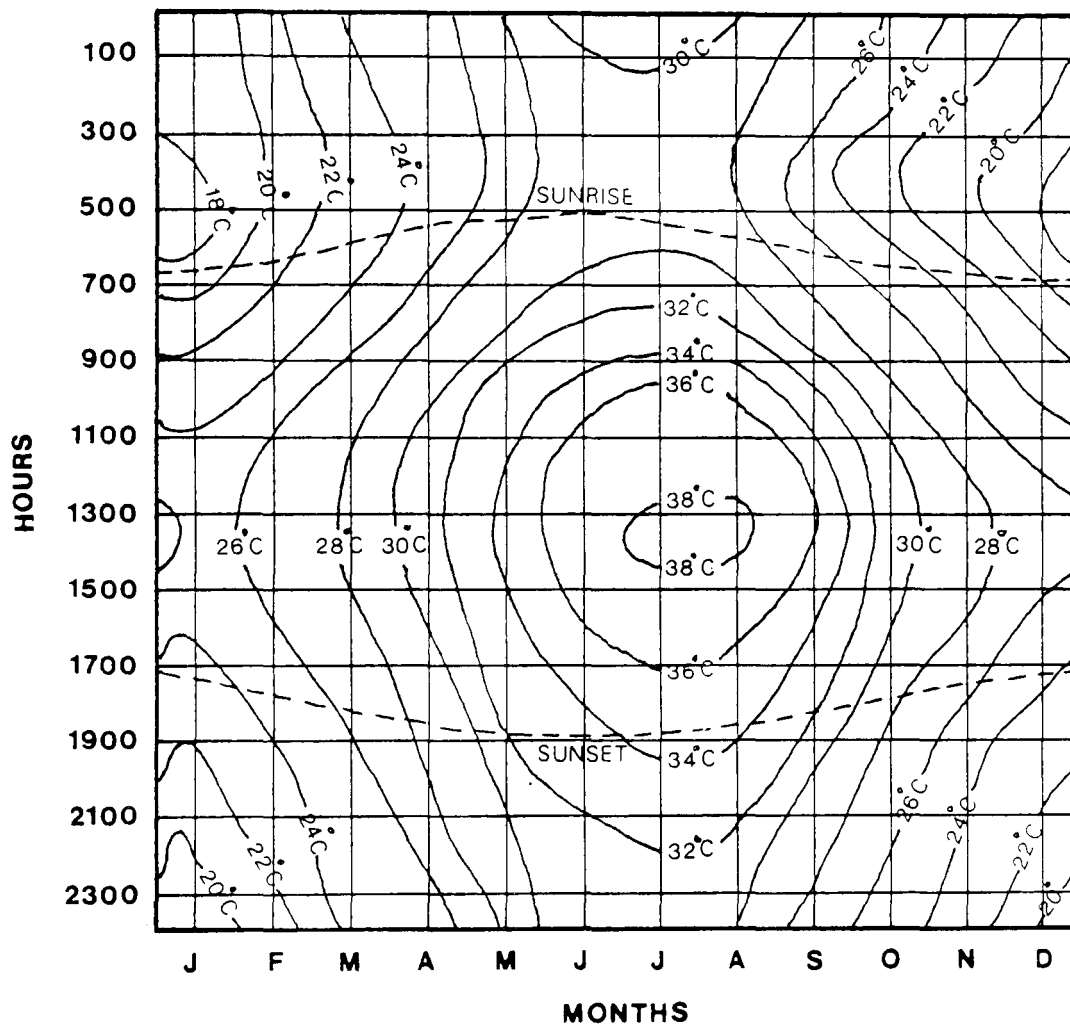


Fig. (3.2) Dry bulb outdoor air temperature isopleth chart for Jeddah. Note that the vertical thermo isopleth gradient is less steep than the horizontal gradient, showing that the diurnal temperature variations are smaller than the seasonal variations.

### 3.1.2.2 Relative Humidity Isopleth

The relative humidity is lowest in the noon and early afternoon hours during all months (fig. 3.3). The mean minimum relative humidity in the year is about 45% which occurs at 1:00 p.m. at the end of May and during the months of June and July. The corresponding maximum relative humidity at those periods is 85% and shows a relatively small diurnal variation. In winter, the mean minimum relative humidity is 60% in January, and the mean maximum in that month is 85%. It can be inferred that the average humidity at Jeddah is remarkably constant between 60% and 70% in all months with relatively small diurnal variation.

It is important to mention here that the humidity conditions at Jeddah in the course of the day are affected to a large extent by land and sea breezes and temperature variations.<sup>9</sup> At night, breezes from landward tend to be dry, but lower temperatures raise the relative humidity. By day, higher temperatures lower the relative humidity but sea breezes bring in moist air and have the opposite effect (Section 3.1.2.4).

### 3.1.2.3 Wind Speed Isopleth With Predominant Direction

The diurnal variation of wind speed is shown in fig. 3.4. The diurnal range is least in November (2.5 m/s) and increases fairly rapidly in the spring, reaching a maximum value of 6.0 m/s in May and June. In the former month the wind rises from 2.5 m/s at 6:00 a.m. to about 8.0 m/s at 15:00 p.m. The range decreases slowly during the summer until November when the value falls to 2.5 m/s.

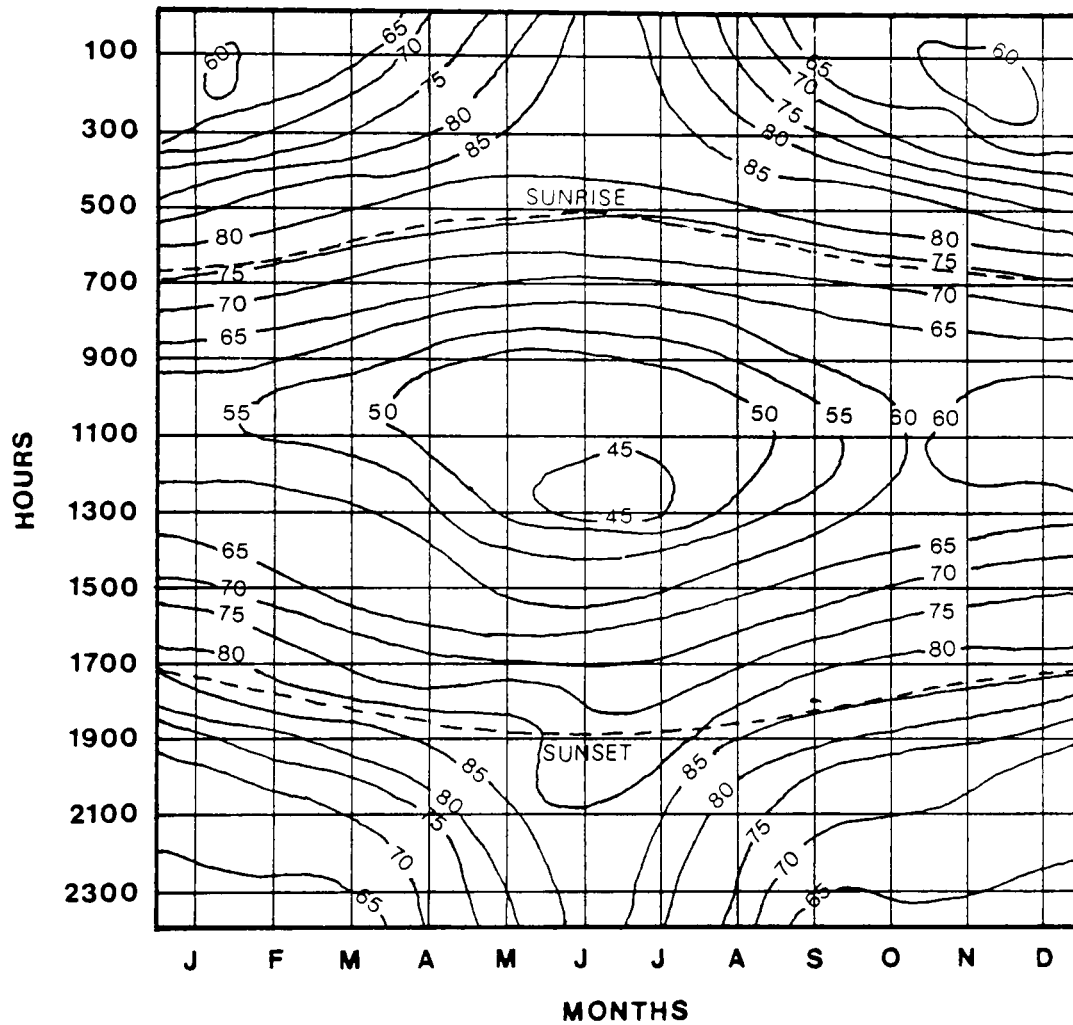


Fig. (3.3) Relative humidity isopleth chart for Jeddah. Values are given as percentage relative humidity.

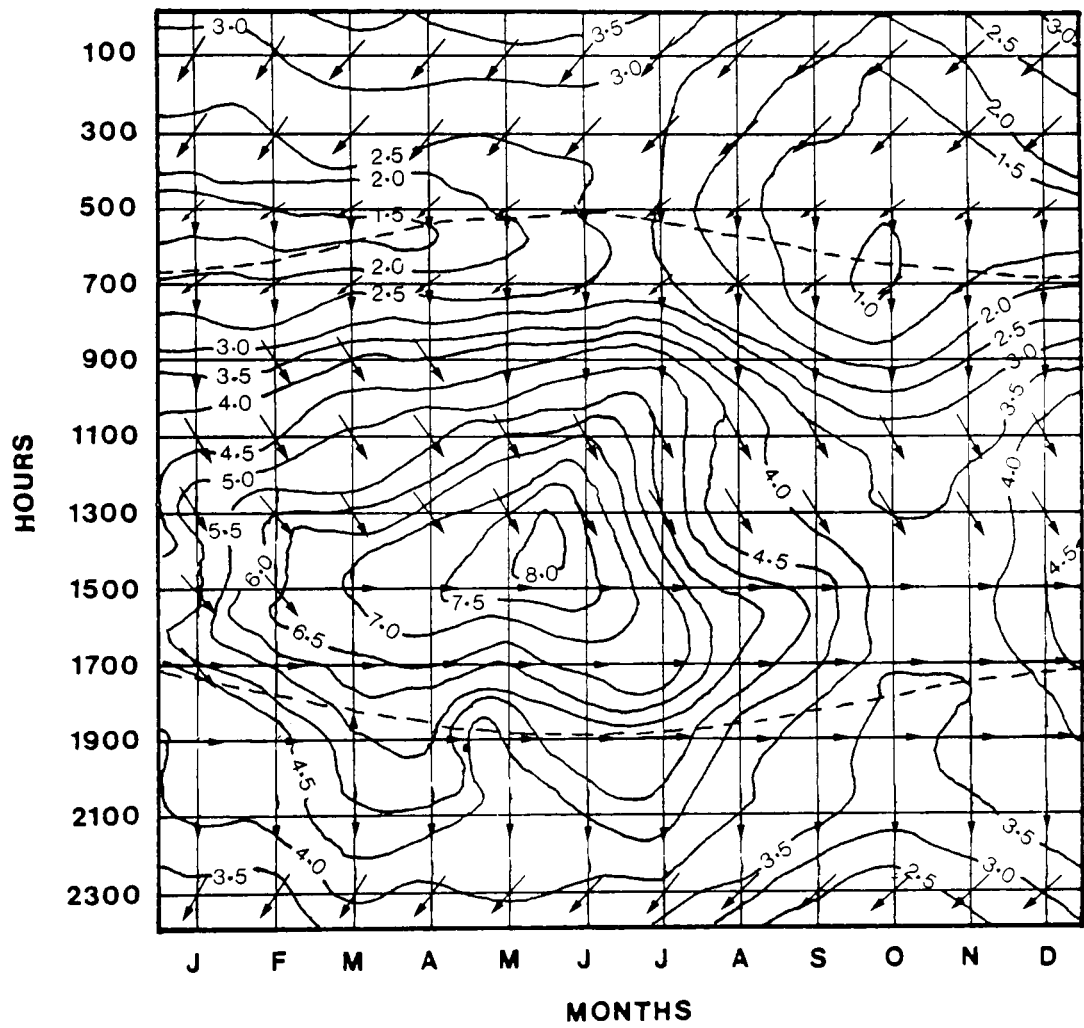


Fig. (3.4) Wind speed (m/s) isopleth chart with predominant directions for Jeddah.

The wind is weakest at about 7:00 a.m. in the summer months and 6:00 a.m. in the winter; its average minimum value is less than 2.5 m/s throughout the year. Generally, as temperature rises the wind strengthens considerably until it reaches its maximum at 15:00 p.m. after which it falls steadily to its minimum near sunrise. This increase in the strength of the wind is more pronounced in spring and summer.

From 7:00 a.m. to 11:00 a.m., the north winds prevail during the whole year with an approximate speed of 2.5 to 3.5 m/s. By noon the winds blow from the north-west direction and persist until 3:00 p.m. during spring and summer and until 6:00 p.m. during autumn and winter. The speed reaches 4.5 to 6.0 m/s during winter and 5.5 to 7.5 m/s during summer. The west winds prevail during spring and summer months from 3:00 p.m. until 7:00 p.m. with an approximate speed of 6.0 to 8.0 m/s. However these winds are associated very much with the sea breezes and bring with them moisture. The north, north-west and west winds are considered the most desirable winds because of their cooling effect during the summer months when they prevail about 50% of the time.<sup>10</sup>

In the evening and late night hours, the winds tend to blow from the east and north-east throughout the year with an approximate speed of 1.5 to 3.5 m/s. During the summer their prevalence is 25-40% while in the winter it is approximately 10-25%.<sup>11</sup> These east and north-east winds are considered the most desirable winds for summer nights, and their lower speed also makes them less harmful during the winter. Still and sultry nights are experienced during summer months

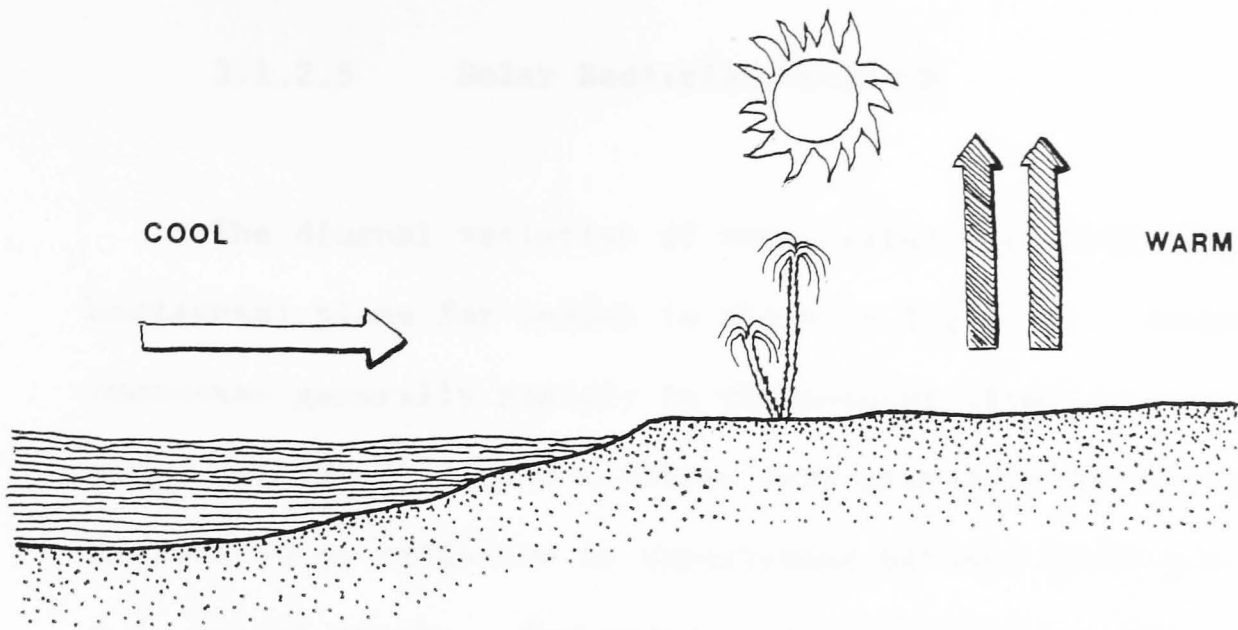
but they are not of very frequent occurrence and the number of nights varies from one month to another.<sup>12</sup>

#### 3.1.2.4 Sea and Land Breezes

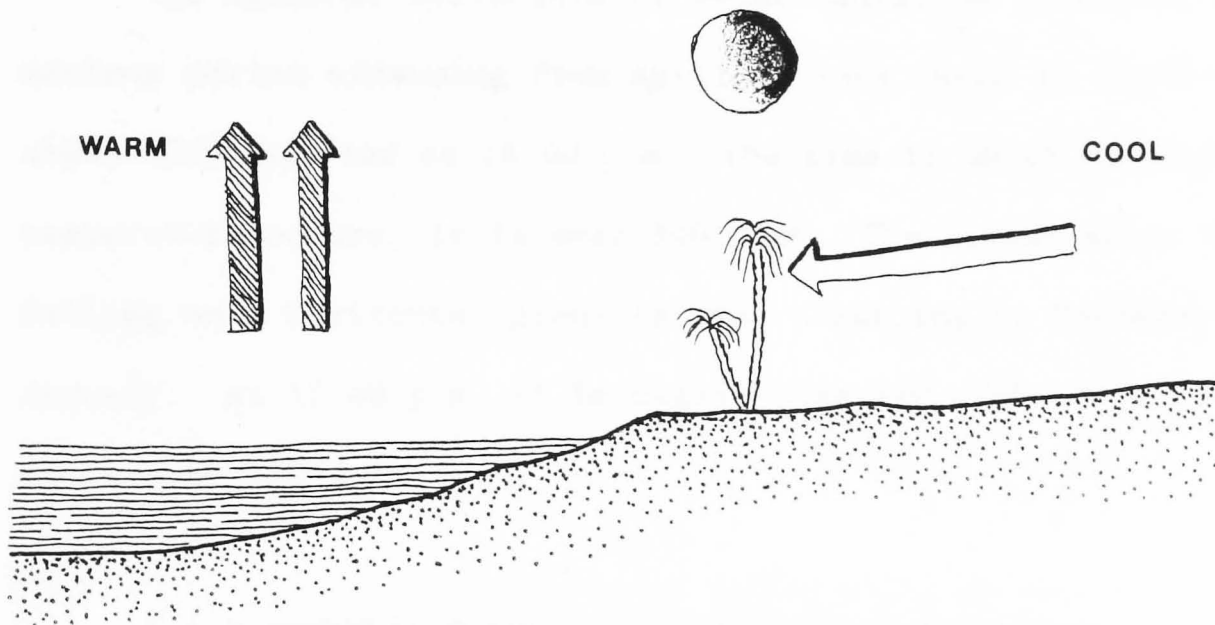
As in all coastal areas prone to strong solar heat, the shores of the Red Sea experience diurnal wind changes commonly referred to as land and sea breezes (fig.3.5). The sea breeze, a flow of air from the sea towards the land, develops during daylight hours, usually reaches its maximum strength in early or mid afternoon, and dies down about sunset. The reverse flow, the land breeze, occurs late at night and is, of course, most strongly developed during quiet, settled weather, but their direction depends on the angle of the shore.<sup>13</sup>

In Jeddah, the sea breeze effect is seen by a change from predominantly north winds in early morning to north-west by noon and backing towards the west by mid afternoon. It seldom extends more than 24 to 32 km inland and 500 to 1000 m above the surface.<sup>14</sup> The sea breeze is most vigorous in spring and summer, since during the winter it tends to be obliterated by the north winds.<sup>15</sup>

Late at night, the land breeze is usually from between east and north-east. However, on all the eastern coasts of the Red Sea (see fig 1.1) land breezes appear to be less well developed than on the coasts of the African side. This may be due to the greater average elevation of the hinterland to the east compared with that of Egypt and the Sudan, which also is likely to result in greater irregularity and squalliness of the land breezes.<sup>16</sup>



**TIME - SEA BREEZE**



**TIME - LAND BREEZE**

Fig. (3.5) The difference in temperatures of the air over land and water cause pressure differences which in turn induce localized winds. This is known as the onshore/offshore or land-sea breeze effect.

Source: R. Sanderson, Meteorology at Sea, Sanford Maritime, London, 1982, p. 77.

### 3.1.2.5 Solar Radiation Isopleth

The diurnal variation of total solar radiation incident on a horizontal plane for Jeddah is shown in fig.(3.6). Intensity increases generally rapidly in the morning after sunrise under the clear morning skies and declines more gradually during the afternoon. Maximum solar radiation is experienced between 11:00 a.m. and 12:00 p.m. in all months. The maximum air temperature occurs some two to three hours after the time of maximum radiation.

The seasonal variations of solar radiation intensity show a maximum period extending from April to June where at 12:00 p.m. it is about 1000 w/m<sup>2</sup> and at 14:00 p.m., the time in which maximum air temperature occurs, it is over 800 w/m<sup>2</sup>. The lowest solar radiation falling on a horizontal plane is that occurring in December and January. At 12:00 p.m. it is higher than 800 w/m<sup>2</sup> and at 14:00 p.m. it is over 600 w/m<sup>2</sup>.

### 3.1.3 Jeddah's Comfort and Discomfort Conditions

The influence of the four physical parameters (dry bulb air temperature, relative humidity, air speed and radiation) on the thermal comfort sensation of people has been studied extensively by many research workers, among whom Olgyay,<sup>17</sup> Webb<sup>18</sup> and Givoni<sup>19</sup> have made significant contributions. Evans<sup>20</sup> summarized their work and presented scales for comfort temperature ranges against relative humidities for three conditions (table 3.1).

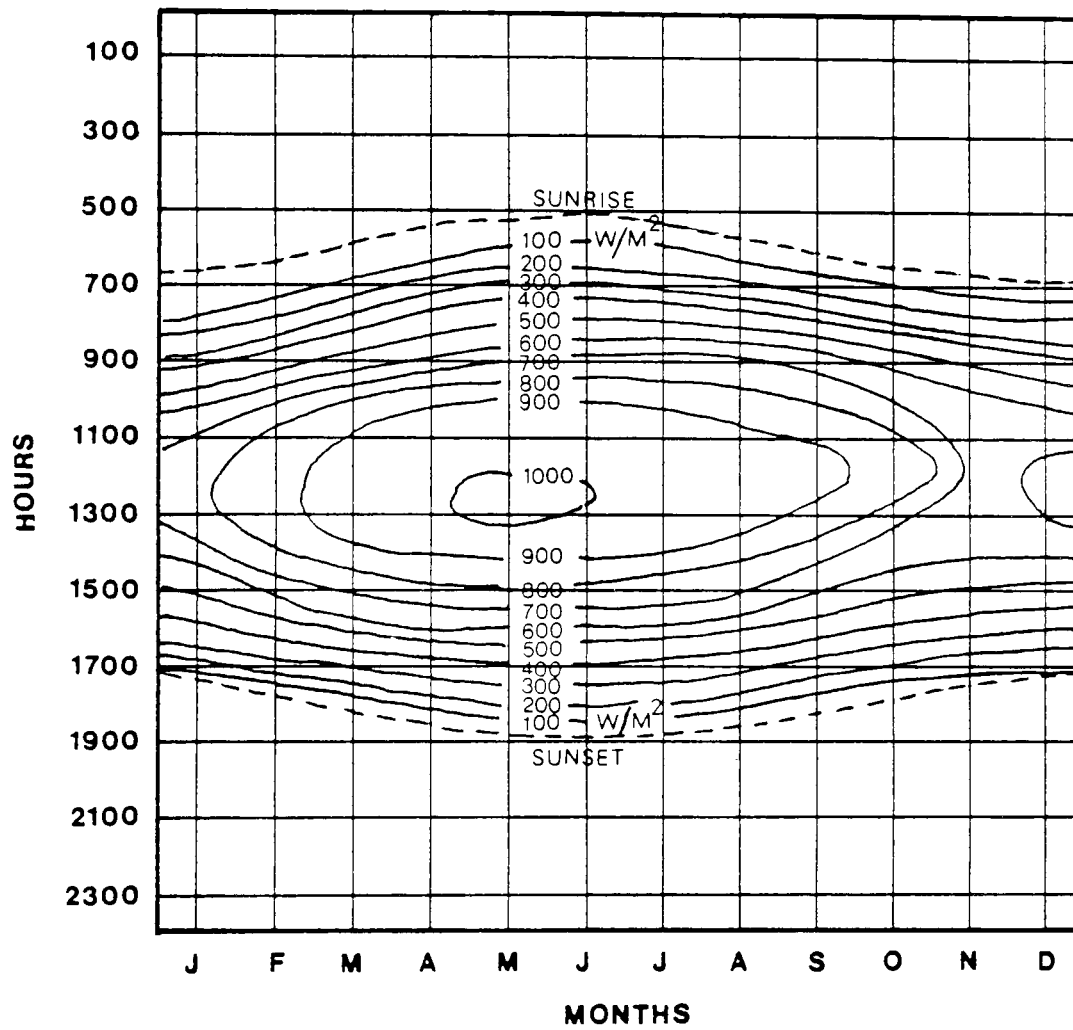


Fig. (3.6) Total solar radiation (W/M<sup>2</sup>) incident on a horizontal plane for Jeddah.

Table (3.1) Comfort temperature ranges.

Scale	Conditions	Humidity %	Day temp °C	Night temp °C
A	Upper range of comfort with 1 m/sec movement	0-30	32.5-29.5	29.5-27.5
		30-50	30.5-28.5	29.0-26.5
		50-70	29.5-27.5	28.5-26.0
		70-100	29.0-26.0	28.0-25.5
B	Range of comfort with light summer clothes or 1 blanket at night	0-30	30.0-22.5	27.5-20.0
		30-50	28.5-22.5	26.5-20.0
		50-70	27.5-22.5	26.0-20.0
		70-100	27.0-22.5	25.5-20.0
C	lower range of comfort with normal or warm clothes and thick bedding at night	0-30	22.5-18.0	20.0-16.0
		30-50	22.5-18.0	20.0-16.0
		50-70	22.5-18.0	20.0-16.0
		70-100	22.5-18.0	20.0-16.0

Source: M. Evans, Housing, Climate and Comfort, The Architectural Press, London, 1980, P. 23.

The condition for the central comfort zone of Evans is that the subject wears light summer clothes during the day, uses a single sheet at night and experiences an air speed of 0.1 m/s. Evans' upper scale gives the dry bulb air temperature range against relative humidity at air speed of 1.0 m/s. For the cold season, he presented the lower scale, which gives comfortable temperature ranges for the subject wears warm clothes during the day and uses thick bedding at night. The first condition is recognised as the comfort conditions; and the other two conditions are termed as modified comfort conditions.

According to Evans, the temperature ranges, (table 3.1), are average ranges and do not indicate that everyone will feel comfortable when temperatures are within the appropriate range. He indicates that age, sex, diet, acclimatization, body shape and state of health will affect the sensation of comfort, and that the comfort can only indicate the conditions under which most people (about 70%) will feel comfortable.<sup>21</sup>

Appropriate comfort temperature ranges can be obtained for 12 months of the year by comparing the mean monthly maximum and minimum dry bulb air temperatures and relative humidities (table 3.2) against the temperature ranges given by Evans' scales (table 3.1). The comfort temperature ranges obtained this way for Jeddah are shown in table (3.3). By applying these ranges to the dry bulb air temperature isopleth the comfort zone chart is developed (fig. 3.7). Zones which meet Evans's middle scale criteria are the comfort zones, and zones which satisfy Evans's upper or lower scale criteria are

Table (3.2) Summary of Jeddah's Climatic Data.

	Dry Bulb Temperature (°C)			Rel Humidity (%)		Wind Speed (m/s)		Rainfall (mm)	Sky Clarity (okta)	
	Max Mean	Min Mean	Mean Diurnal Range	Max Mean	Min Mean	Max Mean	Min Mean	Monthly	Max Mean	Min Mean
January	28.5	19.0	9.5	93	45	5.8	3.2	19.6	2	1
February	29.1	18.7	10.4	92	42	6.0	3.4	16.6	2	1
March	30.9	20.4	10.5	93	46	6.9	3.5	00.0	2	1
April	33.5	22.2	11.3	93	50	6.8	3.4	1.6	2	0
May	35.4	24.5	10.9	95	52	7.2	3.8	2.1	1	0
June	36.6	25.3	11.3	96	56	8.5	4.1	0.0	0	0
July	37.7	26.7	11.0	94	56	9.0	4.2	0.0	0	0
August	37.2	27.2	10.0	95	52	8.4	3.0	0.0	0	0
September	35.8	26.2	9.6	97	54	7.7	2.3	0.0	0	0
October	34.9	24.2	10.7	97	56	6.5	2.2	0.8	0	0
November	32.4	22.2	10.2	93	52	6.0	2.3	10.0	1	0
December	29.8	20.0	9.8	91	50	5.8	2.8	10.7	2	1
Annual Mean	28.0		10.4	72.5		5.2		5.0		

Source: Weather Records, 1970-1983, General Directorate of Meteorology, Western Region, Jeddah, Saudi Arabia.

Table (3.3) Day and night-time comfort temperature ranges for Jeddah obtained by Evans' method.

Time	Month											
	J	F	M	A	M	J	JL	A	S	O	N	D
Day	27.5	27.5	27.5	29.0	29.5	29.5	29.5	29.5	29.0	27.5	27.5	27.5
	22.5	22.5	22.5	26.0	27.5	27.5	27.5	27.5	26.0	22.5	22.5	22.5
Night	20.0	20.0	20.0	25.5	28.0	28.0	28.0	28.0	25.5	25.5	20.0	20.0
	16.0	16.0	16.0	20.0	25.5	25.5	25.5	25.5	20.0	20.0	16.0	16.0

Source: M. Evans, op.cit., p 25-26.

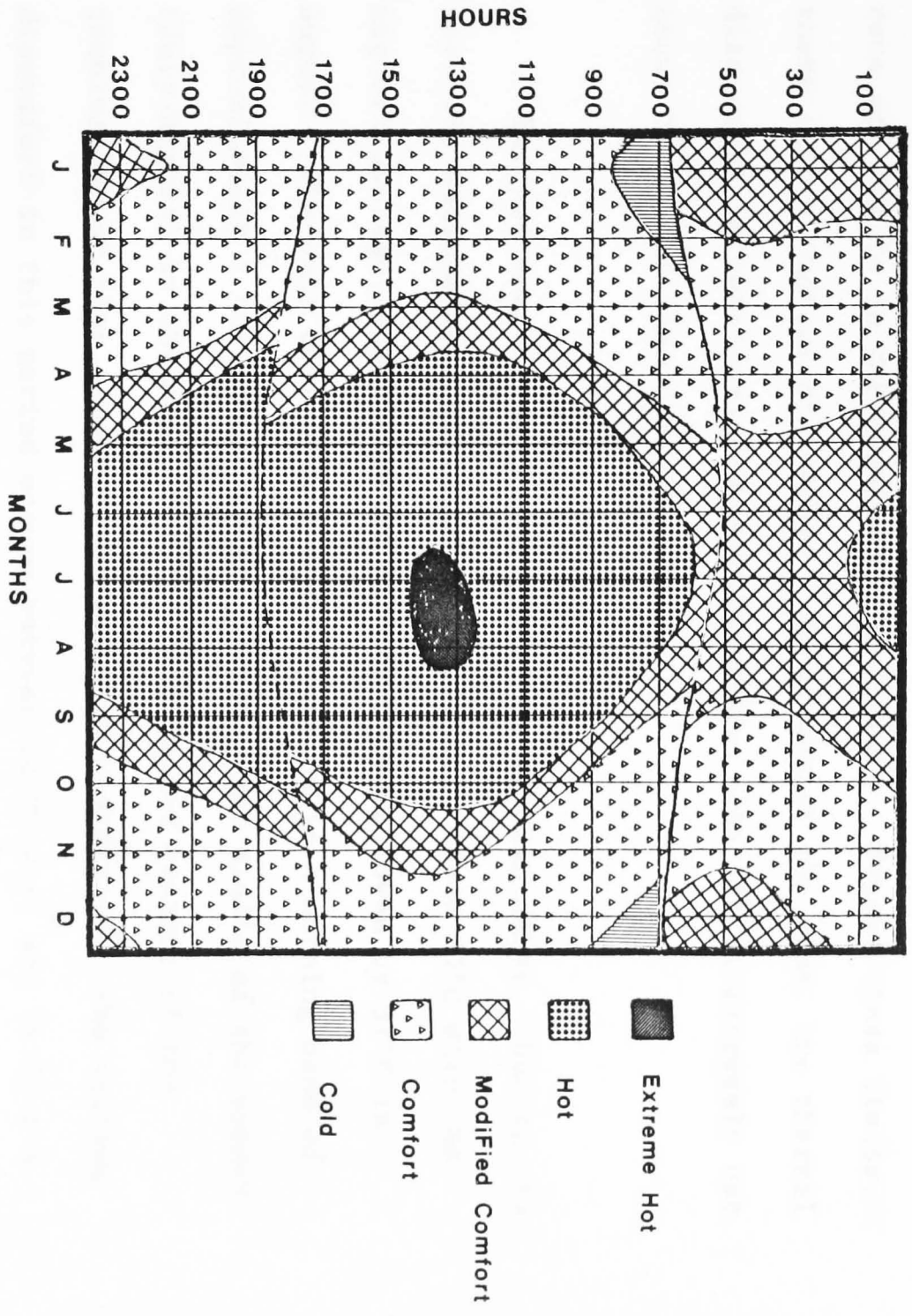


Fig. (3.7) Comfort zone chart for Jeddah.

modified comfort zones. Zones which do not meet the criteria of any of these scales are zones of thermal discomfort.

From the comfort chart (fig. 3.7), it is interesting to note that in Jeddah approximately 34% of the year falls within the comfort zone and 20% is in the modified comfort zone. Beyond these limits, there exists thermal discomfort. About 40% of the time, the thermal discomfort is considered hot and 3% of the time, it is extremely hot. About 3% of the time, it is cold.

The hot season lasts from April through September. During the day, the maximum average temperatures are all above 30°C with the highest average temperature of 38°C in July followed by 37°C in August. The only comfortable daytime period is a morning band of approximately 1 to 2 hours after sunrise. The middle of the summer (July-August) is the most uncomfortable period because of the combination of high temperatures and high humidities. The maximum discomfort in this period occurs between 12:00 p.m. and 14:00 p.m. The modified comfort period extends from 1:00 a.m. to 7:00 a.m.

It can readily be seen from fig.(3.7) that only in February and November do the daytime and night temperatures fall within the comfort zone, whilst in March and October (transitional months) the temperatures are within the modified comfort zone from 11:00 a.m. to 19:00 p.m. During December and January, the night-time temperatures fall within the lower modified comfort range from 23:00 p.m. to sunrise. The early morning hours, however, are relatively cold causing discomfort, while the rest of the daytime hours are fully comfortable.

The fact that temperatures are above, within or below the comfort zone does not necessarily indicate the precautions that are required to achieve or maintain comfort. That will depend on a further analysis to establish the nature and extent of discomfort. Table (3.4) summaries the limits of comfort and discomfort for day and night conditions as defined by Evans.<sup>22</sup> By comparing dry bulb air temperatures and corresponding relative humidities shown in figs.(3.2) and (3.3) to these limits, the comfort and discomfort analysis is further elaborated, (fig. 3.8).

It can readily be seen from fig.(3.8) that 42% of the time discomfort is due to relatively high temperatures by day and night whilst 3% is due to excessive discomfort due to high temperatures by day. A further 16% is still in an extremely uncomfortable range due to high temperatures and humidities by day and night, 5% of the time the discomfort is due to relatively low night temperatures whilst 3% is due to relatively low day temperatures. 34% of the time is in shade comfort.

Other points of interest arising from fig.(3.8) are first, the time of excessive discomfort due to high temperatures is two hours or so earlier than the time of maximum temperature, the effect of the later being offset by the corresponding maximum wind speeds. Second, the excessive discomfort due to high relative humidities in combination with relatively high temperatures begins to be felt between 17:00 p.m. and 21:00 p.m. A second period occurs two hours after midnight and continues until dawn coinciding with period the wind speed is at a minimum.

Table (3.4) Temperature and humidity limits for different forms of discomfort.

Condition	Average daily temperature for the month		Average daily humidity for the month		Diurnal range
	Maximum	Minimum	Maximum	Minimum	
1. High temp. and high humidity	over 27 or over 27.5	- -	and and	- -	over 70% 50-70% and 10°C or less
2. High temp. and high diurnal range	over 32.5 or over 30.5 or over 29.5	- - -	and and and	- - -	0-30% 30-50% 50-70% and >10°C
3. Excessive discomfort	over 30 or over 37 or over 35.5 or over 32	- - - -	and and and and	- - - -	0-30% 30-50% 50-70% over 70% and 10°C or less
4. Day and night comfort but with high diurnal range	below 32.5 or below 30.5 or below 29.5 or below 29	above 10 above 10 above 10 above 10	and and and and	- - - -	0-30% 30-70% 50-70% over 70% and >10°C 10°C > 0°C >10°C >10°C
5. Day comfort	All conditions not included in 1, 2, 3, 4, or 6				
6. Low day temperature	15-18 (fresh)	-		-	-
	10-15 (cool)	-		-	-
	below 10 (cold)	-		-	-
7. High temperature and high humidity by night	- or -	above 25.5 above 26	and and	above 70% 50-70%	- - and 10°C or less
8. High temperature and low humidity by night	- or - or -	above 27.5 above 26.5 above 26	and and and	0-30% 30-50% 50-70%	- - - and >10°C
9. Low night temp.	-	below 10		-	-

Source: M. Evans, op.cit., P.29.

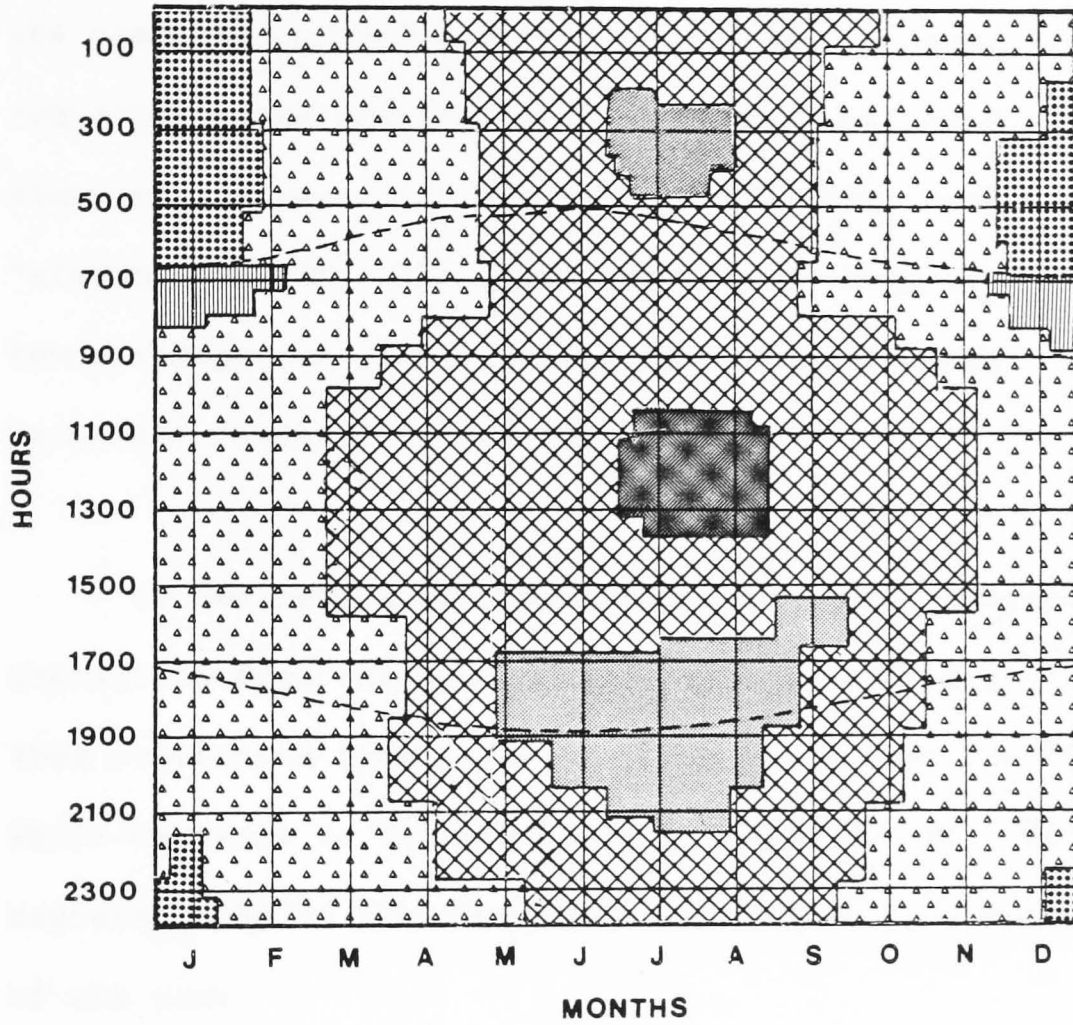


Fig. (3.8) Discomfort analysis chart for Jeddah.



Comfort



Discomfort due to relatively high day and night temperatures



Excessive discomfort due to high temperatures by day.



Excessive discomfort due to high temperatures and humidities by and night



Discomfort due to relatively low night temperatures



Discomfort due to relatively low day temperatures

#### 3.1.4 Bioclimatic Needs

The bioclimatic shading analysis is given in fig. 3.9. Evans' lower comfort scale designates the "shading line". The area below this line is called "underheated zone". Above the shading line are the areas of thermal comfort and overheated conditions, both requiring shade and this area is termed the "shading zone". The times of the year that belong to the shading zone are called the "shading period". The chart shows that shade is needed all year round except for early morning and late afternoon hours in November, December, January and February.

An evaluation of the bioclimatic needs in terms of exposure or protection from the sun and wind are given in fig.(3.10). It shows that protection from solar radiation is needed for 92% of the time. While exposure to the sun is only needed for 3%. Wind needs represent 58% of the time while protection from wind is as much as 8% of the year.

#### 3.1.5 Comfort and Indoor Climate

The comfort analysis (Section 3.1.3) shows us that Jeddah experiences two forms of daytime discomfort during summer, the critical season. The first form of discomfort is due to high air temperatures and relative humidities.

The thermal sensation of heat discomfort is experienced under "steady state" conditions, when the average skin temperature is elevated above the level corresponding to the state of comfort.

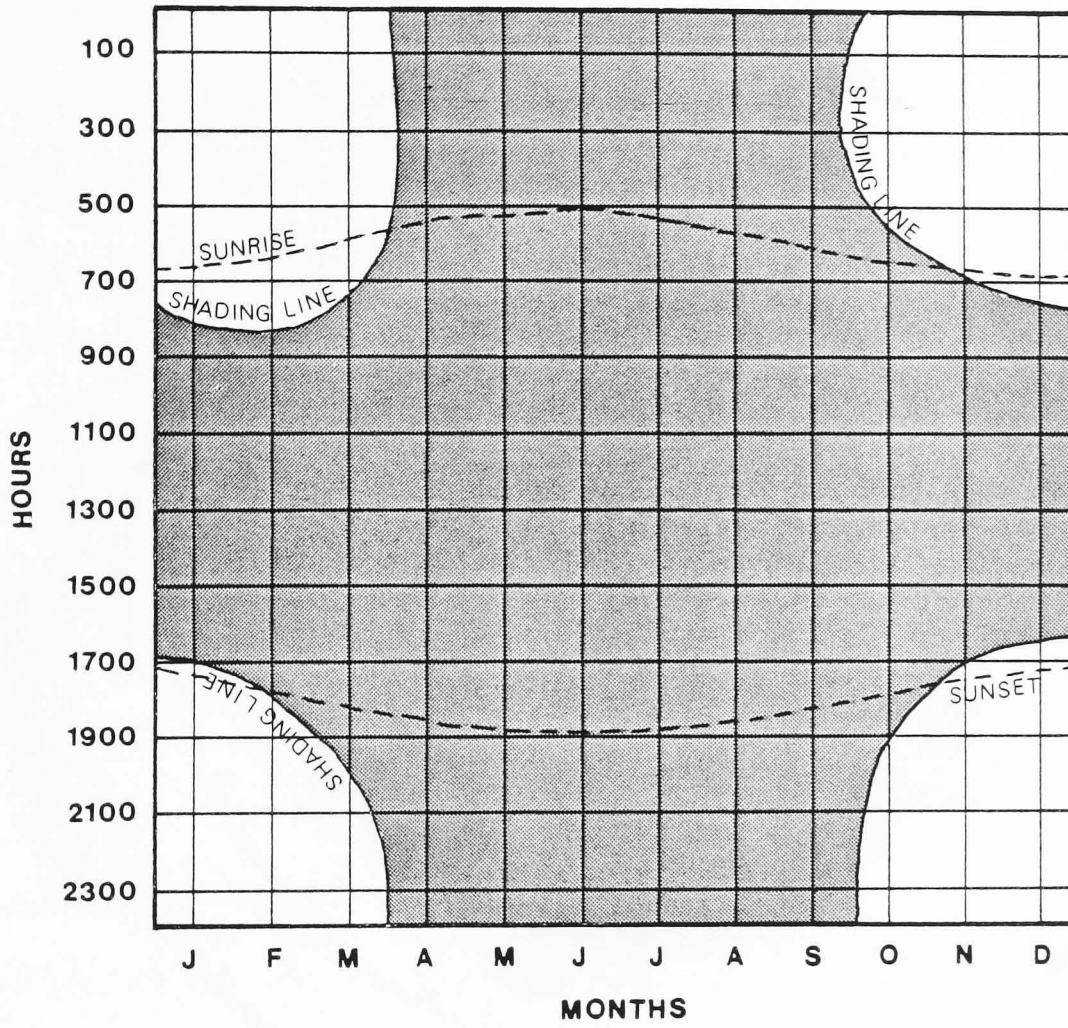


Fig. (3.9) Annual shading period for Jeddah.

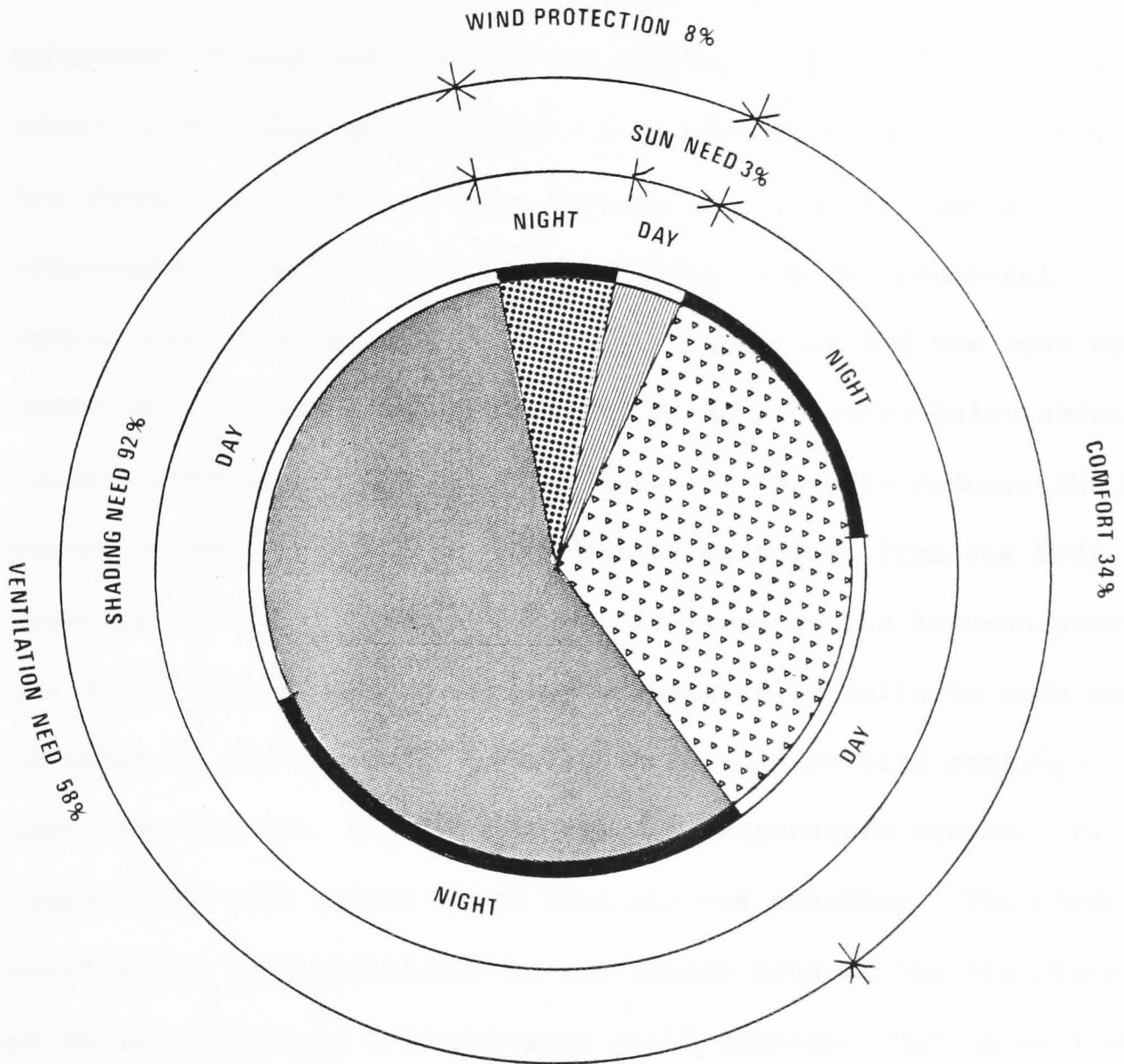


Fig. (3.10) Annual percentage time distribution for Bioclimatic needs for Jeddah.

Under sedentary activity this about 32-33°C. The "comfort" skin temperature is lower with increasing metabolic rate (physical activity).<sup>23</sup>

The main environmental conditions which effect the thermal sensation of heat are the air and radiant temperatures, and air velocity over the body (Appendix A). The effect of air velocity on the thermal sensation of heat depends on the environmental temperatures (for unconditioned building, the environmental temperature combines the indoor air temperature and the mean surface temperature of the surroundings).<sup>24</sup> At temperatures below about 33°C (under sedentary activity) increasing air velocity reduces the heat sensation due to the higher convective heat loss from the body and lowering of the skin temperature. At temperatures between about 33 and 35°C, the convective cooling theoretically falls to zero and no increase in air velocity, however large, can provide cooling. In practice, however, by the time the air temperature reached skin temperature, the person would have started sweating. The evaporation coefficient is proportional to the square root of the air velocity, so an increased air velocity will still increase cooling as long as the evaporative capacity of the air is high enough to evaporate the sweat as it emerges from the skin.

At environmental temperatures above about 35°C the effect of air velocity works in two opposite directions. On one hand, increase in air velocity causes higher convective heat exchange and warms the body, but on the other hand an increase in air velocity increases the evaporative capacity and hence the cooling efficiency.<sup>25</sup>

High relative humidity in combination with high air temperature, results in a feeling of thermal discomfort due to the combined effects of heat sensation and skin wetness. The familiar saying, "It's not the heat, it's the humidity", is not strictly true for the feeling of oppression which one associates with hot humid conditions is dependent fully as much on the high air temperatures as on the high humidity.<sup>26</sup>

At environmental temperatures in the range 20-25°C approximately, the humidity level does not affect the physiological and sensory responses, and variations in relative humidity between 30% and 85% are almost imperceptible. Only when the air is almost saturated are feelings of clamminess and dampness noticeable. At environmental temperatures above 25°C the influence of humidity on the response becomes gradually most apparent, especially the effects on the skin wetness, skin temperature and, at higher temperatures, the sweat rate.<sup>27</sup>

Under such oppressive conditions evaporation of moisture from the skin quickly forms a saturated air envelope around the body. The saturated air envelope prevents any further evaporation from the body and undermines the last means of heat dissipation.<sup>28</sup>

Thus to achieve some degree of thermal comfort the saturated air envelope around the body must be removed. Air flowing across the body can remove the saturated air envelope and accelerate evaporation. The effect of air velocity on the evaporative capacity is interrelated with the effect of humidity, as an increase in air

velocity raises the evaporative capacity and thus may offset the effect of high humidity.<sup>29</sup>

However, there is a minimum value of the air velocity, at which air motion can restore comfort. Reduction of the velocity below this level causes discomfort and heating, by reduced efficiency of sweat evaporation. This value is not constant but depends on the air temperature and humidity. This is illustrated in fig.(3.11) which shows the minimum air flow to restore comfort for a range of dry bulb temperatures and relative humidities with 1.5 m/s as a fixed limit above which the air motion causes annoyance.<sup>30</sup>

Thus, in Jeddah comfort depends not only on the rate of fresh air supply in a room, but even more on the speed at which the air moves across the skin of the occupants thereby promoting cooling by evaporation. However, indoor comfort during the day is largely dependent upon the control of radiant heat gain. High internal surface temperatures should be eliminated as sources of radiant heat gain to occupants. Only then can natural ventilation be relied upon as the main factor in improving the thermal comfort of occupants. This calls for effective shading of the openings, light external colouring and thermal insulation in the building envelope.

From the physiological viewpoint night comfort is more important than that during the day. High temperatures at night can disturb or delay sleep, preventing the rest and recuperation that is so essential in hot climates where a considerable heat stress on the body is experienced during the day.<sup>31</sup> Moist or damp skin is a particular problem at night when temperatures and humidities are

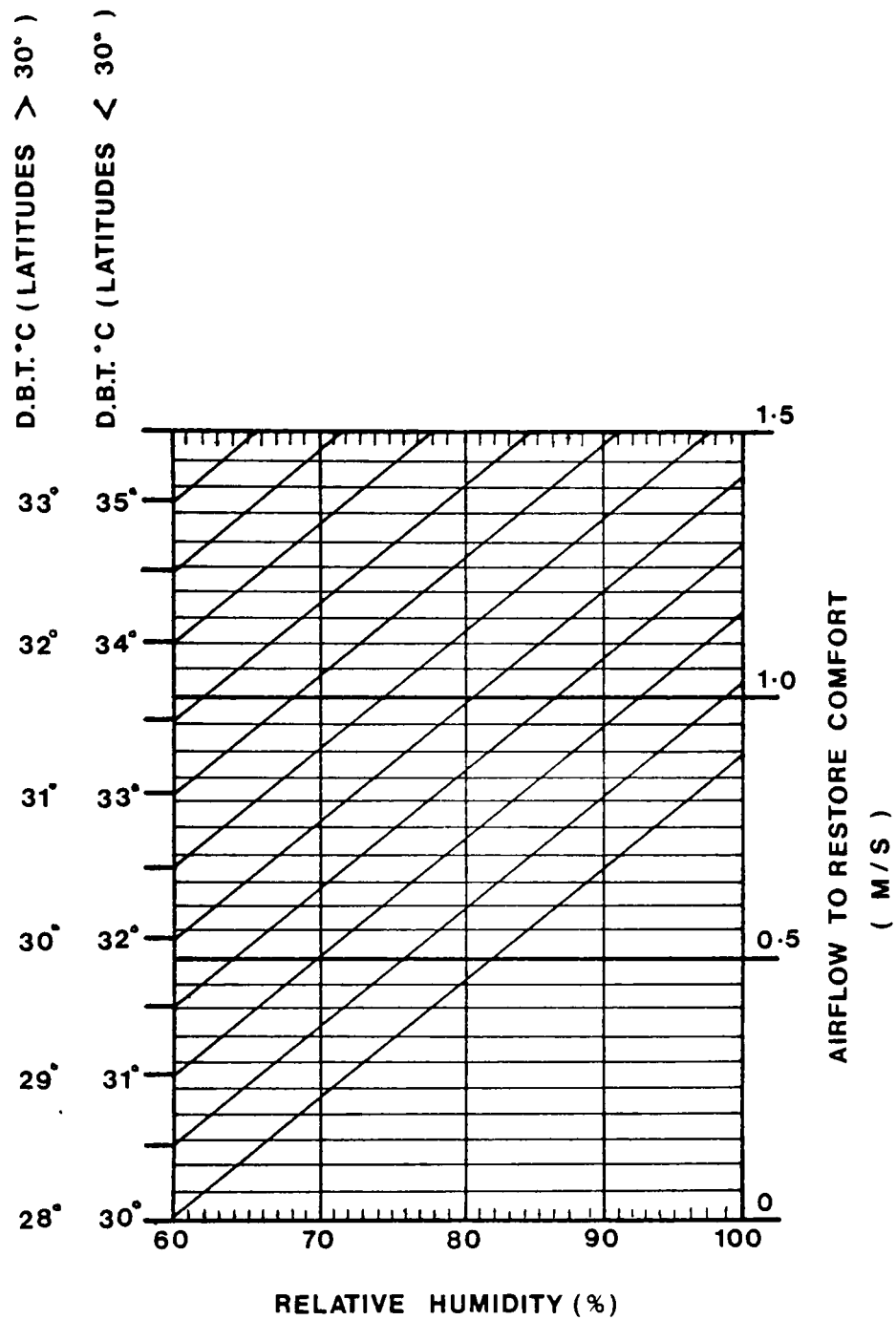


Fig. (3.11) Minimum airflow to restore comfort for a range of dry bulb temperatures and relative humidities.

Source: R. Aynsley, W. Melbourne, B. Vickery, Architectural Aerodynamics, Applied Science Publishers, Ltd, London, 1977, p. 183.

high, since the body is more sensitive to sweat when at rest. The bedding under the body where sweat cannot readily evaporate may become damp, though this problem is reduced by frequent body movement. Sleep then becomes restless and disturbed.

Since summer outdoor air temperatures in Jeddah do not cool down substantially at night and relative humidities are high in late night and early morning hours, comfort can be improved first by ensuring rapid cooling of the interior in the evenings. Indoor temperatures should closely follow even small drops in the outdoor temperature at night. Second, by providing free air movement over the body to increase the evaporation of sweat. This will dry the skin and improve the efficiency of evaporative cooling of sweat as well as increasing heat loss from the skin by convection. With medium to high humidities it will be possible to achieve thermal comfort with temperatures of up to 28-28.5°C and a 1 m/sec wind speed.<sup>32</sup>

The deep understanding of such thermal comfort requirements and the nature of Jeddah's climate is clearly reflected in the urban pattern of the town and the climatic adaptation of the traditional house discussed in the following sections.

### 3.2 URBAN FORM AND MICROCLIMATE MODIFICATION

In the light of the previous sections one can establish the following criteria for consideration in the planning and layout of buildings in Jeddah with respect to the climate.

During the hot period the general objective should be to minimize exposure to direct solar radiation thus avoiding additional heat gain, and to maximize the cooling potential of the N-NW prevailing winds and sea breezes blowing from the west. In other words, the planning should be directed towards optimum ventilation conditions and maximum protection from solar radiation.

With the above criteria in mind we can begin to examine the urban pattern and morphological character of the old town in terms of its climatic response.

### 3.2.1 The Town Layout and Street Orientation

A careful examination of the old town plan, fig.(3.12) shows that the layout of the town clearly corresponded to and respected the contour of the waterfront. The general character of the street system was made up of a few relatively regular main streets radiating out from the shore from which branch secondary smaller streets (alleys) laid out along N-S axis, thus taking full advantages of the prevailing N-NW winds and sea breezes.

Being narrow and flanked by tall houses, these streets channel breezes, reducing the volume in which the air travels, and thus increasing its velocity.<sup>33</sup> This increased air speed tends to create low pressure areas in the upper parts of the side streets with respect to the atmospheric pressure in their lower parts. Thus air is drawn up the side streets by the pressure difference which are proportional to the square of the velocity (fig. 3.13).<sup>34</sup> Furthermore, streets conveying air flows tend to create low pressure

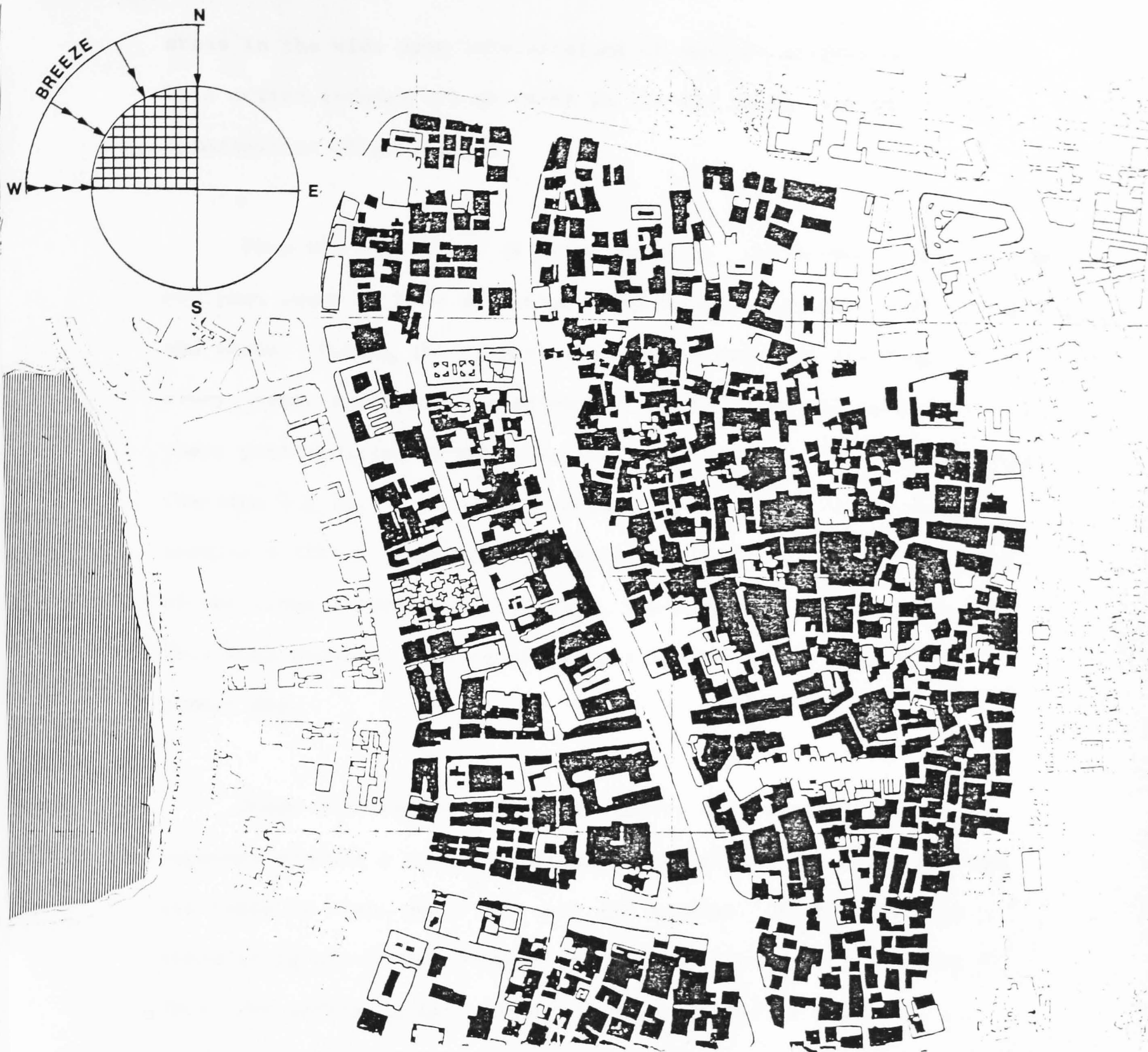


Fig. (3.12) The old town of Jeddah with its traditional urban form and the adjacent new city.

Source: S. Khan, "The influence of Arabian Tradition on The Old City of Jeddah: The Urban Setting", in The Arab City: Its Character Islamic Cultural Heritage, Proceedings of a symposium, Median, Saudi Arabia, 28 Feb - 5 Mar., 1980, Edited by I. Serageldin, and S. El-Sadek, AVDI, Riyadh, 1982, p. 193.

areas in the wide open intersections of smaller streets on the side. This action induces air movement in the air up the streets to the intersection (fig. 3.14).<sup>35</sup>

From the view point of solar exposure, the street system of the old town seems to have advantages regarding street qualities of light and shade. During the summer, shadows are cast all day long into every street running along north-south axis, with the exception of a short period during midday when the solar altitude is nearly overhead (Section 3.1.1). By contrast, streets running east-west usually receive a little shadow between 9:00 a.m. and 3:00 p.m., but because of the close grouping of buildings, the effective street width is very much reduced, leaving the street in the shadow most of the summer day.

These differences in street quality that result from solar exposure produce a natural thermosyphonic effect, in which the hot air tends to rise, while the cool air settles. This assists in circulating air in the streets and around buildings (fig. 3.15).<sup>36</sup> Thus, the entire street network can be regarded as a passive air movement system generated initially by the prevailing breezes blowing from the north, north-west and west directions. This combined with the natural convection system created by temperature difference, forms a definite satisfactory air movement and ventilation system in the streets and in the more inner parts of the town.

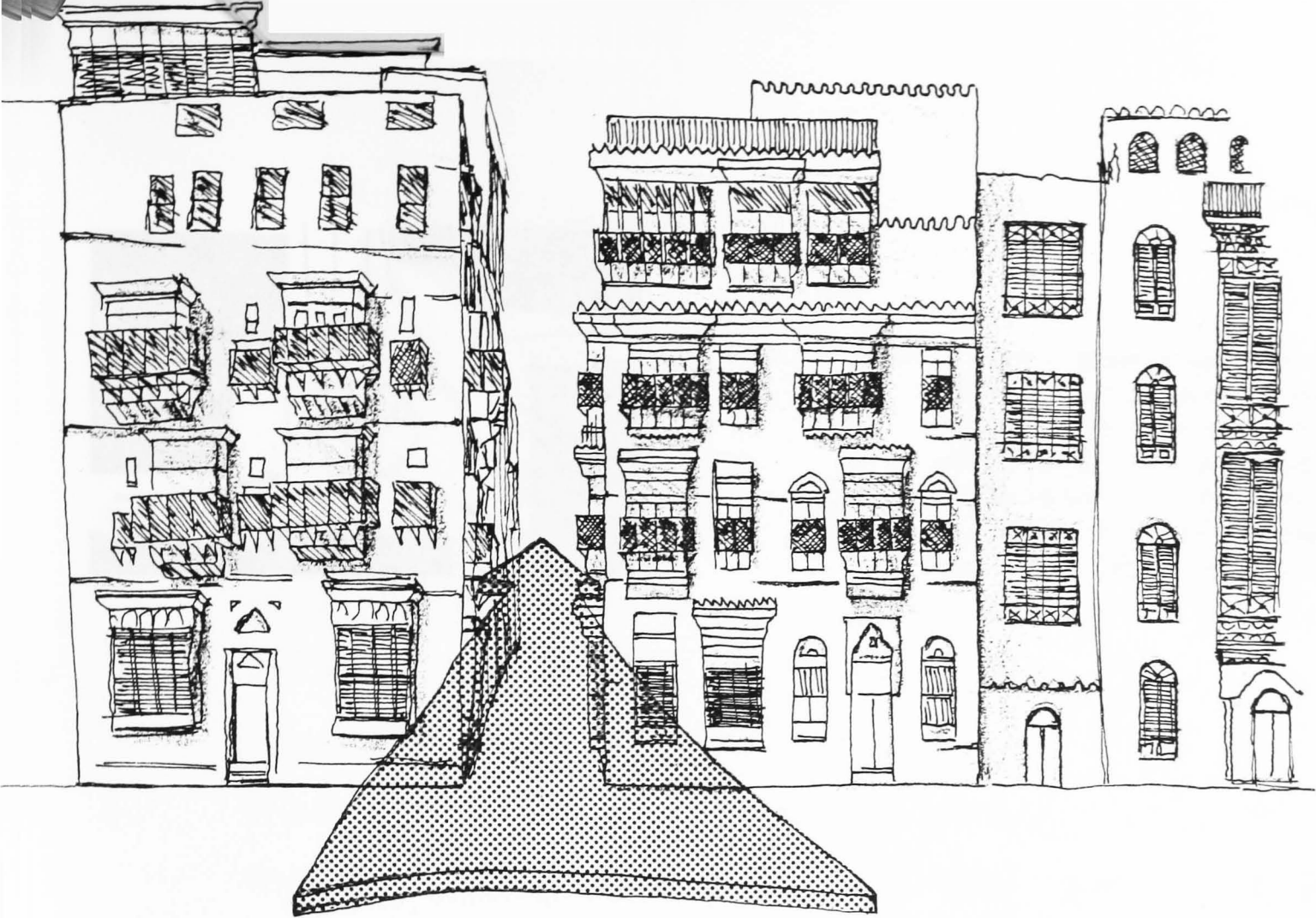
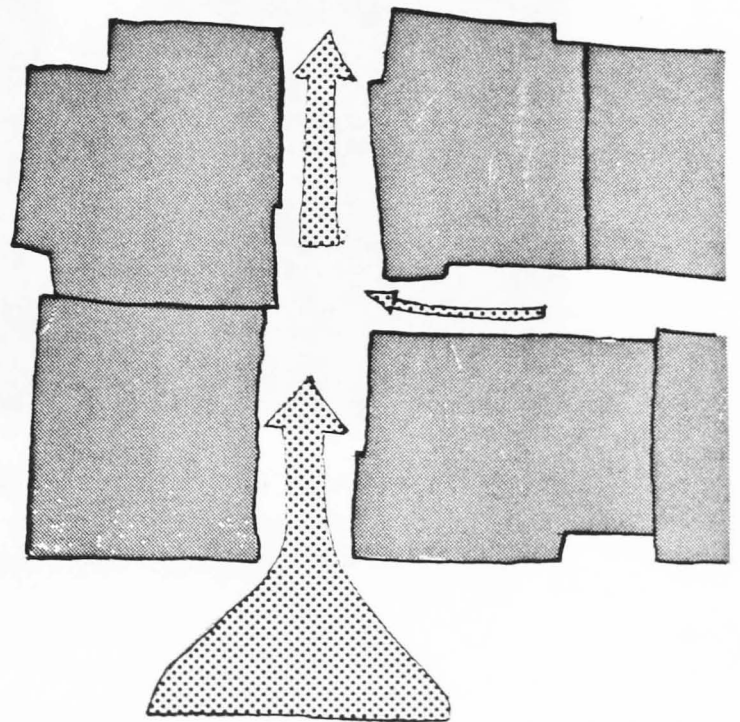


Fig. (3.13) The channelling effects of the street 'gorge'. Air is drawn up the side streets by pressure differences.



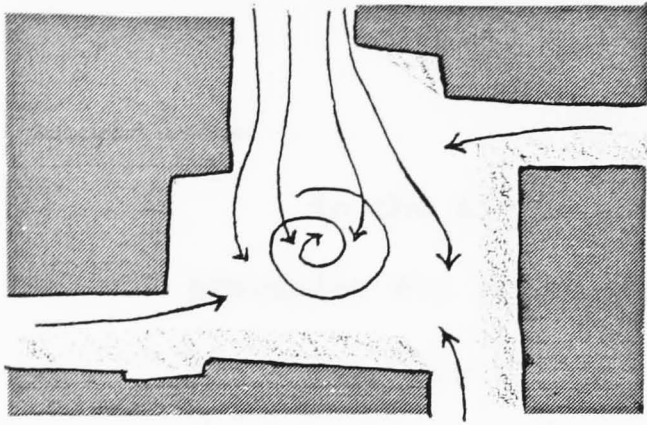


Fig. (3.14) Streets conveying air flows often release into open spaces which in turn reduce the air speed and create moderate turbulence, thereby dragging air from the side streets and from gaps between houses.

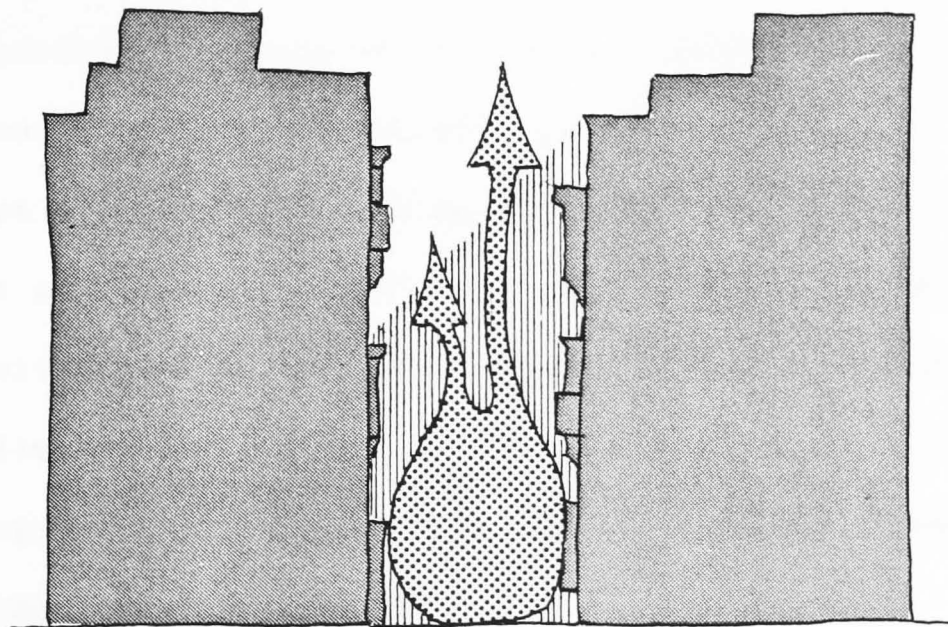


Fig. (3.15) The differences in street quality that result from solar exposure produce thermosyphonic effect.

### 3.2.2 Grouping of Buildings in Relation to Wind and Solar Exposure

In the old town of Jeddah protection from excessive heat and provision for air movement dictated the urban pattern. Houses were grouped in blocks or terraces of three and more, thus forming a relatively dense development of tall buildings with narrow streets and alleyways (fig. 3.16). Sometimes the houses formed a haphazard conjunction, back-to-back or side-to-back, but the majority of the houses, were detached or semi-detached buildings occupying all or most of a site to themselves. Building blocks seem to tend towards a certain amount of scattering, so as not to obstruct incident prevailing breezes and increase the potential for natural ventilation (fig. 3.17). Regarding heat gain protection the limited angle formed by street width to building height proportions (ranges from 1:4 through 1:9) stops the sun from striking the facades of houses in summer except for a little while each day. This reduces the heat that might otherwise be gained by direct solar radiation. On the other hand, the limited angle minimizes the amount of direct solar radiation striking the ground between the houses, and thus shades the streets and shields them from glare.<sup>37</sup>

### 3.2.3 The Effect of Urban Surfaces

An interesting feature of the old town fabric was texture (fig. 3.18). The buildings were of unequal heights with set backs on the upper floor levels and high parapet walls creating an uneven skyline and shading each other in the process. Air breezes flowing over this irregular upper surface tend to create turbulence at this height,

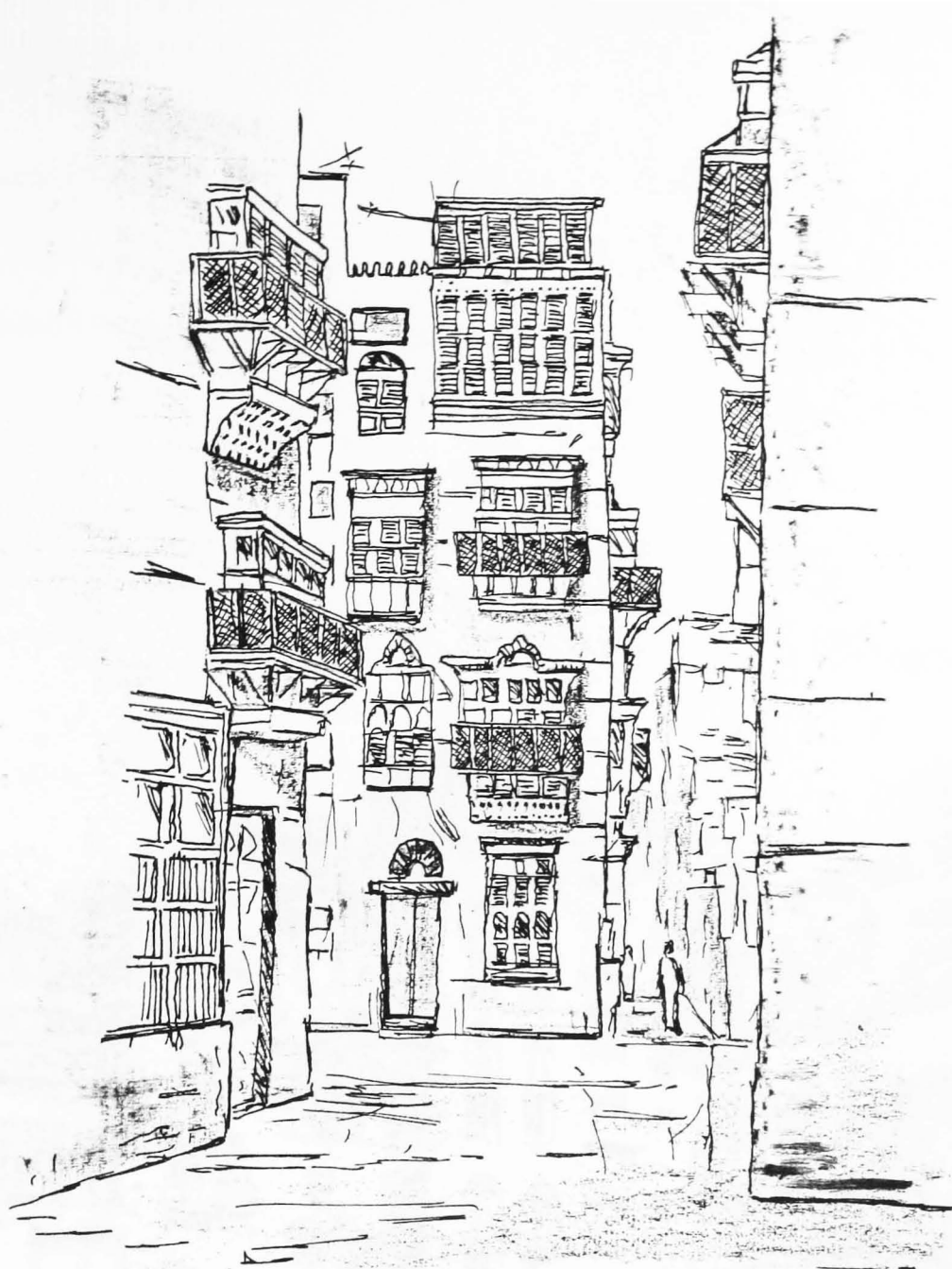


Fig. (3.16) Narrow streets hemmed in by four to six-storey houses.

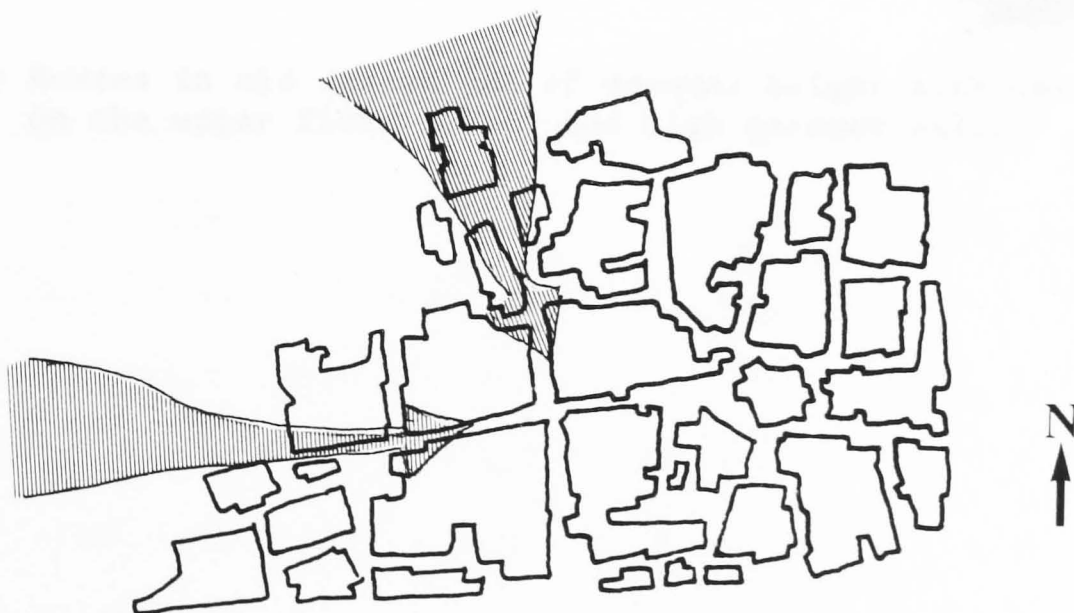


Fig. (3.17) Traditional housing pattern - loose clusters-in hot humid Jeddah.

Source: K. Talib, Shelter in Saudi Arabia, Academy Editions, London, 1984, p. 8.



Fig. (3.18) Houses in old Jeddah are of unequal height with set backs on the upper floor levels and high parapet walls.

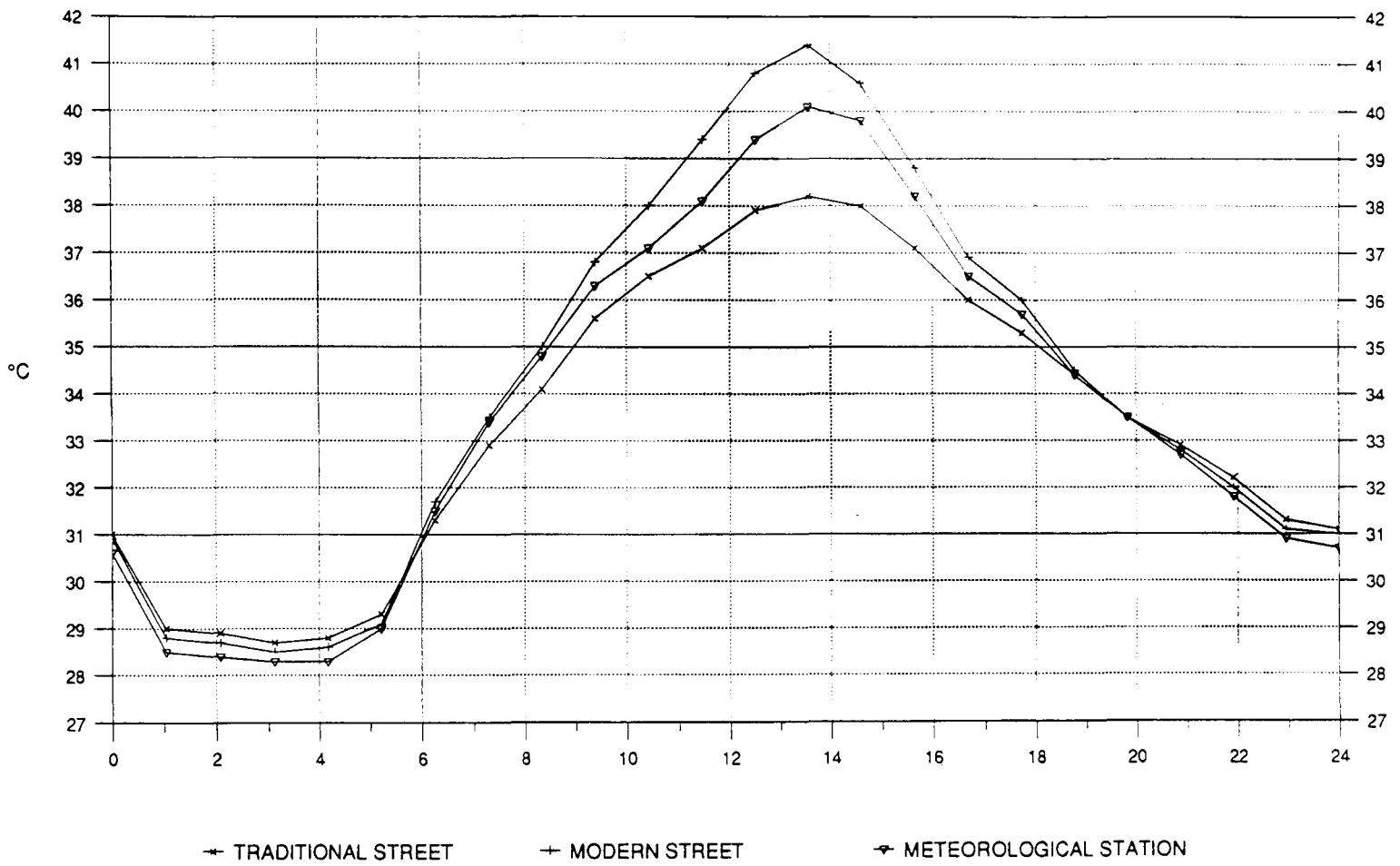
thereby stirring up the mass of hot air in amongst the houses.<sup>38</sup> In addition, the building facades were not straight, but were staggered with projecting rawashīn to provide shade differential and to receive the cool breezes flowing in the narrow alleys (see fig. 3.16).<sup>39</sup>

#### 3.2.4 Comparative Evaluation of Microclimate in a Traditional and a Modern Street Using Measured Air Temperatures

The effect of the traditional urban layout on microclimate can be seen from fig.(3.19) which shows the air temperatures recorded by the author in 18th of July, 1987 at a narrow alley within the old town and at a modern street just outside the town (fig. 3.20), compared with the simultaneous readings at the airport meteorological station. It can be seen that the maximum air temperature within the narrow alley was 1.8 to 2.0°C lower than that recorded at the meteorological station, while at night the minimum air temperature was slightly higher than that at the airport.

The modern street was appreciably warmer than the traditional alley. The difference in maximum air temperature can be as high as 3.2°C. This can be attributed to two main factors. The first is the greatly increased absorption of solar radiation in the modern street. This is caused by the fast absorption of heat by dark-coloured bricks, marble and asphalt, which constitute the major part of the surface in the modern street. In addition, the wide angle formed by the proportion of the street width to building height mean that the

### TEMPERATURE (DEG C) v HOUR OF DAY



Curve Description	AV.	Min.	Max.
1. Met. Station	34.2	28.2	40.1
2. Traditional St.	33.5	28.7	38.2
3. Modern Street	35.5	28.5	41.4

Fig. (3.19) Hourly air temperature variations at Jeddah's traditional street, modern street and the Meteorological station measured on 18/7/1987.

int Two  
dern St.



Fig. (3.20) A plan shows the locations of the thermohygrographs in a typical traditional street running north-south and a modern street just outside the old town.

total surface area on which the sun shines in the modern street is at least three times that in the traditional alley, so that there is a greater absorption of solar energy in the modern street.

The second factor which explains the higher temperatures in the modern street is the heat generated by cars and engines which lead to strong heating of the lowest layers of the atmosphere, directly above the ground, where all measurements were taken (the standard height of the thermohygrographs is about 1.5m above the ground).

At night the narrow alley was cooler than the modern street by about 0.8°C during the first hours of the night. After midnight the temperatures at the narrow alley were very similar to those recorded in the modern street because of the weak land breezes, which slowly aid the release of the heat stored in buildings during the day. The minimum temperatures of both the narrow alley and modern street were reached around 3:00 a.m. and were slightly higher than the corresponding minimum air temperature recorded at the airport meteorological station. The cooling process at the airport is relatively fast because of radiation losses.

To sum up, it can be stated that climatic considerations had played an important part in shaping the urban fabric of the old town and morphological character. The town layout is totally in harmony with the direction of the prevailing breezes, and while the major street-network is oriented for best air flows (N.,W.), sufficient differences in pressure are created to encourage the movement of air through all alleyways, regardless of orientation. The entire urban mosaic of light and shade, warm and cool surfaces, heated and cooled

spaces, produces countless local air flows and currents that help to ameliorate the micro-climate in the streets and between houses. The close grouping of buildings and high structures all contribute to limiting the solar access to streets and building facades.

### 3.3 THE CLIMATIC RESPONSE OF THE TRADITIONAL HOUSE

Not only the town but also the house had evolved along climatic lines. This is clearly reflected in its form, orientation and internal layout.

#### 3.3.1 Form of the House

##### 3.3.1.1 Shape

The significance of the traditional house shape can be easily seen by making a simple analysis of the surface to volume ratio. Fig.(3.21) reveals an interesting correlation between the distribution of family activities and the vertical differentiation of surface to volume ratio. The lower floors of the house were used for the daytime activities. They contain the most volume and expose the least surface area relative to that volume. This results in a reduced susceptibility of the inside spaces of these floors to environmental stress, irrespective of construction type (heavy or light).<sup>40</sup>

On the other hand, the uppermost floor was used for nocturnal activities and sleeping during the summer. It contained the least volume and exposed relatively the most surface (two to four times

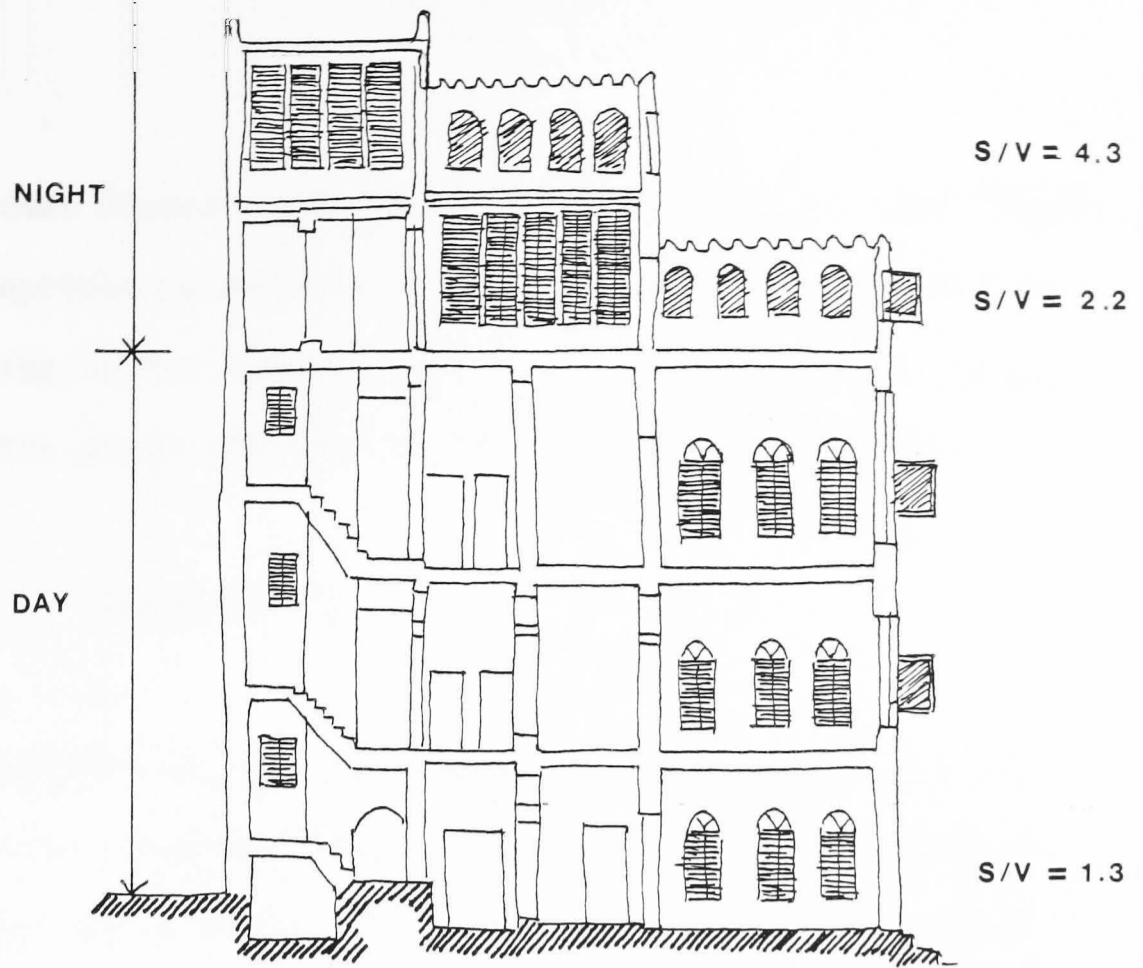


Fig. (3.21) The correlation between the distribution of family activities and the vertical differentiation of S/V.

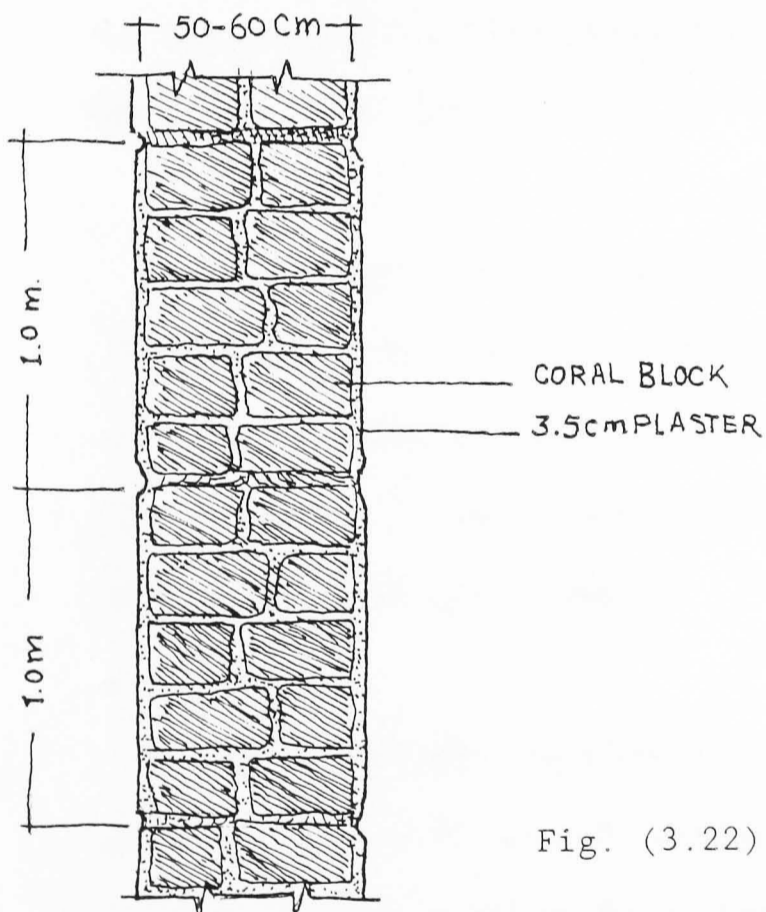


Fig. (3.22) A typical section in the load-bearing external wall of the traditional houses (scale 1:20).

that of the lower floors). Inside thermal conditions at this level are more susceptible to external variation than at the lower floors, but for sleeping in the summer nights this may be important as well as being off the ground and having more openings to fresh air.<sup>41</sup>

#### 3.3.1.2 Structure

The properties and disposition of materials comprising the traditional house structure were used harmoniously by the master builder against the climate. The 50 cm. thick coral stone walls (fig. 3.22) built in the lower floors offer a considerable resistance to the passage of heat due to the low thermal conductivity of the material ( $0.35 \text{ W/M}^\circ\text{K}$ ).<sup>42</sup>

In addition to its good insulating qualities, the substantial thickness of the construction gives capacity to absorb heat and delay its passage towards the interior so that when the heat does penetrate, it is much attenuated in amplitude (decrement factor) and delayed in time (time lag).

Barkat Ullah<sup>43</sup> conducted a study on the thermal control characteristics of a fifty centimetres thick coral stone wall. In this study Barkat Ullah found that the mass causes a time lag of about 24 hours. He also found that decrement factor for this particular wall is small (0.13). As a result of these experiments, Barkat Ullah came to the conclusion that the thermal storage of the mass is so high that there is not any appreciable transmission of a periodic wave from the outside to the inside of the wall. At this point, the excellent insulation property of the coral stone comes

into play to reduce the flow of heat to the inside thus ensuring that the inside surface temperatures would not be greatly increased.

The heavy roof construction (fig. 3.23) possesses high heat insulating qualities and heavy thermal mass to ensure the least intake of solar heat and the least heat flux entering the living spaces beneath. Earth is a good insulator of heat,<sup>44</sup> so placing a 7 cm layer of pressed dry earth below the top layer of pulverized pebbles considerably reduces the amount of heat penetrating to the limestone layer during the day. The reduced amount which penetrates is absorbed in the sizeable mass of limestone and the resulting elevation in ceiling temperature is small.<sup>45</sup>

A classic architectural response to climate is al-mabîṭ built on the uppermost floor (fig. 3.24). This room was invariably constructed of panelled woodwork with movable louvres, and a light roof, in contrast with the massive lower floors. The latter would stay cool during the daytime in the summer but would tend to warm up in the late night. Al-mabîṭ, on the other hand, would be warm during the daytime but would cool down quickly at night, when it could be used for sleeping.

The white lime wash of the walls and the roof constitutes a very effective defence against radiation impacts. It reflects 80% or more of solar radiation received on the surface thus contributing significantly to the reduction of heat transmission through the walls and roof structure during the day.<sup>46</sup> On the other hand, the rate of heat loss by thermal radiation increases due to the emissivity of the whitewashed surfaces for long-wave radiation.<sup>47</sup> It should be

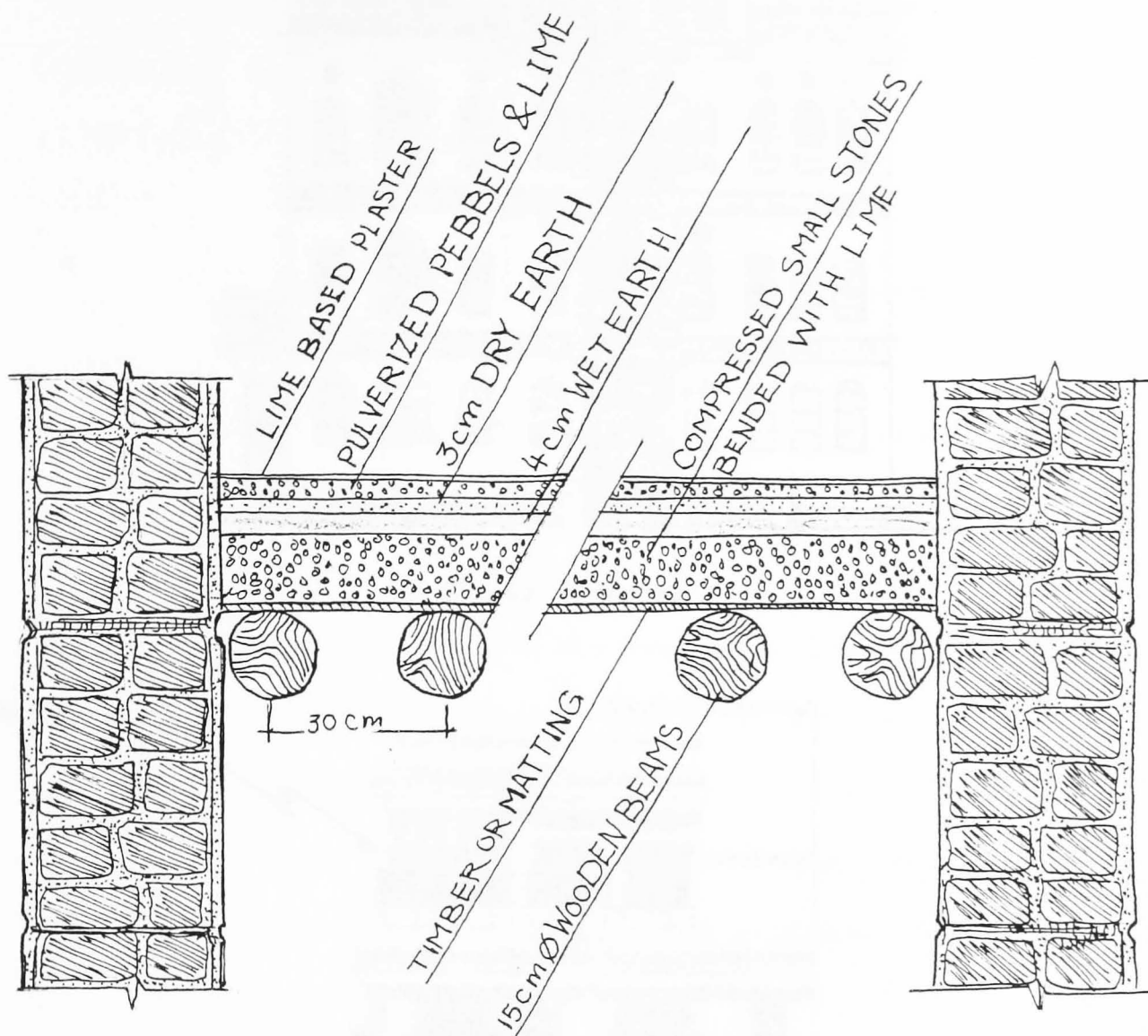
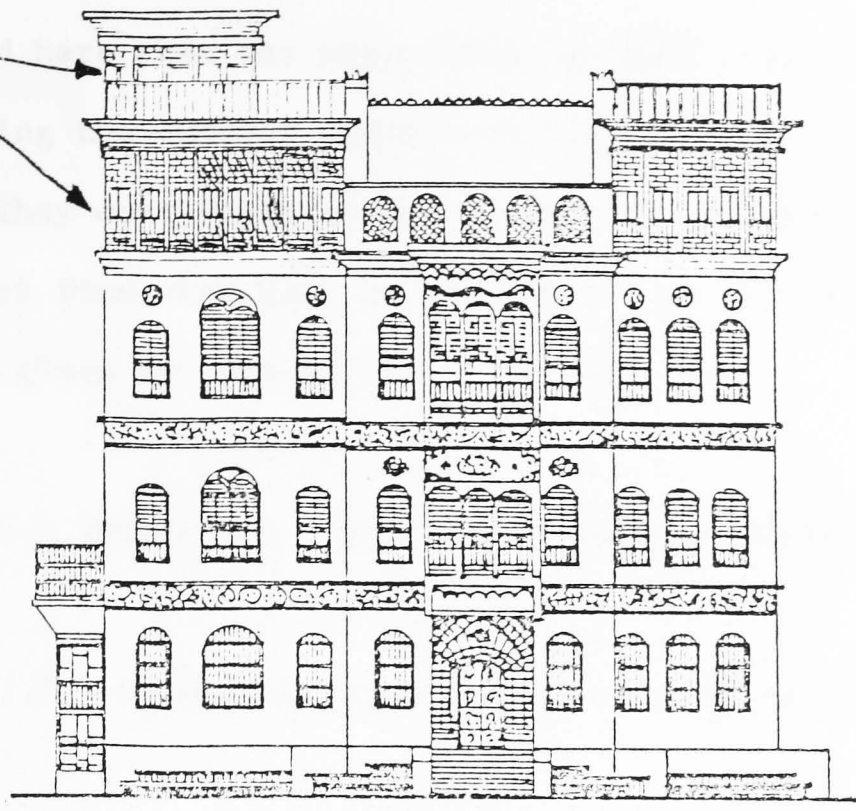


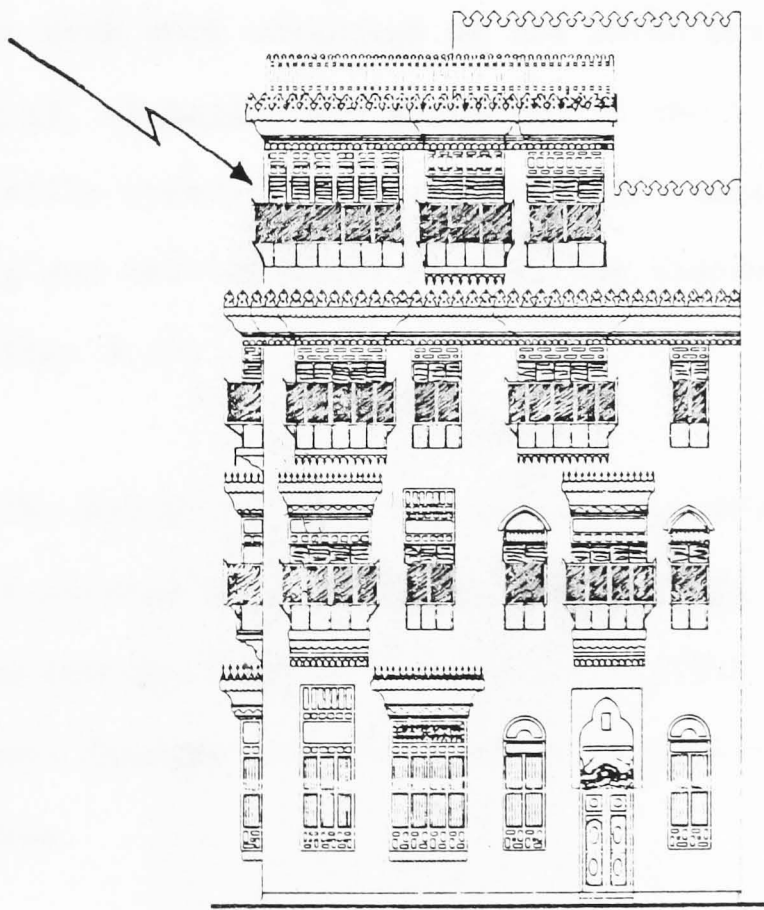
Fig. (3.23) Typical section, showing roof and ceiling construction in the traditional houses of Jeddah (scale 1:20).

Al-mabīṭ



Naṣṣeif House

Al-mabīṭ



Al-shāfiay House

Fig. (3.24) Al-Mabīṭ built on the terraces of the uppermost floor of the traditional house.

mentioned here that the projecting rawāshīn play an important role in reducing the outdoor glare resulting from the white colour of the walls. They cast shade on the section of the wall below them and also block from view part of the sunlit section above them thus reducing glare for pedestrians (see fig. 3.16).

### 3.3.2 Indoor Air Flow Patterns and Ventilation System

#### 3.3.2.1 Wind Orientation and Floor Plan Arrangement

A simple response to local climate and prevailing breezes was the governing factor in the allocation of living-rooms. The master builder took much advantage of the north and sea breezes by locating al-maq'ad, al-majlis and al-ṣuffah in the north and west parts of the house while reserving the southern and eastern parts for only al-muákhir and service areas such as the stairway, latrines, storages, etc. (fig. 3.25).

The north and west facades are therefore the main exposed facades pierced by many tāqaat and rawāshīn in order to allow maximum through flow of breezes (fig. 3.26). In contrast, the east and south facades have few windows, and only light or ventilation apertures.

Cross-ventilation is facilitated by the proper arrangement of rawāshīn and tāqaat. Most living-rooms have at least one rawshān or tāqah in each of the two outside walls. A slight pressure difference between inlets and outlets provide a good source for continuous circulation of air in the space<sup>48</sup> (fig. 3.27). The provision of

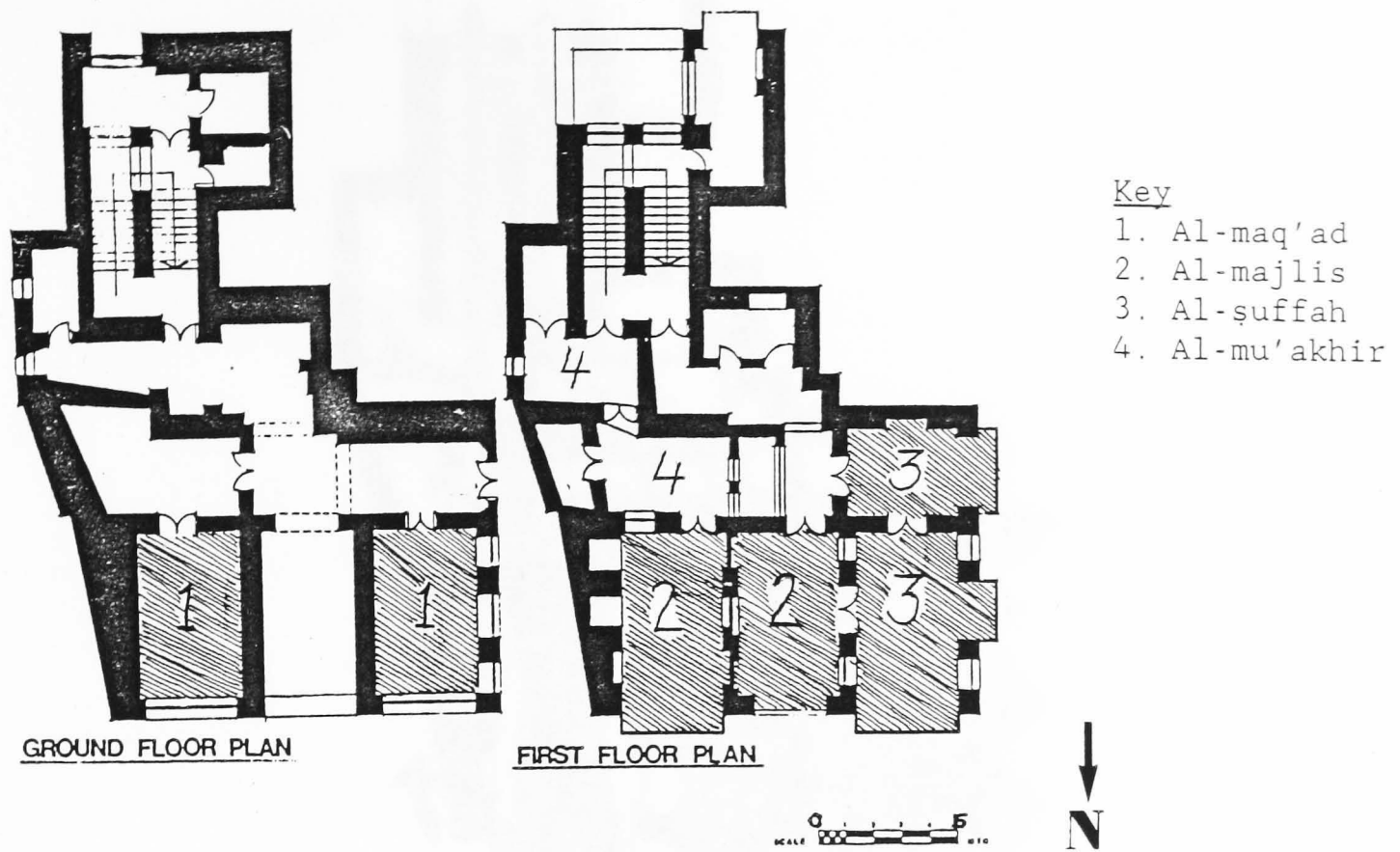


Fig. (3.25) The main living quarters are located in the northern and western parts of the house to benefit from the prevailing breezes.

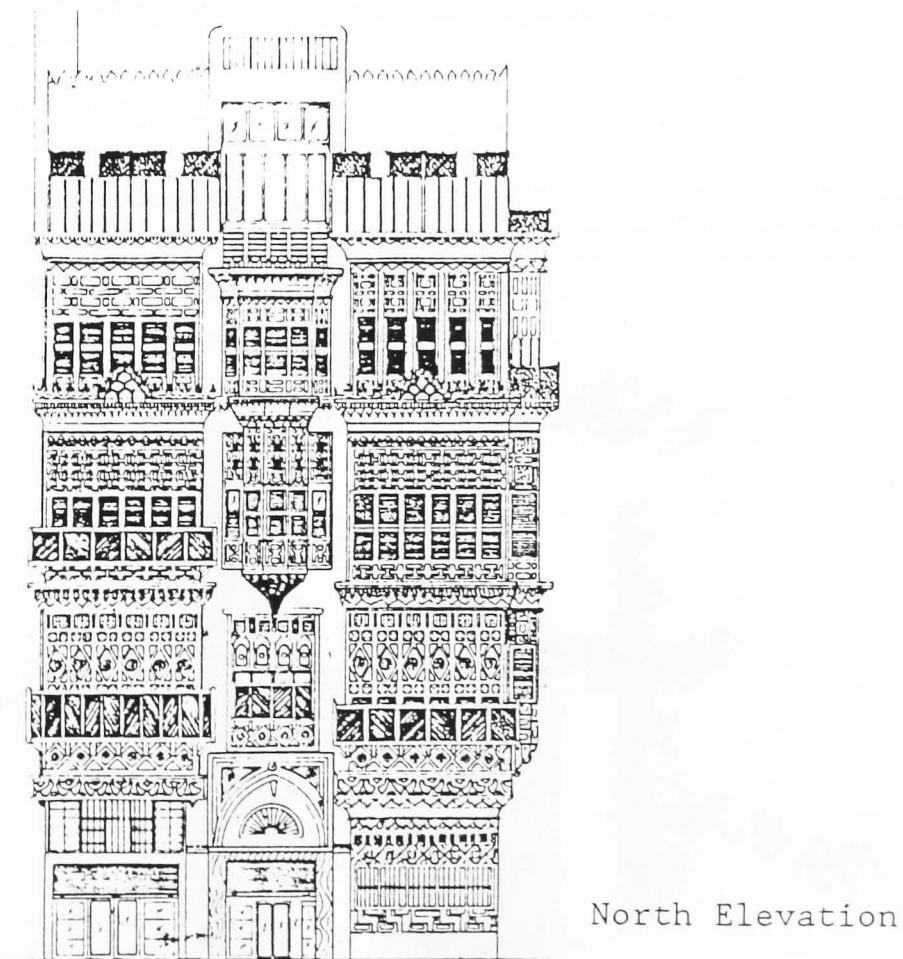


Fig. (3.26) The north and west facades are pierced by many tāqaat and large rawāshīn.

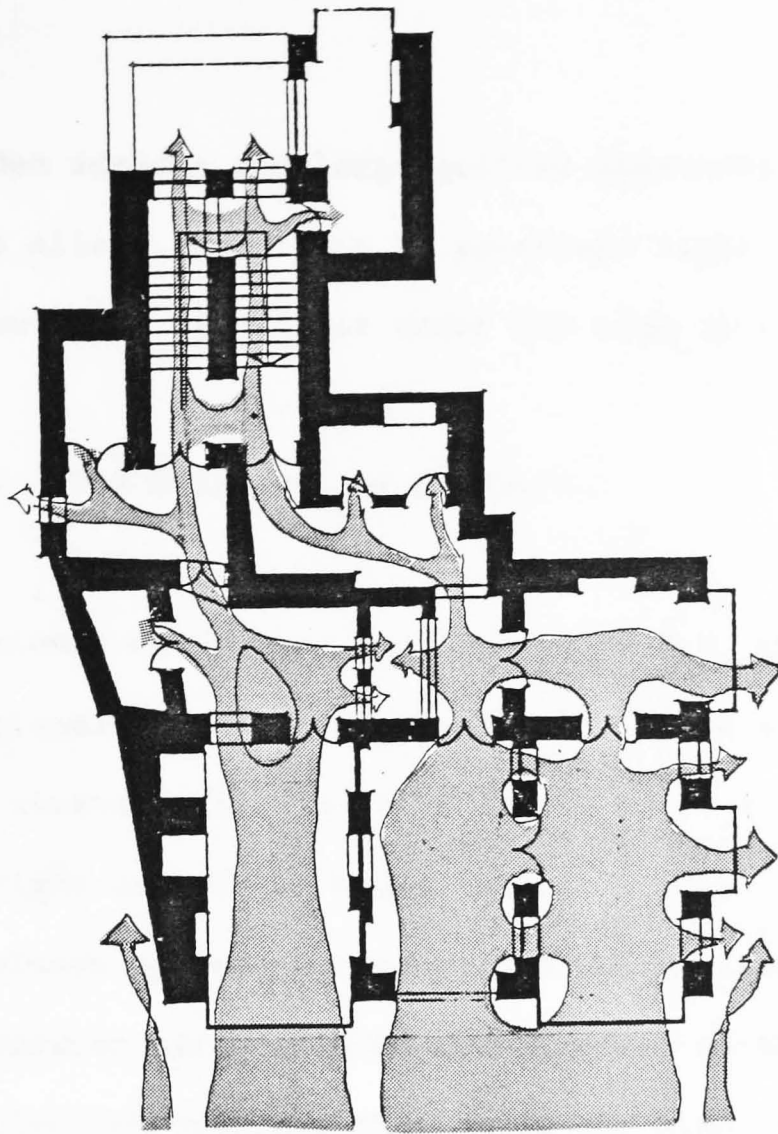
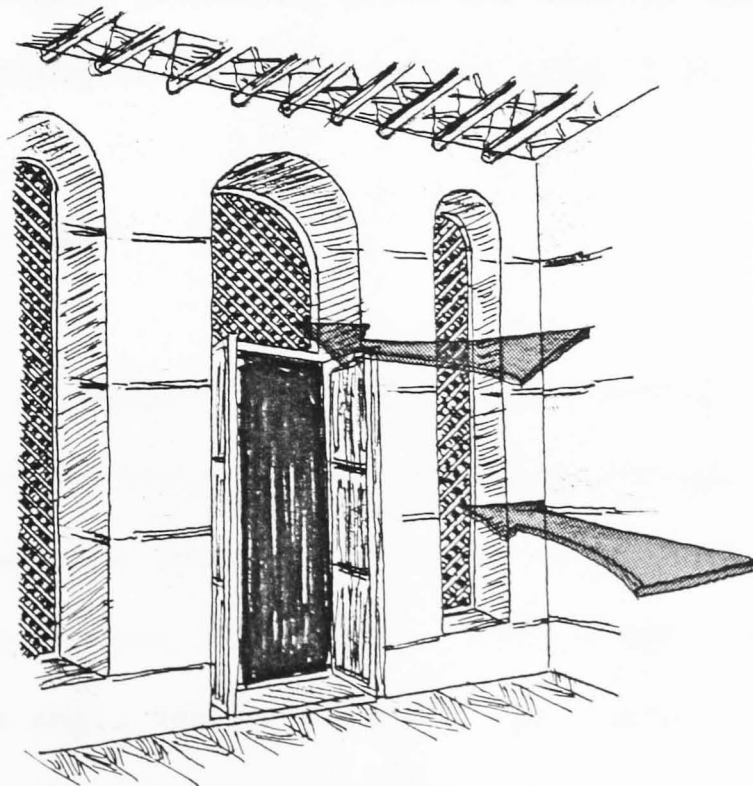


Fig. (3.27) The internal plan of the house allows easy passage of air and good cross ventilation.

Fig. (3.28) The internal wooden screens and ventilating grills allow the air to penetrate right into the centre of the house.



internal wooden screens and large grilled apertures above internal doorways also allows the breeze to penetrate right into the house and prevent the build up of hot air under the high ceiling (fig.3.28).

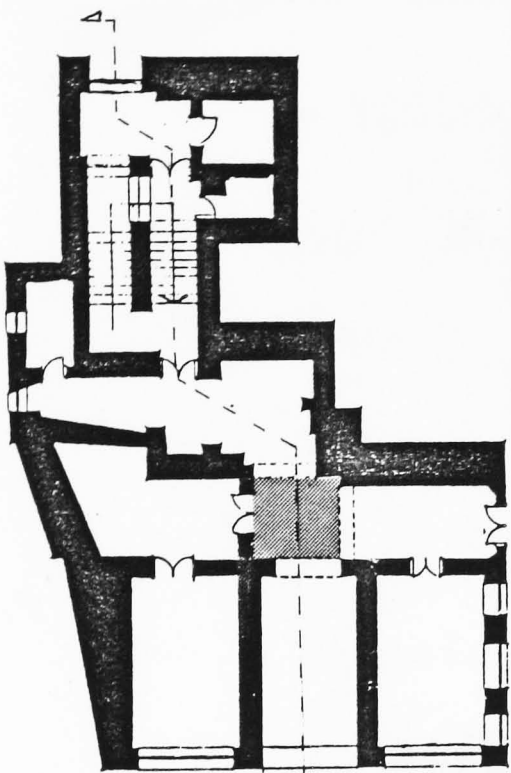
### 3.3.2.2 The Stairwell or Airshaft

As mentioned in Chapter Two, Section 2.2.1, the living quarters of the traditional house were usually distributed around a vertical stairwell or airshaft (fig. 3.29). This acts as a chimney conducting the hot air right out of the house (stack effect). The mouth of the airshaft is always opened to the sky and has no openable flaps to control the flow of air in the shaft. The top of the stairwell, however, has louvred openings that allow the wind to flow through (fig. 3.30).

Air flowing over the mouth of the airshaft or through the top of the stairwell creates a low-pressure area which tends to pull air into the house from higher pressures below and through the airshaft or stairwell, thus adding to the stack effect (fig. 3.31).<sup>49</sup>

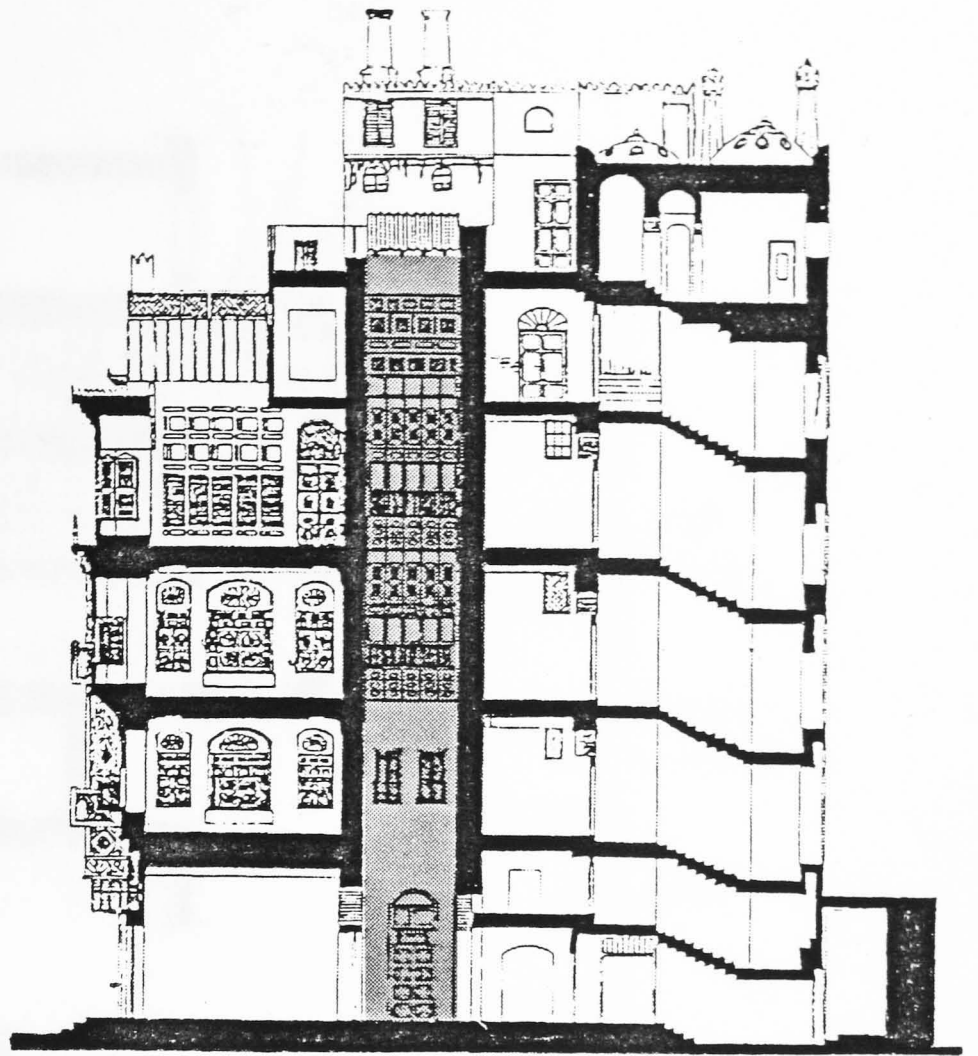
### 3.3.2.3 The Rawshān

The rawshān as an integral part of the ventilating system played the key role in directly cooling occupants through evaporation. It allows the incoming breeze to flow across the entire rawshān's seat on three sides (fig. 3.32). The wooden louvres are fully operable so the angle can be changed. This feature of adjustability renders the rawshān very effective in regulating the airflow at body level.



GROUND FLOOR PLAN

SCALE 0 1 2 3 4 5 METERS



SCALE 0 1 2 3 4 5 METERS

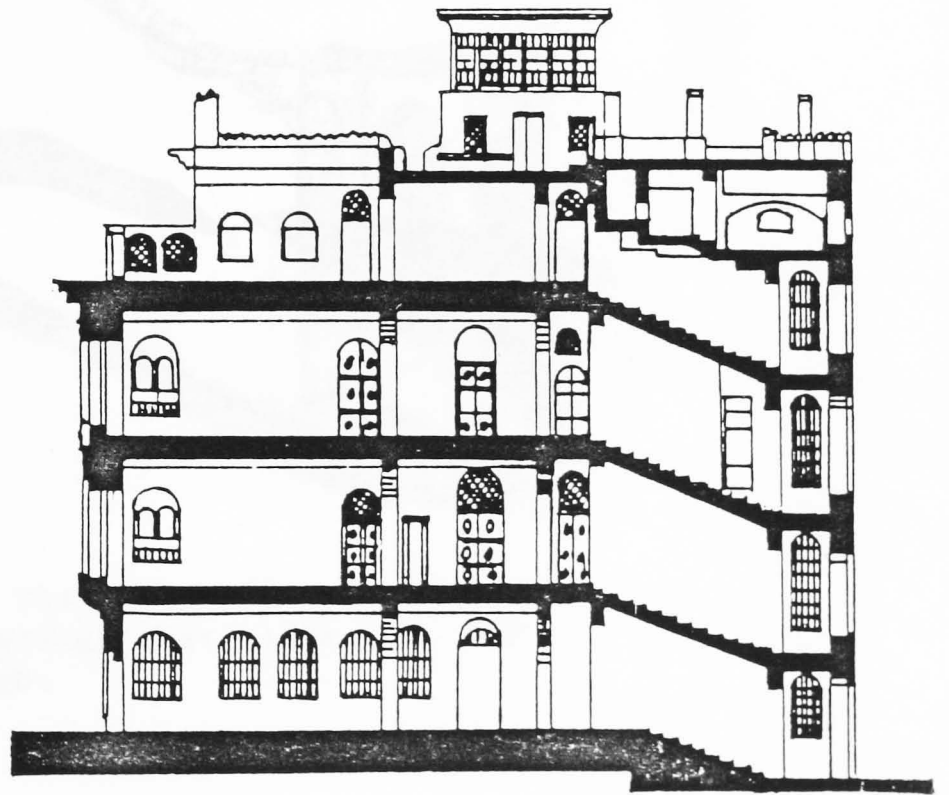
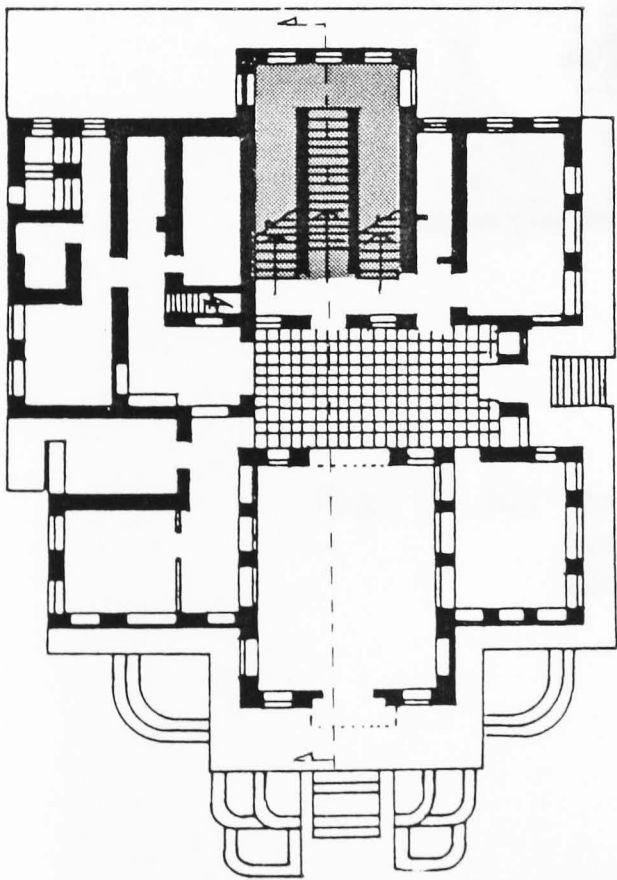


Fig. (3.29) The living quarters are usually distributed around a vertical stairwell or airshaft.

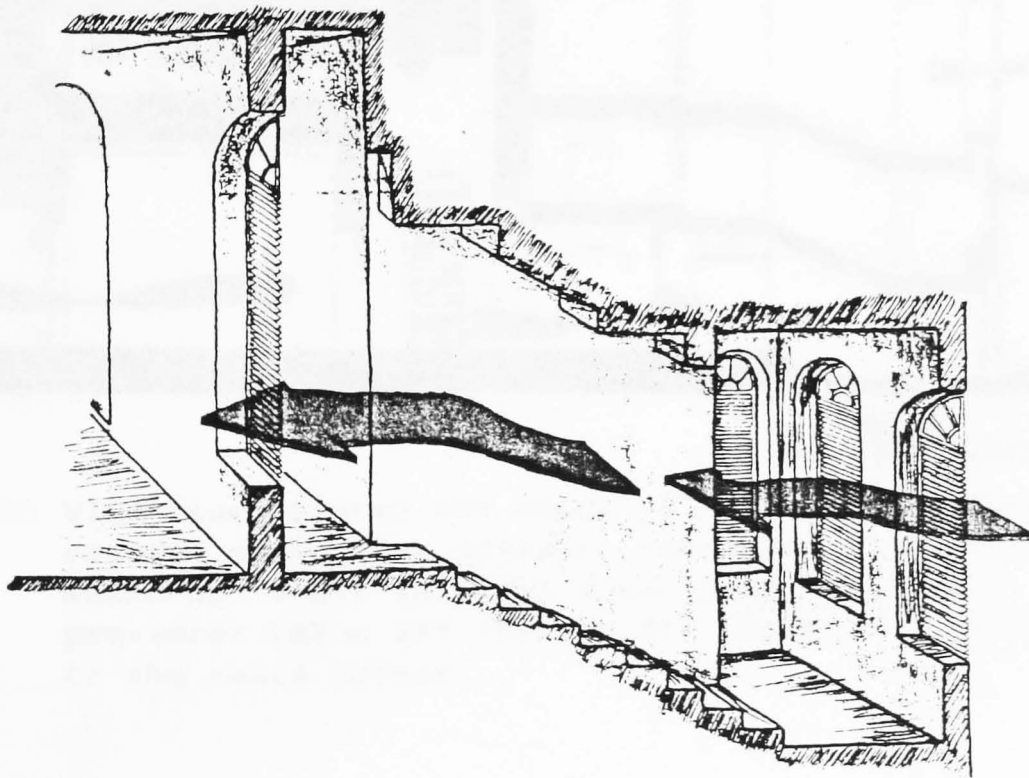
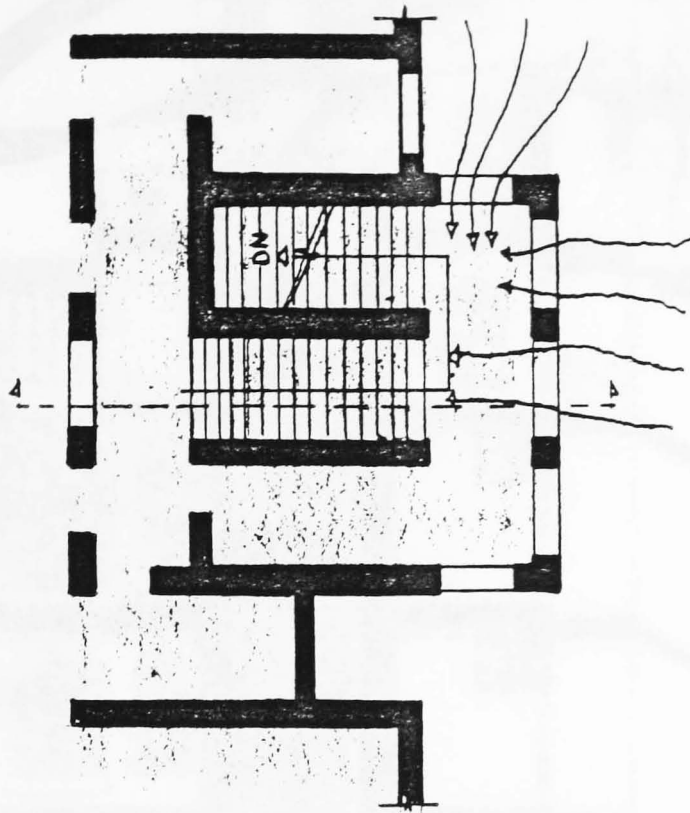


Fig. (3.30) The top of the stairwell usually has louvred openings that allow the wind to flow through.

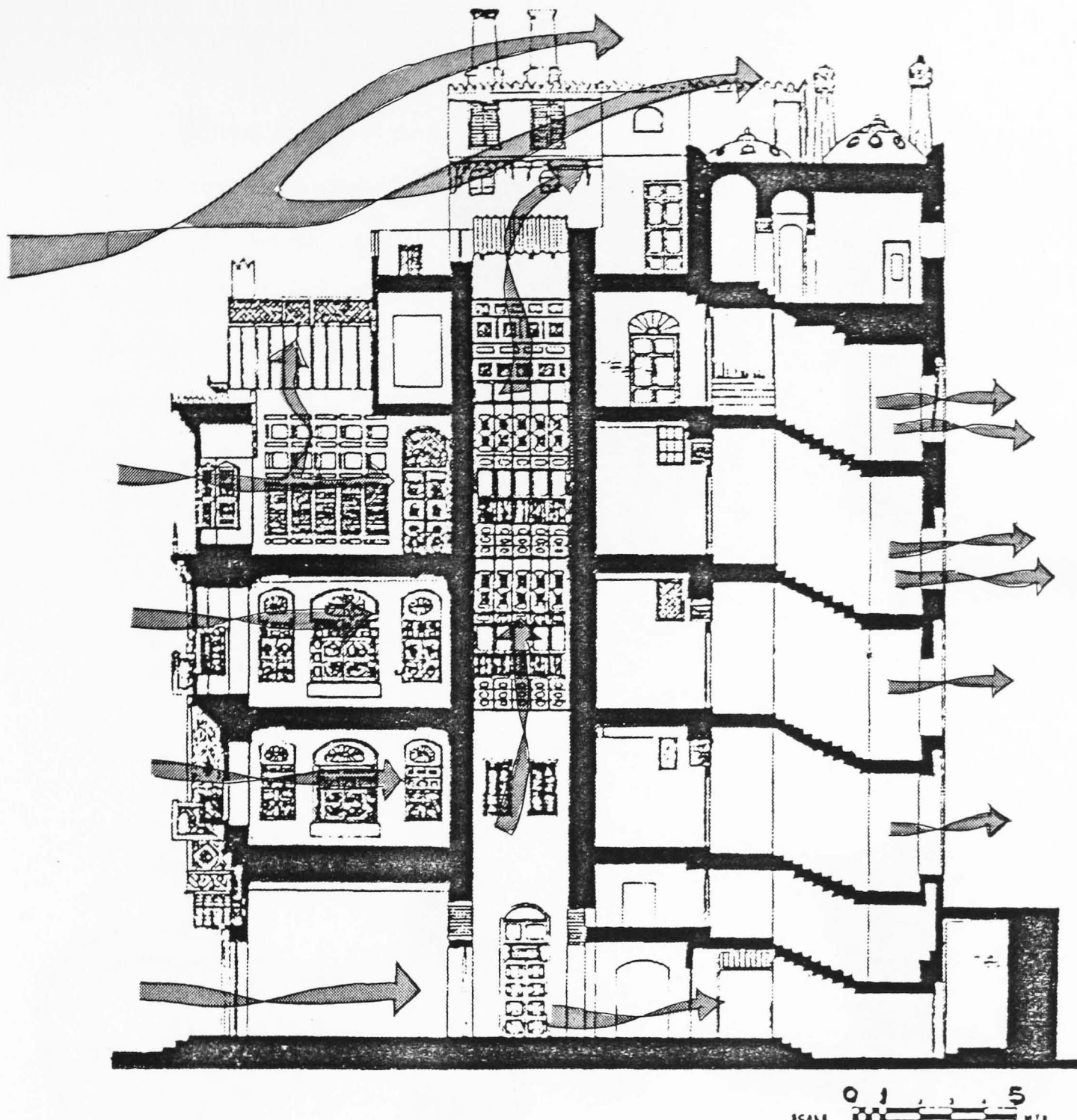


Fig. (3.31) Wind flowing over the mouth of the shaft always creates a negative pressure (suction) on the top which pulls air into the house from positive pressures below and through the shaft thus adding to the stack effect.

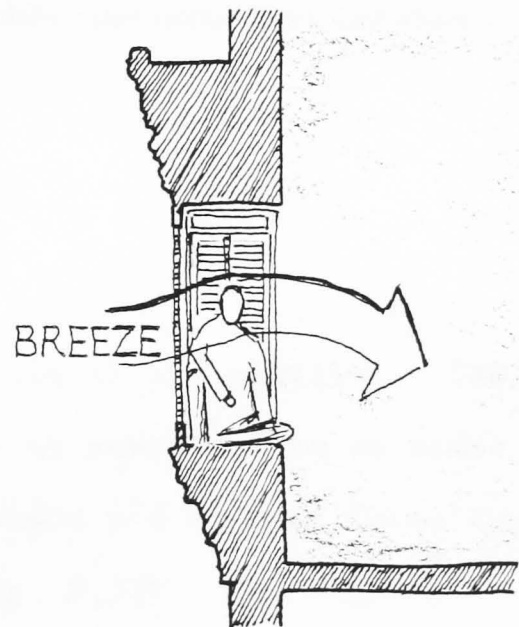
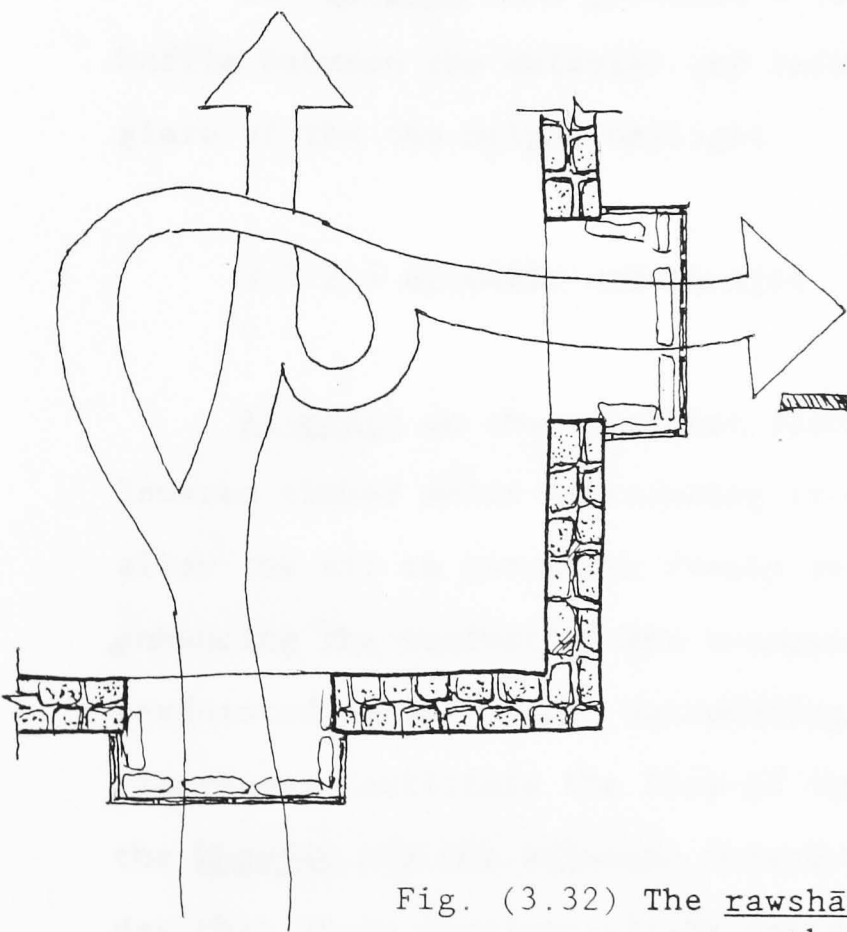
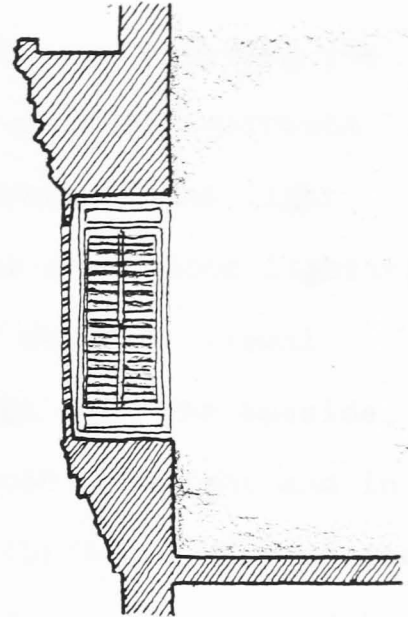
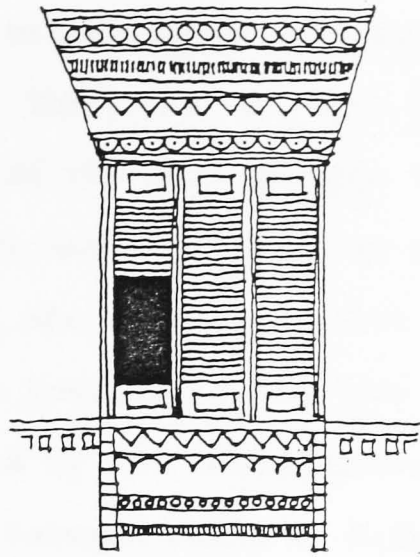


Fig. (3.32) The rawshān allows the incoming breeze to flow across the entire rawshān's seat while preventing the direct sunlight from entering the space.



Glare is also controlled by the closely set wooden louvres which break up large bright areas into tiny ones, yet allowing the interiors to be lit. There are no sharp edges or harsh contrasts between the darkness of the wall and the brightness of the light, therefore the eyes are not dazzled.<sup>50</sup> As well as the indoor lighting and visual qualities, the occupants would be in complete visual privacy, because when looking towards the rawshān from the outside, the solid areas formed by the wooden louvres would be bright and in contrast the gaps in between would be dark prohibiting a view of the interior. In such shadowed privacy the women of the house could look out on the life of the street without being seen.<sup>51</sup>

The rawshān thus provides a cool well ventilated spot and a baffle between the exterior and interior that softens the intense glare of the the bright daylight.

#### 3.3.2.4 Al-mabīṭ and Kharjāt

Al-mabīṭ on the uppermost floor is like an air pavilion. The louvred timber walls surrounding it on two or sometimes three sides allow the air to circulate freely in the space and at body level thus enhancing the comfort of the occupants (fig. 3.33). The high perforated parapet walls surrounding the edges of the kharjāt (terraces) facilitate the flow of the cool evening breezes throughout the kharjāt and the adjacent interior space (fig. 3.34). During the day they shade portions of the terrace surfaces. The differentiation of temperature between sunny and shaded surface of terrace creates a system of air movement parallel to the surface which reduces the effect of solar radiation on the surface, and hence the heat transferred by to the interior space below.<sup>52</sup>

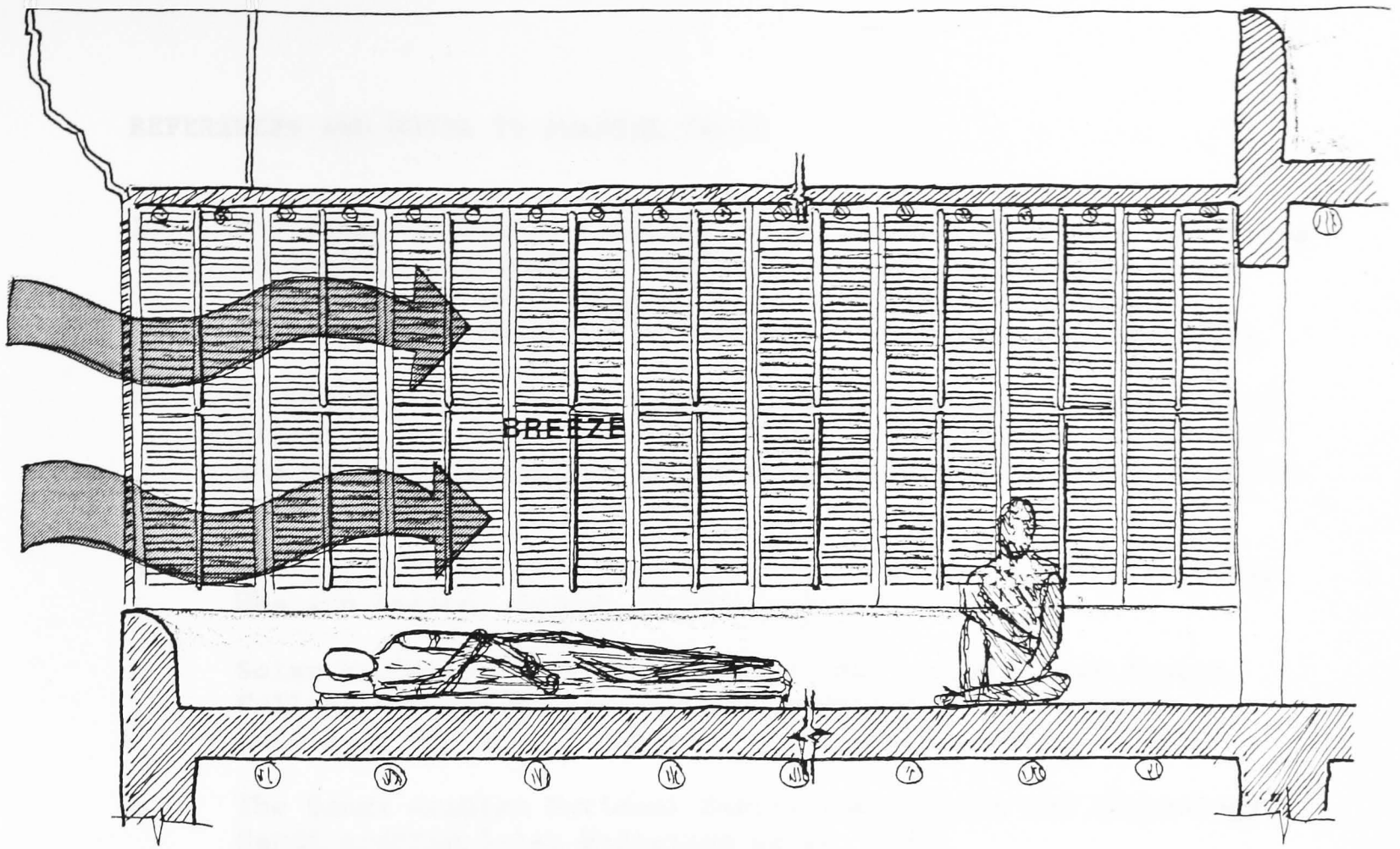


Fig. (3.33) The louvred timber walls surrounding al-mabit on the uppermost floor allow the air to circulate freely in the space and at body level.

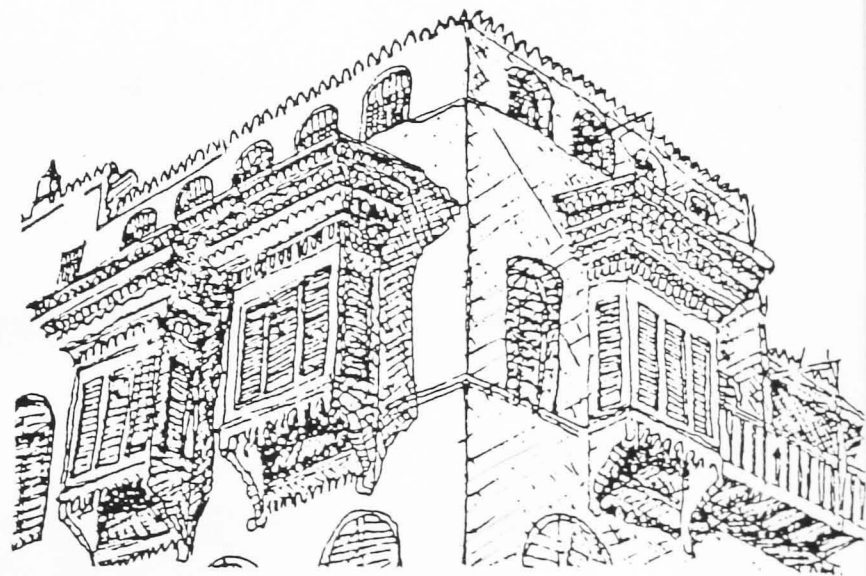
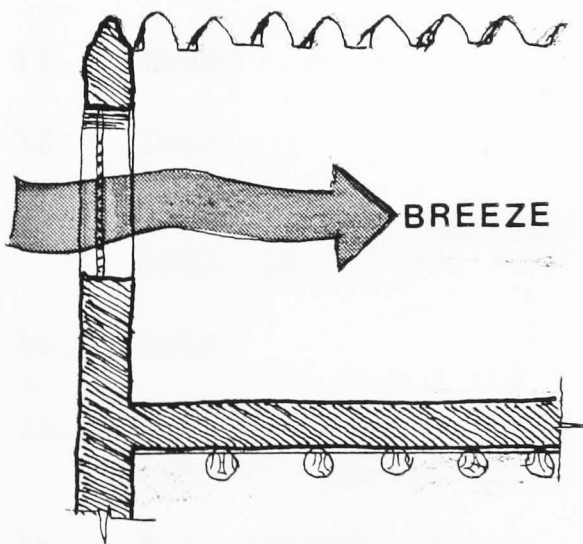


Fig. (3.34) The terraces and roof openings facilitate the flow of breezes.

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## CHAPTER FOUR

### OCCUPANTS' RESPONSE TO CLIMATE:

#### COMFORT AND BEHAVIOUR

So far we have described how the traditional house and its different architectural elements intervened by acting as a barrier and as a responsive filter between the exterior and interior climates. The line of argument has been that four factors effectively controlled the internal climate of the house - the exclusion of solar radiation, the degree of protection afforded by structural mass, the admission of breezes, and the exhausting of hot air by stack effect.

We now turn our attention to the conscious and subconscious adaptation of occupants and their behaviour response to maximise their thermal comfort. This involves not only an understanding of the occupants' traditional clothing, rest habits and activities but also a knowledge of their patterns of space-use and spatial habits.

#### 4.1 CLOTHING TRADITIONS AND THE SOCIAL CONTEXT OF THERMAL ADAPTATION

A significant contribution to thermal comfort was gained by wearing appropriate clothing. Men and women often wore lightweight white cotton or linen clothes. The men's traditional house dress was a long or sometimes knee-length ample sūrwāl (trousers or drawers) and a T-shirt made of thin muslin with an open chest, called 'arrāqiyyah.' Over this, men wore the thūbe - a loose white linen or cotton gown reaching down to the ankles with long wide sleeves that

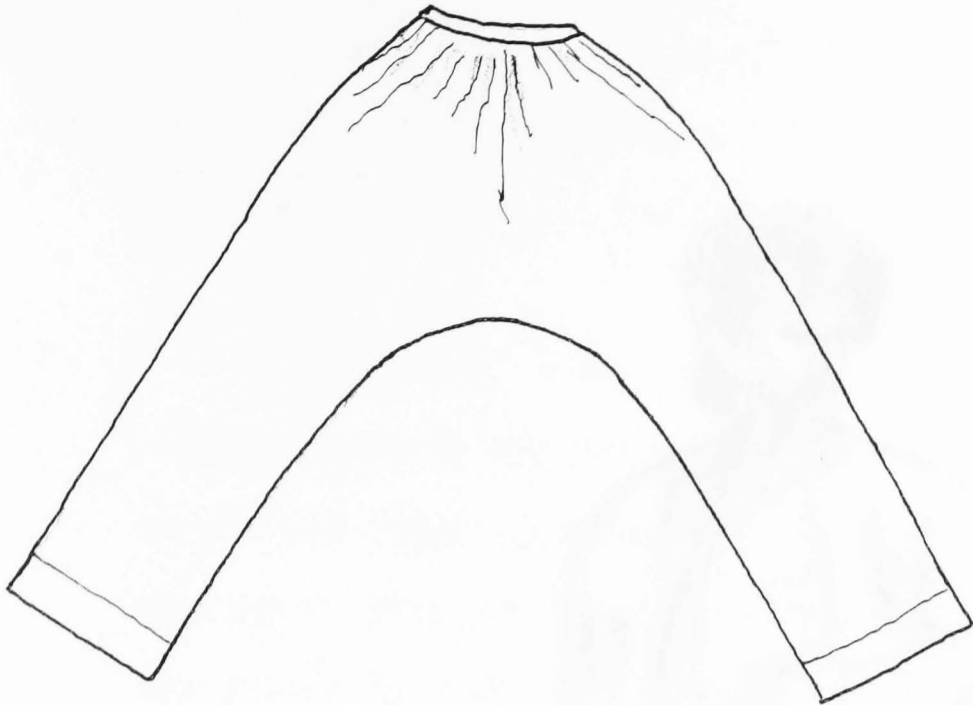
covered the hands (fig. 4.1).<sup>2</sup> The night-time sleeping dress was usually the 'arrāqiyyah and the fūṭah which was an ankle-length piece of lightweight batic cloth wrapped around the waist.<sup>3</sup>

The men's outdoor traditional dress was distinctive. It consisted of the shāyah, a long over-robe worn over the thūbe. It was opened all down the front and drawn in at the waist by a thin cloth belt. Over all came the Jubbah, another long over-robe again opened all down the front with wide sleeves.<sup>4</sup> The head-dress was usually the 'emāmah (turban). This was a length of folded white cotton cloth wound several times round the head (fig. 4.2).<sup>5</sup>

The women's traditional house dress usually consisted of a long ample sūrwāl (trousers) made of cotton often with dark lines and embroidered edges, and sidiyyah (vest) with elbow-length sleeves made of cloth woven from tenuous cotton.<sup>6</sup> To cover the hair, women often wore a white head-cloth called mahramah. Over it came another white head-cloth called muduwwarah worn as a loosely bound turban.<sup>7</sup>

The women's outdoor traditional dress was the curtah, a long-sleeved loose dress, slightly longer than the wearer, that fitted close to the neck and was clasped at the waist by embroidered cloth belt. The fabrics were of plain to patterned cotton embroidered with coloured threads.<sup>8</sup> Over it, the women wore the milāyah (voluminous outdoor cloak) and the būshiyyah (full face veil).<sup>9</sup>

Such clothing worn by men and women, particularly the indoor clothing had extremely sophisticated thermal functions. The undergarments were light in weight, and sewn loosely enough to allow



Sūrwāl



'Arrāqiyyah



Thūbe

Fig. (4.1) Men's traditional house dress.



Fig. (4.2) Men's traditional outdoor dress.

Source : A. Pesce, Jiddah, Portrait of an Arabian City, Falcon Press, London, 1974, p. 38.

reasonably free passage of evaporation from the surface of the skin.<sup>10</sup> The loose gown (thūbe) was made with an open collar and wide sleeves in order to aid ventilation of the air layer between it and the under-garments (fig. 4.3).<sup>11</sup>

In addition, cotton and linen fabrics used in the traditional clothing possess special properties of coolness. They are permeable to air and offer less resistance to convective and evaporative cooling.<sup>12</sup> They act to some extent as a wick, which transfers sweat and vapour from the skin surface to the outer surface of the cloth. The evaporation can occur either from within the fabric of the clothing or from its surface. In either case, the total rate of evaporation required for thermal balance is increased (Appendix B).<sup>13</sup>

Before leaving this point, it must be pointed out that traditional clothing was more than an adaptation to climate, it also expressed traditions and customs which stem in part from Islamic values (fig. 4.4).<sup>14</sup> It evolved steadily along rather eclectic lines as it included versions of basic garment types which were worn over a wide area of the Hejaz.<sup>15</sup> New influences in cut, fabric and decoration imported through Jeddah's extensive trading contacts, came directly to the town dweller through goods available in the sūq and filtered more slowly into the society.<sup>16</sup>

In addition to clothing, occupants also adapted their posture to maximise their thermal comfort. For example, they used to sit back on the floor mattresses with limbs apart.<sup>17</sup> When sitting in a rawshān platform, they often sat parallel to the rawshān panels with legs up on the platform-seat (fig. 4.5).<sup>18</sup> Such a posture enabled the

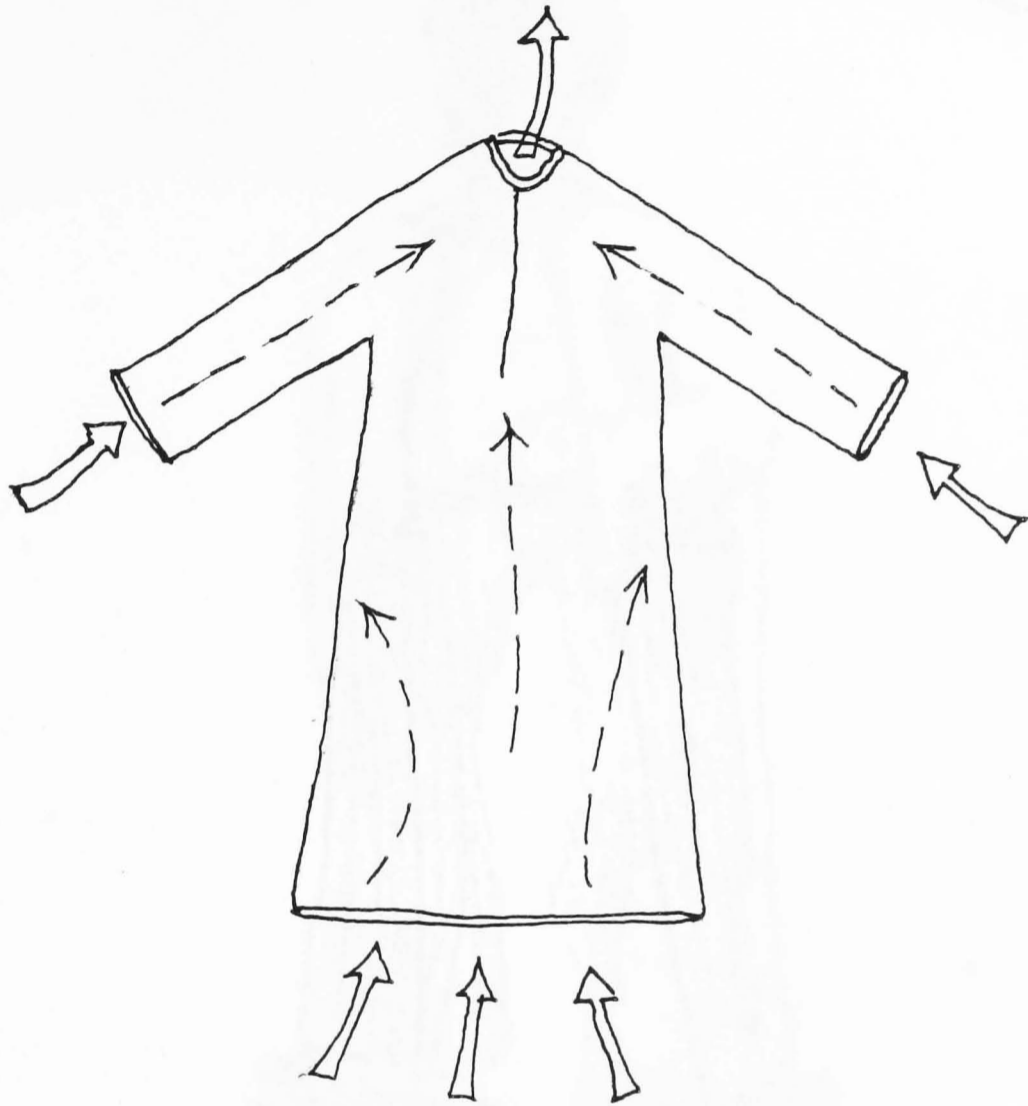


Fig. (4.3) The loose thūbe helps to fan air past the body and increases evaporative cooling.

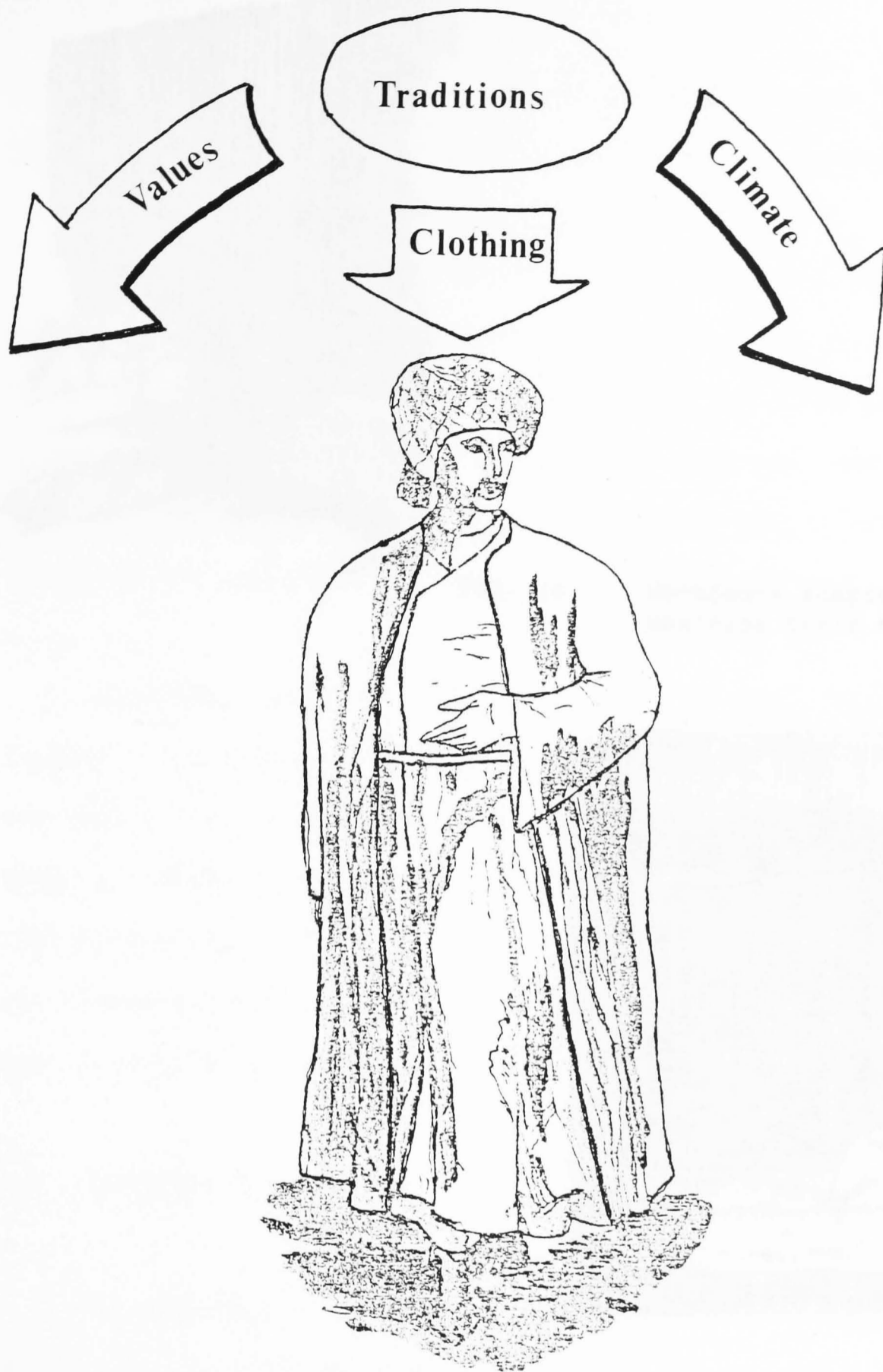
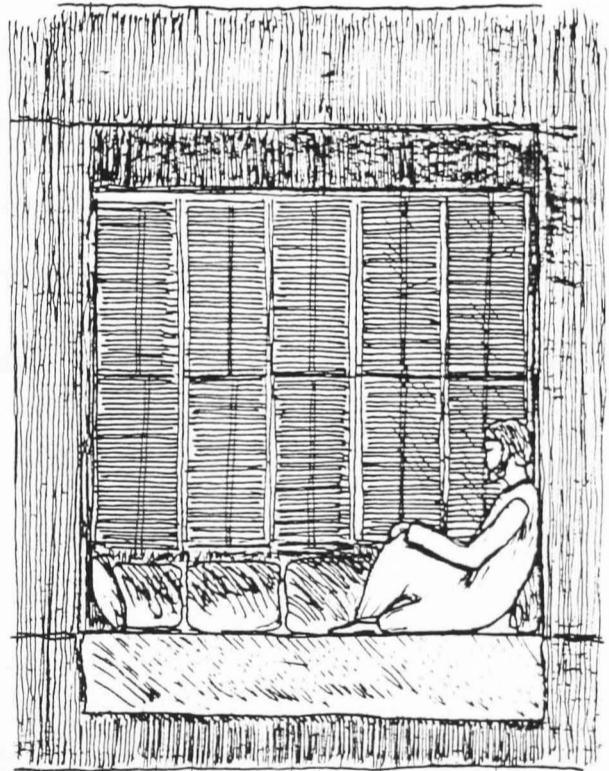


Fig. (4.4) Elements that influenced traditional clothing.



Fig. (4.5) Occupants adapted posture to maximise their thermal comfort.



occupant to increase the effective exposed surface area of the body to the incoming breezes and consequently body heat losses increased.<sup>19</sup>

However, the degree to which this adaptation was employed depended on the social environment. In the presence of the head of the family or an older family member, posture had to be adjusted accordingly. Family members, particularly the young, had to change their posture to show respect by folding their legs or bringing them down from the rawshān platform-seat or the bench.<sup>20</sup>

Occupants' activities and rest habits were also related to comfort. In domestic life, the relatively cool morning was usually the time of most women's strenuous domestic tasks such as sweeping rugs, scrubbing stairs and washing clothes, whereas during the hot afternoon everything slowed down.<sup>21</sup> The custom of taking a siesta in the afternoon ensured that the occupant's own heat production was kept to a minimum during the hottest part of the day.<sup>22</sup>

#### 4.2 PATTERNS OF SPACE-USE

As described earlier (Chapter Two, Section 2.2.1), the interior spaces of the traditional house were generally not defined by the use of the space but rather by the house form itself. They were multi-functional and non-specific in use. This means that the same space was used for many different purposes such as sitting, eating, sleeping or as circumstances dictated.<sup>23</sup>

The use of minimal and multi-purpose furniture helped to create such flexible interior spaces. Complete traditional furnishing

consisted of rugs or mats, floor mattresses along the walls, cushions for the back and arm rests. The centre of the space was left free for circulation and family activities.<sup>24</sup>

In some spaces such as al-majlis, these mattresses and cushions were placed not on the floor, but on raised wooden benches, generally 60 centimetres high, about a metre wide to take the legs folded, and with a length which depended on the perimeter of the space.<sup>25</sup> The floor mattresses and the upholstered wooden benches were served as seating during the daytime as well as a bed for a short rest or siesta.<sup>26</sup>

Clothes or personal effects were usually kept in trunks and decorated wooden chests, or hung from a large iron or wooden pegs in the walls. Small objects like lamps, trinket boxes, coffee jugs, cups and water jugs were placed in the recessed shelves or niches and built-in cupboards.<sup>27</sup>

There was no bulky furniture like wardrobes, tables, beds and so on that clutter and break up the interior space. Meals were served on a circular or rectangular mat made of palm leaves, or on a waxed cloth laid on the floor, around which members of the family would sit cross-legged.<sup>28</sup> At night, foldable mattresses were placed on the floor for sleeping, and in the morning they were rolled up and stored.<sup>29</sup>

Unfortunately, information on occupants' space-use patterns and spatial habits tends to be sparse. The majority of the studies on Jeddah's traditional houses focused on the description of the

physical relationships between the different living spaces, but little attention was paid to how and when these spaces were ultimately used.

The first step in gathering such information was through my first informant, my own grandmother, who many times visited relatives in the old town of Jeddah when she was living in Mekkah. She gave a general account of the family traditional life as it was fifty years ago and provided me with many local words and idioms. This basic information provided me with the key for subsequent interviews which then led to acquiring further knowledge about the family's normal daily activities and added other insights and understanding of how the family used the house.

#### 4.2.1 Interviews

While conducting a field work during summer 1987, I interviewed two elderly men who had lived in traditional houses. The primary purpose of the interviews was to obtain a clear picture of the family's space-use patterns and spatial habits. The informants were Mr. Ahmed Bokhari and Mr. Saleh Ba-sharahel. Mr. Ahmed Bokhari, 74 years old, is appointed by the Municipality of Jeddah to supervise the renovation program of Jeddah's traditional houses. He was a traditional mason and had lived for fifty years in a traditional house. Mr. Saleh Ba-sharahel, 77 years old, is a merchant and had lived for about fifty five years in the old town of Jeddah. His four storeys traditional house is now used as a warehouse.

Each interview took about one hour and half and was tape recorded. At the beginning of both interviews, I explained to the informants the nature of my research, in general, and what I am interested in knowing. The basic substance of conversations was about the history of the town, the social life of the old inhabitants, and the process of house construction. In these informal discussions I covered a great deal of information on the inhabitants' traditional life style in terms of activities and use patterns and allowed the flow of conversation to generate chance discoveries of new topics of areas for further exploration.

#### 4.2.2 Tour of al-Jokhdar Traditional House

In the course of conducting interviews, I went with Mr. Bokhari on a tour around al-Jokhdar house, one of the traditional houses renovated by Jeddah's Municipality. As we moved around the house, I asked Mr. Ahmed to say what each space was called, who tended to use it most, how and when it was usually used, and the significances that different parts of the house. It was important to identify how the family used the house and determine whether certain parts in the house were associated with particular seasons of the year, or times of day. The tour of the house was also tape recorded and notes regarding space-use patterns were recorded during the tour on the house plans obtained from the Municipality of Jeddah.

#### 4.2.3 Findings

According to the information concerning the family's space-use patterns and spatial habits, the family had a daily and seasonal

movement within the house. In summer, they spent the late evening in the Kharjāt (terraces) and slept in al-mabīt located on the uppermost floors. In the early morning, they moved to the lower living quarters, often on the first floor level where they spent the daytime, starting with the north-facing living space (al-majlis) in the morning, moving to the west-facing living space (al-suffah) in the afternoon and again to the Kharjāt (terraces) in the late evening (fig. 4.6).

During winter months, the family activities were usually concentrated in the second or third floor and night time socialising and sleeping took place in al-mua'khir living quarters.

This spatial behaviour can be further illustrated by outlining the daily routine in such a house. The family usually rose early between 4:30 and 5:30 am for dawn prayer, and after sunrise, they gathered in al-majlis for breakfast and tea. At about 8:00 am, the head of the family usually accompanied by his sons left for work in his shop or warehouse, or in the ground level of his house where he ran his business. The women of the household carried out the domestic tasks until lunchtime when they joined the rest of the family in al-majlis for the largest meal of the day.

It is worth mentioning here that no clear demarcation between work and leisure existed. Normal social life was interwoven with work and home based activities. For instance, men usually offered coffee and tea while discussing business affairs, and women assembled to share domestic tasks, tea and gossip.

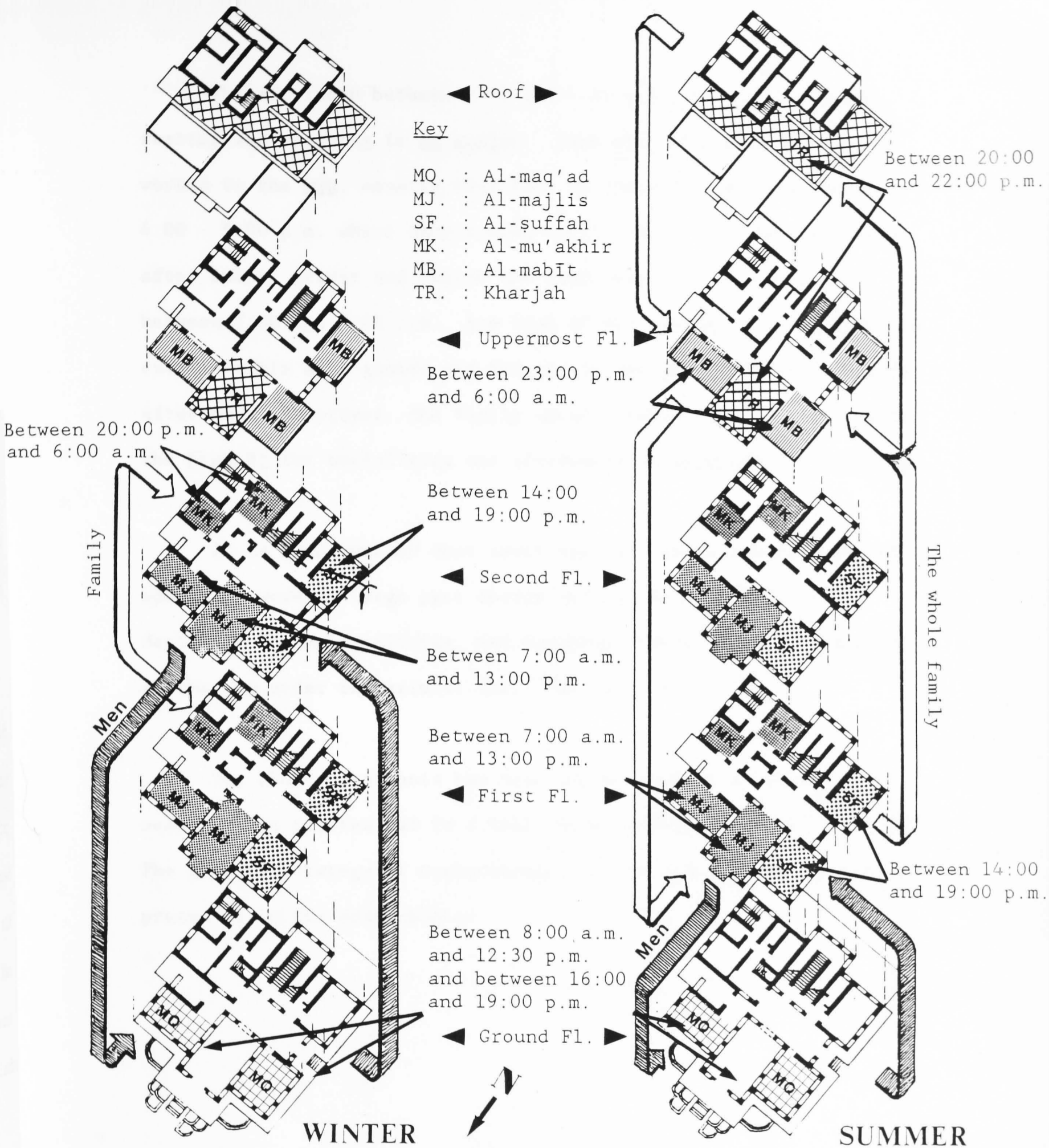


Fig. (4.6) Diurnal changes in the use of space during the summer and winter seasons.

The afternoon between 2:00 and 4:00 p.m. was usually spent resting and sleeping in al-suffah. Many men, such as those who worked in the sūq, usually went back to their occupations between 4:00 - 5:00 p.m. where they stayed until sunset. In the few hours after sunset prayer and before the last prayer which was usually between 8:00 and 9:00 p.m., the head of the family would receive and entertain his male guests and friends in the ground floor. Shortly after the last prayer, the family usually had dinner and retired to the Kharjāt for socialising and afterwards to al-mabīt for sleeping.

It is hypothesized that these spatial habits and patterns of space-use were in large part determined by the availability of desirable thermal qualities, and occupants moved from one place to another in order to maximise their thermal comfort.

The above hypothesis has been tested through thermal measurements carried out in a field work conducted during July, 1987. The general strategy of measurements and the analysis of results are presented in the next chapter.

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## CHAPTER FIVE

### AN ASSESSMENT OF THE INDOOR THERMAL ENVIRONMENT OF THE TRADITIONAL HOUSE

This chapter is concerned with testing the hypothesis established in Chapter Four that the use of space in the traditional house of Jeddah was closely related to, if not dominated by, a need to maximise thermal comfort. Thermal measurements were carried out in a traditional house in order to compare and evaluate the thermal qualities obtaining in different levels and spaces, and to relate them to the occupants' space-use patterns as established on the basis of the interviews described in Chapter Four, Section 4.2.1.

#### 5.1 THE FIELD MEASUREMENTS

##### 5.1.1 The Investigated House

Rather than attempting to investigate several traditional houses, the author considered it more practical and more in line with the overall intention of this research to take thermal measurements in just one house in order to have better understanding of its thermal qualities.

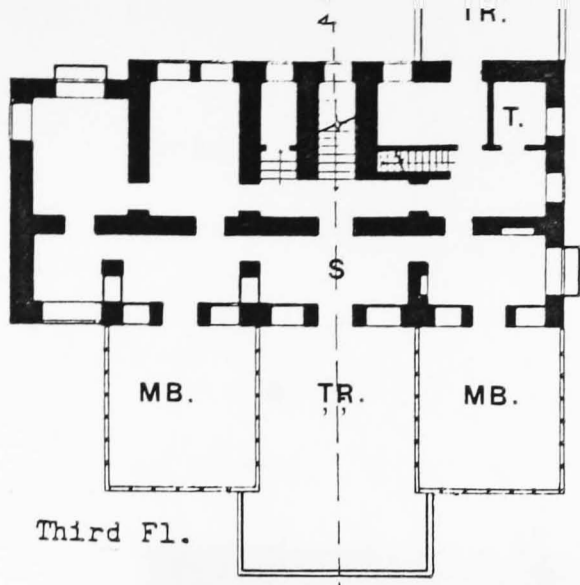
The majority of houses are in bad condition and have many structural problems as a result of the neglect and lack of maintenance. These houses are not occupied and some of them are planned to be restored by the Municipality of Jeddah and some are going to be demolished. However, occupied houses are usually in good

condition, but they are not inhabited and used in the way for which they were built: as one-family houses. Many of these houses are used as multi-tenant housing units for communal groups of foreign bachelors, ranging from road-sweepers to construction workers. In addition, mechanical services are introduced in these houses, especially with the installation of air conditioning units. Thus, it is was essential to have access to an unoccupied house that has no structural problems and has not been modified in any ways. In view of this and to fulfil the aim of this investigation, a specific dwelling, namely al-Jokhdar house restored by the Municipality, was selected. Its plans and sections are shown in fig. (5.1).

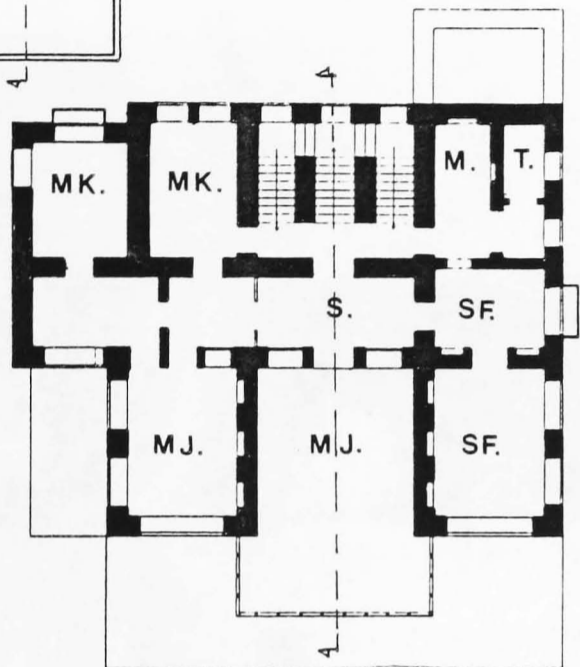
#### 5.1.2 Measuring Instruments

Continuous monitoring of dry bulb air temperature, relative humidity and air velocity was achieved using an electronic thermo-hygro-anemometer borrowed from King Abdul-Aziz University in Jeddah (fig. 5.2). It has a microprocessor with a complete data logging system that could measure dry bulb air temperature, relative humidity and air velocity through 16 channels. The instrument can be programmed to suit different types of probes. The accuracy is  $\pm 0.5$  K for a temperature range from -190 to 600 K,  $\pm 2\%$  for humidity range from 0 to 98% and  $\pm 1\%$  for air velocity range from 0 to 30 m/s.<sup>1</sup>

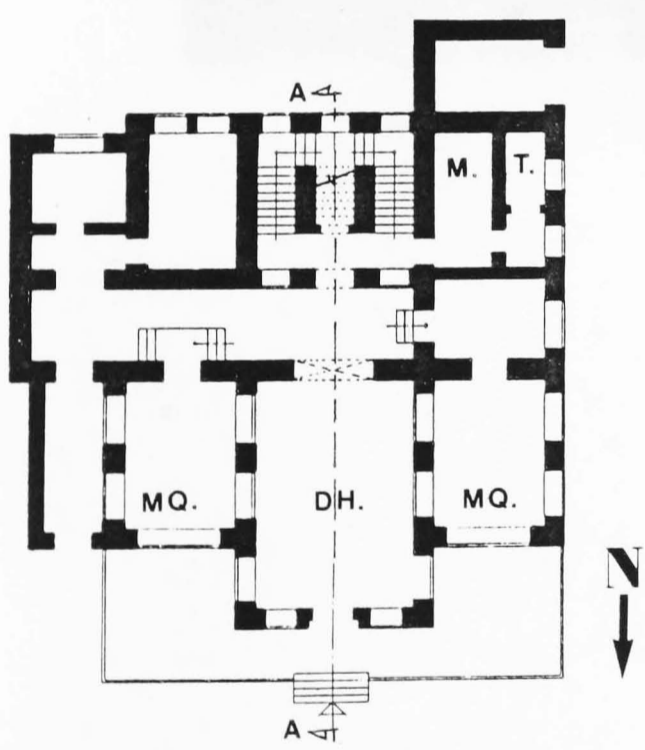
The output from the instrument can either be given as a digital display, or as a digital display together with analogue output to a data logger that can store data for up to seven weeks at switch-selectable intervals of 1, 5, 15 or 60 sec/min. All information (including the number of the channel whose reading is being measured,



Third Fl.

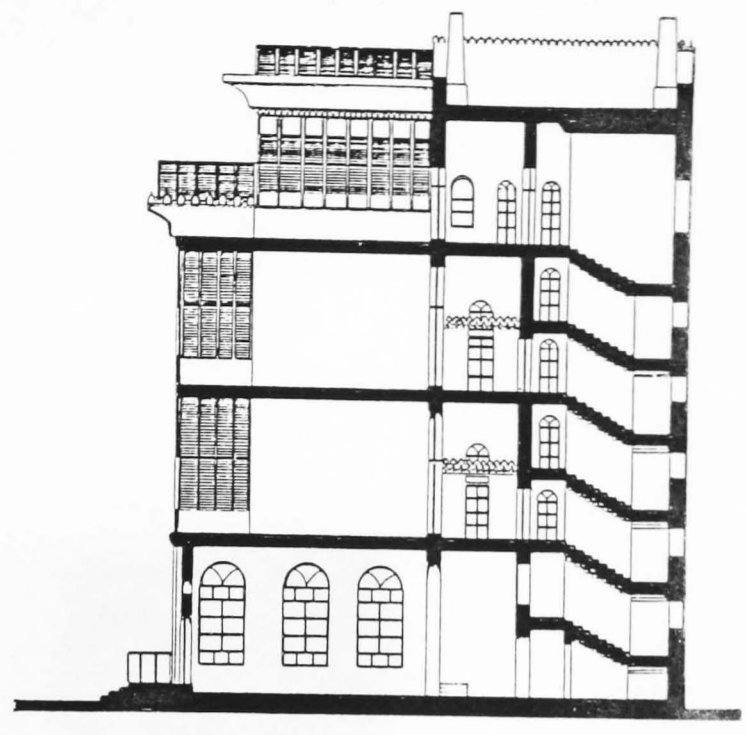


First Fl.



Ground Fl.

- Key
- DH.: Al-dahleez
  - MQ.: Al-maq'ad
  - MJ.: Al-majlis
  - SF.: Al-şuffah
  - MK.: Al-mu'akhir
  - S. : Şālah
  - T. : Ṭahārah
  - M. : Mirakkab
  - MB.: Al-mabīt
  - TR.: Kharjah



Sec. A-A

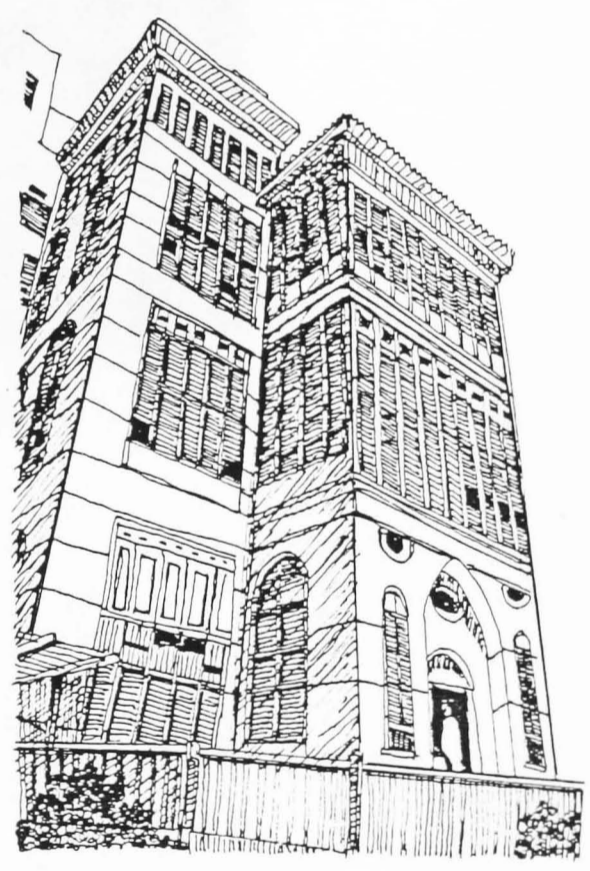


Fig. (5.1) Al-jokhdar house.

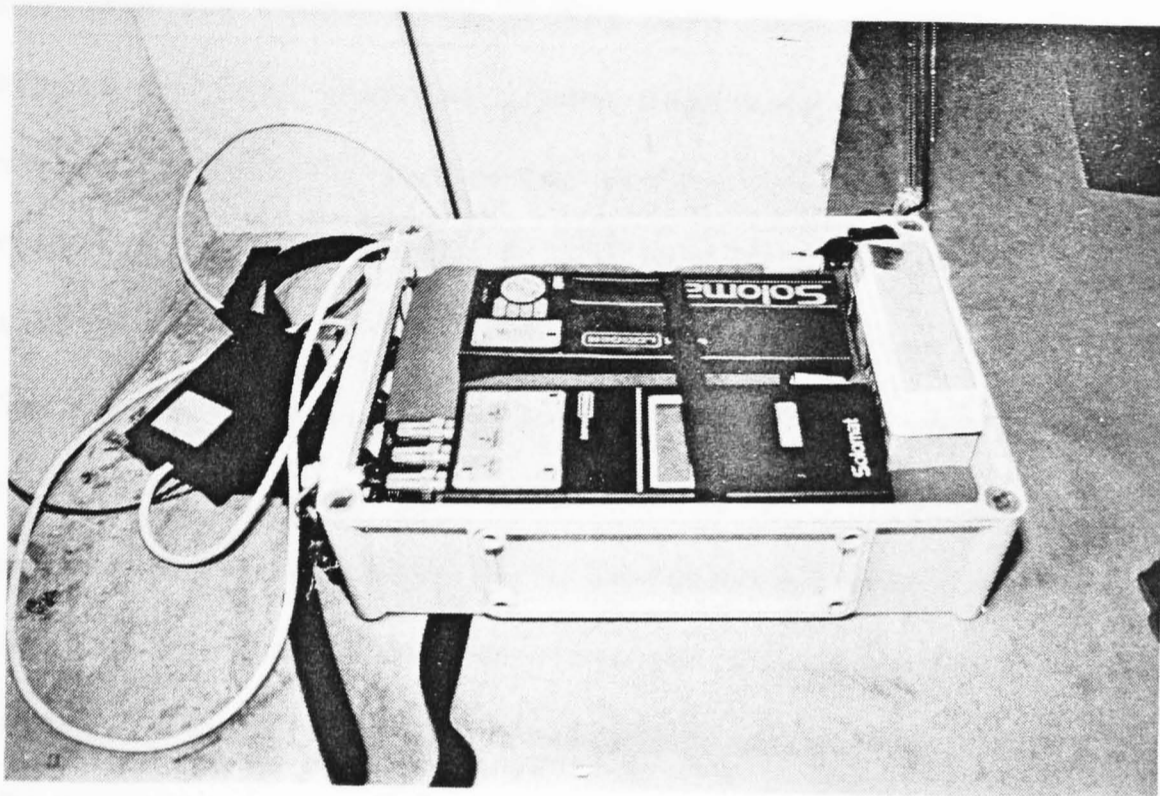


Fig. (5.2) CC20/21 data logging system.

decimal point, units symbol, time and data) is stored for later transfer into a computer.

The instrument was supplied with a sufficient number of extension leads each 10 metres in length. Platinum Pt 100 fast response air temperature probes were used to measure air temperature; hygrometer fast response probes were used to measure relative humidity; hot wire anemometer probes were used to measure air velocity whilst Platinum Pt 100 surface flexible patch probes were used to measure surface temperature. The probes were positioned at the centre of each investigated space at a height of approximately one metre. Wall surface temperatures were taken from outside as well as inside the test wall, with the probes placed immediately opposite each other. The probes were carefully mounted on the surface and covered with an effective insulating material to insure accuracy of the temperature reading. The data logger was programmed to measure and store at 1 hour intervals.

The thermal conditions in the different spaces were evaluated using a B & K thermal comfort meter borrowed from King Faisal University (fig. 5.3). It is designed to calculate the predicted parameters of thermal comfort, using methods based on the thermal comfort equations of P.O. Fanger.<sup>2</sup> The predicted mean vote is a shifted scale human perception index. The PMV scale extends from hot (+3) to cold (-3). Fanger's method<sup>3</sup> suggests that an individual whose thermal sensation was warmer than slightly warm (+1) or cooler than slightly cool (-1) would be dissatisfied with the environment and would be likely to complain. For every test group, Fanger

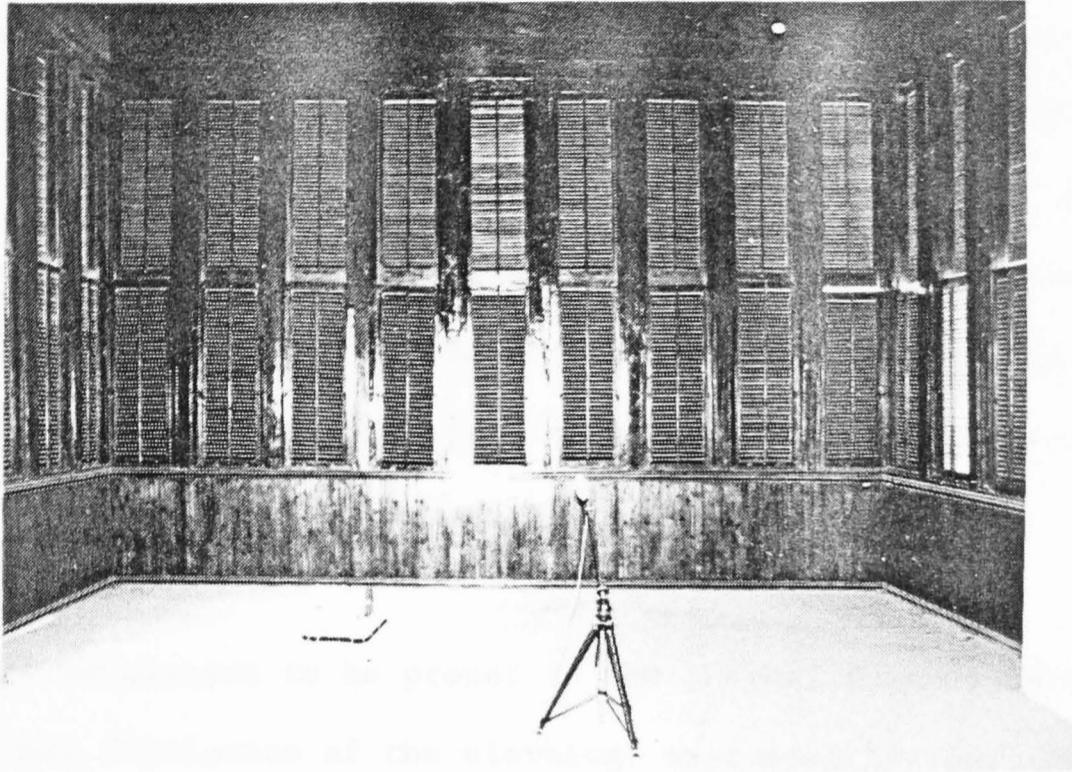


Fig. (5.3) B & K thermal comfort meter type 1212.

determined the average sensations and the percentage of subjects voting who had thermal sensations between +3 and -3 and +2 and -2.

The PMV values were then related by Fanger<sup>4</sup> to the percentage of people who would be dissatisfied, based upon the test subjects responses. For example, at a thermal sensation of neutral, the predicted percentage of dissatisfied (PPD) had a minimum of five percent dissatisfied. As the environment deviated from this optimum thermal comfort condition, the dissatisfaction increased. At a PMV of (+2) warm or (-2) cool the predicted percentage of dissatisfied was approximately 77%. The predicted mean vote relationship to predicted percent of dissatisfied (PPD) and predicted percent of satisfied (PPS) is shown in table (5.1).

The parameters to be preset in the thermal comfort meter are the thermal insulation of the clothing, expressed in Clo. and activity level, expressed in met. The thermal comfort meter determines the joint effect of air temperature mean radiant temperature, air velocity, and partial water vapour pressure of the air on a person by measuring the heat loss from a transducer (an analogous sensor). It is a sensor with the same surface temperature, emissivity, orientation and placement as the person it is meant to simulate.<sup>5</sup>

The thermal comfort settings and calculated PMV values in this study were based upon a sedentary and lightly clothed person for summer conditions. The values were 1.0 and 0.6 respectively.<sup>6</sup> The thermal comfort transducer was located in the centre of the room space, 1.09 m above the floor. A strip-chart recorder was provided

Thermal Sensation	PMV	PPD	PPS
Hot	+3		
Warm	+2	76%	24%
Slightly Warm	+1	27%	73%
Neutral	0	5%	95%
Slightly Cool	-1	27%	73%
Cool	-2	77%	23%
Cold	-3		

Table (5.1) Distribution of thermal sensation votes (%).

Source: Bruel & Kjaer, Instruction Manual, Thermal Comfort Meter Type 1212, DK-2850 Naerum, Denmark, 1982, p.2.

to record the PMV values in the investigated spaces, each for one day periods. However, it should be pointed out here that the feeling of comfort is a subjective perception that varies from person to person and from one culture to another. Peoples' habits, the clothes they wear, the manner of their sitting or resting, the type of bed they sleep upon, the character of life they lead, and the character of food they eat all vary according to the tradition, cultural background, time and place. Thus, although the calculated PMV values will enable an evaluation of the thermal qualities obtained in the different spaces, they can never tell us the level of comfort experienced by the original inhabitants fifty or one hundred years ago.

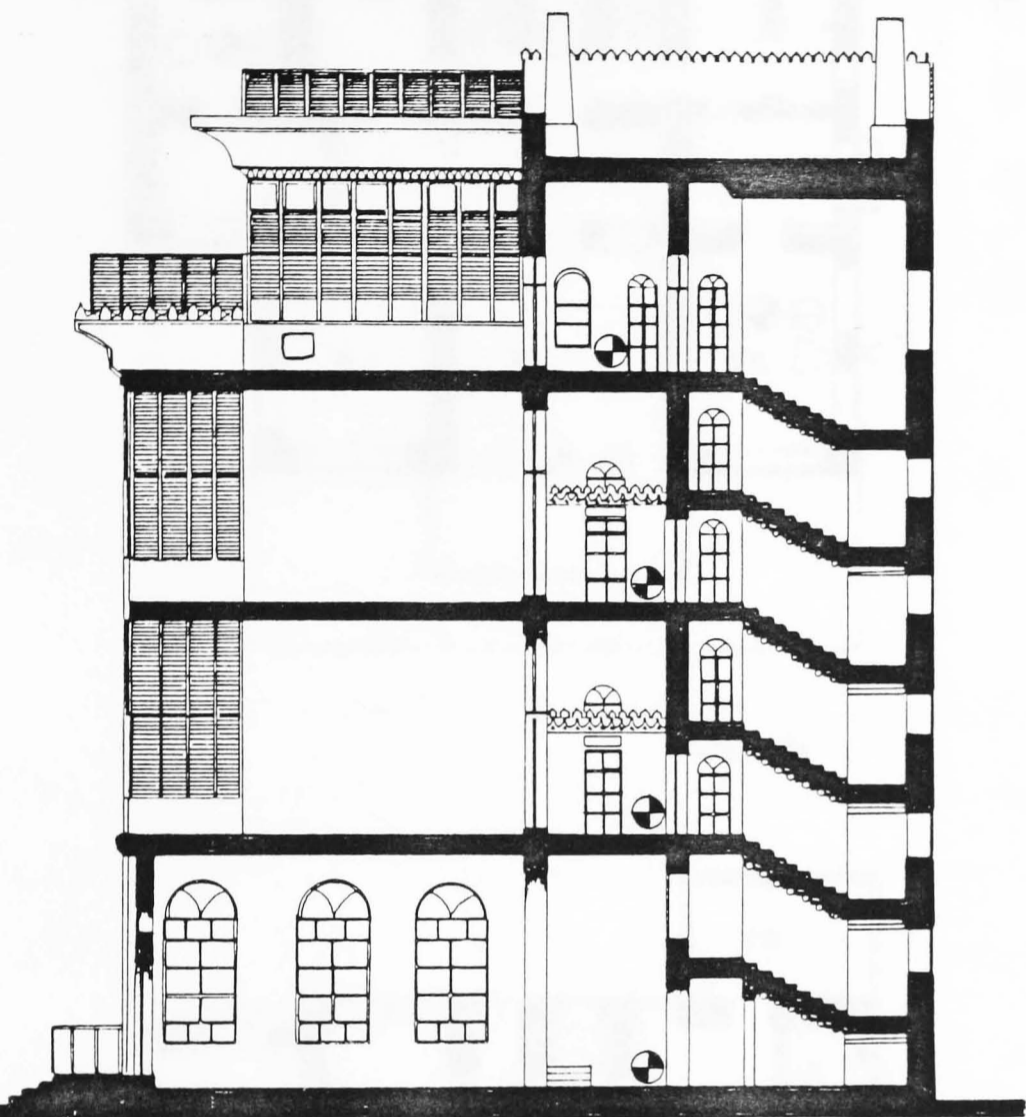
Continuous monitoring of outdoor air temperature and relative humidity was achieved using a thermohygrograph, protected by Stevenson screen and placed on the roof. The instrument was borrowed from the Meteorological Station at Jeddah. It records both parameters in the form of a continuous trace and can be operated without chart replacement for a week.

The thermohygrograph used was carefully calibrated at the Meteorological Station before being moved to the investigated house. A digital hand-held temperature and humidity probe was used to carry out daily checks on the thermohygrograph calibration while it was in situ.

### 5.1.3 Period of Measurements and Experimental Set-Up

It was impossible to undertake field measurements on time intervals representative of all climatic seasons due to the limited time available and constraints on the borrowed instruments. It was therefore decided to make relevant short period measurements for only the summer, the extreme season. The field work was conducted during the month of July, 1987, and as constant climatic conditions usually prevail during the summer months (see Chapter Three, Section 3.1) the general weather pattern during the period of measurements was thus fairly representative of conditions throughout the summer and the measured data can be taken as typical of the indoor climate in the traditional houses during the hot season. All measurements were undertaken between 11th to 16th of July. During this period three tests were carried out.

The first test was carried out from Saturday 11th to Monday 13th of July, 1987. It included measurements of air temperature in typical locations on the different floor levels (fig. 5.4). This test was carried out to observe the vertical temperature variation through the house. The second test started on Tuesday 14th of July and lasted for three days. This test was carried out to examine and compare the thermal conditions in al-majlis, al-suffah and al-mu'akhir located on the first floor level, and al-mabîr on the uppermost floor (fig. 5.5). The measured thermal parameters were air temperature, relative humidity and air velocity. In addition, the internal and external surface temperatures of the western wall of al-suffah were recorded during the same period. No direct measurements of mean radiant temperature were carried out as it was found during a

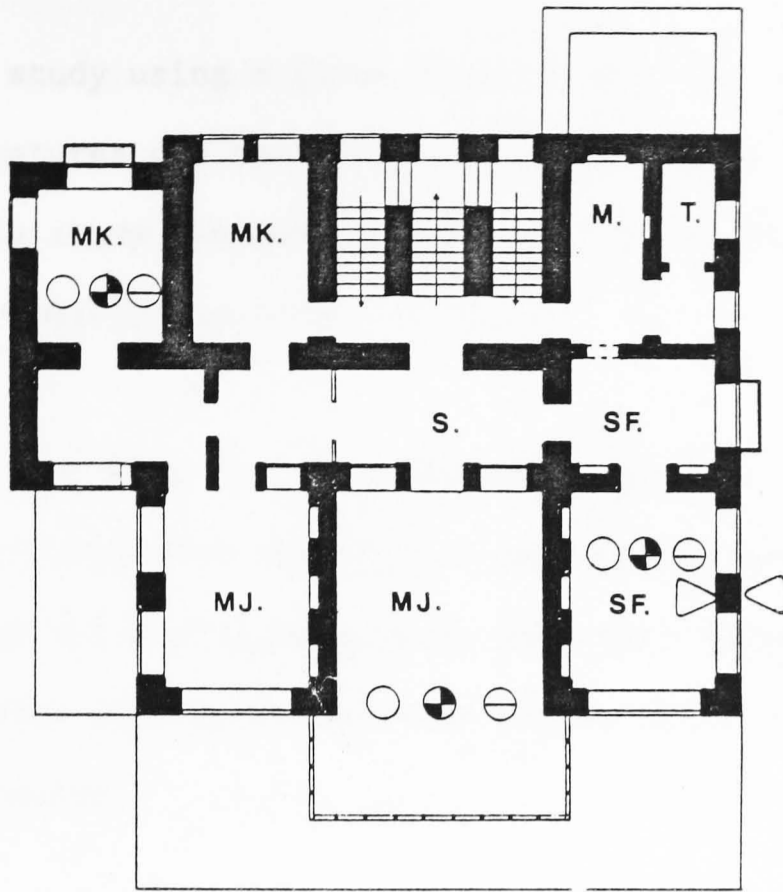


Observation points

- Air temperature probe
- Thermohygrograph

Section A-A

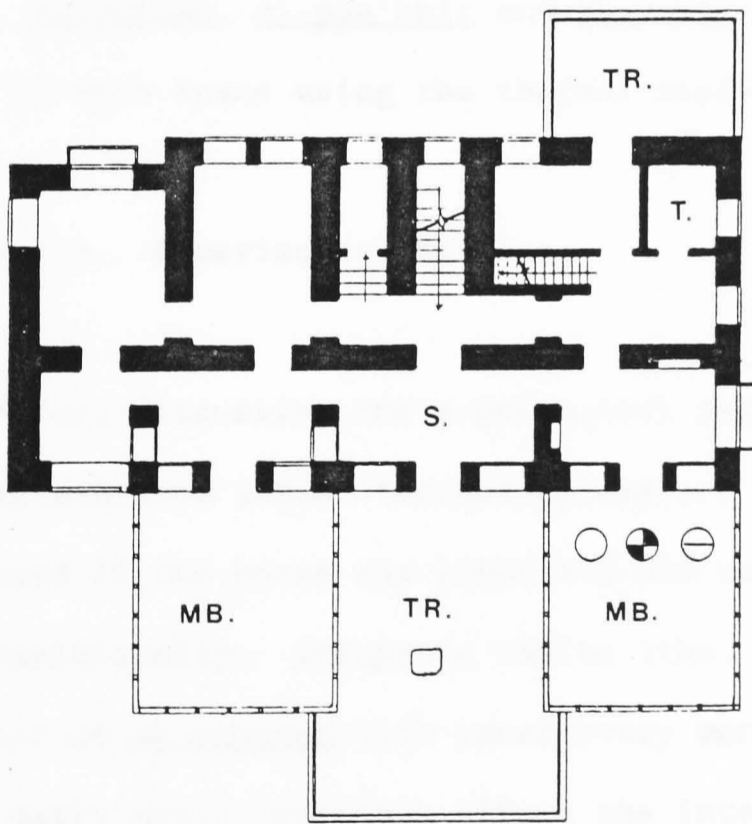
Fig. (5.4) First test measurements.



Observation points

- ⊗ Air temperature probe
- ⊖ Relative humidity probe
- Anemometer probe
- △ Surface temperature probe
- Thermohygrograph

First Fl.



Uppermost Fl.

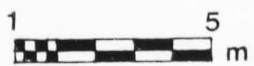


Fig. (5.5) Second and third tests measurements.

pilot study using a globe thermometer that air and mean radiant temperatures did not differ by a measurable amount. For the purpose of this study the mean radiant and air temperatures have been assumed to be numerically equal.

According to the conducted interviews (Chapter Four, Section 4.2.1), selective ventilation was not practiced by occupants and usually all the rawāshīn were kept open throughout the 24 hours. Therefore all the spaces were tested under conditions of continuous ventilation.<sup>7</sup>

The third test was conducted during the period 13th to 17th July. In this test the thermal performance was evaluated in al-majlis, al-ṣuffah, al-mua'khir and al-mabīt by calculating the PMV values in each space using the thermal comfort meter (see fig. 5.5).

#### 5.1.4 Experimental Results

Before discussing the experimental results, it has to be said that the measured indoor thermal parameters would have been influenced if the house was inhabited and used in the way it had been used traditionally. Occupants habits like, for instance, sprinkling the floor of al-dahleez with water every morning or washing the stairs daily would obviously affect the internal environment. However, the extent to which the indoor thermal environment would have been influenced by such habits and activities is unknown, and therefore it has not been considered in this study.

The plots prepared for the analysis of the first two tests are a 24 hour average value for the three days measured data of each test. Concerning the vertical temperature-gradient through the house, fig. (5.6), shows a clear distinction between air temperatures of the different floors. The outdoor air temperatures changed from 28.5 to 39.6°C only, and the first and second floor air temperatures were consistently higher by 1.0 to 1.5°C and by 2.0 to 3.0°C respectively. Because of much greater exposure to the outdoor environment, the air temperature fluctuation at the uppermost floor level was much greater, being 29.3 to 39.9°C.

Fig. (5.7) shows the variations in the air temperature of al-majlis, al-suffah and al-mu'akhir located on the first floor level, and al-mabit on the uppermost floor. In all the three investigated living spaces of the first floor, air temperatures fluctuated between 1.0 and 3.0°C over a 24 hour period. However, the air temperature of al-majlis rose slightly more than that of al-suffah and al-mulakhir between about 0800 and 1300 hours. On the other hand, the small rise in air temperature was also noticed between 1400 and 1900 hours in al-suffah. In contrast, air temperatures in al-mu'akhir were fairly stable and there was no noticeable rise between 0800 and 1900 hours. During night and early morning hours air temperatures of al-majlis and al-suffah fell below the air temperature of al-mu'akhir by about 0.5 to 1.0°C.

Generally, air temperatures in the three living spaces remained below the outdoor temperature by between 2.0 to 6.5°C between 0800 and 2000 hours. During late night and early morning hours indoor air temperature rose by about 2.0°C above outdoors.

### TEMPERATURE (DEG C) v HOUR OF DAY

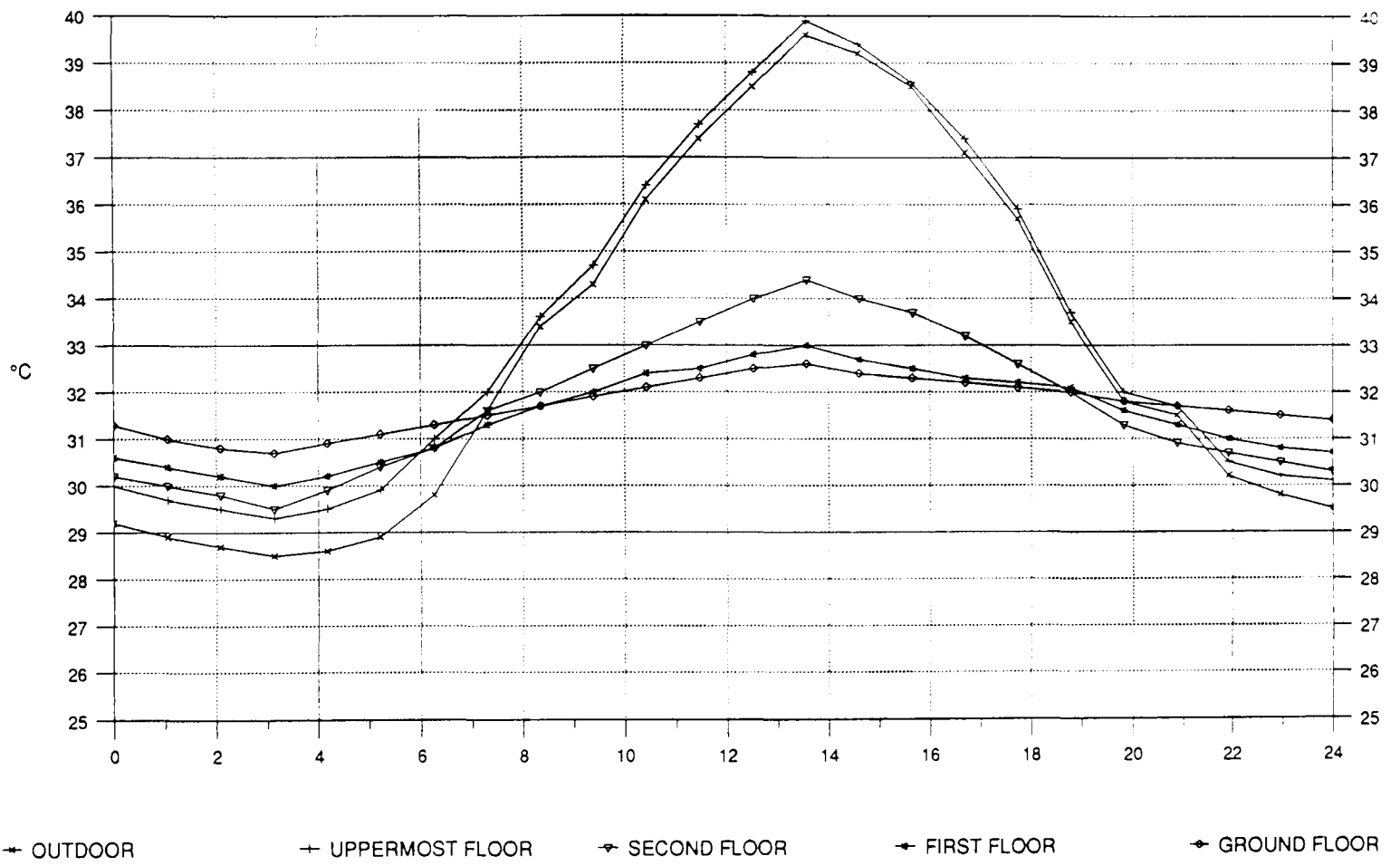


Fig. (5.6) Average of three days hourly variations of the different floors air temperatures.

## TEMPERATURE (DEG C) v HOUR OF DAY

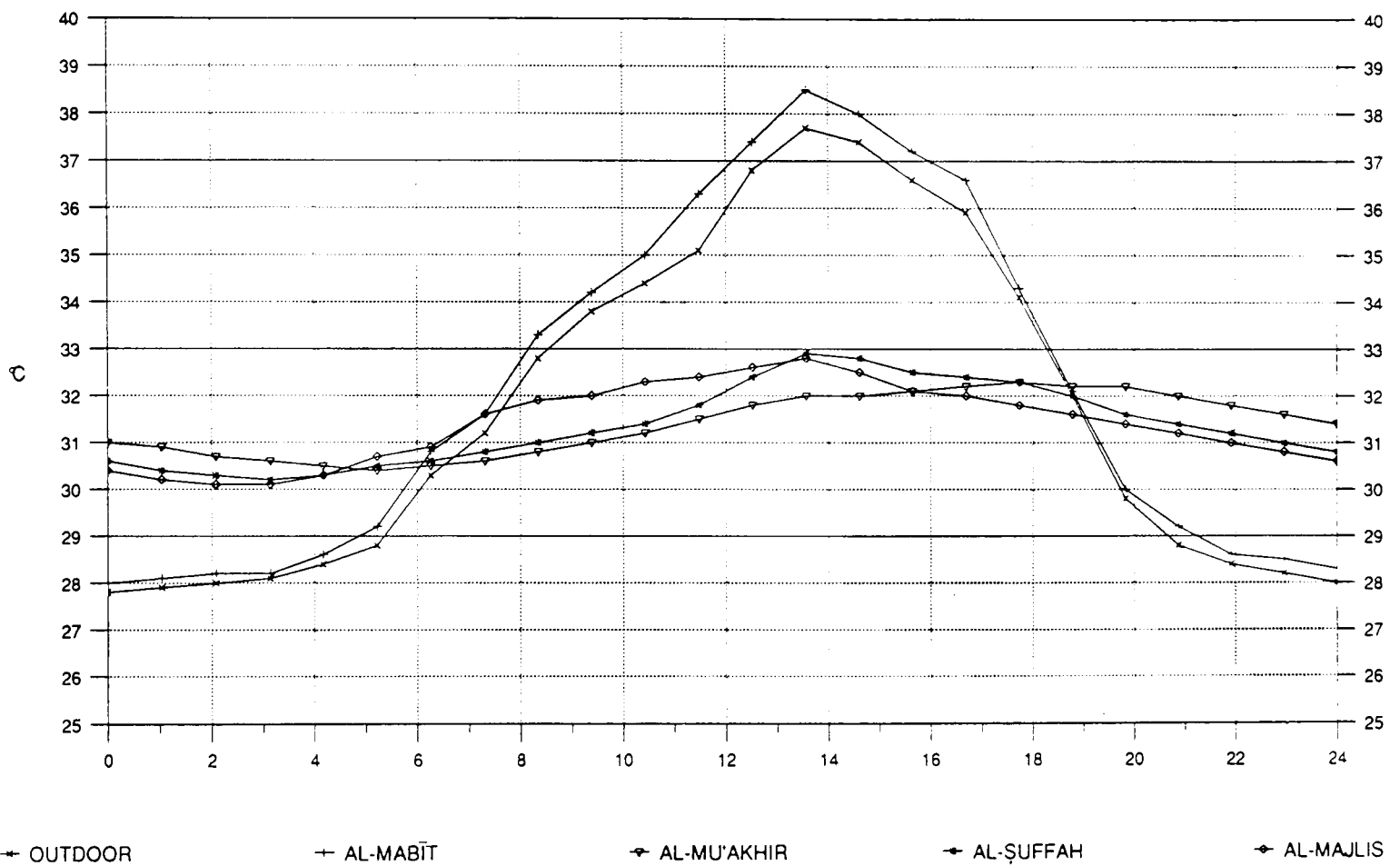


Fig. (5.7) Average of three days hourly air temperature variations of al-majlis, al-şuffah, and al-mu'akhir of the first floor and al-mabit on the uppermost floor.

The pattern of air temperature in al-mabîr located on the uppermost floor contrasts strikingly with the patterns of the three spaces described above. The air temperature of al-mabîr climbed rapidly after 0800 hours and the highest recorded was 38.5°C at 1400 hours. After 1600 hours, the air temperature started to decline and the minimum recorded was 28.2°C very close to the corresponding outdoor air temperature.

Examination of fig (5.8) shows that indoor air velocities varied from one space to another. These variations were due to many factors such as changing wind directions and speeds, location of the different spaces, and the number and size of the rawāshin in each space. Air velocities ranging between 0.3 to 1.3 m/s were recorded at a level of 1 metre above the floor level of al-majlis. The forenoon hours show air velocities between 0.8 to 1.3 m/s, while the afternoon and night hours show a decrease in air velocity to 0.3 m/s. In al-şaffah, the forenoon measurements ranged between 0.5 to 0.8 m/s, while the afternoon hours show an increase in air velocity, up to 1.4 m/s. On the other hand, the night and early morning hours measurements show a decrease in air velocity to about 0.2 m/s. Air velocities in al-mu'akhir were low and ranged between 0.1 and 0.7 m/s during 24 hour period. Al-mabîr however, experienced air velocities higher than that of al-majlis, al-şaffah and al-mu'akhir due to its location on the uppermost floor and its louvred structure. During night and early morning hours air velocity ranged between 0.5 and 1.0 m/s in al-mabîr.

Fig (5.9) presents the continuous record of relative humidity in al-majlis, al-şaffah and al-mu'akhir of the first floor. As would

### AIR VELOCITY (DEG C) v HOUR OF DAY

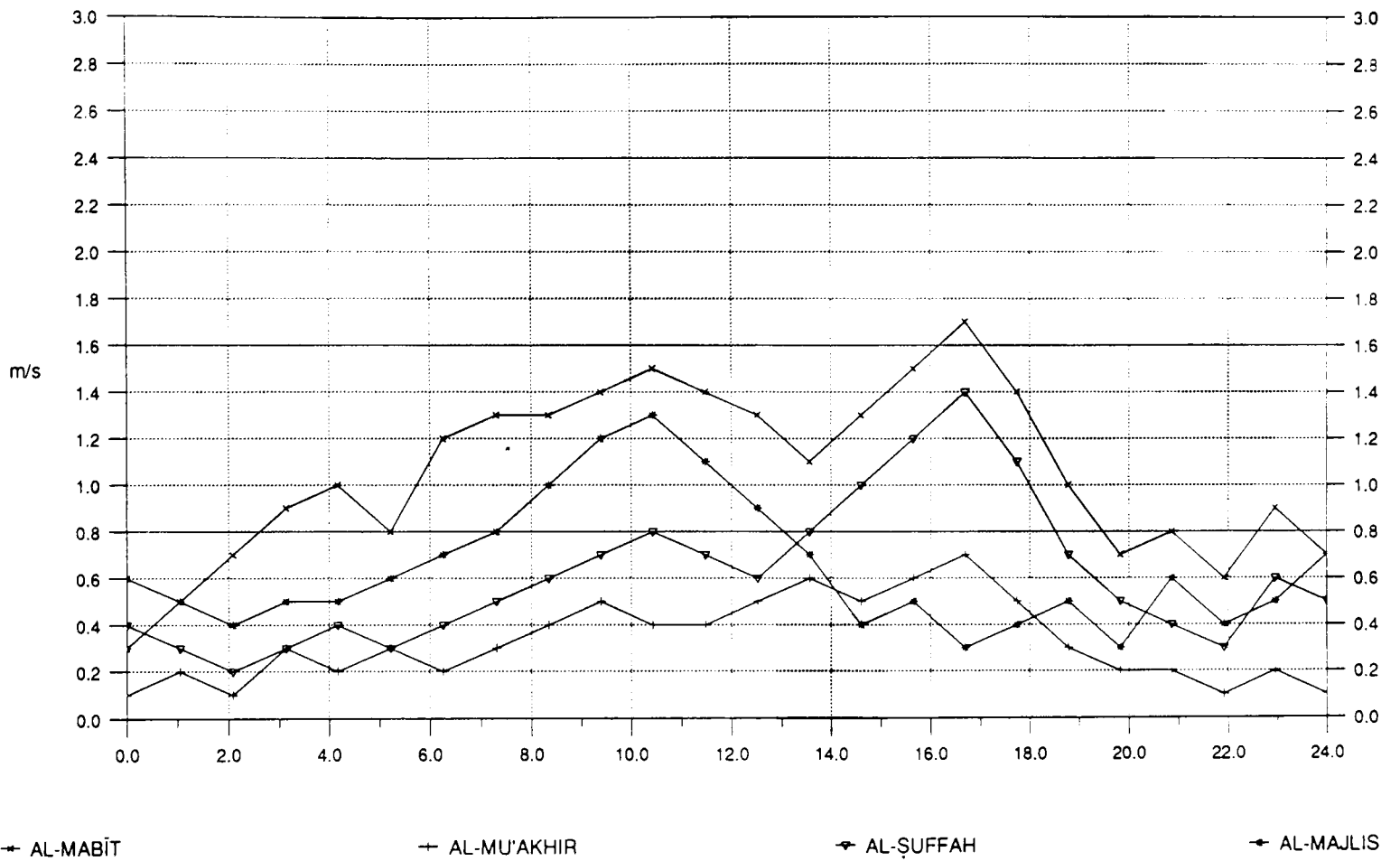


Fig. (5.8) Average of three hourly air velocity variations of al-majlis, al-suffah, and al-mu'akhir of the first floor and al-mabit on the uppermost floor.

### RELATIVE HUMIDITY (%) v HOUR OF DAY

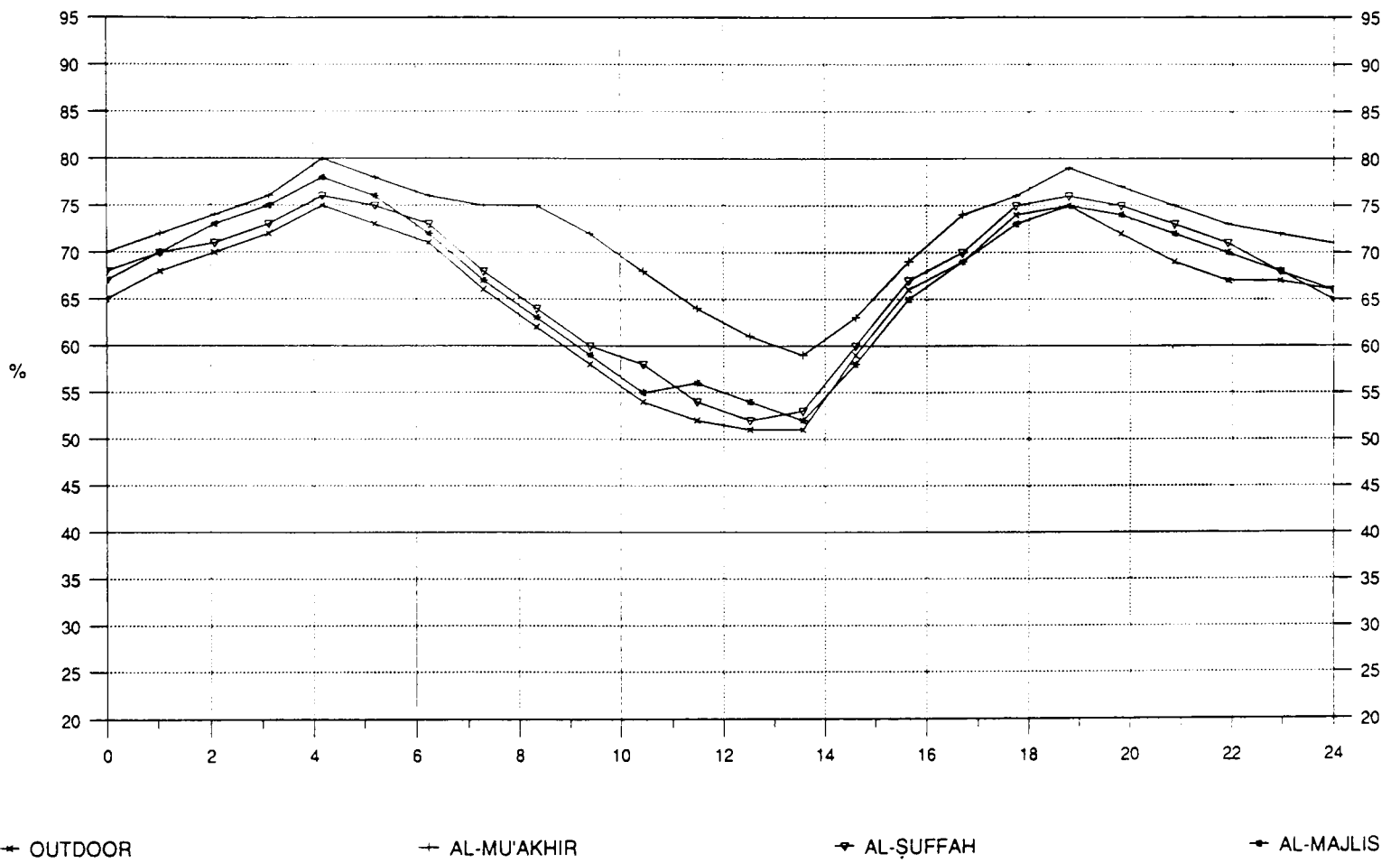


Fig. (5.9) Average of three days hourly relative humidity variations of al-majlis, al-suffah, and al-mu'akhir of the first floor.

be expected the relative humidities in al-majlis and al-suffah closely paralleled those outdoors during the day, no doubt reflecting the very free air circulation obtaining there. During night and early morning hours, indoor air humidities were slightly higher than that of the ambient. In both spaces relative humidity fluctuated between 52% at about 1400 hours to 78% at 0500 hours. Relative humidity in al-mu'akhir was higher than outdoor during the 24 hour period reflecting the comparative lack of good cross-ventilation.

Concerning the internal and external surfaces temperatures, the west wall of al-suffah was in sunlight between 1400 and 1600 hours. The external surface temperature reached its maximum at 1600 hours when 46.5°C was recorded, while the lowest external surface temperature was 28.6°C at 0600 hours, a temperature difference of 17.9°C over a 24 hour period (fig. 5.10). Because of the high thermal resistance of the thick coral stone walls, the internal surface temperature remained stable and closely followed that of the indoor air.

## 5.2 DISCUSSION OF THE RESULTS

The experimental results show that the temperature variation vertically through the house was in the region of 7°C to 8°C at mid-day. The amplitude of ground floor air temperature was no more than 2°C while the outdoor temperature fluctuation was of the order of 11°C. On the other hand, the temperature gradient horizontally around the house was not as significant as that vertically, and in all investigated spaces on the first floor level, air temperatures

### TEMPERATURE (DEG C) v HOUR OF DAY

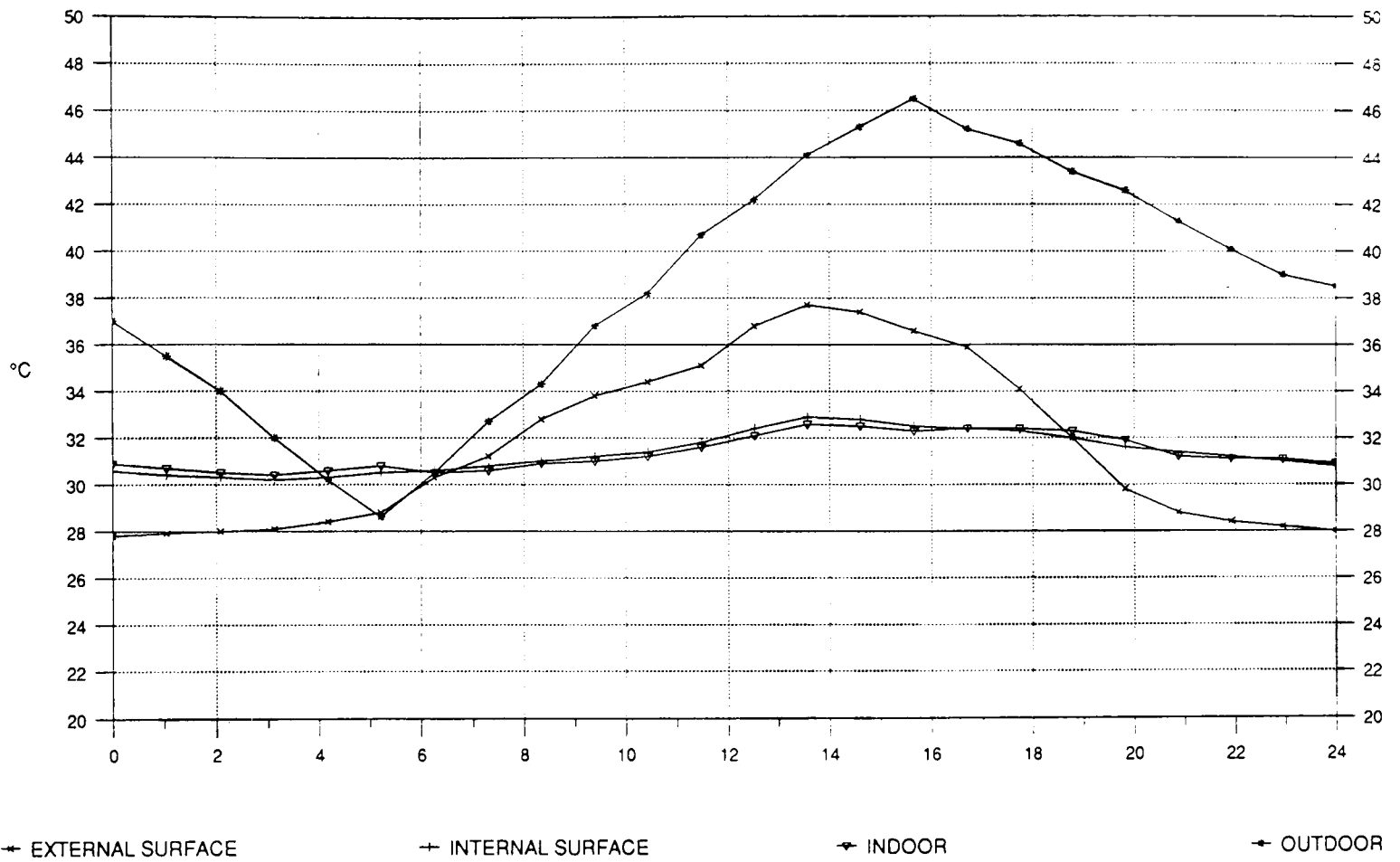


Fig. (5.10) Average of three days hourly variations of external and internal surface temperatures of the western wall of al-suffah.

were fairly stable throughout the 24 hours and showed very little fluctuation.

The experimental results also show that the air temperature of al-majlis located in the north part of the house rose slightly beyond that of al-suffah and al-mu'akir between 0800 and 1300 hours. This may be attributed to the high air movement experienced in al-majlis due to the north-northwest breezes blowing during the forenoon hours. A small rise was also noticed between 1400 and 1900 hours in al-suffah located in the west part of the house. This rise again might be explained by the high air movement experienced in al-suffah due to the sea breezes blowing from the west during the afternoon hours.

The introduction of warmer air into the space may seem a contradiction, in terms of comfort, but this is easier to understand if one considers the basic needs of a human body in hot climates. As discussed earlier (Chapter Three, Section 3.1.5) heat losses from the body by radiation and convection, the normal methods in a temperate climate, become progressively less effective as the ambient temperature rises. Unless the body can sweat enough, these methods cease altogether when the skin is at the same temperature as that of the surrounding air and of the walls, floor and ceiling of a room. Then the only way the body can lose heat is by evaporation. This process, however, depends on the vapour pressure between the skin surface and the ambient air. High relative humidity slows it and only air flow can increase the evaporative capacity and hence the cooling efficiency. It does not matter if the draught is slightly warmer than the ambient air: it will evaporate sweat and reduce the subjective discomfort due to wet skin.<sup>8</sup>

It is interesting to note that the indoor peak temperatures of al-majlis and al-suffah occurred at about the same time as the outdoor peak temperature and thus there was no apparent time lag even though the structure was massive. This was certainly due to the continuous ventilation which kept the indoor air temperature changes in line with the outdoor temperature and had a very clear effect in concealing the lag of the massive walls.

Ventilation during the night was found to be not very effective in al-majlis and al-suffah of the first floor due to the low air movements experienced during night and early morning hours. A negligible effect of night ventilation was noticed in al-mua'Khir due to its location at the back of the house and the lack of large external openings compared to al-majlis and al-suffah.

In al-suffah, the internal surface temperature of the west wall was slightly higher than the room air temperature during the late night and early morning hours but lower during the day and early evening time. Hence, heat exchange between thick wall surfaces and the indoor is reversed, i.e. heat flows from the indoor air to the wall surfaces during the day and early evening time, and from surfaces to the indoor air during the late evening and early morning hours.

Air temperatures in al-mabit showed large fluctuation and rapid changes throughout the 24 hour period. After 0800 hours air temperature rose rapidly to about 39°C at 1400 hours. At 1600 hours, air temperature started to decline until it reached 28°C at 0100 hours. This sharp rise and decline of air temperature was due to the

low thermal resistance and heat capacity, of the wooden structure of al-mabîr which allowed the space to heat and cool more quickly.

### 5.3 THERMAL PERFORMANCE EVALUATION USING PMV VALUES

Examination of fig. (5.11) shows that between 0600 and 1300 hours al-majlis was slightly warm. The PMV values during this period ranged between +0.3 and +0.7. During the period of 1400 to 1600 hours the PMV values were slightly above the morning readings and ranged between +0.8 and +1.0. Between 1700 and 0400 hours the PMV values ranged between +1.0 and +1.6 thus indicating a warm environment.

An inspection of fig. (5.12) shows that during the period of 0600 to 1900 hours al-suffah was slightly warm and the PMV values ranged between about +0.5 and +1.0. However, there was a noticeable difference in the level of comfort achieved in al-suffah and al-majlis. During the period from 0700 to 1300 hours the PMV values in al-suffah were slightly above those recorded at al-majlis, but between 1400 to 1900 hours they were appreciably lower. During the night and early morning hours al-suffah was uncomfortably warm and the PMV values followed those recorded at al-majlis.

It can be seen from fig. (5.13) that al-mua'kir was uncomfortably warm almost all of the time, except for a very short period in the morning hours when the PMV values ranging between +0.8 and +1.0 indicated a slightly warm environment for about 3 hours.

### PMV VALUES v HOUR OF DAY

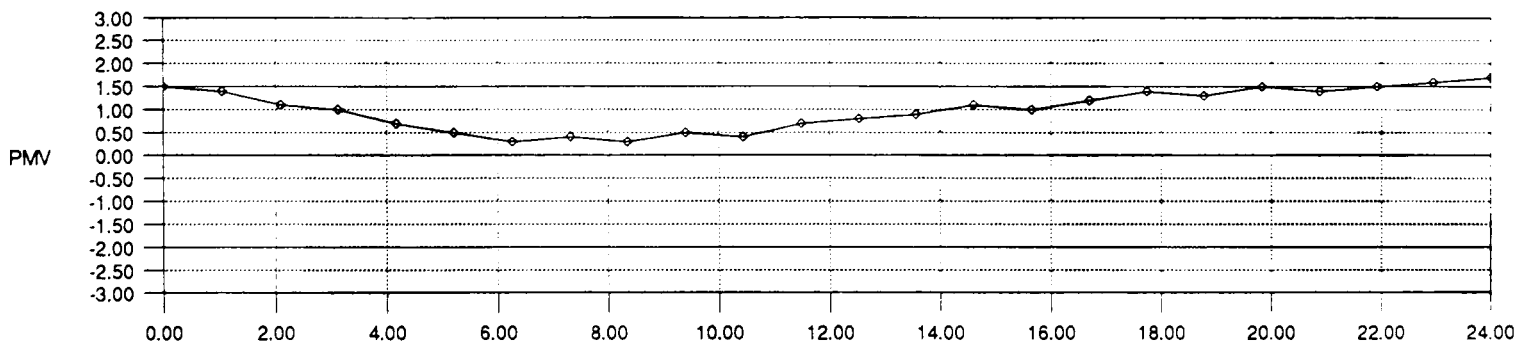


Fig. (5.11) Hourly variations of PMV values in al-majlis.

### PMV VALUES v HOUR OF DAY

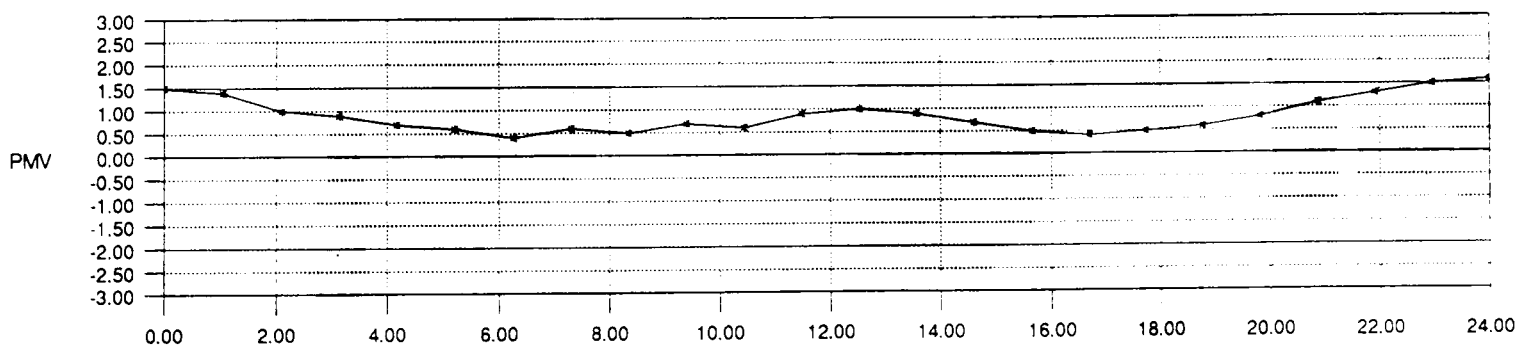


Fig. (5.12) Hourly variations of PMV values in al-suffah.

### PMV VALUES v HOUR OF DAY

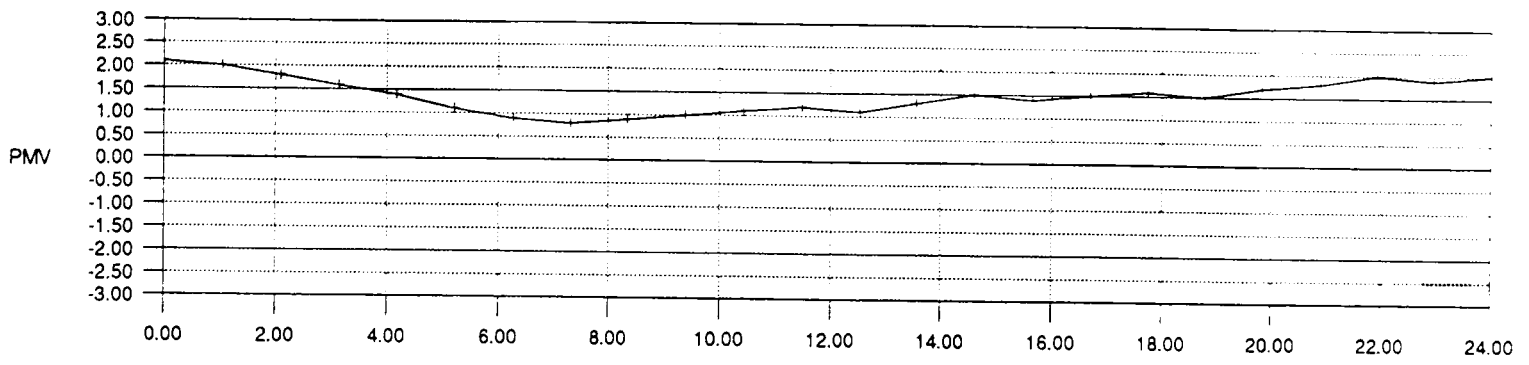


Fig. (5.13) Hourly variations of PMV values in al-mua'khir.

### PMV VALUES v HOUR OF DAY

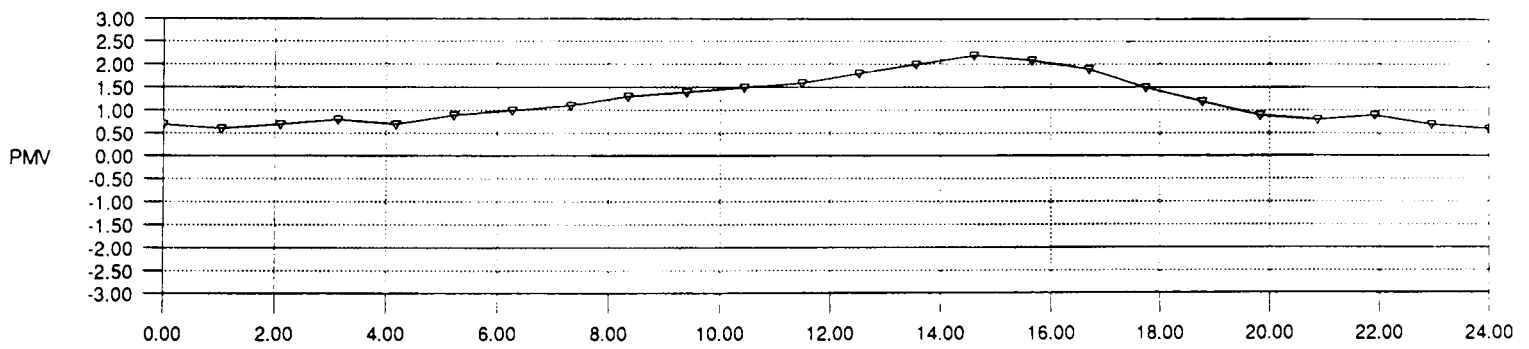


Fig. (5.14) Hourly variations of PMV values in al-mabit.

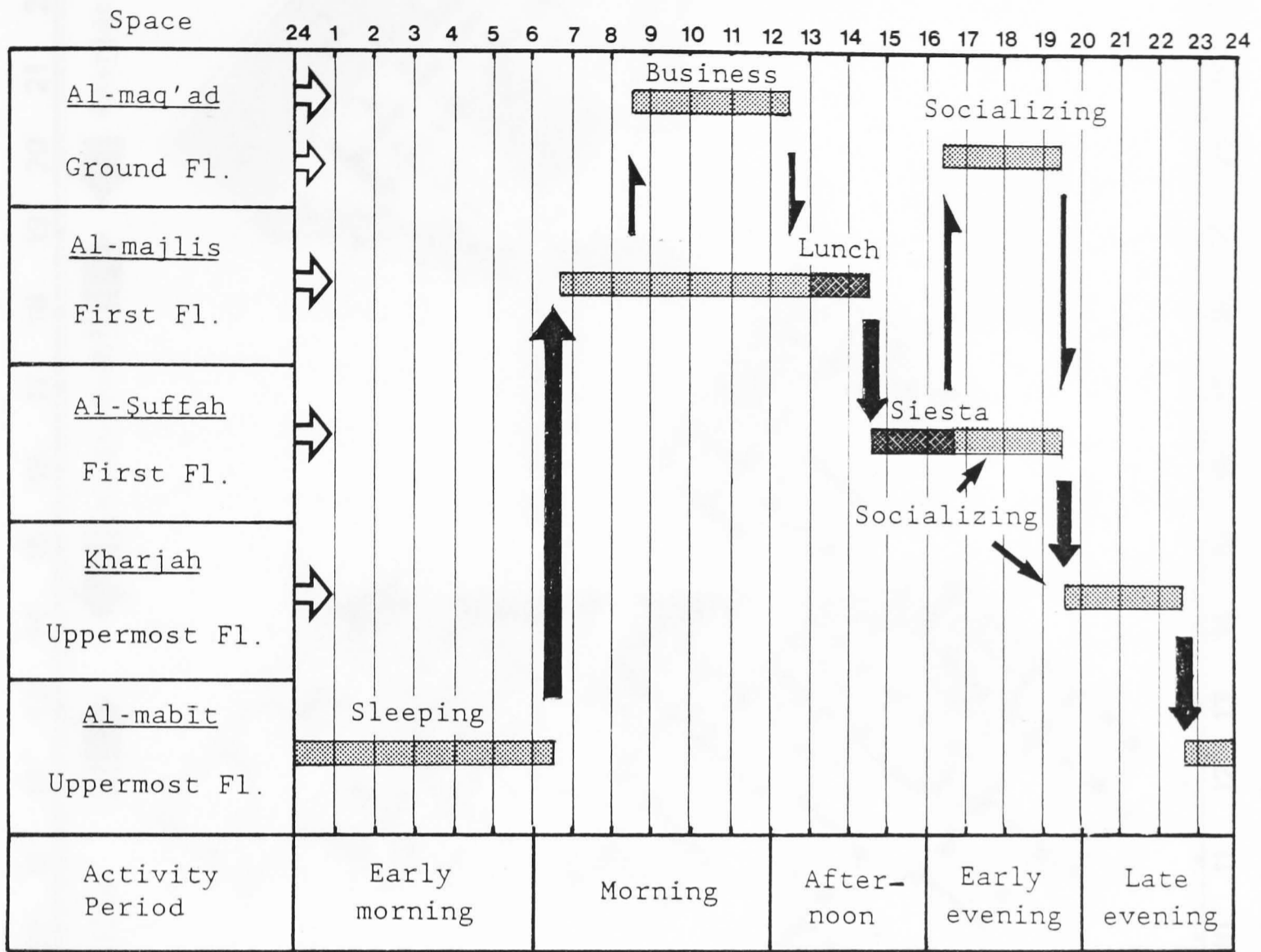
Examination of fig. (5.14) shows that a al-mabîr on the uppermost floor was uncomfortably warm during the periods of 0700 to 1100 hours and 1600 to 1900 hours. The PMV values ranged between +1.0 and +1.8 during these two periods. However, between 1200 and 1600 hours al-mabîr was almost hot and the PMV values ranged between +1.9 and +2.2. During night and early morning hours the PMV values were below those recorded at the living spaces of the first floor and ranged between +0.6 to +0.8 thus indicating a slightly warm environment.

#### 5.4 TESTING THE HYPOTHESIS

The measurements indicate the thermal conditions of the different living spaces in the traditional house and the level of comfort or discomfort experienced in each space during the 24 hour period. The nature and extent of the interaction between the thermal performance of the house and the spatial behaviour of occupants will now be considered. The thermal acceptability of the space will be evaluated in the light of the measured thermal parameters, level of comfort and the time during which the space was most used.

Fig. (5.15) summarizes the space-use pattern in the house based upon the conducted interviews (Chapter Four, Section 4.2.1). The family summer activities were usually concentrated in the first floor level during the day and in the uppermost floor during the night. The experimental results show that at mid-day there was a vertical temperature-gradient in the region of 7°C to 8°C through the house (fig. 5.16). However, the temperature gradient horizontally around the house was not as significant as that vertically, and air

Space v Time of Use



↑ The whole family

↑ Men

Fig. (5.15) Space and time use chart for the summer season based on the interviews conducted by the author. (See Chapter Four, Section 4.2.1).

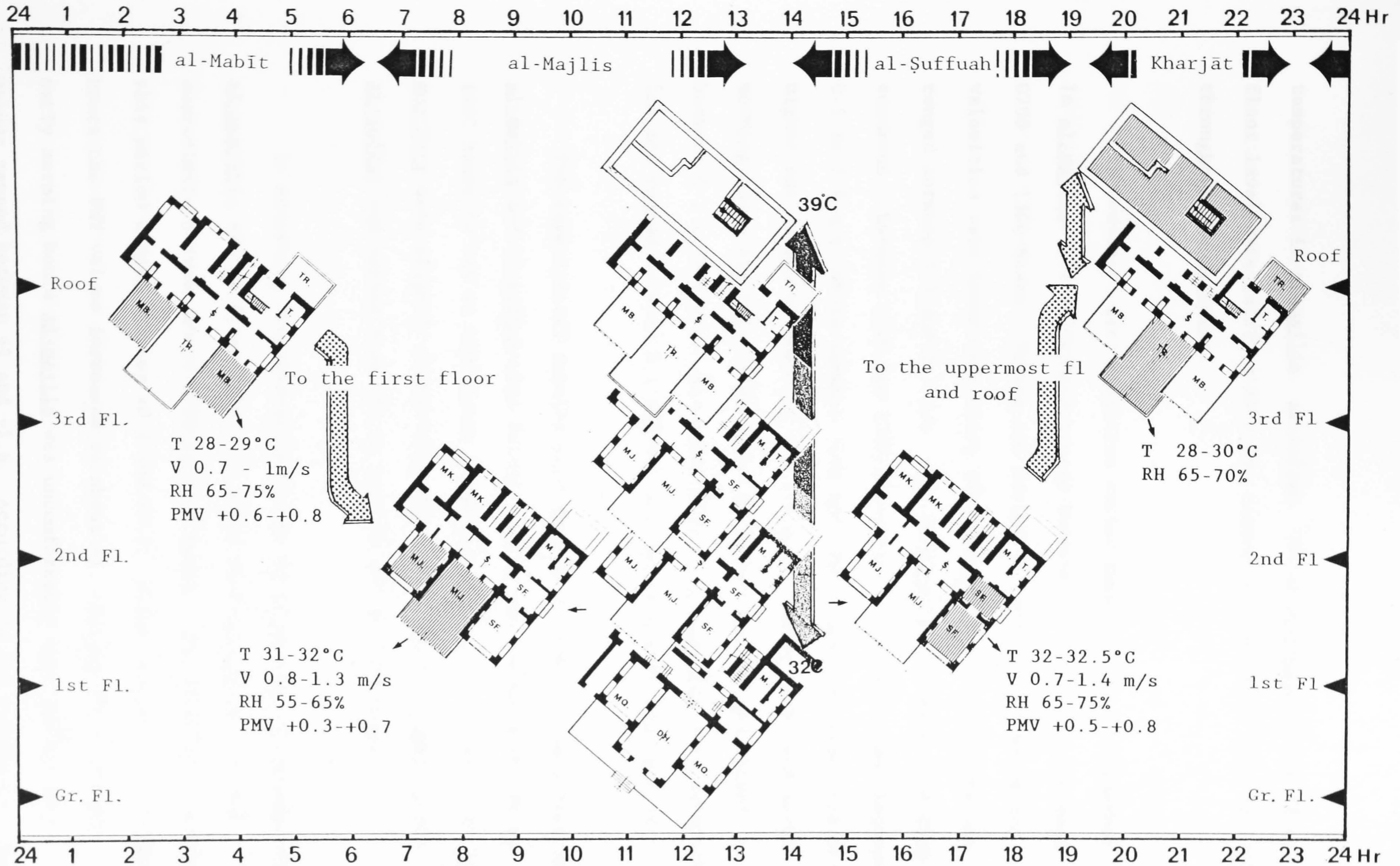


Fig. (5.16) The correlation of experimental results and the patterns of space-use during the summer.

temperatures in al-majlis, al-suffah, and al-mua'khir of the first floor level were fairly stable and ranged between about 30°C to 33°C throughout the 24 hours.

In contrast, air velocities varied from one space to another. In al-majlis, air velocities ranged between 0.8 to 1.3 m/s between 0700 and 1300 hours. During the period of 1400 to 1900 hours air velocities were lower than those recorded in the morning hours and ranged between 0.3 and 0.7 m/s. But in al-suffah reverse conditions occurred. Between 0700 and 1300 hours air velocities ranged between 0.5 to 0.8 m/s, while between 1400 and 1900 hours air velocities were higher and ranged between 0.7 and 1.4 m/s. During night and early morning hours air velocities were low in both spaces and ranged between 0.2 to 0.6 m/s. Air velocities in al-mua'khir were generally low and ranged between 0.1 and 0.7 m/s during the 24 hour period.

The experimental results also show that relative humidities in al-majlis and al-suffah were fairly similar and varied from 52% at 1400 hours to 78% at 0500 hours. However, relative humidities in al-mua'khir were slightly higher than those recorded in al-majlis and al-suffah and varied from 58% at 1400 to 80% at 0500 hours.

In assessing the thermal qualities of al-majlis, al-suffah, and al-mua'khir of the first floor, it seems that al-majlis was most comfortable between about 0700 to 1300 hours. The PMV values during this period ranged between +0.3 and +0.7. While between 1400 to 1600 hours the PMV values increased to about +1. During the night and early morning hours al-majlis was uncomfortably warm and the PMV values ranged between +1 and +1.6. According to the informants, the

family usually moved from al-mabîr in the uppermost floor to al-majlis of the first floor between about 0600 and 0700 hours and used this space until noon when they had lunch. On the other hand, the PMV values in al-şuffah were slightly higher than those of al-majlis between 0700 and 1300 hours, but they were appreciably lower between 1400 to 1900 hours. During the night and early morning hours the PMV values in al-şuffah followed those recorded at al-majlis. Thus al-şuffah was most comfortable between about 1400 to 1900 hours. The family usually moved from al-majlis to al-şuffah between about 1300 and 1400 hours and used it for the afternoon siesta and socializing until 1900 or 2000 hours. On the other hand, al-mua'khir was uncomfortably warm almost all of the time and the PMV values ranged between +1 and +2. This space was most used during the winter season for night time socializing and sleeping.

Regarding the thermal conditions of al-mabîr on the uppermost floor, the experimental results show that air temperatures in al-mabîr were 3°C to 6°C above those recorded in the living spaces of the first floor during daylight hours, and about 2°C to 3°C lower during night and early morning hours. Air velocities in al-mabîr were also higher than those recorded in the first floor throughout the 24 hour period and ranged between 0.5 and 1 m/s during the period of 2200 to 0500 hours. The PMV values in this space ranged between +1.0 and +2.2 during the period of 0700 to 1900 hours thus indicating an uncomfortable warm environment. However, during night and early morning hours al-mabîr was relatively comfortable compared to the living spaces of the first floor. The PMV values ranged between +0.6 to +0.8 during this period. The family usually retired to the roof

and kharjat of the uppermost floor for socializing and afterwards to al-mabit for sleeping.

## 5.5 FINDINGS

The correlation of the experimental results with the patterns of space-use during the summer clearly indicates that the family movement from the uppermost floor to the first floor at the beginning of the day enabled them to take advantage of the temperature variation through the vertical section of the house and the good thermal characteristics of the thick and heavy structure of the lower floors. They moved from a floor level that contained the least volume and exposed relatively the most surface area to one that contained the most volume and exposed the least surface area relative to that volume. In other words, they moved from a floor level that was more susceptible to heat stress during the day to a lesser one.

Also, the overall relationship between the measured thermal conditions and level of comfort in al-majlis and al-suffah of the first floor, and the time during each space was most used indicates that the family movement around the first floor living spaces during the day was dependent on the daily variation of air movement. Air temperatures and relative humidities in al-majlis and al-suffah were fairly similar and showed minor differences throughout the day. The only significant difference was in air velocities.

During the morning hours al-majlis experienced high air movement due to the north-northwest breezes while during the afternoon hours air movement decreased. On the other hand, al-suffah

experienced low air movement during the morning hours and high air movement during the afternoon hours due to the sea breezes blowing from the west. Therefore, al-majlis was more comfortable than al-suffah during the morning hours but less comfortable during the afternoon hours. This is clearly shown in the PMV values results which even though indicated a "slightly warm" environment in both spaces during the morning and afternoon hours, they varied in each space according to the differences in air velocities experienced during these two periods.

At night, the family movement through the house was reversed. They moved from the first floor which was less susceptible to external variation to the uppermost floor which was more susceptible. This movement also enabled the family to take advantage of the higher air velocities obtained at the uppermost floor and the thermal characteristics of the lightweight structure of al-mabit.

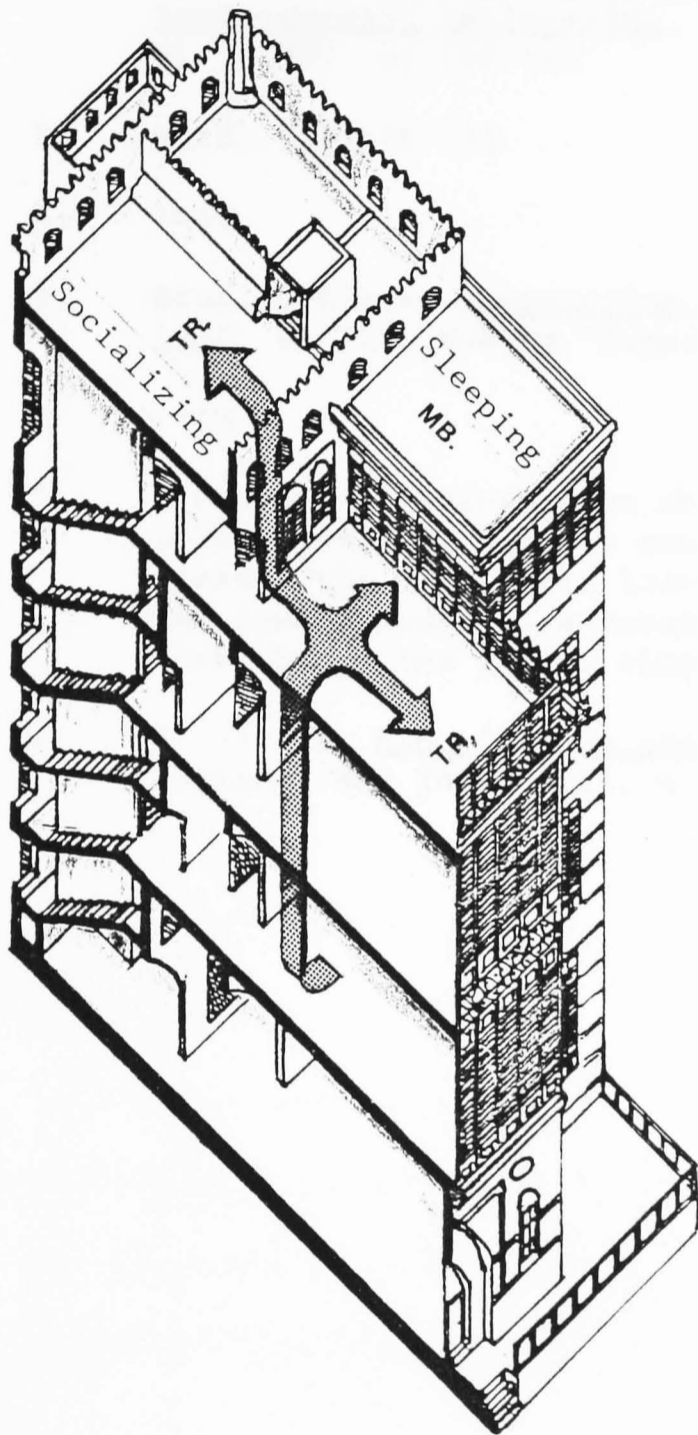
It should be noted here that unlike Mekkah and Medina, sleeping on the open terraces was not practised by the old inhabitants of Jeddah during the summer nights. This was certainly due to the problems of dew. In Jeddah, where the relative humidity is usually high during the summer nights, the prevailing air circulation during late and early morning hours cools the air below the dew-point. This in turn causes the vapour in excess of the air's capacity to condense into overnight dew. Thus it was essential to provide a sheltered place for sleeping while allowing the air to flow freely in the space to increase the potential for evaporative cooling.

## 5.6 CONCLUSION

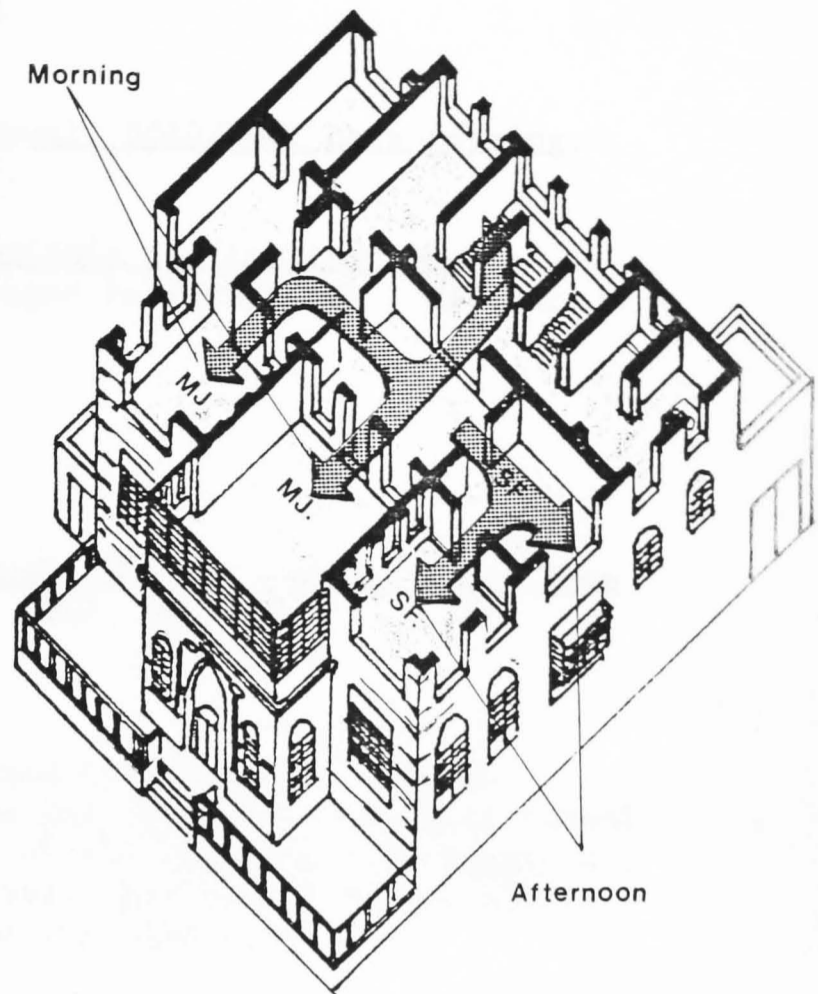
Although the thermal measurements cannot claim to be comprehensive, the results do strongly support the hypothesis that the occupants' spatial habits and space use patterns were in large part determined by the availability of desirable thermal qualities. The findings of this investigation are, first, the variation of temperature through the vertical section of the house during the day provided the most advantageous conditions for living in summer. Second, there is a strong correlation between the vertical differentiation of surface to volume ratio, the properties and disposition of materials, and the daily summer movement of the family through the house. Third, there is also a strong correlation between the daily summer movement of the family around the house and the presence of sufficient air movement. The family moved from a low air movement space to one that was better ventilated. In other words, they moved from a less comfortable space to a more comfortable one.

In general, it can be concluded that comfortable living conditions during the summer were achieved by a rather distinctive form of migration. The daytime was usually spent at the first floor and the night-time on the uppermost floor. At the first floor level, the family spent the morning in the north-facing living space (al-majlis) to take advantage of the prevailing north-northwesterly breezes. In the early afternoon the family moved to the west-facing living space (al-suffah) to benefit from the sea breeze blowing from the west. At night the family retreated to the uppermost floor level where they socialized on the terraces, under the stars, and slept in the airy structure (al-mabîr). Thus the hot period was passed

comfortably by a gentle diurnal migration: a horizontal migration around the house during the day and a vertical migration through the house at night (fig.5.17).



Vertical migration during night



Horizontal migration during daytime

Key

- MJ. : Al-majlis
- SF. : Al-şuffah
- MB. : Al-mabîṭ
- TR. : Kharjah or Terrace

Fig. (5.17) Diagrams demonstrating the family's summer diurnal movement around and through the house.

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2. P. Fanger, Thermal Comfort, Analysis and Applications in Environmental Engineering, Grieger Publishing Co., Malabar, Fl., 1982, pp.107-142.
3. Ibid., pp.128-133.
4. Ibid.
5. Bruel & Kjaer, Instruction Manual, Thermal Comfort Meter Type 1212, DK-2850 Naerum, Denmark, 1982, pp.1-10.
6. Ibid.
7. According to information obtained by the author through interviews with elderly men who had lived in these traditional houses, the adjustable louvres of the rawashin and tagaat in the lower floors were usually left open during summer nights even though the family slept in the uppermost floor.
8. B. Givoni, Man, Climate and Architecture, Van Nostrand Reinhold Company, New York, 1981, p.67.

## CHAPTER SIX

### AN EVALUATION OF THE TRADITIONAL

### HOUSE OF JEDDAH

In a pre-industrial economy, before the advent of electricity, appliances, and automobiles, the traditional tower house of Jeddah represented a highly developed and sophisticated thermal adaptation to the problem of comfortable living in the hot humid climate of Jeddah. Its success was dependent upon the urban pattern, the composition of the house and its elements and materials, and the living patterns of its occupants.

The orientation of the main facades, the size and location of openings, relative locations of the various living spaces, the rational and effective use of building materials and the colour of external surfaces, all indicated an intimate knowledge of the local climatic conditions as well as a successful traditional building techniques. Elements such as the rawāshin, indoor wooden screens, and stairwell or airshaft each served as a part of a single thermal system and functioned efficiently to circulate air within the house.

In responding to the climate, the form of the house interacted with the different sorts of weather conditions in different ways at various times throughout the day and created different kinds of microclimate indoors. On the other hand, the family developed a way of life which allowed them to use the different living spaces in optimal patterns in order to take advantage of these environmental opportunities. This behavioural response discouraged the elaborate

furnishing of rooms for specific purposes. The idea of a bedroom was as meaningless as a dining room. Non-specialization of the use of space therefore allowed comfort choice as family had more than one place to sleep, more than one place to eat, etc. This clearly indicates that the living atmosphere in the traditional house was very interesting and dynamic. The family moved from one place to another in order to maximise their comfort throughout the day and night. Thus, the traditional house must be seen as a complex set of microclimates where each space would be used to its best advantage and according to the thermal needs of the family.

However, thermal comfort did not just draw family members together, it also enriched their social life. Places with desirable thermal qualities became social places. The rawshān, for example, provided a cool and well ventilated spot. As it was fitted with a cushioned bench it became a favourite place to sit for passing the time in easy and intimate socializing. The roof terrace was another example. During summer nights, it functioned as a dynamic space where the family gathered to socialize in an open, yet private living setting. Thus, a symbiotic relationship between the climatic modification function associated with these spaces and their social and cultural significance was formed.

Equally as important, the traditional house satisfied the needs of the family from the point of view of social customs and religious demands. The boundary of the house and its relationship to the street and neighbouring houses clearly reflected the influence of the Islamic and socio-cultural principles and rules on the building process. The size of the house and its living arrangements mirrored

the large size of the extended family. The vertical division of the house into semi-private and private domains clearly reflected the concern for privacy encouraged by Islamic culture. The rawāshīn were veils drawn against the outside world and behind their shield of louvered panels family members reclined in shaded privacy while gazing down at the streets and, unseen, shared in the life of the outside world. The high parapet walls surrounding the edges of the terraces provided proper privacy for the family and prevented overlooking into neighbours' roof terraces.

Hospitality was strongly emphasized on the ground floor or male guests domain. The spatial arrangement and furnishing of this domain created an atmosphere of warm welcome and friendly shelter. No wonder that many prominent families in old Jeddah had the custom of leaving the main entrance of the house open during the day and early evening.

Social status and wealth were mainly reflected in the quality of woodwork contained in the house. For example, the houses of the notables and merchants were characterized by elaborately decorated rawāshīn, carved and ornamented external doors, fretted arches, and decorated internal and cupboard doors; while the houses of the common people had simple rawāshīn with a minimum of detail and ornamental treatment. Street-doors were mostly made of plain panelling with little decoration.

Technology and available resources were reflected in the construction techniques and in the use of building materials. The house form responded structurally to the mechanical stresses of

gravity and the poor bearing capacity of soils with intermittently high water tables as well as to the problem of weathering. The main body or building mass was never forced into shapes unnatural to the coral stones it was built of, and the limitations of this soft and porous material were overcome by the proficient use of qandal courses. Articulations of the facade were achieved in masterly fashion with the projecting wooden rawāshīn. As a result of this, and despite the geometrical simplicity of the form, the overall appearance of the house displayed a very rich formal character with perfectly harmonious and balanced proportions and highly articulate facade treatments that projected a pleasant aesthetic onto the townscape.

Rigidity of the inner envelope was broken down by the projecting rawāshīn, recesses, and niches which created positive sub-spaces for different uses around the main space and gave architectural richness to the enclosing surfaces. Their locations manifested the well-balanced relationship between solids and voids and established the personality of each space.

In summary, the traditional house of Jeddah not only responded to the local climatic conditions but did so with the combination of beauty and physical and social functionality. Its distinctive character was manifested in its rational and pragmatic approach to creating an optimum living environment for life as it was then.

The master builders possessed both a vivid imagination to see things three-dimensionally in their minds, and the ability to form and conform their buildings into an expressive and coherent organism.

They always worked within the framework of the social culture and economic and technological realities. They were sensitive to the needs of the families for whom they were building, and they were familiar with harsh natural constraints upon house construction. They had a good knowledge of the behaviour and characteristics of materials, not just in terms of climatic response and construction, but also in regard to weathering - how the materials and building fabric would stand up to the ravages of time and weather.

Finally, the old town was distinguished by variety within unity; hardly two houses were identical, and still they all belonged to the same "family". Unity of character was achieved through a defined vocabulary of formal and stylistic elements, using limited materials and limited colours. This consistency could not have been achieved without tradition, nor without a natural response to local environment. A tradition that remained stable over a long period only to be upset by the impact of modernization and the imported new technology in the mid of the twentieth century.

## CHAPTER SEVEN

### THE MODERN VILLA

The changes in residential architecture experienced by Jeddah over the last thirty years or so, are almost beyond imagination. The full visual impact that recent structures have had and still continue to have on the built environment can only be assessed by actual experience. The feeling might perhaps be comparable to visiting a Disneyland of residential manifestations.

Having examined the traditional house in some detail in the previous chapters, I felt it would be interesting to review briefly the modern residential architecture in the context of what is known about the traditional house. I will therefore attempt to provide as realistic a picture as possible of the causes and circumstances that have led to the debilitation of the traditional house building and emergence of new housing patterns.

I shall, however, restrict the discussion to private villas. I shall not include multi-storey flat buildings nor any form of government housing. The reason for this is that villas are the largest category of dwelling in Jeddah.<sup>1</sup> Saudis always prefer to live in single private houses. The first thing that families channel their saving towards is the building of a private house. This preference is for three reasons. First, the private house bears the name of the family occupying and owning it, a custom which has a long history in Jeddah. Second, Saudi families prefer to have a lot of space in their houses, thus flats will not meet their desires, as the

space inside flats is much less than that of a private house.

Finally, the private house in the Saudi society is closely linked to the expression of status.<sup>2</sup>

The private villa is therefore probably the greatest influence on the built environment, and its form and ensuing pattern will be crucial to the future of residential development in Jeddah.

It is also worth noting that due to the great diversity of modern villas in Jeddah, what can be said about them in a brief chapter has to be rather general. The main objective is to present the general characteristics of the modern villa and its shortcomings assessed in relation to the traditional house. Consequently, the examination of a specific period or particular buildings is not necessary for the purpose of this study. Finally, I will present some personal views and suggestions for developing a new attitude in Jeddah's contemporary residential architecture.

## 7.1 CAUSES OF CHANGE

The last four decades have witnessed major transformations and rapid changes in Saudi Arabia, in both the social order and the physical environment. Numerous interacting factors have contributed to these changes. However, the real impetus undoubtedly came with the exploitation of the vast oil resources of the country, shortly after World War II, coupled with the governmental decision to diversify the economy through modernization and industrialization. The exploitation of oil generated tremendous revenues, inducing a sudden economic boom of anomalous dimensions which brought freedom

from financial constraints, but, in addition, a whole new complex set of social and technological pressures.<sup>3</sup>

#### 7.1.1 Change in the Social Structure, Family Type and Way of Living

The occurrence of the economic boom and the modernization process, resulted in sudden changes in society. With more varieties of occupation and experience available than earlier, and with jobs easily accessible in different regions of the country, the extended family household began to give way to the nuclear family household. Some members of the family had to take jobs in other remote cities, while among the younger generation there seems to have grown a common preference for private life after marriage.<sup>4</sup> However, despite this relative independence, emotional support and financial obligations remained strong among the separated members of the extended family.<sup>5</sup> It is interesting to note here that in many cases, older parents might move into a married son's home (preferably into the home of the oldest son or the one in the best financial situation), and on occasion a nuclear family might have one or more relatives of each side (the husband's or the wife's) living with them.<sup>6</sup>

At the same time, social ties and interactions have been weakened through the introduction of modern services and modes of communication along with other aspects of modernization. For instance, the telephone is one cause of the weakening of direct social interaction; and the TV set has replaced discussions among the family members in the evenings. In the society at large, people are

becoming more independent, communal interaction is weakening and ties between neighbours and friends are not as valued as before.<sup>7</sup>

The importation of a foreign workforce during the modernization process was also instrumental in opening up the way for socio-cultural change in Jeddah's society. A large number of foreign professionals and labourers (both Arab and non-Arab) were brought to the town in an effort to build the modern Jeddah. Whereas the traditional society of old Jeddah had always been able to adopt and assimilate foreign customs without losing its distinctive compact structure and identity, the post-1948 society could no longer cope with the immense encroachment of alien values. Thus within approximately two decades, the culture of Jeddah had changed into a complex and less integrated one, losing much of its simplicity, homogeneity and compactness.<sup>8</sup>

Also the improvement of the transportation network at both the international and domestic levels, the availability of market facilities, the contact with other cultures, new educational facilities and so forth, made it possible for almost every member of the society to be better informed about the rest of the world. It has also become economically feasible for every citizen to go abroad. The people who have travelled have seen different social norms and different life styles. Some of them have been influenced by what they have seen there and tried to emulate it regardless of its suitability for their own society.<sup>9</sup>

### 7.1.2 Change in Building Materials and Techniques

During the economic boom and modernization process, an imported building industry emerged. New and different materials of construction such as cement, steel reinforcement bars, pinewood and tiles were imported from Europe. In addition to these building materials, a variety of sanitary fittings, plumbing pipes and fixtures, electric wiring, sockets, plugs and light bulbs, ceiling fans and air conditioning devices were introduced.<sup>10</sup>

Along with the new building materials came new building techniques and construction systems, which brought about a drastic change in the local characteristics of the built environment. Frame construction became a new phenomenon in housing construction in Jeddah. The building materials used in this form of construction are reinforced concrete for all structural elements and hollow concrete blocks for the walls.

With the introduction of new building materials and techniques, the unity of construction has been lost. The relationship between locality and building material has been almost completely eroded. The new building materials and techniques were appreciated for three reasons. First, they satisfied the urgent need for housing which resulted from the high rate of population growth. Second, the high durability and enhanced structural properties of the new building materials made them superior to the traditional porous and soft coral stones. Finally, such materials were also seen as modern and therefore were equated with progress by the mass of the population as

against traditional and backward ones. They thus acquired also a 'status' value.<sup>11</sup>

### 7.1.3 Introduction of Professionalism

The introduction of new manufactured building materials and new techniques, coupled with the need to build a considerable number of houses built in a short time, created new conditions in building practice in Jeddah. The master builders of Jeddah, who previously excelled in applying the coral stones qandal and teakwood to create the classic town houses within a long established building tradition were suddenly confronted with new materials, the property and application of which they could not easily grasp. In addition, the great opportunities at that time induced many foreign, particularly Arab architects, structural engineers, surveyors, contractors and draughtsmen.<sup>12</sup> These newcomers were not familiar with the socio-cultural traditions of the society and the various aspects of Jeddah's environment. They brought with them new design concepts and solutions to be built in Jeddah. The local builders were thus faced not only with new building materials, but also with alien designs, different construction methods, ventilation, lighting and plumbing systems.

Under these pressures, the master builders were gradually ignored and architecture took a completely different turn. House construction was no longer an incremental building process involving the user and the master builder. Instead, building practice became virtually a finished product, in which several professional groups (designers/architects, builders/contractors, and structural,

electrical, and services engineers) participated and shared responsibility for the physical outcome.<sup>13</sup>

## 7.2 LAND SUBDIVISION: THE SQUARE LOT AND THE VILLA

During the period between 1950 to mid 1960 most owner-occupiers of Jeddah's traditional houses moved out to the outlying suburbs to live in new houses based on totally new land ownership laws and imported urban patterns and building codes that complied neither with the Islamic religion or the traditions of the society, nor even with the climate of Jeddah. The urban development of Jeddah since the demolition of its surrounding wall in 1947 has been very complex, and therefore, difficult to evaluate. The western standards and urban planning concepts generally imposed upon a basically different cultural and physical climate, not to mention the different social and psychological environment, caused a great deal of damage.

A typical land subdivision zoned for residential purposes in modern Jeddah (fig. 7.1) illustrates several changes from traditional form. The old, organic, pedestrian-oriented street patterns were replaced by grid-irons of wide streets. Street patterns, which were formerly defined by man alone, are now defined by taking man together with his motor car. No longer does the street benefit from the shading that was a distinctive characteristic of the old town. Uniform lots contain detached villas with relatively big side and front yards. Thus the climatic benefit of mutual shading is lost.<sup>14</sup>

Beyond the loss of physical enclosure with its shaping of the microclimate is the additional decrease of spatial hierarchy of open

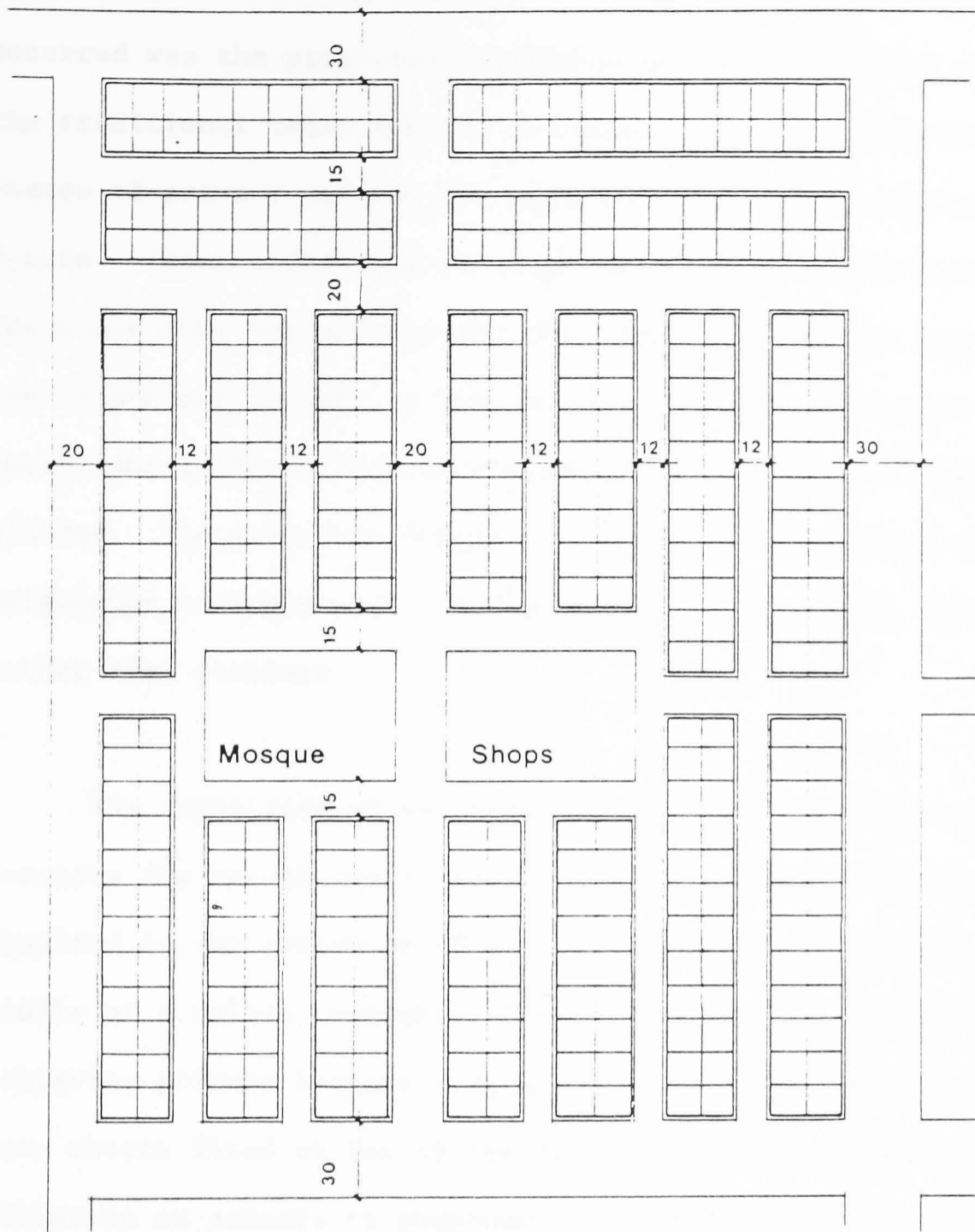


Fig. (7.1) Typical Municipal subdivision according to western planning practices.

Source: J.J. Boon, "The Modern Saudi Villa: Its Cause and Effect", The Arabian Journal for Science and Engineering, UPM, Vol.7, No.2, 1982, p.133.

spaces within the neighbourhood. The most significant change that occurred was the progressive elimination of semi-public space. In the traditional urban fabric, the hierarchical control over the degree of privacy allowed its open areas to become semi-public spaces. These conditions no longer exist with a grid-iron plan. There are only the private and the public spaces, the transition from one to another is left to its own devices.<sup>15</sup> An important element of social and cultural life in the society has thus been significantly altered. The street no longer enhances the interaction among neighbours living along it and people venture outside only for need rather than pleasure.

The imposition of set-back planning regulations to meet concerns for access, ventilation and fire spread in new dwellings resulted in the evolution of a box-like structure sitting in the middle of a walled compound. This created a main problem in achieving privacy between neighbours. One often sees long corrugated iron sheets fixed on top of the boundary walls between adjacent villas in an attempt to overcome the problem of overlooking from one building to another across the few metres of separation. Thus, the yard which surrounds the house is not private in the sense that family can socialize there, as it might be overlooked by neighbours.

### 7.3 DEVELOPMENT OF THE MODERN VILLA FROM EARLY 1950'S TO LATE 1980'S

Broadly speaking, in my opinion, the mediocre architects who arrived and practiced in Jeddah in the early 1950's neither valued nor maintained the traditional because they could not understand it.

They did not develop, enhance and refine its form and character in the context of the new because they had no sense of either, and they could not properly apply the new building materials to satisfy the aesthetic and functional requirements of the society.

The resulting residential architecture of what might be called Jeddah's early post-oil period was therefore one of strange and alien forms, a motley architecture which neither belonged to any school of thought nor was inspired by the charming and tranquil traditional forms (figs. 7.2 and 7.3). It was a true representation of the nondescript, crisis architecture, containing neither traditional references nor reflecting functional and climatic requirements.<sup>16</sup>

By the beginning of the 1970's, immense wealth was flooding the public and private sectors, causing an exceptional degree of instability in all aspects of Jeddah's urbanism.<sup>17</sup> The most salient motivating values of the city became more and more based on material fulfilment, power and mobility. As expected, however, such material dynamism immediately bred an unusual architectural craze: all of a sudden every citizen wanted to build a private house, especially after the foundation of the Real Estate Development Fund in 1974.<sup>18</sup> The major function of REDF is the provision of long-term loans to families and individuals who desire to build their own houses. The amount of the loan is equivalent to 70% of the total construction cost provided that the loan does not exceed three hundred thousand Saudi Riyals. This loan is interest free and should be repaid within 25 years after the completion of construction. The loan is granted only for the construction of a new house and not for purchasing an existing one.<sup>19</sup> However, there is no control by REDF on the form of

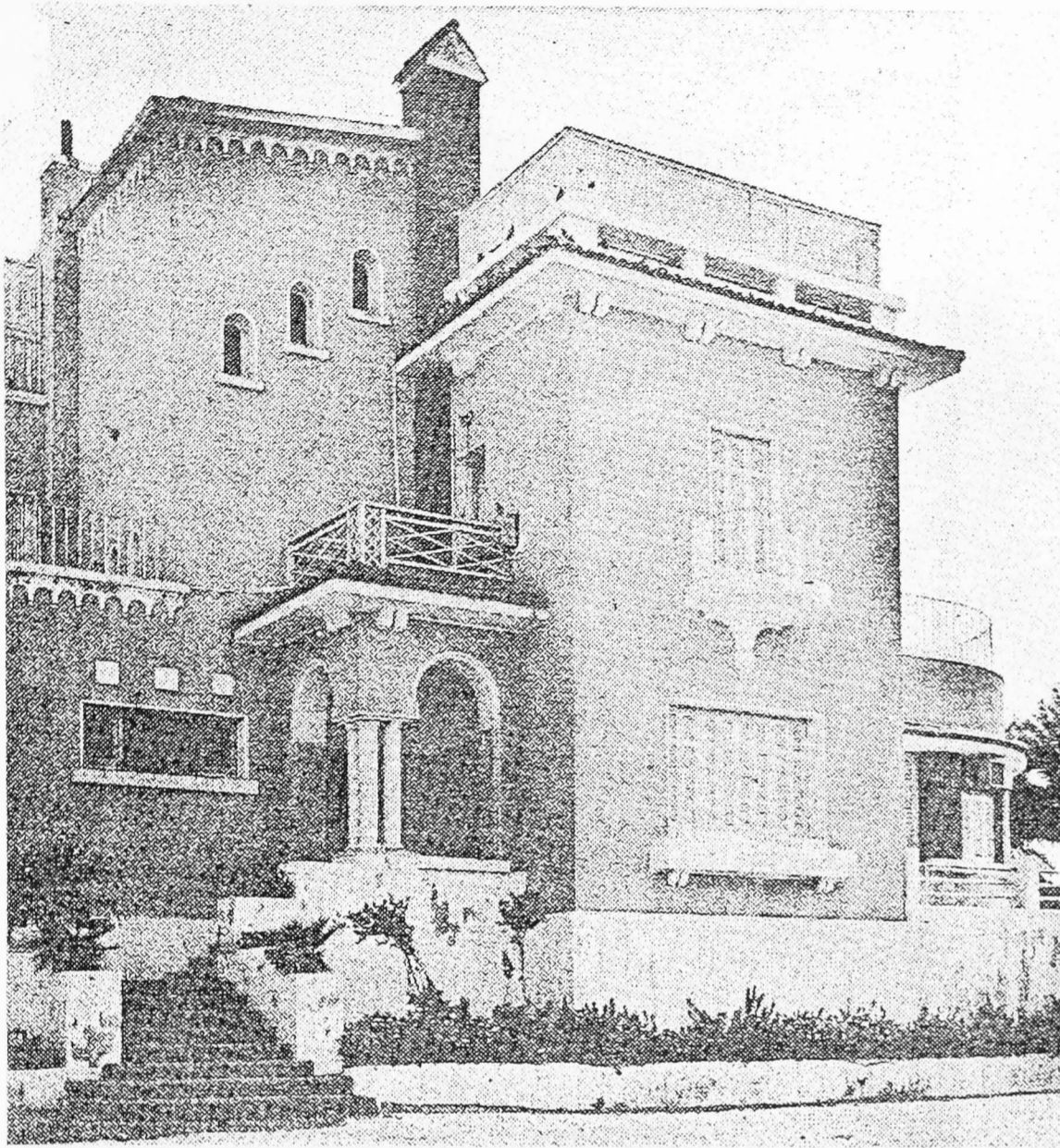


Fig. (7.2) An example of Jeddah's villas of the 1950's and mid 1960's. The geometric nature of the facade was expressed by the large balconies, the concrete and tiled friezes, the multi-colour scheme of the plastered exterior, the shuttered windows and balconies' doors, and the iron balustrades for balconies.

Source: A. Al-Ansāri, Tārīkh Madīnat Juddah, Dār Misr Letteba', Cairo, 1982, Appendix Three, Plate (L).

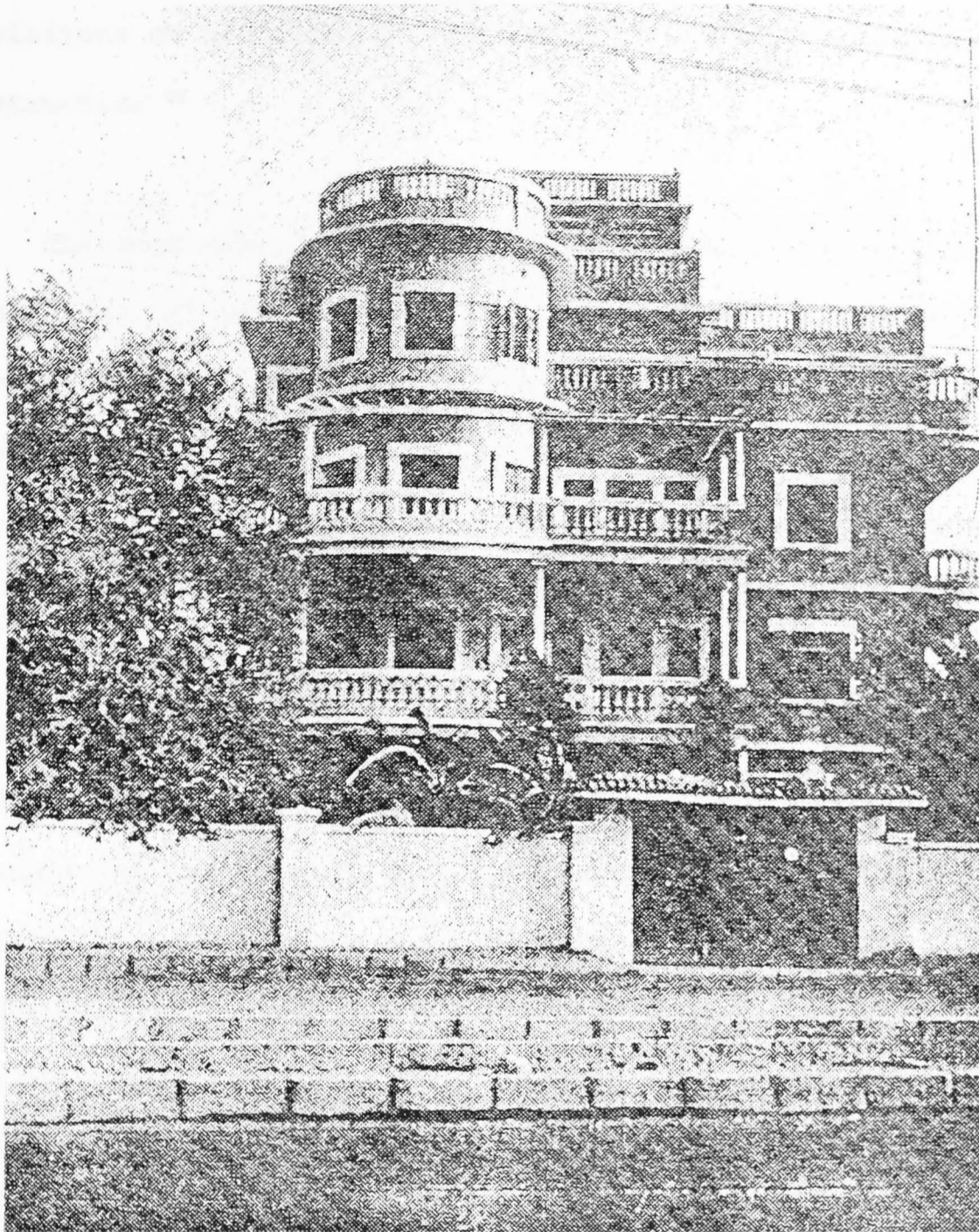


Fig. (7.3) Another example of Jeddah's villas in the early post-oil period. The iron door of the main entrance, topped with a canopy was also a characteristic architectural feature of this period.

Source: Ibid., Plate (M).

dwelling or its quality in design or construction, and building regulations do not exist for standards of daylight, ventilation or construction.<sup>20</sup>

The most conspicuous difference between the architecture of the middle post-oil period and the earlier period lies basically in improved building techniques, superior building materials and extravagant finishes, all made affordable by the increased wealth of the public and private sectors.<sup>21</sup> Yet the architectural confusion and the lack of an intelligible, architectural direction became even more ominous. New houses sprang up in every conceivable form, governed only by fashion and changing taste (fig. 7.4). It is worth mentioning here that the architectural boom and the large expenditures on urbanism during this period attracted a large number of architectural hucksters and businessmen "architects". Unfortunately some of them are Saudi architects who usually employ foreign professionals in their architectural firms. They would stop at nothing, including compromising professional ethics and principles in order to pocket a contract.<sup>22</sup>

The resulting residential architecture of the middle post-oil period was also characterless, anti-aesthetic and non-functional, and expressed quite astonishing gestures in the name of modernisation.

However, the country and its citizens witnessed even greater affluence in the 1980's.<sup>23</sup> This - the late post-oil period - can be considered as a transitional period. The individualistic statement of each residential form became of paramount importance at this time. People perceived their private houses as a symbol of their affluence



Fig. (7.4) An example of a modern villa in Jeddah during the middle post-oil period. The confused and irrational facade treatment adds yet another cosmetic design approach to Jeddah's eclectic architectural scene.

and status in society and each individual was compelled to state uniqueness in architecture. This in turn generated the eclectic forms that are now so much part of Jeddah's residential architecture. Neo-classical, Baroque, Neo-Islamic, Spanish, North African and a strange fusion of forms indiscriminately combined in exotic shapes which belong nowhere. More often than not one would encounter single family houses or villas combining traditional and Islamic motifs with modern western architecture, sloping roofs, and expansive glass surfaces and panoramic openings (figs. 7.5 and 7.6).

These extraordinarily eclectic dwellings stand side by side in Jeddah's modern residential neighbourhoods to display an architectural extravaganza, a carnival, a showroom of copied styles and motifs, results of confused aesthetic values and an apparent lack of any need to develop an appropriate architectural identity.

The extensive direct and indirect contacts of Saudi society with other societies and cultures through travel, education and media most likely contributed to this situation. Many alien concepts and values were translated into Jeddah's modern residential environment in a dramatic way with the help of architects who accepted the society's confused thoughts of modernization and expressed them in their designs. Many architects and architectural firms during this period became the agents of a specific class of citizens who only wanted to be different by building exotic and luxury villas.

Architecture was thus exploited as a means by which the ultra-rich gained social distinction or notoriety. At the same time it

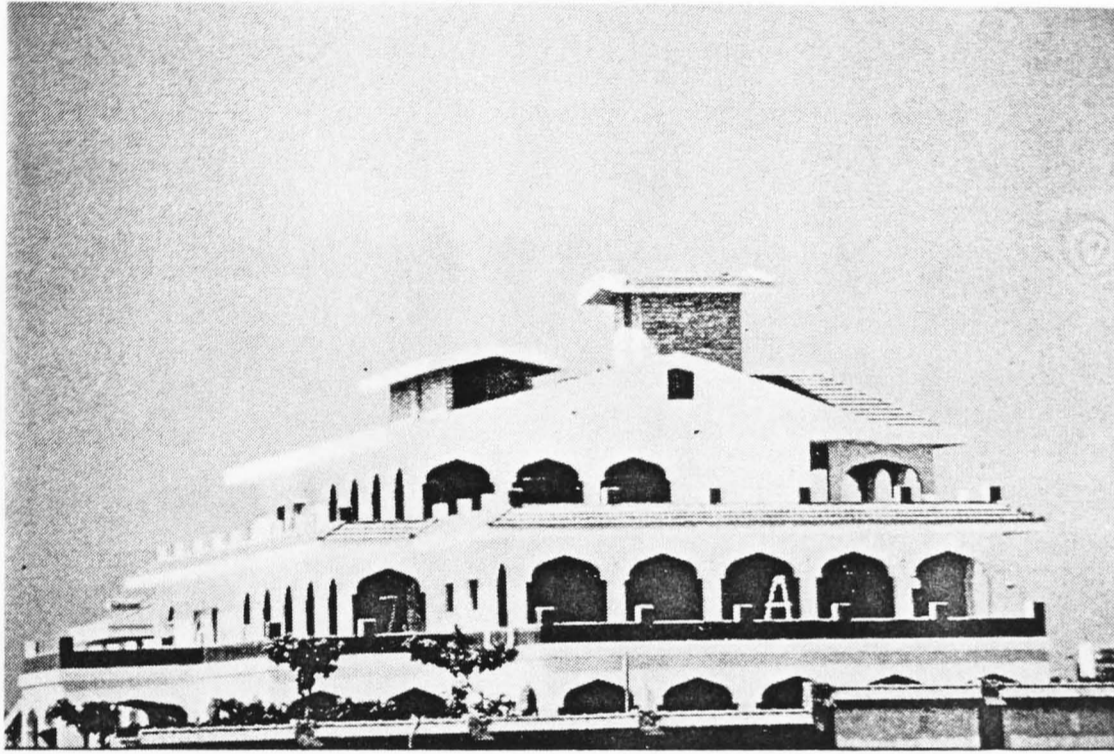


Fig. (7.5) An example of a modern villa in Jeddah during the late post-oil period. The image of monumentality is very strongly expressed throughout the structure. The exterior shows a mix of styles and different facade elements such as sloping tiled roof, arcaded colonnade, and large open terraces.

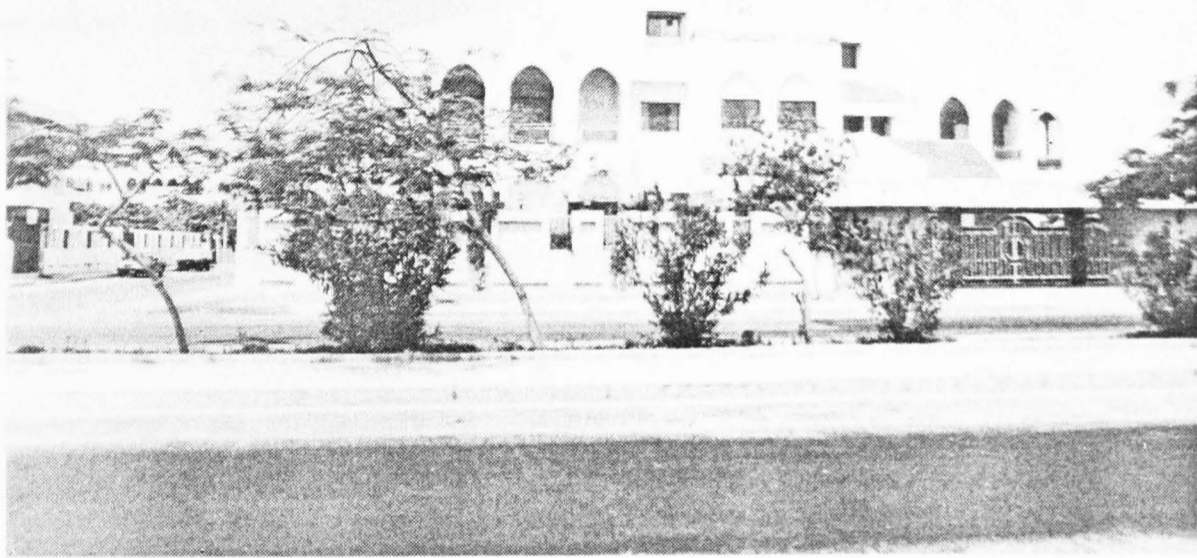


Fig. (7.6) Another eclectic example of the late post-oil period. A monumental, pseudo-Islamic image is portrayed through the use of pointed arches on the facade.

also lost any meaningful contact with the prevailing social spirit and consciousness.<sup>24</sup>

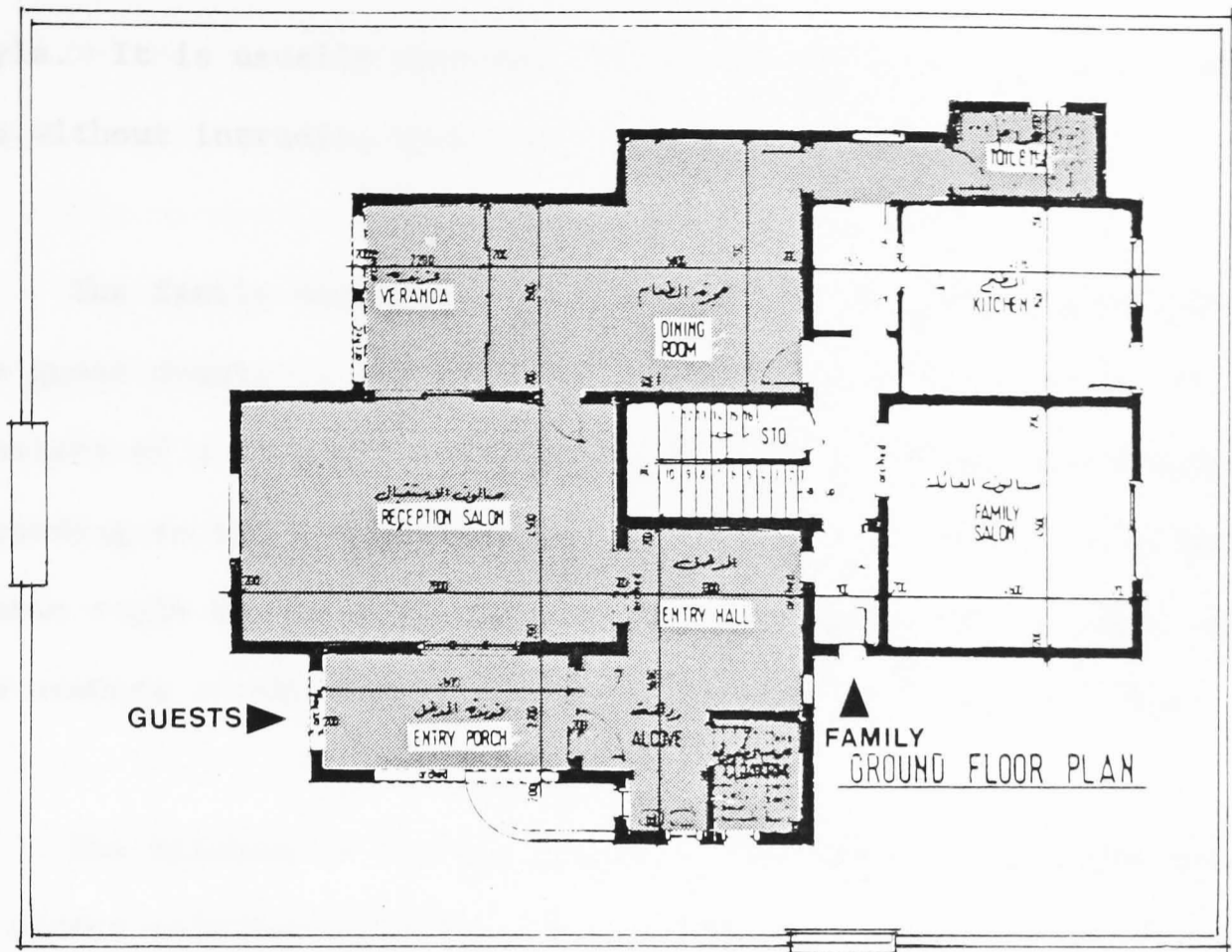
#### 7.4 A NOTE ON THE GENERAL ORGANIZATION OF DOMESTIC SPACE

The modern villa is usually two storeys high, sited on a lot that varies in size according to the means and status of the owner. However, the usual size ranges between 500 square metres and 1000 square metres. It is always surrounded by a boundary wall which is usually two metres high (fig. 7.7).<sup>25</sup>

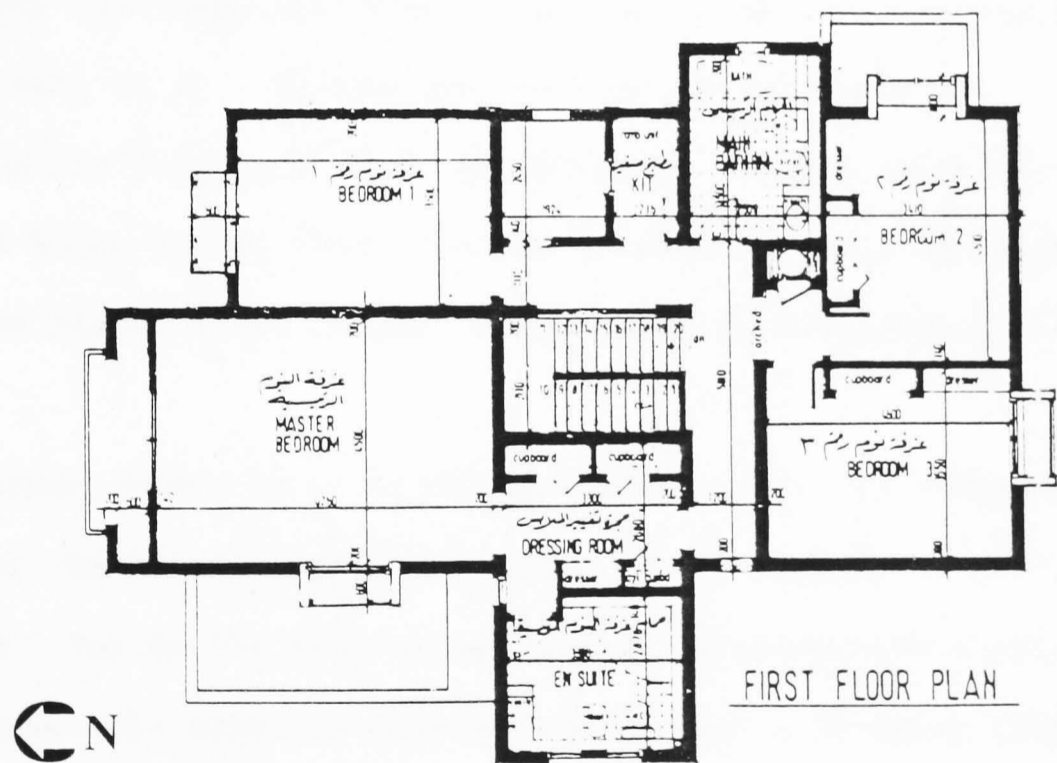
Most of the villas have two entrances to the lot; a main entrance for men guests and the other for the whole family. The symbolic importance of the main entrance is often emphasized by an extravagantly constructed gate.<sup>26</sup>

The interior space of the villa can generally be divided into two broad categories: public and private. The ground floor comprises public and private domains, and has two entrances, one for men guests, usually located towards the main entrance gate of the villa, and the other located towards the family entrance gate. The guest entrance leads into a hall where male guests are received. It is a transitional space between the outer space and the interior space of the house.<sup>27</sup>

The men's reception area is always located next to the entrance hall and directly accessible from it. It is usually divided into two rooms, one for sitting and the other for dining and mostly furnished in western style and sometimes in modernized Arabic style or Oriental



GUESTS' DOMAIN



SCALE 1:200

Fig. (7.7) An example of a modern villa plan in Jeddah.

Source: S.A. Saeed, *El-Eskān Walmaskan Walbeia'h*, Dar Al-byan Al-Arabi, 1986, p.138.

style. It is usually provided with a washroom and w.c. for guests to use without intruding upon the privacy of the household.<sup>28</sup>

The family domain at the ground floor is usually separated from the guest domain by means of closed doors and traffic halls. It consists of a kitchen, bathroom, and a family living room furnished according to the comfort criteria of the family, mostly in modernized Arabic style or Oriental style. This room is the place where mostly the members of the family gather to watch TV or video, or talk.

The kitchen is located close to the family living room and also in direct relation with the men's dining room for the ease of service. It is equipped with all kinds of modern cooking facilities. For the every day items and food, a storage space provided inside the kitchen or next to it. In some villas two storage rooms are provided, one for long term items which can be located preferably outside the house in the yard, and the second for every day items which can be placed close to the living quarters and kitchen area.<sup>29</sup>

The upper storey is a totally private domain. It contains the bedrooms for the family members, a bathroom and perhaps a kitchenette. The master bedroom is usually provided with a private bathroom accessible from the bedroom and through a dressing room.

As most families rely on servants for various household services, servants quarters are always incorporated in the design. They are usually built as independent units in one corner of the yard.

Unlike the abundance of exterior architectural styles and motifs, domestic space organization does not vary significantly from one villa to another. The basic functions of spaces and their relation to one another are usually present in similar forms and design concepts. Only the numbers and sizes of these spaces as well as the quality of the interior finishing materials vary from one villa to another. It is significant to note that interior eclecticism is more apparent in the furniture and furnishings than in the spaces themselves. Modern, ultra modern, high tech, French of various periods, other European, Far Eastern, Arabic and other styles can all be seen, and a variety is often present in a single residence where each living space is furnished in a different style.

#### 7.5 A NOTE ON STRUCTURE AND MATERIALS

Most of Jeddah's modern villas are reinforced concrete structures, using reinforced concrete ribbed slabs filled with hollow red brick tiles for floors and roofs and concrete blocks for walls and partitions.

The exterior is either plastered or often veneered with brick or marble and travertine or various configurations and textures of precast or cast in-situ concrete veneer elements. The brick commonly used is produced in Saudi Arabia whereas marble and travertine are always imported, commonly from Italy and Canada.<sup>30</sup>

Wood is scarcely used except for some interior spaces, doors, railings and balustrades. In some luxury villas wood is also utilized in the construction of extravagant lattice screens imitating

the traditional Cairene mashrabiyyāt (sing. mashrabiyyah) (fig. 7.8).<sup>31</sup>

Roofs are frequently flat although different forms of pitched and tiled roofs are becoming increasingly popular. Windows are almost always of aluminium frame, whether rectangular, arched or circular, and most are manufactured locally.

#### 7.6 THE MODERN VILLA IN THE LIGHT OF THE TRADITIONAL HOUSE: A COMPARATIVE EVALUATION

The modern Saudi villa is often inaccurately described as a 'western villa'. While it is true that it is derived from the western detached house, it is adapted to the life style of the Saudi society.

In order to meet the need for privacy, the ground floor of the villa is usually divided into sections. The first is reserved for the male guests. The second section is reserved for the immediate members of the family. The first floor is totally reserved for the family. Thus the spatial division of the villa into public and private domains is manifested in both plan and section, unlike the traditional system which divided the house vertically into a male section on the ground floor and a family section on the upper floors (see Chapter Two, Section 2.3).

However, the use and meanings of the spaces and their spatial relationships are quite dissimilar to those of the traditional house. This emerges from the fact they are designed for special purposes

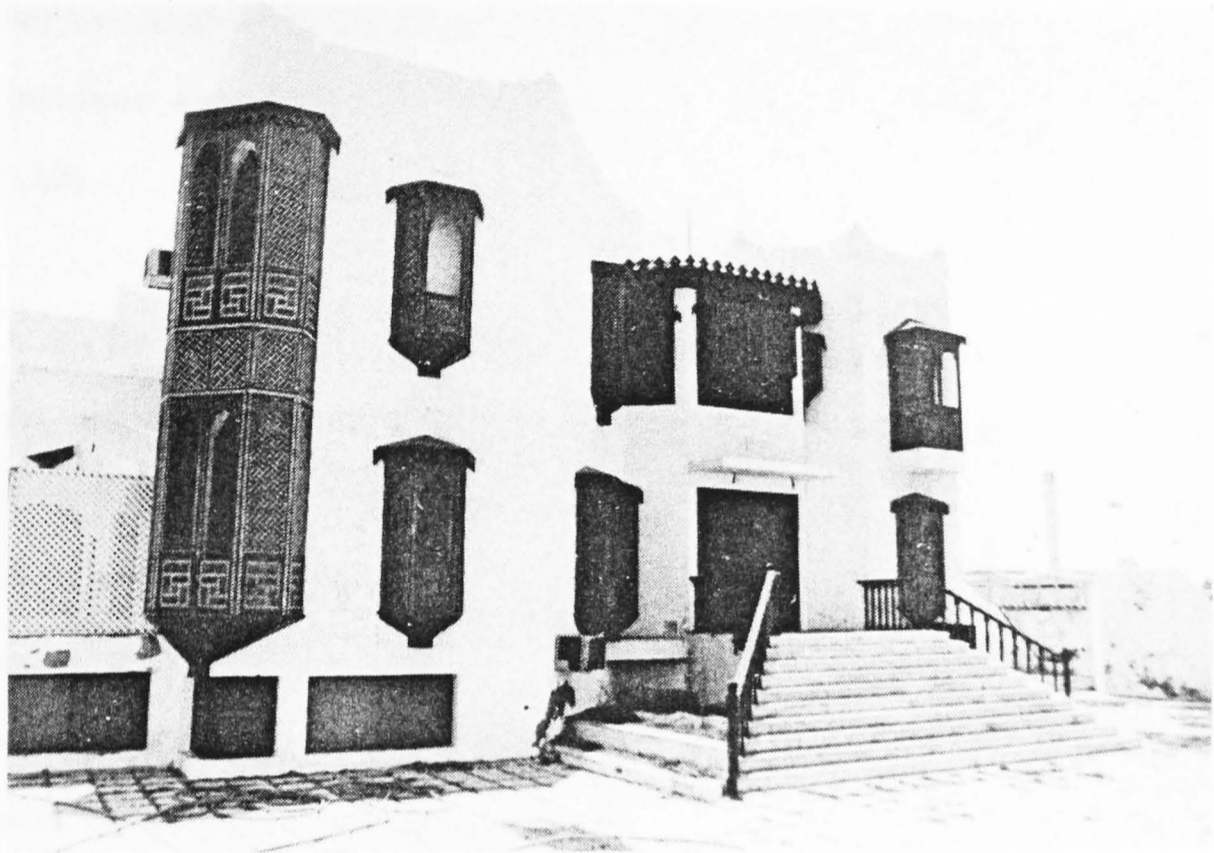


Fig. (7.8) A "free style" pseudo-Islamic revival of the late 1980's. Disenchanted with alien international forms, another cosmetic approach to architecture is chosen by applying extravagant lattice screens on windows and balconies.

incorporating the appropriate furniture under certain names. The notion of proper furnishing became a factor in this new living environment whether people could afford it or not, or even whether they really needed it or not. In a reception room, dining room, or bedroom, one can see that a certain set of hard-to-move furniture commits each room to a special function, so that no other activities can be conducted easily in this space. In other words the furniture 'defines and confines' the space to certain use only (figs. 7.9 and 7.10).

By contrast, the traditional house was functionally polyvalent and non-specific. Spaces could be used interchangeably for eating, sleeping, socializing and other domestic purposes. The flexible use of space was possible due to the absence of bulky furniture. The furniture that was used in the space was simple, easily movable and multi-purpose. For example, the upholstered wooden benches might be used as seats or as beds.

The primary objective of spatial organization in the traditional house was a compliance with nature so as to provide a natural flow of give and take with the surroundings. The traditional house and its surroundings complemented one another. Spaces were well protected against the constraints imposed by nature in order to keep out the undesired effects of climate, and to create a suitable milieu inside the house. Environmental factors having desirable effects - like prevailing breezes and daylight - on the other hand, were admitted to the indoors.

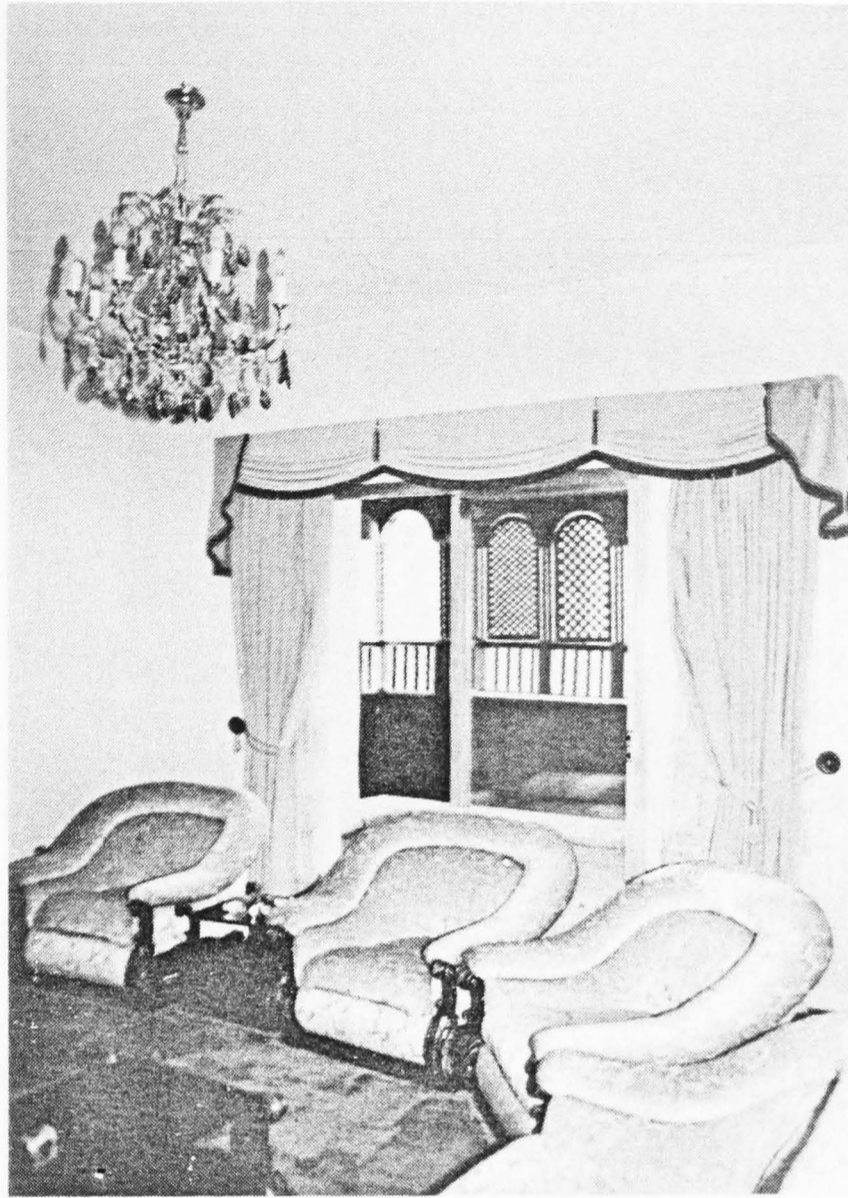


Fig. (7.9) A typical setting room furnished in western style.

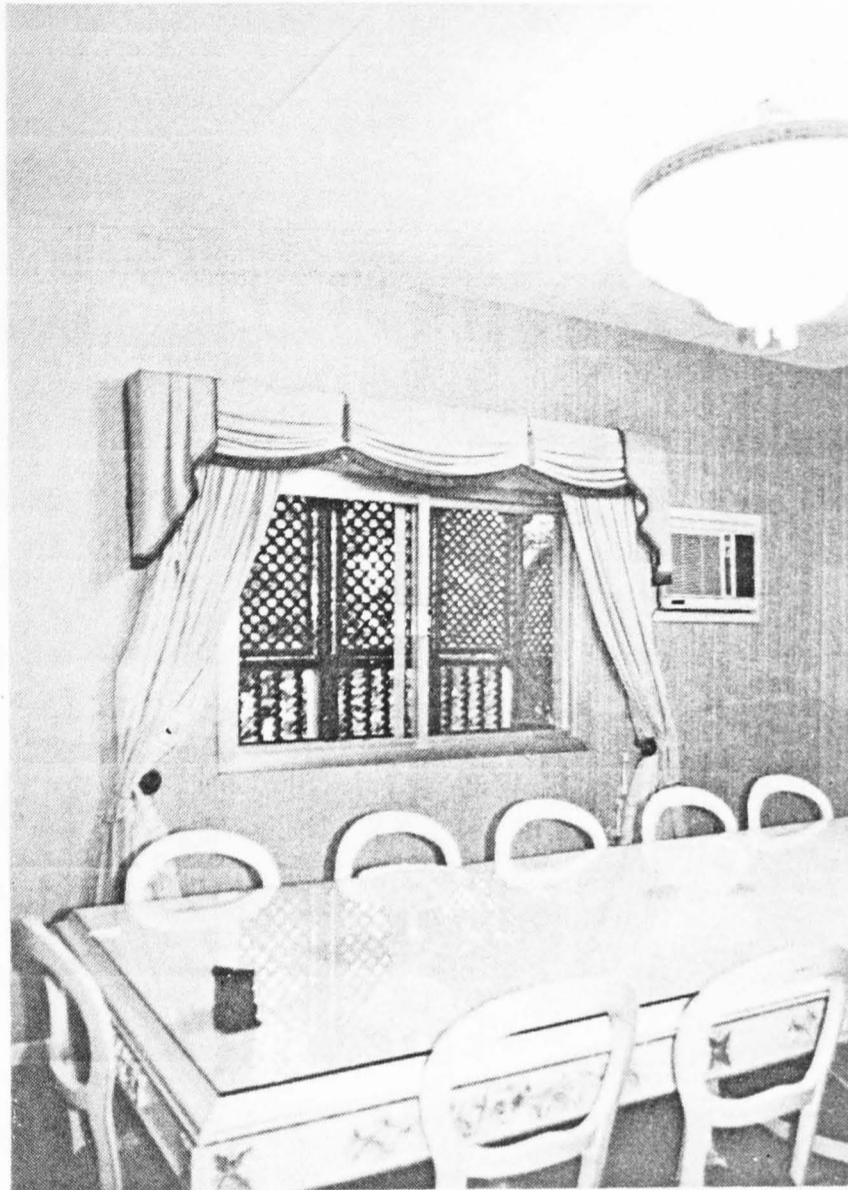


Fig. (7.10) A typical dining room in the men's reception area.

This interaction with climate created various microclimates within the house. In response to that the occupant moved from one place to another to take advantage of these microclimates.

In sharp contrast with the traditional house, the modern villa challenges nature and its constraints. Far from complementing one another, the modern villa and its surroundings are in opposition to each other. The villa isolates itself from the natural environment and relies on electro-mechanical means to control the indoor microclimate. Thus, irrespective of the design of the villa, comfort can always be achieved.

There are, of course, energy costs involved, but in a country like Saudi Arabia where energy is still one of the cheapest commodities this consideration rarely appears to be taken into account. It is unfortunate that air-conditioning devices are used as a compensation for bad design, and villas being erected today consume much more energy than they would if the potential of the building fabric to modify interior climate was rediscovered.

Thus unlike the traditional house, the living atmosphere created in modern villas is inflexible and static. Thermal conditions are no longer a determinant of behaviour. Instead, air-conditioning devices are used to keep the entire living environment at a uniformly comfortable temperature. As a result, occupants' spatial habits have become diffused, and activities that were once localized by thermal conditions have spread out over the whole house. It is forgotten, unless the system breaks down, that such wide-

ranging use of space is completely dependent upon the available cooling equipment.

The convention of providing open spaces above the ground level which ensure the privacy of both the occupants and their neighbours does not exist in the modern villas. Although the vast majority of villas have flat roofs, this space no longer has a social function, simply because it is not meant to be used and belongs to nobody. It houses the water storage tank, air-conditioning equipment in the case of a central air-conditioning system, and often a laundry room.<sup>32</sup>

Open balconies are a distinctive feature of the modern villas. This is a concept which sharply contradicts the understanding of extended interior space organization. These balconies are attached to the main space but they are not in the form of a continuation of it. They do not constitute an extension to the indoor space. They have the character of an exteriorized interior space. Neither do they possess the character of a Kharjah, for they are horizontally extended in contrast to the upward vertical extension of the latter.<sup>33</sup> (See Chapter Two, Section 2.2.1). Most of the time they are completely unprotected and totally open to the outside. In some villas balconies are provided with wooden lattice screens, in this case in-between spaces are created which belong neither to the inside nor to the outside (fig. 7.11). Generally the balconies are seldom used by the occupants of the house.

Furthermore, window openings are usually on the same plane as the solid surfaces. They seldomly correspond to a spatial change as was the case in the old. They are mostly transparent surfaces

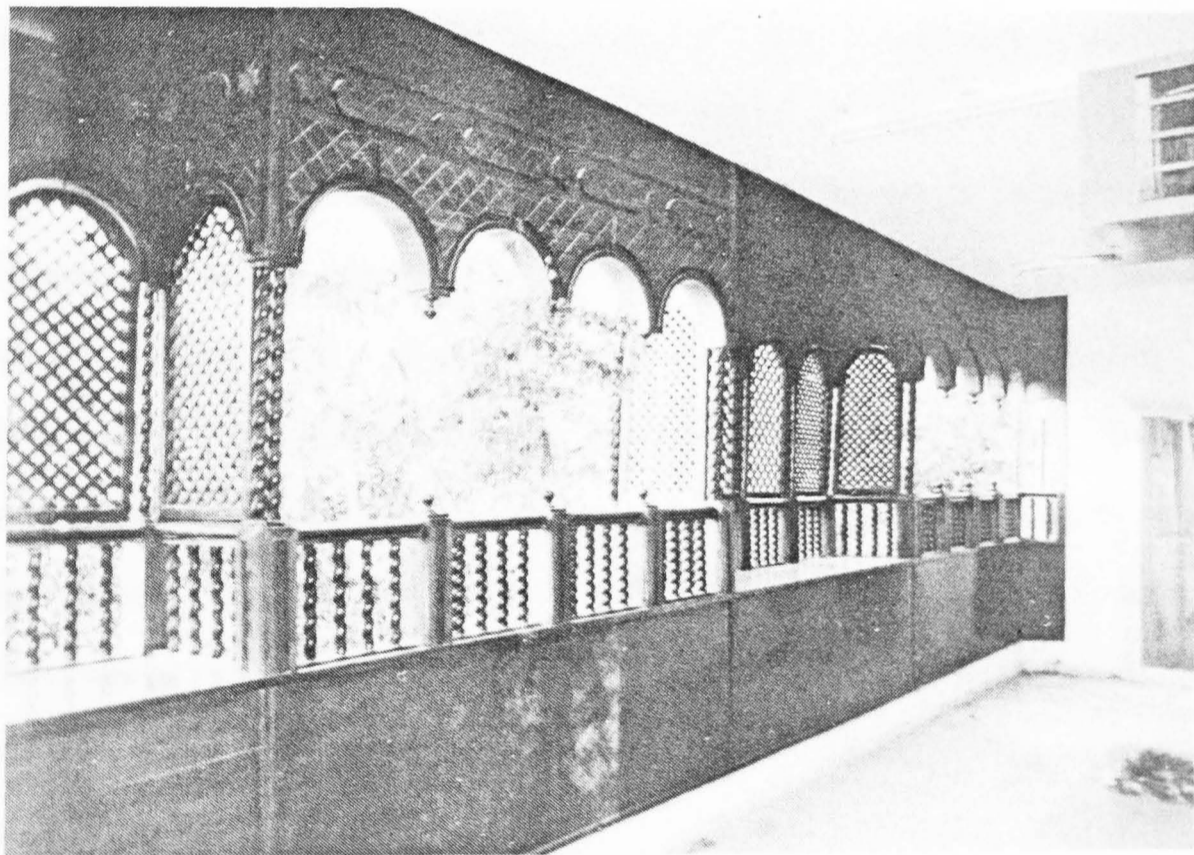
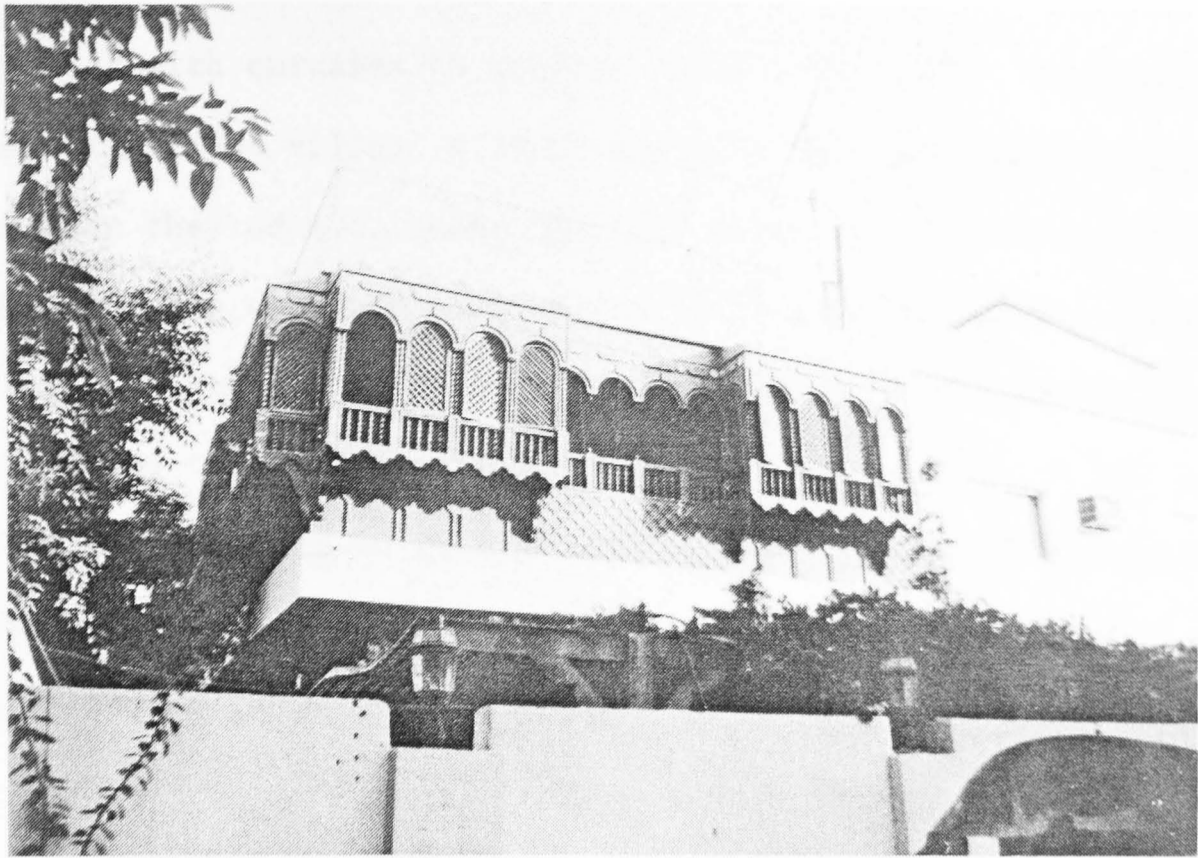


Fig. (7.11) An example of a balcony provided with wooden lattice screens in Jeddah.

covered with curtains to prevent visual intrusion. In some of the more luxurious villas, windows are provided with mashrabiyyāt. But in plan they do not create the semi-opened alcoves that provided by the rawāshīn of the traditional house. They are merely ornamental façade elements attached to the plate-glass windows which are always closed to trap mechanically cooled air inside (figs. 7.12). Thus, the understanding of spatial differentiation and sub-spaces within the main space pertaining to the traditional house totally disappeared in the modern villa.<sup>34</sup>

Last but not least in the distinction between the modern villa and the traditional house is architectural character. This constitutes the most fundamental difference between the traditional and the modern. The latter does not conform to a common building language that is shared by everyone as was the case for the former. In the traditional, the framework of each house was similar. Materials, colours and facade treatments were similar. Each house contributed to a coherent whole. Hence, a sense of unity was generated. But in the modern environment each villa is seen as an instrument to express the egos of the architect and owner. There exists no agreed building language or framework. The result is a sense of confusion.

## 7.7 DEVELOPING A NEW ATTITUDE TOWARDS DESIGNING PRIVATE HOUSES IN JEDDAH

Given the current attitude in Jeddah's contemporary residential architecture, best expressed by the private villas, serious thought must be devoted to the re-orientation of architectural philosophy and

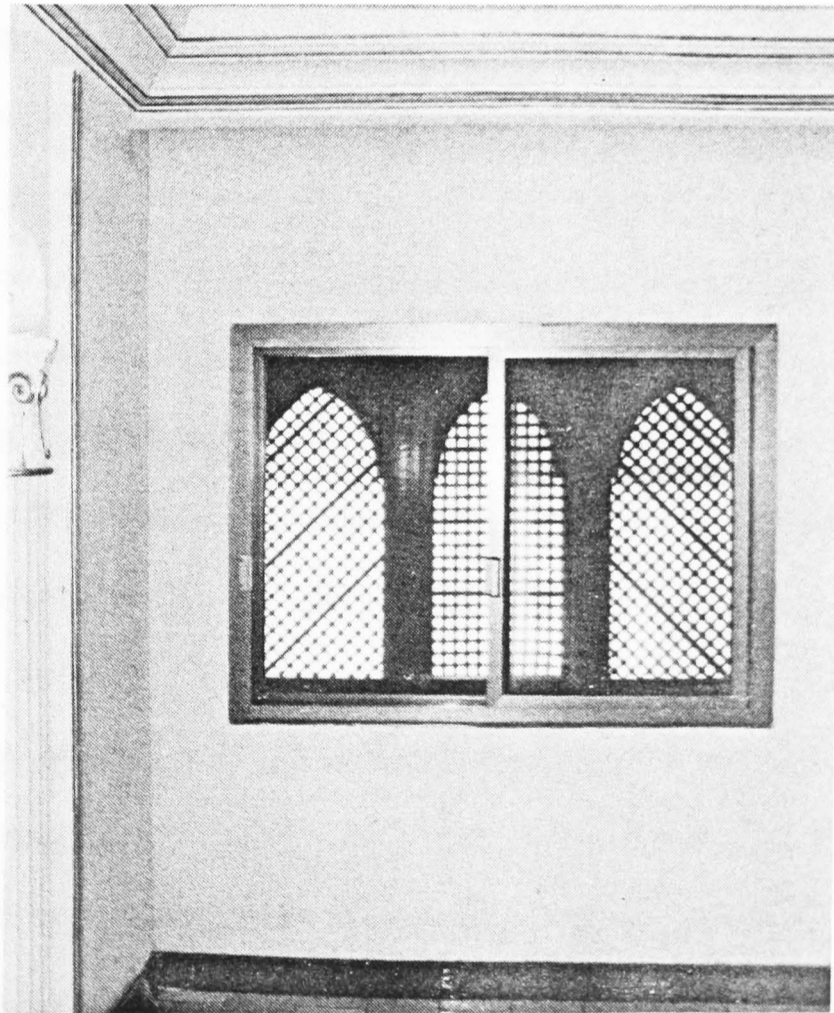
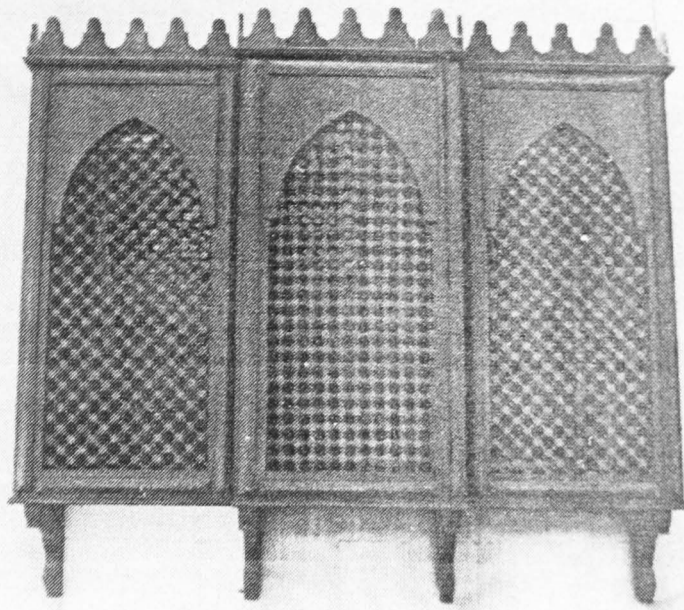


Fig. (7.12) An example of a wooden mashrabiyyah attached to a plate-glass window.

practice in the city. Immediate and radical action is needed to salvage the architectural quality and to correct the course of designing private houses in Jeddah. A complete and systematic re-examination of architectural policy must be initiated to advance the creation of a meaningful residential architecture, appropriate to the locale of the city, its people and the contemporary era in which they live. This can be attempted only if one views architecture as a socio-cultural phenomenon, or as a reflection and an image of man's condition, rather than as abstract forms or isolated objects.

Planners and architects will not, in spite of their best intentions, find an appropriate residential architecture for Jeddah until they acknowledge that the physical and socio-cultural needs of the society are unique and cannot be fulfilled by imported concepts and designs. It takes courage to face the fact that until now Jeddah's modern private villas have failed to find a balance between preserving socio-cultural norms and solving the environmental problem. This means that architects have failed to make a correspondence between reality and its description - a correspondence which was superbly mastered by the traditionally built environment. Instead of developing new design concepts that serve the utilitarian needs of Jeddah's society and respond to its environment in the context of modern living, architects adapt western concepts of design to meet the socio-cultural needs of the society and rely on technology to overcome the thermal deficiencies of these designs.

This reality poses a question: should this continue? And if not, what is the alternative? Most people are now becoming more conscious about the functional aspects of their private houses and

young Saudi's express concern about the quality of their residential built environment. They seem to show more interest in modern designs inspired by tradition. Some are still confused about design aesthetics. Some want "Islamic designs" that they think they can identify with, being disenchanted with the alien international forms, but this limited perception only magnifies the problem as the architecture of the Islamic world varies appreciably from one region to another.

Suitable designs for private houses will result only when valid principles and concepts derived from the socio-cultural needs of Jeddah's society can be generated, analyzed intelligently in the context of the society's current state and probable future, and interpreted within the reality of the relevant factors of traditions, economy, materials and building technology and environmental setting.

This goal is not only the concern of architects but also of policy makers and planners in the Municipality, who must realize that the unsatisfactory concepts and criteria applied to the planning of modern residential neighbourhoods have led to the present unbalanced environment. Reliance on imported western planning concepts and building codes must be discarded and the self-confidence to define new concepts that serve the socio-cultural needs of the society and modify the microclimate must be developed. The building regulations should specify performance rather than effectively prescribe form. The traditional approach strongly emphasized human interaction as the basis for defining the physical environment, not prescriptions for building volumes, heights, set backs, which are derived from some western norms and to which the social behaviour of the inhabitants is

expected to adapt. An identification must also be made of who "the people" are and what they want to be and it must incorporate images of their past, their present and their future.

Although these goals cannot be achieved easily, I would like to suggest some directions for further research and possible implementation which could be continued by colleagues who are concerned about the quality of the residential environment of Jeddah.

A definition of Saudi family needs in the contemporary Saudi social setting is required, with a clarification of the means by which this definition could be reached and identification of the possible design concepts that correspond to these needs. The design concepts must reflect the structure of the interpersonal relationships and family needs rather than an idealized version of a physical design. The anatomy of privacy must be adequate to the life style of the inhabitants. The varying sizes of spaces and their spatial relationships must be compatible with the daily activities of family life. The articulation of volumes, masses and elevation elements must respond to functional requirements rather than just being a play with shape.

Contrasting evaluations of past and present experience could give valuable information about the nature of consistency and change of these requirements and the social mechanisms they represent. Various kinds of architectural research and field studies could define the social and physical features of modern Jeddah and its residential neighbourhoods, the change in family use of private, communal and outdoor space. This partial list could go on to include

many other points, such as an evaluation of users' responses to their houses, their life styles and aspirations in terms of activities and use patterns, the impact of the existing concepts of planning and building practices on microclimate and energy consumption.

If these studies were carried out within the notion that dwelling and forms of habitation should represent a relationship between form, culture and climate, then very useful information could be obtained, based on the socio-cultural value system, about the correspondence between the built form and the characteristics of the family and the community, and also on the effect of the built form and building envelope on modifying the external climate and conserving energy.

Ideally, a way could be found to provide for the social, spiritual and aesthetic needs of the people at both the neighbourhood and dwelling levels in a way that would be best suited to Jeddah's modern society and its environment. This very complex task could only be achieved, as just indicated, through extensive research and evaluation of both the past and the present and through an exploration of the means by which the findings could be translated into the present day language of building. This does not mean that the old should be copied. It means that the lessons from its analysis could be reinterpreted in new ways.

The prevailing attitude of copying the traditional architectural elements and incorporating them in alien international forms is, in my opinion, mere dressing. In the short term, this might provide an agreeable illusion, but in the long run the fake

could not be dissimulated and the results would be superficial and unsatisfactory. In order to avoid such fallacies, a deeper approach is needed, one which considers all the various form-defining factors: an approach which integrates and adapts the values and principles of the traditional into today's house design.

Although it is probably unrealistic to expect the present widespread wasteful dependence on mechanical air-conditioning to be completely changed, at least new house designs should be able to considerably reduce the cooling load to a level at which the consumption of energy for providing comfort is kept to the minimum. Energy conservation in houses should be considered a major factor in both national and individual economic interest, as well as a factor governing human comfort indoors. It should be appreciated by the public, architects, and policy makers, and it must be understood that it can only be achieved through the appropriate design and construction of houses. This would require an extensive research and experimental studies on passive and low energy studies for Jeddah's hot humid climate. There are many possibilities as yet untried and untested.

Meanwhile, the long term future of the process of developing a new attitude towards designing appropriate and energy efficient private houses lies in a thorough and fundamental re-assessment of the curricula in the schools of architecture within the country. Most of these schools are still operating on obsolete, borrowed architectural curricula and programmes, adapted largely from American schools of architecture. It is now of great importance that the academic programs in these schools be geared to the creation of a

significant contemporary architecture, recognizing the socio-cultural and aesthetic needs of the Saudi society, as well as the geographical, climatic and topographical determinants of each city in the country. The schools should also develop comprehensive teaching methods, tools and research facilities aimed at the design of energy efficient and climate-related buildings.

Above all, it is necessary to instill in the general public understanding of the built residential environment and a realisation that this can be consciously improved for their own benefit. This can only be achieved through a widespread educational programme and is therefore a long-term objective. However long it may take this is an essential task; because in the final analysis a good residential environment cannot be willed upon people but can only develop in response to a popular demand for it.

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29. H. Kilical, op. cit., p.18.
30. J.J. Boon, op. cit., p.11.
31. Unlike the rawshān of old Jeddah, the traditional Cairene mashrabiyyah was a cantilevered space with a wooden lattice screen composed of small wooden balusters that were circular in section and arranged at specific regular intervals, often in a decorative and intricate geometric pattern.
32. A. Eyuze, op. cit., p.109.
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## CHAPTER EIGHT

### SUMMARY AND CONCLUSION

This thesis has set out to study the traditional house of Jeddah in terms of its response to climate. It has looked mainly at the interaction between the climate, the form of the house and the living patterns of occupants. Two fundamental ideas served as beacons to guide the research work and analysis involved. The first is a strong belief that climate played a role in the morphology of the town and the form and construction of the house. The second, which is closely related to the first idea, is the hypothesis that the use of space in the traditional house was dominated by a need to maximise thermal comfort.

In testing this hypothesis, the research contained two main components. First, a discussion of the occupants' patterns of use of space based on interviews conducted by the author with elderly men who had lived in traditional houses. Second, thermal measurements carried out in a field investigation of the thermal conditions of the traditional house. The findings demonstrated that the occupants' spatial habits were indeed strongly correlated with the availability of desirable thermal conditions.

A brief review has also been offered of the causes and circumstances which contributed to the abandon of traditional house building and the emergence of the modern private villa as a new housing pattern in Jeddah. This included an assessment of the modern villa and its characteristics in the light of the traditional house.

This concern, although not the main theme of this thesis, is of importance since it should give the reader a general picture of the quality of the modern living environment offered by private villas, and the changes that have taken place in the philosophy of the house and in the organization and use of spaces at both house and neighbourhood scales.

A comprehensive examination of the existing modern residential architecture in Jeddah is needed to establish a sound basis for formulating valid design principles and planning guidelines for the development of a satisfactory contemporary residential architecture that is more responsive to energy considerations. This is an area of research that requires much attention from architectural academics, professionals and also planners and policy makers in Jeddah's Municipality.

The thesis has presented a way of understanding the nature of the traditional house of Jeddah, a way of viewing the house as a three dimensional structure behaving dynamically in response to the climatic variations outside. It is hoped that this thesis will help to fill the vacuum of studies on the climatic adaptation of the traditional house of Jeddah, but more importantly to create an awareness of its quality and significance amongst academics and professionals.

Like any other research work, this study is by no means a complete. More research needs to be done on the performance of the ventilation system in the traditional house with respect to its adequacy in providing continuous and sufficient air movement.

Further work is needed to examine how the rawshān works as a ventilating device. The present study has looked into the question of how the rawshān was used. But precisely what role did it play in occupants' lives? Why was it so lavishly valued? How was it part of a greater whole? In addition, studies need to be carried out to examine the effect of the vertical temperature gradient in producing stack effect in the stairwell as well as the effectiveness of the rawashīn and the stairwell in performing jointly. Further investigations are required of the different factors affecting indoor air flow patterns and velocity. These studies will require field measurements, experiments using a low speed wind tunnel, and computer thermal modelling.

The traditional house has a great potential for inspiration. However, it is most important to understand properly the nature and function of the traditional residential environment in relation to both physical and socio-cultural factors in order to extract its values and principles which can serve as a basis for the development of a new approach to designing modern responsive private houses.

APPENDICES

## APPENDIX A

### THERMAL COMFORT

#### A.1 Thermal Performance of the Human Body

Human beings are warm blooded creatures. This means that their body core temperature (i.e. the temperature deep in the body tissues) must be regulated to remain within a narrow range, namely  $36.9 \pm 0.5^{\circ}\text{C}$ ; the process is known as heat homeostatisis.<sup>1</sup> The reason for this is that many of the critical biochemical and cellular processes on which bodily functions depend take place efficiently and correctly only within this narrow range of temperatures. If the core temperature drops to about  $31^{\circ}\text{C}$  consciousness is lost and death can ensue rapidly; if the temperature rises to about  $43^{\circ}\text{C}$ , thermoregulation is lost, and unconsciousness and death can again ensue. Hence, for simple health and survival reasons, this constancy of temperature must be maintained.<sup>2</sup>

The human body extracts energy from its surroundings by consuming food to generate an ordered self-contained system, i.e. the body as a whole, which can function efficiently to maintain the energy input on which it depends. The input is required to sustain the cellular functions, produce new cells and provide muscular action. This energy is all created by the breakdown of food, with an associated generation of thermal energy. A typical individual may consume 12 MJ of energy in a day, and the majority of this (70-80%) is converted to heat.<sup>3</sup> This heat contributes to maintaining body temperature and when the body is performing normally there is excess

for this requirement and heat must therefore be lost to the surroundings. The climates in which the humans survive successfully, without excessive dependence on technology, are those providing temperature conditions which enable the heat loss process of the body to take place effectively and in a controlled fashion.

The rate of heat generation, i.e. the metabolic rate, and hence of heat loss is closely related to the nature of the activity that the body is undertaking. Typical figures for a range of activities are given in table (A.1).

Thus the greater the activity the higher the rate of heat loss required to keep the body temperature constant, while at low activities the usual problem is to reduce heat loss sufficiently to avoid a fall in body temperature. The mechanisms by which the body gains and loses heat are now considered.

#### A.1.1 Heat Transfer to and from the Body

The four modes of transfer of heat - conduction, convection, radiation and evaporation - all contribute towards the thermal balance of the human body.<sup>4</sup>

Conduction plays a minor role in that it essentially only operates when the body is in direct contact with solid objects, e.g. bare feet on a cold floor, or a bare arm on the metal rest of the chair. If the loss or gain of heat by the contact is high this is immediately sensed and remedial action taken. Conductivity values,

however, play an important role in terms of the insulation value of the clothing.

Radiation to and from the body depends on the surface temperature of the skin and the radiant temperature of the surroundings. Usually the net result is radiation loss to the surroundings, but, for instance, lying in the sun can produce a net gain.

Convection losses depend on the air temperature and air movement. A windy day 'feels' colder than a still day, even if the air temperatures are identical, because of the forced convection effect. However, passing warm air on the body will cause localised heat gain by convection because the air temperature is higher than the body surface.<sup>5</sup>

Evaporation losses occurring through respiration and perspiration, depend on the relative humidity, temperature and movement of the air and the rate at which moisture is being produced. This mechanism always contributes to heat loss, not to heat gain, and becomes the mechanism for loss when air temperatures exceed about 25°C.<sup>6</sup> The four mechanisms are summarised in fig. (A.1).

For heat balance to be maintained the heat generated internally combined with any changes in the heat stored in the tissues must be balanced by these four heat loss (or gain) mechanisms. The balance is maintained to some extent by the control of heat production but mainly by the regulation of heat loss, and is summarised below.<sup>7</sup>

Activity	Metabolic Rate for a Typical Adult (W)
Sleeping	75
Sitting	105
Standing	125
Walking at 3.2 km/h	210
Walking at 6.4 km/h	270
Heavy work	360-450

Table (A.1) Typical metabolic rates for varying activities.

Source: J. Weller, and A. Youle, Thermal Energy Conservation, Building and Services Design, Applied Science Publishers, London, 1981, p.43.

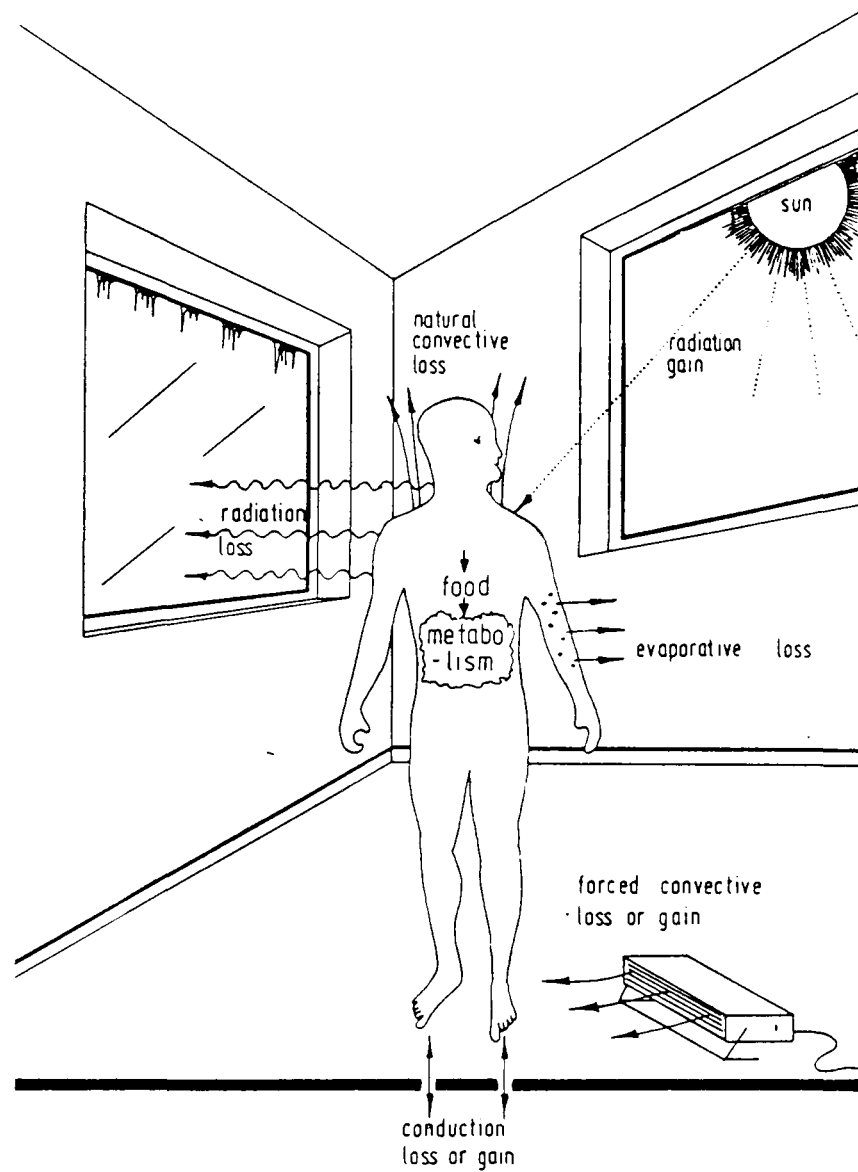


Fig. (A.1) The human body: heat losses and gains.

Source: Ibid, p.44.

M	±	S	=	E	±	R	±	C	±	Cd
Body heat production (metabolic rate minus energy expended in working)	±	Changes in heat stored in tissues	=	Evaporative loss	±	Radiation exchange	±	Convection exchange	±	Conduction exchange

### A.1.2 The Thermoregulatory System

The temperature of the bloodstream flowing in the core tissues is sensed in the regulation centre at the base of the brain known as the hypothalamus (which is responsible for a number of other sensing and control processes).<sup>8</sup> If the blood temperature is sensed to be too high then the blood is made to flow closer to the outside surface of the body by an 'opening-up' of the blood vessels (vaso-dilation) and more heat is lost by convection and radiation because of the increased body surface temperature. If the blood temperature is sensed to be too low a 'closing-down' of blood vessels occurs (vaso-constriction) and heat loss is reduced. There are also hot and cold sensors in the skin which cause the same effects by reflex action on a localised basis. The shift of blood flow explains why people appear red and flushed when they are hot and white when cold.<sup>9</sup>

Moisture is continuously evaporated through the skin (known as insensible perspiration) and from the lungs, and this accounts for about 25% of heat lost under typical comfort conditions.<sup>10</sup> This process is not controlled and the evaporative loss depends on the psychometric properties of the surrounding air. However, when an increase in heat loss from the body is required (either because of activity or raised external temperatures) sensible perspiration, i.e.

sweating, occurs from sweat glands in the skin, the sweat production rate depending on the conditions, and more heat is lost by evaporation.

In typical comfort conditions less than 0.1 litres of moisture is lost from the body per hour. This rises to approximately 0.5 litres per hour for light work or in warm temperatures (about 28°C, but may rise to 1 to 2 litres per hour or more for heavy work and high temperatures (35°C).<sup>11</sup> If high sweat rates continue for an extended period then the body loses large amounts of water and salt and if these are not replenished in a regular fashion then medical effects occur such as heat exhaustion, heat cramp and thermal anhydrosis (insufficient fluid for full sweating to take place).<sup>12</sup> The body's core temperature will also tend to rise above the norm because heat loss is insufficient. In the extreme case this leads to heat stroke, which is a breakdown of the thermoregulatory system followed by an uncontrolled rise in the body core temperature, unconsciousness and eventually death unless remedial action is taken rapidly. This involves a rapid artificial cooling of the body which can be achieved by spraying the body with water and inducing convection and evaporation by rapid air movement.

Improved tolerance to high temperature conditions, termed acclimatisation, can occur in about two weeks of exposure and this is aided if heavy work is undertaken. Acclimatisation results from an increase in the body's ability to sweat, so enhancing evaporative cooling.<sup>13</sup> However, the regular intake of water and salt is still of great importance.

The relative rates of heat loss from the body by convection, radiation and evaporation will depend on the external temperature conditions, as summarised in fig. (A.2).

There are also other voluntary modes of control. These include the posture of the body; curling up reduces heat loss by reducing the surface area, while posture which creates the maximum surface area and free air movement around the body is appropriate in hot conditions. Clothing is an additional artificial means of affecting heat losses and gains to the body (see Appendix B).

### A.1.3 Thermal Parameters

The thermal parameters which will affect heat transfer to or from the body are

- (a) air temperature
- (b) mean radiant temperature
- (c) air velocity and
- (d) relative humidity

It is these four parameters which must be controlled to appropriate values if desirable thermal conditions are to be achieved.

(a) Air temperature will affect the heat loss through natural convection from the body. If the air temperature is above the skin temperature then there will be heat gain to the body.

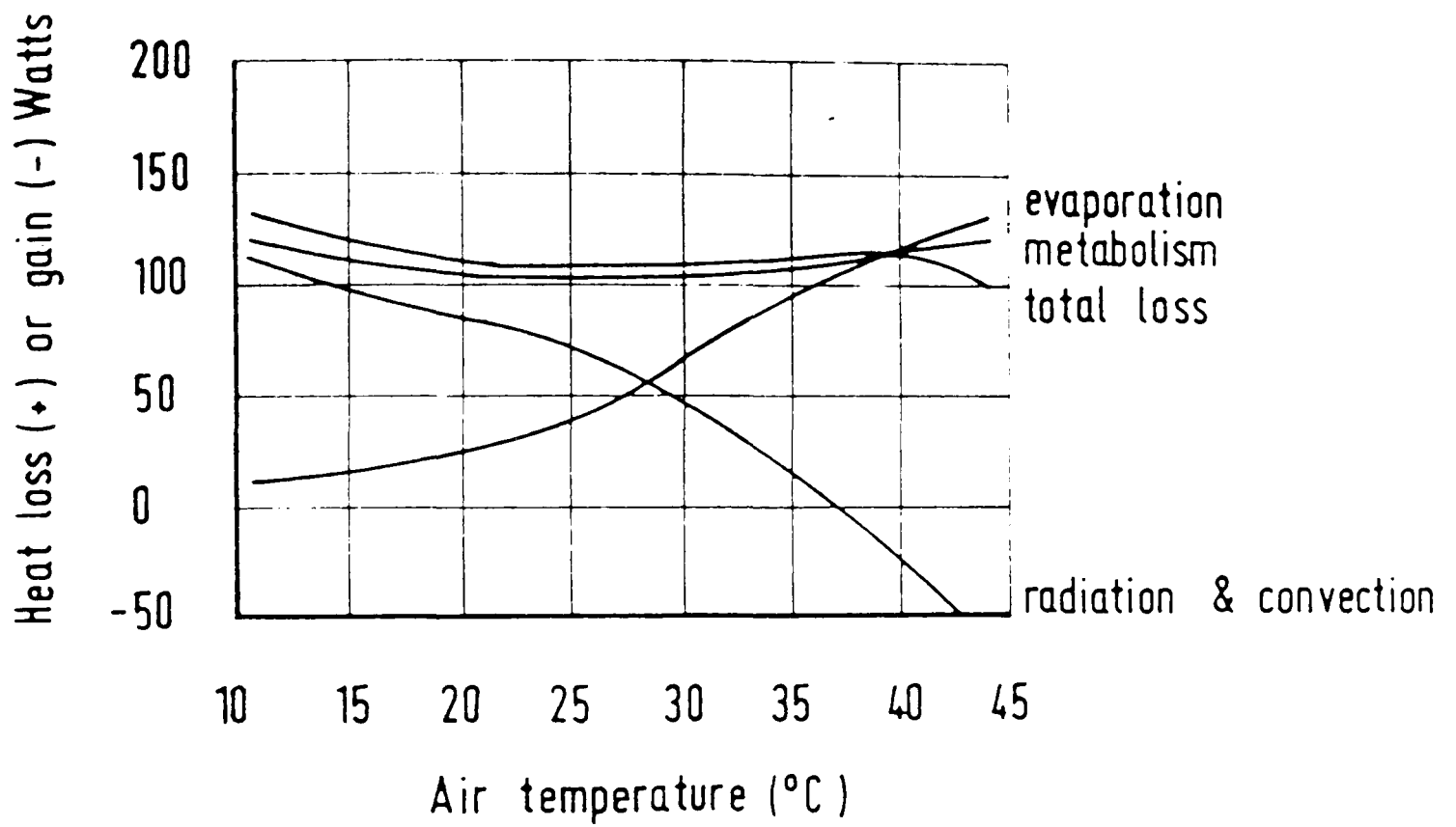


Fig. (A.2) Relative rates of heat loss from the body with increasing air temperature.

Source: Ibid., p.47.

(b) Mean radiant temperature, i.e. the averaging of all the surface temperatures (walls, floors etc.) around the body, will affect the radiant loss or gain to the surface of the body. In typical conditions in well insulated buildings the mean radiant temperature is usually similar to the air temperature, and is not normally sensed directly. However, when asymmetric radiation conditions occur or there are extremes of surface temperatures then radiation effects become noticeable.<sup>14</sup>

(c) Air velocity affects the human body in two different ways. Firstly it determines the convective heat exchange of the body and secondly it affects the evaporative capacity of the air and consequently the cooling efficiency of sweating. The effects of air velocity and air temperature on the convective heat exchange are interrelated, as the convection is a function of the product of some power of the velocity and the temperature difference between the skin and the air. The effect of air velocity on the evaporative capacity is interrelated with the effect of humidity, as an increase in air velocity raises the evaporative capacity and thus may offset the effect of a high humidity.<sup>15</sup>

When the air temperature is below skin temperature the two effects of air velocity operate in the same direction. Thus an increase in air velocity always produces a cooling effect, which increases as the air temperature is lowered. When the air temperature is above the skin temperature, however, the two effects of air velocity work in opposite directions. On one hand, increase in air velocity causes higher convective heat exchange and warms the

body, but on the other hand an increase in air velocity increases the evaporative capacity and hence the cooling efficiency.

When the skin is wet and the cooling efficiency of sweating is below 100%, an increase in air velocity affects the sweating efficiency more than it does the convective heating. The net result is a cooling, which is reflected by a reduction in the sweat rate. At the same time, the higher velocity reduces the subjective discomfort due to wet skin. But this effect of air velocity only continues until the skin is dry. A further increase in air velocity does not effect the cooling efficiency of sweating although its convective heating effect continues. Therefore at high air temperatures there is an optimum value of the air velocity, at which the air motion produces the highest cooling. Reduction of the velocity below this level causes discomfort and heating, by reduced efficiency of sweating, and increasing it beyond this level causes heating by convection. This optimum velocity is not constant but depends on the air temperature, humidity, metabolic level and clothing.<sup>16</sup>

(d) Relative humidity affects the rate at which moisture can evaporate from the skin. If the relative humidity values are kept within a certain range then this evaporation process can take place readily at rates governed by air temperatures and perspiration rates. This range is generally considered to lie between 40% and 70%. Air movement is again important because in still conditions the layer of air close to the skin rises in moisture content and the evaporation process is hindered. This partly accounts for the 'stiffness' effects previously referred to. For relative humidity values higher

than 70% discomfort can occur, especially in higher temperature conditions when heat loss is very dependent on evaporation. Generally, at air temperatures in the range 20-25°C approximately, the humidity level does not affect the physiological and sensory responses, and variations in relative humidity between 30% and 85% are almost imperceptible. Only when the air is almost saturated are feelings of clamminess and dampness noticeable.<sup>17</sup>

At temperatures above 25°C the influence of humidity on the responses becomes gradually more apparent, especially the effects on the skin wetness, skin temperature and, at higher temperatures, the sweat rate.

Thus the four thermal parameters are all interrelated and comfort requirements may vary from one type of climate to another. However, in a warm humid climate indoor comfort is largely dependent on the control of air movement and radiant heat. Rapid air movement past the body must be encouraged to ensure rapid evaporation of sweat from the skin. Solar heat must be prevented from reaching the building's occupants either directly through doors and windows or indirectly by heating the structure, which would then re-radiate heat on the occupants or warm the indoor air. Buildings must cool quickly after sunset to give maximum night-time comfort.

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5. Ibid., p.95.
6. J. Weller, and A. Youle, op.cit., p.45.
7. Ibid.
8. Ibid.
9. Ibid.
10. B. Givoni, Man, Climate and Architecture, Van Nostrand Reinhold Company, New York, 1981, pp.57-59.
11. Ibid.
12. J. Weller, and A. Youle, op.cit., p.46.
13. Ibid.
14. Ibid., p.48.
15. B. Givoni, op.cit., pp.65-67.
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17. J. Weller, and A. Youle, op.cit., pp.48-49.

## APPENDIX B

### THE THERMAL EFFECT OF CLOTHING

Clothing forms a barrier to the convective and radiative heat exchange between the body and its environment and interferes with the process of sweat evaporation. It also reduces the sensitivity of the body to variations in air temperature and velocity. At air temperatures below 35°C the effect is always to reduce the rate of 'dry' heat loss from the body and so produce a heating effect.' At air temperatures above 35°C the affect of the clothes is more complicated. On the one hand they reduce the 'dry' heat gain from the environment but on the other hand increase the humidity and reduce the air velocity over the skin, resulting in a reduction of the cooling obtained from sweat evaporation. It does not mean that the total evaporation is reduced by clothing; in most cases it is actually increased, but part of the evaporation then takes place from the clothing and not from the skin; so the cooling efficiency of the evaporation is reduced. The net result of the two opposing effects depends on the metabolic rate, humidity and air motion. The thermal resistance (insulation) provided by the clothing depends not only on the resistance of the fabrics, but also on the stiffness and fit of the garments. Therefore this resistance must be computed from direct measurements of the dry heat exchange of subjects wearing clothes. The unit of thermal resistance is the "clo" which is equivalent to  $0.155\text{m}^2 \text{C/W}$ .<sup>2</sup> Typical values for a range of clothing are given in table (B.1).

Attire	Clo-value
Naked	0
Shorts	0.1
Light summer clothing	0.5
Indoor clothing	1.0
Heavy suit	1.5
Suit plus overcoat	2.0
Polar clothing	3-4

Table (B.1) Typical clo-values.

Source: J. Weller, and A. Youle, Thermal Energy Conservation, Building and Services Design, Applied Science Publishers, London, 1981, p.50.

When a man is exposed to solar radiation his clothing reduces the radiant heat gain. At rest and in conditions of low humidity this always reduces the overall heat load. But the cooling efficiency of sweating is also reduced and when the humidity is high and the evaporation restricted, or under working conditions when the sweat rate is increased, this may have a greater physiological effect than the lower heat gain, in which case the net result is an increase in the heat stress.<sup>3</sup>

The interaction between the effects of wind speed and clothing is dependent on the air permeability of the clothes. For impermeable clothing, the wind speed affects only the surface coefficient of the clothing system and does not alter the thermal resistance of the fabrics. On the other hand, when the clothing system is permeable to wind, either through the fabrics or between the body and the clothes, an increase in air velocity reduces the thermal resistance of the actual materials.<sup>4</sup>

Hence in hot humid weather, clothing should provide protection from solar radiation and, at the same time, provide minimum resistance to conductive, convective and especially evaporative cooling. With lightweight clothing, there is adequate protection from solar radiation. Making the fabric as thin as possible reduces conduction resistance. Being absorptive, the material soaks up excessive moisture. When it is wet, it provides a reasonable surface for evaporative cooling, particularly when it clings close to the body. Clothing in such climatic conditions should also be loose enough to permit air flow and even gentle breezes induced by walking

or moving to reach the skin in order to allow sufficient cooling to inhibit sweating.<sup>5</sup>

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GLOSSARY

<u>Ahkām</u>	( اَحْكَام )	:	the verdicts of the judge.
' <u>Arrāqiyyah</u>	( عَرَاقِيَه )	:	men's under-garment to absorb sweat.
<u>Ashrāf</u>	( اَشْرَاف )	:	"nobels"; those who are descendants of the Prophet Muhammad (peace upon him).
<u>Aziqqah</u>	( اَزَقَّة )	:	alleyways.
<u>Būshiyyah</u>	( بوشِيَه )	:	full face veil for women.
<u>Curtah</u>	( كُرْتَه )	:	women's outdoor dress.
<u>Dahleez</u>	( دَهْلِيَز )	:	entrance hall.
' <u>Emāmah</u>	( عِمَامَه )	:	men's turban.
<u>Fiqh</u>	( فِقْه )	:	Islamic jurisprudence.
<u>Fūṭah</u>	( فُوْطَه )	:	an ankle-length piece of lightweight batic cloth.
<u>Hadīth</u>	( حَدِيْث )	:	the Prophet's sayings.
<u>Hajar Manqaby</u>	( حَجْر مَنَقَبِي )	:	coral stone.
<u>Hārāt</u>	( حَارَات )	:	residential quarters.
<u>Ījtihād</u>	( اِجْتِهَاد )	:	scholarly opinion.
<u>Imām</u>	( اِمَام )	:	prayer-leader.
<u>Jāwī</u>	( جَاوِي )	:	Java teak used for constructing <u>rawāshīn</u> and doors.

<u>Jubbah</u>	( جبّه )	:	men's long over-robe.
<u>Kashūr</u>	( كاشور )	:	another local term for coral stone with the connotation of something rough.
<u>Khalīfah</u>	( خليفة )	:	leader of all muslims; at the beginning, the <u>Khalīfah</u> was both the religious and political leader of all the faithful.
<u>Khānāt</u>	( خانات )	:	inns or caravanserais.
<u>Kharjāt</u>	( مزجات )	:	open terraces.
<u>Khazānah</u>	( خزانة )	:	a small storage room.
<u>Khūkhah</u>	( حوخة )	:	a small door; usually located in the right-hand leaf of most main doors of Jeddah's traditional houses.
<u>Mabīt</u>	( مبيت )	:	a family room located in the uppermost floor.
<u>Mahallāt</u>	( محلات )	:	another term for quarters.
<u>Mahramah</u>	( مزماره )	:	women's head-cloth cover.
<u>Majlis</u>	( مجلس )	:	a family living room, located at the front of the house and towards the main facade.
<u>Maq'ad</u>	( مقعد )	:	men's sitting room located at the ground floor and next to the entrance hall.
<u>Mashrabiyyāt</u>	( مشربيات )	:	bay windows with wooden lattice screens to provide privacy without impeding the flow of air.
<u>Milāyah</u>	( ملايه )	:	women's outdoor cloak.
<u>Mirakkab</u>	( مركب )	:	kitchen.

<u>Mu'akhir</u>	( مؤخر )	:	a family room located towards the back of the house.
<u>Muduwwarah</u>	( فودوره )	:	women's turban.
<u>Nūrah</u>	( نوره )	:	lime.
<u>Qandal</u>	( قندل )	:	wood imported from India and used for reinforcing walls and to turn the corners of the <u>rawāshīn</u> and door-openings.
<u>Quḍāh</u>	( قضاہ )	:	judges.
<u>Rawāshīn</u>	( رواشین )	:	bay windows with adjustable louvres placed in sliding wooden panels to provide privacy while allowing the breeze to flow freely.
<u>Sālah</u>	( صالہ )	:	hall.
<u>Samūm</u>	( سموم )	:	hot summer winds that sometimes develop into sand and dust storms.
<u>Sharī'ah</u>	( شریعہ )	:	Islamic law.
<u>Shāyah</u>	( شایہ )	:	men's long over-robe worn over the <u>thūbe</u> .
<u>Shīshah</u>	( شیشہ )	:	hubble-bubble used to smoke a tobacco paste imported from India.
<u>Shīsh</u>	( شیش )	:	an external lattice screen attached to the <u>rawshān</u> or <u>ṭaqah</u> .
<u>Shwāri'</u>	( شوارع )	:	wide streets.
<u>Sidīriyyah</u>	( صدیرتیہ )	:	women's vest worn below the <u>curtah</u> .

<u>Suffah</u>	( صُفَّة )	:	a family living room located next to <u>al-majlis</u> .
<u>Sunnah</u>	( سُنَّة )	:	the Prophet's traditions, sayings and deeds.
<u>Sūq</u>	( سَوْق )	:	market.
<u>Sūrwāl</u>	( سُرْوَال )	:	trousers or drawers.
<u>Tahārāt</u>	( طَهْرَات )	:	latrines.
<u>Tajlīlāt</u>	( تَجْلِيلَات )	:	a wall reinforcing system using <u>qandal</u> wood inserted horizontally at regular intervals of 1.20 m.
<u>Tāqaat</u>	( طَاقَات )	:	casement windows constructed of louvred sliding panels but not protruding from the wall.
<u>Thūbe</u>	( ثُوب )	:	men's gown.
<u>Zawāyah</u>	( زَاوِيَة )	:	private, local oratories used during the week, but not the Friday mosque where all in the quarter should go.

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