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Mahmoud Tavassoli

Urban Structure in Hot Arid Environments

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Strategies for Sustainable Development

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ISSN 2365-757X ISSN 2365-7588 (electronic)
The Urban Book Series
ISBN 978-3-319-39097-0 ISBN 978-3-319-39098-7 (eBook)
DOI 10.1007/978-3-319-39098-7

Library of Congress Control Number: 2016939909

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG Switzerland

To my dear ones
Nayyereh
Babak
Bahman
Sana
Fatemeh and Maryam

Acknowledgements

This book has had a long gestation period, stretching back for more than four decades, and finally become quite different from what was originally shaped. I would first and foremost like to express my gratitude to the old masters, local architects, and people of the towns and cities and villages of the hot arid regions, who provided invaluable aid in giving information about the life and spaces of traditional fabrics; then to the late Iranologist M.K. Pirnia of the Office of Preservation of National Monuments in Tehran; to the late Professor Victor Olgyay pioneer of the bioclimatism for their inspiration for the original edition of this book; and to Iraj Afshar the late professor of Tehran University for his vast research on the Yazd region. I am grateful to Prof. S.H. Nasr for his profound view and influential role in expression the essence of Traditional Persian Art and Architecture, and to professor Amos Rapoport for his basic research dealing with Man–Environment Studies of Urban Form and Structure of Asian and African cities.

Special thanks also goes to my colleagues and students at the time of preparation of master and detailed plans, and urban design projects for the historic cities of Yazd, Semnan, Birjand, and Tehran.

I received help from Mrs. Mary Zahedi, who read the first part of the manuscript and made suggestions for better expression. I wish to also thank Ms. Monir Taghavi for her kind and helpful comments, and also Mrs. Maryam Seyf, and Mr. Amir Soheylee for their kind suggestions.

This book would not have been possible without great support of my wife Nayyereh, and my sons Babak and Bahman. My wife shared many of my research journeys to the remote desert towns, cities, and villages from the beginning in the early 1970s.

Finally, I thank the Springer team for their support and fruitful collaboration. I wish particularly to thank Ms. Juliana Pitanguy, editor at Springer, for her quick response, kind support, and encouragement. Ms. Nishanthi Venkatesan, project coordinator, provided invaluable help and great efforts for preparation of the book.

Thanks are also due to Ms. Sudeshna Das production editor for her painstaking hard work and sympathetic understanding of this illustrated book. Mr. Rajesh Sambandam provided fruitful information. Ms. Naomi Portnoy did a first-rate job in the last check of the manuscript.

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Introduction

The objective of this research was to examine the influence of historical factors on the one hand and climatic factors on the other, to consider urban spatial forms and rural complexes in the hot arid environment of Iran. It reflects extensive journeys in many cities, towns, and villages.

The first Persian edition of this book, *Architecture in the Hot Arid Zone*, was published in 1974. The second expanded edition, *Urban Structure and Architecture in the Hot Arid Zone of Iran*, was published in 1982 and then with some changes in 2003. The 2012 edition continued and expanded the tradition established in the second edition, which was well received outside Iran.

In this revised English edition, new materials have been added, bringing the effort up to date, considering such issues as sustainability. In this work, a considerable attention has been given to the problems of traditional fabrics, urban blocks, and ordinary buildings, an insignificant matter in the academic education and profession.

Today, many courtyard houses, which were once belonging to the extended families, are falling into ruin and replaced by poorly designed multi-story buildings. The compact traditional urban blocks are replaced by massive buildings without public space. This process in the profit-oriented environment is worsening the situation and maximizing the potential effects of natural disasters, such as earthquake. In the historic cities, focus is placed on the restoration of historic heritages, without paying due attention to integration and inseparable surrounding fabric.

Although understanding the past is difficult, especially in our present situation, because of enormous changes in culture and society during the twentieth century, however, through our long journeys, we have been able to recognize the evidences through which the hot arid environment speak to us like an old master. By in-depth analysis of urban form and structure we can understand how past generation's solution to climatic problems had a logical basis. And today in the twenty-first century, that interest is centered on issues of energy conservation, and utilizing natural energy, it is logical to understand the essence of lessons which can be drawn from the past experience for sustainable development.

Fig. 1 Iran and the Middle East

Part I of this book deals with historic, economic, and social context of the old town structure, origin of urban and housing form, mainly during the Middle Ages, Islamic era, up to the twentieth century, modern Iran. It also points out the regional inequality, the problem of accelerated growth of a few large cities, due to the increased sale of urban densities, and widening gap among the regions.

Part II discusses the impact of climatic factors on spatial form of towns and cities and architecture in the hot arid environments. Here, the emphasis is on the manner in which past generations have sheltered themselves under the harsh climatic conditions (Fig. 1).

Part III is devoted to several spatial criteria, considering the lessons from the past, the meaning behind the forms, without replicating them. It also treats in more detail the problem of repeating poorly designed contemporary buildings, and urban block design, considering use of natural energy, and the problem of earthquake.

Appendix 1 includes climatic characteristics and their general distribution in Iran. The information in this section is mainly based on Adl and Ganji, the late professors at the University of Tehran.

Appendix 2 and 3 are structured on the system of research, findings, and methods by Victor Olgay in *Design with Climate*, and a United Nations report on *Climate and House Design*. Here, I have carried out an examination and an analytical and comparative study between the Yazd region, in Iran, and Phoenix, in Arizona, using the methods described by Olgay. Comparison between climatic needs of Phoenix and Yazd shows interesting differences.

As we can see, urban form is determined by three influential factors: climate, belief, and power. Despite of historical difficulties and rigors of his environment,

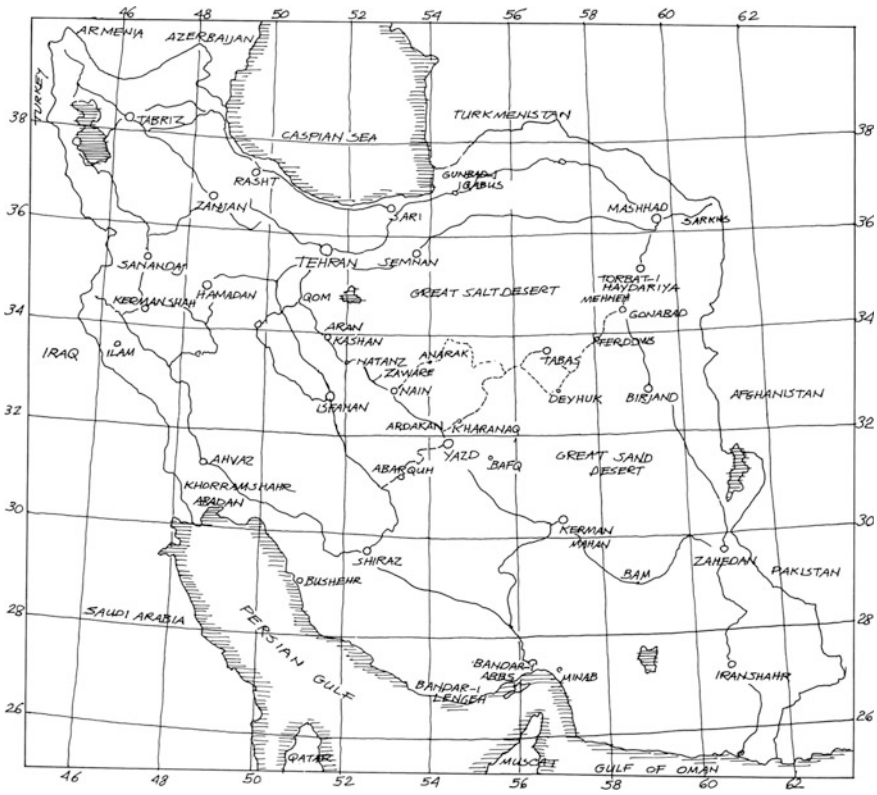

Fig. 2 Map of Iran

men's inventiveness in the hot arid zone enabled him to resist and be innovative, imaginative, and think about problems in a new way, to produce new works of art. Not only unique architectural solutions, but also hot arid environment mysticism and literature are deeply indebted to difficult historical and climatic circumstances (Fig. 2).

Considering knowledge of utilization of natural energy in shaping urban form, we can study different periods:

(1) Ancient times, (2) Islamic era up to the twentieth century, (3) the twentieth century, and (4) entering the twenty-first century.

1. **Ancient times**: Information about pre-Islamic cities is very limited. During this period, in spite of the role of climate as a determining factor in shaping urban form, the design of some cities often reflects images of power and centrality. The power system-based design was demonstrated in circular pattern, for example, in the Median city of Ekbatana in the cold region of today Hamadan, eighth century BC, or Ardashir-Kurra the Sassanian capital third century CE in the hot arid province of Fars, and later in Islamic period the city of Bagdad, eighth century in today Iraq.

However, Archaeological discoveries depict some unique examples of ancient settlements in conformity with climate and culture. For example, Tepe Zagheh a fifth millennium BC village in central region of Iran shows interesting features, especially favorable orientation, considering winds and sun. Also, archaeological discoveries of a part of housing area in the city of Ur, third millennium BC, show an interesting integrated and mixed use of elements.

2. **Islamic period up to the twentieth century**: This is a long period, more than a thousand years, from the first centuries, especially fourth/tenth century that we have more information about it, up to the first decades of the twentieth century. In this long period, utilization of natural energy is best demonstrated in architecture and urban form. In this period, identity, culture, and urban structure have also remained remarkably constant. These characteristics have been well expressed in the cities that have been studied in the present book.

The fifteenth-century local historian "Ja'fari" has depicted structural pictures of Yazd, from eleventh century, which have a lot in common with nineteenth-century map of Qajar period, and to some extent with 1938 and 1974 maps that have been presented for the first time in this book (Figs. 4.4 and 4.5). The most notable changes, however, have come from the first decades of twentieth century and accelerated in the last forty years.

In Shiraz also, many structural features of the city in the age of Hafez, fourteenth century, have remained constant to some extent. The most notable changes, during centuries, have been the gradual expansion in the number of quarters, which structurally developed in continuation of the previous quarters. Neighborhoods of Shiraz in the age of Hafez had a special cultural and sociopolitical atmosphere. The city's power was in the hand of people from certain social groups, champions, libertines, neighborhood's headmen, and people who were able to cause serious disruption.

Prior to the twentieth century, Kashan, another desert city of great architectural value, underwent changes at a slow pace. The first new street's construction was started at the first decades of twentieth century. But despite of the destructive effects of earthquakes in recent centuries, the city center complex, some of the structural elements, and city quarters were perfectly preserved.

The one unique element, which witnessed and survived the harsh history of the city, is the famous Fin Garden: From Solomanic spring which feeds the garden pertaining to Prophet Soloman, and in local tradition, it is considered as a symbol of purity. In the tenth century CE, the Buyids rulers added Royal buildings and garden. In the sixteenth century, Safavid rulers held ceremonies and banquets there. The Garden survived the destructive earthquake of sixteenth century; later again became a place of pleasure retreat for Fath Ali Shah of Qajar (1772–1834); then became the site of murder of the chief minister Amir Kabir (1807–1852) and changed to a derelict space and place of refuge for thieves; and at the end found a new life and registered as a cultural heritage by the late minister Ali Asghar Hekmat in 1934.

3. **Twentieth century**: Iranian cities after ages of slow change entered the twentieth century. Over the last century, Iran has undergone significant sociocultural and economic changes. These changes, resulting from the historical transformation in culture and economy, have had a considerable effect on Iranian city life and fabric.

After the White Revolution in 1963 and its centerpiece, the land reform, there has been intensive migration from rural areas to urban centers, areas of increased economic activity.

Concentration of industrial production centers, roads, and railway lines close to economic, cultural, educational, and health centers, especially in northern regions and Tehran City Region, has resulted in regional inequality throughout the country.

Tehran changed enormously, with largest rural migration and population growth from 1.5 million in 1953 to 5.5 million in 1979, and approximately 12 million in 2011, 6 % of the total population of the country. During the last two decades, a new determining factor, i.e., increased sale of urban density, especially in large cities, has accelerated regional inequality, urban traffic, and pollution.

Physically also, Iranian cities have changed largely both in size and in population. The development of Tehran since the mid-nineteenth century shows this feature clearly. The historic inner areas of the cities have also changed enormously during the recent decades.

> Towns and cities have largely evolved without recognition of urban problems. The compact structure of the city has been divided into pieces by many irrelevant wide streets. A lot of main passageways and bazaars have been widened or ruined to form transport avenues. The principal objective here has been to facilitate the penetration of automobiles into the compact structure of the city, and a lot of available urban traditional open spaces (takyah, maydan), were changed to traffic squares because of their width and size…. Modern city services have been concentrated in the new developments. City landowners,… have had a considerable influence on urban speculation. As a function of these considerations, historical areas of cities in Iran are falling into ruin and have become the shelter of the urban poor. This ruin has been accelerated by the gradual increase in the number of vacant houses in these areas. (Mahmoud Tavassoli, City Planning in the Hot, Dry Climate of Iran, in G. Golany, ed., *Design for Arid Regions*, Van Nostrand, 1983).

Altogether in this period, we have ignored the utilization of natural energy.

4. **Entering the twenty-first century**: Extensive research has shown the need for energy conservation and utilization of natural energies. Such an energy is available in the hot arid environment, a matter that should be taken into consideration at university level, both education and research. Other matters that have been discussed in the present book include the problem of regional imbalance, mainly in remote areas. This inequality is the result of uncontrolled compact development of Tehran City Region and several other large cities, and increased sale of urban density, despite environmental problems and natural disasters, especially earthquake. As we will see, also, we need to take firm steps in urban renewal and new urban block design.

Research Method

From the beginning, in the early years of 1970s, I have always had this question in my mind, that, while every urban elements as individual part, such as courtyard house, mosque, or seminary, have always had a cohesive composition and integration of elements, what about the distinctive characteristics of the whole city? Can we say that Iranian cities in Islamic period have had an integrated structure, considering the state power, culture, and climate?

Accordingly, in order to find reliable information, a vast and continuous field studies were conducted in the towns and cities and villages which hardly underwent significant changes. The city of Yazd considered as a center for research. The reason for choosing Yazd was that, in the early stage of this work, the city's old fabric was still to some extant intact. Names and particulars of many places in the old historical document of the city were still recognizable. Local architects and old masters, familiar with the environment of the old fabric, who had the basic role in orienting this research, were still alive.

The method used for this research is both qualitative and quantitative. An exhaustive field research has been conducted during several years, interviewing local architects, elders of neighborhoods, and heads of old families. One distinctive aspect in field studies was a comparison between the information of an old historical document: *Tarikh-i Yazd*, (History of Yazd), from fifteenth century with the existing old fabric, places, and spaces of the historic city of Yazd. The same method and findings were applied in other cities such as Nain, Zaware, and Kashan. As we shall see, it can be concluded that *traditional towns and cities in the hot arid environment of Iran have a common spatial characteristics based on their interconnected parts: neighborhoods and neighborhood centers, and city center, through the main passageways as connected elements*.

The study of spatial structure of neighborhoods, neighborhood center complexes, old urban blocks, and urban and architectural elements such as double domes for the first time, and the complicated form of wind catchers especially in the Friday mosque of Tabas which was destroyed in the 1978 earthquake, expresses creative methods of sustainable design and utilization of natural energy in the hot arid environments.

Part I
Influence of Historical Factors

Chapter 1
Ancient City Structure and Its Transformation in Islamic Period

Abstract The four interrelated chapters of part I deal with the influence of historical factors on the historic town structure, considering socioeconomic and cultural aspects. This chapter discusses the ancient city structure and its transformation in Islamic period. It identifies that origin of urban forms is not confined to one culture. This leads to some comparative studies in all chapters. Altogether, because of the shortage of information, result of wars, invasions, and natural disasters, scholars usually are reluctant to give a clear image of ancient city form. Information clarifies that although we have a limited knowledge about the physical aspects of ancient city form as a whole, we understand the role of power and centrality in shaping urban form.

Keywords Ancient city · Shortage of information · Origin of forms · Power and centrality · Numbers

The origin of architectural forms and urban structure in historical cities of Iran should be searched comparatively and analytically through the valuable written heritages and archaeological discoveries of ancient civilizations. This includes civilizations which first appeared in Mesopotamia such as Sumerian, Babylon, and also Elam and Medes, Achaemenians and later the influence of Greece and Rome, and finally new ideas by Parthians and Sassanians. In the process of this search, we will be able to understand the meaning behind many forms and the shape of urban structure and courtyard housing in the hot arid environments and to discover the symbolic essence of forms.

M. Tavassoli, *Urban Structure in Hot Arid Environments*,
The Urban Book Series, DOI 10.1007/978-3-319-39098-7_1

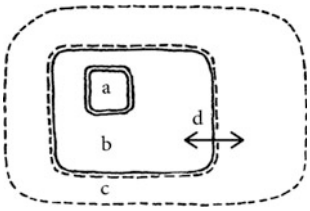

Fig. 1.1 A general plan of a pre-Islamic and Islamic town: **a** Citadel, *Arg/Kohandez.* **b** Inner area *Sharestan.* **c** Outer area *Rabaz*, Islamic period. **d** Bazaar area, after Islam the Friday mosque was founded and integrated with the bazaar

First of all, we can depict an overall town structure immediately before and after Islam (Fig. 1.1). And as we can see, because of the shortage of information, scholars usually are reluctant to give a clear image of pre-Islamic and ancient city form.[1] But some archaeological discoveries give information about a few excavated parts of ancient towns. As, in the city of Ur, third millennium BC, there were three basic parts:

> … the old walled city, the *temenos* or religious precinct, and the outer town:… .The *temenos* … was essentially reserved for the priests and members of the royal household. … The remainder of the city within the walls was densely built up as residential quarters. A considerable part of one such district has been excavated.[2]

The detailed plan of part of this housing quarter shows a considerable similarity to residential quarters of historical cities in the hot arid zone of Iran. Similarities include local squares, market space, bazaar alley, local shrines, and courtyard houses (Fig. 1.2).

Excavations in recent decades by Iranian archaeologists and scholars in *Tepe zagheh*, a fifth millennium BC village in the Qazvin plain of the central Iranian plateau, show interesting features. Here, we see some L-shaped courtyard houses with the main parts orientated toward the northeast–southwest and northwest–southeast. Interestingly, the public space has taken shape in the complex, and entrances are not exposed to unfavorable winds including the hot and sandy from the southeast and cold from the northwest[3] (Fig. 1.3).

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[1]Researchers and archaeologists such as J. Perrot, D. Huff, and R. Ghirshman because of shortage of information are reluctant to express a definite view about the form of Achaemenians and Sassanian towns and cities. In fact, the spatial structure of pre-Islamic cities, except for Merv, Ardashir-Kurra (Firuzabad), or Bishapur remains obscure. And only with few examples, we cannot give a clear image of pre-Islamic city form. The prominent Russian orientalist view V.V. Barthold who quotes from E.G. Brown, and he from Husein b. Mohammad Alavi's book: *History of Life and Work of Isfahan*, stating that the city of Jay in Sassanian period, was built on the basis of all Sassanian cities with four gates, because insufficient archaeological researches remain only as a hypothesis. For more information on this matter see Ghirshman (1954, p. 320, 1991, pp. 34–35 and 135); Perrot (1986); Barthold (1930), pp. 225–226.

[2]For a detailed information on the city of Ur in ancient times see Morris (1974), p. 8.

[3]For excavations in *Tepe Zagheh*, a fifth millennium BC village of Qazvin plain see S.M. Shahmirzadi, *A General Study*… pp. 6−9.

Fig. 1.2 **Ur**. Detail plan of part of the housing area, 1900−1674 BC: *A*. Baker's Square, a small market space, *B*. Bazaar Alley leading to it from the main street, *C*. small local shrines, streets are in random tint, house courtyards in dotted tint (Morris 1974)

Fig. 1.3 **Iran, Zageh Village**. Detail plan of part of the housing area, the period around 5000 BC. The structure has been oriented favorably, considering sun radiation and unfavorable winds (Shahmirzadi 1986)

Up to the present time, we have no such detailed information about pre-Islamic vernacular residential fabric. According to Diakonov, in the excavation of Susa, the effort was concentrated on the discoveries of historical monuments, power

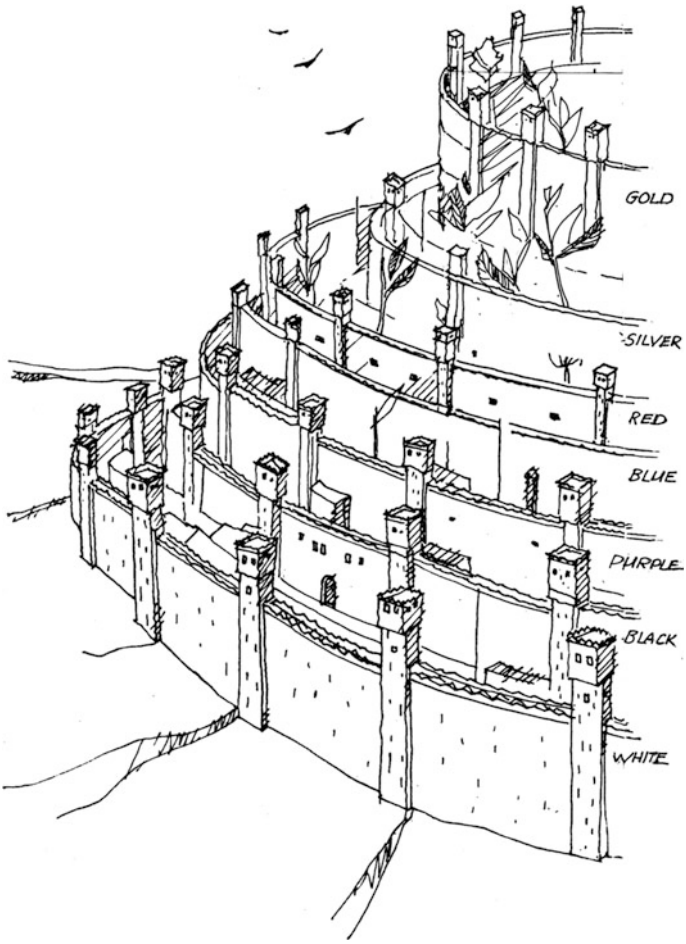

Fig. 1.4 Iran. Median fortifications, an example: Ecbatana, Hamadan, founded 715 BC, circular pattern with seven concentric walls. The king and his entourage in the center, then lesser officials, and the common folk beyond the outer walls. Each wall was painted a different color and identify it with one of the planets… (Lethaby 1892; Diakonov 1956; Kostof 1991)

architecture, rather than living spaces of ordinary people, whose physical structure we do not know much about. Diakonov, based on Herodutus, points out that the Median first lived in separated villages, again whose physical structure is rather obscure. The city which we know today as Ekbatana was built with seven concentric walls,[4] thus forming that of a kingdom and central power (Fig. 1.4). Lethaby, a leading figure who has examined the inherent mysticism common to architecture, also quoted the Herodutus explanation as follows:

[4]See Diakonoff (2004, p. 6, 2008, pp. 377−378).

> … This fortification is so contrived that each circle was raised above the other by the height of battlements only. The situation of the ground, rising by an easy ascent was very favourable to the design. But that which was particularly attended to is that, there being seven circles altogether, the king's palace and the treasury are situated within the innermost of them. The largest of these walls is about equal in circumference to the city of Athens.[5] The battlements of the first circle are white; of the second, black; of the third, purple; of the fourth, blue; of the fifth, bright red. Thus the battlements of all the circles are painted with different colours; but the two last have their battlements plated, the one with silver, the other with gold.[6]

Diakonov[7] and later Spiro Kostof also emphasize the seven concentric walls and range of colors described by Herodotus, pointing to the grades of status ranking in the city.

> …The king and his entourage were in the center rings, then lesser officials in descending order. The common folk lived beyond the outer walls.[8]

Arthur Upham Pope also referring to Herodotus view about the color of the walls and concludes as:

> … All these were expressions of the ever-recurrent attempt to establish communication between the heavens and human life on earth.[9]

Iranian professor of history and culture, Abd al-Hosein Zarin Kub, reminds us of mistakes in the writings of Herodotus and raises doubts about the colors of the seven concentric walls each related to heavenly bodies.[10]

However, because of mystical aspects of some works in the history of Persian cities such as Median fortress, comparative study of few researchers such as Lethaby, who investigates deeply the old documents, is very interesting. He quotes that:

> …The story of the seven walls is one of the Sabæn origin and the seven colors are precisely those which are used by the Orientals to denote the seven great heavenly bodies or seven climates in which they revolve.[11]

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[5]The size of the city of Athens at this time was nearly 1/5 × 1/5 km.

[6]For a distinguished work which discusses spiritual power and mystical aspects of architectural space in different cultures see Lethaby (2004). In his remarkable book, Lethaby examines this matter universally with many references to pre-Islamic Zoroastrian and Islamic symbolism of Iran. In particular, about the Median city pattern see pp. 128−129.

[7]See ibid., *History of Media,* pp. 377−378.

[8]See Kostof (1999), p. 183.

[9]See Pope (1965), p. 30. Pope's pioneering research is one of the best in the field of Persian Architecture.

[10]Zarin-kub (1996), p. 37. *Rouzegaran* (The Ages) a notable book which discusses Iran's history from the beginning to the fall of the Pahlavi. The book as a common thread deals with identity and events runs through the ages.

[11]W.R. Lethaby, op. cit., p. 132.

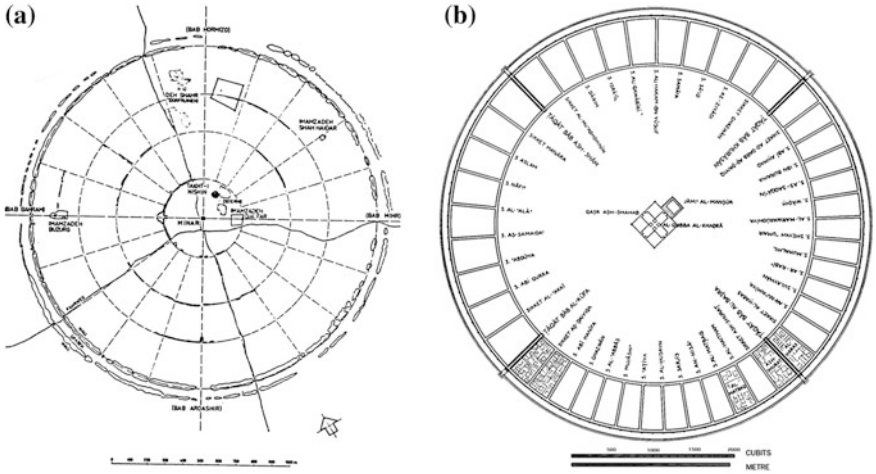

Fig. 1.5 **a Iran**. Ardashir-Kurra/Gur/Firuzabad, Sassanian capital third century CE. Centrality expresses political power and the concept that everything emerges from the center. **b Iraq**. Bagdad, eighth century, the design continued the Royal tradition of Persia (Creswell 1958; Huff 1986; Kostof 1990)

In fact, the question of numbers in human tradition, and also in pre-Islamic and Islamic culture of Iran, has a deep root in the distant past, historical, mathematical, and fictional.[12] For example, *seven* as the number of the universe, the macrocosm, in Islamic culture is considered as the first perfect number. In the Quran, we read that Allah has created seven heavens in layers, one above another.[13] In the elemental structure of cities in the Islamic period, we always find out the special numbers as symbolic quality, such as seven neighborhoods, or *Husayniyyah-yi Chehel Dokhtaran* (a neighborhood square named after the forty girls) in the city of Nain.[14] In the pre-Islamic period, we again find Sassanian fortresses with four gates. Or it is said, the pre-Islamic Sassanian city, Ardashir-Kurra had a radial pattern and was divided into twelve sections, named after the twelve sign of the zodiac,[15] a city which was considered as a model in the early Islamic period in the

[12]For a profound view on the science and art of numbers, by an outstanding Iranian philosopher, and the world's leading expert in Islamic philosophy and his amazing contribution to Islamic art and architecture, see Nasr (1976), especially Chap. 5. Also see Homai (1977), pp. 173–175. Homai a prolific and detail minded scholar, in this substantial study of Rumi's philosophy and theology refers to number 7 in the tradition of Persian mysticism. Also for a study of great depth on numbers also see Cooper (1993), pp. 113–120.

[13]Moin (1985). In this pioneering work, Moin a prominent Iranian scholar of Persian literature and Iranian studies has discussed the meaning and concept of Number 7 in many traditions, notably the Semitic, Pythagorean, Zoroastrian, and Islamic. Also, on the significance of numbers in the Quran for example see Leaman (2006).

[14]See our study here, pp. 82–83.

[15]See D. Huff, *A General Study*…, op. cit., p. 178.

construction of the city of Baghdad (Fig. 1.5). However, except a few types, the shape of Achaemenian, Partian, and Sassanian cities is not clear, and researchers and archaeologists evade to express a clear view about the shape of pre-Islamic ancient cities. J. Perrot's statements about the city of Susa, in the Achaemenian period,[16] and D. Huff's about the Sassanian cities[17]confirm this matter. Also quoting from Herzfeld, Perrot declares that the capital of Achaemenian king Cyrus was more like a camp than a city.[18] Only through a map prepared by M. Dieulafoy in the continuation of the work of archaeologists, we see two separated parts including the city of the kings and the general location of craftsmen's city.[19]

Therefore, due to the shortage of information about the residential spaces of ordinary people, we notice the importance of discoveries of Tepe Zaghe village and the housing area in the city of Ur.

Although we do not have a clear idea of residential districts of pre-Islamic cities in Iran, but considering the researches of Bartold, Khosravi, Honarfar, and Ashraf, we can get a general image of the Sassanian cities. For example, the historic city of Jay in the location of present Isfahan, which was a fortress with four gates, each opened toward a part of the world. Here, we can identify three basic parts: first, the walled city and the main part including quarters and bazaars which were called *sharestan*; second, the citadel, with high walls and towers, military and governmental spaces, called *kohandez*; and third, the outer areas, including rural quarters, fields, and gardens. In the Islamic period, the outer areas were renowned as *rabaz*.[20] Some texts give information about the bazaars and lively activities of the squares of Sassanian cities,[21] but in comparison with Greek agoras and Roman forums, limited archaeological discoveries and researches are reserved about this matter.

However, Iranian cities in the Islamic period, before the profound political and economic changes of the twentieth century,[22] had a special structure that will be discussed at greater length in the next chapters. Furthermore, because many problems of Iranian cities are the result of forgotten cultural and climatic factors in design, we need to get a better understanding of this period. In fact, with this knowledge, understanding of the past, and the meaning behind urban form and structure, we will be able to take proper steps.

[16]Ibid., J. Perrot, pp. 99−101.

[17]Ibid., D. Huff, p. 176.

[18]Ibid., J. Perrot, p. 101.

[19]Mecquenem (2009), pp. 164–165.

[20]For a discussion of structural pattern of pre-Islamic city see W. Barthold, *A Survey*... op. cit., pp. 225−226, and Khosrovi (1972), pp. 36–46, Honarfar (1973), pp. 24–36, and Ashraf (1974), pp. 7–49.

[21]Pigoulevskaya (1976), p. 142.

[22]For a discussion of political and economic changes of twentieth-century Iran see Abrahamian (2008).

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Chapter 2
Urban Structure in Islamic Territories

Abstract In this chapter of the historical part, part I identifies socio-spatial and cultural aspects of the historic towns. It considers historic towns as a collection of homogenous neighborhoods including structural and functional elements typical of Islamic towns inside and outside Iran. Integrated neighborhoods were bounded together by ties of climate, culture, custom and beliefs, and art. The comparative study in this chapter shows structural similarity between some African, Asian, and Iranian cities, but as shown in Chaps. 3 and 4, Iranian cities in the hot arid environment, because of clarity and character of desert life, demonstrate a legible structure.

Keywords Islamic towns · Comparative study · Climate and culture · Homogenous neighborhoods · Earthquake

In general, in Islamic territories, the city is being considered as a collection of homogenous and integrated neighborhoods (Fig. 2.1). For centuries, there is a slow pace of change of traditional society. Integrated neighborhoods were bounded together by ties of climate and culture, custom and beliefs, and art.

In special cases, power was the principle shaping factor. The design of the old city of Baghdad in the Early Islamic period was more for power than for people. The city here is a clear manifestation of power into a circular form. The Abbasid Caliph al-Mansur in 762 founded the city 32 km from the remains of Ctesiphon, the historical Partian and Sassanian city, as follows:

> …al-Mansur wrote to every city to send engineers and people acquainted with building, surveying, and mensuration. Engineers, architects, and land-surveyors from Syria, Mosul, Western Persia, Kufa, Wasit, and Basra were gathered together, and not until thousands of men had been assembled did the work begin. Tabari says that the plan of the city was first traced on the ground with lines of ashes, for al-Mansur wished to see its actual form. The plan was circular, with four equidistant gateways named after the city or province towards which they opened.[1]

[1]For detailed information of the city of Baghdad, see Creswell (1958), pp. 161–182. And on the point of view that design of Baghdad continued the royal tradition of Persia see Spiro Kostof, *The City Shaped,* op. cit., p. 184, and also D. Huff, *A General Study…* , op. cit., p. 181.

M. Tavassoli, *Urban Structure in Hot Arid Environments*,
The Urban Book Series, DOI 10.1007/978-3-319-39098-7_2

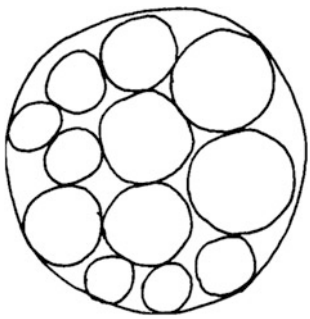

Fig. 2.1 The Moslem city as a collection of homogenous areas (Rapoport 1977)

The palace and mosque were in the center with streets oriented from the four gates toward them. The round city shape is derived from Ardashir-Kurra/Firuzabad, Sassanian capital third century. Centrality here expresses political power, and the concept is that everything emerges from the center. Here, power overcomes climate as the principle shaping factor in the hot arid zone city.

Spatial form of some of the Asian and African cities is also structurally significant. About the ancient city of Antioch/Antakya[2] in Asia Minor, founded in 300BC, Rapoport writes:

> …as recently as 1934, there were many specialized areas…, ethnic and religious residential quarters… independent, self contained and exogamous. Within the quarter one knew everyone and felt safe. Twenty-seven of the 45 quarters were Turkish and grouped in one area of 18,000 people [i.e., there was a hierarchy of grouping]; Christian and Arab quarters were even more differentiated, subdivided and varied and in the case of Arab areas, even more introverted.[3]

Also, in Damascus with several layers of history, the city was structured according to the integration of quarters which:

> …was divided into Souk areas and other quarters along ethnic, religious and other lines, subdivided into microquarters; each was a miniature city with all services—mosque, baths, bake oven and market—the same elements and organization as the whole city…. In North Afghanistan, in a town like Akapruk, even today each ethnic group and Moslem sect has separate quarters,… In traditional African cities there is a similar pattern. Thus in Nigeria there are regional tribal divisions, while cities are divided into quarters of the different groups and the heterogeneous population is grouped by ethnicity, religion, occupation and social status…. Yoruba cities are divided into areas of extended families comprising hundreds of nuclear families. All people within a neighborhood are closely related and adjoining areas are also related, although less closely. The city is thus a hierarchical system

[2]Antioch was founded about 300 BC by Seleucus, one of the Alexander's generals.

[3]For a basic study dealing with man–environment studies of urban form and structure, including Asian and African cities, see Rapoport (1977), p. 252, and on comparative analytical study of culture in many Asian and Western countries, see Rapoport (2005).

Fig. 2.2 Tripoli. The main structural elements of the old city *a* Citadel, *b* Mosques, and Madrasahs (map redrawn from Warfelli)

> of houses, compounds, neighborhoods and clusters of neighborhoods of related people: these are closely built and larger spaces separate less closely related groups.[4]

In addition to the spatial organization of African cities, such as Tripoli, we find a structural similarity between some African, Asian, and Iranian cities. The main structural elements include citadel, mosque, Madrasah, Bazaar, and Neighborhood system. Some of these cities have changed, but have preserved their main spatial structure. The present city of Tripoli is built on the ancient site Oea (Fig. 2.2). The history of the inner core goes back to pre-Islamic Roman times. The city was conquered by Arabs in 642–643, and we do not have much information about the structural elements at this period. Only we know many elements including mosques and madrasahs were built gradually along the main structural passageway near the sea. According to the old sources, the city could boast of beautiful houses, baths, and markets.[5]

A comparative look at the famous Middle Asian Cities such as Bukhara and Samarkand is also important (Figs. 2.3 and 2.4):

[4]A. Rapoport, op. cit., pp. 252–253. Also for an enlightening master work on a historic city, see Ross Burns, *Damascus,* Routledge, 2005.

[5]On the history and structural elements of Tripoli, see Warfelli (1976), pp. 2–18.

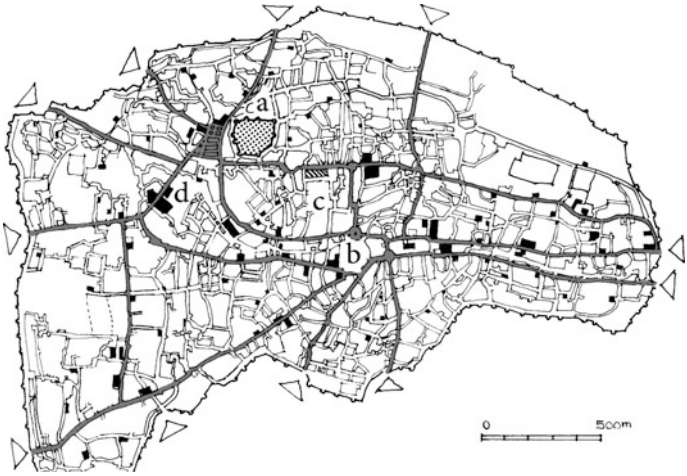

Fig. 2.3 Bukhara. The main structural elements of the old city: *a* Citadel. *b* Bazaar. *c* Friday mosque, *d* Mosques, Madrasahs, and Mausoleum (map redrawn from Giese)

Fig. 2.4 Samarkand. Two main section and structural elements of the old city: *a* Islamic old town. *b* Russian new town. *c* Citadel. *d* Mosques and Madrasahs. *e* Cupola Bazaar Charsu (map redrawn from Giese)

… Most of the old structures still existing at Bukhara originate from the second half of the sixteenth century… Bukhara presents structural and functional elements typical of an Islamic-oriental town of the Iran-Turanic region. These are: (1) The Friday Mosque; (2) the Bazaar; (3) the Citadel; (4) the cell and blind-alley structure of housing quarters with their interdependence of family bonds as well as ethnic, religious, and corporational relationships; and (5) the compact wall with its town gates, enclosing the town compound and separating it from the rural environment.

> The location of these elements and their relationships to each other correspond to their importance and functions in town life. In the center of the town, there is the Friday Mosque. The bazaar district follows suit. Adjacent, but distinctly separated from the bazaar, is the extensive area of the living quarters. The three independent, functional elements are formally united by an enclosing wall.
>
> The *Citadel*, residence of the *secular reign* (khan, beg), is a structural part of the encircling wall as in Samarkand, or as in Bukhara, located at the periphery of the town's economic and spiritual centre, but in any case not in the middle of the city. As a rule, it is a self-contained district, mostly built on elevated ground and protected by walls.
>
> The *Friday Mosque*,… the town's spiritual and religious centre, is located in the center of the town; in Bukhara, in its immediate vicinity are the Kalyan Mosque, …, and the Kalyan minaret, closing the open forecourt used for assemblies and executions between mosque and medrese to the south.
>
> Analogous to the central business districts of Western cities, the *Bazaar* of large Islamic-oriental town is the centre of economy and finance, connecting closely knit organizational and financial systems of wholesale trade and retail business, (stationary and ambulant), private and public services, crafts, and finance institutions. Within the bazaar, which in contrast to West-oriental towns, does not consist of a closed-in, frequently lockable, spatial area, but presents a more linear structure; the various branches of business are gathered in narrow lanes or sections; the respective branches do not occupy random sections of the lanes, but depending on their rank in business and the attractiveness of the site are in specific locations considerably affected by the proximity of the Friday Mosque.
>
> Spatial order is also displayed in the housing area encircling the core of the town, i.e., the Friday Mosque and the bazaar. It is divided into innumerable living quarters (cells) occupied by groups adhering to the same religion, nationality, and corporation under the protection of community life.… In large Islamic-oriental cities like Bukhara, Samarkhand, Kokand, or Tashkand, there are sub-centers of various kinds as well as their main central bazaar.[6]

In historical Iranian cities, the city form demonstrates a legible structure. This structure has been so organized that each neighborhood had one center shaped in a proper location, considering the harsh climatic condition of the hot arid environment. All the neighborhood centers were connected to the city center through main passageways.[7]

In many of these cities, the citadel as in the old Tehran located near the town's economic and religious center including the bazaar area with complicated and connected spaces.[8] But, in some cases as in the city of Bam, it was a self-contained, defensive, and protected element located on a height. In the 2003 earthquake, the city of Bam and the historical walled old town including the citadel were totally destroyed[9] (Figs. 2.5 and 2.6).

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[6]For an analysis of spatial structure of two important Middle Asian Cities, see Giese (1979), pp. 145–165.

[7]In next chapter, neighborhoods and neighborhood centers in several typical cities in the hot arid zone of Iran are presented. Appropriate distance between neighborhood centers is notable.

[8]The first complete drawing of spatial structure of Tehran bazaar, including caravanserais, saras, mosques, and schools, was made by the author after field survey, for the *First Detailed Plan of Tehran*, at the office of the Mayor, Tehran Municipality in 1972. This drawing was introduced in Tavassoli and Bonyadi (1992), p. 62.

[9]For a considerable first study on the historic Citadel of Bam, see Nourbakhsh et al. (1976).

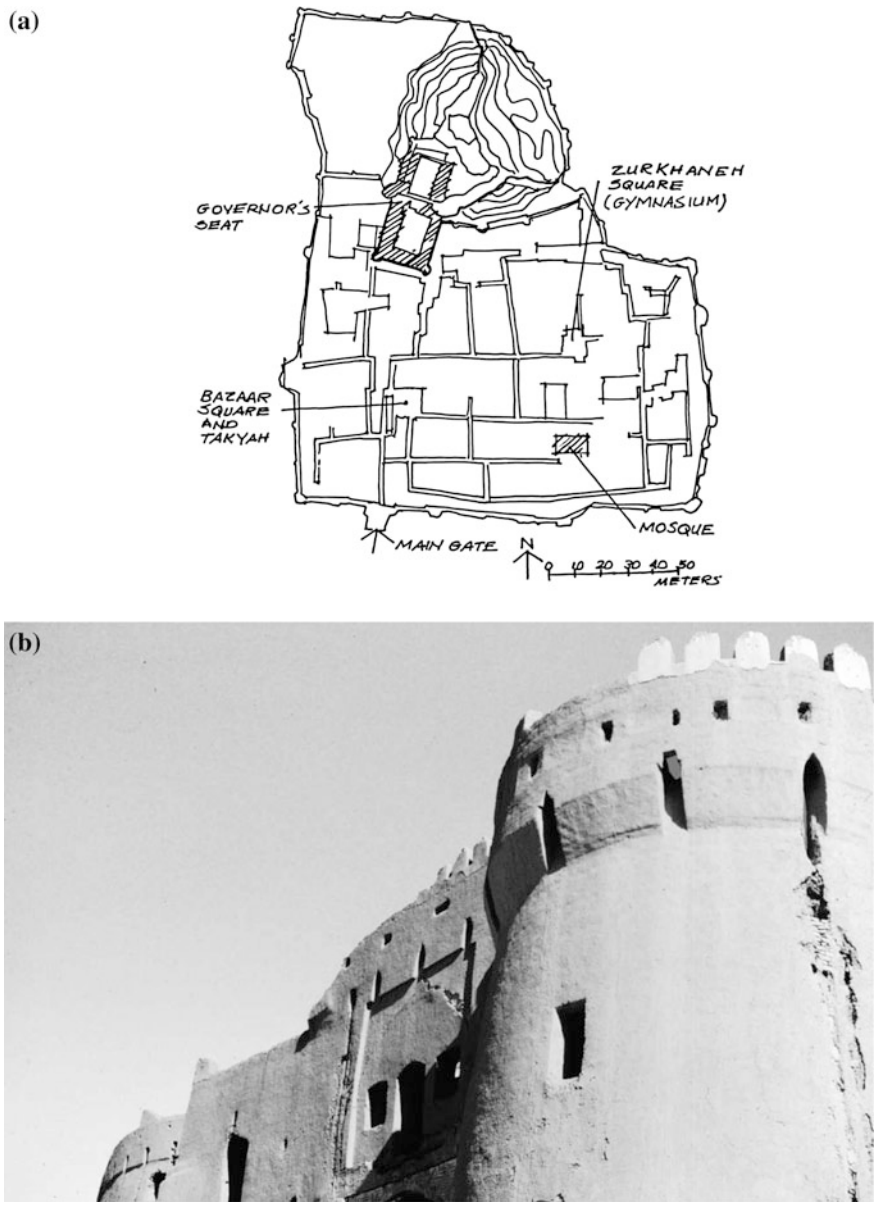

Fig. 2.5 Bam. **a** Main structural elements of the old town (plan based on Noorbakhsh). **b** The town fortification before the 2003 earthquake

Fig. 2.6 **Bam**. After the 2003 earthquake: **a** Bazaar area. **b** Shrine. **c** The old citadel

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Chapter 3
Iranian Cities in Islamic Period, the Middle Ages

Abstract In this chapter, the basic elemental structure as independent parts but interrelated elements has been discussed. As we can see among three factors, climate, religious beliefs, and power, those have a decisive role in shaping urban structure, harsh climatic condition is of prime importance. The study of this chapter is based on exhaustive field research. The research also considers the symbolic interpretation and artistic aspect of perception of inner meaning behind the sustainable forms, sustainable urban fabrics integrated with nature, and discovers the secret of beauty of Persian garden.

Keywords Elements of urban structure · Neighborhood centers · Mosques · Public spaces · Bazaar

3.1 Research Domain

The climate of most of the Iranian plateau is hot and dry, and most of the historical cities of great artistic merit are situated in the hot arid environment. The history of some of these cities dates back to pre-Islamic period,[1] but the historical part of their existing structure took shape in the Islamic period (Figs. 3.1, 3.2 and 3.3).

As we can see among three factors: climate, religious beliefs, and power that have had a decisive role in shaping urban structure and architecture in the hot arid zone in Iran, harsh climatic condition is of prime importance.

Because of war and earthquakes destruction during the centuries, the form and structure of pre-Islamic urban living spaces are not clear. Archaeological discoveries

[1]One of the first reliable local historical text about the Yazd region is *Tarikh-i Yazd,* (History of Yazd), written in fifteenth century. The information of the book is mainly concerned with Islamic era, from eleventh century (Atabekan period) till the author's time, fifteenth century. The book also covers a summary of information about pre-Islamic and early Islamic period. Historical studies in the present book are specially based on a comparative study between contents of *Tarikh-i Yazd* and remains of structural elements in the years 1971–1972. At this time, many spaces and places mentioned in *Tarikh-i Yazd* were still survived with their old names. See Ja'fari (1965). Also for historical pattern of Yazd region see Estakhri (1969).

M. Tavassoli, *Urban Structure in Hot Arid Environments*,
The Urban Book Series, DOI 10.1007/978-3-319-39098-7_3

Fig. 3.1 **Nain**. Remains of the central citadel, *Narin Qal'ah* a pre-Islamic element

Fig. 3.2 **Aradan**. A village near Garmsar, remains of the feudal citadel

only give a general picture of several typical cities, and a few excavated parts. It seems that the primary response to the problem, lies on the one hand in taking advantage of archaeological discoveries, and simultaneously a comparative study based on old documents; and on the other hand to organizing a symbolic interpretation and artistic research on the perception of the inner meaning behind traditional forms. But how does the researcher of today be able to perceive the spirituality of forms. What picture can he get of the spiritual meaning and secret realities behind the forms of Iranian art and architecture. Such researches are to be organized not only in the exterior knowledge but in the interior knowledge of forms before and after Islam. And this is not just a work of putting the information together, which is usual in our universities, but needs penetration of love from origin toward the researchers.

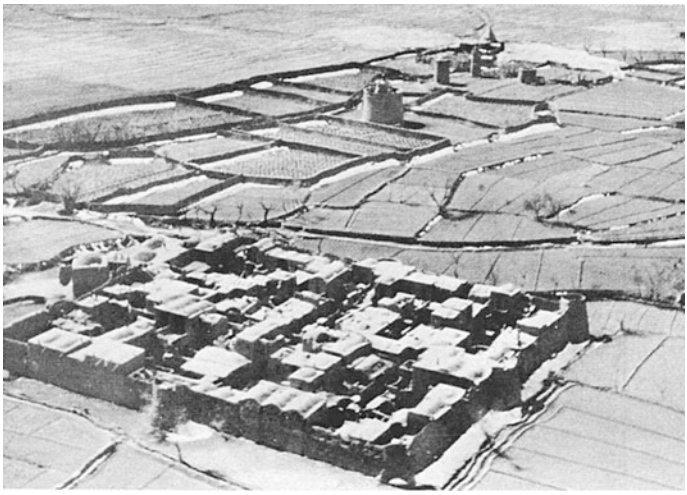

Fig. 3.3 Iran. "A long, close contact with nature evolved solutions such as those of the Iranian village in the Oasis of Veramin, where the village huddles together to leave the least surface to the scorching heat. The geometric minimum of the individual units is echoed in the total layout, bringing an appealing unity, and the closeness yields protection through mass. The thick walls tame and delay the thermal variations. The courtyards are shaded, providing cooling wells and establishing 'introvert' dwelling units looking inward from the hostile environment. This distinct order took form through the urgency of biological necessity" from Olgyay

In order to clarify the spatial structure of Iranian cities in the hot arid environment, a comparative study between several important historical cities has been conducted. In the process of this study, it is necessary to draw the reader's attention to several significant points:

1. The cities under study here are among the most important historical Iranian cities in the Islamic period.
2. When in 1970, the present research started, in spite of significant sociocultural and economic changes of the twentieth century, the cities still presented the old structural elements that could be sought in local historical texts.
3. Today because of uncontrolled urban renewals and earthquakes, some of the old spaces and structures presented in this book have been demolished.

Also, we should pay attention to the differences between the urban spaces in different cultures. For example, the effect of sociocultural and climatic factors in Persian architecture has resulted in the shape of inward-looking composition, which is in contrast to a more outward-looking Western architecture. Indeed, while the aesthetic characteristic of outward Western architecture, which for example has appeared in street architecture, but in Persian architecture this characteristic is transferred to courtyards behind narrow streets enclosed by simple walls. In Persian architecture, this inward-looking characteristic is not only the effect of climatic

but also cultural and social factors. In a few temperate zones, we also see the inward-looking spatial characteristics, but not as compact as urban forms in the hot arid zone. Also, historically this characteristic is not confined to the Islamic period, but its origin goes back to pre-Islamic times.

But in Iranian cities, there were some spatially arranged and ordered urban spaces which were enclosed by distinctive elements. These places for sociocultural activities were unfortunately destroyed during the street construction in the 1930s.[2] Researches in order to discover the reasons behind these form a considerable chapter in the political history of Iranian cities.

Urban structure as a whole, including squares and main passageways which were integrated with active elements such as bazaars, Friday mosques, and neighborhood centers, formed a coherent whole. This structure was the result of sociocultural and religious beliefs which permeated the life of the city for centuries. Studies indicate that except the citadel that was usually a self-contained and walled section and sometimes built on the elevated part of the town, the rest of the town as a collection of homogenous quarters, were spatially interrelated.[3]

3.2 The Elements of Urban Structure

Three distinctive efforts over a period of time, with different power, in different times and places,[4] including the following:

1. local rulers;
2. men of religion and politics, and also people of knowledge
3. people of spiritual virtue, merchants, and local notables,

have shaped elemental structure and urban form as follows:

1. the citadel;
2. inner and middle area of the city(*sharestan*) walled and gated, including neighborhoods;
3. city center complex including bazaar as the center of economy and finance and Friday mosque as the spiritual and religious center;
4. neighborhood centers;

[2]For example, two main urban spaces in Yazd, *Amir Chaghmagh and Shah Tahmasb,* which were constructed in fifteenth and sixteenth centuries and named after their founders, have been divided into pieces by newly built straight streets since 1930s. See the present book (Figs. 3.16 and 3.17).

[3]See the present book (Fig. 4.26).

[4]For example, the power of social strata, including *rendan, pahlavanan,* against the ruling system and some independent guilds, and also some influential figures in local politics such as *Sadat* (decedents of the Holy Prophet), and *Zohhad* (ascetics), are considerable. See Abd al-Hossein Zarin-kub, *Az Kucheh-yi Rendan,* a fascinating account dealing with sociopolitical and cultural life of Shiraz in the fourteenth century, the age of Hafez.

5. connected elements in the form of urban and neighborhood spaces(*takyahs* and *husayniyyahs*) through main passageways;
6. outer areas including the areas between *sharestan* and rural areas *rabaz*, and surrounding rural gardens, and cultivated areas;
7. subterranean aqueducts *qanats*, water reservoir *ab-ambar*, and ice houses *yakhchal*

Altogether, the city in the hot arid environment consists of three main parts[5]:

First: the inner area or the old walled section of the city, including the city center complex, bazaar, Friday mosque, neighborhood and neighborhood centers. The history of this section goes back to the first centuries of the Islamic period, and continues till the enormous changes in twentieth century modern Iran. Urban structural elements of great value were created mainly during this period.

Second: the middle or semi-old area, mainly including developments outside the town wall, in the form of connected or separated pieces. These developments started mainly in the first decades of the twentieth century and continued till the years of land reform in the 1960s, years of social transformation and excess in Westernization and moving away from religious and national traditions. Earlier in the years of the 1930s many urban spaces, mainly religious, were destroyed. But simultaneously much outstanding street architecture took shape.

Third: outer areas, including new developments during the last 50 years, which are rarely incompatible with their environment.

3.3 Neighborhoods and Neighborhood Centers

The historical city as a whole consisted of integrated collection of neighborhoods. Each neighborhood was considered as an administrative, sociocultural, economic, and religious unit of the city. The neighborhoods were places of residence of craftsmen and special occupations, religious minorities, and different social classes, which were organized harmoniously within the walled section. An example of religious minorities neighborhood is the Armenian neighborhood in the city of Isfahan, Zoroastrians in Yazd, and Jewish neighborhoods in many Iranian cities. In the outer areas of many cities, there were some neighborhoods/villages which were integrated with gardens. Since the last fifty years, many of these structures have changed or destroyed for new developments. But a few exceptional types, architecturally valuable, still exist (Fig. 3.4).

From economic activities and professional point of view, we can mention hat-makers and camel drivers neighborhoods in Isfahan, silk-weavers in Yazd,

[5]The process of division of the city into three structurally different areas was first proposed in our book: *Principles and Techniques of Urban Design in Iran*, Tehran, 1365/1987.

Fig. 3.4 Ghasem Abad. A neighborhood village in the southern part of Yazd, a typical compact shaded structure. *source* Iran, *National Cartographic Centre* 1972

cloak-weavers in Muhammadiya, a small town near Nain, or spoon-makers in Hamadan. Also after Islam, Arab rulers in their newly conquered cities, in order to secure their domination, established new neighborhoods encouraging Arab migration to Iran.[6]

The number and largeness of a neighborhood depended on the size of the city. As, the city of Nishapur, during the era of Abu Said Abil-Khayr, the celebrated Sufi (d. 440/1048) had forty-seven neighborhoods, some of them as large as the whole city of Shiraz at that time. And in exceptional cases, a large neighborhood could be administratively independent and have separate drum and flag.[7] In the age of the Buyid dynasty, fourth/tenth century, the city of Shiraz had twelve quarters (*called tassuj*) and eight gates.[8] Also in the eight/fourteenth century, Shiraz of Hafiz had seventeen neighborhoods and nine gates.[9] In the fourteenth century, the city was

[6]See A.H. Zarin-kub, *Rouzegaran 2,* op. cit., pp. 16–17.

[7]For a prominent document on the history, society, and culture of Iran in fifth/eleventh century, see *Asrar al-tawhid,* a large biography of the famous Sufi saint Abu Said Abi l-Khayr, with a very notably complete introduction by Shafiei Kadkani, Tehran (1366, 1988).

[8]See Limbert (2004), p. 9.

[9]See Zarin-kub (1985), op. cit., p. 178.

divided into seven areas (*nowbat*) in relation to pilgrimage to the grave of saints, the seven days of the week. Here again, we notice the hidden meaning of the number 7 in the physical shape of the city. The neighborhoods might take their names from neighborhood villages in the outer areas, absorbed into the city.[10] As we can see in the present study, nearly almost all the villages in Yazd have been absorbed into the city (Fig. 3.30).

Changes in the form of neighborhoods throughout history, destruction, and construction of new areas, also help us to discover the identity of a city. Although today the old neighborhood system has completely vanished, but in Yazd the information about some of the old neighborhoods that Ja'fari, the local historian of ninth/fifteenth century gives us, is still recognizable.[11] In Hafiz's Shiraz, although there is no trace of Dar al-Shafa Seminary, founded by Shah Shoja (a ruler praised by Hafez) in the dashtak (Sar-i Dozak) quarter, south of the congregational mosque, but the neighborhood is still recognized by its old name.[12]

The role of the rulers in urban management, and division of the city into relatively independent neighborhoods with limited power is also important. Indeed, the neighborhoods were not just a physical territory. Neighborhoods of Shiraz in the time of Hafiz had a cultural and specially a sociopolitical atmosphere. The city's power was in the hand of people from all social strata, champions, libertines, neighborhood's headmen, people who were able to cause serious disruption.[13] In the history of Persian cities, the neighborhood chiefs rarely had power, but in the Shiraz of Hafez they had a special power, a rare sociopolitical phenomenon which drew their power from the control of street mobs and their ability to turn those mobs for or against the ruling system.[14] In the climate of suspicion and violence, the ruler Abu Eshaq's mistrust led him to execute the chief of the *Seyyeds* in important areas and quarters, accusing them of collaborating with the besieging Mozaffarids. But before his intention to execute *Kalu Omar*, the son of the chief of another quarter pre-empted and made secret contact with the Mozaffarid ruler Amir Mohammd.[15]

Segregation was also one of the most important social characteristics of some towns and cities. Some cities were divided into two groupings Haydari and Ne'mati, who periodically clashed in massive fights. This to a certain extent resulted in a tragic situation. The city of Qazvin was divided between Haydari and

[10]See J. Limbert, op. cit., p. 54.

[11]For example, some of the old outer area neighborhoods, such as *Maryam Abad,* or a historical gate named *Mal Amir* (Mother of Amir).

[12]See John Limbert, op. cit., p. 43.

[13]See Zarin-kub (1985), op. cit., pp. 2–5.

[14]See John Limbert, op. cit., p. 89.

[15]Ibid. p. 35–36. In addition to the sources mentioned above about Shiraz of Hafez, and points of views of many scholars about Hafez, for a distinguished work which discusses 77 selected sonnets in relation with history and culture of Iran, see M.A. Eslami Nadooshan, *Taammol dar Hafez*, Yazdan Publisher, Tehran (2009).

Ne'mati, and citizens were belonged to one of these particular groups.[16] Also in Shiraz at the end of the eighteenth and nineteenth centuries, five neighborhoods in the north and east were Haydari-khane and five in the south and west were Nemati-khane. Thus, causing division among citizens facilitated the work of the ruling system.[17]

Studies about the population of neighborhoods indicate that in 1956 the city of Yazd with a population of 63000 people consisted of 43 old neighborhoods, on the average 1500 people for each neighborhood. In the case of Nain, with a population of 4600 in 1956 and 7 old neighborhoods, the population of each neighborhood was less than 700 people.[18] Small neighborhoods with a small population decreases their role as an effective political unit in the city. This aspect of neighborhoods and guild organizations has not yet been studied in Iran. But it seems that the population of neighborhoods in the unsettled city of Shiraz in the age of Hafez, in the period of authority of kalus was much more than the untroubled cities like Yazd and Nain.[19]

Each neighborhood as a homogenous part, similar to the whole city had a center. In other words, the city was structured on the basis of hierarchy of centers connected together through main passageways. The neighborhood center was formed according to the socioeconomic condition of the residents. The elemental structure of the neighborhood center which was formed at the intersection or along the passageways usually included: small bazaar, mosque, square/Husayniyyah, and water reservoir/ab-ambar. Field studies in different historical cities, presented in the first part of this book, clearly explain this characteristic. The city and neighborhood centers with their certain places or hang-out *patoq*, were centers of communication and gathering of the chivalrous people, who were organizer of many activities such as ceremonies during mourning days.

Comparison between movable and exciting atmosphere of Shiraz with sociopolitically calm cities such as Yazd is also interesting. In most of these cities, the chief of the neighborhood was elected by the people. The reason for giving a particular name to a neighborhood was also related to an important person, a chief, an elder, or a special elemental structure in the neighborhood. For example, the name of one of the oldest neighborhoods in Yazd, *koosk-i now*, is related to a palace that was once built in the area.[20] Or a neighborhood in Kashan, known as *Tahir va*

[16]Urban hostile rival groups, the origin of conflicts is not clear. Although some trace it to Sufi orders going back to Safavid times and continued during Qajar rulers. It is said that Haydari faction took its name from Qutb al-Din Haydar a Persian Sufi saint from thirteenth century, and Ne'mati from Shah Ne'matollah Vali a Sufi master and poet from fourteenth and fifteenth centuries. See, Mosahab, (1996).

[17]On the point of view: "divide and rule" see John Limbert, op. cit., p. 100.

[18]Concerning the population of cities of Yazd and Nain in 1956, see the article on population in *The Book of Iranshahr,* UNESCO, Tehran (1963). Also on the study of the population of Yazd, see *Master Plan of Yazd,* University of Tehran, Faculty of Fine Arts (1973).

[19]For the population of Shiraz in the age of Hafez, see John Limbert, op. cit., p. 50.

[20]For the history of elemental structure of Yazd see Afshar (1975), p. 281, and p. 346.

Mansur,[21] where the ceremony of sacrificing a camel, on the day of the Feast of Sacrifices, is held in its central square,[22] or the neighborhood known as *Ab pakh-shan*, a place where water was distributed, in the historic city of Zaware.[23]

After constructing new streets through the fabric of the old cities, and dividing them into parts, changes in the administrative organization and urban management, the arrangement of the old neighborhood system was disrupted. Today, only the name of these urban units is remained, and only a few ceremonies are held on Islamic feasts or mourning days.

3.4 Mosques, Tombs, and Musallas

Islam at the beginning, added an important and distinct elemental structure to the city. This basic element, i.e., the congregational mosque, played an important role in the religious life of people. Spatially it took shape in connection with other elemental structures of the city center. In the early years of Islam, the early mosques were very simple and lacked decoration.[24] The Prophet'smosque in the city of Medina was built from mud brick and clay, the same as ordinary houses of the city. During the period of Uthman the Caliph, the columns of the mosque were covered with stone, and the ceiling with teak wood. In this period also, applying gypsum to the walls of the houses became common, which according to some early Muslims such as Abu Zar-i Gaffari was considered as sign of Mammon.[25] Under the Arab Caliphs, Omayyad, and Abbasid, mosques once simple were transformed into magnificent buildings. Afterward, the building of elaborate Mosques continued, and Friday mosque became one of the main structural elements of the cities. Excepting some points about maintenance, building mosques as a simple element has not been mentioned in the Quran. Interpreters have emphasized on the movement of wor-shippers and the spiritual climate of mosques as a sign of maintenance.[26]

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[21]See Naraghi (1969), p. 175.

[22]See the present book, Fig. 3.15.

[23]See Abu'l Qasim Rafii Mehr Abadi, *Atishkadeh-yi Ardestan*, *Part one,* Tehran (1957).

[24]Pirnia (1974), p. 7.

[25]Emam Shushtari (1969), pp. 18–23.

[26]Some commentators of Quran, old and new, such as Abol Fotouh Razi, Meybodi, Lahigi, Sultan Ali Shah Gonabadi, Allamah Tabatabai, and Allamah Mustafavi, have argued the physical dimensions and doing material services to mosques as well as the spiritual dimension. They believe in addition to doing material services to mosques, we need to touch the soul and make connection with the esoteric truth of sacred space. See especially, Gonabadi (2000), pp. 108–109. And, Hasan-Mustafavi, *Tafsir-i Rowshan*, vol. 10, Tehran (2001), pp. 67–68. Also Karim Zamani, researcher and translator of *Quran-i Karim,* Tehran, (2010), p. 378.

In addition to the importance of the Friday mosque as a center of sociopolitical in the history of Iranian cities, we should also consider its great architectural values. Although some aesthetic and stylistic features and building techniques have been discussed by prominent researchers of Persian architecture such as Pope and Godard, their work did not continue to be as powerful as it was in the early stages. Later studies have more or less repeated the work of the old masters, rather than proposing new ideas. It is evident that the discovery of the old Friday mosque at Fahraj by the late scholar M.K. Pirnia, as the oldest mosque in Iran, is of great importance. This Mosque which was built in the early decades after Islam, includes some shaping components from the Sassanian period before Islam. Unfortunately, it has not yet been completely recognized and Pirnia's consideration has not been continued.[27]

Traditional Muslim architects, in their world of mysteries, have created spaces of great values. The architecture of Friday mosques in towns and cities such as Isfahan, Yazd, Zaware, Ardestan, and Nain or an exceptional type, the Sheikh Lutf Allah mosque, and also small unknown local mosques are so considerable that a course about the architecture of Iranian Mosques can be propounded in the departments of architecture. Obviously, in pursuing such a course, the discussion should not just be concentrated on history, historical period, or architectural styles. But the aim is to understand the art of space design, visual values and the meaning behind forms, and also the role of climate and culture in shaping the structure. An example of climatic response is the Friday mosque of Bafq, with enclosed courtyards at two levels (Fig. 3.5). Considering the importance of climatic factors in shaping building form, we have given an account of the unique structure of the Friday mosque in the town of Tabas, before the destructive earthquake of 1978 (Figs. 6.40 and 6.41).

Considering planning measures in the historical section of cities during the last century, attention was not paid to the principle that the Friday mosques were spatially integrated with other elemental structures of the city center. In Semnan, the new street, previously named Shah street, cut the linear bazaar lane into two pieces and separated two main urban spaces (Takyah), one including the Friday mosque and a shrine (Fig. 3.9). In Yazd, the building of a straight street on the axis of the main entrance of the Friday mosque, imitating the Baroque style, led to the separation of the forecourt of the main entrance from the surrounding fabric. Accordingly, the scale of the forecourt space was confused, and the secret character of the main entrance totally disappeared (Figs. 3.6, 3.7, and 3.8).

The mosque's courtyard as a public space is one of the distinctive feature of many Iranian mosques. Friday mosques are usually integrated with the main structure of the city and the life and activities of surrounding passageways. Here, the mosque as a house of God becomes the house of the people, a completely public space (Fig. 3.9). Again as a unique example, we can see the integration of the Friday mosque with Khanaqah in Natanz (Fig. 3.10).

[27]The Friday mosque in Fahrag was first introduced by Pirnia (1970), pp. 21–24.

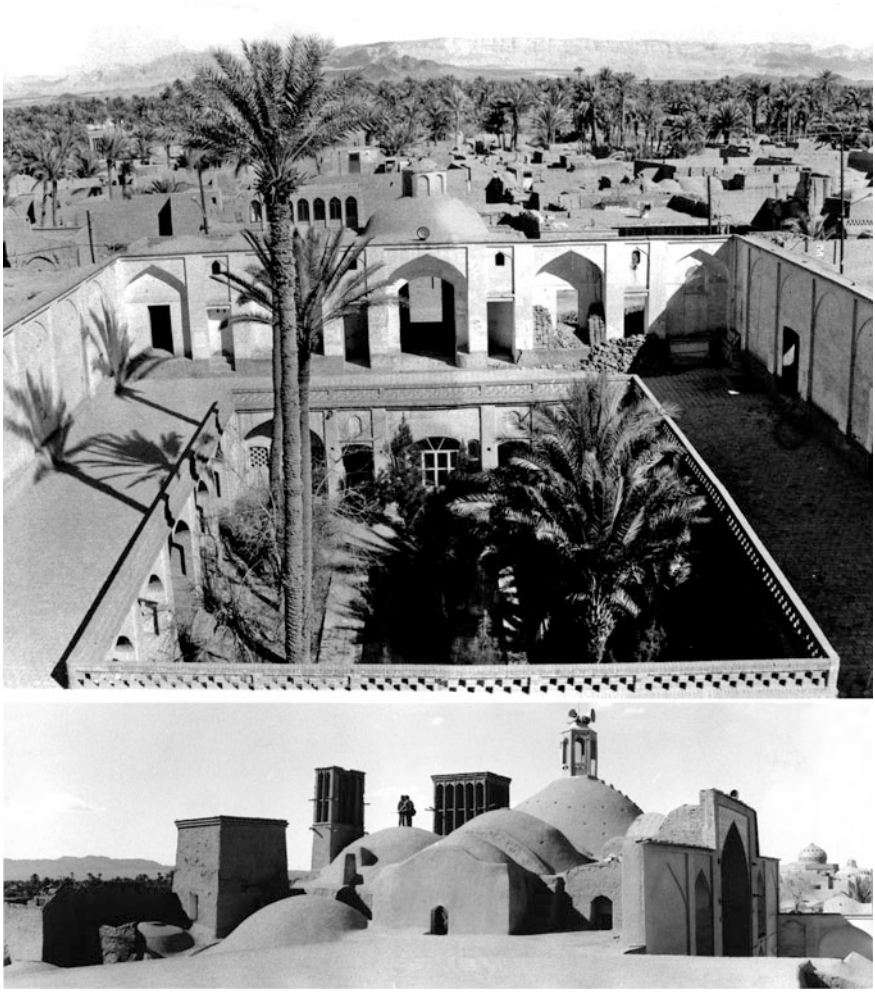

Fig. 3.5 Bafq. Friday mosque's courtyards at two levels, and the main sanctuary roof shape

Continuous perfection in the spatial structure of some mosques throughout the ages indicates that this architectural element should not been considered as a static element. In several cases, as in Isfahan and Yazd, the Friday mosques have been altered and renewed gradually in response to new needs and thoughts. The Arab style, colonnaded spaces enclosing courtyards, transformed into Iranian pre-Islamic four ivan structures (Fig. 3.11). Socially, Adam Metz describes the life and activities of mosques in the tenth century and explains the characteristics of this urban element as public space, a space that was open to the public day and night, a space in which people took shelter in order to get away from the difficulties of everyday life.

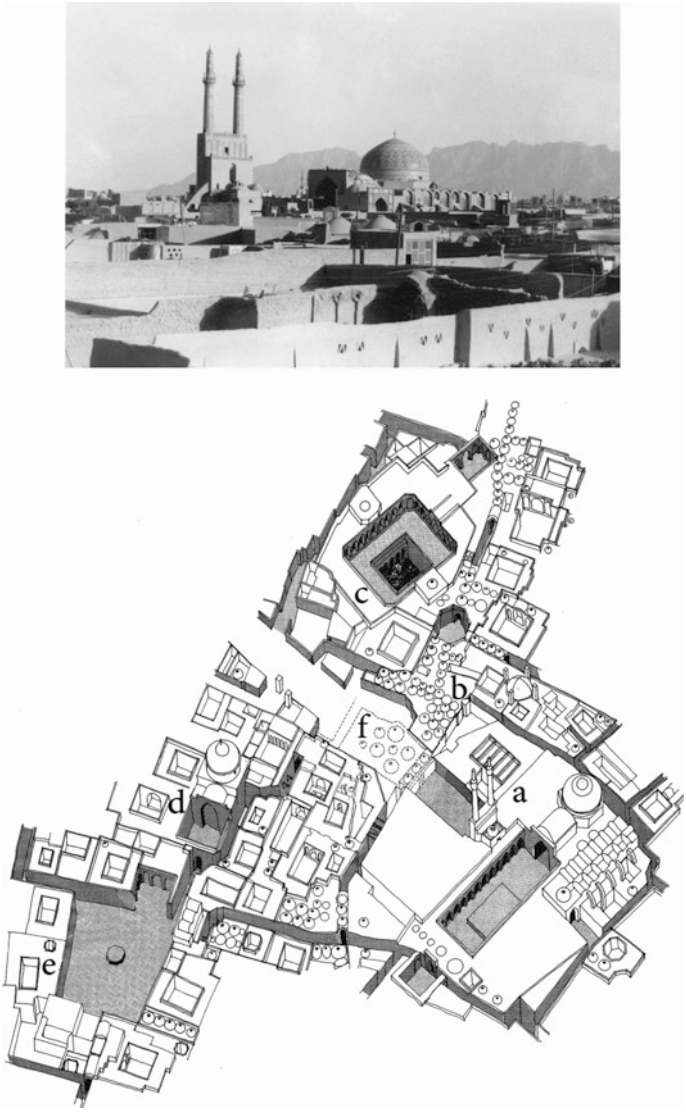

Fig. 3.6 Yazd. The historic inner core city center, including: **a** Masjid-i Jami (congregational mosque), the mosque's minarets the tallest feature in the sky line. **b** Bazaar/Chahar su (four arched, usually domed space at the intersection of two bazaar lanes). **c** Madrasah (institution for teaching Islamic sciences). **d** Madrasah/Marqad (tomb). **e** Maydan (square). **f** Hammam (bath), demolished. These elements are physically interconnected and inseparable from the life of people (from Tavassoli 1986)

Another uniquely religious place in the city is Musalla. It is a place for prayer especially on feast days. It appears to have been a large open space totally devoid of constructions, usually outside the walled city. In some cases, it was characterized by

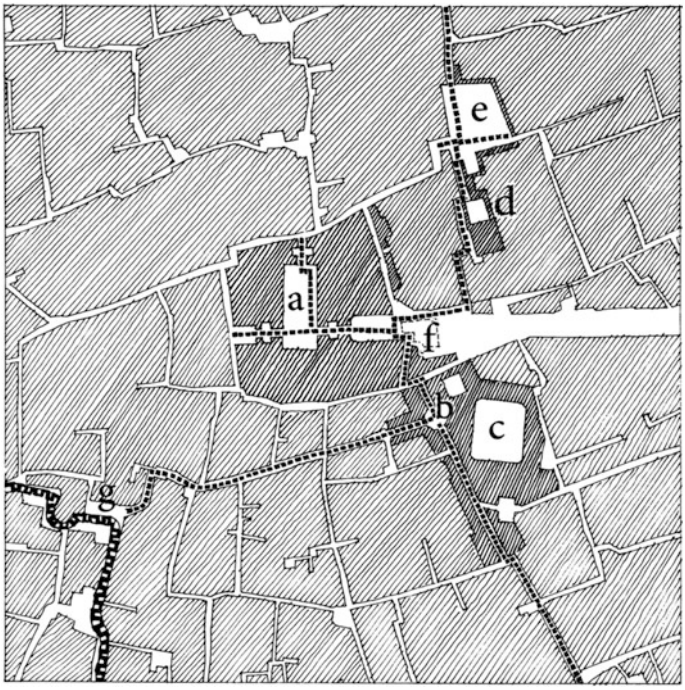

Fig. 3.7 Yazd. The historic inner core, plan showing integration of the old city center with the surrounding housing areas: **a** Masjid-i Jami. **b** Bazaar/Chahar su. **c** Madrasah. **d** Madrasah and Tomb of Seyyed-i Rokn al-Din (a prominent public figure). **e** Maydan (named after Seyyed-i Rokn al-Din). **f** Hammam (demolished). **g** Traces of Mozaffarid wall, thirteenth century (from Tavassoli 1986)

a simple structure on the qiblah side including talar, ivan and mihrab such as Musalla-yi Toroq and Mashhad (Fig. 3.12). In Yazd, Musalla-yi Atiq now located in the middle of the city is named after an old quarter (Mahalleh-yi-Musalla-yi Atiq) outside the city in the fifteenth century.

The present structure is a collection of seminaries and mosques with courtyards on two levels enclosed by rooms. Rooms were living spaces for seminary students. A simple pre-Islamic structure *chahar taq* (a fire temple form with the dome resting on a square of four arches) on the upper courtyard is incorporated into this complex. The whole structure and incorporation of the pre-Islamic element into it requires comprehensive study. However, this structure is compatible with the hot arid climate of Yazd. Access to groundwater and vegetation makes the lower courtyard cool in summer, while the upper courtyard is favorable in the winter sun[28] (Fig. 3.13).

[28]On the relationship and integration of mosque with other urban elements, see M. Tavassoli with N. Bonyadi, *Urban Space Design 1,* Urban Planning and Architecture Research Center of Iran, 1992,

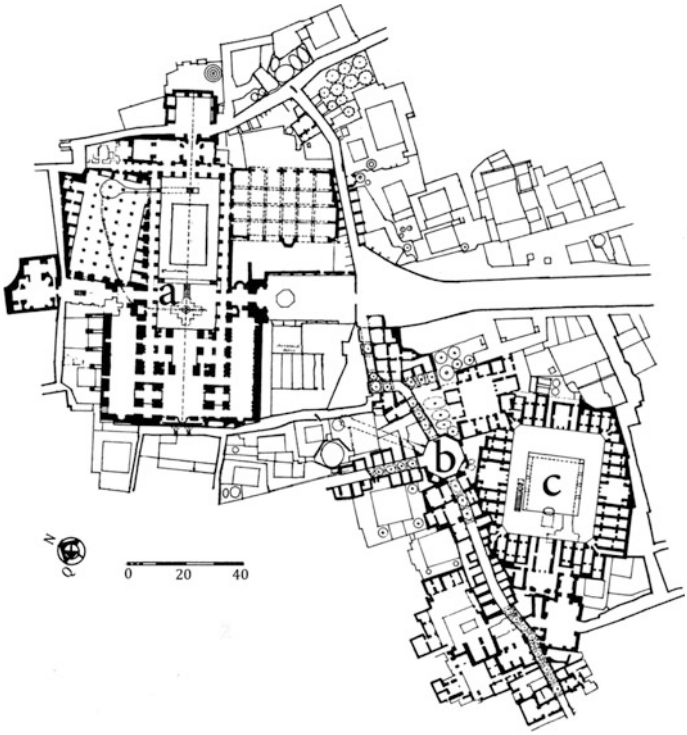

Fig. 3.8 Yazd. Part of the historic inner core, plan showing the organic relationship and interwoven elements. **a** Masjid-i Jami. **b** Bazaar/Chahar su. **c** Madrasah (the basic plan of mosque from M. Siroux 1937, completed with adjacent urban elements by Tavassoli and others in: *Detailed Plan for Yazd* 1975)

The subject of sacred tombs and Shiite shrines within the historical fabric of towns and cities in the hot arid zone of Iran requires particular attention. John Limbert describes some of the historical events in Shiraz, from the execution of many descendents of Ali b. Abi Talib, the first Shiite Imam, to rediscovering the martyr's tomb after centuries, from taking refuge of the eight Imam Reza's brothers in Shiraz, living in obscurity in a cave, and gathering and selling firewood. He then discovered and executed by Abbasid agents. The grave of Ahmed b. Musa (now famous as Shah-i Cheragh) was found after four hundred years while having land cleared for a building near the old congregational mosque.[29]

(Footnote 28 continued)

p. 49. Also, the social aspect of mosque in everyday life is discussed in Metz (1983), pp. 71–76, especially on the connection of meaning of Musalla and Mosque see Grabar (1987), p. 103.

[29]For description of these events see John Limbert, op. cit., pp. 6–8.

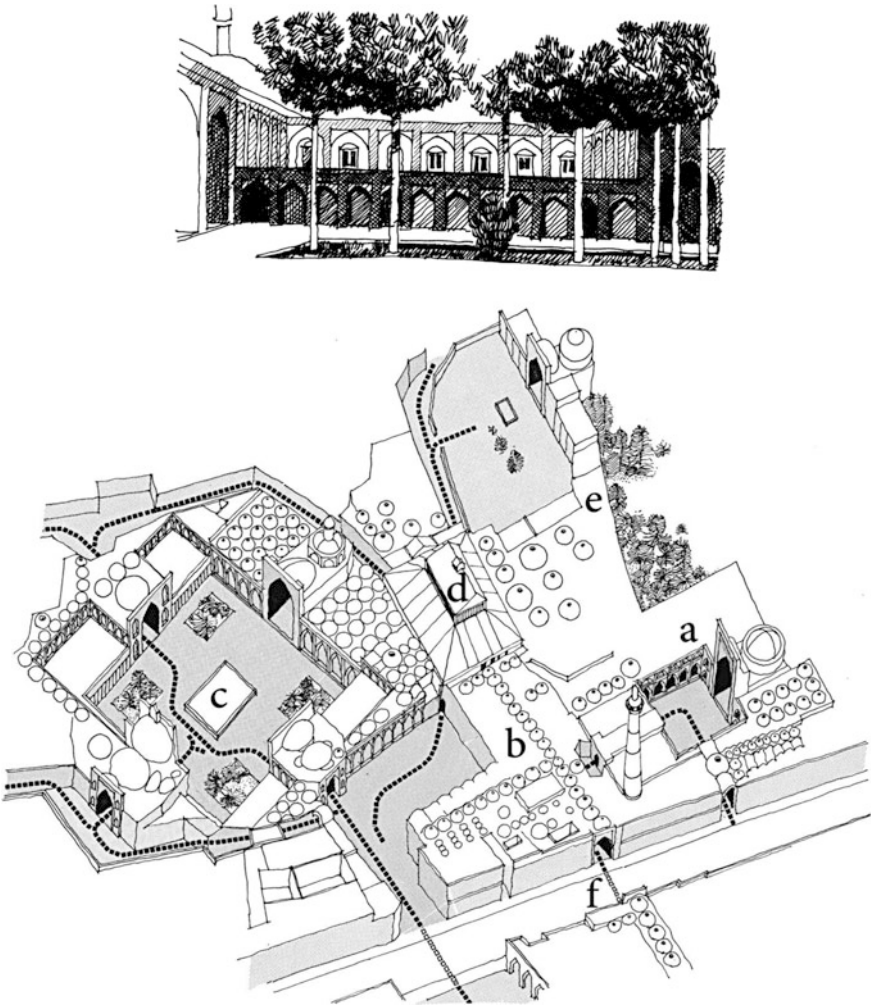

Fig. 3.9 Semnan. Historic city center complex: **a** Masjid-i Jami. **b** Bazaar. **c** Masjid-i Sultani. **d** Takyah-yi Pahneh (roofed space). **e** Imamzadeh-i Yahya, shrine. **f** A new street that has cut the bazaar lane into pieces. All elements are interwoven with each other, presenting a whole complex. The above drawing presents one of the four upper level courtyards of Masjid-i Sultani (from Tavasoli 1986)

3.5 Public Spaces

Mosque's courtyard, Takyah, and Husayniyyah

Public spaces in the hot arid environment were integrated with the spatial structure and compact fabric of towns and cities. These spaces were spatially active during mourning and feast days (Fig. 3.14). A comparative study between such

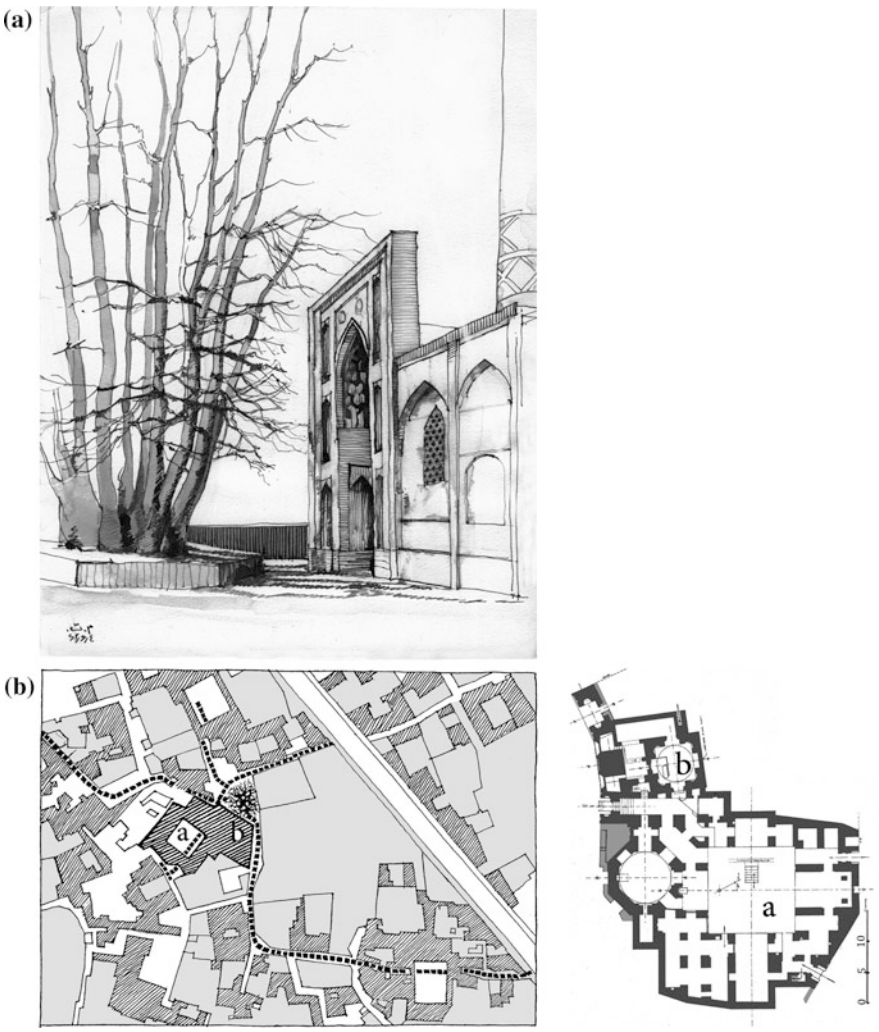

Fig. 3.10 Natanz. A unique complex including two integrated and inseparable elements: **a** Masjid-i Jami. **b** Khanaqah and Tomb of Shaykh Abd al Samad (a Persian mystic), early fourteenth century (from Tavassoli 1986, the architectural map right from Godard 1936)

spaces and urban spaces in the west has been conducted earlier.[30] Also, their visual values have been discussed.[31] In the past, in many of these spaces, staging spectacles, passion plays, and the sacrificing of camels on the day of the Feast of Sacrifices were held by general public (Fig. 3.15).

[30]See M. Tavassoli with N. Bonyadi, *Urban Space Design 1,* op. cit., Chap. 1.

[31]Visual aspects have been discussed in our book, *Urban Space Design Criteria,* Urban Planning and Architecture Research Center of Iran (1992).

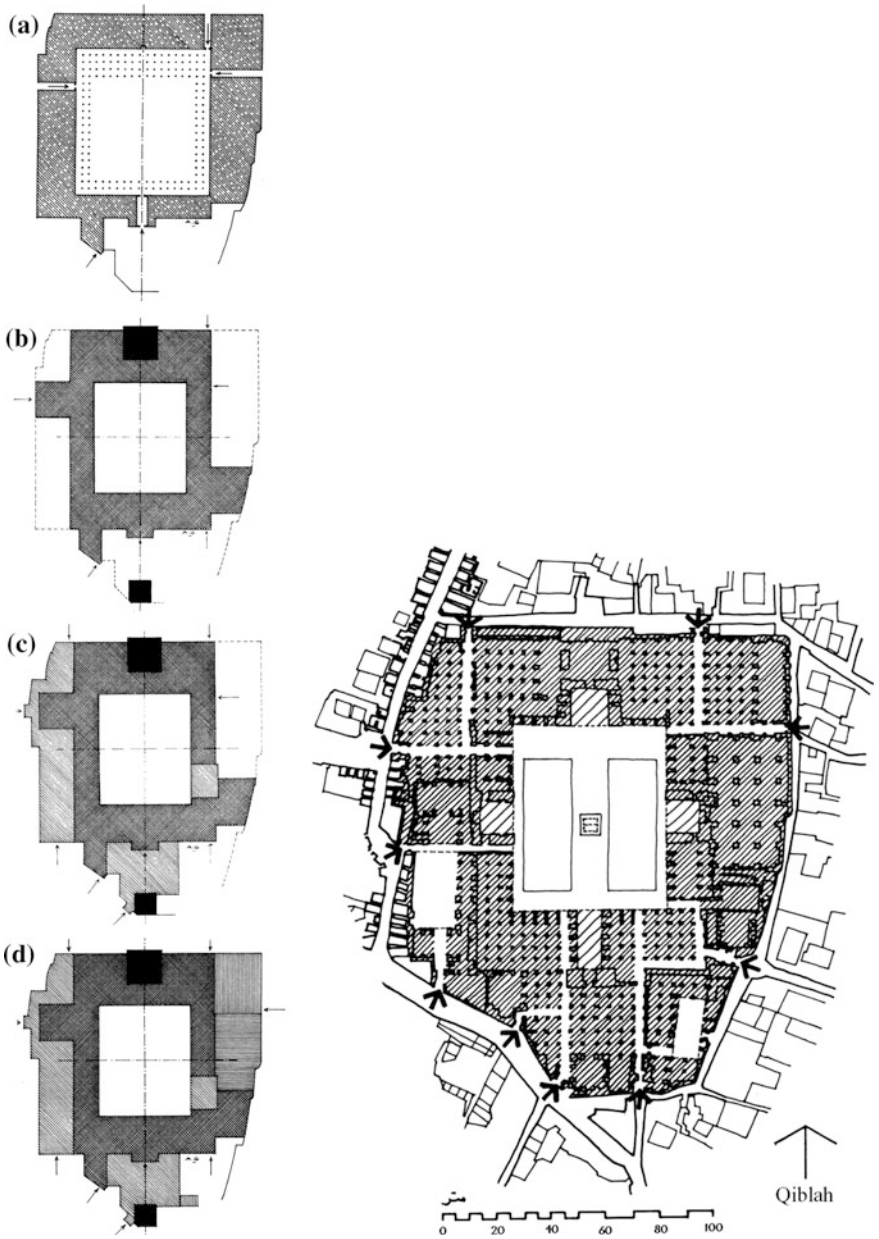

Fig. 3.11 **Isfahan**. Friday mosque, Masjid-i Jami, gradual perfection, being renewed and changed during centuries, as, the renewal of creation at every instant (here form and space, such as creation of a four ivan court and the most perfect dome). **a** Abbasids, ninth century. **b** Seljuqs, eleventh/twelfth centuries. **c** Muzaffarids, fourteenth century. **d** Safavids, seventeenth/eighteenth centuries (for renewal of creation see *Aziz Nasafi*, L.V.J Ridgeon, Curzon1998, p. 34., plans on the left from Godard 1936, plan right from Pope 1969, drawn by Eric Schroeder 1931; simplified by Tavassoli/Bonyadi 1992)

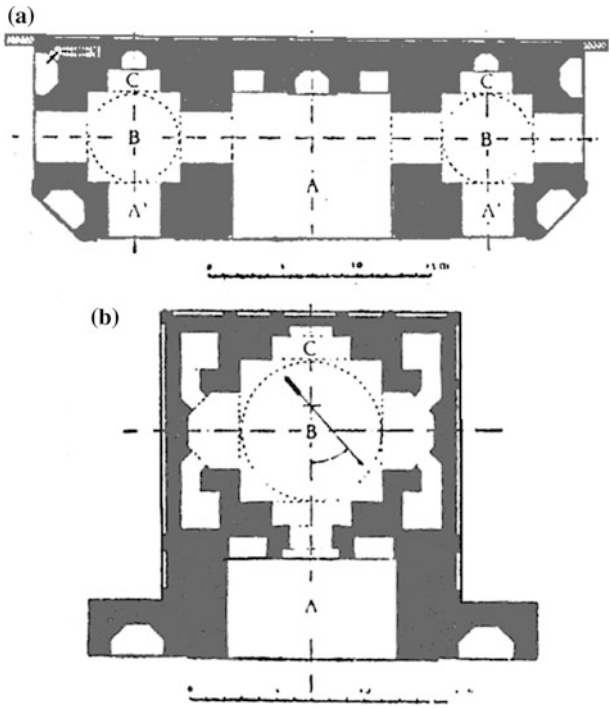

Fig. 3.12 Mashhad. Two historic Musallas: **a** Musalla-yi Toroq. **b** Musalla-yi Mashhad (from Godard 1962)

In exceptional cases, the simple and popular atmosphere of ceremonies was changed, and the government and wealthy merchants conducted magnificent ceremonies. A painting by Kamal al Molk, an artist from the Qajar period shows architectural space and detailed expression of a government passion play in Takyah-yi Dowlat in Tehran. Takyah-yi Dowlat was inside the citadel and in close proximity to Gulestan palace and Shams al Emareh building. The Royal court of Qajar equipped the organizers with the greatest possible facilities and indeed behaved as the chief mourner.[32] After his 1873 tour of Europe, Nasser al Din Shah built Takyah-yi Dowlat, a round building which, could house 20000 spectators under a canvas covered domed shape. Some thought the architectural pattern was inspired by the Albert Hall in London. Tehran at this period had more than forty

[32]This Government Theater of nineteenth century is discussed by, Mehdi Forough in: *Honar va Mardom* no. 29. Tehran, p. 7.

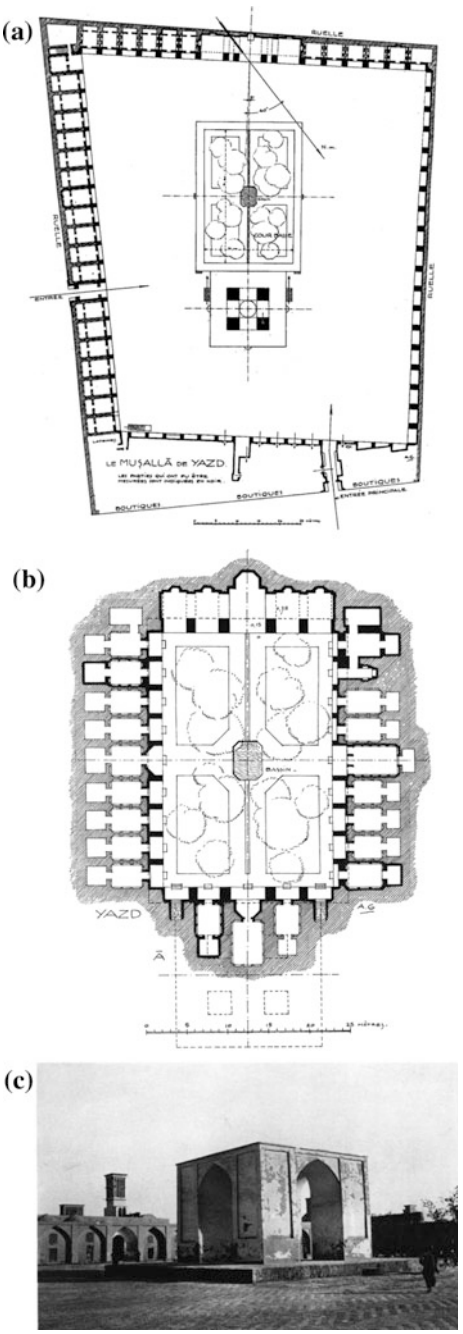

Fig. 3.13 Yazd. Musalla-yi Atiq. **a** The upper courtyard. **b** The inner courtyard. **c** A pre-Islamic form, Chahar Taq (from Godard 1938)

Fig. 3.14 yazd. Ashura, the greatest mourning day of Shiite Muslim, the day of martyrdom of Imam Husayn (from Malcolm 1908)

takyahs, many on a neighborhood scale.[33] Later while renewing the old inner core of Tehran, Takyah-yi Dowlat was demolished. Also, two unique urban spaces in Yazd were completely changed[34] (Figs. 3.16 and 3.17).

Naghsh-i Jahan square in Isfahan is the only important urban space that has survived since the sixteenth century up to the present day. Some researchers consider it of the first rank in comparison with important urban spaces in Europe.[35] Whereas others look upon it as a free area somewhat similar to the late Hellenistic agoras or Roman fora[36] (Fig. 3.18).

Some researchers also believe that the design of the new square and its enclosing elements followed the pattern of the large old square southeast of the Friday mosque, but in a planned way. Today, the old square has been built over and has completely disappeared. The process of the formation of the old square is not clear

[33]For social aspects of such spaces and their historical backgrounds, see Abrahamian (2008), pp. 15–17.

[34]Demolition of two magnificent urban spaces is presented here in this book, (Figs. 3.16 and 3.17).

[35]See Diolafoi (1992), p. 308.

[36]Concerning this point of view, see Zuker (1959), pp. 63–69.

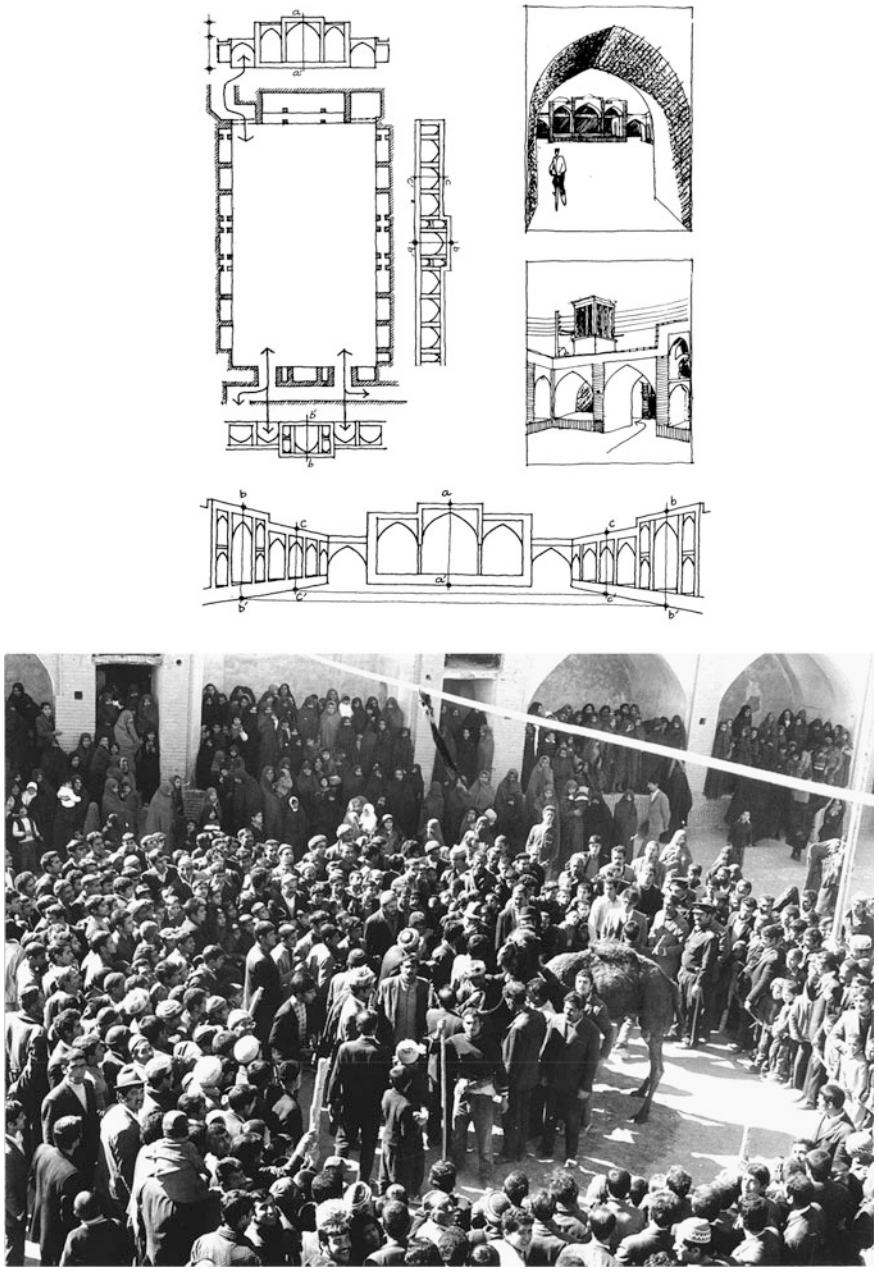

Fig. 3.15 Kashan. A local square (Maydan-i Wali Sultan), form and function, ceremony of sacrificing a camel on the day of the Feast of Sacrifices

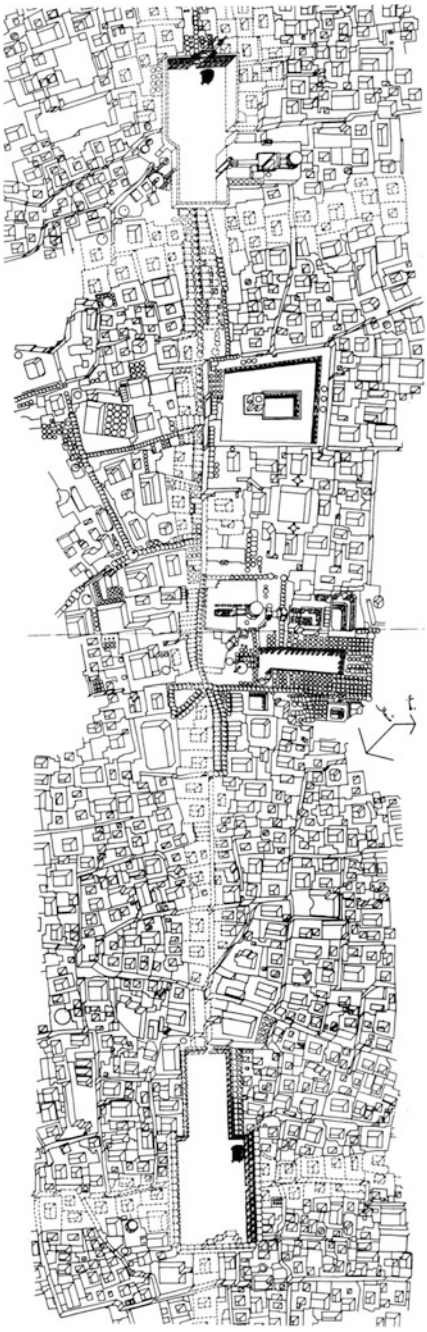

Fig. 3.16 Yazd. The main historic integrated complex including: bazaars, mosques, Islamic schools (madrasahs), and specially two main urban spaces. The complex has been divided into pieces by newly built straight streets since the 1930s (originally from: Tavassoli, *principles and Techniques of Urban Design 1* (1986) pp. 32–34. Completed in Tavassoli and Bonyadi, *Urban Space Design 1* (1992) pp. 57–59

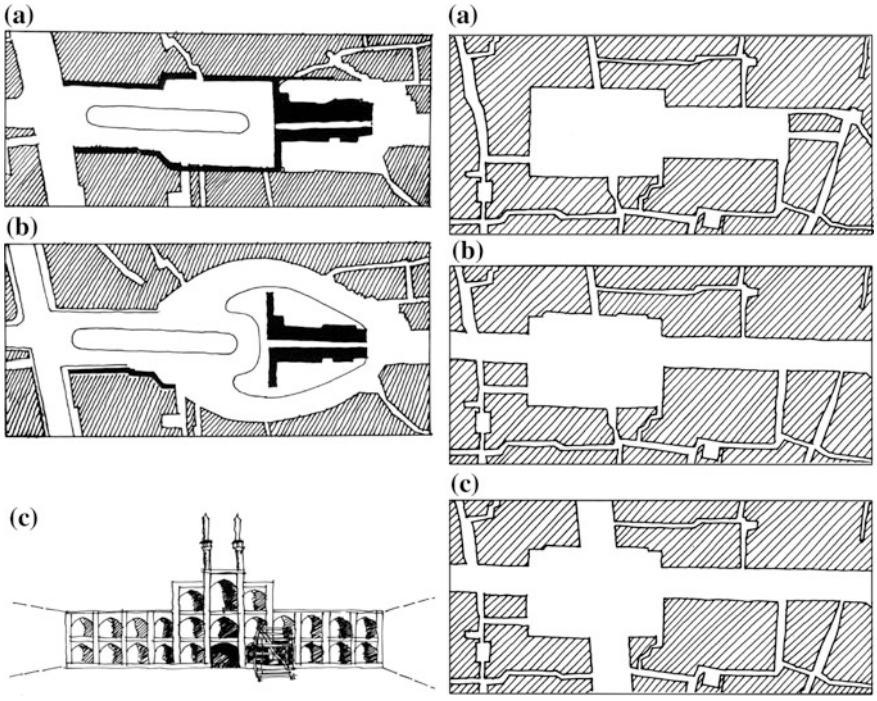

Fig. 3.17 Yazd. Different stages of demolishing two main urban squares between the 1930 and 1970s, *left* Amir Chaqmaq: **a** The original shape. **b** Constructing car access. **c** Remains of the central part. *right* Maydan-i Shah Tahmasb: **a** The original shape. **b** Constructing street. **c** Constructing junction. The picture below showing a square at local scale: Yaqubi neighborhood center

and it is said that the origin may go back to pre-Islamic times. The construction of the Friday mosque was begun in the eighth century in connection with the old square. And gradually the old square was surrounded by different elements such as mosques, madrasahs, and bazaars; buildings which survived until the sixteenth century. Analysis of urban form reveals that the old square and the Friday mosque had a basic role in shaping the medieval city structure. In the sixteenth century, Shah Abbas transferred the capital from Qazvin to Isfahan and founded his court on the south eastern part of the city. New developments took shape, including new square integrated with new administrative, economic and religious center, and Shah Abbas forced further developments into a new direction.[37]

This aspect of the role of royal power and profiteers in urban development and the reaction of citizens, in the past up to the present, require considerable studies. We should also note that new developments and the creation of a new center were

[37]On the development of Isfahan up to seventeenth century, see Gaube (2008), pp. 163–171.

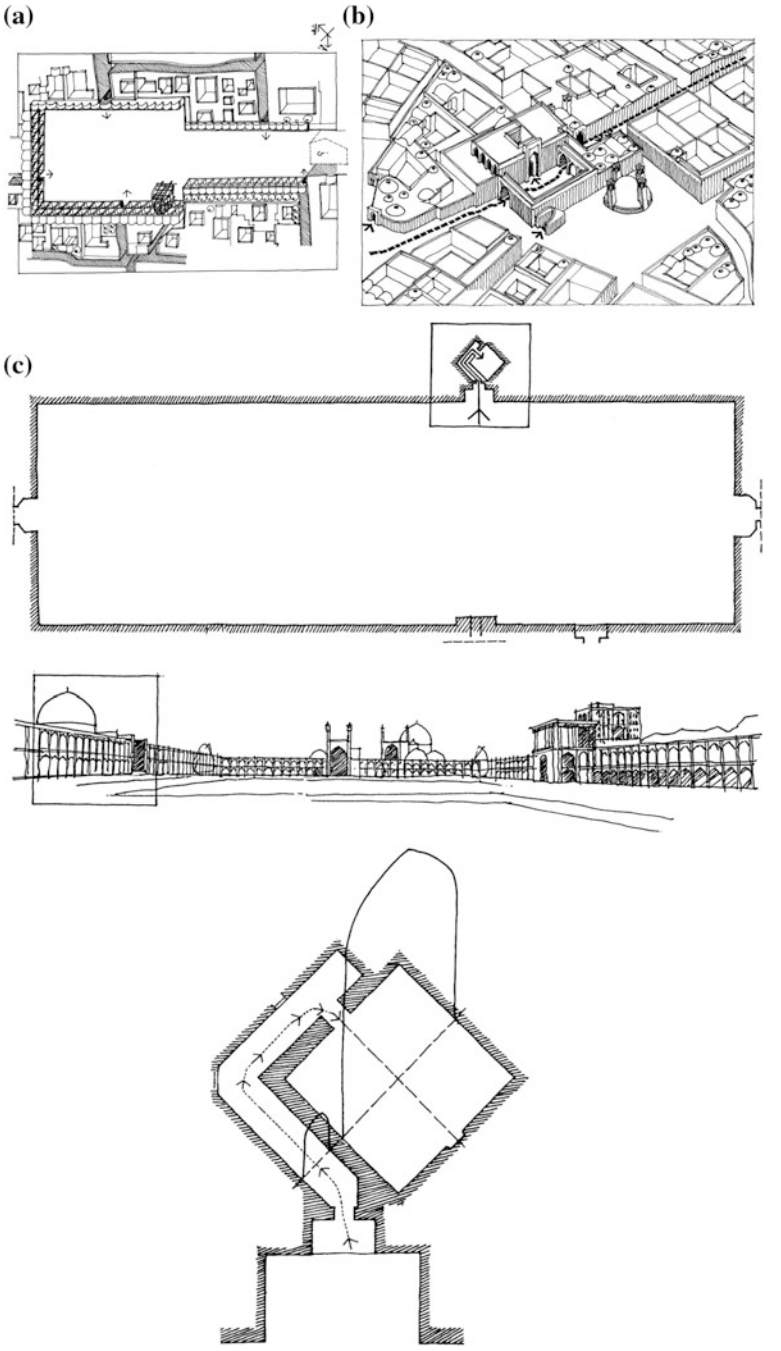

Fig. 3.18 Isfahan. Squares at different scale and form: **a** Yazd. Shah Tahmasp square at city scale. **b** Yazd. Mahalleh-yi Yaqubi center/square, neighborhood scale. **c** Maydan-i Shah and Masjid-i Shaykh Lutfullah, a series of spaces with different scales, from vast urban space to narrow architectural spaces, which are the secret power of this complex. This mosque in a newly built urban context, for examples at the edge of a street, loses its values

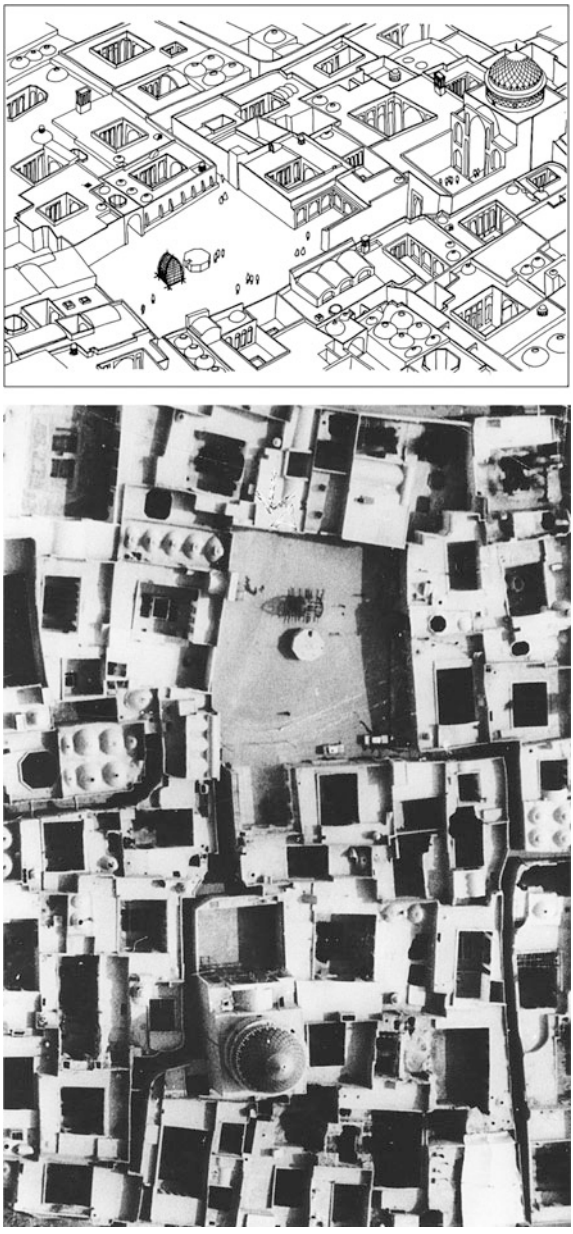

Fig. 3.19 Yazd.
A neighborhood square at the intersection of four narrow lanes, and Seyyed Rokn al Din, a distinguished figure tomb (the picture bellow right from *Iran National Cartographic Centre* 1973)

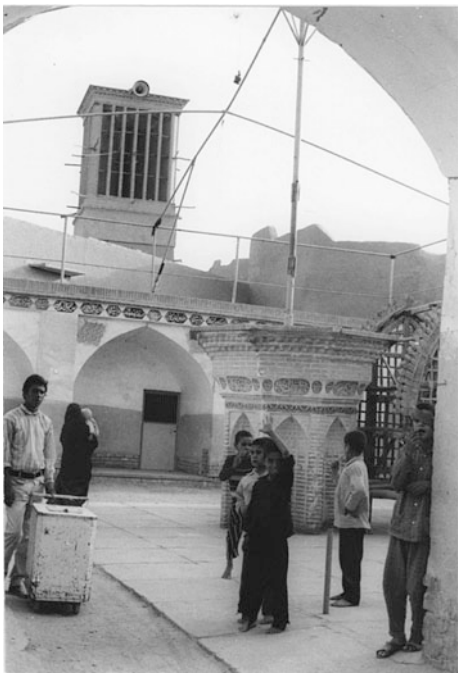

Fig. 3.20 Yazd. A square (Husayniyyah) at neighborhood scale

the manifestation of Shiite power against the powerful Ottomanid state.[38] And it is said that the motor power of the Safavid state was more or less stemmed from the conflict between religions than patriotism.[39] But, however, in order to manifest his power, Shah Abbas employed the best artists for the design of the new center. As, in the period of dominance of Popes, Michelangelo was invited to redesign the Campidoglio hill in Rome. However, in my opinion, valuable works of architecture are not confined to monuments. Within the compact integrated urban fabrics, there are many unknown works that have both aesthetic and functional values (Figs. 3.19, 3.20, and 3.21).

[38]For a detailed account of this important historical period, see A.H. Zarin-kub, Safavid, glory and decline, in: *Roozegaran 3,* op. cit., Chap. 10.

[39]See *The Persian Encyclopedia*, vol. II, op. cit., p. 1569.

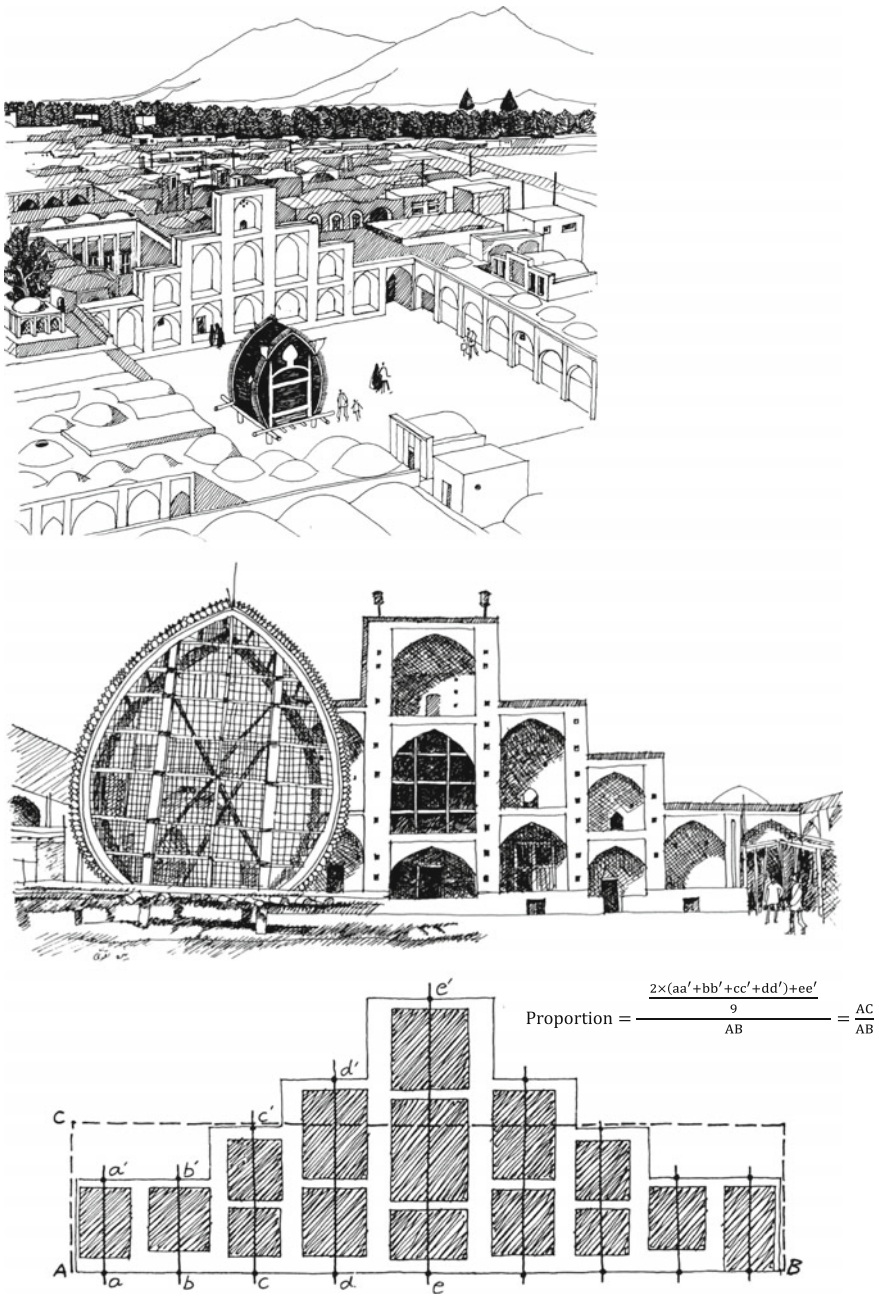

Fig. 3.21 **Taft**. City square, Husayniyyah-yi Shah Wali, the big Nakhl, and proportion system (drawing in the middle is based on a photograph in: Andre Godard and others, *Athar-e Iran,* Tome 11, Fascicule 1,1937, p. 138. Proportion system from M. Tavassoli, *Urban Space Design Criteria,* 1995)

3.6 Bazaar

The bazaar was the main center of economy and finance, including main organizational and financial systems of wholesale trade and retail business.[40] The bazaar exhibited the concentric hierarchy of crafts and trades with its functional elements such as Qaysariyah, Caravanserai, and Timchah. Each guild operated in a separate spatial area belonging to different branches of businesses such as rosary sellers, stationeries, shoemakers, jewelers, grocers, and textile sellers. It was linear or gridiron. Its different areas were lockable, as in Shiraz. The spatial occupation of businesses and their proximity to the Friday mosque was not random, but depended on their importance and function.

In the modern times, several crafts were moved to the newly built streets. However, many crafts were still localized in different sections of the bazaar. Indeed, in spite of successive plans during recent decades, the bazaar complex in many cities is still the city center of gravity, although many commercial activities have shifted to the newly built streets.

The bazaar was not only an economic center, but also had a powerful sociopolitical role in urban events. In the period of Hafez, businessmen in the bazaar acted to some extent independently in decision making regarding urban affairs.[41]

Physically, the bazaar was linear in shape, as in Nain, Shiraz, Zaware, and Semnan, or nonlinear with numerous twisting lanes as in Yazd and usually related to the Friday mosque and other structural elements (Fig. 3.22). Spatial division of occupations were also related to the Friday mosque.[42] Also, some spaces of the bazaar were named after their activities, such as the Grand Bazaar (Bazar-i Bozorg) as a part of Bazar-i Vakil in Shiraz, which offered different commodities, or other parts such as Bazar-i Bazzazan (cloth drapers), Bazar-i Sarrajan (leather goods), and Bazar-i Shamshirgarha (sword makers).[43] The old bazaar in Shiraz was gradually extended and integrated with the Friday mosque, an element whose construction was ordered by Amru Leith the Saffarid in 894.[44] An example of the good connection between the old and new centers was in Isfahan, where the old center including the Friday mosque was integrated with the new center through the Grand bazaar. This unique complex was divided into two parts by a newly built street in the early twentieth century (Figs. 3.23 and 3.24).

To provide security, all the doors to the bazaar passageways, or some sections, were closed at nights and on holidays, thus ensuring no entry. For example, before the construction of Zand street, and splitting the bazaar-i Vakil complex in Shiraz

[40]For an analysis of spatial structure of two important Middle Asian Cities see Ernst Giese, Transformation of Islamic Cities in Soviet Middle Asia into Socialist Cities in: The *Socialist City*, R.A. Frenchand F.E. Ian Hamilton, eds., 1979, pp. 145–165.

[41]See A.H. Zarin-kub, *As Kucheh-yi Rendan,* especially the first chapter, cited above footnote 4.

[42]On the social structure of bazaar, see Ashraf (1980), pp. 23–26.

[43]Bahari (1976), p. 61.

[44]See john Limbert, op. cit., p. 8.

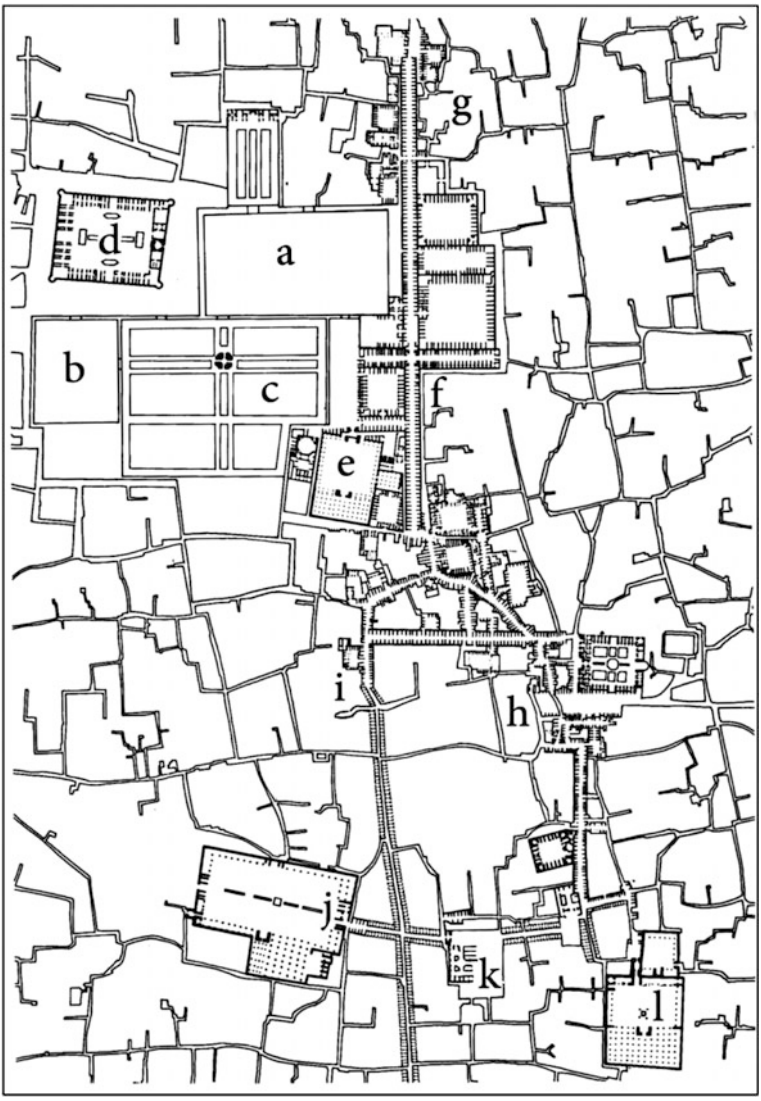

Fig. 3.22 Shiraz. The Bazaar complex, nineteenth century: **a** Artillery square. **b** Training square. **c** Bagh-i Nazar (Nazar garden). **d** Karim khani citadel. **e** Masjid-i Vakil. **f** Bazaar lanes connected with caravanserais. **g** Bazaar-i Now. **h** Bazaar-i Hajji. **i** Bazaar-i Morg. *j* Masjid-i Now (new congregational mosque). **k** Seyyed Amir Ahmad b. Musa (today's famous Shah-i Cheragh), and Seyyed Amir Mohammad shrines. **l** Masjid-i Jami-yi Atiq/old congregational mosque (from Tavassoli and Bonyadi 1993)

Fig. 3.23 Isfahan. Masjid-i Hakim linked with the main bazaar (from *Isfahan, The City of Light*, Ministry of Culture and Arts of Iran. 1976, p. 83)

into two parts, the bazaar had five large doors which were locked up at nights and on holidays.[45]

Presenting similar commodities in the shops next to each other across the bazaar passageways gave the right of choice to purchasers. Especially, in the environment of the hot arid zone of Iran, the domed roof and cool space of the bazaar were pleasant for business and browsing.[46] In some towns and villages, there were temporary bazaars or weekly markets, named after one of the seven days of the week. Also there were some villages that at the beginning were places of temporary bazaars and later extended as a village.[47] Weekly bazaars were usually held in the

[45]Islami (1972), p. 7.

[46]Concerning activities and architecture of bazaar, see Pirnia (1969), pp. 55–60.

[47]Khosrov Khosrovi, *Pezhouheshi dar Jame'e Rusta'i Iran,* Tehran, pp. 4–5.

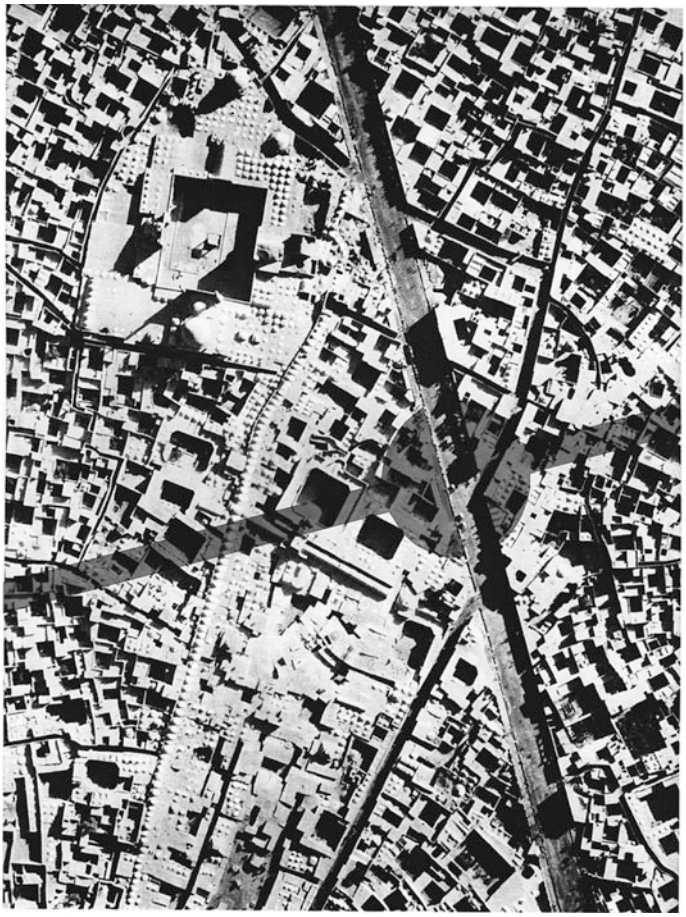

Fig. 3.24 Isfahan. Separating the Friday mosque from the bazaar complex by a new street in the late 1930s (the original aerial photograph before building the street's gray area is by Schmit, from Godard and others, *Athar-e Iran,* Tome 1, Fascicule 11, 1936, p. 219)

town's squares. In Minab, a town on the coast of the Persian Gulf, a weekly market is usually held on Thursdays. Most of the sellers in the market are women, dressed in local costumes with mask, and selling foodstuffs and handicrafts.[48]

Although the process of shifting elements weakened the historic city centers, but did not obliterate them. The bazaar is still the center of import–export commerce, and at neighborhood scale, the small bazaars (bazaarche), in many historic cities are still active.

[48]Varjavand (1972), pp. 11–12.

Fig. 3.25 **Semnan**. Remains of city wall

3.7 Citadel

The citadel included the residence of the Governor and his family, the government departments, army camps, and other elements. It was usually a self-contained and walled section, sometimes built on the elevated part of the town, as in Bam. Construction of citadels goes back to ancient times and continued into the Middle Ages up to the modern Iran, an era of political conflicts and power struggle among ethnic groups.

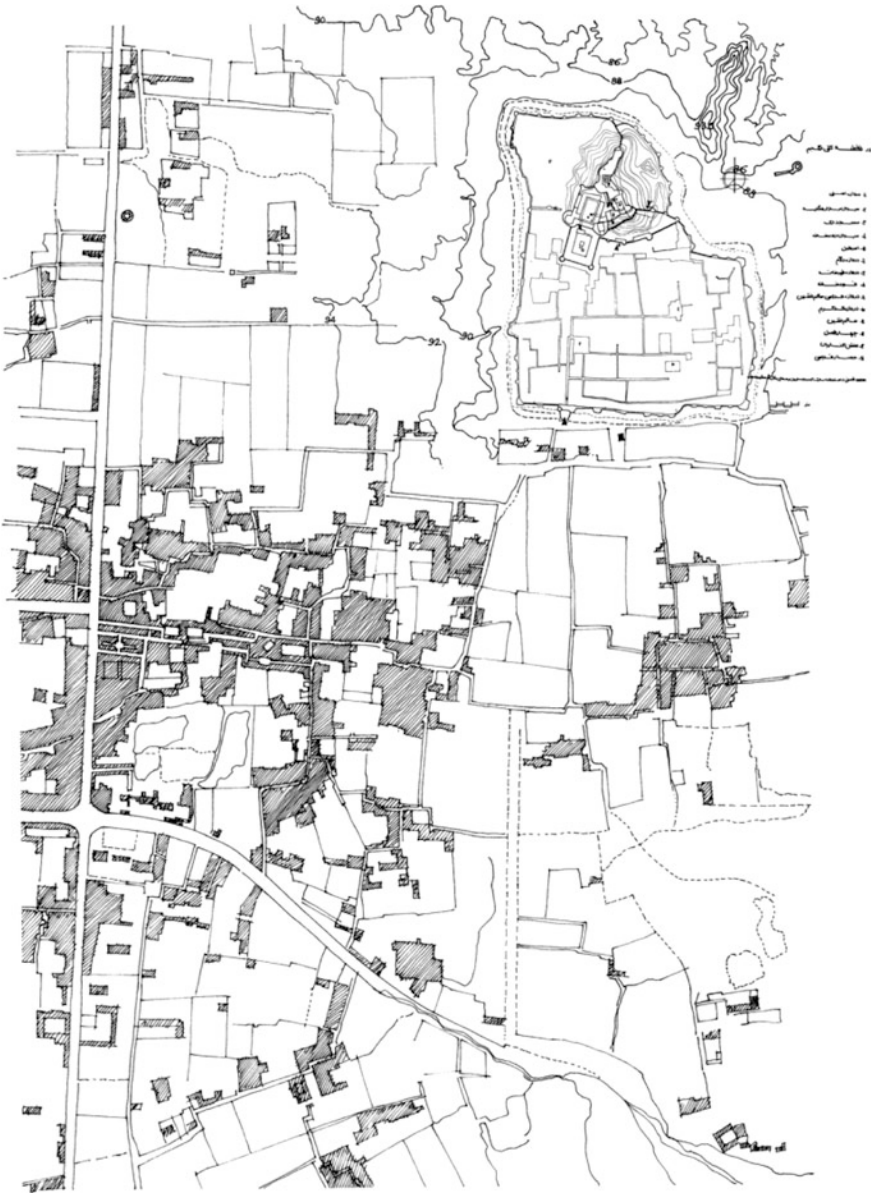

Fig. 3.26 Bam. The historical old town including citadel (*top right*) including citadel (*top right*) in connection with the old city, destroyed in 2003 earthquake

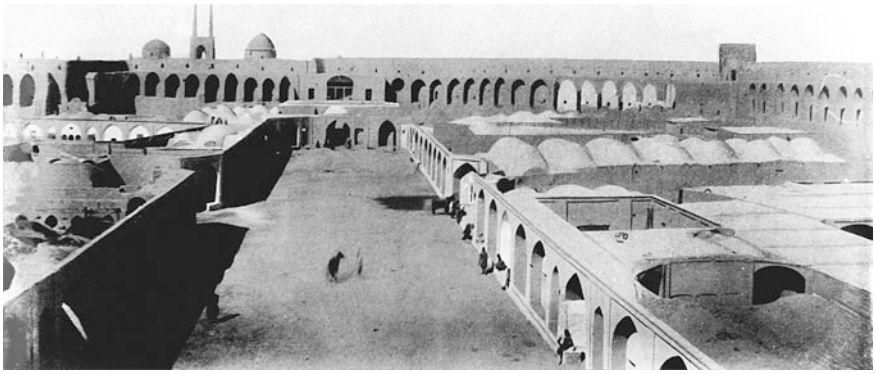

Fig. 3.27 Yazd. The city citadel, completely demolished (from Malcolm 1908)

The remains and traces of citadels still exist in some cities. In Semnan, the inner spaces of the citadel have changed, and the new spaces are used as administrative offices by the local government, but traces of the city wall still exist (Fig. 3.25). In Bam, the 2003 earthquake destroyed the old city and citadel (Figs. 3.26, 2.5, and 2.6). In Tabas, the remains of the old citadel existed before the 1978 earthquake. In Yazd, the wall of the citadel no longer exists, but spaces were used as government offices until recently (Fig. 3.27). In Old Tehran's citadel, different elements were spaced, including Dar al-Funun school, granary, government treasury, Takyah-yi Dowlat, and royal palaces. Today elements such as the Dar al-Funun and Golestan palace are still in evidence, while other elements have disappeared.

3.8 Qanat, Garden

People of the hot arid environment have made enormous effort for water supply throughout the ages. Among four sources of water, i.e., rivers, springs, lakes, and groundwaters, in Iran's desert, groundwater has always been life giving. Since ancient times, water in the desert has always been considered as a sacred entity, and the foundation of an ancient civilization in Iran has been established on artificial irrigation. If the ancient Egyptians were skillful in controlling surface waters; undoubtedly, the Persians were unique masters in the extraction and use of groundwater. Both creating and enlightenment were predominant in the arid land of Iran, thus making it one of the greatest civilizations of the ancient world.[49]

[49]For water and art of irrigation in ancient Iran, see the articles by leading scholars in: *Ab va Fann-i Abyari dar Iran-e Bastan,* Ministry of Water and Electricity, Tehran (1976), especially on qanats, Chap. 7.

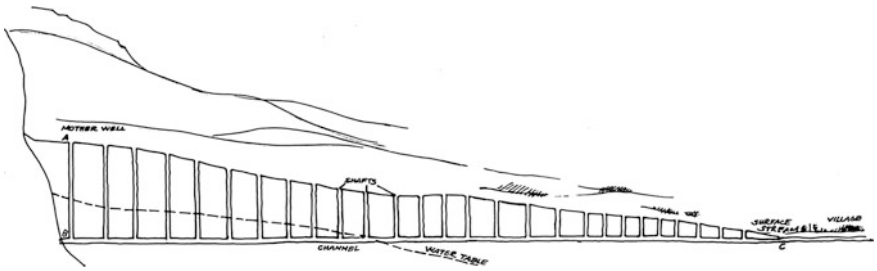

Fig. 3.28 Cross section of a typical qanat redrawn from Paul Ward English, *City and Village in Iran* 1966)

An innovative method for collecting subterranean water and bringing it to the surface, by Iranians thousands of years ago, was the invention of the qanat. The exact date of this invention is not clear. But according to archaeological discoveries, a series of qanat wells have been identified in Zagheh village the Qazvin plain, from the fifth millennium BC.[50] The groundwater was brought from the foothills of the mountains from long distances by way of tunnels and emerged as the surface stream to settlements and fields. The depth of qanat shafts increases from the surface stream toward mother wells. The mother wells of some qanats were several hundred meters deep (Fig. 3.28). It is said that there were nearly 50000 qanats in Iran,[51] which many have dried up because of deep well construction. The longest qanat in the Khurasan province ran seventy kilometers to the city of Gonabad.[52] Some rulers paid considerable attention to the irrigation and construction of qanats. In Khurasan, Abdollah b. Taher, a powerful ruler of the Taherian dynasty in the ninth century, devised laws on irrigation and construction of qanats.[53] In Shiraz, five streams presumably from qanats passed through the city. The best-known water source, Ab-i Rokni, was built by the Buyid Rokh al-Dowleh the father of Azod al-Dowleh in 950. Particular places of access to water (*saqayeh*) were endowed by rulers and other wealthy benefactors.[54] In Yazd prior to the early years of the 1930s, qanats were the major source of water (Figs. 3.29 and 3.30). But gradually afterward, in the 1950s digging deep and semi-deep wells led to a significant decline in groundwater tables and many qanats dried up. It is said that there were 406 qanats in the Yazd–Ardakan plain, the longest being 39 km named Mehdiabad qanat. The greater part of Yazd's groundwater comes directly from the highlands of the

[50]Sadegh Malek Shahmirzadi, *A General Study,* op. cit., p. 11.

[51]For water and art of irrigation in ancient Iran, see: *Ab va Fann-i Abyari dar Iran-e Bastan,* op. cit., Chap. 7, p. 145.

[52]Ibid., p. 150.

[53]A.H. Zarin-kub, *Rouzegaran 2,* op. cit., p. 65.

[54]J. Limbert, op. cit., p. 9, and p. 55.

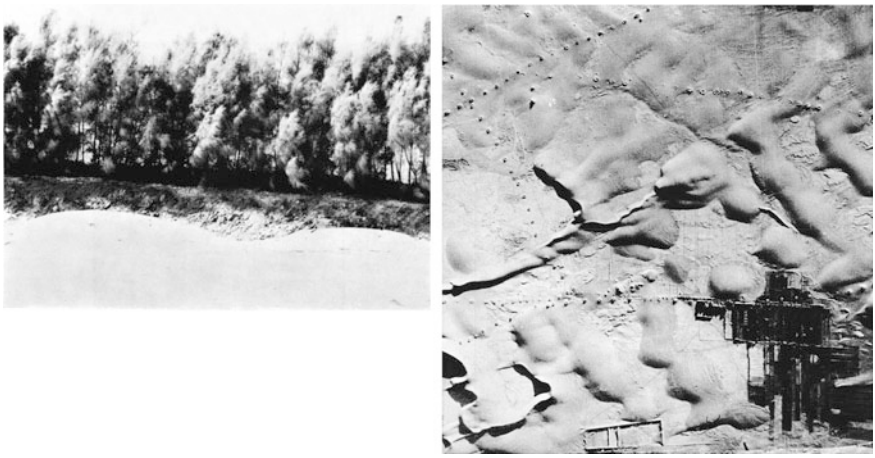

Fig. 3.29 Yazd. Aerial view of qanats and moving sands north part of Nasr Abad village, and anti-desertification tamarisk trees in the region

Shirkooh Mountains.[55] Usually, two determining factors, defense against invaders and access to water, played a major role in the site selection for settlements in desert regions. In the region of Kerman, every permanent settlement had at least one qanat and large settlements had several.[56]

The ownership of many structural elements in the town and cities and rural areas in the hot arid zone is relied on public or private endowment of the Islamic culture, such as qanat, water reservoir, garden, and mill. In Yazd, each neighborhood had at least one water reservoir, some were one hundred steps deep.[57] In Yazd also, one of the tribal chiefs, Mohammd Taghi Khan, first endowed a qanat nearly sixty kilometers long, then built the famous garden, both named Dowlat Abad.[58] But a unique example of a Persian garden is Fin garden in Kashan which has existed for centuries. Its source of water, the Fin spring, is considered by people as a symbol of purity (Fig. 3.31). In some cities, we also find underground water mills which were worked by the power of qanat water. An example is the remains of a water mill in the *Kooshk-i Now* neighborhood of Yazd, dating back to the seventeenth century.[59]

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[55]For ground water, wells and qanats in Yazd region, see *Master Plan of Yazd, second phase,* Faculty of Fine Arts, University of Tehran (1975), pp. 502–508.

[56]For a profound study of the city of Kerman and its region, including pre-Islamic, Islamic and modern period, and specially detailed study of ground water and qanats, see English (1966), Chap. 2.

[57]Afshar (1974), op. cit., p. 647.

[58]Ibid., p. 729.

[59]Kooshk-i Now water mill was a part of the whole complex of the Kooshk-i Now neighborhood center in the inner core of the historic city of Yazd. See Fig. 4.7.

Fig. 3.30 Qanats of the Yazd basin 1970, and the remains of the gardens within the compact fabric of the historic city

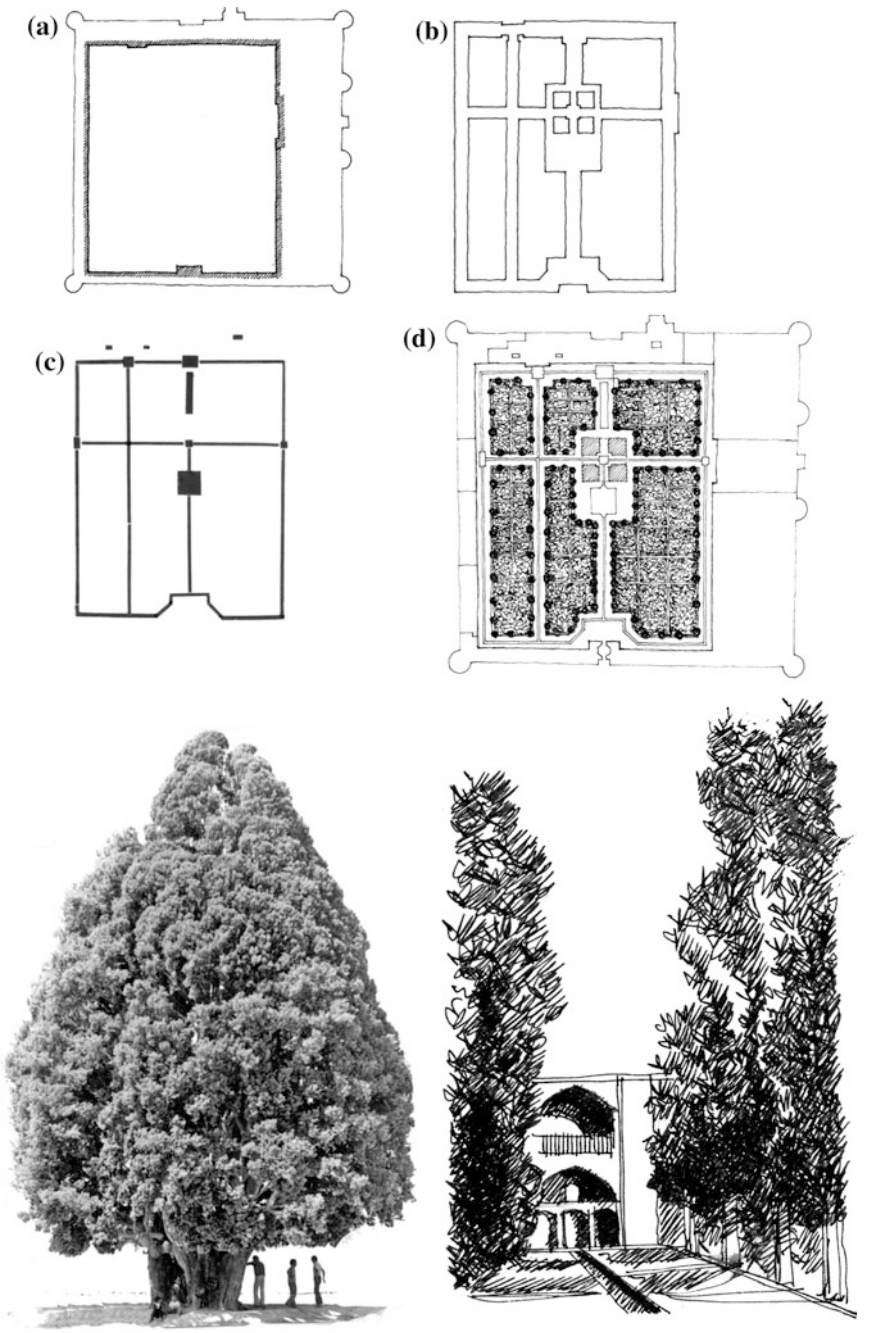

Fig. 3.31 **Kashan** and **Abarquh**. Symbolic elements: Fin garden manifests the shaping principles and simplicity of Persian gardens in the hot arid environment: **a** An enclosed space surrounded by ramparts with four circular towers. **b** Streets and buildings/pavilion arrangement. **c** Circulation of spring water on the axis of streets. **d** Enclosing the streets by cypress trees. Below on the left, the cypress of Abarquh, the height and its dark evergreen leaves in contrast with the light color of the town's mud brick make the tree the town landmark

Altogether, the construction of the qanat as a creative method for supplying water in the hot arid zone of Iran indicates great lessons, patience, and tolerance under extreme difficult conditions.

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Chapter 4
Typical Historical Cities

Abstract This chapter shows how integration of the elemental structure discussed in Chap. 3 and comprises a unified whole: a city. An exhaustive field research has been conducted during several years, interviewing local architects, elders of neighborhoods, and heads of old families. One distinctive aspect in field studies was a comparison between the information of an old historical document: *Tarikh-i Yazd,* (History of Yazd), from fifteenth century with the existing old fabric, places and spaces of the historic city of Yazd. The same method and findings were applied in other cities such as Nain, Zaware, and Kashan. As we shall see, it can be concluded that *traditional towns and cities in the hot arid environment of Iran have a common spatial characteristics based on their interconnected parts: neighborhoods and neighborhood centers, and city center, through the main passageways as connected elements*.

Keywords Exhaustive field research · Yazd · Interconnected parts · Inner and middle areas · Uncontrolled development

4.1 Yazd

The whole city: During the first of our visits in 1970, both two main parts, the old and new, were easily distinguishable. But later it became clear that three distinctive areas could be recognized:

M. Tavassoli, *Urban Structure in Hot Arid Environments*,
The Urban Book Series, DOI 10.1007/978-3-319-39098-7_4

1. Historical walled section, including the old inner city, mainly before the fifteenth century (the time of compiling the local history of Yazd).[1]
2. Semi-historical section, including the middle area which had taken shape in the last decades of the nineteenth century, till the establishment of the Pahlavi Dynasty in 1913.[2]
3. New developments in outer area(s), which were expanded after the years of land reform in the 1960s, and accelerated after the 1979 Revolution.

Each of these parts expresses a different physical fabric. The old inner area is compacted with an intricate network and courtyard structure. The middle area is more ordered, spacious, and structurally open. The outer areas are diverse in form and structure. We can also follow these features in other historical cities which have been studied in this book.

Historical section: The city of Yazd is unique among Iranian desert cities which although much changed by reconstruction during the 1340s–1960s, but still presents the features of a traditional Iranian city in the Islamic period. In the 1960s, there were still some indications of traditional crafts having survived throughout the ages, commerce, and remarkable skill of craftsmen and the hierarchy of guild organizations. These characteristics led us to choose Yazd as a center of comparative study of the arid zone cities. Here, we first investigate the process of changes in different periods, examining the content of *Tarikh-i Yazd* (an old historical document) with the existing spatial structure of the city. Then, an analytical study of the key elemental structure of the historic city will be conducted.

In the 11th century A.D., Yazd under the local rulers Al-i Kakooya grew into a large and prosperous city.[3] In 432/1053, a wall and four gates: Darb-i Kia, Darb-i Qetrian, Darb-i Mehrijerd, and Darb-i Kooshk-i, now surrounding the city were built. Today, a trace of the northern wall exists, though all the gates have been demolished, but are still recognizable[4] (Fig. 4.1). Under the Kakooya rulers, many

[1]One of the first reliable local historical texts about the Yazd region is *Tarikh -i Yazd,* (History of Yazd), written in fifteenth century. The information of the book is mainly concerned with Islamic era, from eleventh century (Atabekan period) till the author's time, fifteenth century. The book also covers a summary of information about pre-Islamic and early Islamic period. Historical studies in the present book are specially based on a comparative study between contents of *Tarikh-i Yazd* and remains of structural elements in the years 1971–1972. At this time, many spaces and places mentioned in *Tarikh-i Yazd* were still survived with their old names. See Ja'far b. Muhammad b. Hasan Ja'fari, *Tarikh-i Yazd,* (composed in 845/1441) edited by Iraj Afshar Tehran (1965). Also for historical pattern of Yazd region, see Abu Eshaq Ebrahim Estakhri, *Masalek va Mamalek*, edited by Iraj Afshar, Tehran (1969).

[2]The most important changes in the physical structure of the city from fourteenth century till the establishment of the Pahlavi Dynasty in the first decades of the twentieth century have been studied in the first part of this book.

[3]Considering this historical period, see explanatory notes by Iraj Afshar in: *Tarikh-i Yazd* (History of Yazd), pp. 212–214.

[4]At the time of the first stage of this research 1971–72, trace of one of the historic gates Darvaze-yi Kooshk-i Now, was still recognizable. See Figs. 4.6, 4.7 and 4.8.

Fig. 4.1 Yazd. The historic core of the city, compact, integrated, and poor public space structure. For more information about elemental structure, see Fig. 4.6. Picture from *Iran National Cartographic Centre, 1973*

urban elements were also built. Abu Yaqub established a new quarter outside the walled city named Yaqubi, a quarter which still survives.[5]

[5]See Figs. 4.5 and 4.6, this quarter still survives on the northeastern part of the old city (hatched area).

The Atabekan rulers in the 12th century A.D. ordered many new buildings including gardens, castles, bazaars, saras, seminary schools, gates, and also neighborhood villages outside the city. A rural quarter was built by mother of the ruler Qotb al-Din Abu Mansur, named Moryabad (today Maryam Abad),[6] and also the installation of a new gate toward a new quarter named Malamir (mother of Amir), outside the wall.[7]

In the 14th century A.D., under the Mozaffarid rulers the city expanded and a new bazaar (the beginning of the existing bazaar) took shape. During this period, the city had become famous and gradually became one of the central desert city regions. Amir Mobarez al-Din Muhammad in 747/1325 added outer area quarters to the city such as Bagh-i Beheshti, Madrasah-yi Atabek, Kuch-yi Jalal, Dar-al Shafa quarter (surviving today), Elchi Khan quarter, Bab(gate)-i Kia, Sharaf al-Din Khazr tomb, and Senjedestan. He also had a new wall and moat built around the city, as well as new gates such as Darb-i Elchi Khan and Darb-i Saadat. Another Mozaffarid ruler, Shah Yahya, in order to ensure more protection for the city constructed six separate towers toward Khurasan. He also had built a new quarter named Deh-i Now, renowned as Fath Abad, and bazaar and dome in the city center. His dependents also built madrasah, bazaar, caravanserai, and baths. Remains of some of these elements such as separated towers still survive[8] (Fig. 4.2).

In the 15th century A.D., the Gurkanian rulers endowed the city with fine buildings and urban spaces, the remains of some of which still stand. Amir Gurkani ordered the construction of new towers and fortresses which were encircled by a moat. Doors made of iron were also installed at the gates. And some parts of the outer areas were added to the city.

Under the rule of Mirza Shahrokh Sultanshah, the Congregational mosque was expanded, and the plastered walls were ornamented with tiles. Also at this period, under the rule of Amir Jalal-ad Din and his descendents a large urban complex was built including a fascinating urban space surrounded by mosques, caravanserai, water reservoirs, and bazaars. They also ordered the construction of seminary schools, khanaqah, and tombs. Today, the complex has changed drastically. The only surviving element is the mosque, and the remains of the square have been changed into a traffic intersection.

There are few surviving elements of the Safavid period, sixteenth–seventeenth centuries in Yazd. During this period, the activities of rulers were concentrated in Isfahan. The only important complex from the Safavid period was Shah Tahmasb square with surrounding elements. This complex was gradually demolished after the construction of new streets since the 1930s.[9]

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[6]See Fig. 4.5, this quarter still survive on the far northeast of the old city and absorbed into the city.

[7]See Figs. 4.5 and 4.6, this quarter took shape on the northeastern part of the old city, adjacent to the gate.

[8]Remains of the city wall, separated towers, and a gate still survive, and some have been restored. See Fig. 4.2.

[9]The process of change of this complex has been studied, see Fig. 3.17.

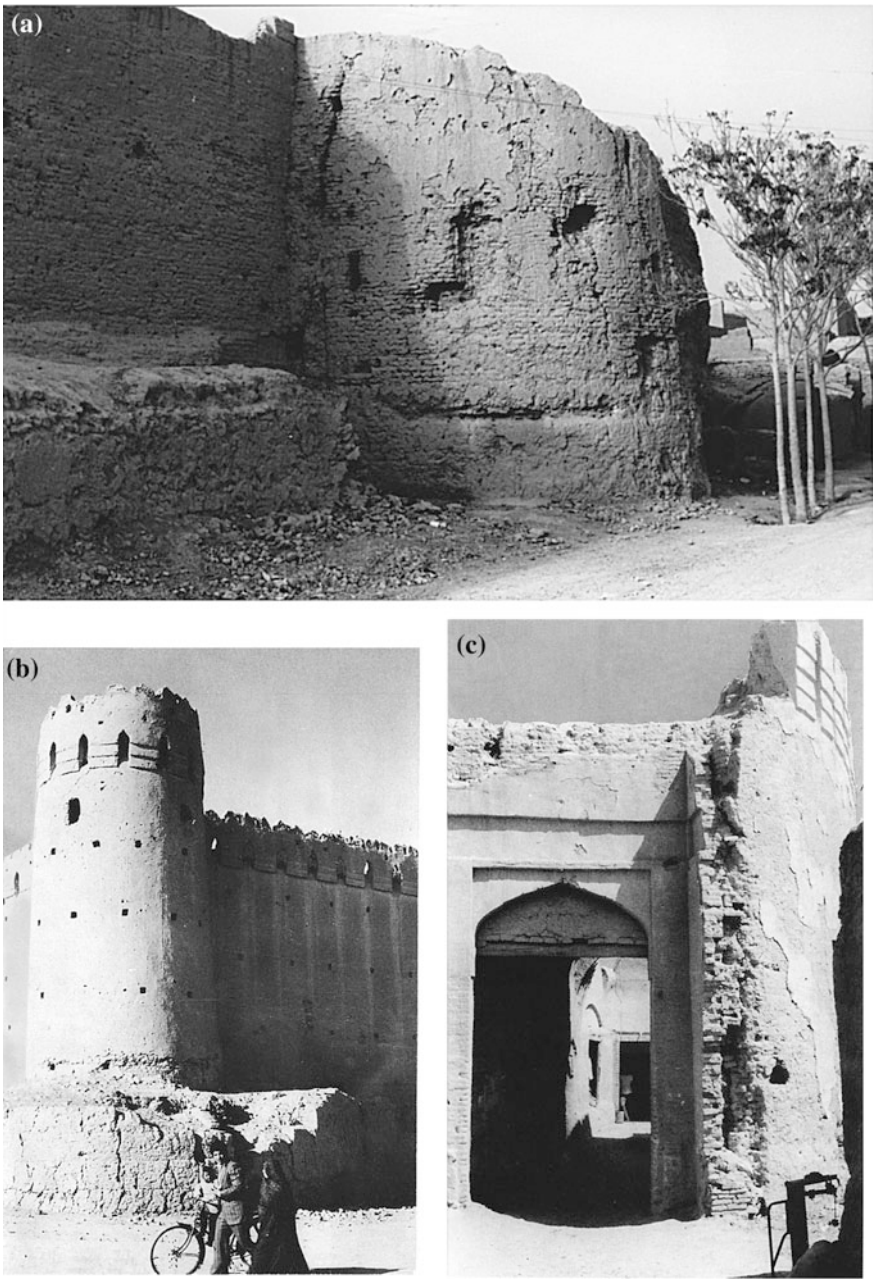


Fig. 4.2 Yazd. Remains of the city wall: **a** twelfth century. **b** fourteenth century. **c** Gate, fourteenth century (Darvazah-yi Shahi)

From the Safavid period on, and especially that of the Qajar period in the nineteenth century (Fig. 4.3), we can mention the works of Muhammad Taqi Khan, who ordered the construction of Dowlat Abad garden. Under his rule and his descendants, also different elements were built, which all survive to this day such as Bazaar-i Khan, Madrassah-yi Khan, and the famous Maydan-i Khan.[10] During the Qajar period, wealthy urban families had magnificent housing complexes built, some of which still exist.[11]

As we can see, the city rulers in different periods have had a considerable role in structuring cities. Although local historical documents give little information about the activities and life of the people, but local field investigations show that the monotonous hard work has continued in the workshops throughout the ages. Today the elders of the old families give us a full account of life and activities of traditional neighborhoods and interrelated elements such as mosques, madrasahs, khanaqahs, and living spaces.[12]

Socio-Spatial Structure of Yazd. Studies show that in the past the walled city of Yazd comprised of homogenous integrated neighborhoods, a central complex, and neighborhood centers. The main complex and neighborhood centers within the city had an important spatial relationship maintained through the main thoroughfares. The surveys of towns and cities within the hot arid regions show that the main communication routes were these main passageways through the town and neighborhood centers. Along the line of these passageways or at their intersections, neighborhood centers were located. This characteristic arrangement also exists in other towns and cities which have been studied in the present book. Neighborhoods were places of different social classes, different occupational, and different religious groups. Integrated relations of activities, a distinctive characteristic of a neighborhood system, have shaped the spatial structure of cities in the Islamic area, so that housing areas or two neighborhoods belonging to the upper classes and middle classes were adjacent. And often it was common for dwellings of the rich, to be situated along the main passageways. As Fig. 4.7 shows, one of the main passageways displays such an arrangement. It stretches between two main gates of the walled city and links several aristocratic housing complexes and neighborhood centers (Figs. 4.3, 4.4, 4.5, 4.6, 4.7, and 4.8).

[10]These elements are the main constituting parts of the bazaar complex which have been divided into two parts by new constructed streets since the 1930s. See Figs. 3.16 and 4.6.

[11]We have dealt extensively with urban and architectural characteristics of these complexes. See Figs. 4.7, 4.9, 4.10, 4.11, and 4.13.

[12]Information concerning sociocultural aspects is based on the knowledge of old traditional masters in the 1970s and most of them have departed. Socioeconomic studies are extracted from the handwritten by the late Hassan Tavassoli, student of juridical law at Tehran University, and a member for the preparation of the Detailed Plan for Yazd, Faculty of Fine Arts.

Fig. 4.3 Yazd. The oldest map (1859), *a* The old Mozaffarid town fourteenth century. *b* City center developed outside the old town. *c* Development between fourteenth and nineteenth centuries. *d* Neighborhood villages integrated with gardens. (Map from M. Mehryar, Sh.S. Fatullayev, F.F. Tehrani, and B. Qadiri, *Pictorial Documents of Iranian Cities in the Qajar Period*, Shahid Beheshti University/Iranian Cultural Heritage Organization, 1999, pp. 186–187)

Investigations show that up to one century ago there were six Zoroastrian quarters in the city of Yazd. The city was famous for having the largest Zoroastrian population. Today these quarters still survive. Zoroastrian occupations were mainly farming, and they owned cultivated fields. The remains of these areas still exist and constitute the majority of wastelands within their quarters. Altogether, except economic relations, the Zoroastrian community was a closed community, as is evident in the physical structure of the city.

In the neighborhoods, a trustworthy person was elected as neighborhood chief. The neighborhood chief was sometimes named Kalantar (bailiff), who in this case played a leading role. He acted as an intermediary between the ruler and the people, and in the current affairs, he might have supported people or the ruler. But as a tax

Fig. 4.4 Yazd. The old map (1928), *a* City center, bazaar area. *b* Amir Chaqmaq square fifteenth century. *c* Shah (Tahmasb) square nineteenth century. *d* Friday mosque. *e* Historic street (Fig. 4.7). *f* First modern street (drawing by the author based on the documents from Ministry of Interior 1972)

collector he usually supported the ruler. In the neighborhoods, weaving textiles was the main occupation of the inhabitants. Their weaving masters were elected as neighborhood chief. For example, we can mention, the Shah Abu'l Qasim neighborhood, whose inhabitants were mainly weavers from the middle and upper classes.[13] A weaving master as a neighborhood chief, because of his reputation and respect in the bazaar, saved his neighborhood weavers from bankruptcy. Under these conditions, small weavers became indebted to the wealthy. This dependence usually resulted in a small monopoly at neighborhood scale.

[13]This neighborhood is one of the oldest neighborhoods in the old city. The spatial structure of its center with another historic neighborhood center, Fahhadan, is shown in Fig. 4.14.

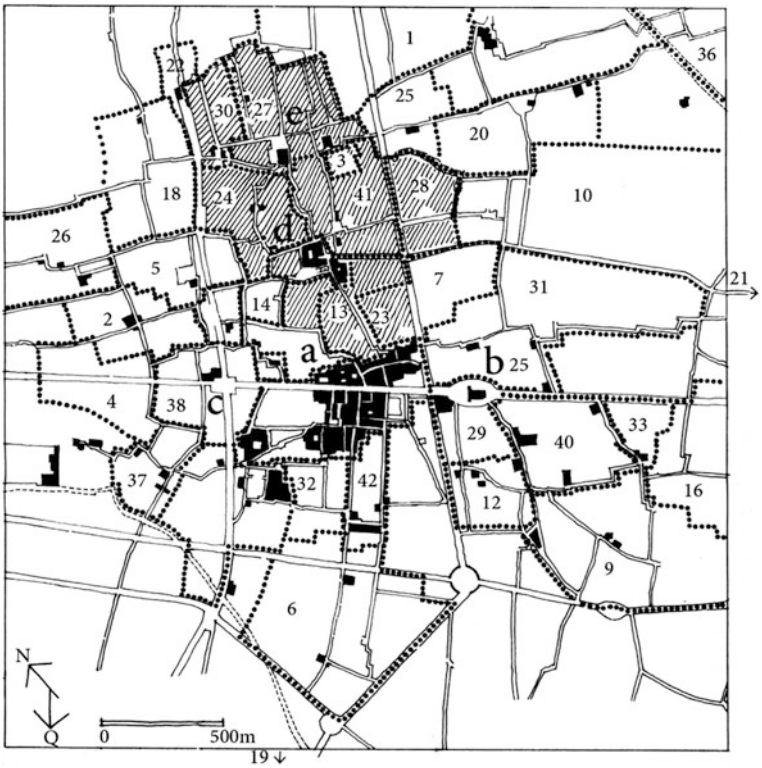


Fig. 4.5 Yazd. The historic city structure, 1972, including the old Mozaffarid town fourteenth century (*hatched area*). Division of city into neighborhoods each with a center is shown by *dotted lines*. Spatial relationship between: *a* City center, (cut into pieces by a new street) connected to neighborhood centers, through interconnected elements: main passageways. *b* Amir Chaqmaq square. *c* Shah (Tahmasb) square

In other neighborhoods, there lived farmers, peddlers, merchants, shawl weavers, etc. Some of the laborious occupations included the weaving of cashmere, weaving textiles, dyeing, rope making, oil mill/pressing, carpet weaving, coppersmith's crafts, and dredging. Production relations were based on relation between labor master craftsmen and apprentices in the traditional crafts of Persia.

Workshops were located along the main passageways or at their intersections. Household production was common. Weaving textile workshops which were managed by women had a basic role in the economy of the family. Today many household workshops are in a very poor condition, as a result of neglect.

The city's economy was based on workshop weaving. Workshop weaving textiles had a significant role in the socioeconomic fabric of the city. Social classes in the weaving crafts included (a) wealthy and merchants and landlords of

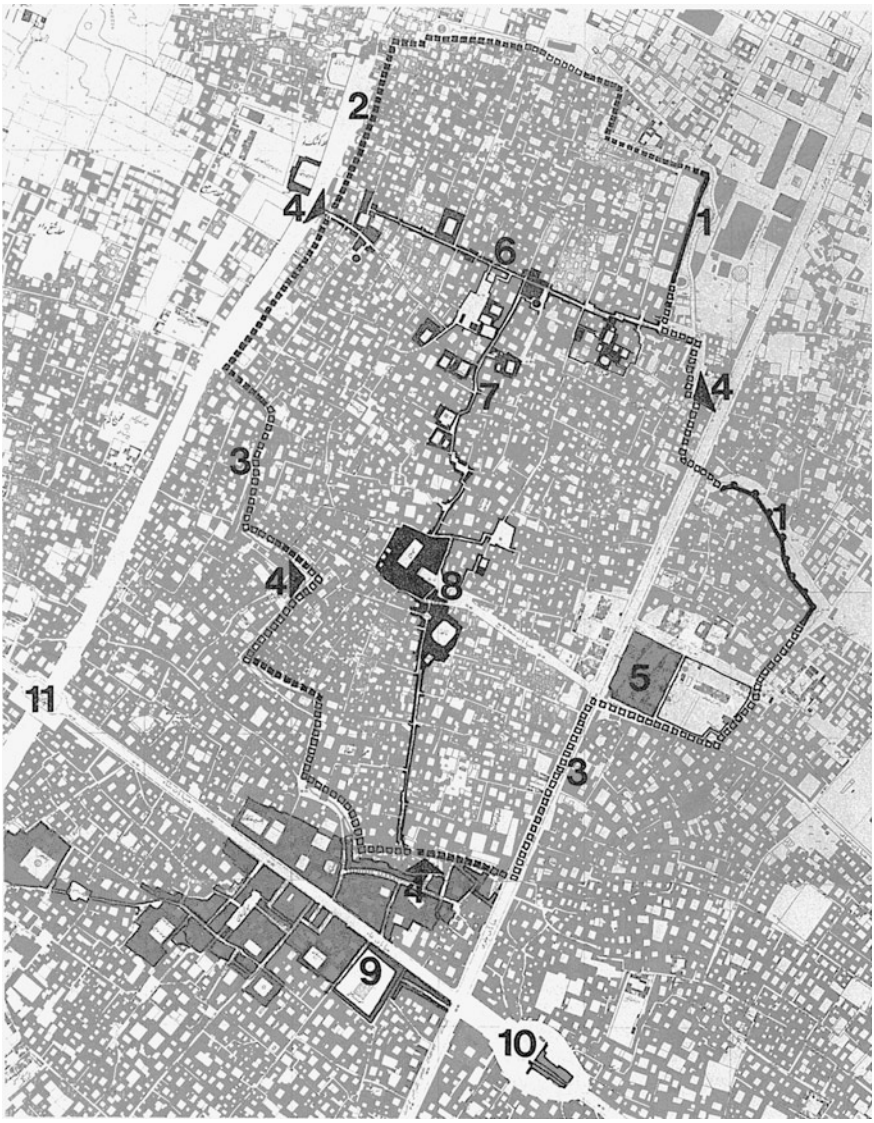


Fig. 4.6 Yazd. *1* City wall (still present). *2* City wall (traces). *3* City wall (destroyed). *4* Main city gates. *5* Citadel (now government offices). *6* Historical street fronted by aristocratic houses, one of the fourteenth centuries. *7* Another historical street passing through Friday mosque. *8* Friday mosque. *9* A main *takyah. 10*, *11* Squares (destroyed). (From Mahmoud Tavassoli. *Architecture in the Hot Arid Zone*. Tehran Iran 1974, pp. 22–27, and an article by author in: Gideon Golany. ed. *Design for Arid Regions* 1983, p. 124)

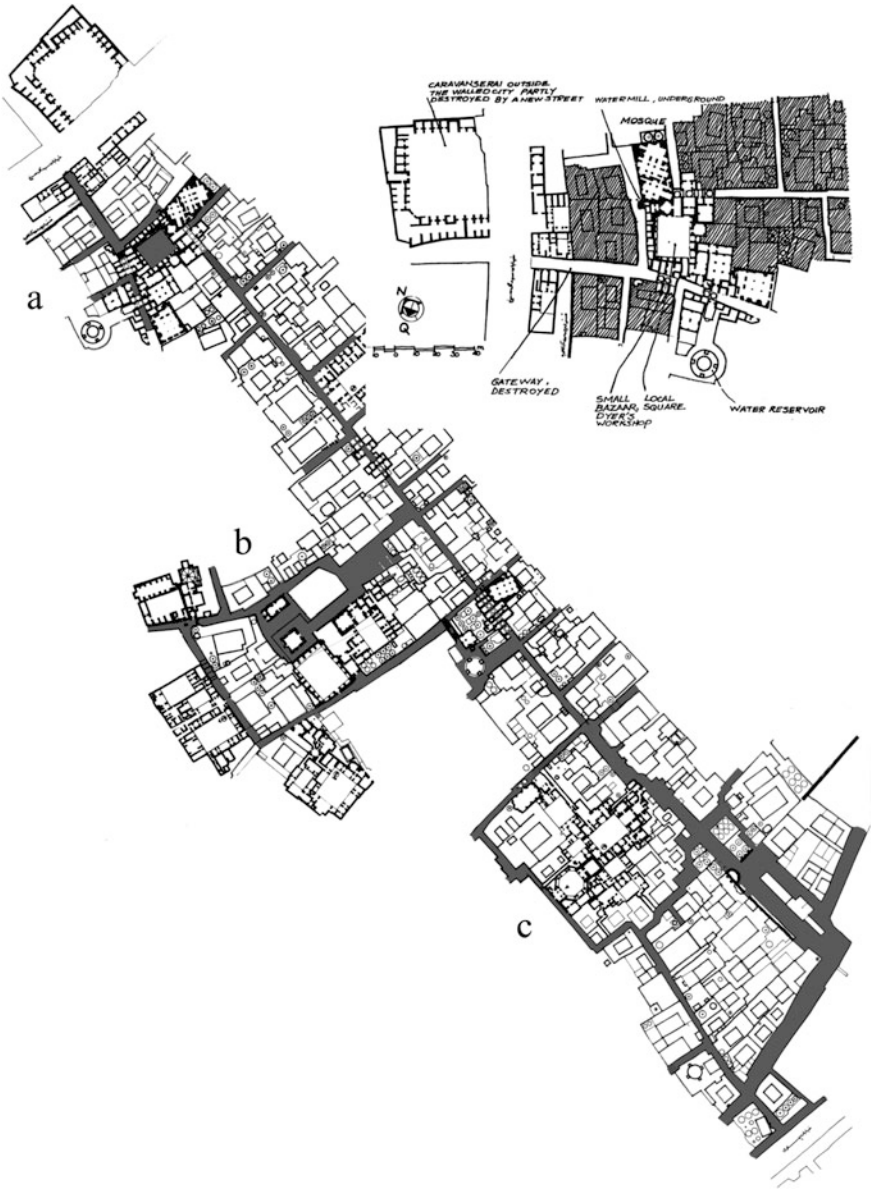


Fig. 4.7 Yazd. Detail of a historical street (see Fig. 4.6), connecting two main neighborhood centers (*a*, *b*) and an old aristocratic urban block (*c*). See Fig. 4.9. (based on Tavassoli *Architecture in the Hot Arid Zone 1974,* and completed from Tavassoli and others, *Detailed Plan for Yazd* 1975)

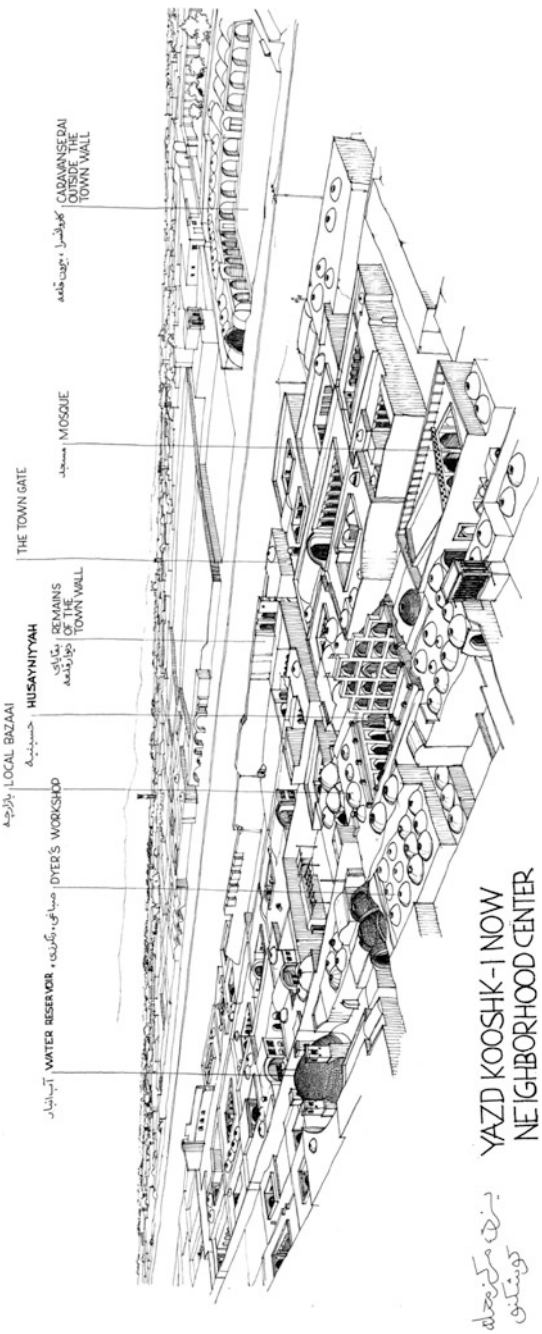


Fig. 4.8 **Yazd**. Detail of the neighborhood center, Fig. 4.7

importance, (b) middle-class weavers, and (c) lower-class weavers, who in some cases worked in neighborhood villages as small farmers. Neighborhood villages had taken shape in different periods on the outskirts of the city. For example, Moryabad (today Maryam Abad) was established 2 km from the nucleus of the city, in the eighteenth century. In 1974, out of a population of 122 thousand in Yazd, nearly 25 thousand lived in the outskirts of the city.

Today because of the complicated socioeconomic relations and the dominance of factory production over much of workshop production, and changes in the administration and political system, the neighborhood system no longer exists. Accordingly, the neighborhood as a unit of urban life has lost its importance.

However, there are still many active neighborhood centers as status symbol of the past. In the present study, a detailed analysis of the oldest passageway is presented. This includes two main neighborhood centers, Kooshk-i Now, Fahhadan, and the complicated urban block, comprising the oldest housing complex, and also, a comparative study of two typical housing complexes: Muslim and Zoroastrian.

The elemental structure of Kooshk-i Now neighborhood center comprises the historic gate although no longer in existence, but its site is recognizable, and Husayniyyah is integrated with the main passageway, mosque, water reservoir, small bazaar, and the city's underground water mill which was active since the 1960s, but today is derelict,[14] as well as a dyer's workshop (Figs. 4.7 and 4.8).

Fahhadan neighborhood center includes a small bazaar, square, traditional gymnasium, water reservoir, Husayniyyah, mosque, an indoor space for launderette, and the historic shrine of the Davazdah Imam dated 1036 (Fig. 4.7b).

The oldest complex urban block includes the city governor and his descendant's residence of the fourteenth century, husayniyyah, madrasah, and tomb (Figs. 4.7c and 4.9). The two typical housing complexes (Figs. 4.10 and 4.11) show interesting differences. In the Muslim type, there is no spatial relationship between different parts, whereas in the Zoroastrian type the system is open.

In addition to the neighborhood center as one of the main structural elements of the city, few exceptional elements such as shrines and temples are of distinctive features. The Zoroastrian Temple in Yazd is a symbol of pre-Islamic culture in the region. The Holy Fire despite being shuttled from one place to another during centuries has come to rest in this temple (Fig. 4.12b).

Outside the old city of the fourteenth century, till that of the nineteenth century also powerful integrated neighborhood centers have taken shape. An example is Hashim Khan Complex in the south part of the bazaar. Two main distinctive characteristics of this complex are the integration of the forecourt (Fig. 4.13b) as a semi-private space with the main passageway, a space which was used for congregating during various ceremonies, and access to water reservoir both from inside (private) and outside (public). In spite of enormous changes, a clear and legible connection between neighborhood centers is a unifying factor in the city structure (Fig. 4.14).

[14]Kooshk-i Now water mill was a part of the whole complex of the Kooshk-i Now neighborhood center in the inner core of the historic city of Yazd. See Fig. 4.7.

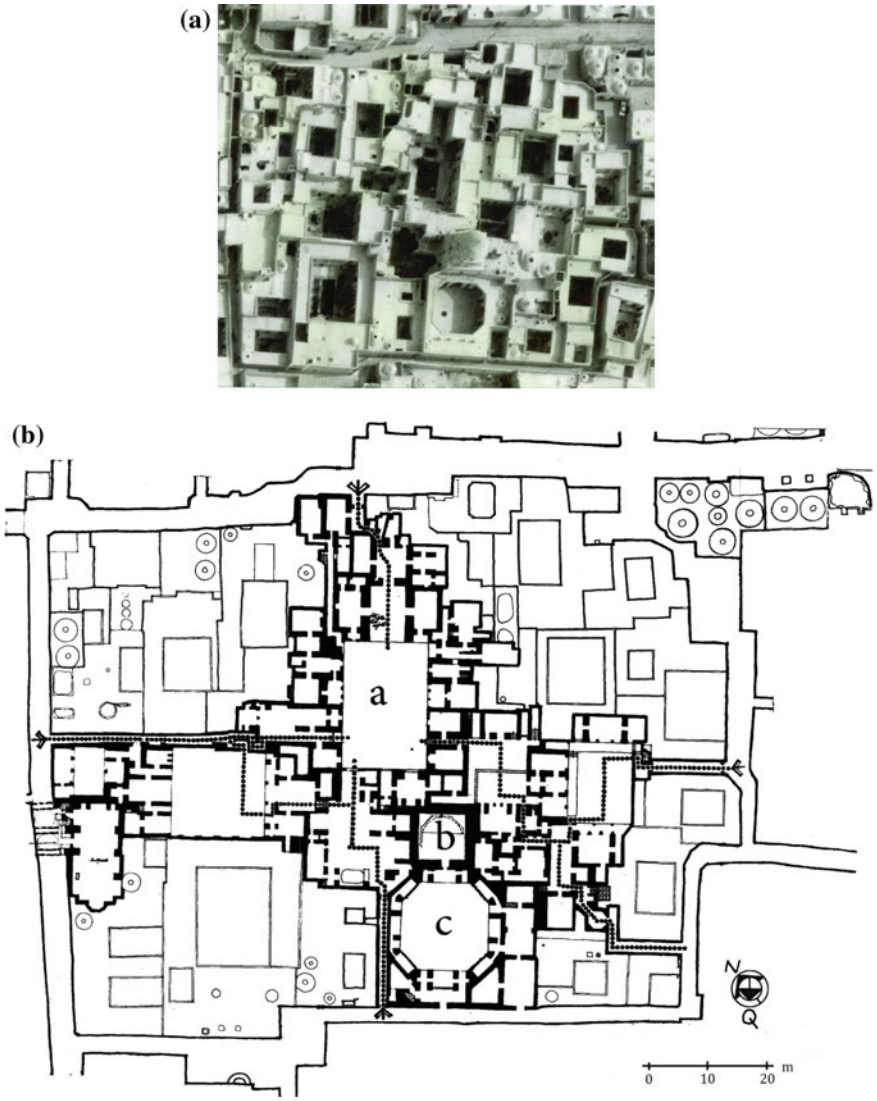
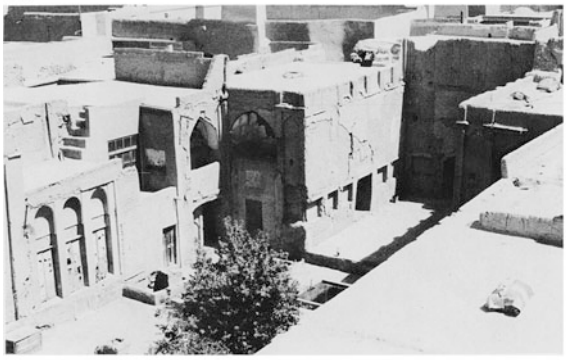


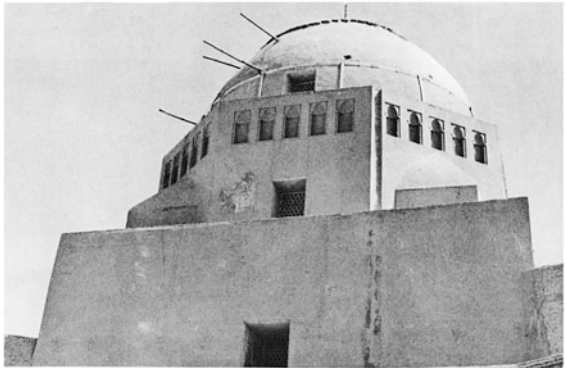
Fig. 4.9 **Yazd**. Detail of a complex along the historical street, as shown in Fig. 4.7. An example of a large complicated old urban block, fourteenth century. **a** Aerial view (from *National Cartographic Centre, Iran, 1973*). **b** Plan. *a* Aristocratic house. *b* Islamic school and mausoleum (madrasah and marqad/tomb). *c* Husayniyyah. Opposite page: **c** Northern ivans (collapsed). **d** Southern part. **e** Mausoleum dome. **f** Remains of the garden ditch. (based on Tavassoli *Architecture in the Hot Arid Zone 1974*, and Tavassoli and others, *Detailed Plan for Yazd* 1975)

(c)



(d)

(e)



(f)

Fig. 4.9 (continued)

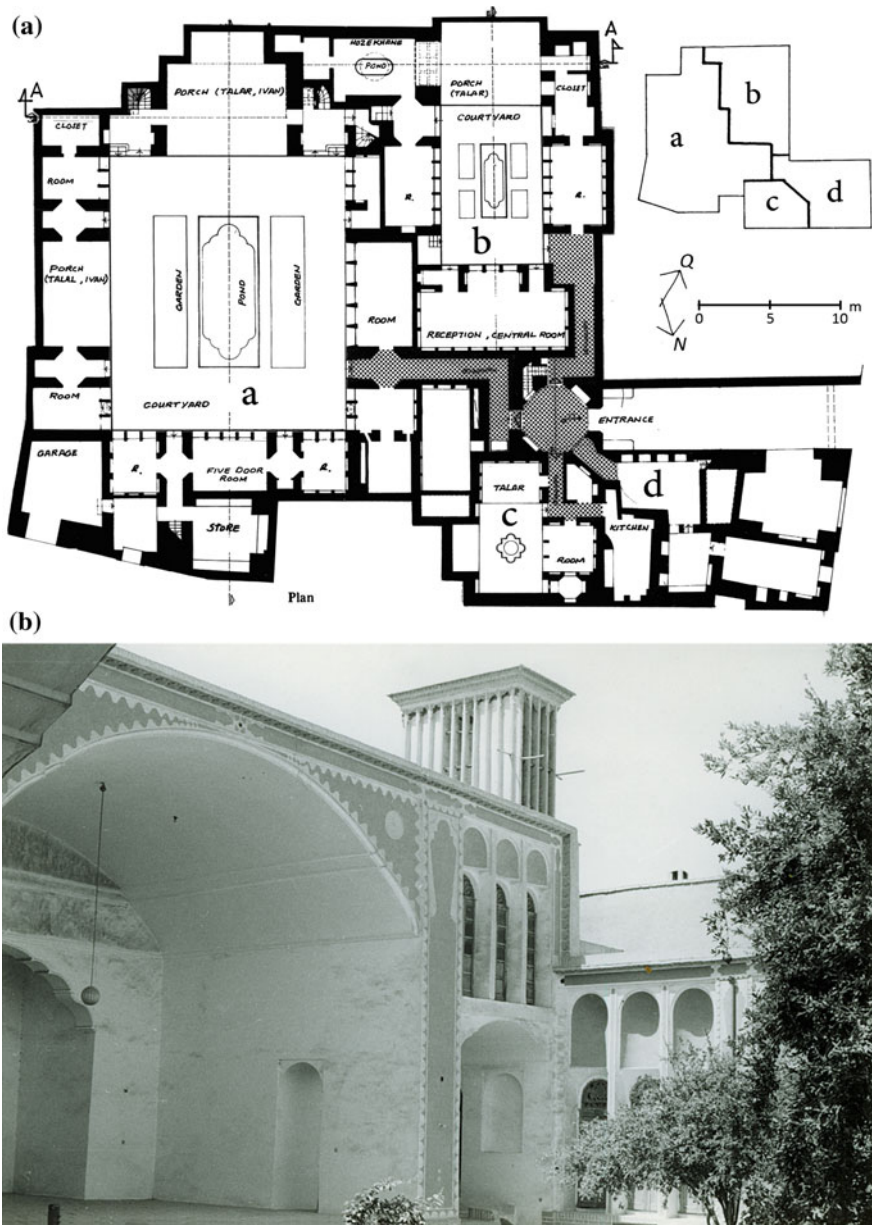


Fig. 4.10 **Yazd**. An aristocratic family's housing connected with historical street, as shown in Fig. 4.7. An example of Muslim housing without open spatial relationship between different sections. **a** Plan: *a* Family's private (Andaruni), *b* Guests and men (Biruni), *c* A small orange garden and men reception (narengestan), *d* Stable (sartavileh). **b** Summer area. **c** Section. **d** Winter area. (completed, from Tavassoli and others, *Detailed Plan for Yazd* 1975)

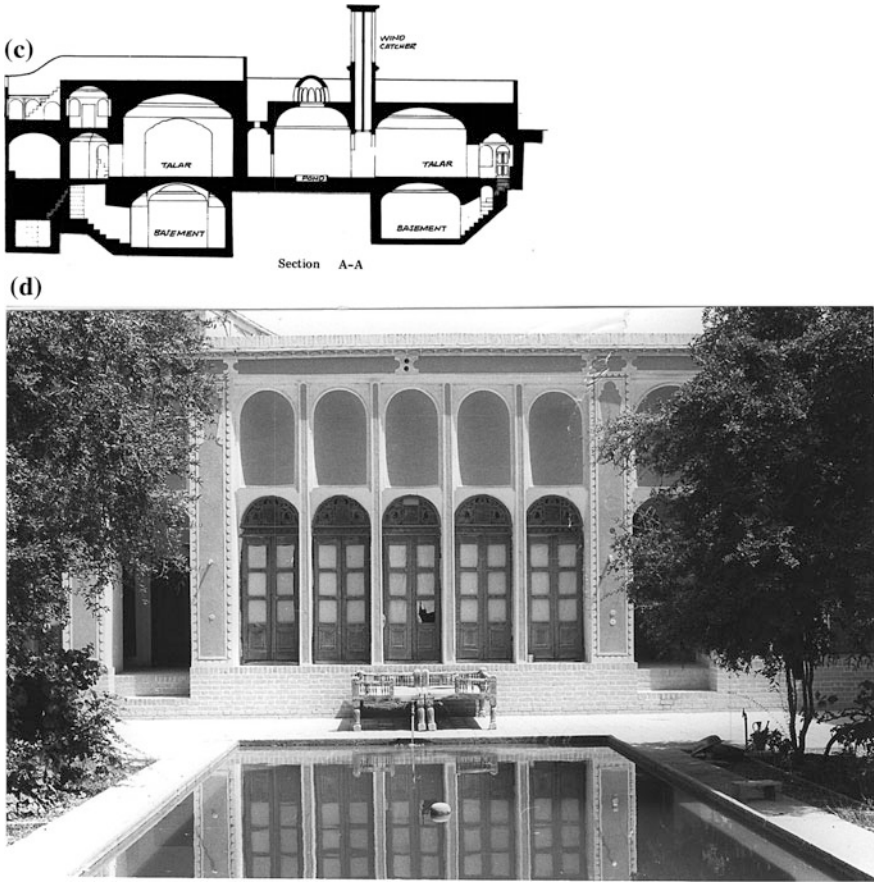


Fig. 4.10 (continued)

The following contains detailed information about the neighborhoods (Fig. 4.5). The late professor, Iraj Afshar of Tehran University, in his book *Yadegarha-yi Yazd* (section on neighborhoods), mentioned seventeen more neighborhoods than what were previously known in our study. There may have been some changes and integration in the neighborhoods during that time.

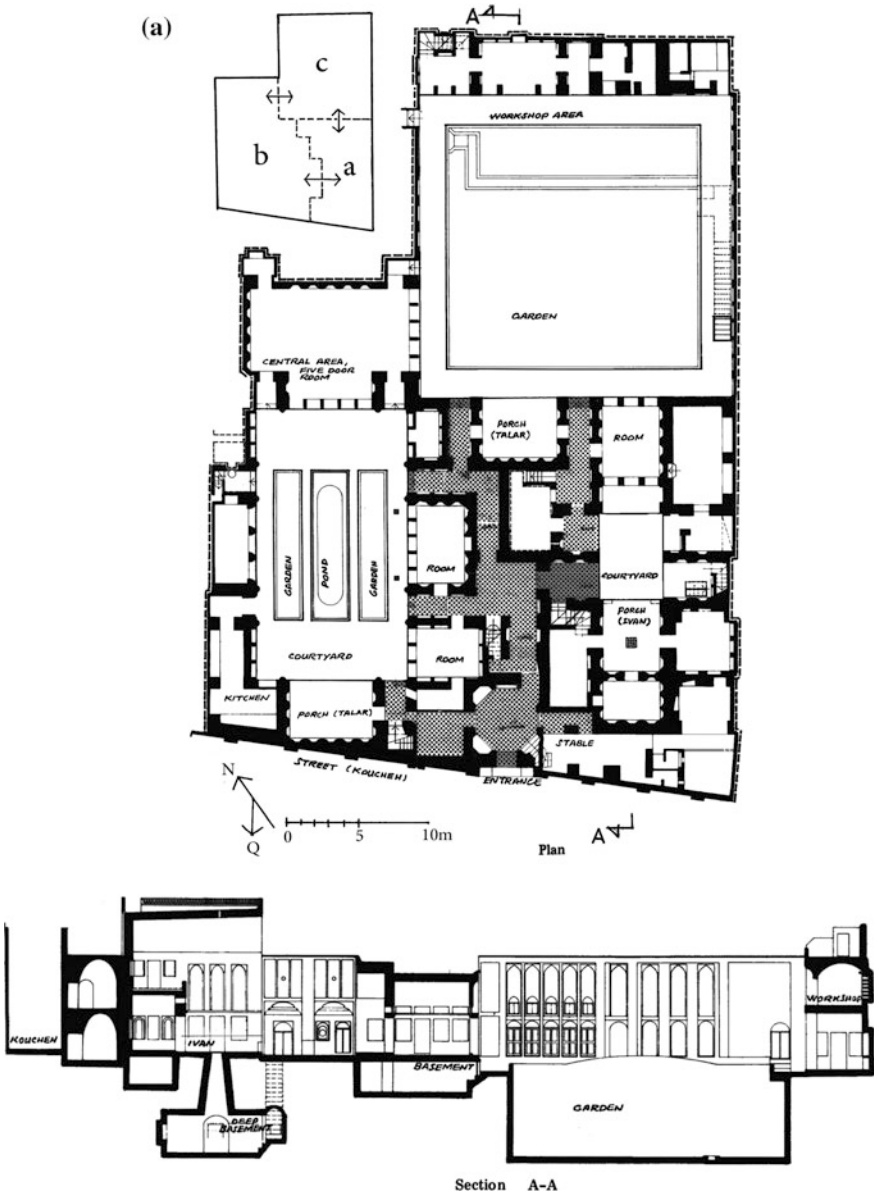
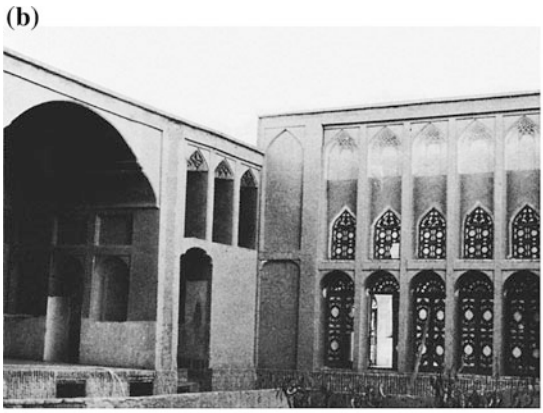
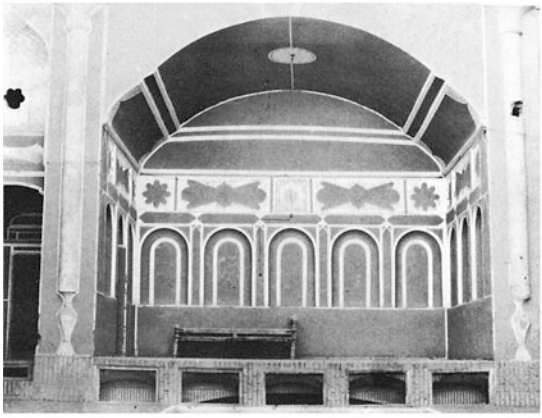


Fig. 4.11 Yazd. Zoroastrian aristocratic family's housing complex with open spatial relationship between different sections. **a** Plan and section: *a* Four-ivan court (chahar soffa). *b* Four season (chahar fasl). *c* Workshop-garden (kargah-bagh). **b** Ivan and five-door room (talar, orosi, shekam darideh). **c** Talar. **d** Kargah. **e** Stone pavement (sangfarsh). **f** Plaster work (gach bori). (completed, from Tavassoli and others, *Detailed Plan for Yazd* 1975)





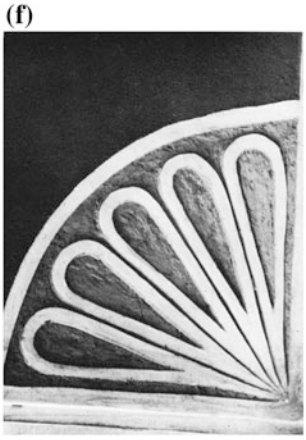


Fig. 4.11 (continued)

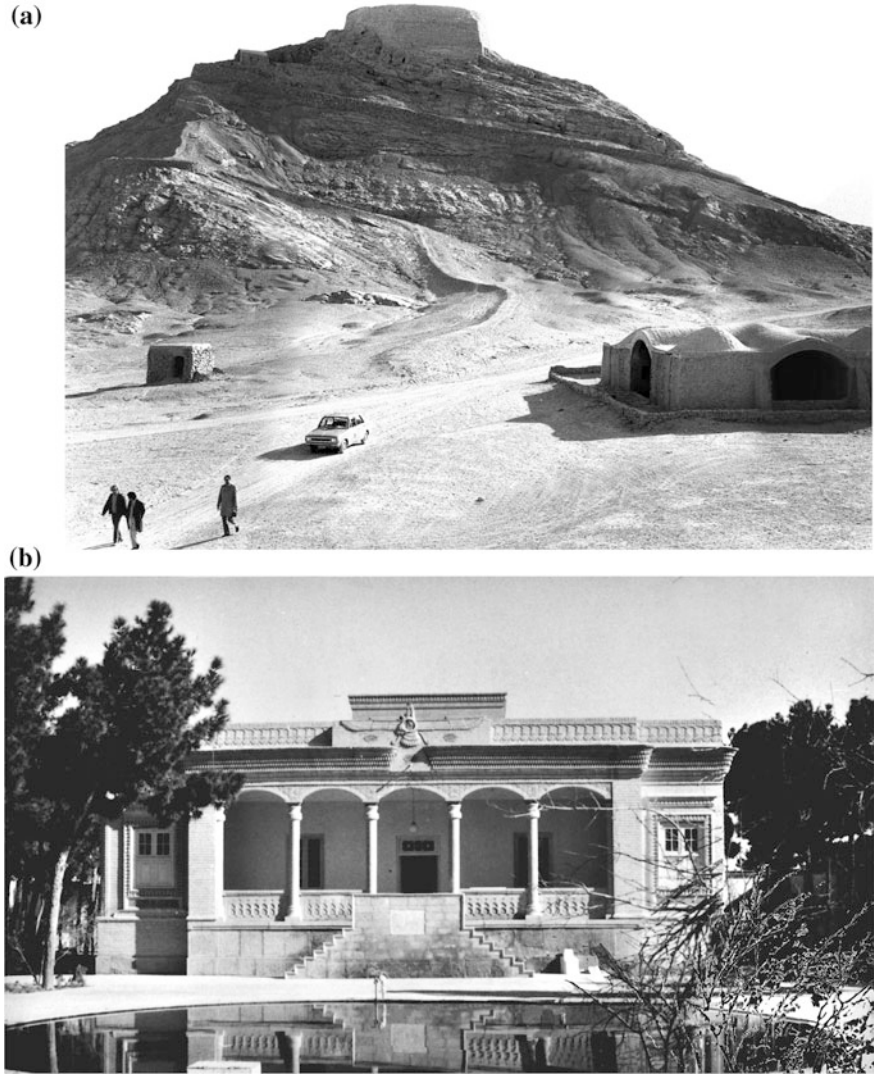


Fig. 4.12 Yazd. Two Zoroastrian elements: **a** Ancient cemetery *Dakhma*. **b** The Zoroastrian Fire Temple (1933), one of the main structural elements in the Zoroastrian neighborhood of the historic city

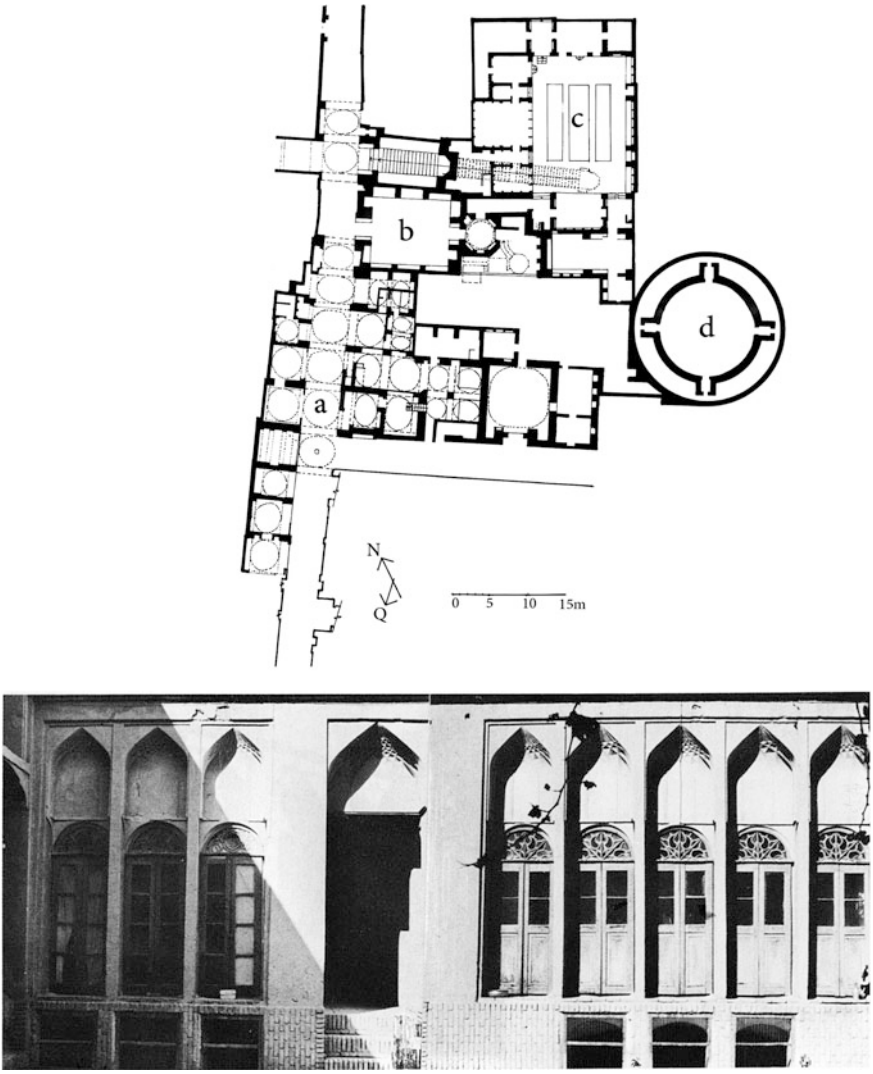


Fig. 4.13 Yazd. A neighborhood center complex, named after the neighborhood headman: Hashim Khan. *a* Small bazaar or bazaarchah including different activities: confectionery (halva-pazi), carpentry (najjari), apothecary in the past (mazari-attari), etc. *b* Husayniyyah-i Hashim Khan. *c* Khaneh-i Hashim Khan. *d* Ab ambar-i Hashim Khan. *Below* Western side of the courtyard of the house. (based on Tavassoli *Architecture in the Hot Arid Zone 1974,* and Tavassoli and others*, Detailed Plan for Yazd* 1975)

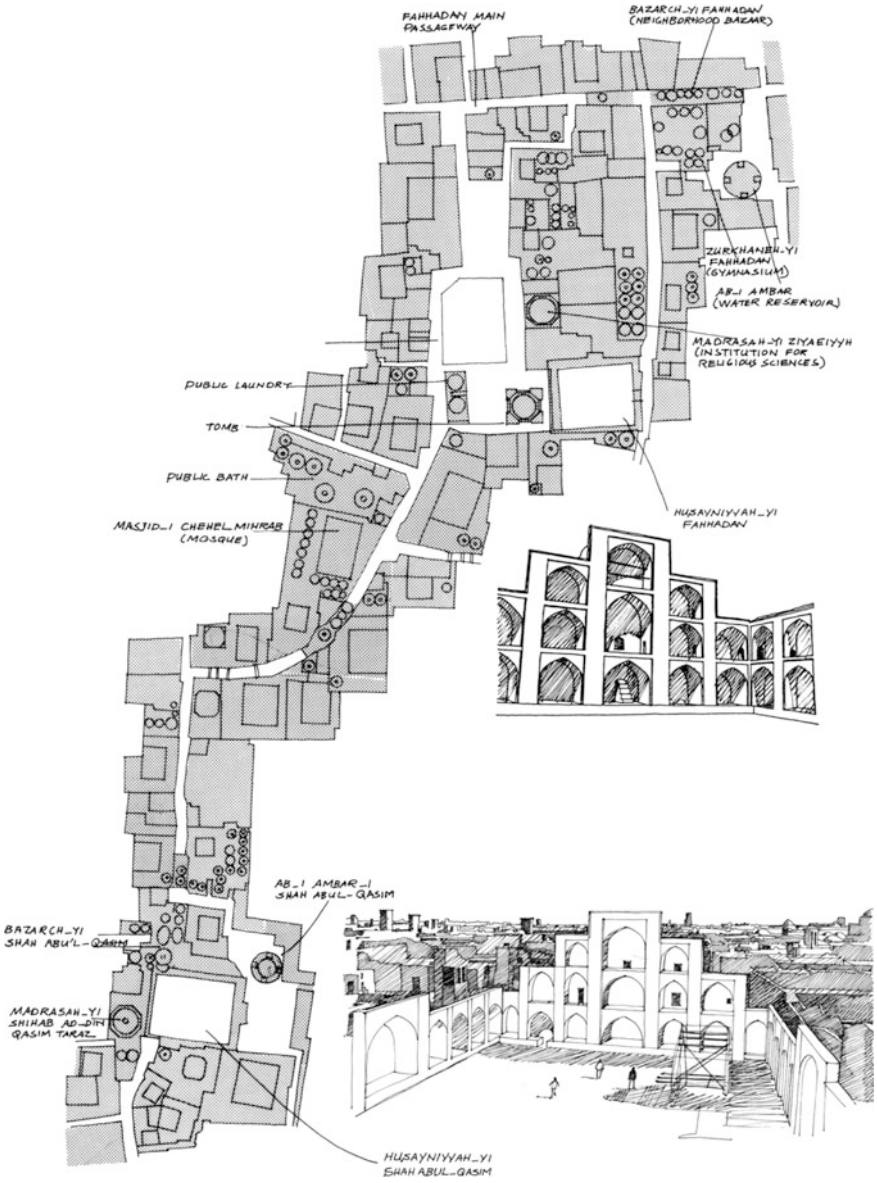


Fig. 4.14 Yazd. A strong connection between two neighborhood centers

Neighborhoods of the city, *Mahalleh*, plural *Mahallat* (each usually with one center)

1. Mahalleh-yi Ab-i Shur
2. Mahalleh-yi Abolmaali
3. Mahalleh-yi Bazar-i Now
4. Mahalleh-yi Bagh-i Sandal
5. Mahalleh-yi Bagh-i Gandom
6. Mahalleh-yi Posht-i Bagh
7. Mahalleh-yi Pir-i Borj
8. Mahalleh-yi Takht-i Ostad
9. Mahalleh-yi Tal
10. Mahalleh-yi Ju Hor Hor
11. Mahalleh-yi Char Minar
12. Mahalleh-yi Khaj-i Khidr
13. Mahalleh-yi Dar al-Shafa
14. Mahalleh-yi Darvaze-yi Shahi
15. Mahalleh-yi Do Minar
16. Mahalleh-yi Zardoshtiha
17. Mahalleh-yi Sar-i Polk
18. Mahalleh-yi Sar Cham
19. Mahalleh-yi Sar-i Dorah
20. Mahalleh-yi Sar Sang
21. Mahalleh-yi Salsabil
22. Mahalleh-yi Seyyed-yi Gol-i Sorkh
23. Mahalleh-yi Shazdeh Fazel
24. Mahalleh-yi Shah Abu'l-Qasim
25. Mahalleh-yi Shahed-i Baz va Mahalleh-yi Gazorgah
26. Mahalleh-yi Shaykh Dad
27. Mahalleh-yi Fahhadan/Usedaran
28. Mahalleh-yi Qal'eh-yi Kohneh
29. Mahalleh-yi Qaysariyah va Mahalleh-yi Bag-i Gandom
30. Mahalleh-yi Kooshk-i Now
31. Mahalleh-yi Gazorgah
32. Mahalleh-yi Gudal-i Musallah
33. Mahalleh-yi Lard-i Asiyab
34. Mahalleh-yi Lard-i kaywan connected with Char Minar
35. Mahalleh-yi Malamir
36. Mahalleh-yi Moryabad/Maryam Abad
37. Mahalleh-yi Moltakiyah connected with Char Minar
38. Mahalleh-yi Maydan-i Shah
39. Mahalleh-yi Mir Chaqmaq
40. Mahalleh-yi Nazar Kardeh
41. Mahalleh-yi Vaqt va Saat
42. Mahalleh-yi Hashim Khan
43. Mahalleh-yi Yaqubi

Fig. 4.15 Nain. Compact structure featured in some damaged areas in the heart of historical section

4.2 Nain

The[15] origin of Nain goes back to pre-Islamic times. Remain of a pre-Islamic fortress Narin Qale'h still exists in the center of the city[16] (Fig. 3.1). Nain presents elemental structure typical of a small traditional Iranian city in the hot arid environment.

The compact structure was enclosed within a wall with four gates. The city included a collection of homogenous and seven integrated neighborhoods, each with a center at the intersection of the main passageways, connected to the city center or the bazaar. Different elements of the neighborhood centers met the requirements of the inhabitants at neighborhood scale. The bazaar has a linear pattern. Its location starts from the main gate, connected by a forecourt, continues, and ends in the center. Distinctly separated from the bazaar, there is the Friday mosque from the tenth century, which was located at the old town spiritual center, near a gate opposite to the bazaar gate (Fig. 4.16).

[15]Nain was the first city that we selected for a comparative study with Yazd in 1974. Also for a useful book on Nain, see Sultanzade (1996).

[16]There is no clear archaeological information about this pre-Islamic fortress. See Mosahab, *The Persian Encyclopedia* on Nain.

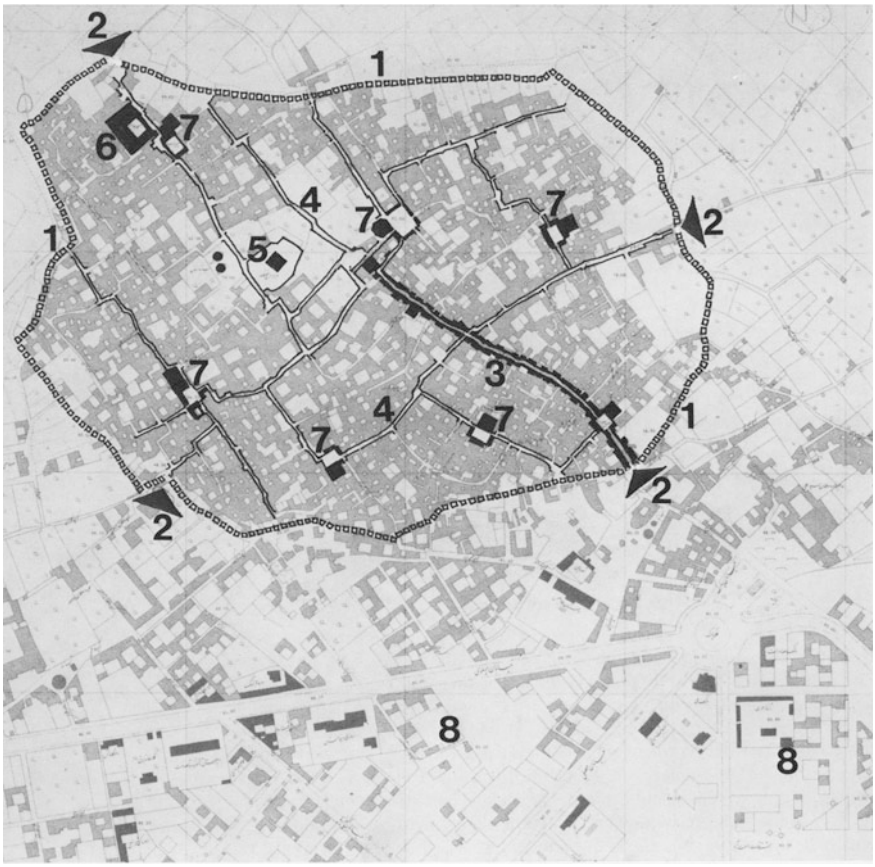


Fig. 4.16 Nain. The historic city spatial structure, relationship between: City center and Neighborhood centers, through interconnected elements: Main passageways. *1* Town (traces). *2* Gates. *3* Bazaar. *4* Main passageways. *5* Pre-Islamic fortress (Qal'ah). *6* Masjid-i Jami. *7* Neighborhood centers. *8* Outer expansion. (from *Urban Structure*… 1981, and *Design for Arid Regions*, 1983)

Today many old houses and urban elements are falling into decay, and the quality of urban life has deteriorated. The main reasons for the physical decay are inaccessibility, lack of city services, poverty, and old housing structure unable to respond to a new way of life (Fig. 4.15).

Neighborhoods of the old city

1. Mahalleh-yi Kelvan
2. Mahalleh-yi Now Gabad
3. Mahalleh-yi Sara-yi Now
4. Mahalleh-yi Bab-al Masjid
5. Mahalleh-yi Chehel Dokhtaran
6. Mahalleh-yi Panjahe
7. Mahalleh-yi Gowdalow

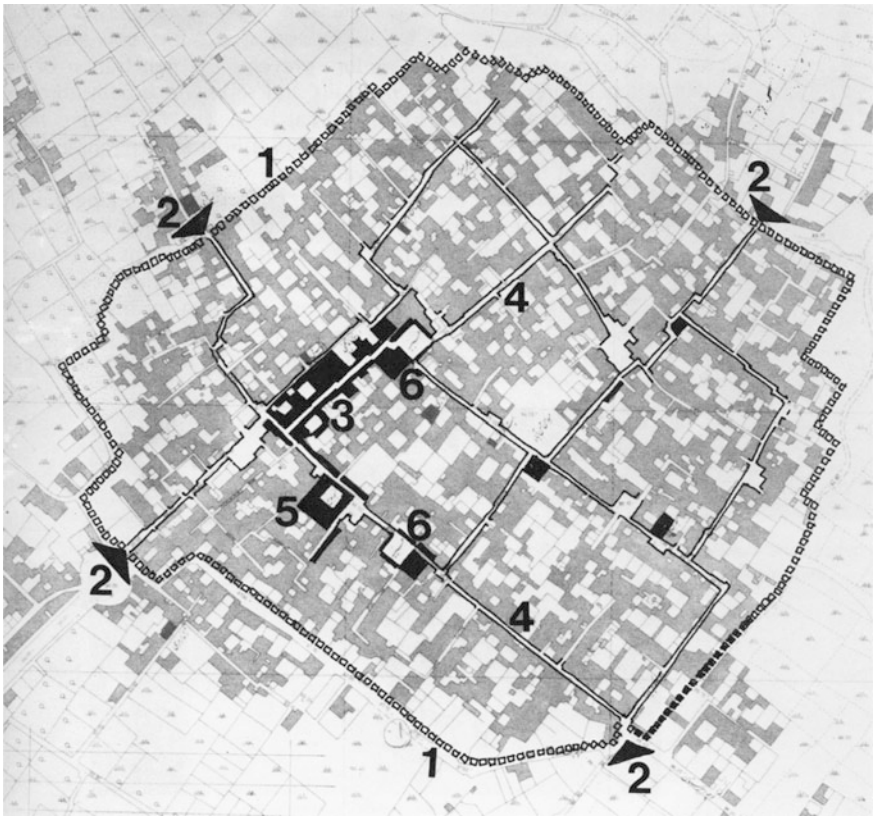


Fig. 4.17 Zaware. Historic town: *1* Town wall (traces). *2* Gates. *3* Bazaar. *4* Main passageways. *5* Masjid-i Jami. *6* Husayniyyah/two large and small town squares, (from *Urban Structure*… 1981, p. 40. *Design for Arid Regions*, 1983, p. 127)

4.3 Zaware

Among the small towns in the desert environment, the old Zaware was a unique example for her profound culture, and consequently clear and well-organized spatial structure.

The town's economy was based on farming and handicrafts. In the past, water in the city originated from qanats. Gradually, digging wells led to the decline in groundwater tables, many qanats dried up, and farming suffered.

The old walled town was structured according to the collection of neighborhoods. Neighborhoods were places of residence of different occupations, such as: *Mahalleh-yi Baziyarha* which was residence of farmers, or *Mahalleh-yi Ab*

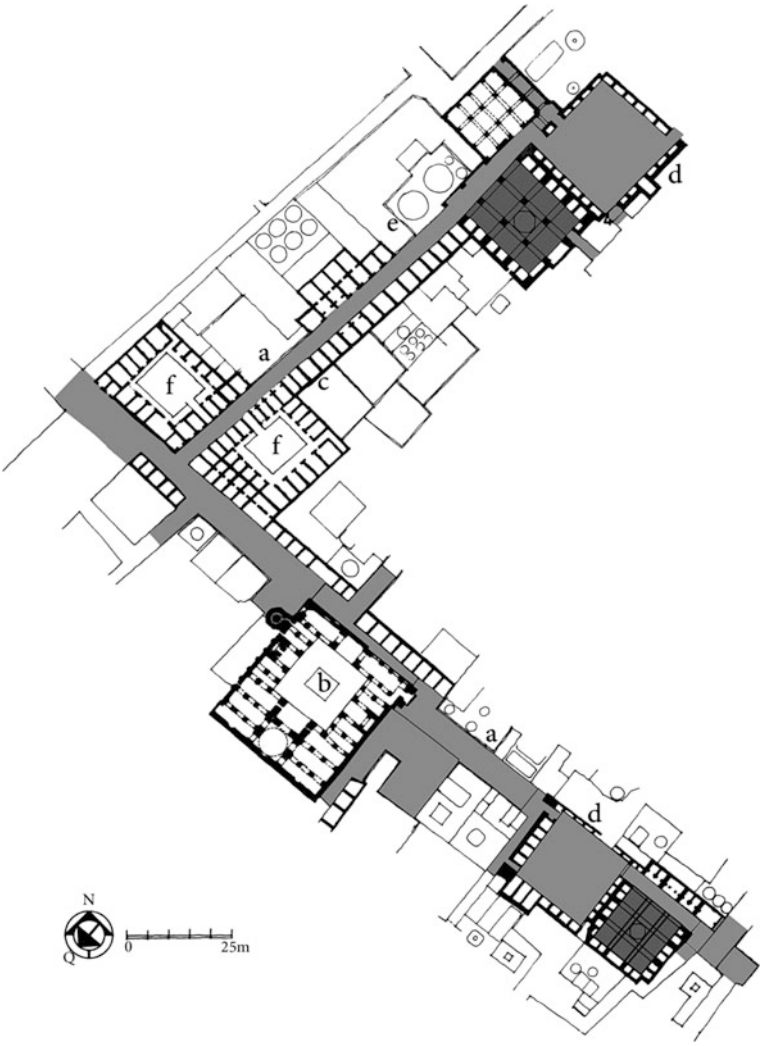


Fig. 4.18 Zaware. Main structural elements and their spatial relationship: *a* Main passageways *b* Masjid-i Jami *c* Bazaar *d* Two *large* and *small squares* (maydan-i Buzurg, Maydan-i kuchak) *e* Shrine, Imamzadeh yahya *f* Caravanserai

Pakhshan which was a place where water was distributed.[17] The integrated neighborhoods were enclosed within the wall with four gates, thus sheltered from the hot sandy desert outside (Fig. 4.17).

[17]See Abu'l-Qasim Mehrabadi, *Atishkada-yi Ardestan,* op. cit., p. 149.

The L shaped city center includes elements such as the magnificent Friday mosque an old four-ivan court, Iranian type mosque,[18] the bazaar, two large and small squares, covered and uncovered.[19] All these elements have been arranged in a small town of nearly 600 × 600 m (Fig. 4.18).

Neighborhoods name of the old town:

1. Mahalleh-yi Pay-i Derakht
2. Mahalleh-yi Bagh Bazan
3. Mahalleh-yi Miran
4. Mahalleh-yi Same-al Din
5. Mahalleh-yi Dasht
6. Mahalleh-yi Posht-i Mashhad
7. Mahalleh-yi Kooskh
8. Mahalleh-yi Kafrood
9. Mahalleh-yi Boz Quch
10. Mahalleh-yi Show Gah
11. Mahalleh-yi Baziyarha
12. Mahalleh-yi Ab Pakhshan
13. Mahalleh-yi Bon Jireh

4.4 Tabas

The[20] enclosed walled city of Tabas was famous as an oasis in the heart of the desert and became more famous after the destructive 1978 earthquake.

Although small, but her simple and legible form included main structural elements: the Friday mosque and Madrasah, the Citadel, and the connected element: the Bazaar lane as the main passageway (Figs. 4.19 and 4.20). The architecture of the Friday mosque in response to climatic factors was totally a unique example in the desert of Iran (Figs. 6.40 and 6.41).

[18]Considering the style of Iranian Mosques, see Andre Godard, *The Art of Iran.* In Part 5, he discusses the formation of Iranian Mosques with central courtyard and four ivans and identifies the Friday mosque of Zaware as the first type of this style.

[19]The study of the spatial structure of Zaware is based on a comparison between the information of the old document: *Atishkada-yi Ardestan*, with the existing fabric and guidance of local masters in 1972.

[20]For a selected information on Tabas, see *The Persian Encyclopedia.*

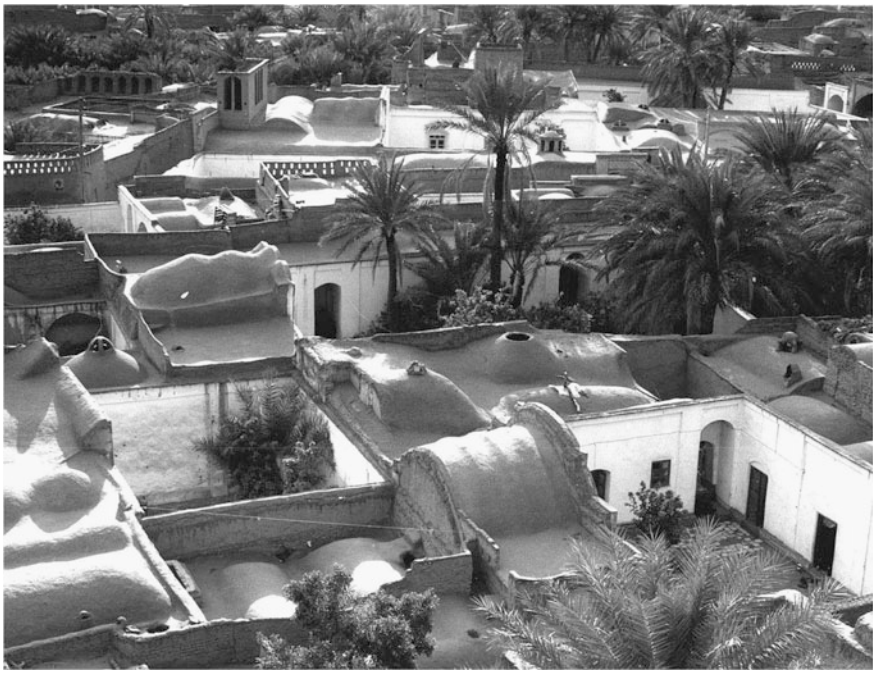


Fig. 4.19 Tabas. The town fabric integrated with palm trees. The 1978 earthquake completely destroyed the town

The structure of this complex in order to avoid excessive solar heat took shape on northeast southwest axis. Prevailing benign breezes mostly from the north had led to the construction of one-sided wind catchers. Accordingly, the houses with their large opening ivans and wind catchers were oriented toward favorable winds. The architectural forms of a typical three-sided wind catcher and a typical house in response to climatic factors have been studied in the present book[21] (Figs. 6.39 and 8.11).

[21]For an illustrated document about the gardens of Tabas, see Daneshdust (1990).

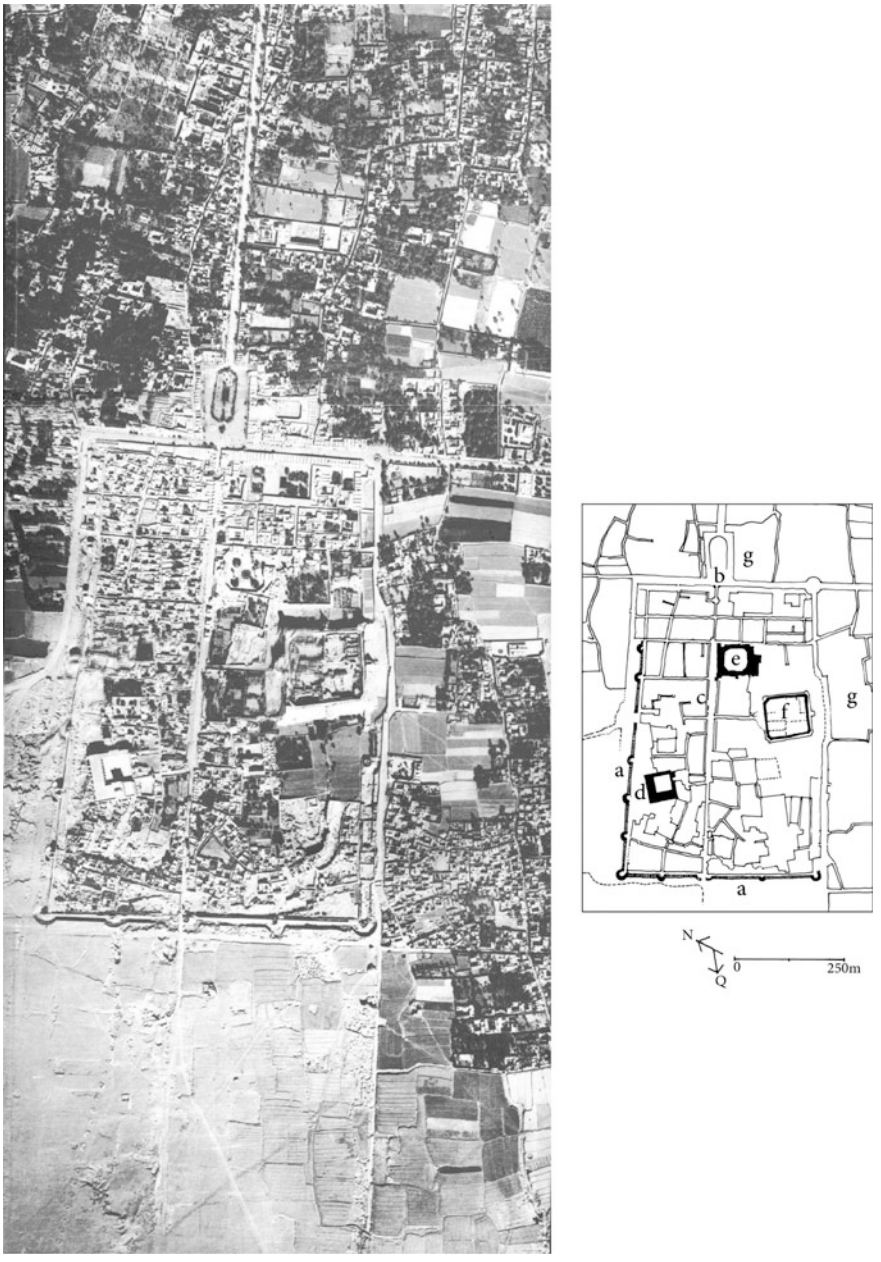


Fig. 4.20 Tabas. Spatial structure including: *a* Town wall (traces). *b* Main gate. *c* Bazaar lane. *d* Masjid-i Jamai. *e* Madrasah. *f* Citadel (Qal'ah). *g* Outer areas, gardens. (Aerial view from: *National Cartographic Centre, Iran, 1973*)

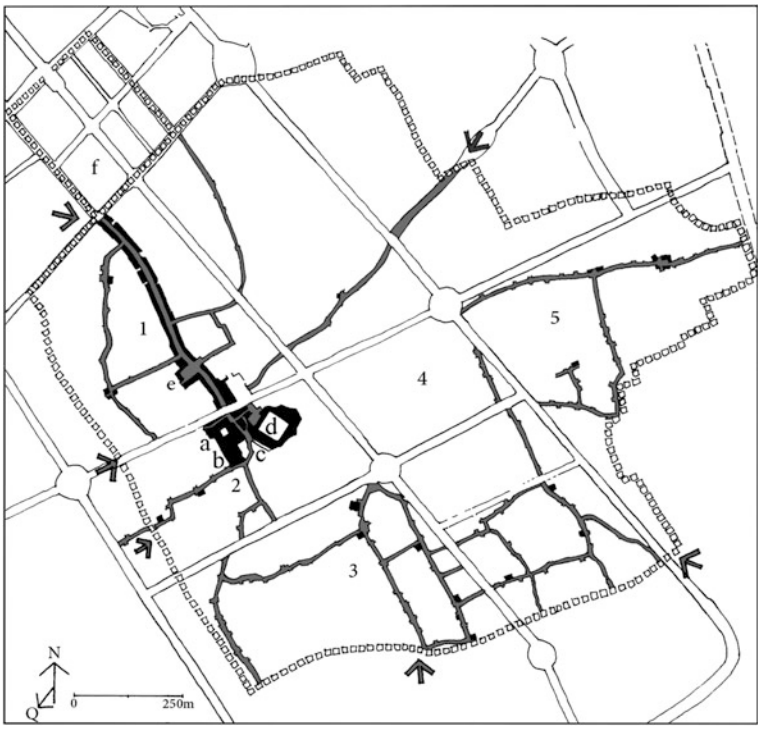


Fig. 4.21 Semnan. Spatial structure of the historic town including city center: *a* Masjid-i Jamai. *b* Imamzadeh-i Yahya (shrine). *c* Takyah-yi Nasar. *d* Masjid-i Sultani. *e* Takyah-yi Pehneh, and the bazaar lane. The neighborhood centers were connected to each other through main passageways. As shown, the structure of the city is divided into several pieces by inharmonious straight streets

4.5 Semnan

The[22] old city of Semnan included five large neighborhoods. Spatial organization of the city, just as Yazd and Nain was based on the connection of neighborhood centers to each other, and to the city center, through main passageways. The whole city was divided into parts by straight streets. The first and the worst street was the one which separated the central elements from each other, i.e., the elements shown as *a, b, c, d,* from the bazaar lane including *e,* element (Fig. 4.21).

[22]We dealt primarily with the spatial structure of Semnan in *Principles and Techniques of Urban Design in Iran.* The information is based on the study by the author for *Detailed Plan for Semnan*, Parhoon consulting engineers, 1983.

The five large neighborhoods and their main structural elements included:

1. Mahalleh-yi Nasar, including the oldest part of the city: *Kohandez* (see Fig. 1.1), the bazaar lane, and Takyah-yi Nasar.
2. Mahalleh-yi Esfanjan, including Masjid-i Jamai, Takyah-yi Pehneh, Imamzadeh-i Yahya and Masjid-i Sultani.
3. Mahalleh-yi Chub Masjid.
4. Mahalleh-yi Latibar including Chapar Khaneh (the old post office).
5. Mahalleh-yi Shah Jugh.

4.6 Kashan

The[23] traditional city of Kashan was divided into several neighborhoods, in the local term, *Kuy*. Although the main passageways as the connecting elements of neighborhood centers are irregular, the architectural elements including houses with their summer areas back to the hot summer afternoon sun give a clear orientation to the fabric of the city.

Kashan similar to other historical cities before entering the twentieth century experienced slow changes. New street construction was begun during the first decades of the twentieth century (Fig. 4.22).

The city is especially famous for its archeological discoveries in the Sialk Hillock near the city. These discoveries reveal that the region is one of the primary centers of prehistoric ages. Another important element in the city is the historical Iranian type of garden, the Fin garden with an amazing history (see introduction). Some of the neighborhoods of the city included the following:

1. Kuy-yi Sar Sang
2. Kuy-yi Posht-i Mashhad
3. Kuy-yi Imamzadeh-i Tahir va Mansur
4. Kuy-yi Chehel Dokhtaran
5. Kuy-yi Sultan Mir Ahmed
6. Kuy-yi Darvazeh-yi Fin
7. Kuy-yi Panjeh Shah
8. Kuy-yi Papak

[23]The study of the spatial structure of Kashan is based on a comparison between the information of the document: Naraghi H (1969), *Athar-i Tarikhi-yi Shahrestanha-yi Kashan va Natanz,* with the existing fabric of the city, and guidance of local masters in 1972.

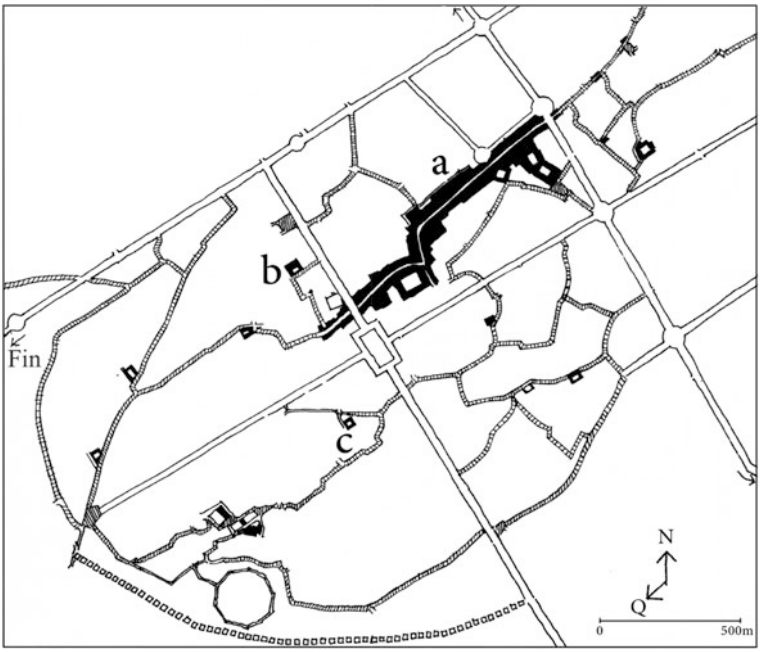


Fig. 4.22 Kashan. A typical desert city: *a* Bazaar. *b* Masjid-i jami. *c* Masjid-i Aqa. Neighborhood centers are connected through main passageways. Here again when looking at the main structure, especially the bazaar lane extending through the heart of the city, we notice how the bazaar complex is divided into two pieces, one including the Masjid-i jami

4.7 Shiraz

Shiraz[24] the capital of Fars Province is known as the city of poets and literature. Historical search into the works of great poets gives valuable information about the life and physical space of the city. We have always discussed the literary and mystical aspect of the poetry of Hafez, but less attention has been given to the role of the sociopolitical circumstances of the city where Hafez created his great work.

Neighborhoods of Shiraz at the time of Hafez had a cultural and especially sociopolitical atmosphere. This aspect and also some points about the bazaar in Shiraz have been discussed in the previous chapter.

[24]We have dealt extensively with historical and spatial structure of Shiraz in Tavassoli (1992–1993). Also for fully rich context on a fascinating place in a dynamic time, see John Limbert, *Shiraz in the Age of Hafez*, University of Washington Press (2004), p. 9.

Fig. 4.23 Shiraz. The walled city of nineteenth century. The main structural elements including: *a* City center. *b* Neighborhood centers were integrated with the main passageways. Today, this structure is divided into pieces by inharmonious streets. (from Tavassoli and Bonyadi 1993)

The eleven important neighborhoods of the city, each with a center (Fig. 4.23), connected to the city center included the following:

1. Mahalleh-yi Eshaq Bake
2. Mahalleh-yi Bazar-i Morgh
3. Mahalleh-yi Bala Keft
4. Mahalleh-yi Darb-i Shazdeh
5. Mahalleh-yi Darb-i Masjid
6. Mahalleh-yi Sar-i Bagh
7. Mahalleh-yi Sar-i Dozak
8. Mahalleh-yi Sang-i Siyah
9. Mahalleh-yi Lab-i Ab
10. Mahalleh-yi Maydan-i Shah
11. Mahalleh-yi Yahudiha

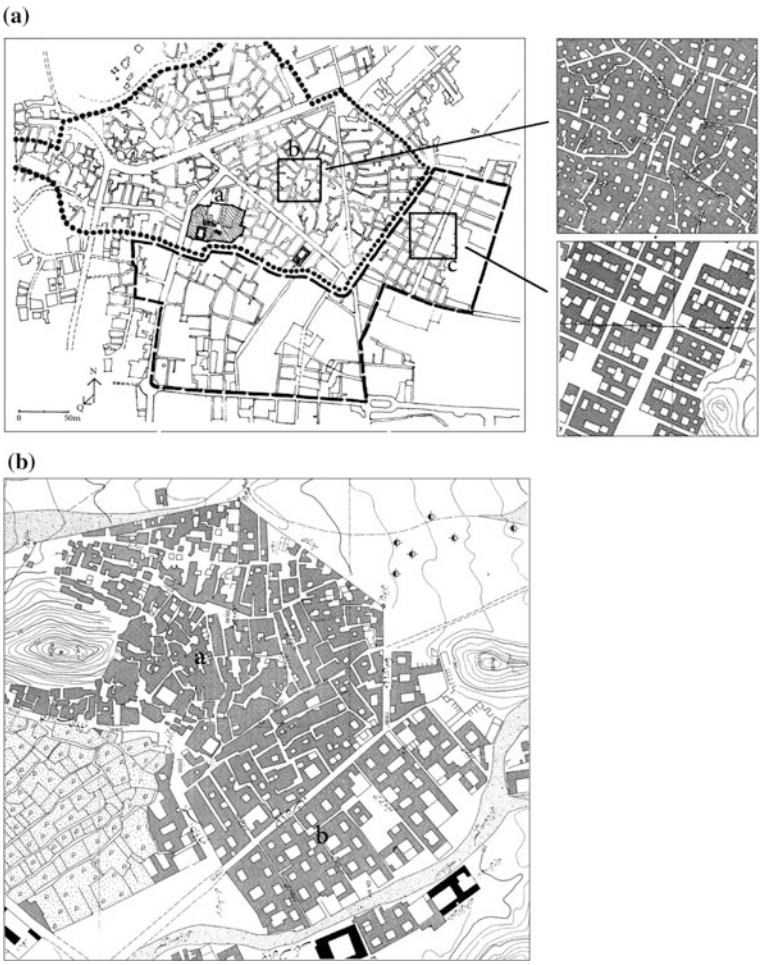


Fig. 4.24 **a Birjand**. *a* Inner core. *b* Inner area. *c* Middle area. **b Anarak** *a* Inner area. *b* Middle area

4.8 Birjand and Anarak

These[25] two desert cities clearly express two quite different sections that we have already mentioned: the inner area or the old part, and the middle area or the semi-old section (Fig. 4.24). Inefficiency of the compact intricate fabric of the old part led to the creation of a more open fabric in the first decades of the twentieth century in most of desert cities in Iran. The governing principle, the enclosed

[25]These two cities clearly express the difference between two historical fabrics, the inner and the middle areas. We proposed this classification for the first time in (1986). See *Principles and Techniques of Urban Design in Iran*.

courtyard house remained constant, a more ordered open access structure took shape. Although the new urban blocks are single story and courtyard housing, but it will help us in the process of design in response to new needs.

4.9 Tehran

Tehran,[26] a small town, in the mid-nineteenth century contained five neighborhoods: 1. Mahalleh-yi Ark (Citadel); 2. Mahalleh-yi Bazaar; 3. Mahalleh-yi Ud Lajan; 4. Mahalleh-yi Chal Maydan; and 5. Mahalleh-yi Sangalag. The 1885 census calculated the population to be 147,206. In the 1930s, Tehran saw the most visible changes. Its population grew to 540,000. Much of the old city, the gates, takyahs, and the complicated old fabric was destroyed by Reza Shah with the goal of making Tehran an "up-to-date" capital. The capital continued to grow. The city attracted migrants from all parts of the country.

From the 1950s onward, Tehran was faced with largest influx of rural migrants, with a the population ranging from 1.5 million in 1953 to more than 5.5 million in 1979, the time of the Revolution, and approximately 12 million in 2011, one-sixth of the total population of the country. The growth of Tehran led to regional inequality all over the country.

In the 1980s, uncontrolled cession of land on the outskirts of cities led to an increase of urban decay. But, most important of all, Tehran lies between the Alborz and Ray fault lines. The uncontrolled development of the city, especially at the slopes of the northern mountains of Tehran, is a basic problem (Fig. 4.25).

4.10 The Essence of Spatial Structure

Part I of this book sought to explore the influence of historical events, cultural behaviors, and religious beliefs on the old town structure of historic cities in the hot arid zone of Iran, including some comparative studies. It concentrated on the long Islamic period. And because of limited information, we had a brief glance at pre-Islamic ancient city form. In fact, despite the importance of climatic factors, the power had the leading role in shaping ancient city form, a tradition which declined in the Islamic period, before dramatic changes in the twentieth century.

[26] We have dealt with the problem of Tehran in the 1982 edition of the present book and discussed that the problems of Tehran should be studied at national level, considering the regional balance all over the country.

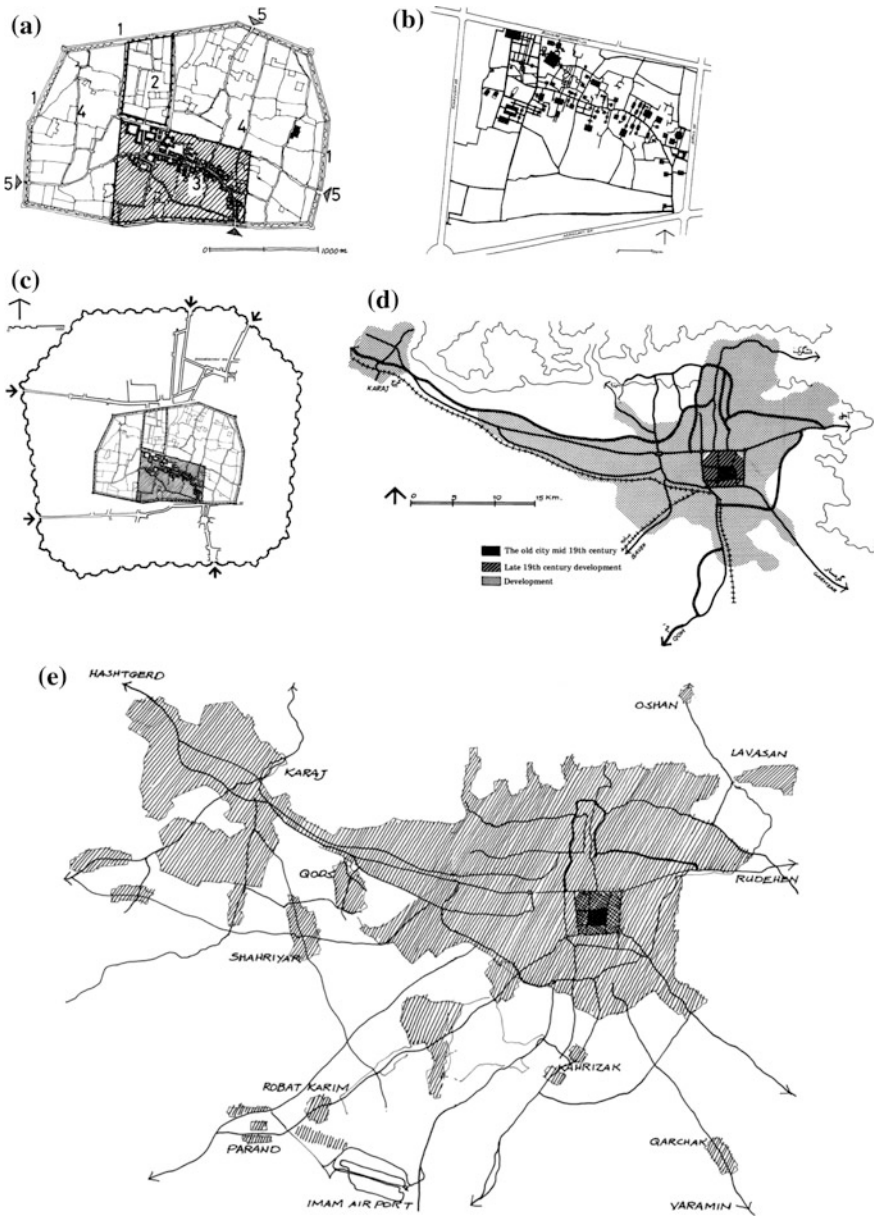


Fig. 4.25 Tehran. **a** Inner core based on the old map by Kershish, mid-nineteenth century: *1* city wall, *2* citadel, *3* the bazaar complex, *4* main passageways, *5* gates. **b** The bazaar complex and spatial relationship between different interconnected elements with the bazaar lane. **c** Tehran early twentieth century. **d** Tehran city region 1980. **e** Tehran city region 2010. Tehran once as region of plane trees has lost most of its vegetation for profit-making high-rise developments

In general, in Islamic territories, the city is to be considered a collection of homogenous and integrated neighborhoods, which were bounded together by ties of climate and culture, custom and beliefs, and art. In the first decades of the twentieth century and onward, this structure gradually disintegrated. The neighborhoods were atomized. The scale of cities changed, and the neighborhood lost its sociocultural identity.

The all-pervading issue that distinguishes the first part of this book is the way that: *the old city has been structured into a collection of homogenous neighborhoods, each with a center, connected to each other and to the city center through main passageways, a principle that is the outcome of socioeconomic, cultural, and climatic conditions* (Fig. 4.26).

From the old structure, despite inefficiencies in response to problems and new needs in the ever-changing world, we could draw some lessons for appropriate design of today. These aspects have been discussed in the following chapters.

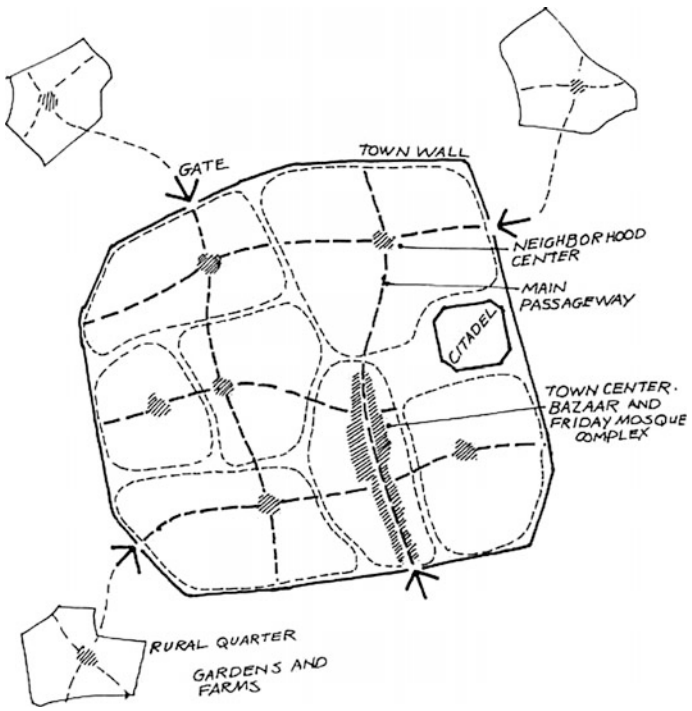


Fig. 4.26 Spatial structure of historic towns

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Part II
Influence of Climatic Factors

Chapter 5
Urban Form and Architecture in the Hot Environment Zone of Iran

Abstract The four interrelated chapters of part II deal with the influence of climatic factors on the historic town structure. This chapter identifies factors such as solar radiation, glaring sun, and large diurnal temperature. Through centuries, people in similar climatic zones, in spite of differences in culture and society, have reached independently to similar solutions to similar climatic problems, although different in appearance, but similar in function and meaning. Sustainable climatic responsive urban form is considered as a creative process, changing, continuing, and renewing over time, a dynamic characteristic which can teach us lessons for the future.

Keywords Climate and urban form · Urban block · Orientation · Creative process · Natural disaster

5.1 Research Domain

Climate plays a great part in the composition of urban form and rural fabrics in the hot arid zone of Iran. Climate has always posed grave problems for the people of this region and had pronounced effects on their behavior. Through centuries, people have lived patiently under severe environmental conditions, presented unique solutions to the problems of survival, and created innovative works of art.

Several major problems faced by people of the hot arid environment include the following:

- Hot summer and cold winter, solar radiation and excessive heat, and glaring sun especially in summer;
- Large diurnal temperature range, hot at daytime and low at nighttime;

Most of the studies of this part were conducted prior to1973 and revised for the present study. We have dealt with the form and meaning of each element such as courtyard, ivan, dome, and wind catcher, first separately, and then in connection with each other, to understand how they work together.

M. Tavassoli, *Urban Structure in Hot Arid Environments*,
The Urban Book Series, DOI 10.1007/978-3-319-39098-7_5

- Low humidity, dry weather, and danger of dryness;
- Dust and sand storms;
- Earthquake;

Through centuries, people in similar climatic zones, in spite of differences in culture and society, have reached independently to similar solutions to similar climatic problems, although different in appearance, but similar in function and meaning.

These solutions continued and completed during centuries and demonstrated in the structure of towns and cities as a whole, and its parts, neighborhoods, its blocks and housing units, and also in its architectural elements. For example, Orientation not only has appearance in the whole structure of the city, but it is clearly visible in the elements such as streets, courtyard houses, and its elements, ivans, and wind catchers (Figs. 6.1−6.12).

Altogether, the urban fabric in the hot arid zone of Iran is comprised of powerful compositions, forms, and spaces, but meanwhile, confronted with many problems. Some of the main points and problems include the following:

- Town and cities were shaped in a fertile spots in the desert, integrated with nature. A matter that man today tends to ignore.
- Traditional urban structure comprises of interconnected parts, which is the result of climatic circumstances and sociocultural relationship between the neighborhoods.
- Neighborhood system included centers in nearby and proper distance to the inhabitants.
- Traditional urban structure, as we discussed in the first part, is considered as a creative process, changing, continuing, and renewing over time, a dynamic characteristic which can teach us lessons for the future.[1]
- Methods of traditional use of natural energy, and the lessons that we can take for the future.[2]
- Compact integrated urban fabric, poor public space.
- Weak against natural disaster, especially earthquake.[3]

[1]As some scholars regarding tradition, they do not mean custom or habit but as a creative process and consider its dynamics for future research, practice, and education. See Seyyed Hossein Nasr, ed., Mehdi Amin Razavi, *The Islamic Intellectual Tradition in Persia,* Chap. 1, Curzon, 1996 and Lindsay (2006), p. 7.

[2]Considering tradition, prominent studies of recent decades also mention that some lessons can be drawn from vernacular architecture. See Baruch Givoni (1998), pp. 336–337. And also in different parts of the book: Konya (2011).

[3]Natural hazards, especially earthquakes in Iran including the hot arid zone, lead to the most environmental and human settlement damage and also economic disruption. Our compact traditional urban fabrics are not resistant against earthquakes. In the process of renewing the old structures and designing new areas, we should change our attitude in education and practice. For a distinguished work which discusses this theme see Gies (1996).

5.2 Climatic Structure of the City and the Old Part

Among the three parts constituting the whole city, inner area, middle area, and outer area, the first two parts comprise valuable architectural forms and climatically responsive elements. These two parts have taken shape and completed during centuries. The outer areas, or the newly built-up parts which have been created mainly during the last decades, lack urban design qualities. However, in the first decades of modern Iran, the 1930s and 1940s, several street architecture with powerful and bold forms took shape.[4]

The compact city in the hot arid environment was integrated with gardens. Outside the walled city, the rural areas were surrounded with farmlands and gardens. Green spaces not only helped to enhance the beauty and environmental quality of urban structure, but had a considerable role in ventilation of the compact hot dry urban fabric. Today, the gradual disappearance of gardens has led to increased climatic dryness. The urban fabric is changing under the power of land speculators. Many decayed one-story courtyard houses within the old urban fabric of the city are being cleared, to make space for the construction of multistory buildings[5] (Figs. 9.25 and 9.26).

Both the whole structure of the historic city, and its containing parts, neighborhoods, and urban blocks, within the inner and the middle areas, were shaped in response to harsh climatic and sociocultural factors.[6] The structural elements of the city center, neighborhood centers, urban blocks, and houses were joined together to reduce the exposed surface to the hot sun.

A unique example for climate responsive structure is the historic city of Yazd which has been fully considered in the first part. The compact structure of the city is based on neighborhood division with connected centers at proper distances from each other. Sun, wind, and water are the basic factors affecting the urban pattern. Altogether, in Yazd, Kashan, Nain, and other examples that have been demonstrated in this part, the urban blocks are usually large, one story, with continuous roofs. Narrow streets, shaded structure, and light color of mud–straw mixture reduce heat impact. By packing houses and urban elements together, each block acts as a resistant unit, with least surface against the extreme heat outside.

[4]Case study 2 in this book includes concise information about this matter. See Tavassoli (2000).

[5]The problem of restructuring the decayed areas and new developments is considerably important. All the four case studies in this book put a great deal of effort on this matter.

[6]We have discussed the characteristics of these two historic urban fabrics, the inner and the middle area, and also urban blocks in different parts of this book.

5.3 Urban Blocks, Courtyard Houses, and Orientation

Urban Blocks: Historically, there are four types of urban blocks in the hot arid zone cities of Iran.

1. The old traditional compact inner area urban block which is the most common. It is a courtyard-structured urban block. The most complicated of this type is within the old Mozaffarid town fourteenth century (Fig. 4.6). In this common type of complicated blocks, ventilation is through wind catchers connected to ivans, basements, and courtyards.
2. Middle area urban blocks which produced by reducing the size of the old large traditional urban blocks. This is a type that was restructured in the first decades of twentieth century in more affluent neighborhoods. Altogether, in this type accesses were opened, and although the structure is more exposed to excessive heat and glaring sun, it utilizes more natural light and current of air.
3. After a few decades, in mid-twentieth century a more rectangular residential block based on courtyard row houses took shape. Plot of land was divided into two pieces, and the building mass was constructed on the one side of the plot, looking to the south. The streets were widened to improve access to motorists. Decline in household size and changes in socioeconomic and cultural condition in modern Iran led to emergence of this new block. In response to climatic problems, the structure is integrated with mechanical ventilation.
4. Since the last three decades, after the act of selling density and developers activity in the construction of apartment blocks, a low-quality multistory buildings in different climatic regions of the country took shape. Climatically and culturally, this structure is incompatible with the urban fabric of the hot arid zone cities (9.25 and 9.26).

For renewing the urban structure, considering climate and culture, some lessons can be drawn from the two first categories: the inner and the middle areas urban block pattern. The difference between these two areas is quite obvious in the cities such as Yazd, Birjand, and Anarak[7] (Fig. 4.24).

Although all these areas were climatically and culturally responsive for centuries, but they are extremely vulnerable against earthquake. Earthquakes of the cities such as Ferdows 1968, Tabas 1978, Golbaf 1984, and Bam 2003, showed the high vulnerability of the compact urban fabrics, especially the large traditional inner areas urban blocks.

As we have shown in the detailed study of the historic city of Yazd in the first part, the old inner area urban blocks is harmoniously integrated with different elemental structure: the dwellings, workshops, religious and cultural elements. But from access and public space point of view, the structure is weak and vulnerable. Historically, urban transformation resulting from workshop to factory production,

[7]We have dealt with the fabric of Birjand, first in 1985, and then in comparison with Anarak in 2009. See Tavassoli (2009).

and the emergence of a new affluent class led to the creation of middle areas and new urban block which provides access to automobile. Distinction between inner and middle areas is quite visible through a morphological rupture, a new street, an element of new urban development in modern Iran.

Orientation: Solar radiation and wind are of the principle climatic factors that affecting orientation of urban units and the whole city. In studying the orientation of traditional fabrics, we discover the combined effects of three integrated structure: the courtyard houses, the urban block, and the whole city. Enclosed traditional courtyard unit is the key element in the orientation of the whole structure.

Long experience and native knowledge have guided the designer of desert towns to position the courtyards on nearly NNE–SSW axis. The enclosed mass of the courtyard constitute two principle parts: summer area and winter area on the main axis, and two secondary parts on the other sides.

Summer area is oriented toward NE, back to the hot afternoon sun, whereas the winter area is oriented toward SW, in order to utilize solar radiation during the cold winters. The most creatively designed architectural elements have appeared in the two principle parts, and especially summer area, such as ivan, talar, deep basement, and wind catcher.

The formation process and orientation of courtyard structure has resulted in the orientation of urban blocks and streets of the whole city. In the pointed out third category courtyard row houses, which did not last long, the building mass is positioned on the one side of the courtyard and oriented slightly toward east of south, which avoids hot summer afternoon sun. In this arrangement, sun radiation on the east and west sides is reduced by joining the buildings together.

5.4 Wind Catcher and Wind Energy

I first studied typical wind catchers in the hot arid zone towns and villages of Iran in 1972.[8] In the compact integrated inward-looking structure, the basic exposed ventilation elements are wind catchers erected over the roofs. Wind catchers face prevailing wind, catching it and bringing it down to the spaces below, rooms and basements.

There are many urban and rural complexes orient their wind catchers in the direction of prevailing beneficial winds. This feature gives a distinctive characteristic to the complexes, mingling with nature. There are also towns and villages layout on the Persian Gulf shore which show street arrangement as well as one-sided wind catchers, bringing the cool breezes from the sea into the heart of hot complexes. Only in case of foothill towns and villages with mid-weather, or areas with hot and sandy storms, we do not face with wind catchers.

[8]The study of Yazd was first conducted in 1972−1973.

Wind catchers were also symbolic elements, elements of distinction in the urban structure. The closed, compact urban structure breathed through wind catchers.

While prevailing favorable winds from Karkas mountain range, from Kashan to Ardestan, have resulted in the construction of tall four-directional wind catchers in Kashan, but in Aran, a town in the suburb of Kashan nearer to desert, we rarely see wind catchers. Here because of the prevailing dusty winds, wind catchers do not work properly. Accordingly, architects of the past instead of wind catcher suggested an air vent which directs air flow upward. Here, the air inlet is located at the basement or the living room and the outlet at the roof level. In a typical house in Aran this pattern of air movement has been shown (Fig. 8.7).

Another solution for cooling housing spaces is an inventively designed architectural element, an air-ventfour-arched type over the central square which is surrounded by four ivan. This type is common in zoroastrian houses.

Unidirectional wind catchers usually occur in the towns and villages that the direction of favorable winds are well known. In desert towns and villages such as Tabas, Aqda, and Mehneh, the range of wind catchers are unidirectional and have oriented toward favorable winds. In Tabas, unidirectional wind catchers and air vents of the Friday mosque which was destroyed in 1978 earthquake had a unique form. Our research about these structures was carried out in 1972 (Figs. 6.40 and 6.41).

Another way of utilization of natural energy winds of 120 days of Sistan are windmills. These elements, originally Persian, are extensively used in Khurasan and Sistan provinces in the eastern part of Iran. They are widely appeared in the eastern side of Bakhazar mountains toward foothills of Qaenat and continue till the city of Zabol. Windmills are arranged as row shape and act as a windbreak structure protecting built forms at their back (Figs. 6.44 and 7.1).

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Chapter 6
Organic Unity Between Urban and Architectural Elements: Urban Blocks, Courtyard Houses, Ivans, Domes, and Wind Catchers

Abstract This chapter shows illustratively form and function of urban and architectural elements: urban blocks, courtyard houses, ivans, domes, and wind catchers. It identifies how these elements function independently with others. The study includes detailed analysis of double domes as an excellent solution to the problem of intense radiation and shows how closed and compact urban structure breathed through wind catchers. The study is based on exhaustive field research conducted during several years.

Keywords Courtyard housing · Dome · Double dome · Proportional findings · Wind catcher

All these elements function interdependently with others. The whole compact fabric of the city is comprised of integrated blocks, surrounded by narrow arched streets, which connect the complicated blocks. Sometimes, the boundary between blocks is not clear. This continuous fabric functions as a unified structure against the hot sun radiation. Also, the whole fabric, as a system, consists of parts as a true organism, including courtyard, ivan, dome, and wind catcher. Considering orientation, the whole fabric with unidirectional wind catchers is oriented toward favorable winds. Also, summer areas of the courtyard houses with ivans are oriented toward north–northeast, back to the hot afternoon sun. And, it is through wind catchers and courtyards that the whole fabric breathes (Figs. 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11, and 6.12).

Most of the studies of this part were conducted prior to 1973, and revised for the present study. We have dealt with the form and meaning of each element such as courtyard, ivan, dome and wind catcher, first separately, and then in connection with each other, to understand how they work together.

M. Tavassoli, *Urban Structure in Hot Arid Environments*,
The Urban Book Series, DOI 10.1007/978-3-319-39098-7_6

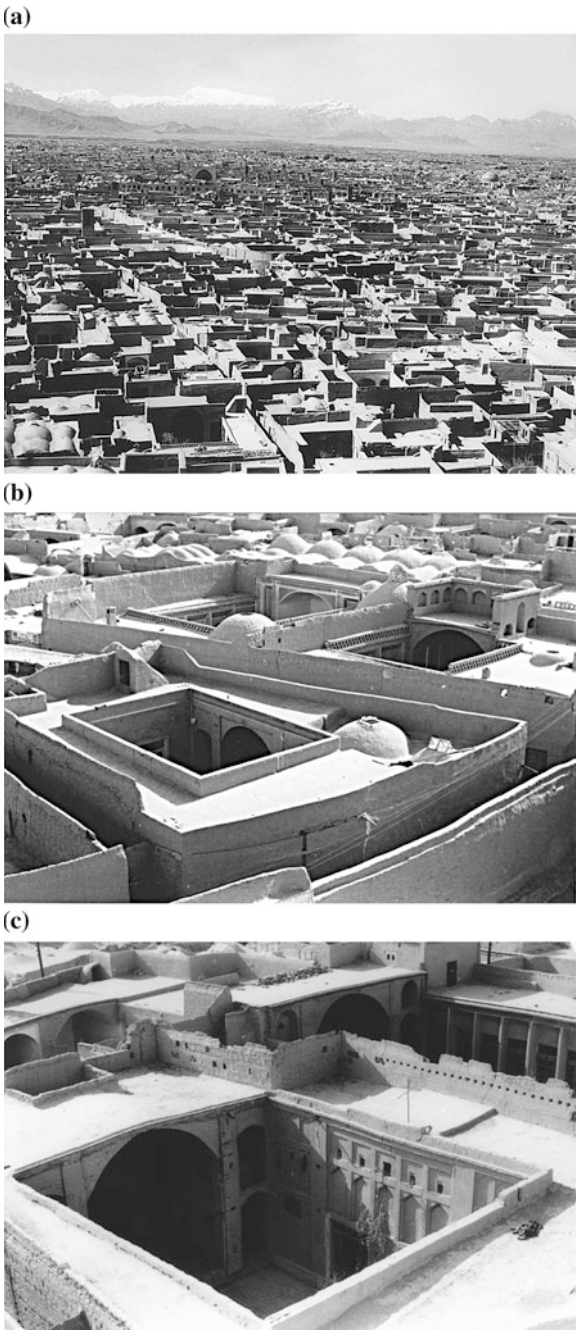

Fig. 6.1 Yazd. Three scales of urban configuration. **a** Aerial view of part of the city including Dar-al Shafa, historic neighborhood. **b** The corner of an urban block. **c** A typical courtyard. The summer area of houses including ivans and talars, look to the northeast to avoid the hot summer afternoon sun

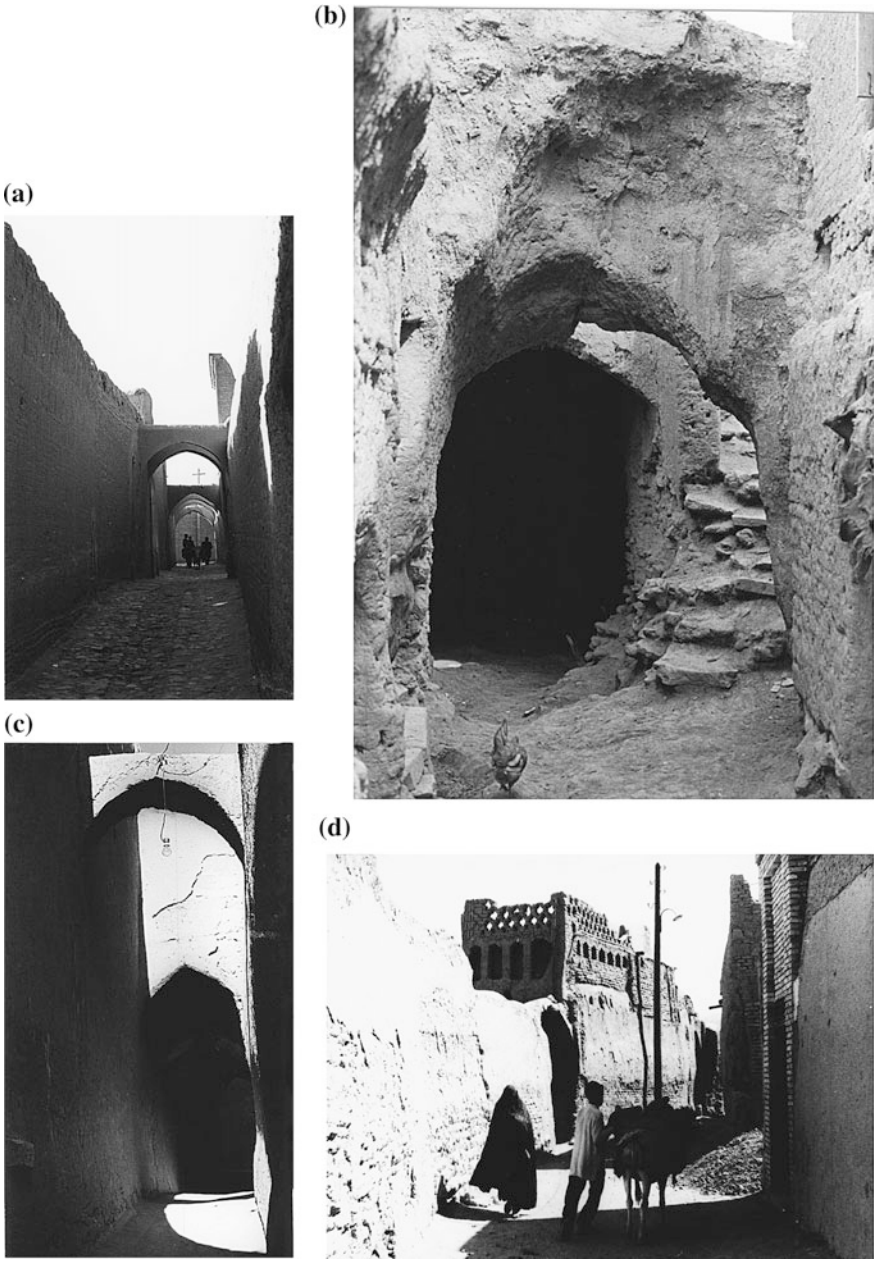

Fig. 6.2 Narrow vaulted roofs and shaded streets crossed by mud buttresses which are cool in summer. Elements that connect complicated blocks. **a** Kashan, **b** Kharanaq, **c** Tabas, and **d** Abarquh

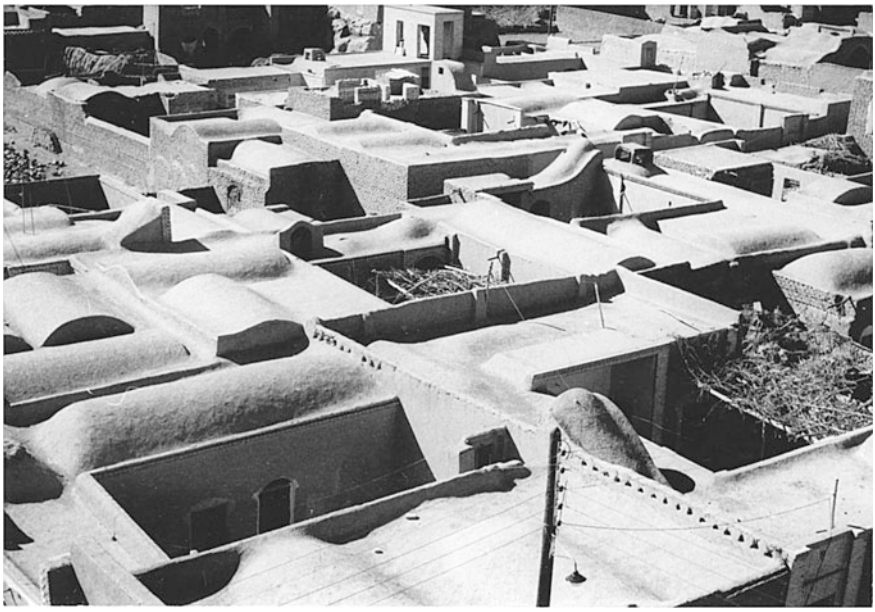

Fig. 6.3 **Ardakan**. Regular urban fabric, compact small courtyard structure, mostly shaded with vine

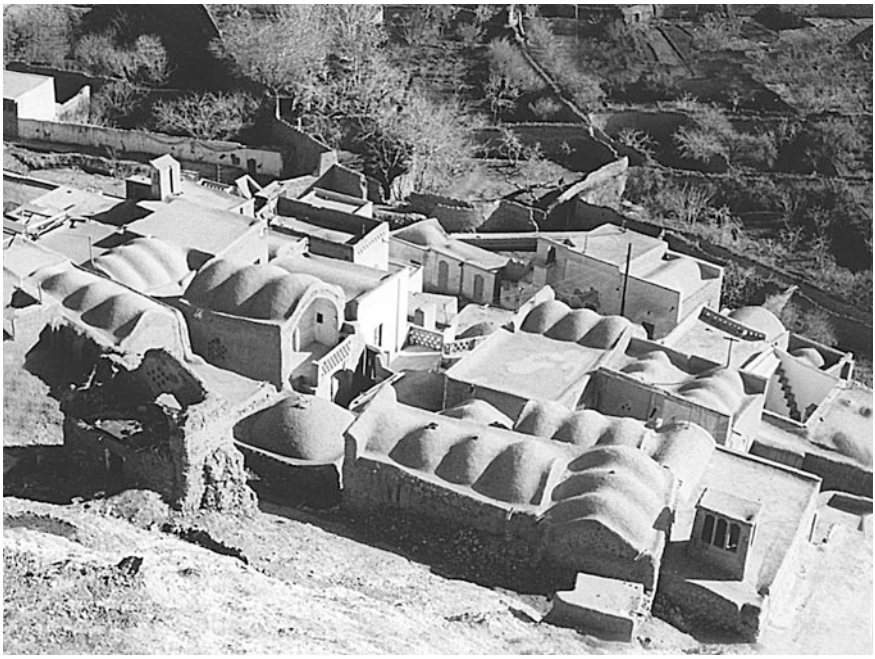

Fig. 6.4 **Anarak**. A part of inner area, irregular domed structure fabric, integrated with gardens

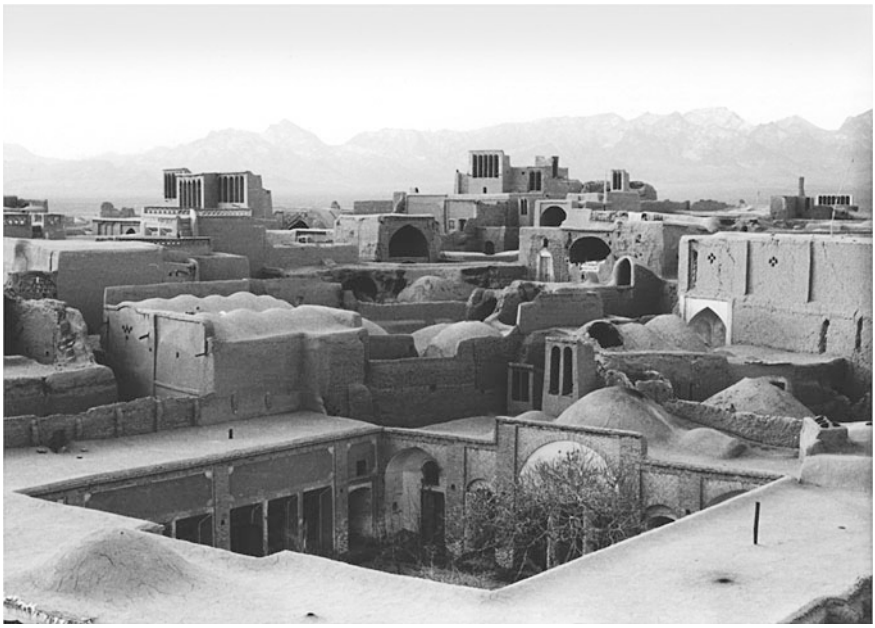

Fig. 6.5 Aqda. The complex with unidirectional wind catchers oriented toward cool winds, natural sources of energy

Fig. 6.6 Abarquh. The compact city and poor public spaces

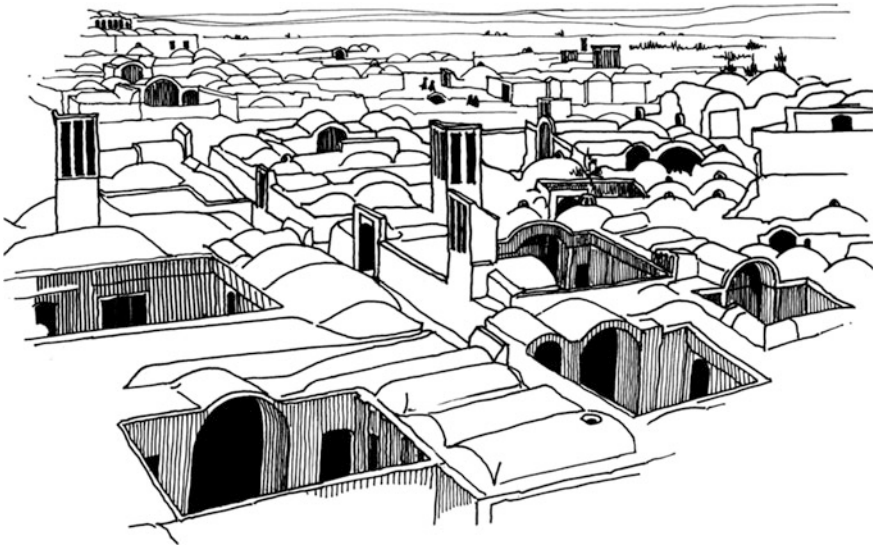

Fig. 6.7 Gonabad. Compact structure and shaded courtyard houses with ivans back to the hot summer afternoon sun. "Unit dwellings are arranged around closed courtyards like cooling wells, and are grouped together to achieve defense in volume. Here the town layout reacts against the heat with shaded dense structure." (from Olgyay 1969) p. 91

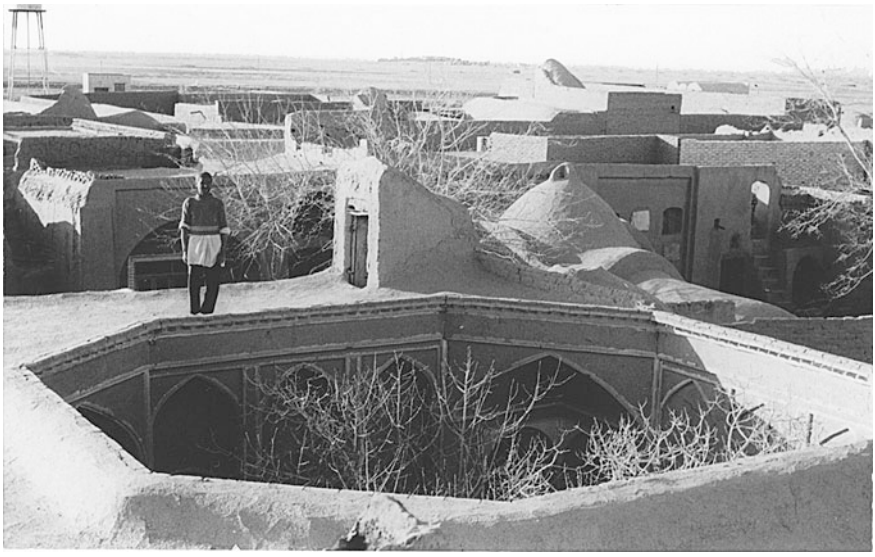

Fig. 6.8 Fahraj. A village between Bafq and Yazd. An eight-sided courtyard, a common shape in Persian urban and architectural spaces

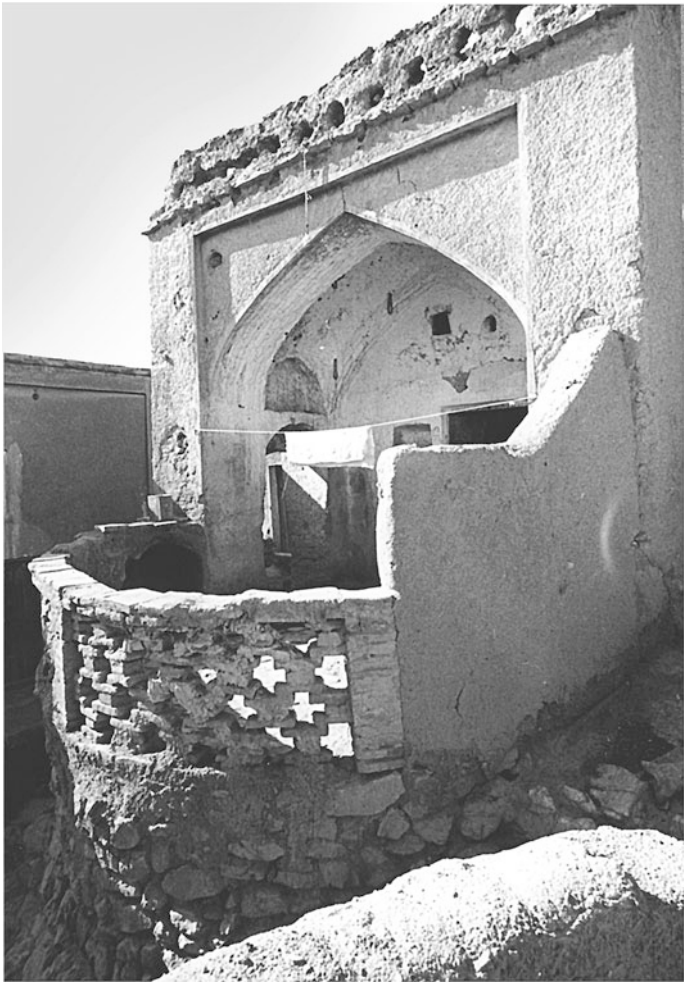

Fig. 6.9 Anarak. A front open space integrated with ivan. The light latticework lets the cool breeze flow in the ivan and the back room at sitting level

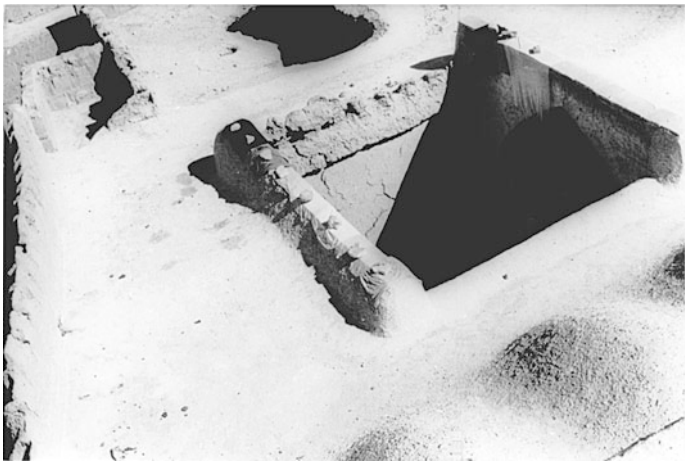

Fig. 6.10 **Nain**. Simplicity at its best, a small house belonging to a poor family with courtyard, and ivan back to the hot summer afternoon sun

Fig. 6.11 **Kashan**. Courtyard at two levels, deep shaded structure, hot summer afternoon sun

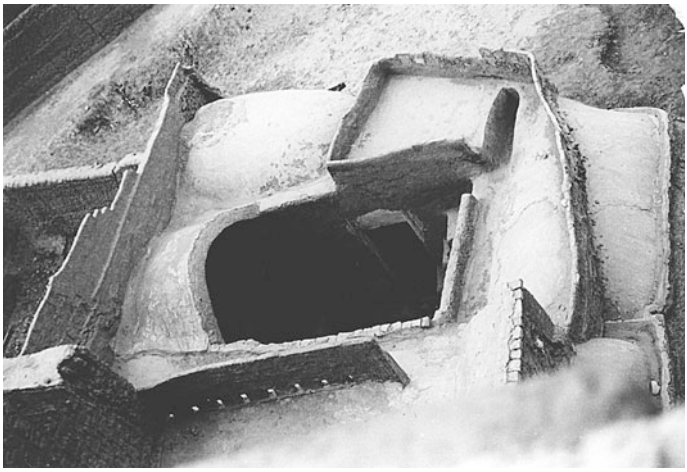

Fig. 6.12 Tabas. A small house belonging to a to a poor family, collapsed in 1978 earthquake

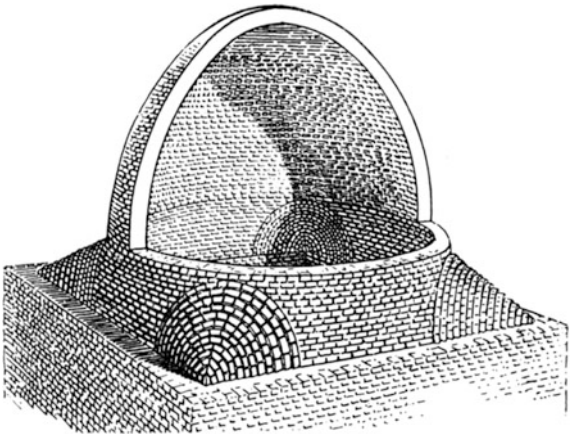

Fig. 6.13 Persian Dome. Dome over a square room, based on intermediary structures: the squinches (from Wulff 1966, quoted from: E. Diez, Iranische Kunst.)

6.1 Dome

Although the history of dome as the main method of roofing monumental buildings is well known, the beginning of construction of mud brick domes in vernacular architecture is not. In the hot arid zone of Iran, convenient shape of dome in response to climatic factors and also scarcity of wood led to unique development of domed spaces.

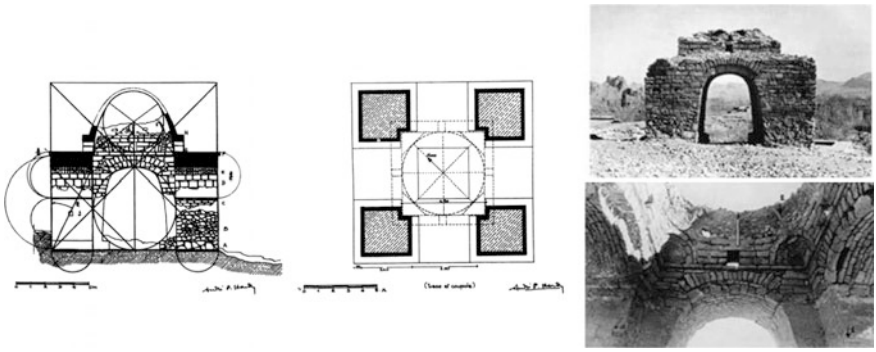

Fig. 6.14 Kashan, Neisar. Sassanian fire temple, probably from the second century, expressing charming proportions, and the early solution to transition square chamber to round dome. (from Andre' P. Hardy, *ATHAR-E IRAN, TOME III FASCICULE I,* 1938, pp. 163–165)

Persian role in the development of dome is best demonstrated in the invention of the squinch. Four squinches on the four corners of a cubic space, as the basic parts of an intermediary structure, enable dome to rest on the cubic space (Fig. 6.13). This structure was first appeared in Sassanian fire temples before Islam (Fig. 3.3). Wulff writes:

> During the Parthian and Sasanian periods vaulting achieved high technical and architectural standards in public and private buildings. There were two basic forms, the barrel vault to cover rectangular rooms and the dome over a square room. For the transition from the square base to the circular dome the Persian builder invented the so-called squinches…He maintained these high standards in vaulting right through Islamic times, as witnessed by many mosques and other public buildings.[1]

The first squinched dome was studied by Hardy[2] (Fig. 6.14). Considering climate responsive role of domes, Olgyay writes:

> …both domes and vaults are most popular in hot arid regions with clear skies, where the low humidity leads to intense radiation exchange and creates extreme temperature variations between night and day. This has an underlying logic, probably discovered through centuries of experience: the envelope of a hemispherical vault is roughly three times the surface of its base, so the radiation of high sun positions is diluted on a rounded surface. This results in a lower surface temperatures, which are further reduced by wind cooling. The rounded form is also suited to release the nocturnal outgoing radiation and facilitate nightly cooling.[3] (Fig. 6.15).

[1]Concerning the building crafts including the origin of the Persian dome, see the eminent work of Wulff (1966), p. 105.

[2]For the investigation of architectural form of the oldest squinched dome, see Andre' P. Hardy, in: *Athar-e Iran, Tome III Fascicule I,* 1938, pp. 163–165.

[3]See Olgyay (1969), p. 7.

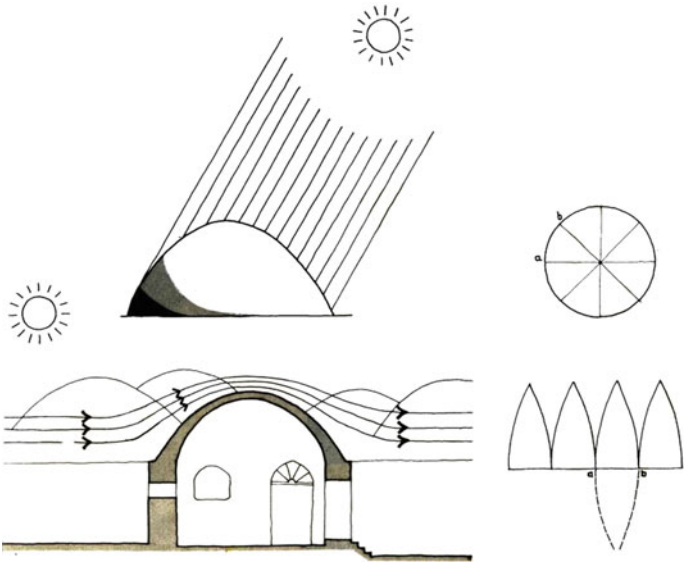

Fig. 6.15 Dome-shaped roof, responsive to climatic factors

Fig. 6.16 **Yazd**. Zoroastrian tombs, barrel vaults intersect at right angles

Through centuries, the vault has been the most important element in Persian architecture. Skilled builders were able to cover long spans by thin vaults. In the case of flat roof, which were used for sleeping at summer nights, and vaulted ceiling, in order to lighten the load and also in response to thermal insulation, the thickness between was constructed hollow. Apertures at the top of the domed roofs

Fig. 6.17 First step in building a simple vaulted roof

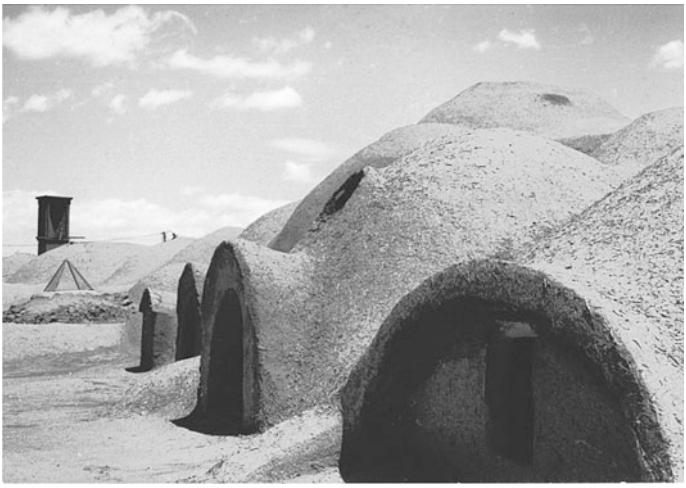

Fig. 6.18 **Kashan**. Connected domes of the bazaar with air vents and apertures

Fig. 6.19 **Kashan**. A bath house, small apertures in the domed roof, let in sufficient light

Fig. 6.20 Tabas. The barrel vault of a room with flat roof (partly ruined). The thickness between ceiling and roof is hollow in response to structural problems and thermal insulation

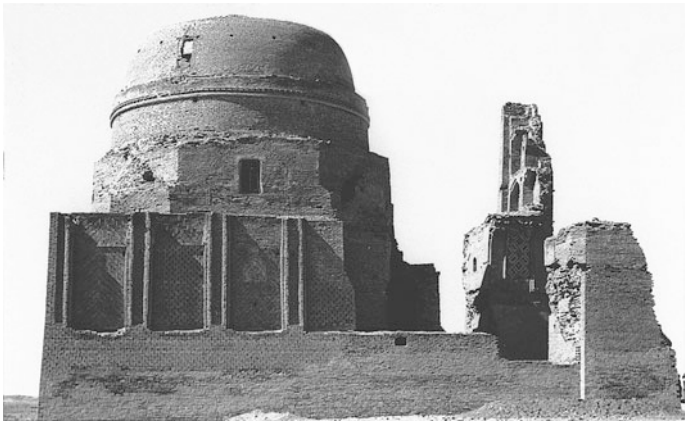

Fig. 6.21 Sarakhs. Baba Logman tomb, the external dome is collapsed. Baba Logman a distraught Sufi was contemporary with the celebrated Sufi Abu Said Abil-Khyar (d. 1048)

let sufficient light and also heat loss during nights. Ingenious use of cheap and accessible materials has had a distinctive role in an imaginatively shaped domes and vaulted structures (Figs. 6.15, 6.16, 6.17, 6.18, 6.19, 6.20, 6.21, and 6.22).

The double dome is an excellent solution to the problem of intense radiation. The space between the inner and the outer dome acts as an insulation layer.

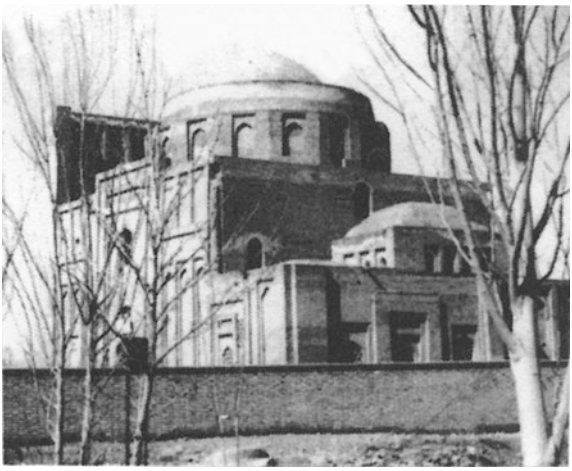

Fig. 6.22 **Tus**. Harunieh tomb. The external dome is collapsed

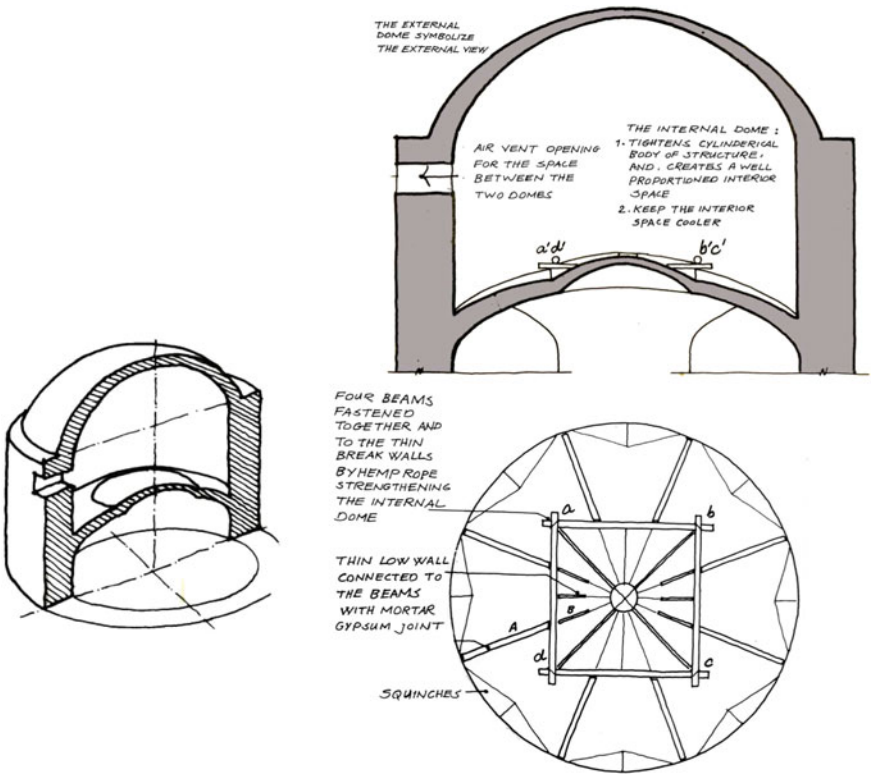

Fig. 6.23 **Torbat-i Haydariya**. Qutb al-Din Haydar, great Persian gnostic tomb

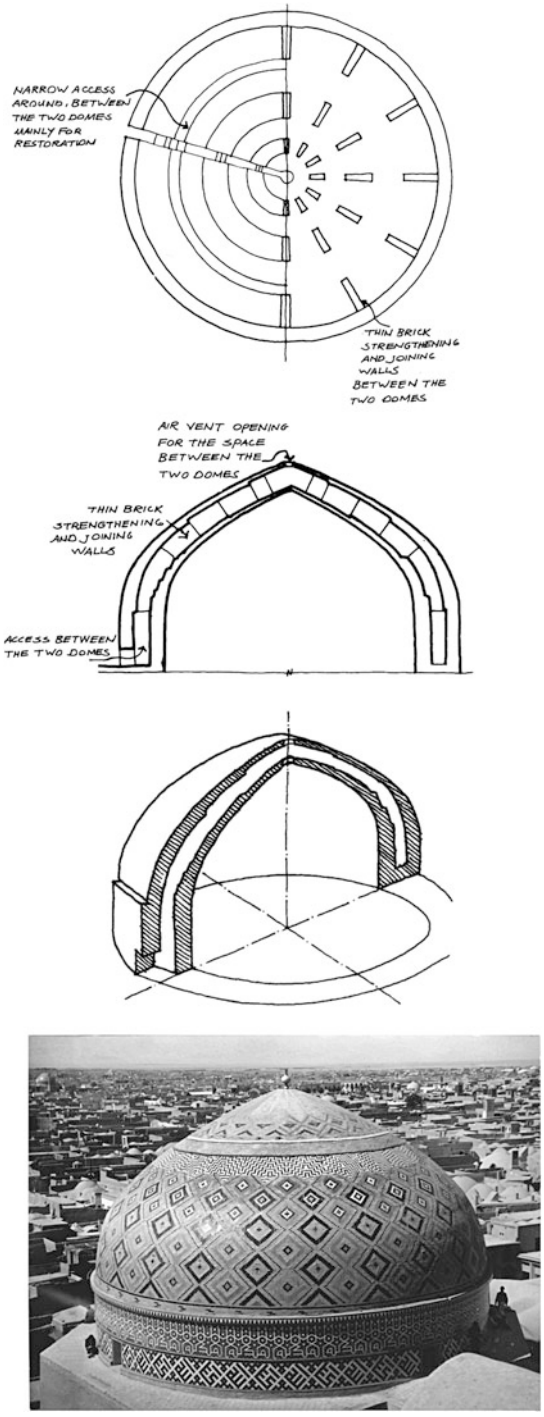

Fig. 6.24 **Yazd**. Masjid-i Jami, a double-dome, section, and structural pattern

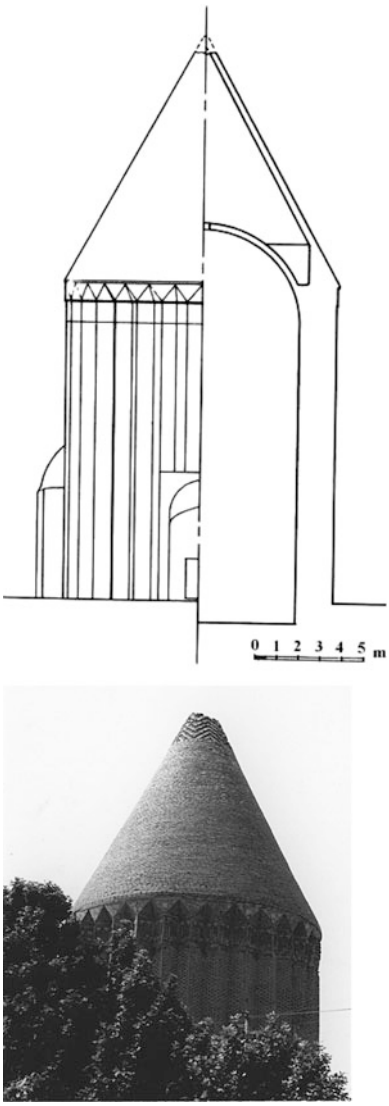

Fig. 6.25 Varamin. Ala ad-Din tomb tower, a double-conical dome (façade—section from Wilber)

Therefore, when there is intense summer solar radiation, the outer dome becomes extremely hot, while the inner dome remains cool. Circulation of air between the two domes from openings reduces the radiation problem.[4]

[4]See M. Tavassoli, City Planning in the Hot Dry Climate of Iran, in G. Golany, ed., *Design for Arid Regions,* New York, Van Nostrand Reinhold, 1983, pp. 128–130.

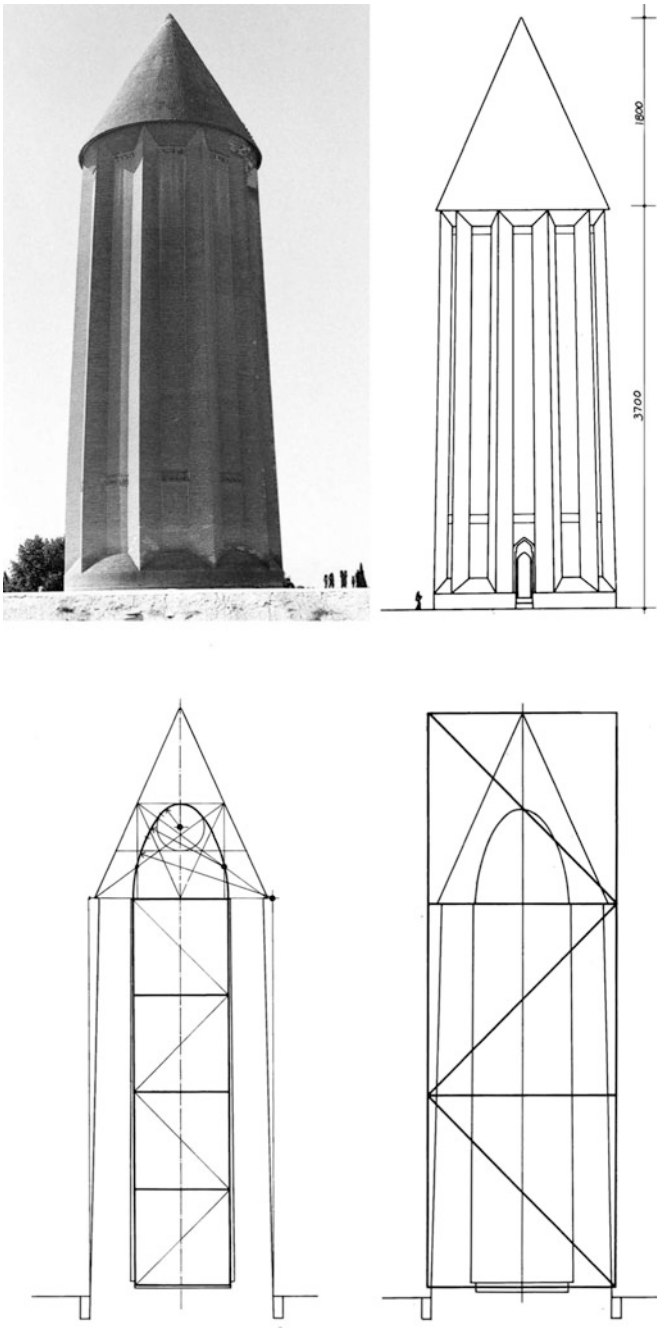

Fig. 6.26 Gunbad-i Qabus. Geometrical and proportional studies, this page and next page (from Tavassoli 1972)

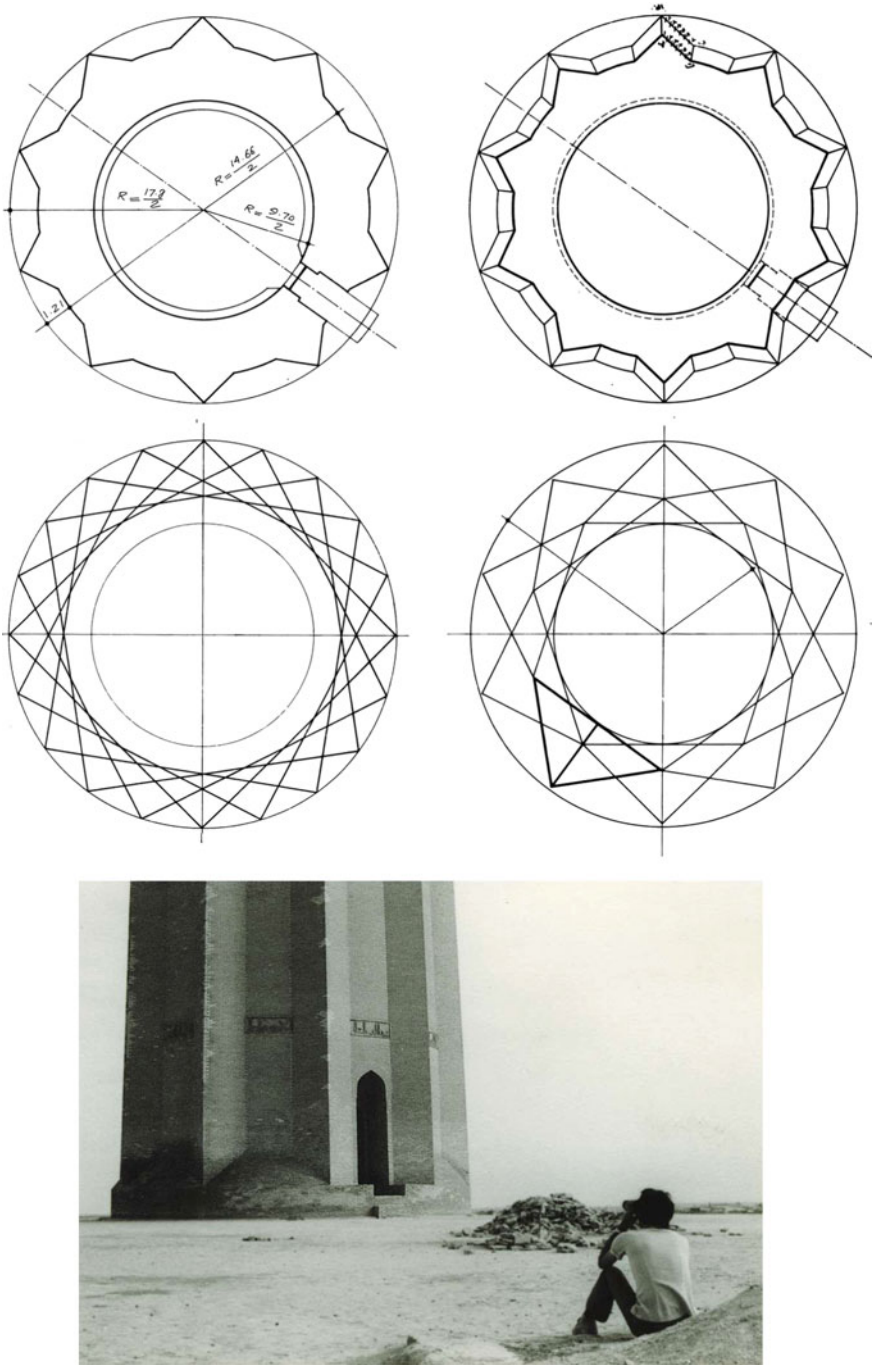

Fig. 6.26 (continued)

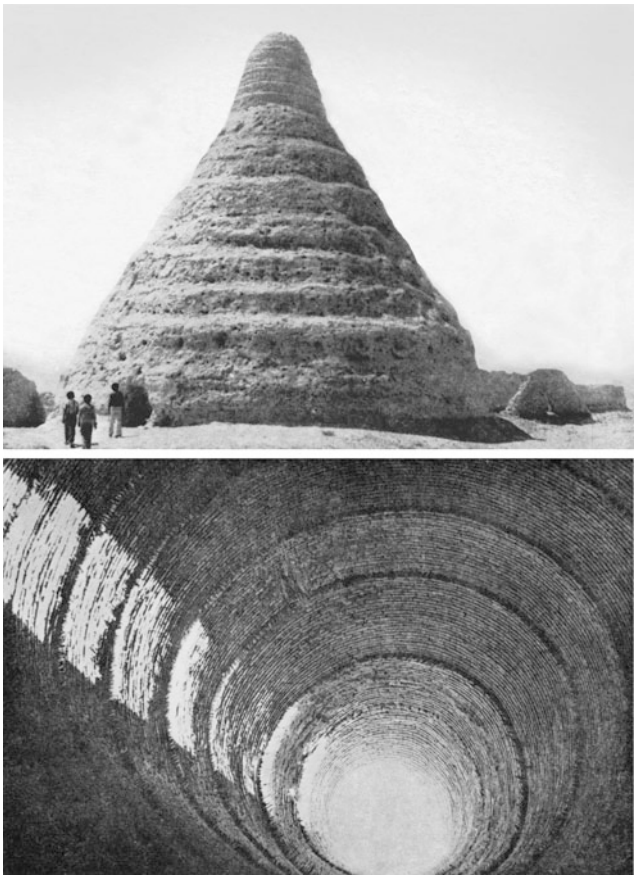

Fig. 6.27 Abarquh. Vernacular type of conical dome, an ice pond (Yakhchal), a building partly underground, for storing ice in winter, for use in summer

We have analyzed the structural pattern of two different types of double[5] domes (Figs. 6.23 and 6.24). Considering the double dome, Pope writes (Fig. 6.25):

> Each discovery reveals new merits in structural inventiveness: double domes, ribs, wider vaults, taller minarets[6]…

But among different types of domes in Persian architecture, the structural form of conical domes both vernacular and tomb towers is exceptionally powerful. Some of them remained safe under extreme stress of earthquakes. We have studied carefully the geometrical feature of one of the masterpieces, the Gunbad-i Qabus, in 1972 (Figs. 6.26, 6.27, 6.28, 6.29, 6.30, and 6.31). Pope writes:

[5]See M. Tavassoli, Gunbad-i Qabus, in: *Art and Architecture,* No. 14, Tehran, 1972.

[6]See A.U. Pope, *Persian Architecture*, The Asia Institute, Pahlavi University Shiraz, 1969, p. 51.

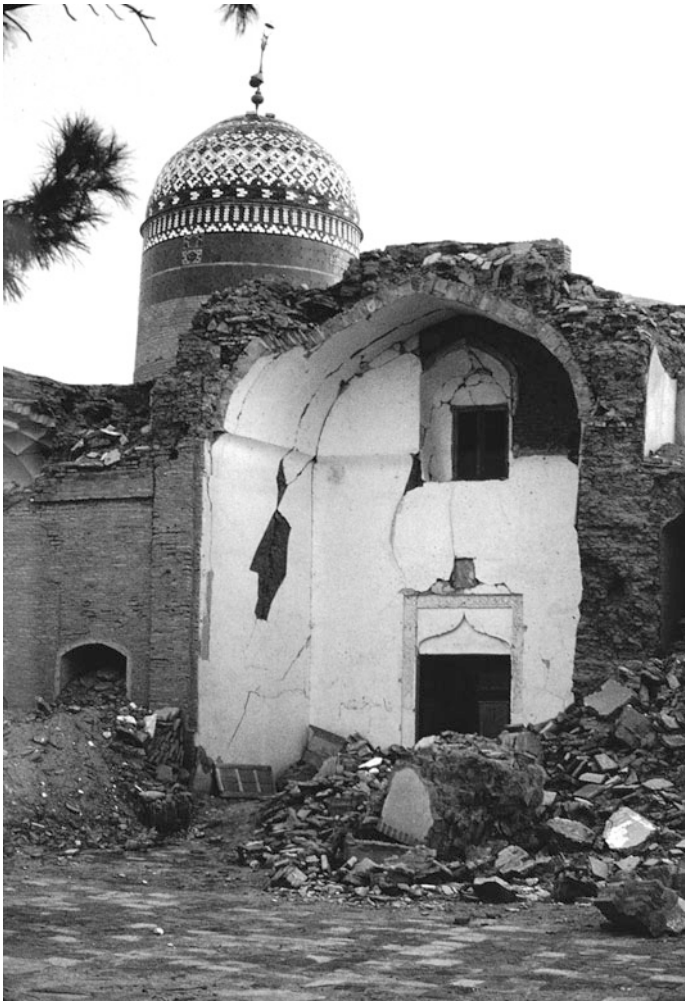

Fig. 6.28 Ferdows. Dome and earthquake, Dasht-e Bayaz and Ferdows earthquake in 1968 completely destroyed the city. Some parts of the city elements remained. *Picture* showing the completely symmetrical structure of the dome on cylindrical base which remained safe

> Under the shadow of eastern Elburz mountains, facing the vastness of the Asian steppes, stands in stark majesty a supreme architectural masterpiece: the Gunbad-i-Qabus, the tomb tower of Qabus-ibn Washmgir…. Ten powerful right-angled flanges project from the circular body, vertically uniting base and roof… built for eternity.[7]

[7]See A.U. Pope, *Persian Architecture*, The Asia Institute, Pahlavi University Shiraz, 1969, p. 44.

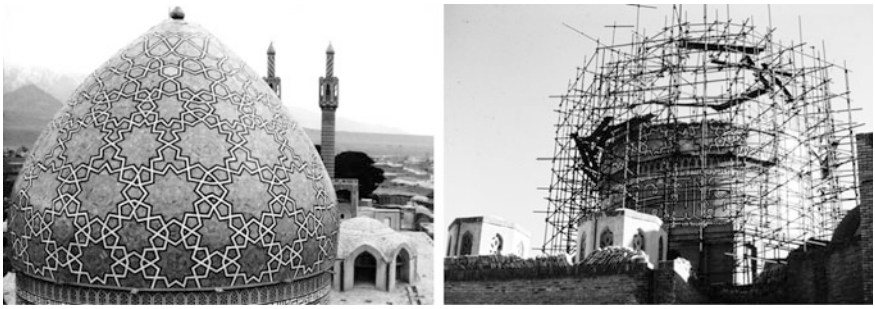

Fig. 6.29 Mahan, Kerman. The dome of Shah Ne'matollah Vali tomb, before and after 1983 earthquake, reconstruction process

Fig. 6.30 Bam. View before 2003 earthquake

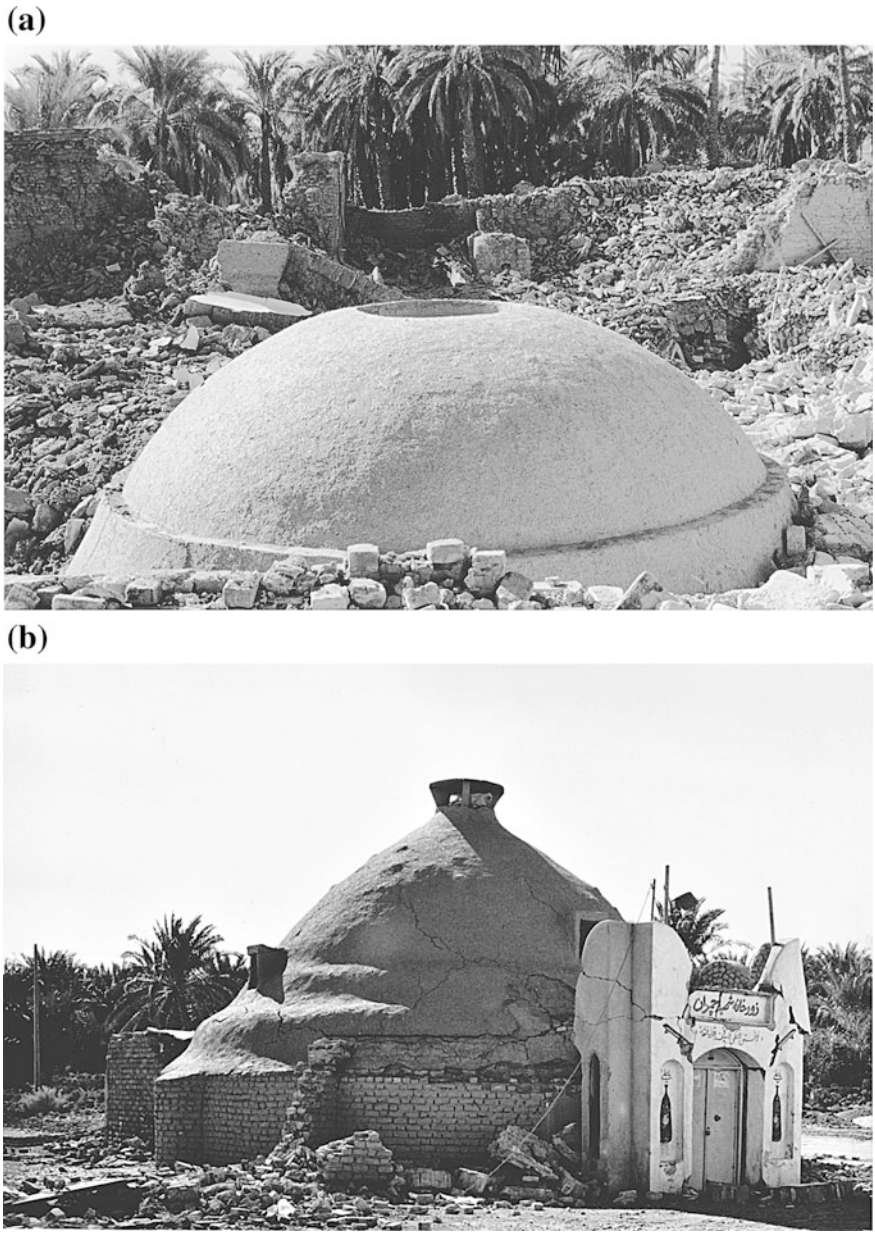

Fig. 6.31 Bam. After the earthquake: **a** A completely symmetrical mud brick dome belonging to a public bath which has remained safe. **b** Dome of a gymnasium. A place for traditional athletic exercises, supporting surrounding forms prevented the structure from collapsing

Fig. 6.32 Abarquh. Two-story wind catcher belonging to an aristocratic house

6.2 Form and Function of Wind Catcher and Air Vent to Ventilate Public and Private Urban Elements: Houses, Water Reservoirs Caravanserai, and Mosques

As discussed before, wind catchers, usually different in shape, are climate responsive elements interconnected with several other elements. Also, they are characteristic and symbolic urban elements of the towns and cities in the hot arid environments (Figs. 6.32, 6.33, 6.34, 6.35, 6.36, 6.37, 6.38, 6.39, 6.40, 6.41, 6.42,6.43, and 6.44).

Fig. 6.33 Abarquh. The wind catcher as a symbol of power, a landmark, dominating the main passageway

Fig. 6.34 Kashan. Simple four-directional wind catchers

6.2.1 Tall Massive Wind Catchers

Bandar-e Lengeh. Along the coastal areas of Persian Gulf, from steppe or semiarid climate (BS, Adl classification), comprising: Bandar-e Daylam, Bandar-e Bushehr, Kangan, Gav bandi, till Bandar-e Lengeh, we enter in a more arid climate (BW), including Bandar-e Lengeh, Bandar-e Khamir toward Bandar-e Abbas; we notice that the prevailing architectural accents appears in the form of massive wind catchers.

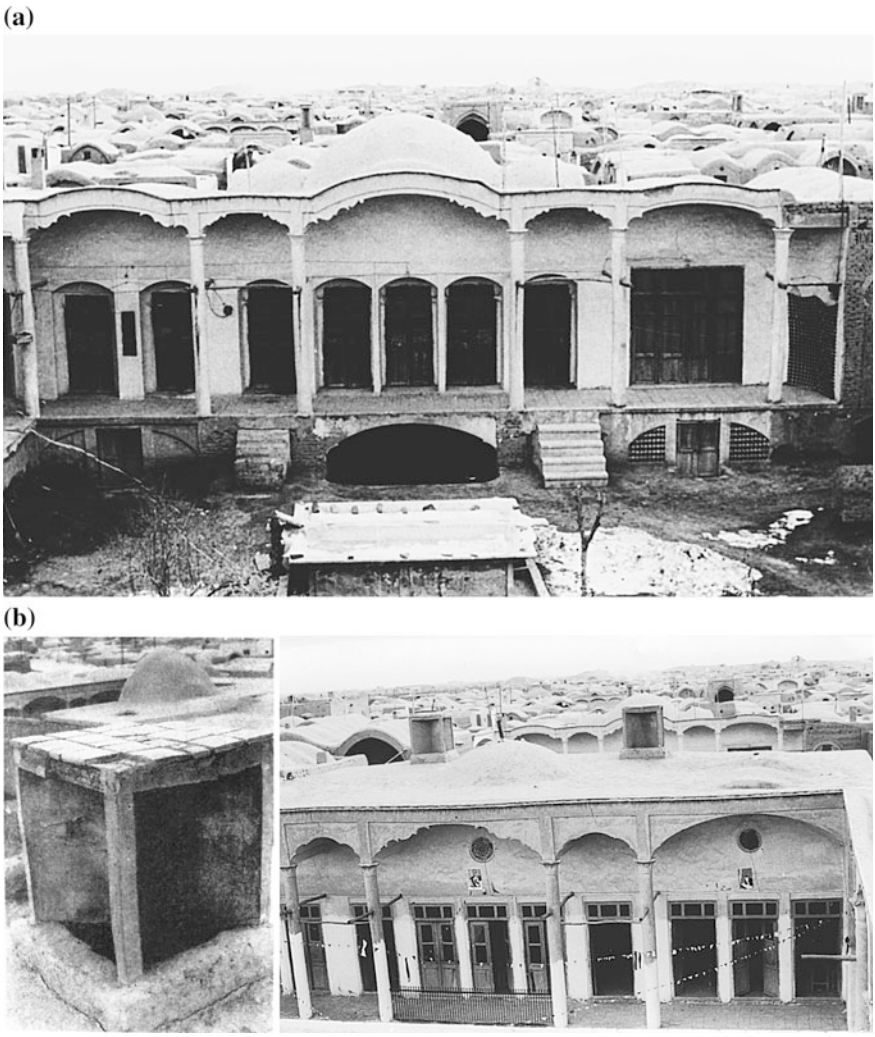

Fig. 6.35 Aran. A town near Kashan, here because of prevailing dusty winds tall wind catchers do not work properly. **a** Air vent which directs airflow from courtyard, usually with a small garden, through the basement and air vent canals at the back, toward air outlets on the roof (see also Fig. 8.7). **b** Low wind catchers

In these dominated elements, the size of their base is sometimes equal to the size of the space below, capturing the breezes of the sea and bringing in the heart of hot structure (Fig. 6.36).

6.2.2 Low Simple Wind Catchers

In comparison with the tall massive wind catchers, there are areas with low simple air vents and wind catchers, such as those as in a unique town as Zaware (Fig. 6.37)

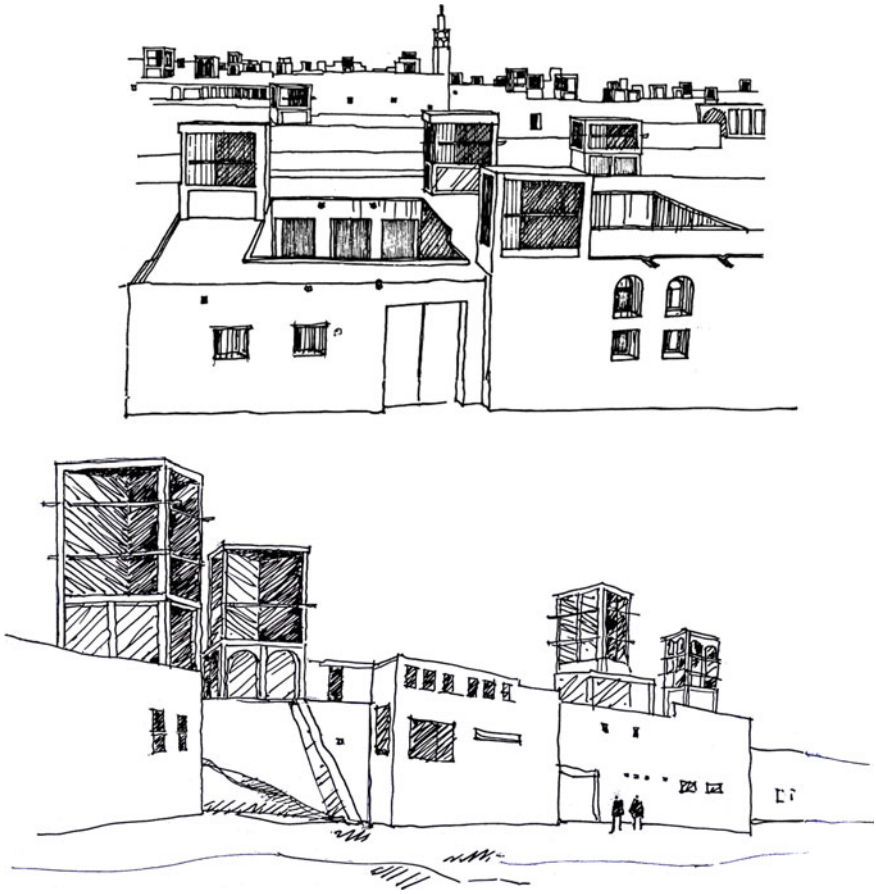

Fig. 6.36 Bandar-e Lengeh. Tall massive wind catchers which bring the coolness of the sea into the heart of compact massive fabric of the city

or the vast areas in Khurasan province toward Zabol region. In Khorasan, on the way of Torbat-i Haydariya to Gonabad, on the northern of Ghaenat foothills, and southern areas of Bakhazar mountains, we see many villages with low unidirectional wind catchers (Fig. 6.38). Microclimatic and wind characteristics of the area are the main factors in creation of the low wind catchers.

6.2.3 Tabas, Imamzadeh Hossein, and Typical Three-Sided Wind Catcher

Although three sided, but because of well-known direction of prevailing winds, the main side of the structure with five inlets is toward favorable winds. The curved shape of inlets enhances the air movement down to the space below (Fig. 6.39).

Fig. 6.37 **Zaware**. Compact structure of the town with low air vent and light inlet

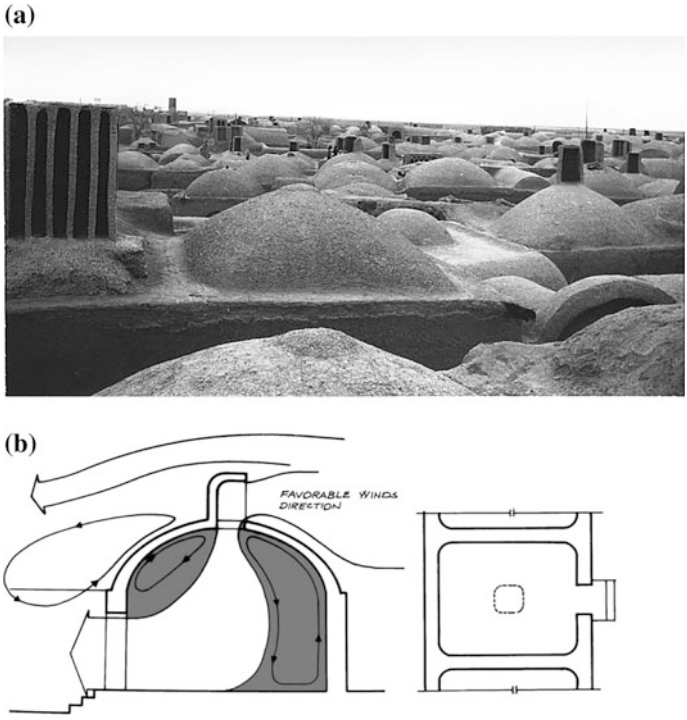

Fig. 6.38 **Mehneh**. A village in Khurasan: **a** unidirectional wind catchers, one over each room. **b** Plan and section of a room, showing entrance, position of unidirectional wind catcher, and the pattern of wind movement

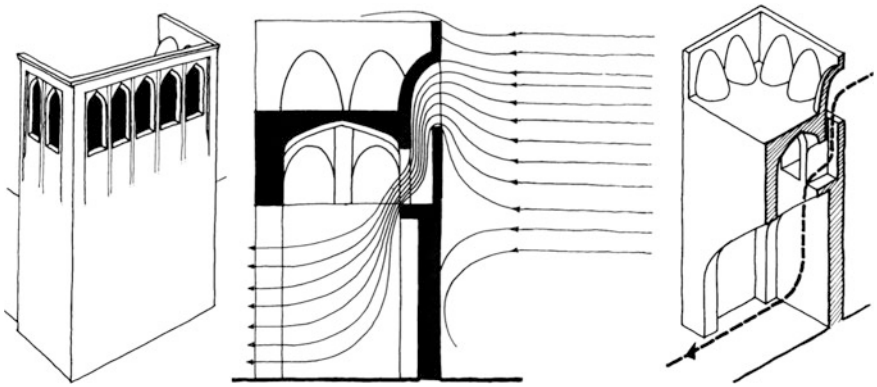

Fig. 6.39 **Tabas**. Imamzadeh Hossein, Three-sided wind catcher, airflow pattern

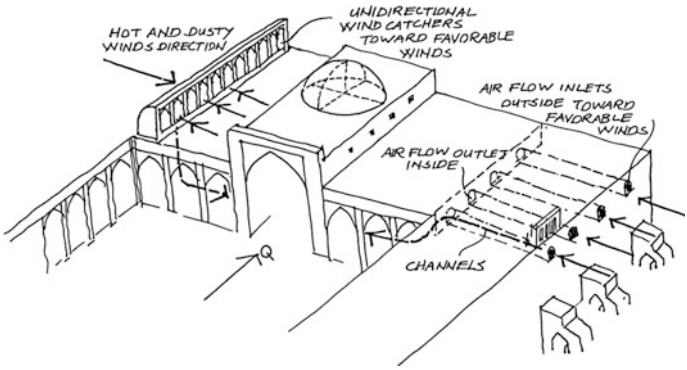

Fig. 6.40 **Tabas**. Masjid-i Jami, Combination of wind catchers and air vents

6.2.4 Tabas, Unidirectional Wind Catcher, and Air Vent in Masjid-i Jami

An unknown masterpiece of climate responsive building was destroyed in 1979 earthquake. In Tabas, there is a hot dusty wind from the south. This may be part of the Indian Ocean currents or Iran's desert. The unidirectional wind catchers of Tabas are structured toward satisfactory breezes, with their back to the hot dusty winds. On the one side of the sanctuary, a range of unidirectional wind catchers is installed. On the opposite side, over a more closed and protected space, a series of air vents between the thickness of the vaulted ceiling inside and the flat roof outside are constructed (Figs. 6.40 and 6.41).

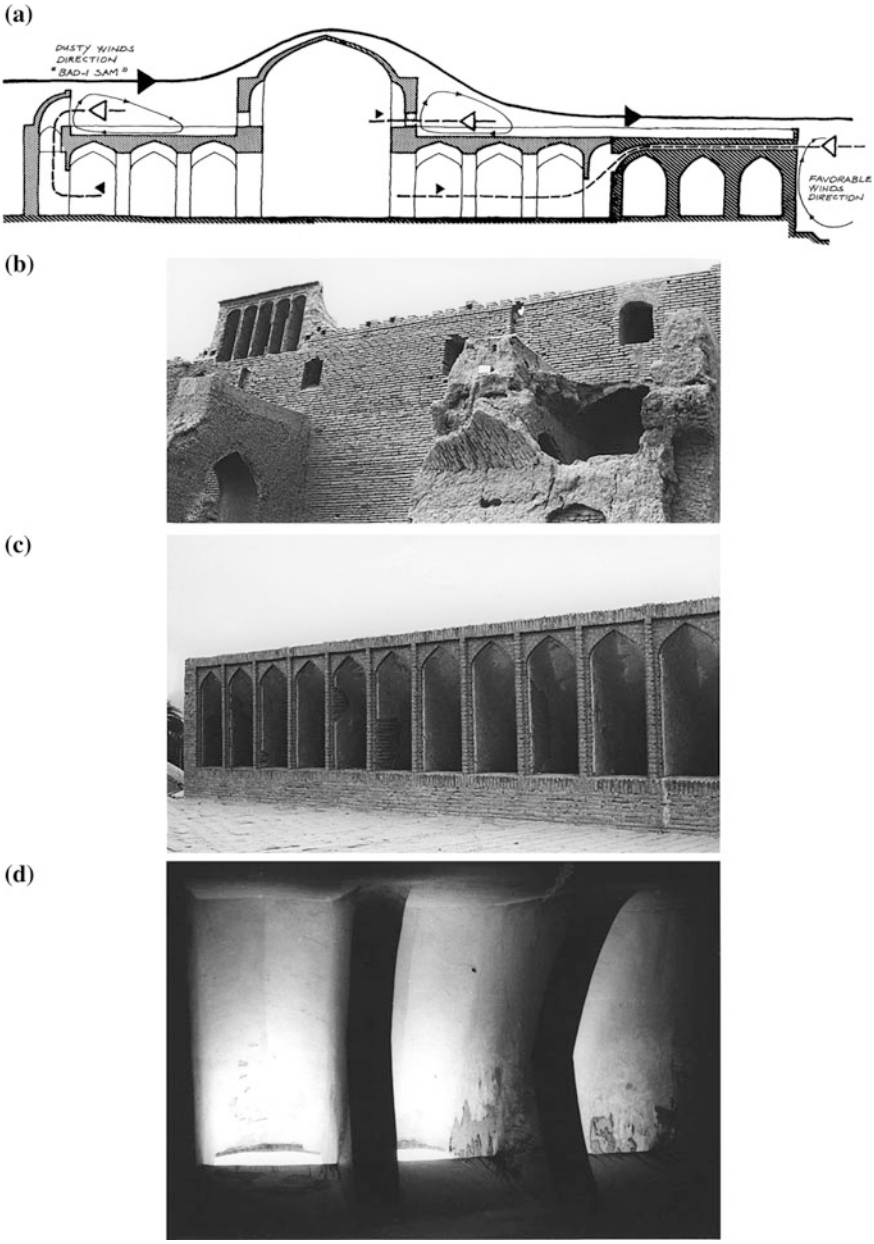

Fig. 6.41 **Tabas**. Masjid-i Jami: **a** Section through the unidirectional wind catcher and one of the airflow inlets. **b** Airflow inlets on the NW wall and unidirectional wind catcher. **c** The range of inlets of the unidirectional wind catcher. **d** Outlets from inside of sanctuary

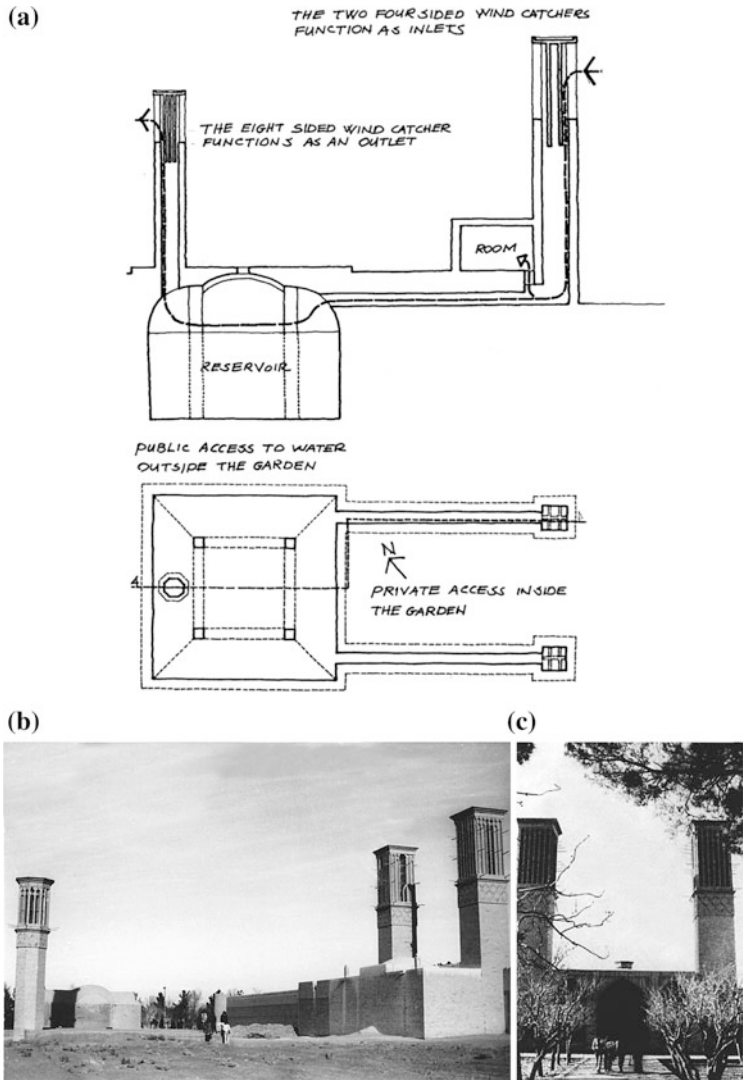

Fig. 6.42 **Nain**. Water reservoir of Musalla: **a** Plan and section showing structure and airflow pattern. **b** External view. **c** Private entrance from inside of the garden

6.2.5 Nain. A Typical Water Storage, Ab-i Ambar-i Musalla

An element that is part of the Musalla (gathering worship space, especially on feast days). Access to water is both from inside of Musalla and outside for public. Two strong four-sided wind catchers function as air inlet, and one octagonal wind catchers as air outlet. Circulation of air keeps the water clean and cool. Contrary to usual, this water storage has no dome (Fig. 6.42).

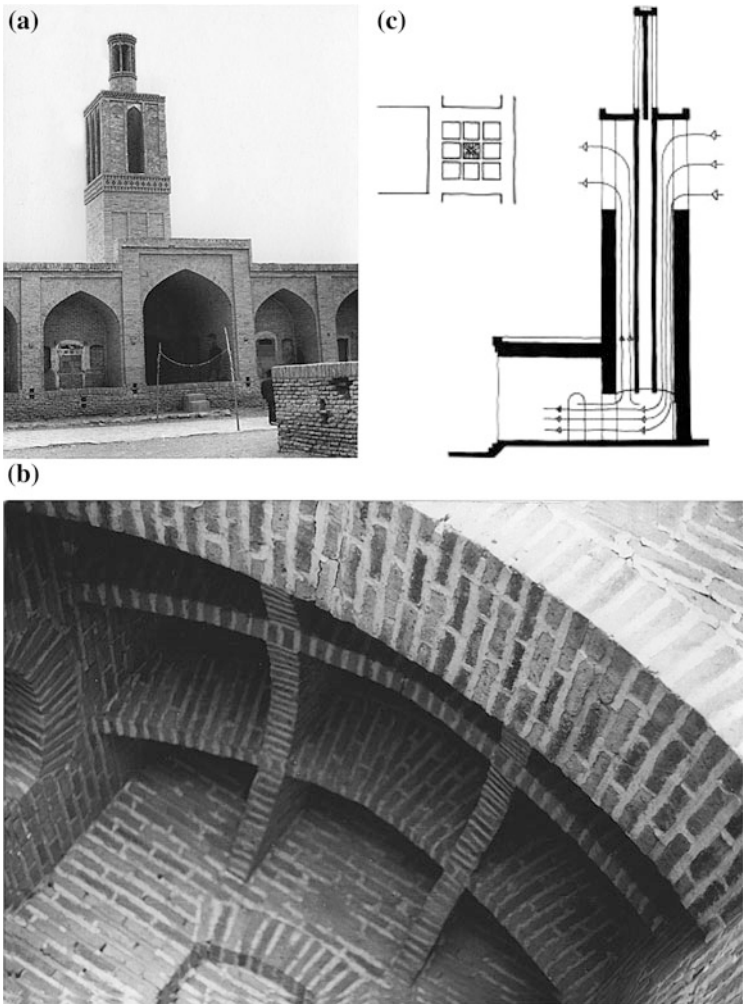

Fig. 6.43 Aqda. **a** Two-story wind catcher of a caravanserai. **b** Airflow outlet from ivan. **c** Plan and section showing airflow pattern

6.2.6 Aqda. Wind Catchers as a Guide for Caravans

Wind catchers in Aqda, a town on the edge of desert, are low and unidirectional (Fig. 6.5). The two-story wind catcher presented here erected above ivan of a caravanserai and is visible from afar. It served primarily as a guide for caravans, and its secondary function is cooling the space below (Fig. 6.43).

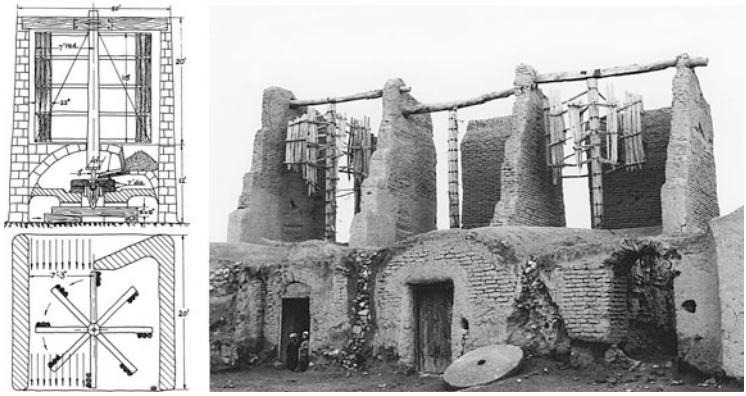

Fig. 6.44 Khaf. Wind mills (plan and section from Wulff)

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Chapter 7
Similarities Around the World

Abstract This chapter includes a short comparison between urban forms inside and outside Iran. In spite of different historical and sociocultural background, we find similarities in the meaning behind forms, although different in outward appearance. Examples include different types of courtyard houses, wind catchers, and compact urban forms in different parts of the world.

Keywords Yazd · Morocco · Baghdad · Hyderabad · China · New Mexico

Considering similarities some of the most common features include: harmonious integration with environment; deep shaded courtyard structure; inward looking spaces; massive adobe roofs and walls packed together; unity of component parts (Figs. 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 7.10, 7.11, 7.12 and 7.13).

Khargird, Iran, is a typical historical village, a place where a thoroughly unified Madrasah (fifteenth century) is located. The simple domed roof village is structured on the plain. The wind catchers are low similar to Mehneh (Fig. 6.38). A range of windmills also constitute a part of village structure (Fig. 7.1).

For comparative study, see Rudofsky (1977); Amos Rapoport, The Pueblo and Hogan, in: *Shelter and Society*, ed., Paul Oliver, Barrie & Jenkins, (1976), p. 69; United Nation (Al-Azzawi) (1971), p. 21; Al-Azzawi (1976) pp. 91–102; and Victor Olgyay, *Design with Climate*, pp. 5–8.

M. Tavassoli, *Urban Structure in Hot Arid Environments*,
The Urban Book Series, DOI 10.1007/978-3-319-39098-7_7

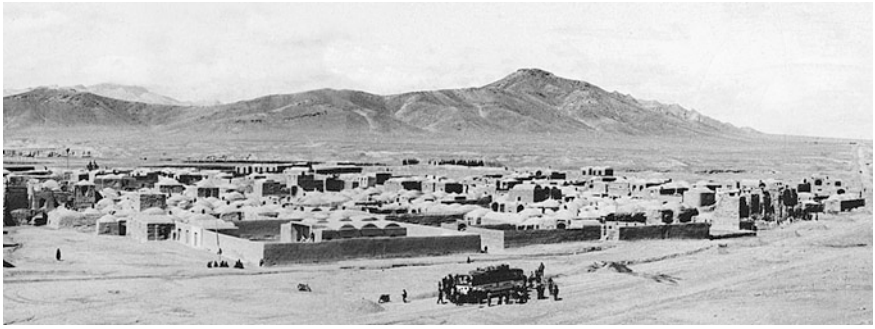

Fig. 7.1 Khargird. A village on the plain, Khurasan Province

Iran, Dayhuk, and kharanaq. Two important influential factors, defense and climate, are reflected in the morphology of these villages. The hill-walled village is usually a solution in a province where nomadic attacks have been a problem historically. Dayhuk a nearly 200 household village in Khurasan has been shaped at the top of the hills and gradually continued on the lower slopes toward the irrigated areas (Figs. 7.3 and 7.4). In addition to the influence of climatic conditions, historical circumstances have had a considerable role in creating a great degree of connection among the inhabitants. So, such villages can be seen as a socio-spatial unity.

Structural pattern of Kharanaq is the best example (Figs. 7.4 and 7.5). In Dayhuk, there is two distinct periods of developments. At the beginning, the old part was clustered on the top of the hill, a secure area. Remains of this part indicate that it was compact and fortified. An observation tower still exists. Spatial structure and morphology change from the upper part of the village to the lower part.

In both villages, domed and vaulted roofs are common. Housing cells are compact and closed. The roof of one house may function as a courtyard space or door step for the next house above. The oldest house in Dayhuk shows the rooms with little natural light (Fig. 7.3b). Access to water at the top of the hill was from a single source, a well, a secure element from the threat of external invaders.

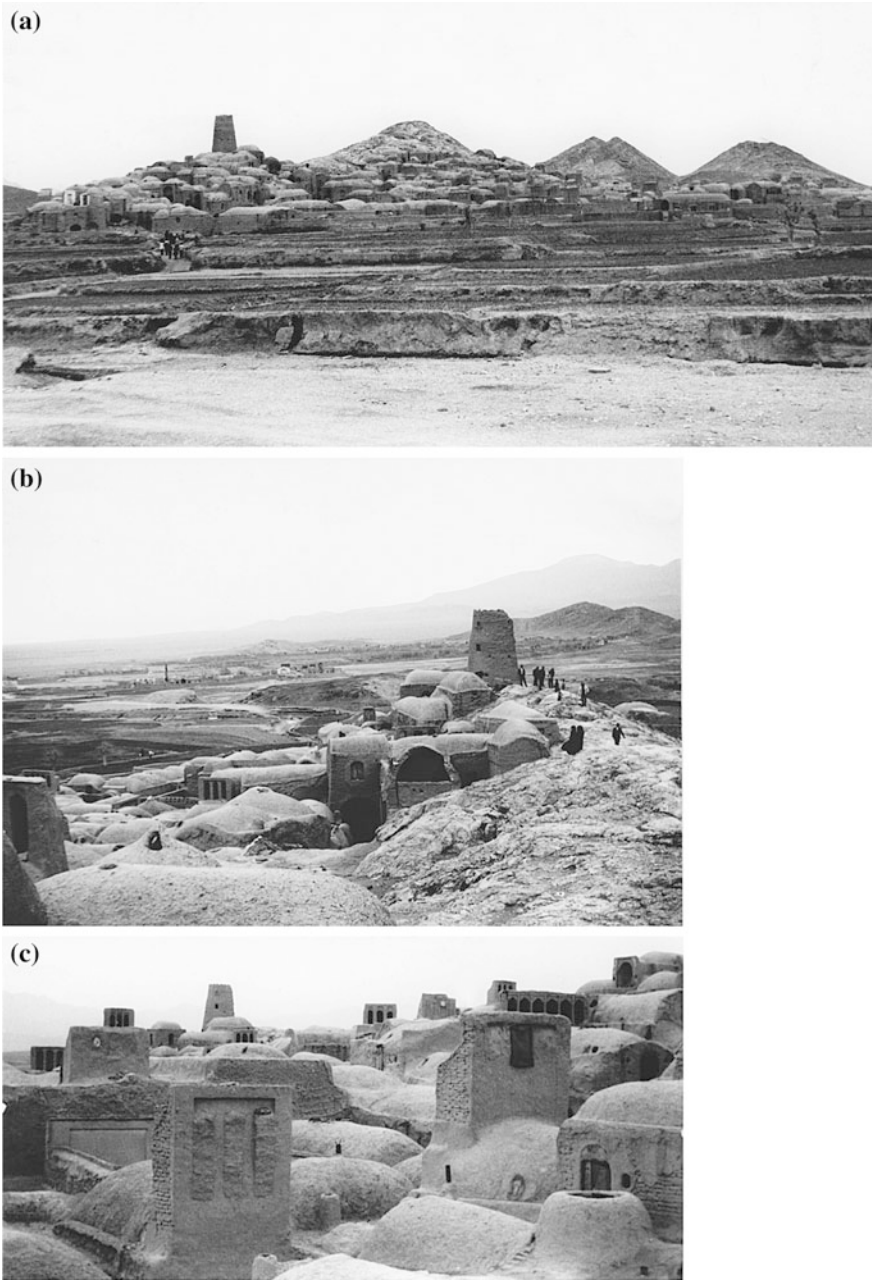

Fig. 7.2 Deyhuk. Khurasan Province: **a** The village in the landscape, the complex is integrated with the environment. **b** The old part of the village is mostly ruined and the only remained tower at the *top* of the hill. **c** A complex with unidirectional low wind catchers which are directed toward favorable winds

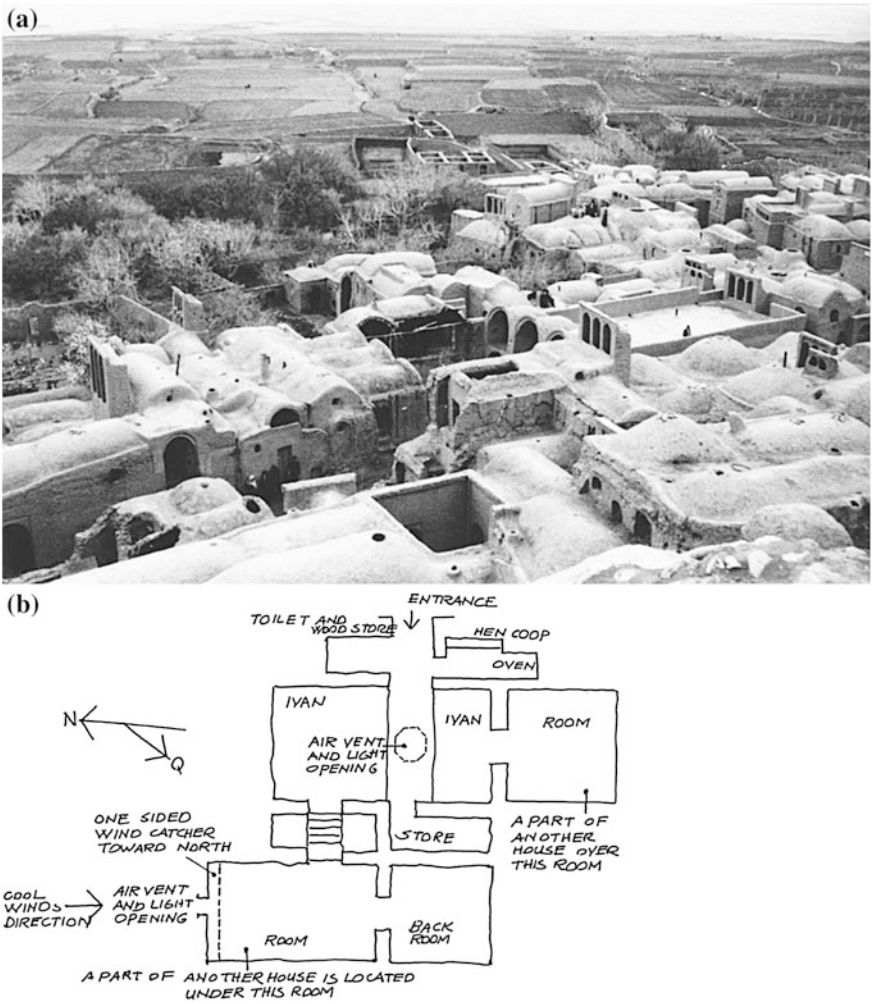

Fig. 7.3 Deyhuk. **a** Later expansion on the foothill with unidirectional wind catchers, and continuous domed roofs. **b** The oldest house in the village, a completely closed example within the old section

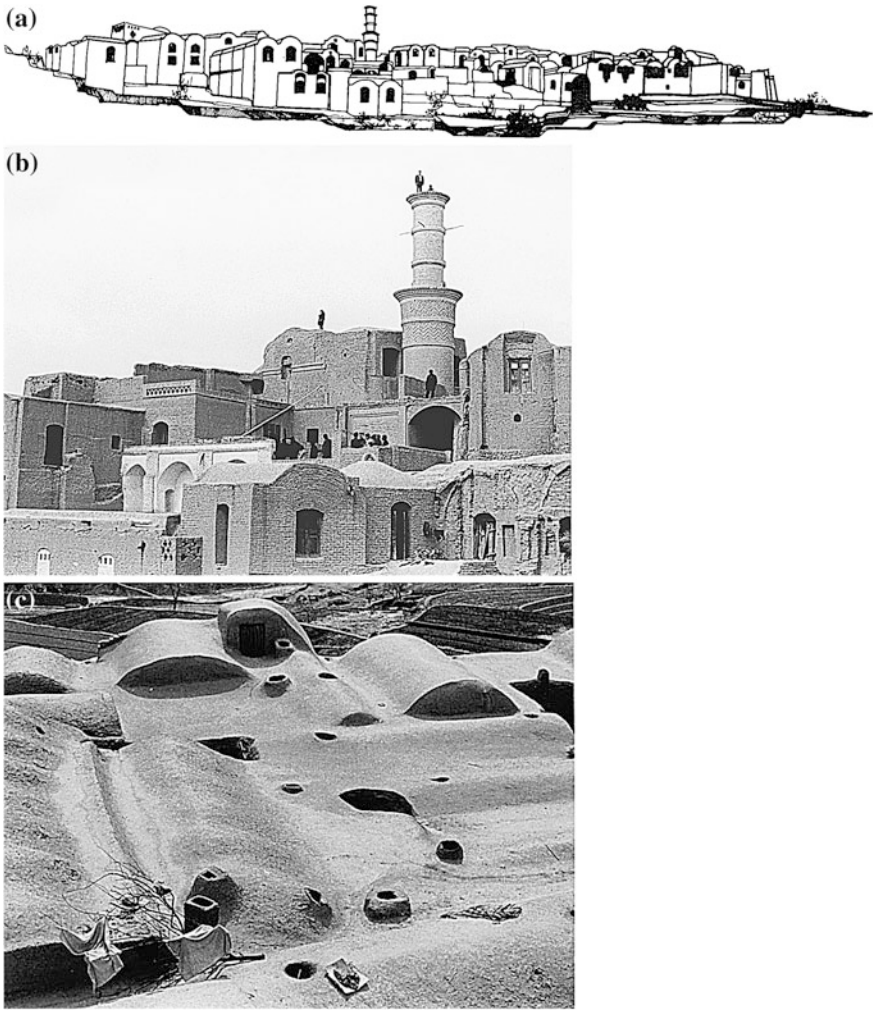

Fig. 7.4 Kharanaq. **a** A compact structured village in Yazd region. **b** The village's minaret. **c** Continuous roofs

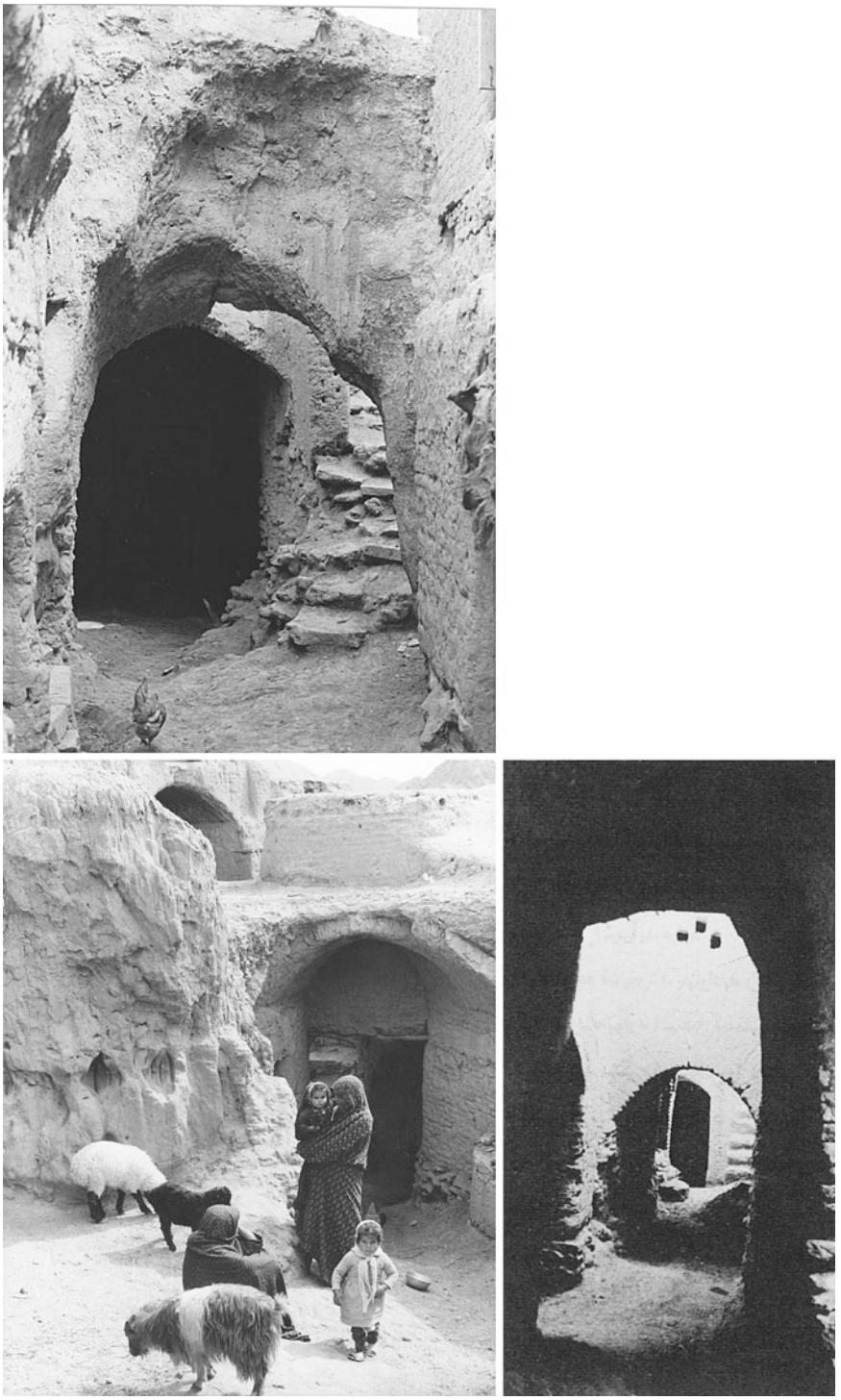

Fig. 7.5 Kharanaq. Access and life at lower layer of the fabric

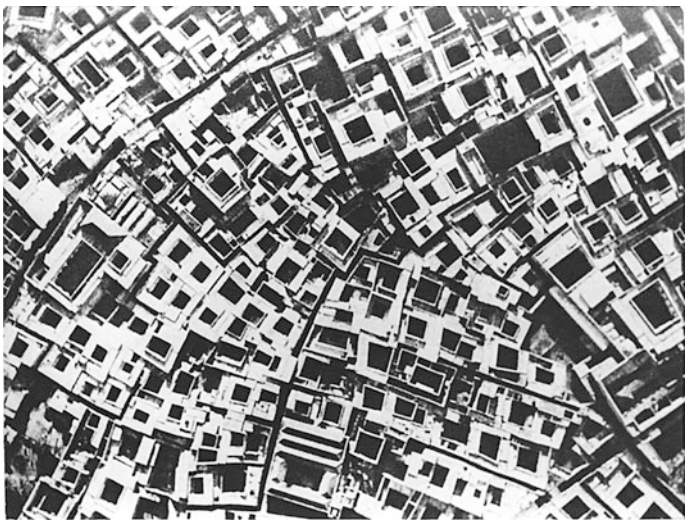

Fig. 7.6 Marrakesh (Morocco). "Archetype of an Islamic town with its quadrangular houses organized around interior courts. There are no traffic arteries to speak of; the cool narrow alleys of broken course often lead to dead ends" from Rudofsky

Fig. 7.7 Yazd. Compact courtyard structure integrated with neighborhood and city centers. A part of the Friday mosque is seen at *top right*

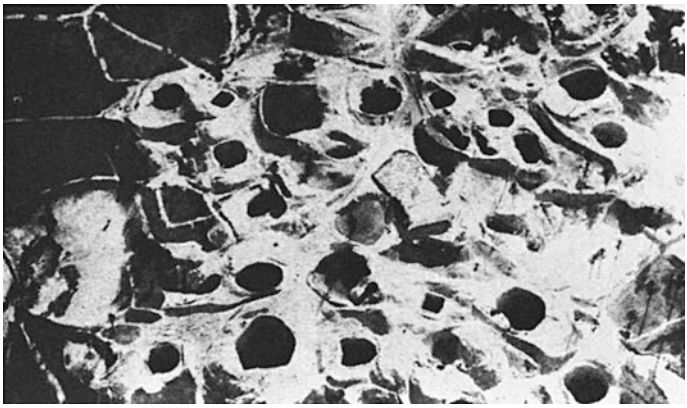

Fig. 7.8 Tunis. "The Tunisian troglodytes of Matmata have their subterranean chambers located around open central wells, which appear on the surface in a complex organic community pattern" from Olgyay

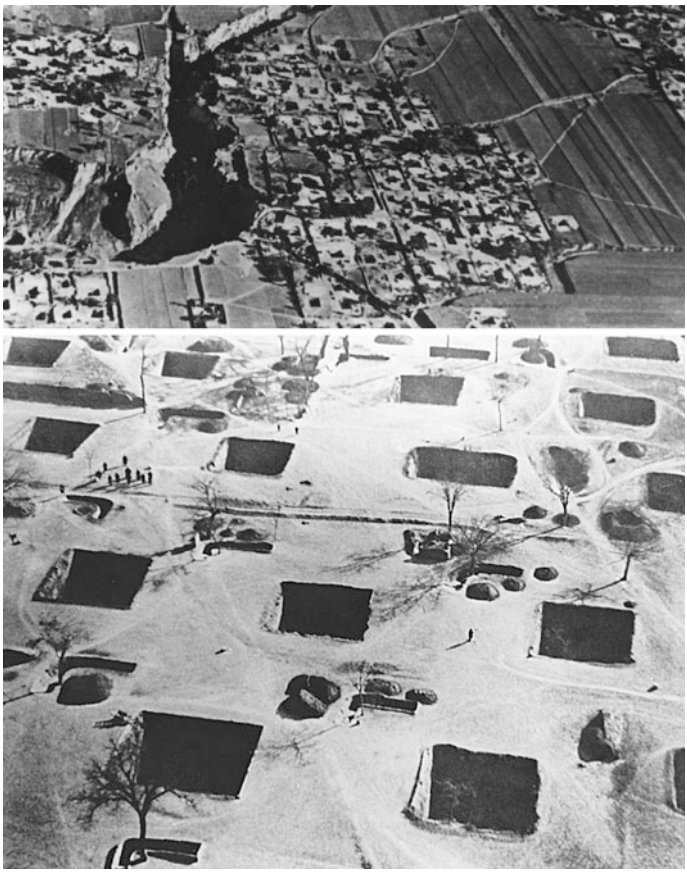

Fig. 7.9 China. "Dwellings below, fields upstairs. One of the most radical solutions in the field of shelter is represented by the underground towns and villages in the Chinese loess belt. … The dwellings are clean and free of vermin, warm in winter and cool in summer. …" from Rudofsky

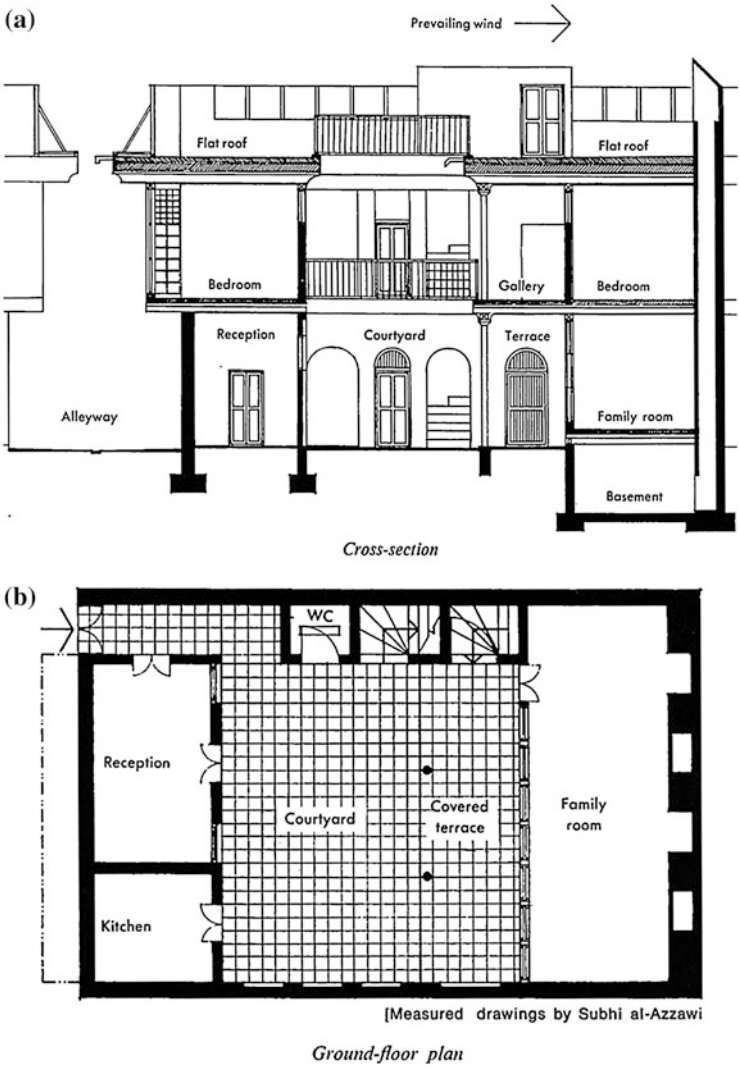

Fig. 7.10 Iraq. "The courtyard house tradition of the hot dry tropics. A town house in Baghdad, Iraq. All rooms open to the courtyard, which is shaded during the day but open to the sky at night. Basement and ground floor are designed for hot-season living with massive walls that provide thermal storage. The first floor is intended for use in the cold season; it is of light construction and open to the winter sun. Note the shaded alleyway, the sleeping space on the roof terrace and the 'windcatcher' with duct to the basement" from al-Azzawi, Climate and House Design, United Nations

Fig. 7.11 Pakistan. "The air conditioners of Hyderabad Sind. These unusual roofscapes are a prominent feature of the lower Sind district in West Pakistan. From April to June, temperatures range above 120 °F, lowered by an afternoon breeze to a pleasant 95°. To channel the wind into every building, "bad-gir," windscoops, are installed on the roofs, one to each room. Since the wind always blows from the same direction, the position of the windscoops is permanently fixed. In multistoried houses they reach all the way down, …" from Rudofsky

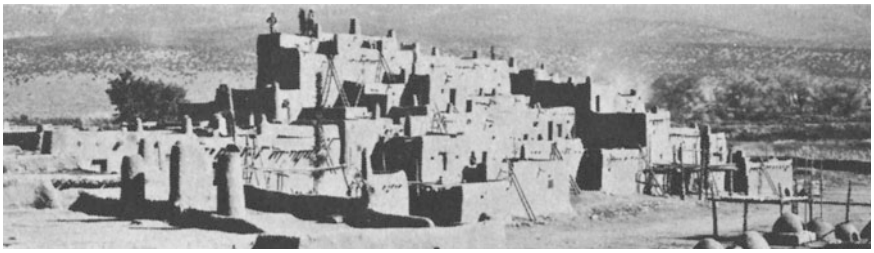

Fig. 7.12 New Mexico. "Structures such as the pueblo of San Juan were constructed of massive adobe roofs and walls, which have good insulative value and the capacity to delay heat impacts for long hours, thus reducing the daily heat peaks. They also used very small windows. By packing buildings together, the amount of exposed surface was reduced. Pueblo structures of this type usually extend on east-west axis, thereby reducing morning and afternoon heat impacts on the two end walls in summer and receiving a maximum amount of south sun in the winter months when its heat is welcome" from Olgyay

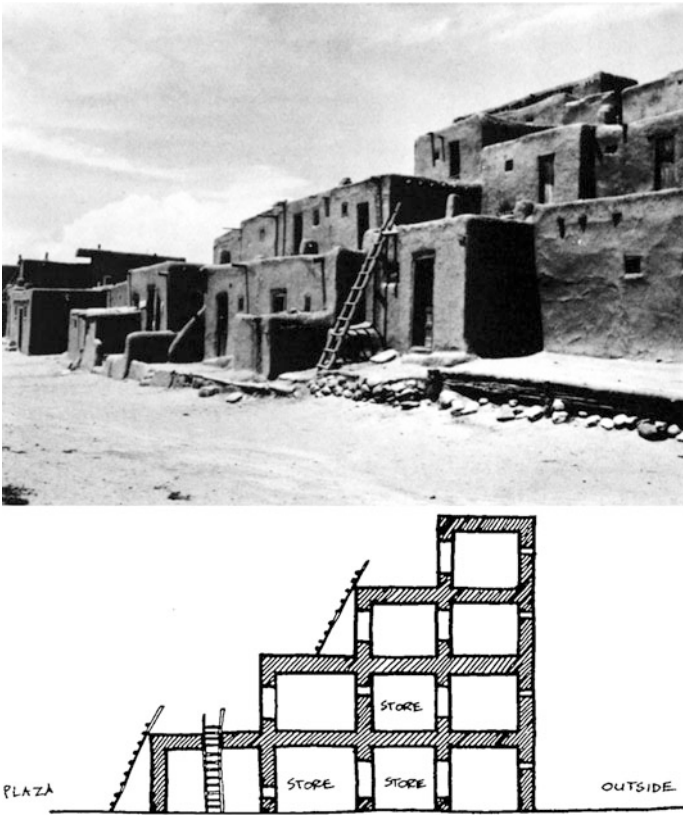

Fig. 7.13 **New Mexico**. Arizona, Taos pueblo and an ideal section through pueblo terrace. From Rapoport

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Chapter 8
Uniting the Parts

Abstract In this completely illustrated chapter, we can see how sustainable energy, sun and wind, and the essence of issues discussed in two previous chapters have been manifested into a whole complex: a house. It includes typical houses from hot arid environments of Iran; some of them have been destroyed in 1979 and 2003 earthquakes. In the process of potential for change in the new developments, lesson has been drawn from the past experience (Chap. 9, Case study).

Keywords Sun · Wind · Interconnected effects · Unified whole · Lesson for future

In the selected traditional houses of this chapter, we can see how form and function of elements discussed in chapter 6 are related and work with each other. Here simplicity of form and space is at its best (Figs. 8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 8.10, 8.11, and 8.12).

M. Tavassoli, *Urban Structure in Hot Arid Environments*,
The Urban Book Series, DOI 10.1007/978-3-319-39098-7_8

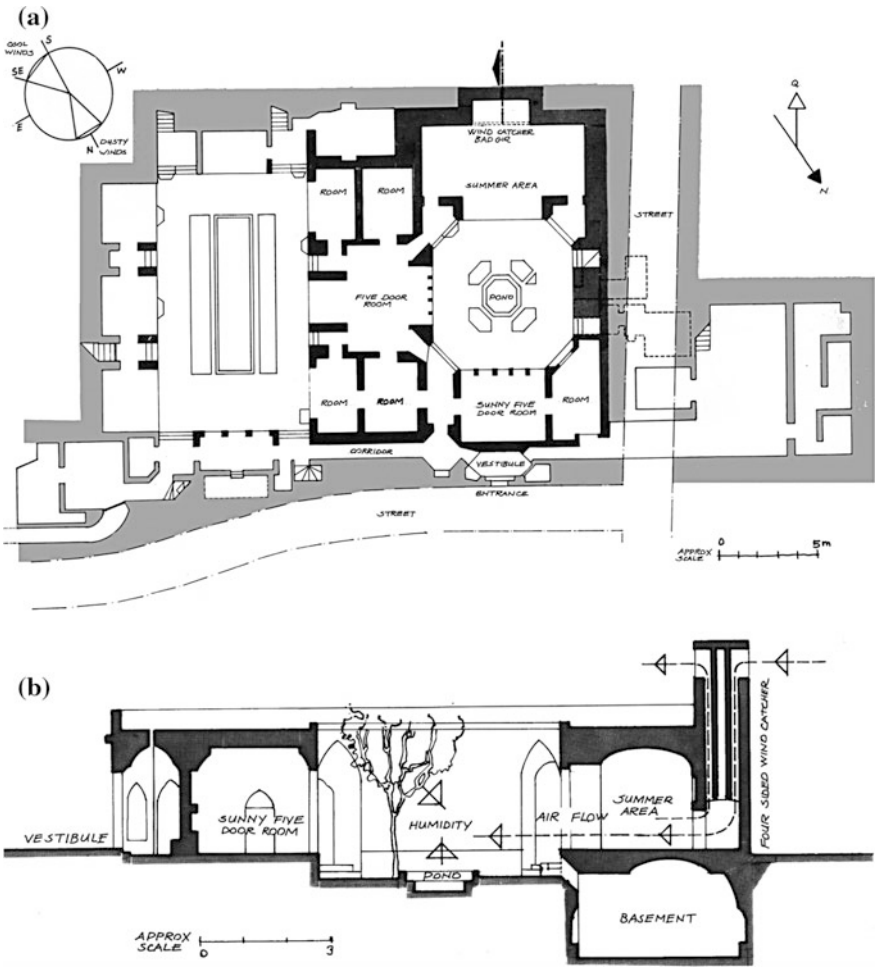


Fig. 8.1 **Yazd**. An aristocratic housing complex. **a** Plan showing the orientation of the house, direction of the winds, and the position of different spaces and elements. **b** Section showing interconnected effects of wind, vegetation, and water. Opposite page: **c** Summer area, talar. **d** Flower beds around the pond. **e** Winter area, sunny five-door room (Pang dari)

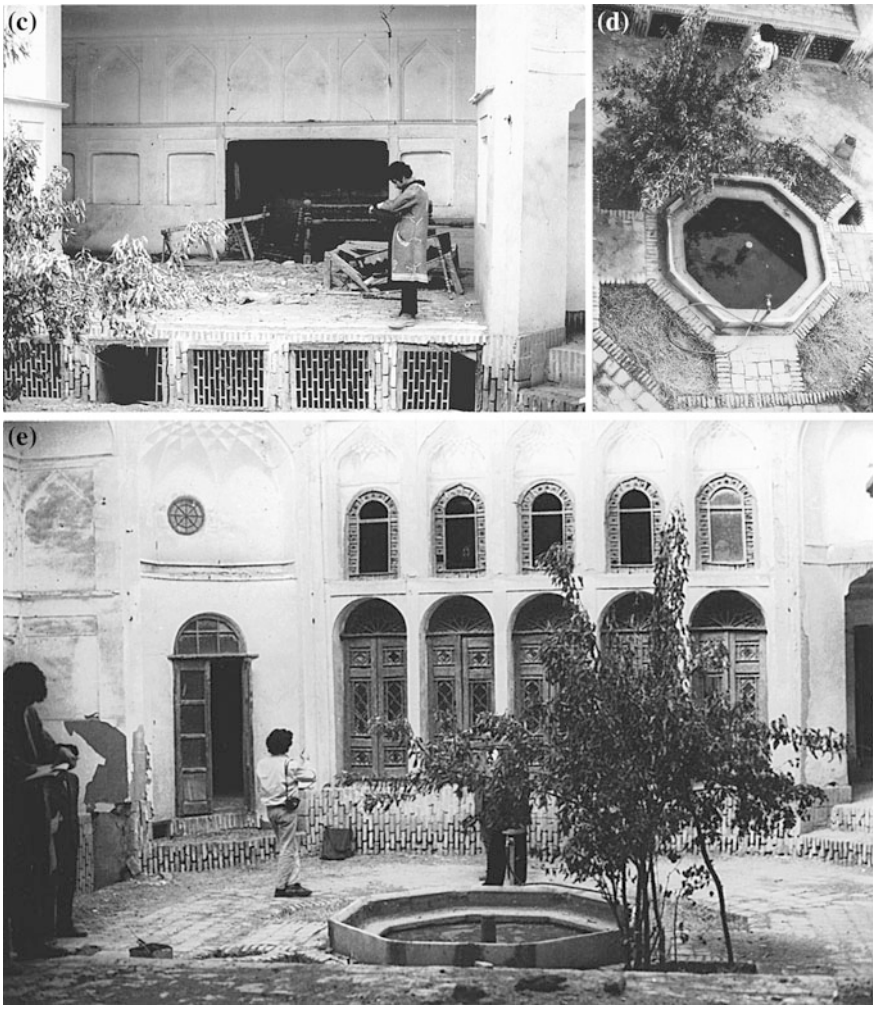


Fig. 8.1 (continued)

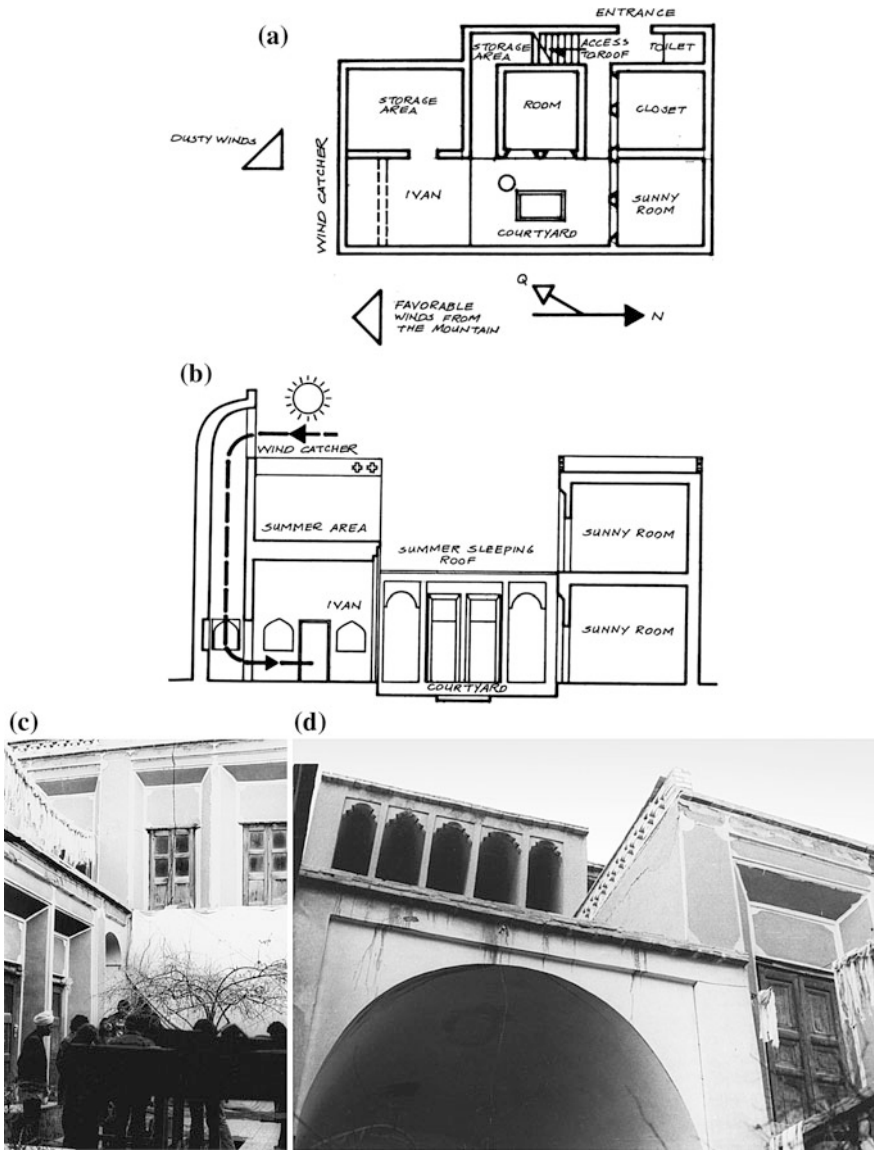


Fig. 8.2 A typical house in Aqda. An excellent combination of well-proportioned spaces and elements, into a whole simple unit, simplicity at its most. Pictures showing spatial arrangements in relation to climatic factors: radiation and wind. **a** Plan. **b** Section. **c** Winter area, sunny room. **d** Summer area, Ivan and unidirectional wind catcher. Summer area is back to the hot afternoon sun, reducing extreme heat impact, and winter area receiving maximum amount of sun heat in the winter

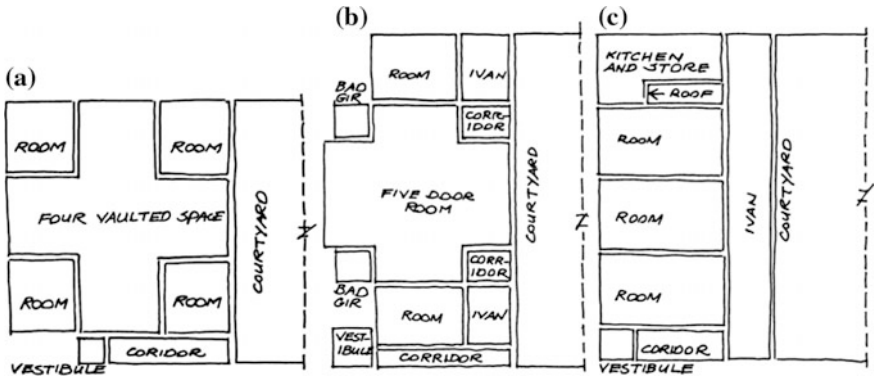


Fig. 8.3 Zaware. Three types of traditional houses: **a** Zoroastrian type, Chahar sofa. A central space with four ivans on the four sides and four rooms on the corners. **b** Usually Muslim type, Howzkhanei (a large room in the basement with a small pond in the center), belonging to middle and upper income families. **c** Lower-income house, Se qesmati

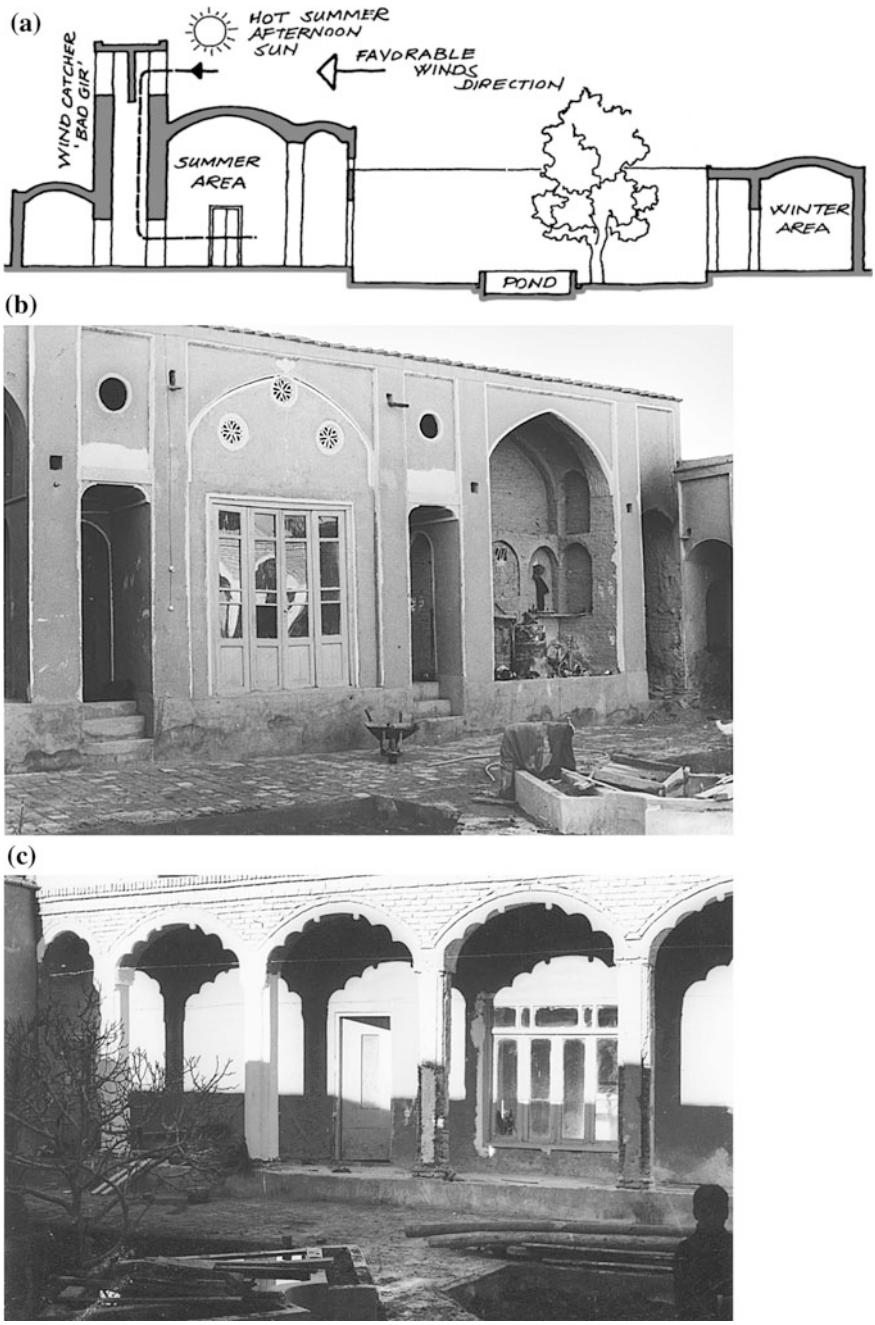


Fig. 8.4 Zaware. Traditional housing type, Howzkhanei, a simple type without basement: **a** Airflow pattern. **b** Summer area. **c** Winter area

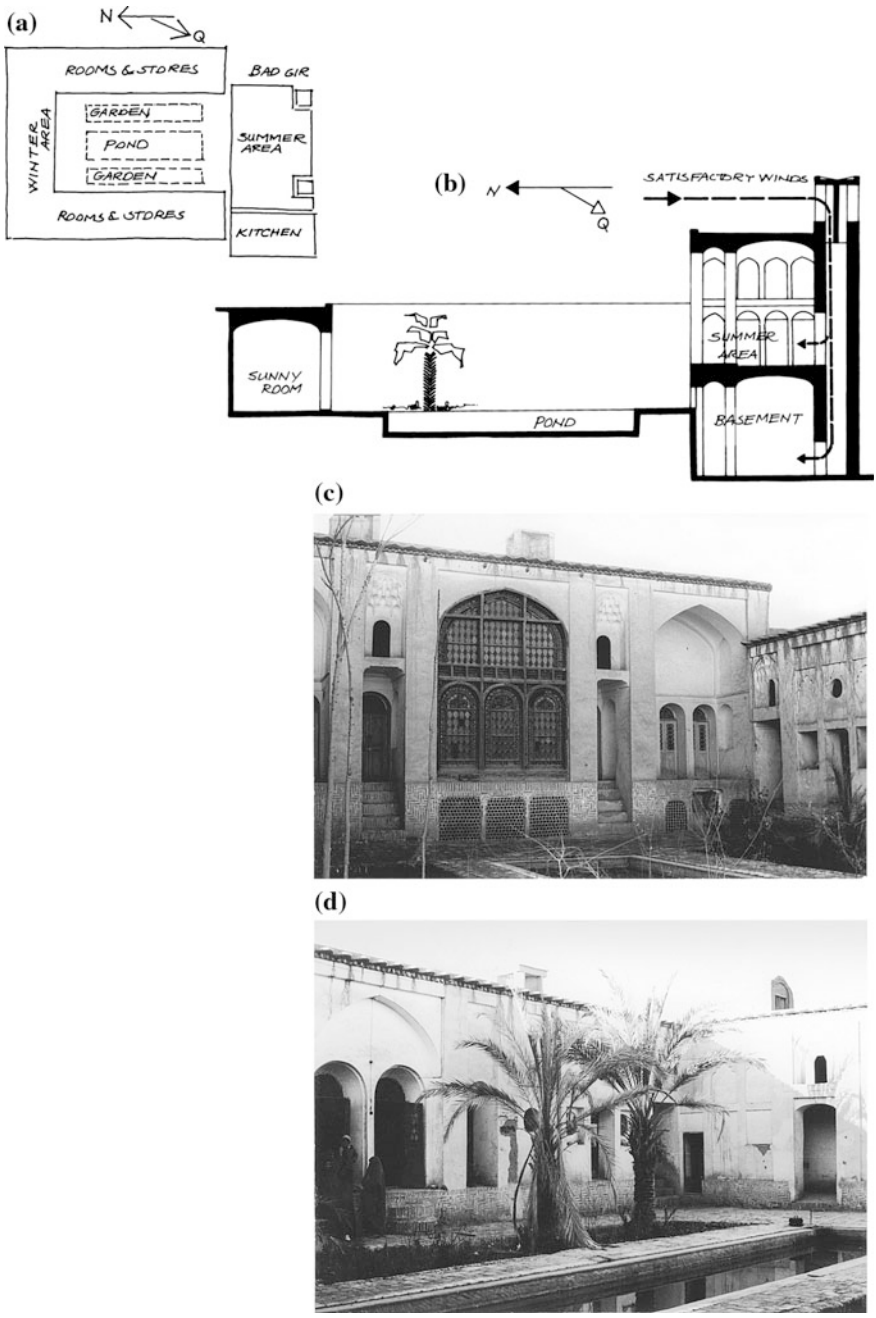


Fig. 8.5 Zaware. A large complete housing type: **a** arrangement of spaces. **b** Airflow pattern. **c** Summer area. **d** Southwest corner and exit

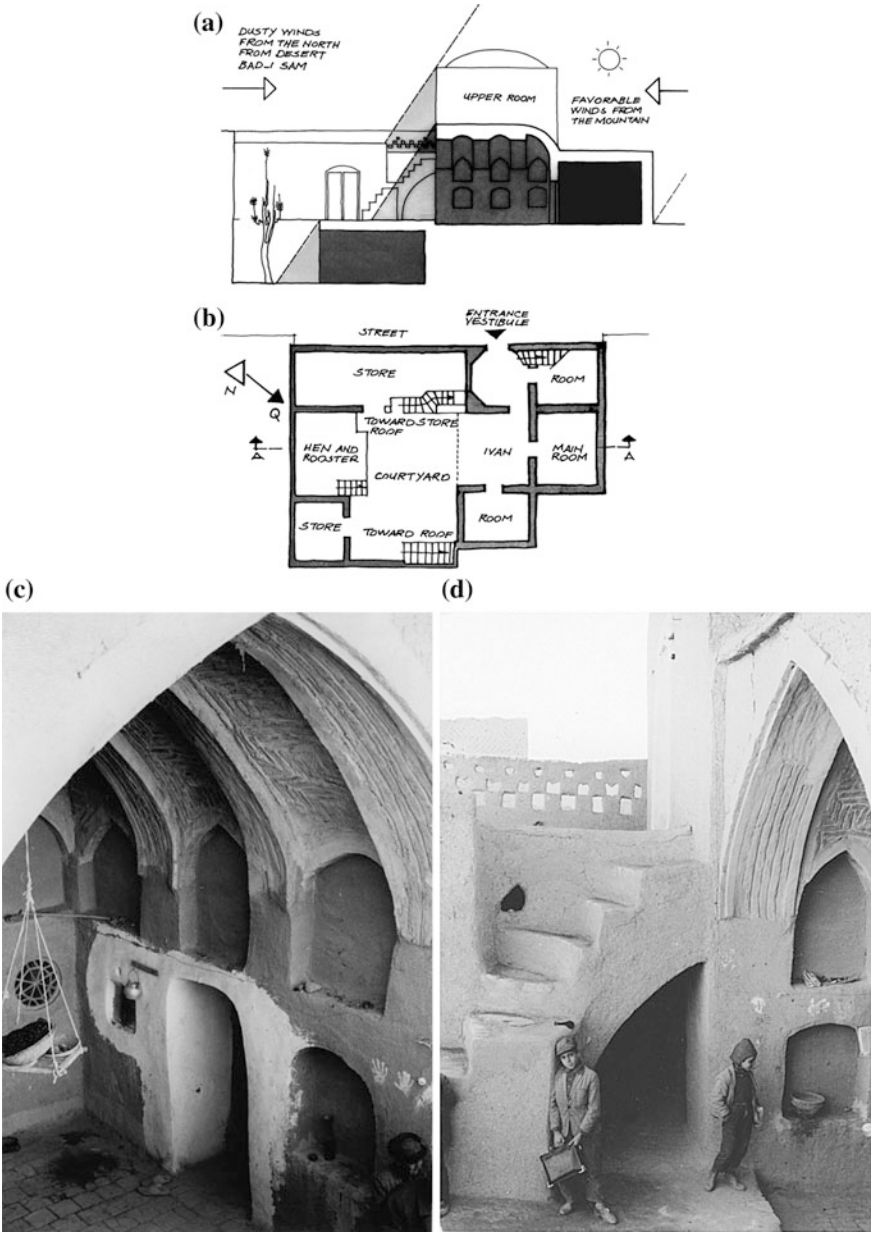


Fig. 8.6 A rustic house type in Ardestan. Spatial arrangement in response to climatic factors: **a** Section. **b** Plan. **c** Ivan, back to the hot afternoon sun. **d** Steps toward the store roof

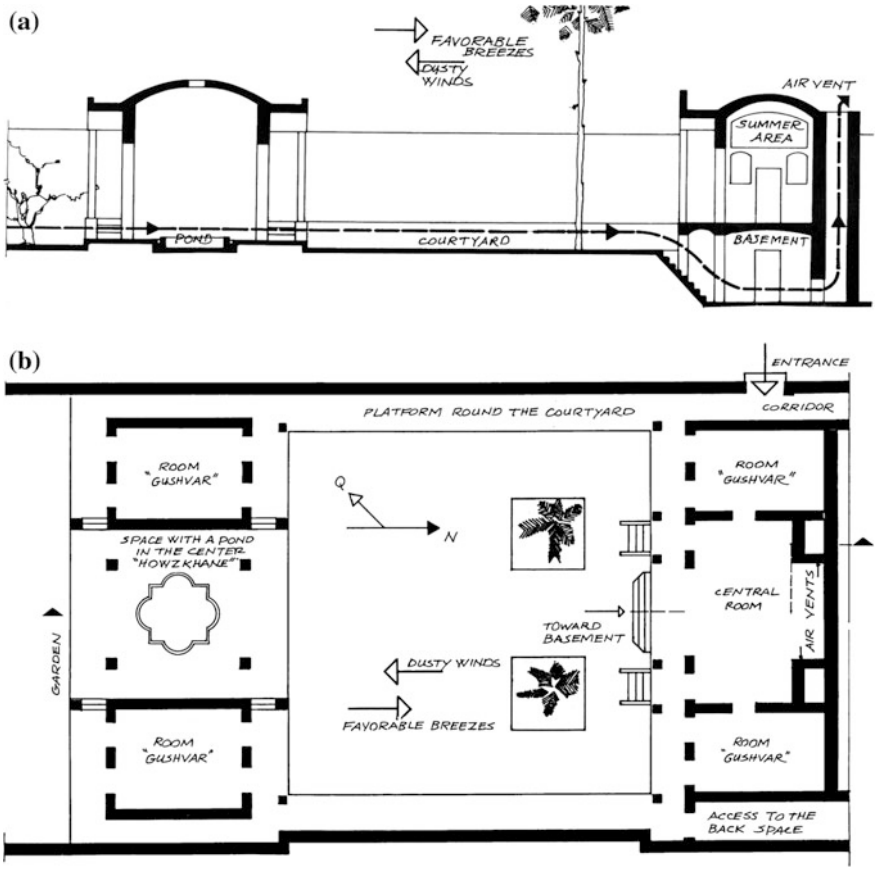


Fig. 8.7 **Aran**. A unique typical large house: **a** Airflow pattern. **b** Plan. **c** Entrance and summer area corner. **d** Summer area, central part. **e** A typical Howzkhanei, space with a pond in the center

Fig. 8.7 (continued)

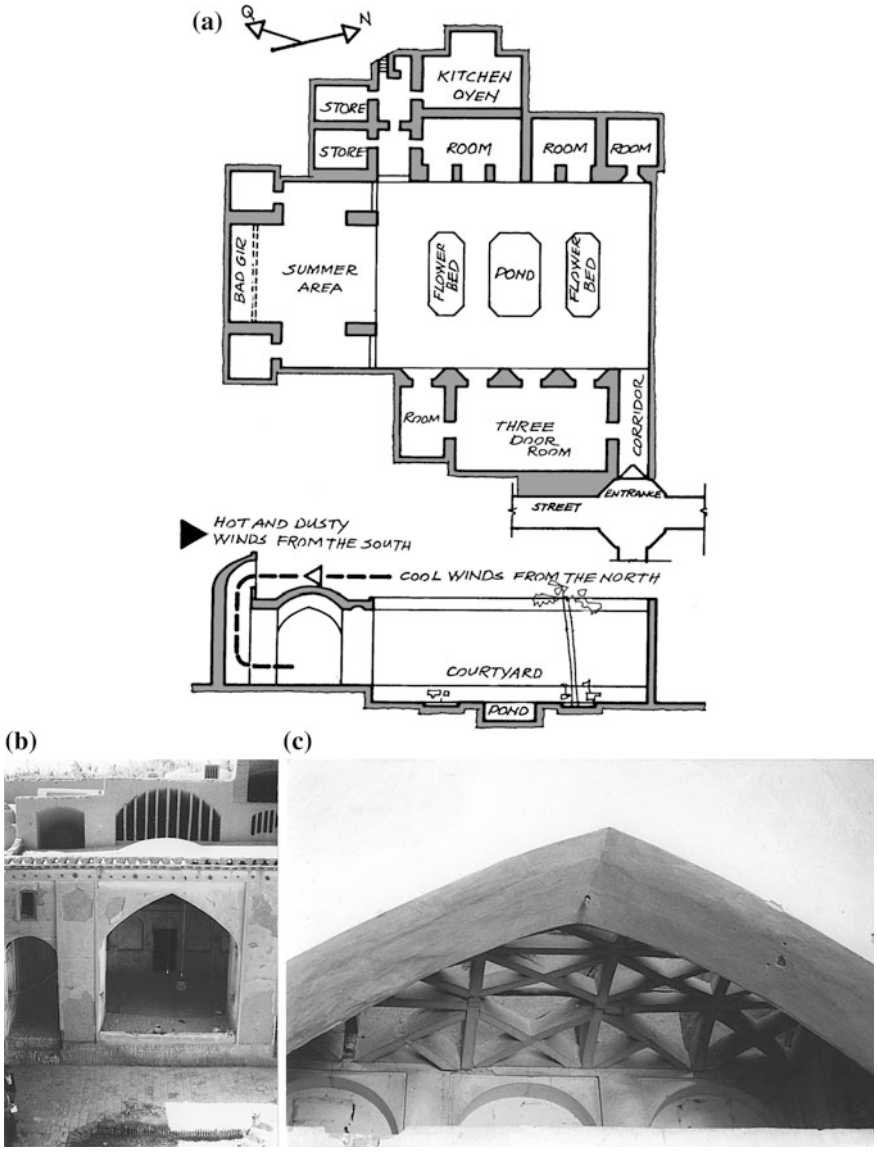


Fig. 8.8 **Bam**. A typical house: **a** Position of different elements and spaces, and airflow pattern. **b** Summer area ivan and unidirectional wind catcher. **c** Wind catcher's outlet

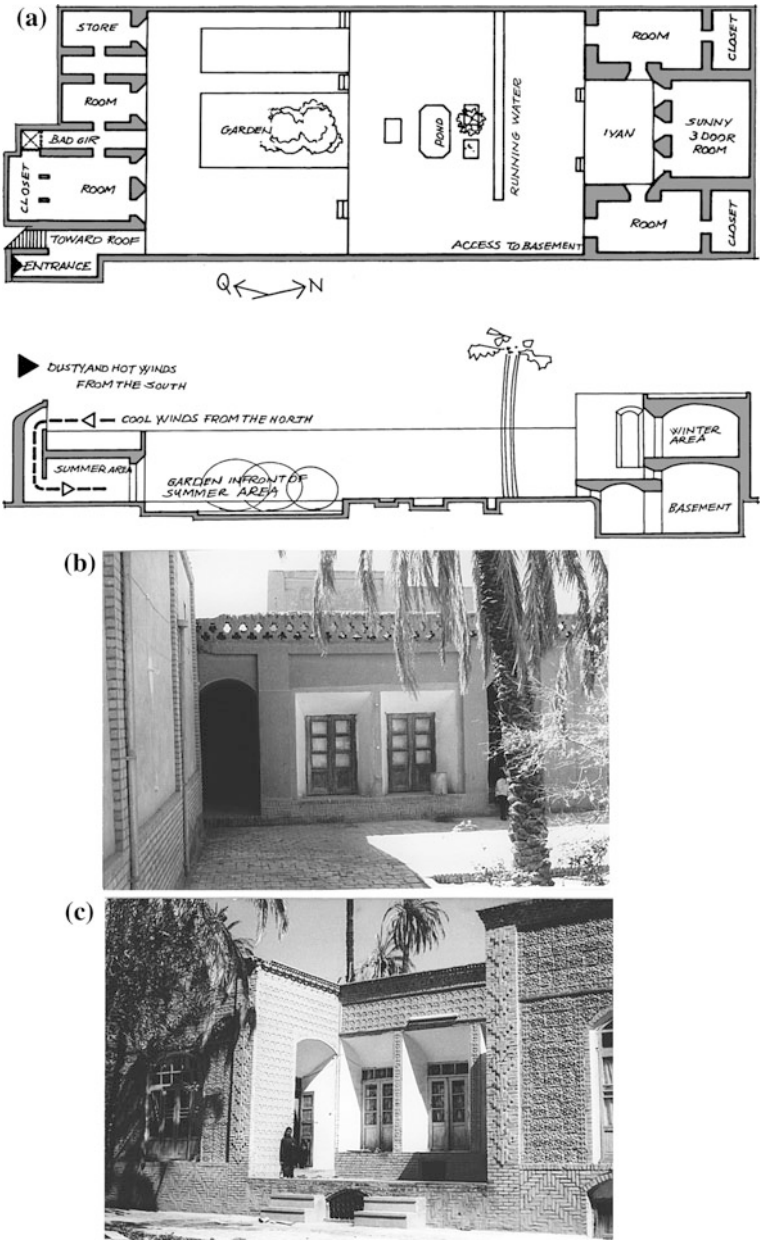


Fig. 8.9 **Bam**. A unique type basement under the winter area: **a** Position of different elements and spaces and airflow pattern. **b** A part of summer area and entrance to the courtyard. **c** Winter area

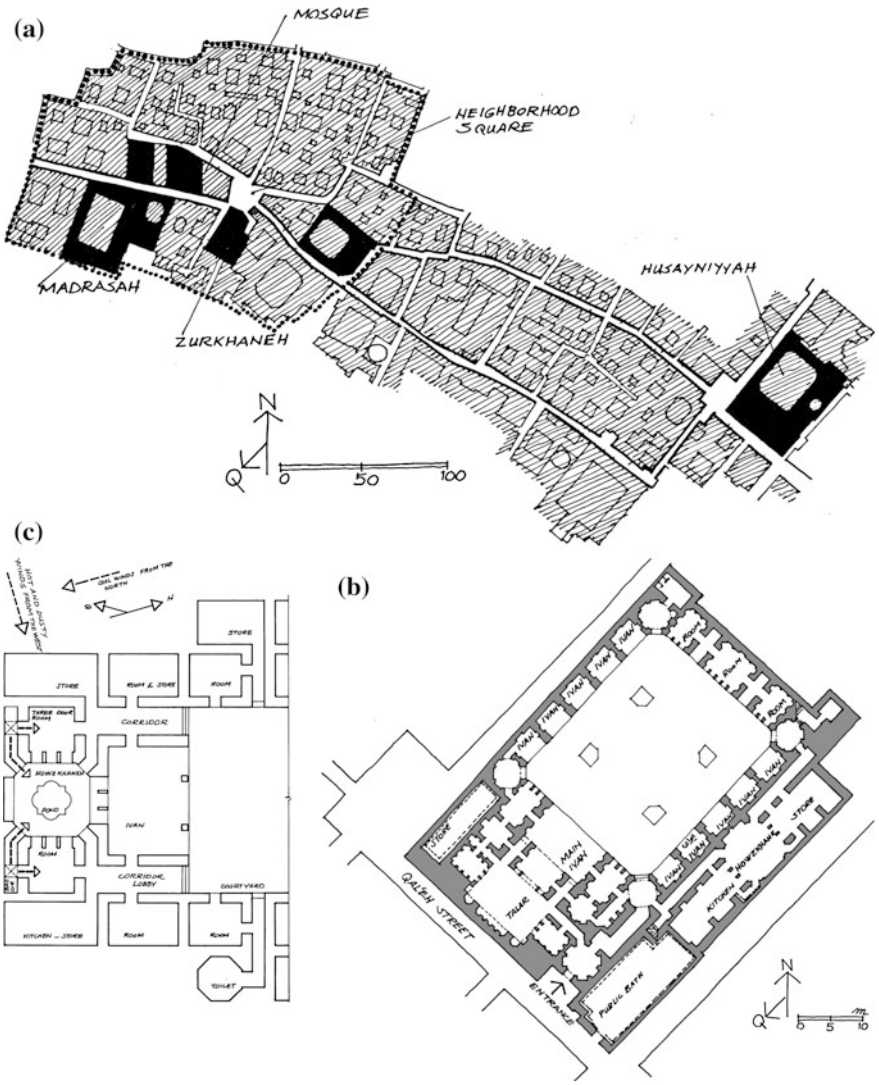


Fig. 8.10 Birjand. **a** Historical core (See Fig. 4.24). **b** A unique school, Husayniyyah, late nineteenth century. **c** Summer area of a large typical house

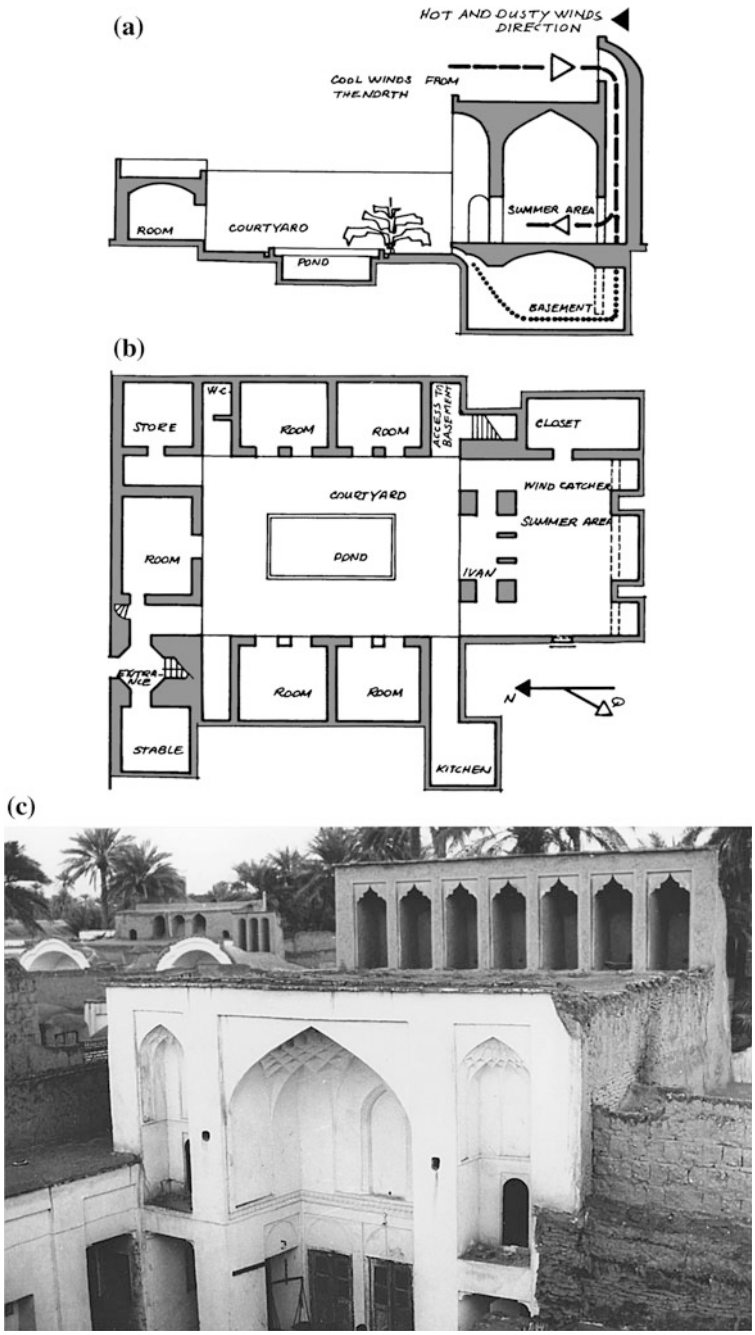


Fig. 8.11 **Tabas**. A typical house destroyed in 1978 earthquake: **a** Airflow pattern. **b** Plan showing position of different elements and spaces considering climatic factors. **c** Summer area including ivan and unidirectional wind catcher

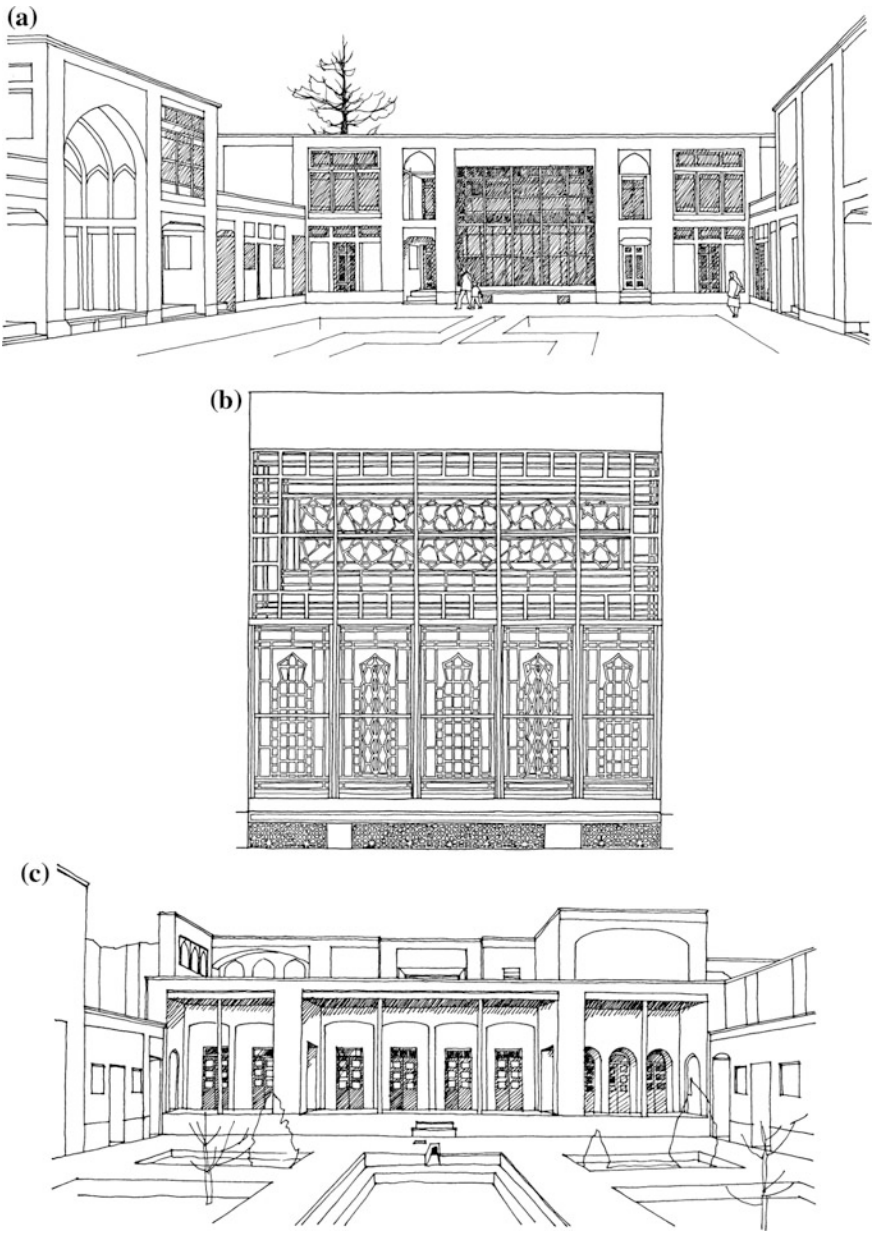


Fig. 8.12 **Nain**. The inner part of Fatemi house, pictures showing the arrangement of all elements into a unified whole: **a** Summer area façade. **b** Detail of central room sash window. **c** Winter area facade

Part III
Guidance Through Case Studies

Chapter 9
Scale of the Problems and Solutions: Case Studies

Abstract This chapter includes 4 case studies extracted from different projects. It considers the problems of spatial structure at three levels: the whole structure of traditional city, the neighborhood system, and the urban block as the principle urban unit. It is not intended to repeat the ideas and views of the scholars that have been referred to in the first two parts of the present book. But it intends to consider several basic problems and solutions of the hot arid zone cities. Four case studies include the following:

- Urban design in the inner core of the historic city of Yazd,
- Urban design Kargar Street, Tehran,
- Redesign of Hasan Abad Square, Tehran,
- Experimentation of new forms of urban block.

Keywords Urban design · Renewing · Privatization of public space · Ordering of a square · New forms of urban block

As we saw, urban structure in the hot arid environment of Iran has been developed in response to three main influential factors: history, culture, and climate. During centuries, designers have sought creative methods which utilize in the best manner natural energy. They have produced creative solutions which have a reasonable role to keep buildings cool in summer and warm in winter. Today, by studying the past solutions and blend them by new creative insights, we would be able to shape a new future based on the use of natural energy and environmentally sustainable design.

This section considers the problems of spatial structure at three levels: the whole structure of traditional city, the neighborhood system, and the urban block as the principle urban unit. It is not intended to repeat the ideas and views of the scholars that have been referred to in the first two parts of the present book. But it intends to consider several basic problems and solutions of the hot arid zone cities through case studies.

M. Tavassoli, *Urban Structure in Hot Arid Environments*,
The Urban Book Series, DOI 10.1007/978-3-319-39098-7_9

9.1 Regional Scale, Inequality

The basic problem at a national level is the overdevelopment and underdevelopment of some arid regions throughout the country. The financial facilities and population centralization in Tehran City region have led to regional imbalance. The basic step in response to numerous problems of Tehran is to establish the appropriate development policies to balance the regions. It ought to be mentioned that large cities are unable to take advantage of natural energy. Today, Tehran because of irresponsible development and dense pollution is no longer able to enjoy favorable winds and breezes from northern mountains.

9.2 City Scale

Access. In the last century, penetration of car into urban fabric changed the lifestyle and family size. Accelerated and profit-oriented development has had a major impact on urban form. Although the old fabric is well structured against direct hot summer sun, and enjoy favorable winds, but it suffer from problems such as weak accesses, poor public spaces, inability in response to new changes, and hazards. These problems led that the new planning in response to new changes completely turned a blind eye on the past use of natural energy.

Ventilation. In the past, local gardens that were integrated with the fabric had a major role in cleaning the arid air of the city. Unfortunately, these naturally ventilated spaces are gradually allocated to the development activity.

Orientation. Orientation of courtyards, which I have mentioned before and will be discussed in detail later, has led to the orientation of historic fabric. The orientation of main structure is in *northwest–southeast* and *northeast–southwest* that reduces heat impacts of hot summer afternoon sun. In many cases, new street construction ignored this principle.

9.3 Neighborhood Scale

In the first part of this book, we have discussed the traditional characteristics of neighborhoods. In the first decades of twentieth century, after changes in administrative organization, the arrangement of neighborhood system was disrupted. But in many cases, because of the comfort and proper walking distance, the neighborhood center as the vital element remained active. In the process of renewing, these centers can be equipped with new elements in response to new needs.

9.4 Urban Block Scale

In Part II, four types of urban block in the hot arid zone cities of Iran were discussed. For renewing the urban structure, considering climate and culture, some lessons can be drawn from the two first categories: the inner and the middle areas urban block pattern (see Fig. 4.24). Meanwhile, we need to create a public space at block scale for social relations and in the time of earthquake.

9.5 Earthquakes

Earthquakes occur frequently in different climatic regions of Iran. For centuries, earthquakes have had the most environmental and human settlement damage and economic disruption. However, many scientific researches have been conducted on building structural aspect, but not much on building an urban form. As the first step to tackle with the problem of urban structure, neighborhood and block form, is simplicity in design, easily comprehended pattern and creating fluent access and public spaces at different scales for emergency escape and accommodation.

In the four case studies, on the basis of in-depth consideration, detailed design studies have been carried out.

9.6 Case Study 1

9.6.1 Urban Design in the Inner Core of the Historic City of Yazd[1]

Urban design in the inner core of the historic city of Yazd aims to consider rich historical heritages within the context of renewed urban structure. The aim is to seek workable and effective solutions to real problems. For decades, historical elements have been studied and preserved separately, without considering their integration with the compact surrounding fabrics.

The planning and design problems of Yazd are more or less the problems of other congested historic cities in the hot arid zone. However, there are hardly inner cities, with so many deteriorated areas such as Nain, Semnan, and Kerman.

[1]From the book by M. Tavassoli (Chief Designer), in collaboration with M. Barkashloo Mansouri, N. Bonyadi, M.H. Momeni; *Urban Design in the Inner Core of the Historic City of Yazd,* Urban Planning & Architecture Research Center, Ministry of Housing & Urban Development, Tehran (1990).

Some of the most important points and policy recommendation, and guidelines dealing with environmental improvement of the city of Yazd and other historic cities in the hot arid zone of Iran are as follows:

- Most of the Iranian city fabrics and architectural types, presented in the Part I and II of this book, belong to the most deteriorated inner areas of the cities.
- The old inner areas of cities are falling into ruin and becoming the shelter of urban poor. In these areas, the number of vacant houses and derelict buildings are increasing. Private sector is not interested, and owners are unable in investment due to high expense of restoration. Therefore, as the first step, the public sector should direct funds into renewal areas of historic core.
- The main reasons for the physical decay of the inner areas are as follows: inaccessibility, lack of city services, the poverty of environment, the especial housing structure belonging to the lifestyle and socioeconomic activities of the traditional Iranian families, physical problems of housing structure such as the mud brick material and large areas of decayed houses, disproportionate private development expansion around the inner areas, and lack of planning control.
- The old inner areas of historic towns need to be equipped with fundamental services.
- The improvement of housing conditions in the inner areas plays a major role in the process of dealing with the urban housing issues.
- Public participation and the need for increasing citizen's awareness of urban issues, as well as civic duties and responsibilities.
- New developments and changes in the fabric of towns and cities should follow a logical pattern, in accordance with the utilization of natural energy, cultural behavior, and socioeconomic condition of the inhabitants.
- Universities should play a crucial role and active participation in the process of research, planning, design, and implementation.

Four further areas for consideration are as follows:

- The need for clarity in urban land policy. Ambiguity is the key factor in the arbitrary changes of the form and the density of the historic cities.
- The need for change of attitude toward education, practice, and research, in response to the needs of society.
- The need for socializing and renewing the traditional urban structure, by creating public space and art space on different scales, the city, and neighborhood centers. Although this physical solution will not solve socioeconomic problems, it helps in creating a healthier environment against addiction or compact urban fabrics, which is also vulnerable to earthquake.
- Good design and renewing approach are not confined to the separate restoration of historic buildings. It has no nostalgic view of urban form. It emphasizes creating a new urban structure with respect to the meaning behind traditional forms (Figs. 9.1, 9.2, 9.3, 9.4, 9.5 and 9.6).

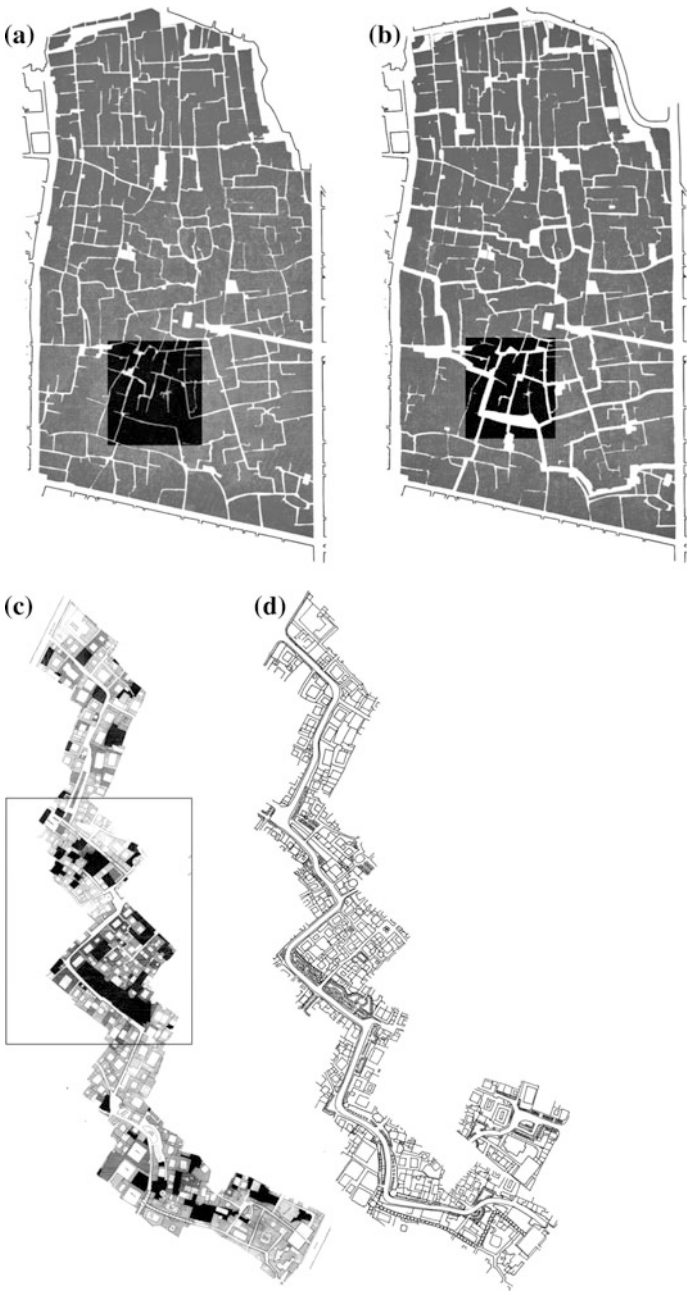


Fig. 9.1 Yazd. **a** The access network of the historic inner core (see Fig. 4.6). **b** Opening and equipping the network, by using the decayed areas. Designing a 12 m street integrated with different elements and spaces, at the edge of the Mozaffarid town, fourteenth century. **c** Narrow alley at the back of the town wall connected with ruined spaces (for detail of the central part, see Fig. 9.2). **d** For designed street, see Fig. 9.3

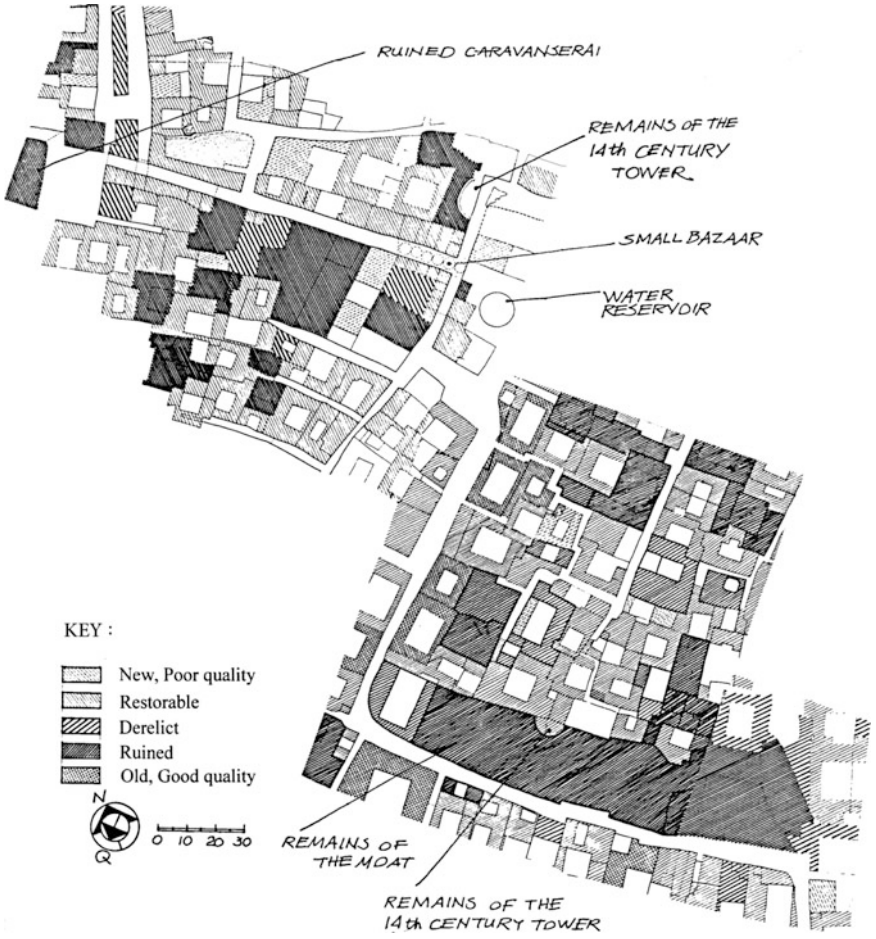


Fig. 9.2 **Yazd**. Condition of buildings and detail of the central part are in Fig. 9.1c

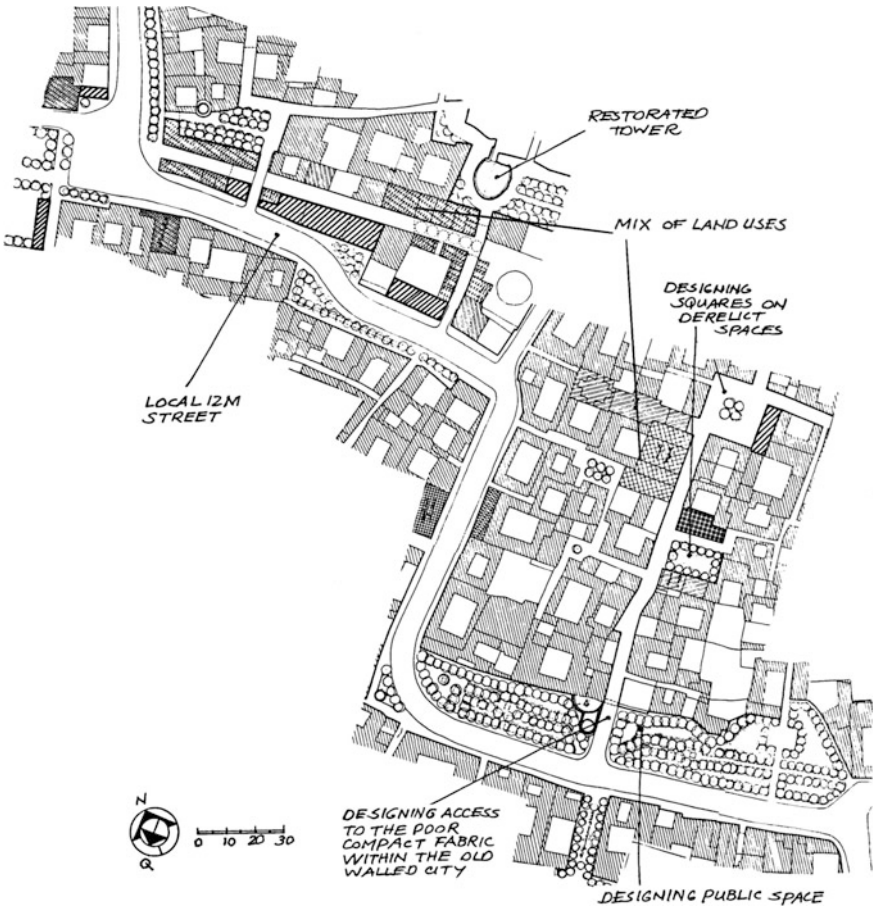


Fig. 9.3 Yazd. Designed street, a part of the 12 m local street and surrounding area. In the implementation process, the old wall was renovated, public space and new elements were created, but the key suggestion in renewing the old structure opening the poor, compact, closed, and unsafe fabric within the old walled city to the outside was not implemented. The effort was concentrated on the appearance of the wall and front space

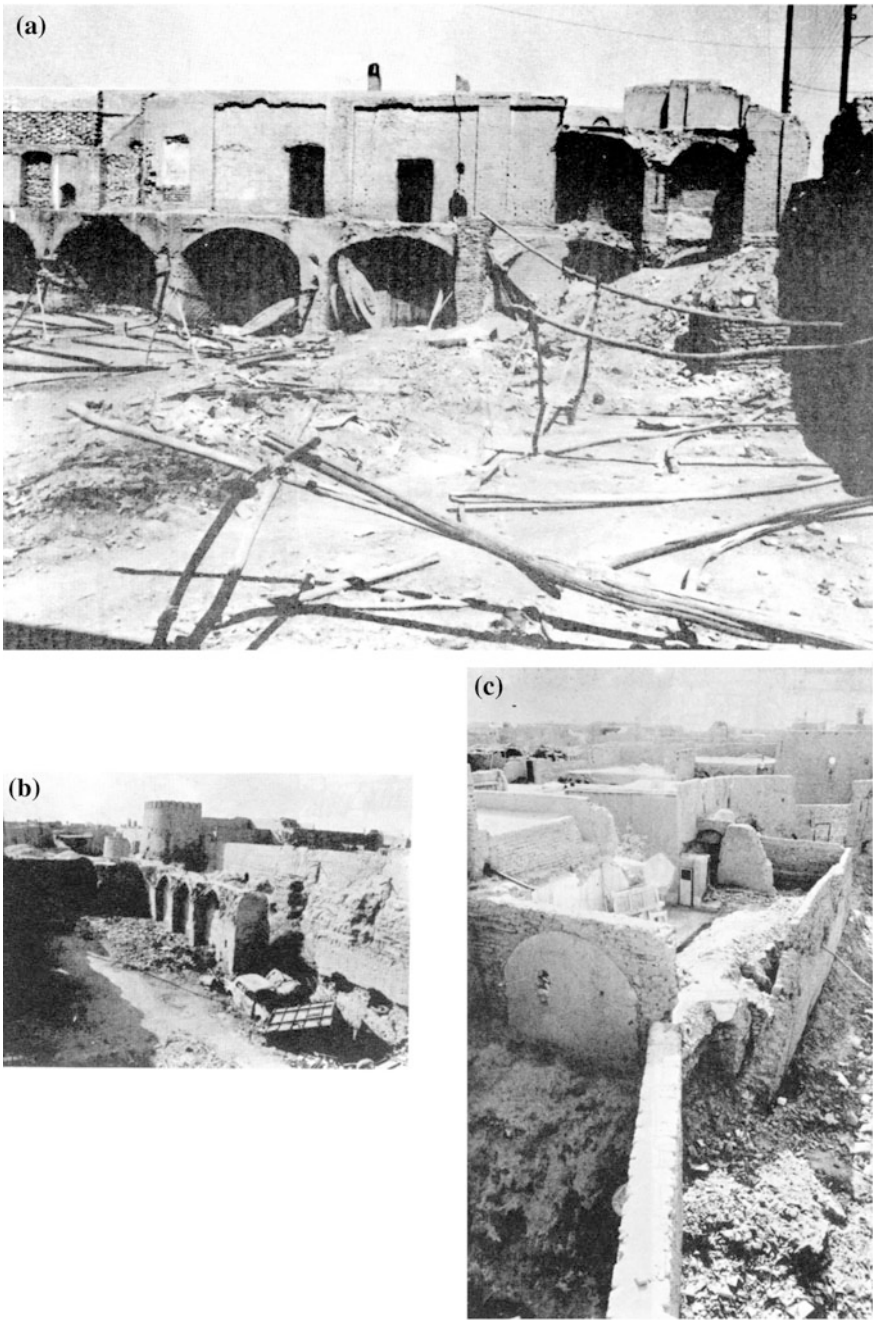


Fig. 9.4 Yazd. Decayed areas (Fig. 9.2): **a** Ruined caravanserai. **b** Remains of the moat, wall, and tower. **c** Decayed fabric at the back of the wall

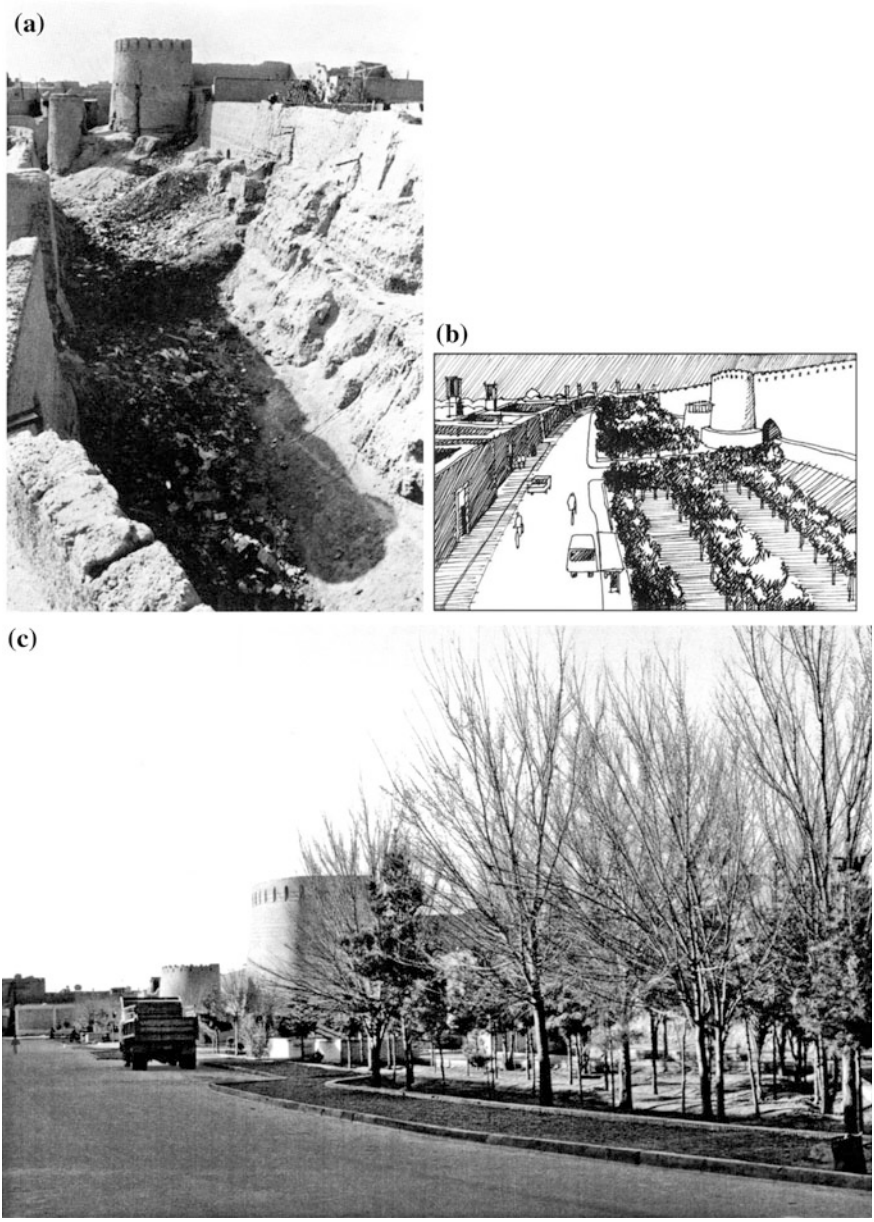


Fig. 9.5 Yazd. **a** Remain of the fourteenth-century tower and the moat. **b** Proposed design sketch. **c** Implemented design

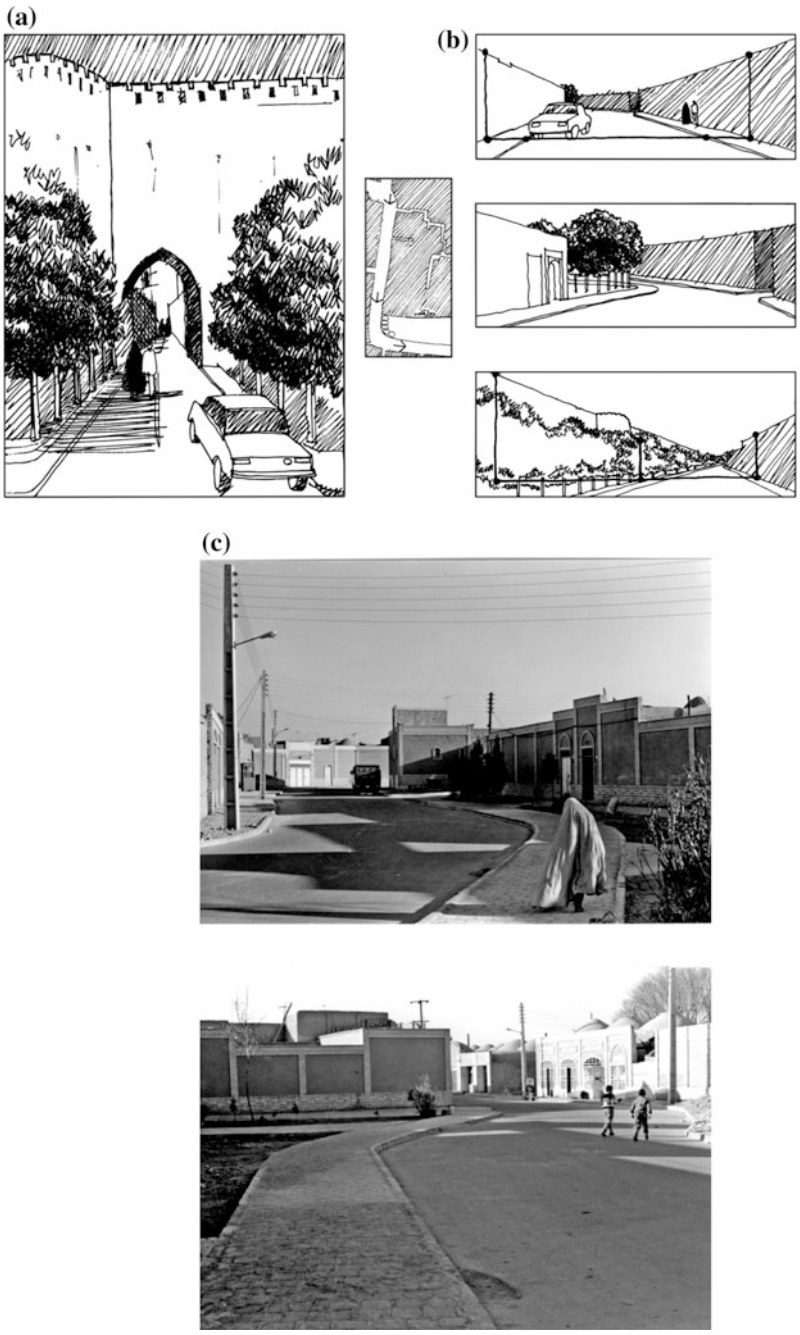


Fig. 9.6 Yazd. **a** Proposed access from the 12 m designed local street to the decayed fabric at the back of the wall. **b** Proposed sketches expressing proportions. **c** Implemented design

9.7 Case Study 2

9.7.1 Urban Design of Kargar Street, Tehran[2]

Kargar Street as a part of the main structure of the city of Tehran is a major north–south street running through the central part of Tehran. It intersects at Enghelab square with another major west–east street which includes University of Tehran and many other educational institutions and art centers. The Kargar Street changes in form and function of activities from the north with educational institutions to the south including military centers.

In the center, it is a part of the main street constructed on the demolished wall and moat encircling the mid-nineteenth-century Tehran (Fig. 4.25).

The study area adjacent to the University of Tehran is the most concentrated center of bookshops, and despite of traffic congestion and pollution, it is a lively place. Bookshops, bookstores, and connected facilities from front space of the University of Tehran are gradually spreading and changing the form and function of surrounding fabric including our study area.

Considering form, it is a straight street enclosed by compact urban block, inharmonious buildings, and crowded narrow sidewalks. Different buildings have been shaped incrementally over its nearly 150-year history. There are few buildings reminding the first decades of the modernization when a wide array of fascinating street architecture took shape with powerful forms. These buildings have been analyzed and simplified, and their shaping principles have been proposed for continuous development of the street. Unfortunately, some of these buildings have been demolished and replaced by high-rise or multistory ugly buildings, without any visual unity.

Today, privatization of the public street surrounded with dense urban blocks continues, and the greedy developers have the main role in shaping the street space.

The redesign of Kargar Street is an example of ordering project. It aims balancing the form and function of the street, but not a picturesque space. It is evident that overcrowding space, compact surrounding blocks, and noisy and polluted environment can not only be tackled through few guidelines.

As well as the refurbishment of the building fronts, we need to improve the spatial structure of the compact blocks. First step is opening the blocks through secondary accesses and creating public spaces at the scale of each block (Figs. 9.7, 9.8, 9.9, 9.10, 9.11, 9.12, 9.13 and 9.14).

[2]Selected from the book: M. Tavassoli (project manager and urban designer), in collaboration with Hamid Reza Parsi, Behzad Eskandarafshar, Sadegh Karimi, Ali Reza Naseralmimar, and Nayyereh Taghavi; *Urban Design Kargar Street Tehran*, Ministry of Housing and Urban Development, Urban Development and Revitalization Corporation, Tehran (2000).

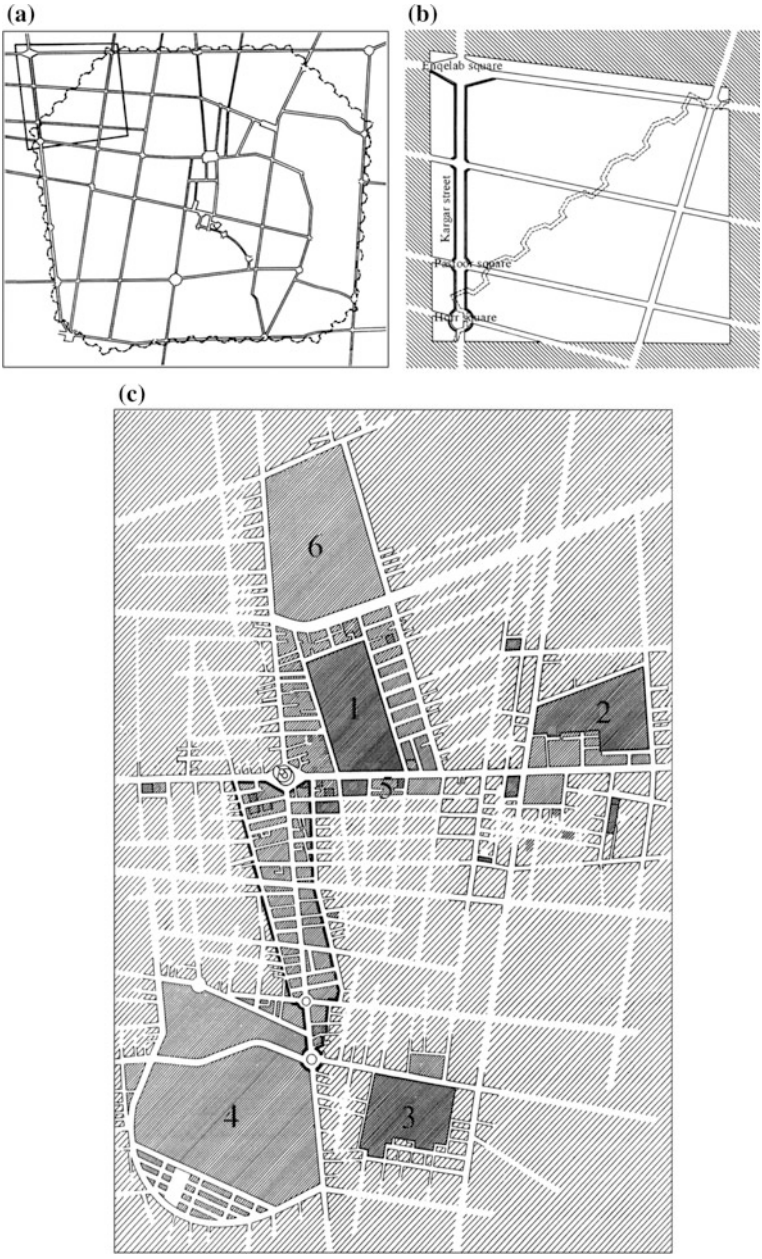


Fig. 9.7 Tehran. The study area: **a** The walled city mid-nineteenth century and later construction of surrounding streets on the demolished walls and moats. **b** A part of the study area. **c** The study area in connection with different elements, mainly university centers such as (*1*) University of Tehran, (*2*) Amir Kabir University, (*3*) the Officers' College, (*4*) garrison, (*5*) bookshop centers, and (*6*) park

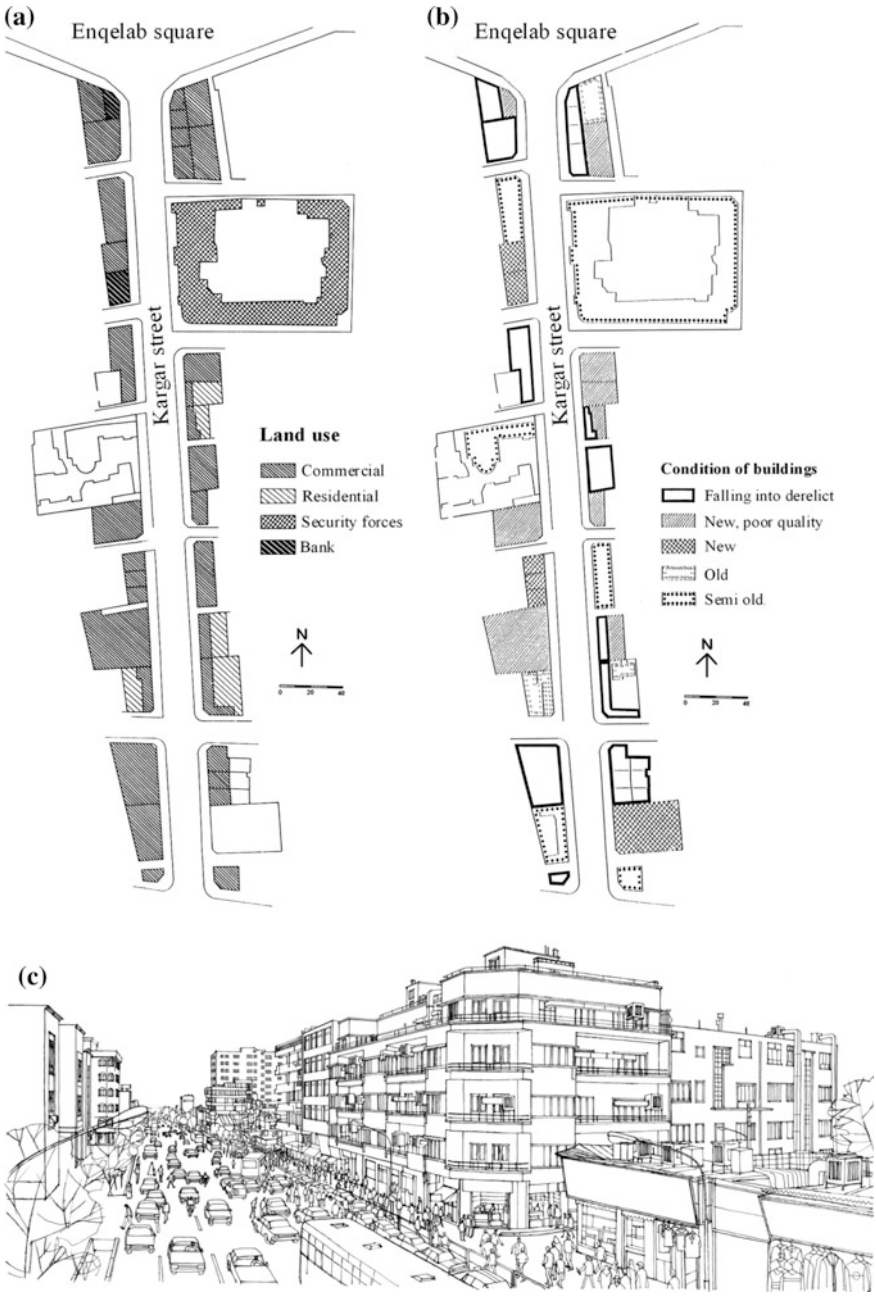
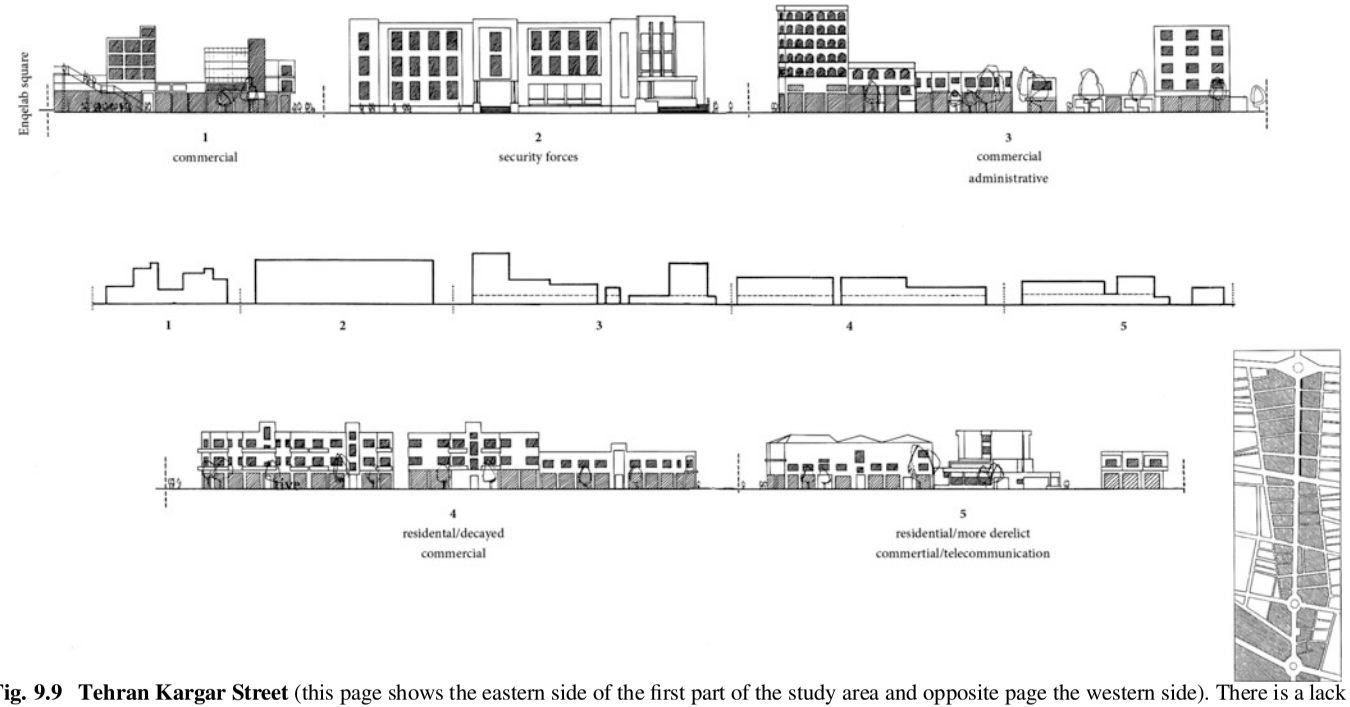
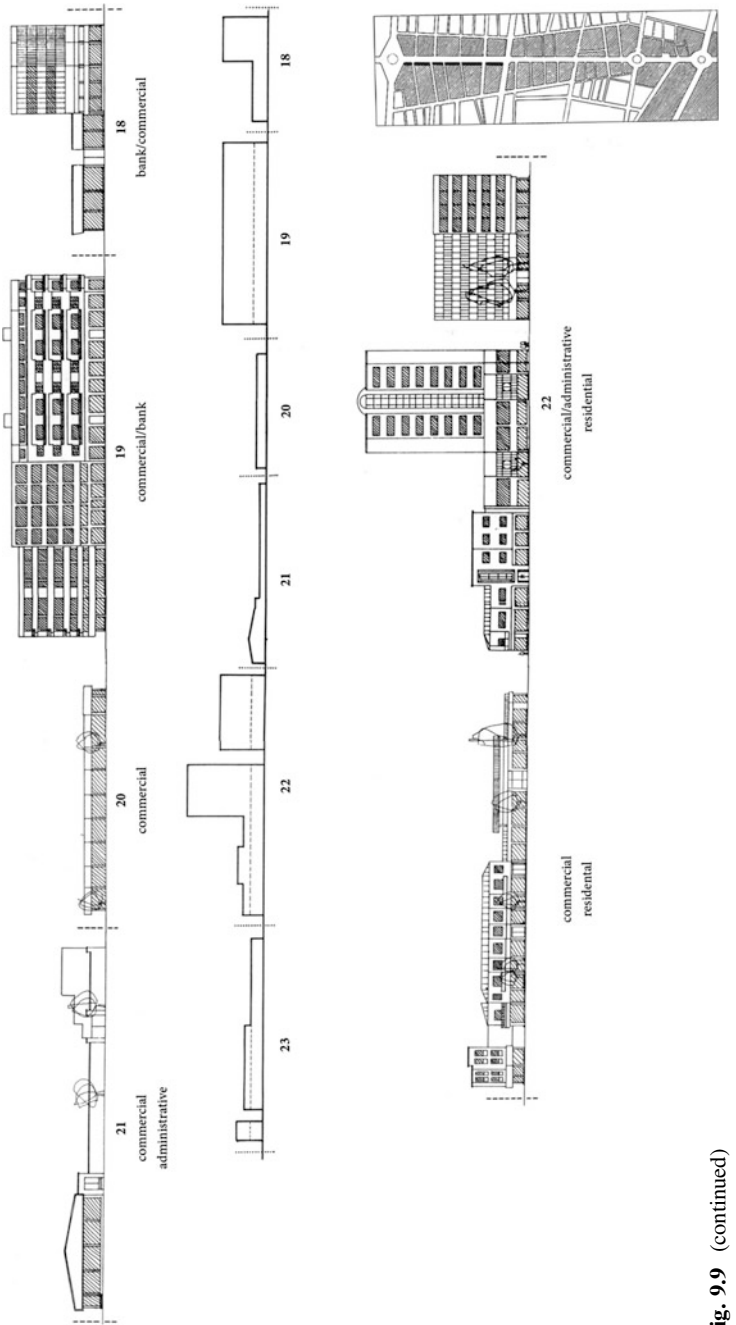


Fig. 9.8 Tehran Kargar Street. A part of study area: **a** Land use. **b** Condition of buildings. **c** Crowded, polluted, and noisy space with narrow sidewalks, enclosed by few remained beautiful buildings of 1920s and 1930s



◀ **Fig. 9.9 Tehran Kargar Street** (this page shows the eastern side of the first part of the study area and opposite page the western side). There is a lack of harmony between enclosing buildings. Each building is designed independently without common characteristics, with some in different periods. The area also includes several types of fascinating street architecture from the first decades of modernism, which in the western side have been reasonably shaped, considering hot summer afternoon sun, and also many irrelevant buildings of the last decades



◀ **Fig. 9.9** (continued)

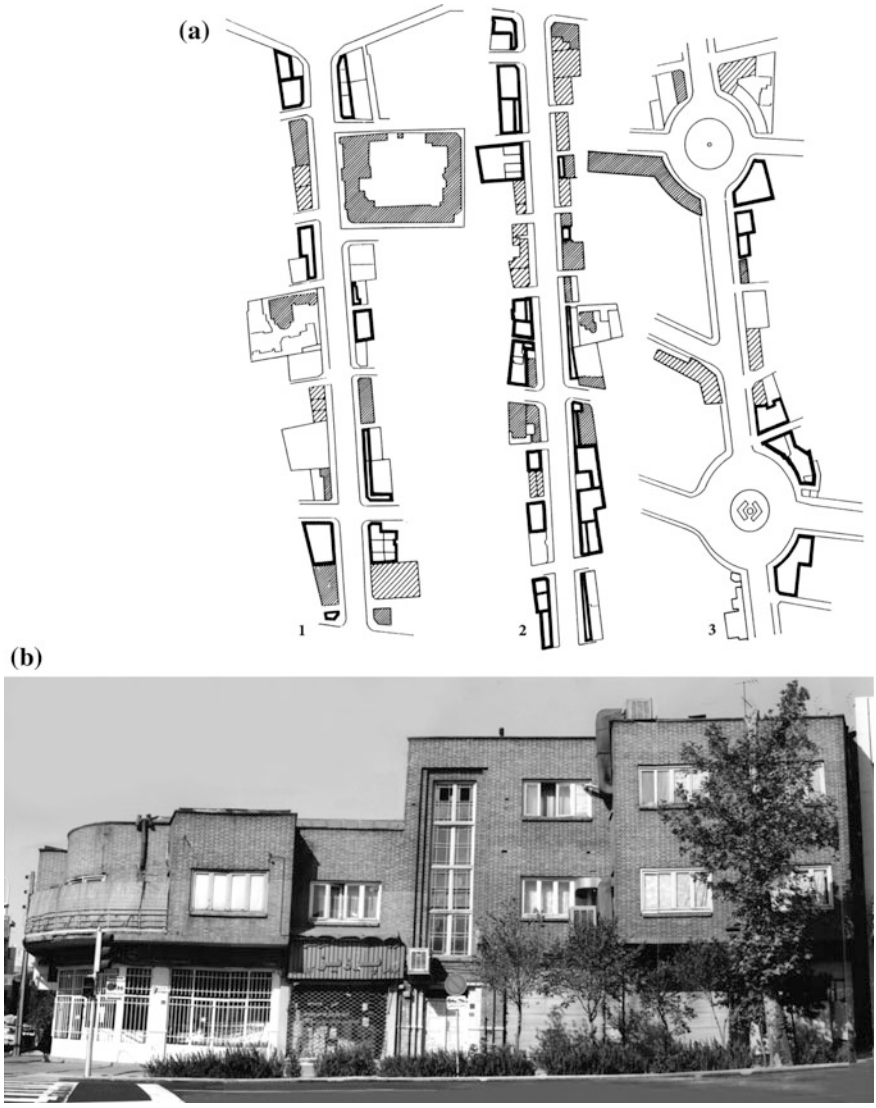


Fig. 9.10 Tehran Kargar Street. **a** The three parts of the study area, an analysis of condition of buildings. Areas with *black line* need controlled urban renewal. Areas with fine hatching need restoration, and those with coarse hatching need cleansing facades. **b** A part of block 22 (see Fig. 9.9), an example of restoration building

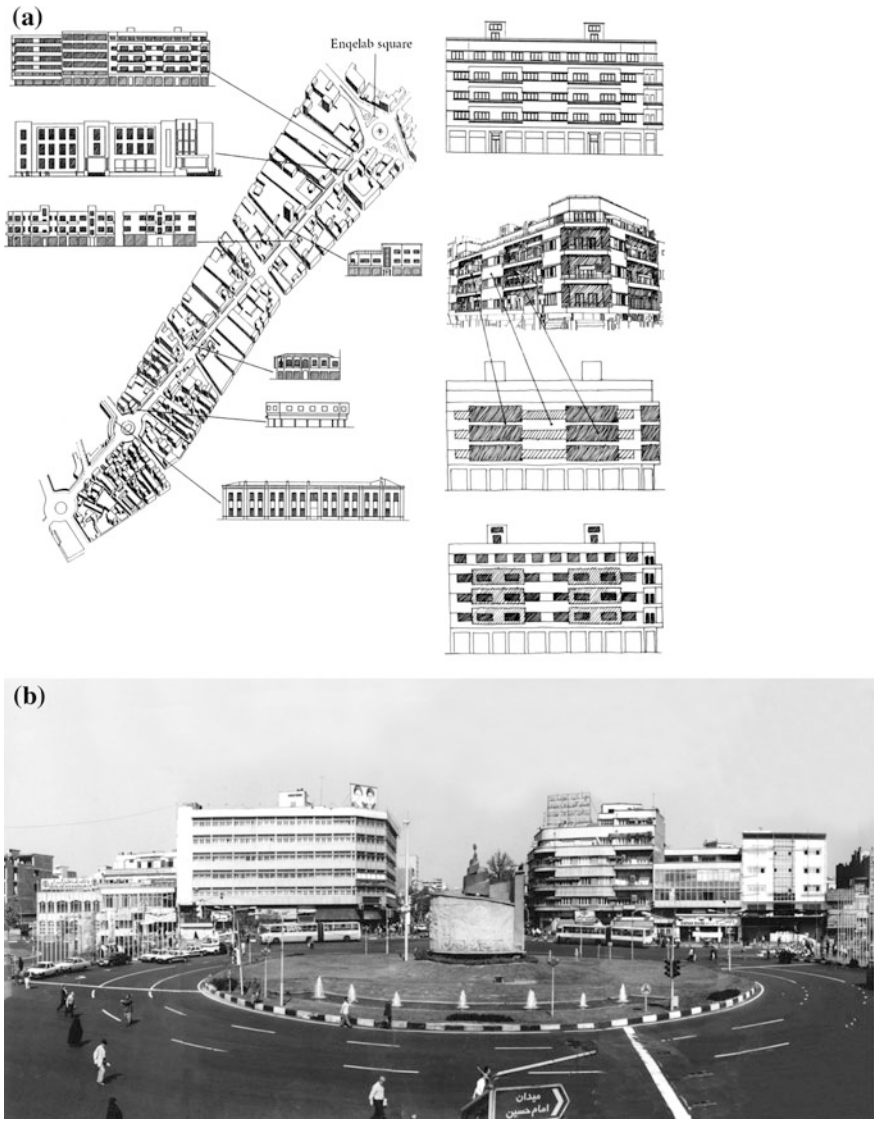


Fig. 9.11 Tehran Kargar Street. **a** Compact urban blocks, enclosing the street, and morphological studies of one of the considerable buildings. **b** Enghelab Square, looking to the south, the study area

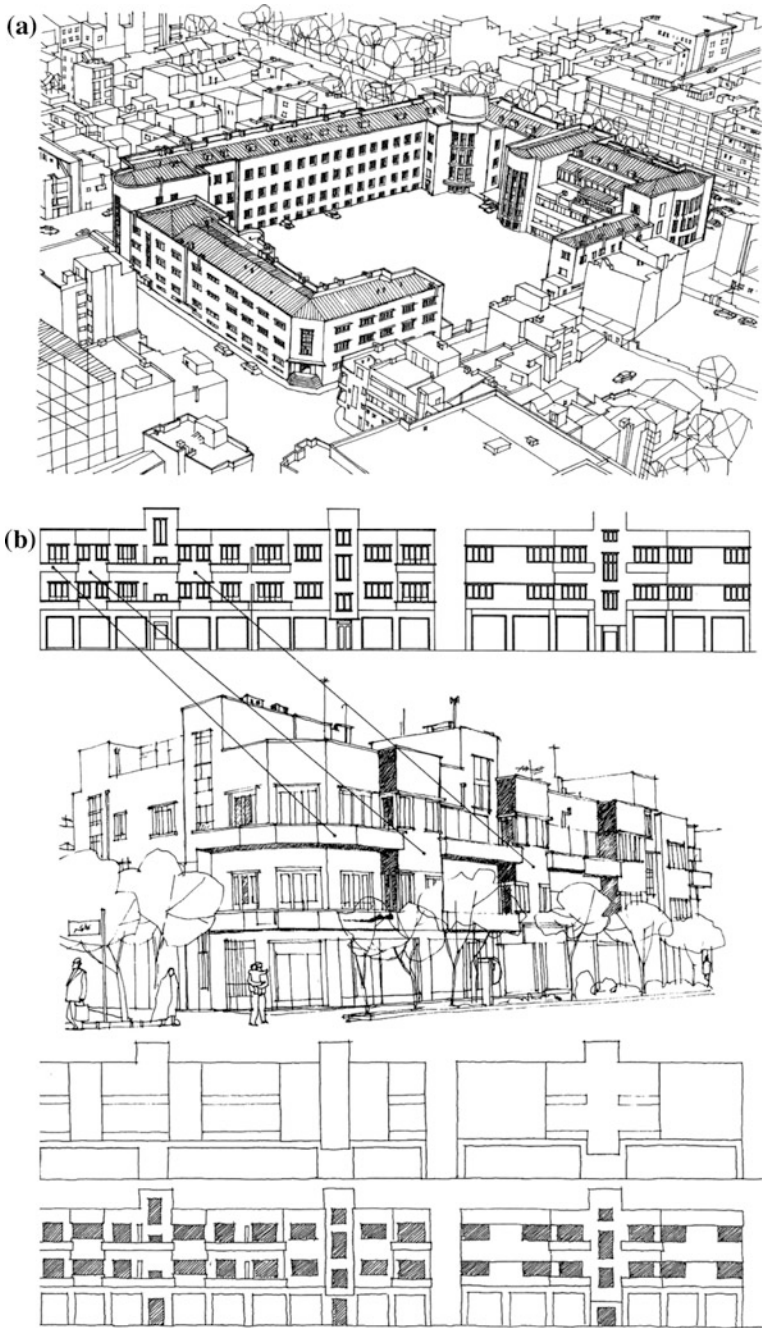


Fig. 9.12 Tehran Kargar Street. **a** Block 2, one building as an urban block. **b** A part of block 4, an example of mixed use buildings. Although structurally resistant and can be considered as building stock, if integrated with one new story, but unfortunately, these buildings are gradually demolished and replaced by tall buildings of poor quality

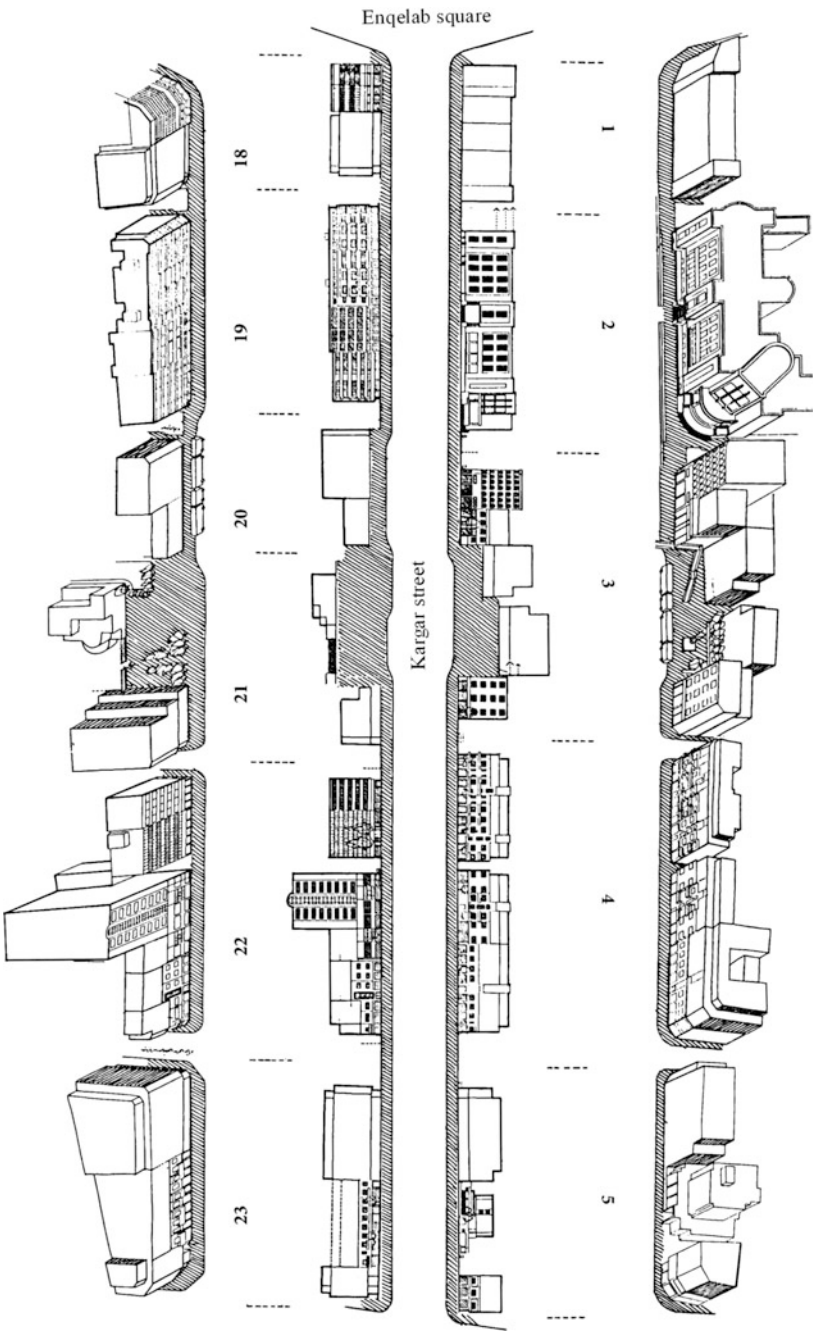


Fig. 9.13 Tehran Kargar Street. Part 1 of the study area, proposal for ordering street

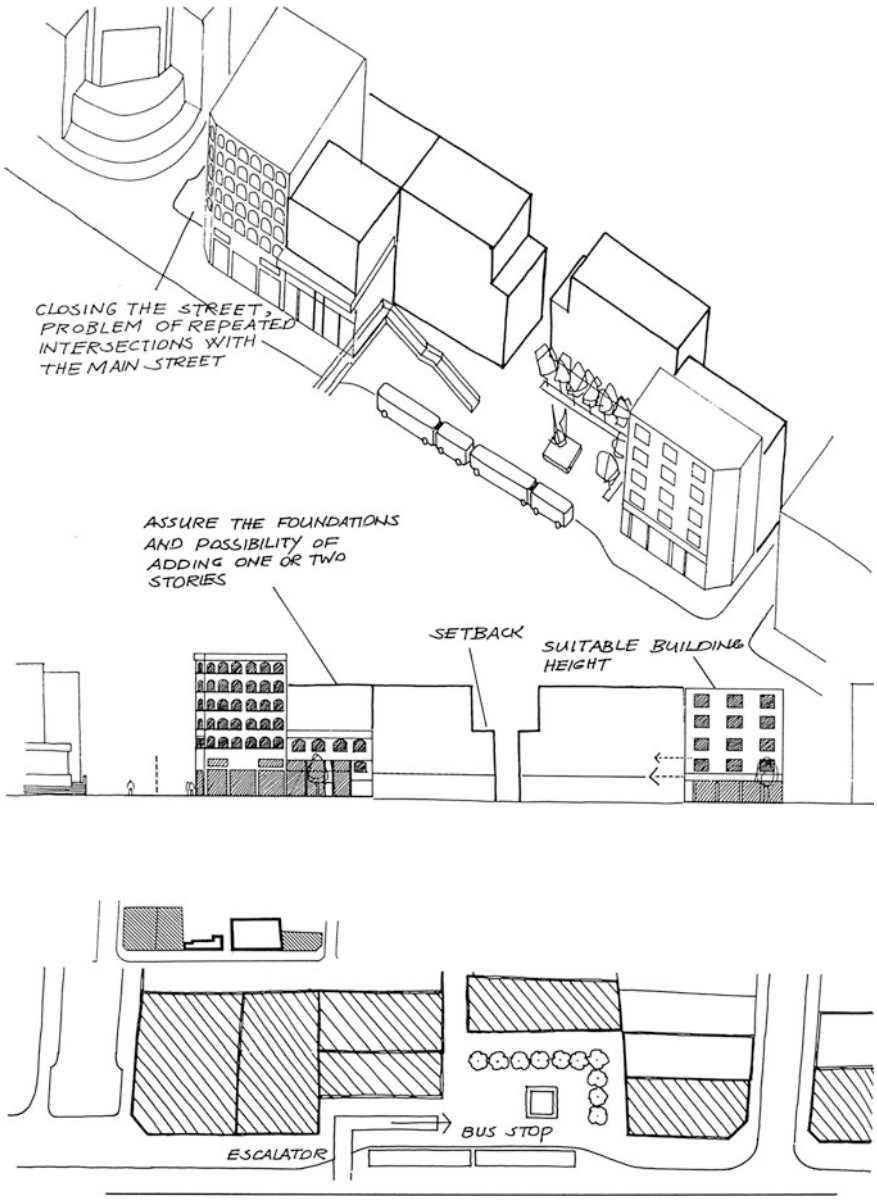


Fig. 9.14 Tehran Kargar street. Spatial improvement of front part of block 3: opening the block, creating open space, bus stop, and access to escalator, and creating urban furniture. Improvement also includes cleaning the facades of the buildings, strengthening the structure of few special three/four stories architecturally considerable buildings, and adding one or two integrated stories

9.8 Case Study 3

9.8.1 Redesign of Hasan Abad Square, Tehran[3]

Structurally, Hassan Abad Square was built on an intersection along one of the passageways of the main structure of Tehran (Fig. 9.15). The study area includes the square till the location of Ancient Iran Museum. Hassan Abad Square is one of the five famous squares in the central part of old Tehran. Today, these squares have lost their functional identity and significance as urban space and function as a traffic circle. Moreover, Hassan Abad Square is a copy from the concepts of Palladio, the famous Italian architect of Renaissance. It has no original form of Persian architecture.

The problem: In the mid-twentieth century, nearly two-third of the southeastern part of the enclosing buildings was demolished. Instead, a modern building for bank was constructed without harmony with the rest of surrounding buildings. In 1990s, the Municipality of Tehran decided to change the feature of the modern building and harmonize it with other buildings. In 1995, a design was accepted and carried out. The basis of it was to repeat the old forms in front of the modern building and change the remaining upper part to glass architecture. This action was criticized in the university's circles.

The present case study is an attempt to tackle with such design problems and was accomplished in 1996. Economically, the study area is the most concentrated center of hardware store and knitting wool. Buildings enclosing the street had decayed substantially. Renovation process faces not only with absence of design guidelines, but problems such as joint properties and absence of inheritors.

Abstraction study: In the study area, the emphasis has been put on the redesign and the ordering of the square. In order to avoid the repetition of the past and renewing the space, the old facade is simplified and abstracted, and the result has been considered in the new arrangement. In this process, analysis of the facade proportion has been carefully studied, and the basic elements such as vertical and horizontal shapes, corner structure, and openings have been regarded carefully (Figs. 9.16, 9.17, 9.18, 9.19, 9.20, 9.21, 9.22, 9.23 and 9.24).

[3]Selected from the book: M. Tavassoli (project manager and chief designer) in collaboration with Lila Tofangchi, Sarkis Barseghian, Nayyereh Taghavi; *Urban Design in the Inner Core of the City of Tehran,* Urban Planning & Architecture Research Center, Ministry of Housing & Urban Development, Tehran (1996).

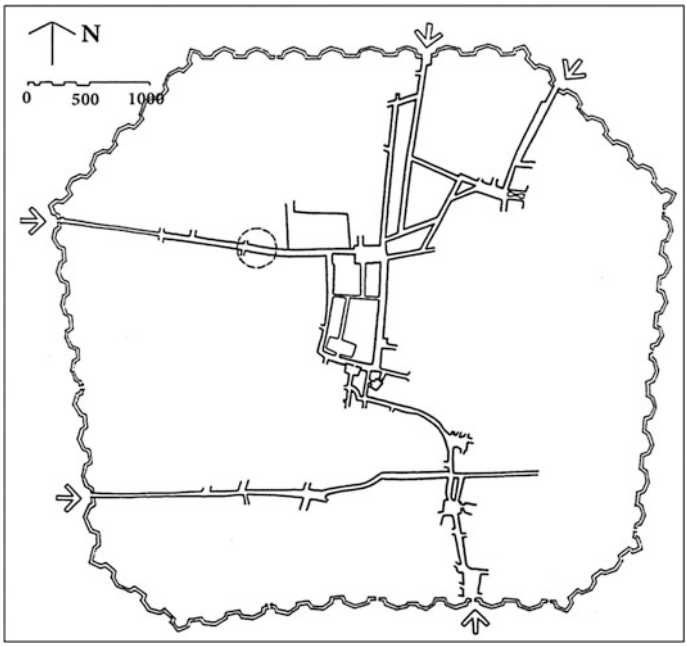


Fig. 9.15 Tehran Redesign of Hasan Abad Square. Main structure of the walled city, mid-nineteenth century, and the location of Hasan Abad Square

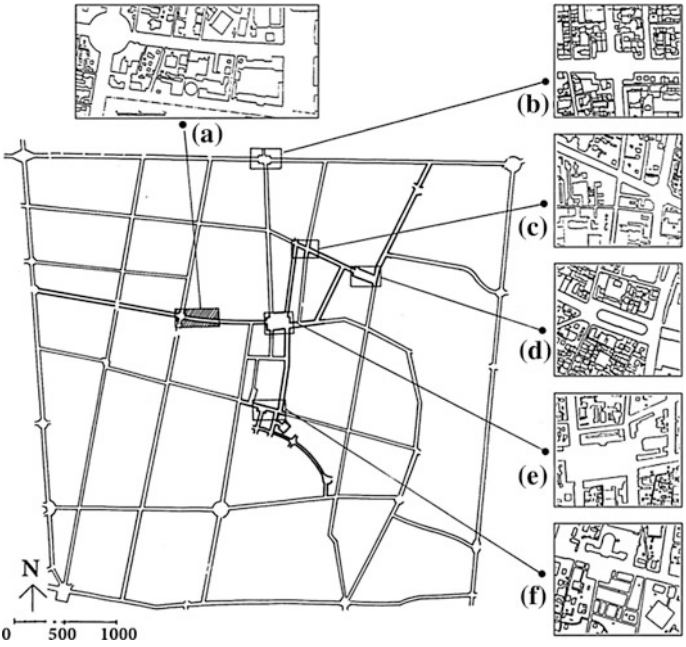


Fig. 9.16 Tehran Hasan Abad Square. Five main squares of the central part of the city: **a** Hasan Abad. **b** Ferdowsi. **c** Mokhber al Dowlla. **d** Baharestan. **e** Toopkhaneh. **f** Sabze meydan

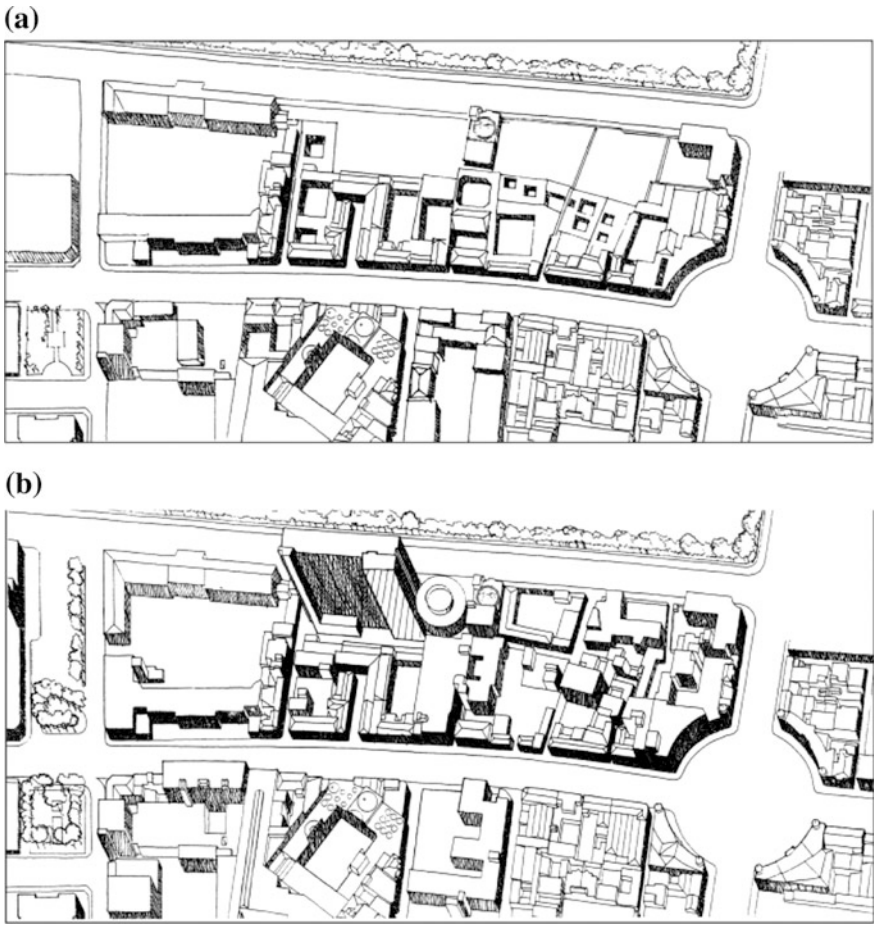


Fig. 9.17 Tehran. **a** The study area including Hasan Abad Square in 1950s. **b** The structure in 1960s. Rapid transformation from courtyard structure, responsive to climatic condition—to apartment blocks in the years of land reform, a process which has been accelerated in the last decades

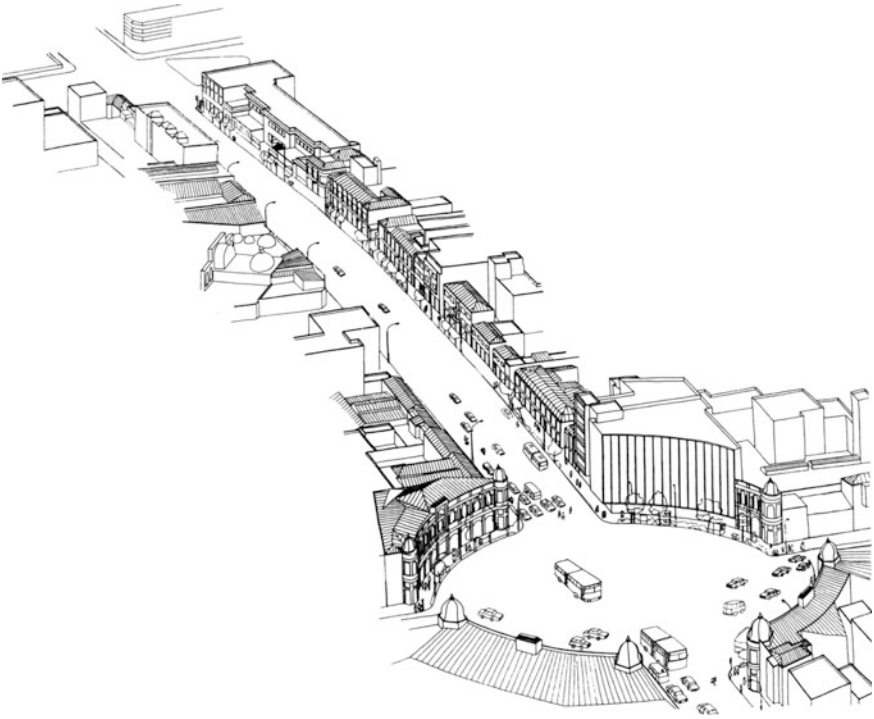


Fig. 9.18 Tehran. Hasan Abad Square and a part of the study area in 1994

Fig. 9.19 Tehran. Hasan Abad Square. The facade of the northwest, similar to the remaining facades at northeast and southwest

Fig. 9.20 Tehran. Hasan Abad Square. View of the southeast facade, exemplifying the square's modernization

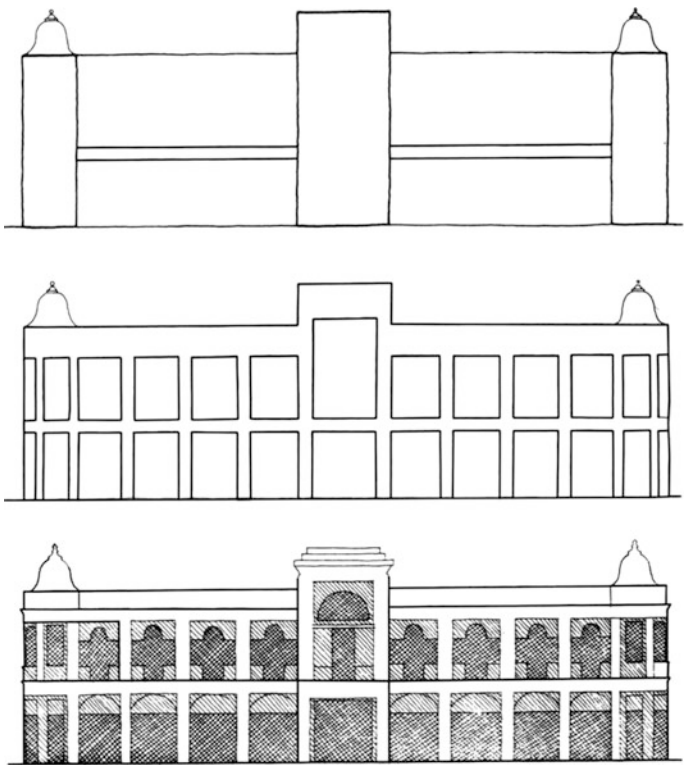


Fig. 9.21 Tehran. Hasan Abad Square. Drawings illustrate the simplification and a degree of abstraction of the old facade. The simplified pattern is considered in two design alternatives: balancing and bringing back symmetry to the square

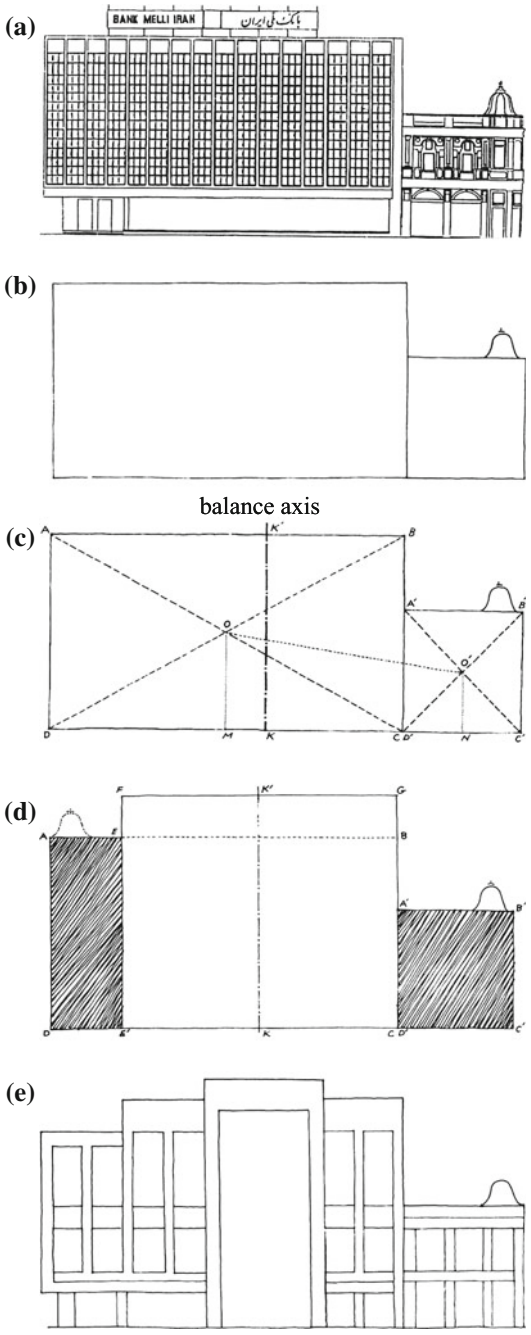


Fig. 9.22 Tehran. Hasan Abad Square. The process of balancing the facade:
a Existing façade.
b Imbalanced surfaces.
c Finding the balanced axis.
d Balancing surfaces. **e** New shape (see also opposite page)

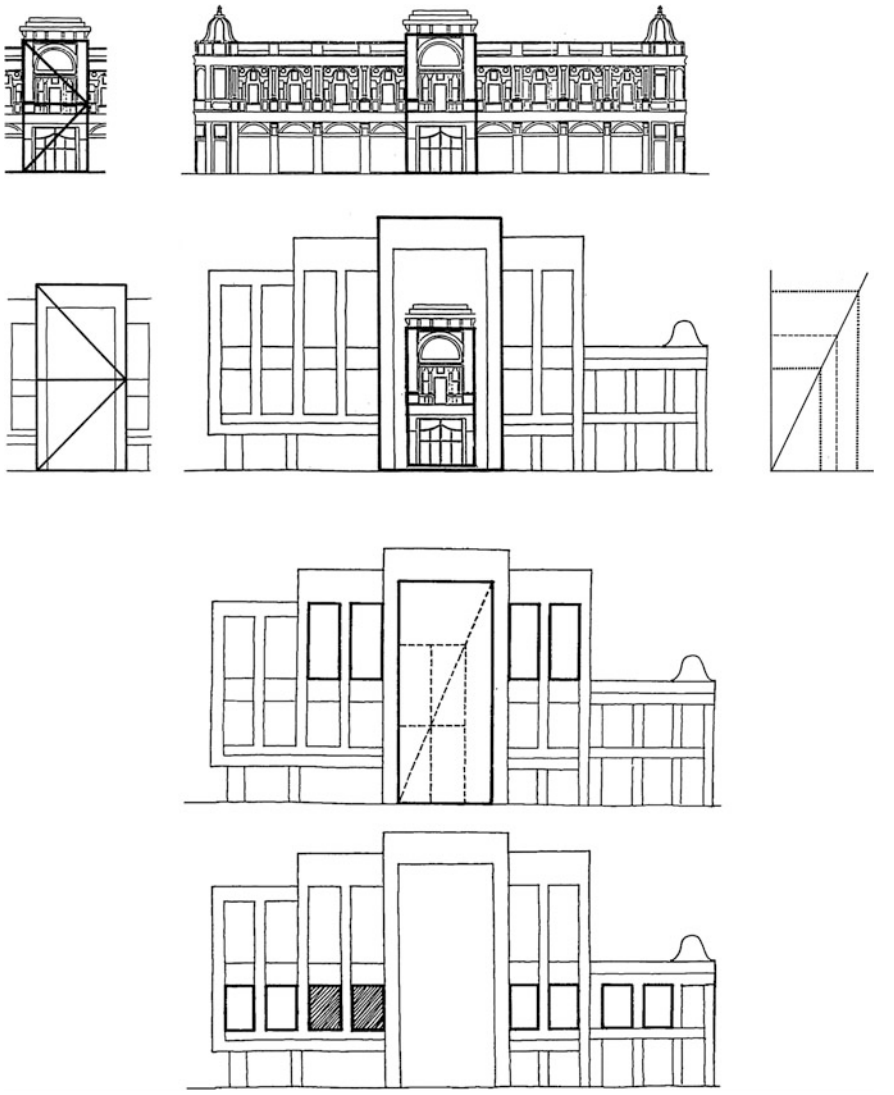


Fig. 9.23 Tehran. Hasan Abad Square. New shape based on the flow of the proportions from the old to the new

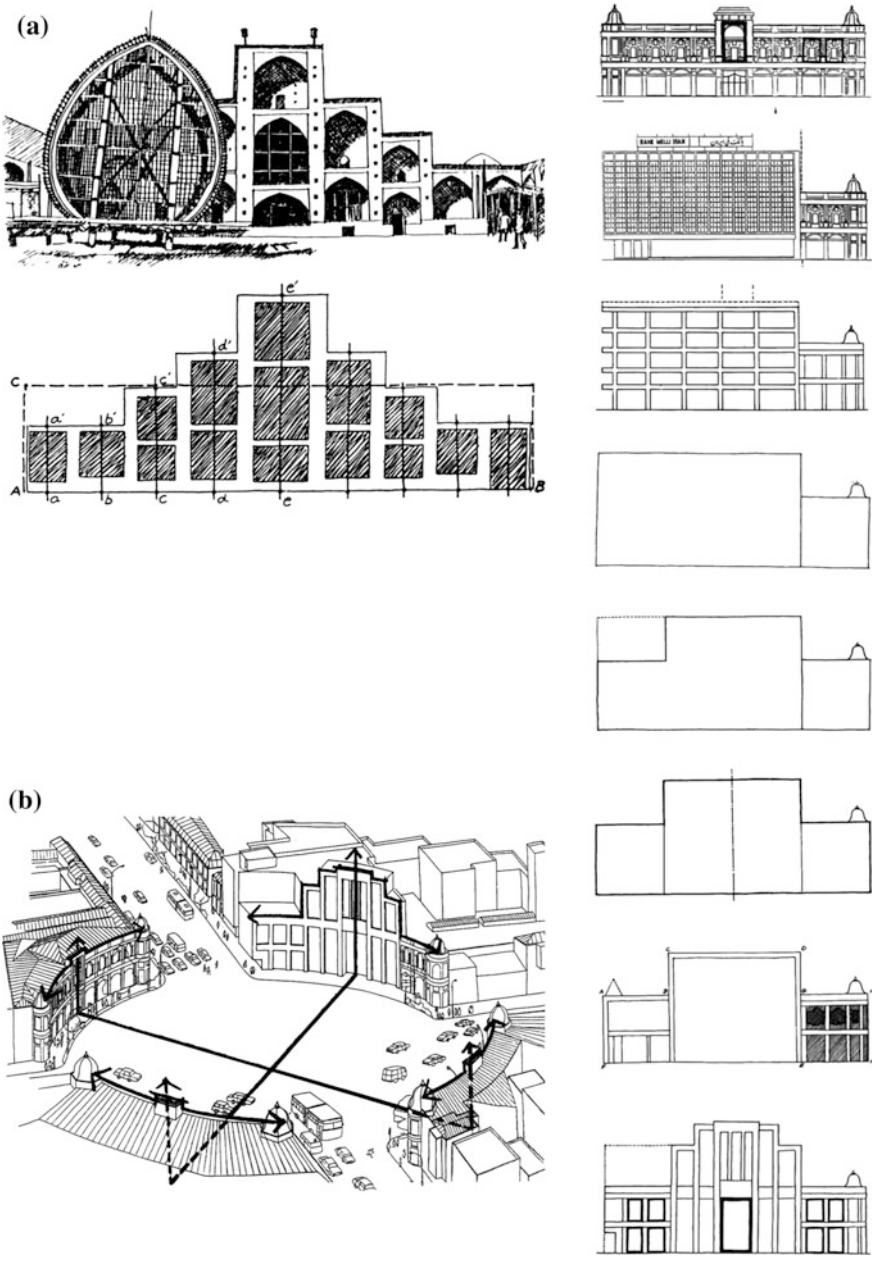


Fig. 9.24 Symmetrical design. **a** Taft. Typical Iranian main facade of urban space in the hot arid zone. **b** Symmetrical arrangement of Hasan Abad Square, lesson from the past in shaping the future

9.9 Case Study 4

9.9.1 Experimentation of New Forms of Urban Block[4]

As we saw in the first two parts of this book, the concern was on the structural form of the historic cities, neighborhood systems, urban blocks, and architectural elements considering historical and climatic factors.

As we saw, in addition to the importance of architecture of individual buildings, the integration of different elements such as mosques, schools, shrines, and houses in the form of urban blocks needs careful attention. Accordingly, renewing urban block to the more complex demands such as higher density and earthquake problem is significantly important.

The inward-looking traditional blocks in response to climatic and cultural factors were well grouped around neighborhood centers. There were also activities connected to housing which had impact on the arrangement of the spaces.

However, at first, changes were in harmony with climatic factors, but altogether with modernism a morphological rupture took shape in the urban structure, neighborhood system, and block pattern.

In the design of new urban blocks, and response to the new needs, the scale and the form of compact traditional urban blocks have been changed. It is aimed to open the compact block to ease circulation and create space for social relation and for the time of earthquake. Today, the most important point of historic fabrics is the abundance of decayed areas, clearing them and making way for new blocks integrated with open spaces.

The distribution of open space can be considered at three levels: city, neighborhood, and block. Altogether, because of sociohistorical and climatic factors, the historic city fabrics lack enough public spaces. In both low–density, one-story courtyard housing (Figs. 9.30 and 9.31) and 3–5-story housing apartments (Fig. 9.32), creation of public spaces has been taken into consideration. In the apartment housing, deep balconies looking to the southeast serve the purpose of a space like a courtyard. The unidirectional wind catchers cause the rapid air movement through ventilation duct. The scheme includes a collective space for social relationship and time of disasters. Considering orientation, the orientation of complex is preferably from south to 25° east of south. The two suggestions in response to climate and culture are inward-looking block schemes (Figs. 9.25, 9.26, 9.27, 9.28, 9.29, 9.30, 9.31, 9.32 and 9.33).

[4]Selected from the book: M. Tavassoli, *Principles and Techniques of Urban Design in Iran*, Urban Planning & Architecture Research Center, Ministry of Housing & Urban Development, Tehran (1986). Revised and enlarged for the present book.

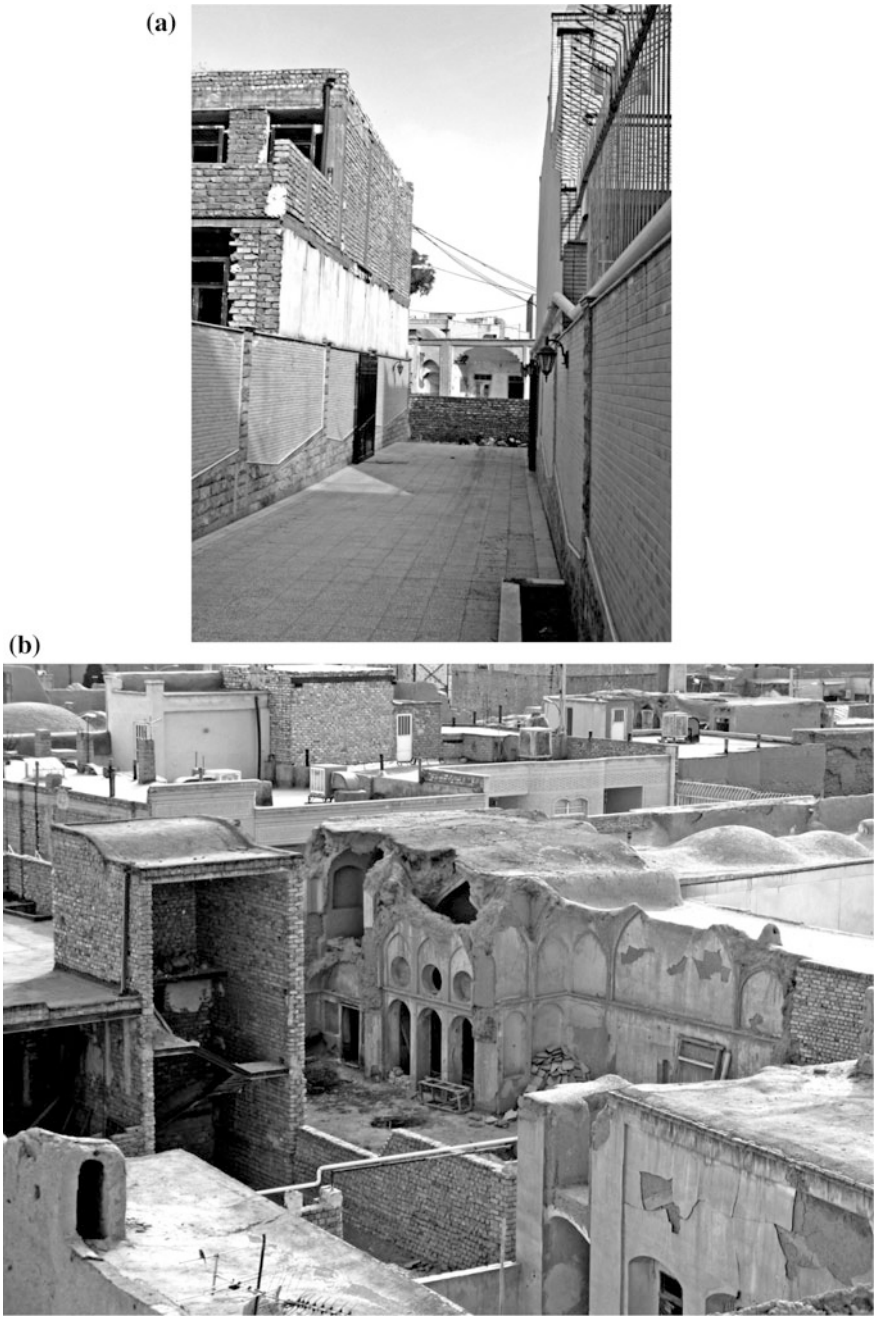


Fig. 9.25 Kashan. **a** Transformation of housing form, changing form of traditional courtyard house into 3–5 apartment blocks. **b** Derelict large courtyard house, problem of abundant examples of such spaces within the traditional urban blocks. New profit-oriented urban blocks ignore history, culture, and climate

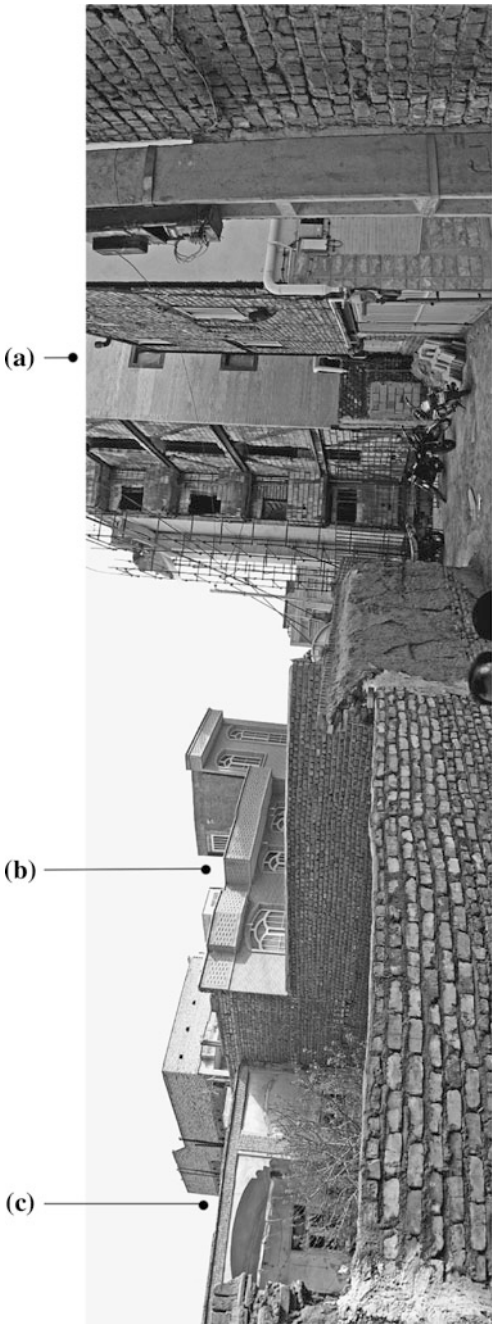


Fig. 9.26 Kashan. Another view of the area Fig. 9.25. Picture showing three historical periods: **a** Remains of the old houses, basic features that were in common use for centuries. **b** Examples of renewal mainly after the land reform in 1962. **c** Renewal in the form of apartment blocks since the last two decades, after the policy of selling density

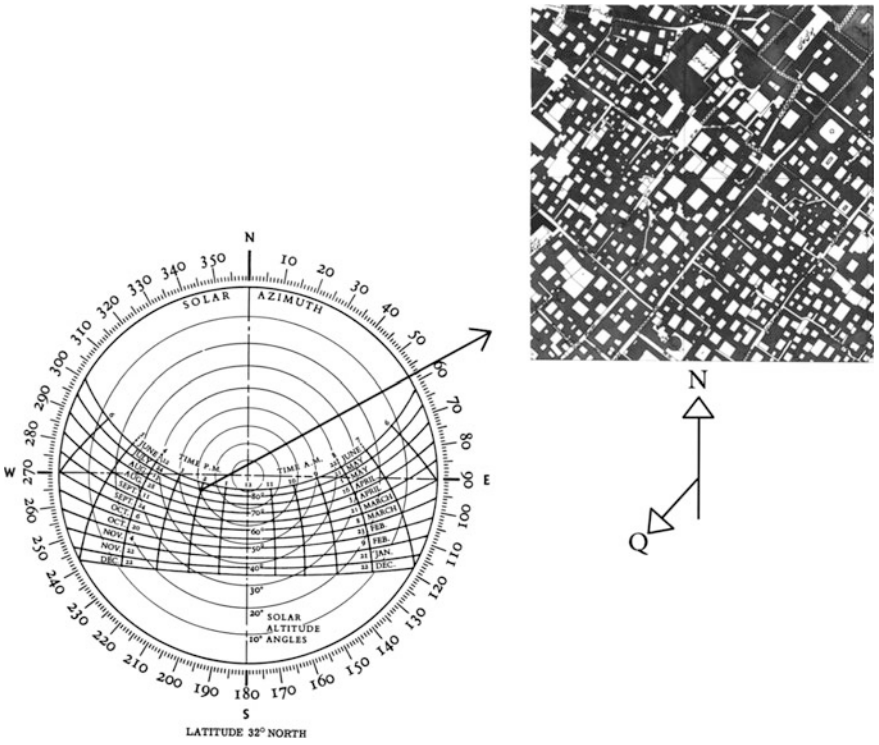


Fig. 9.27 **Yazd**. Orientation of the urban blocks. The city is located at a latitude of 32° north. The old fabric, access pattern, urban blocks, and housing units avoid the hot summer afternoon sun

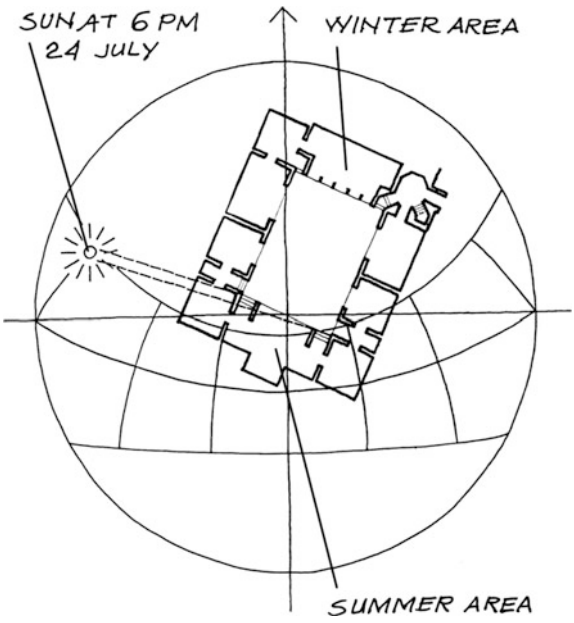


Fig. 9.28 Sun path diagram and the orientation of traditional courtyard housing

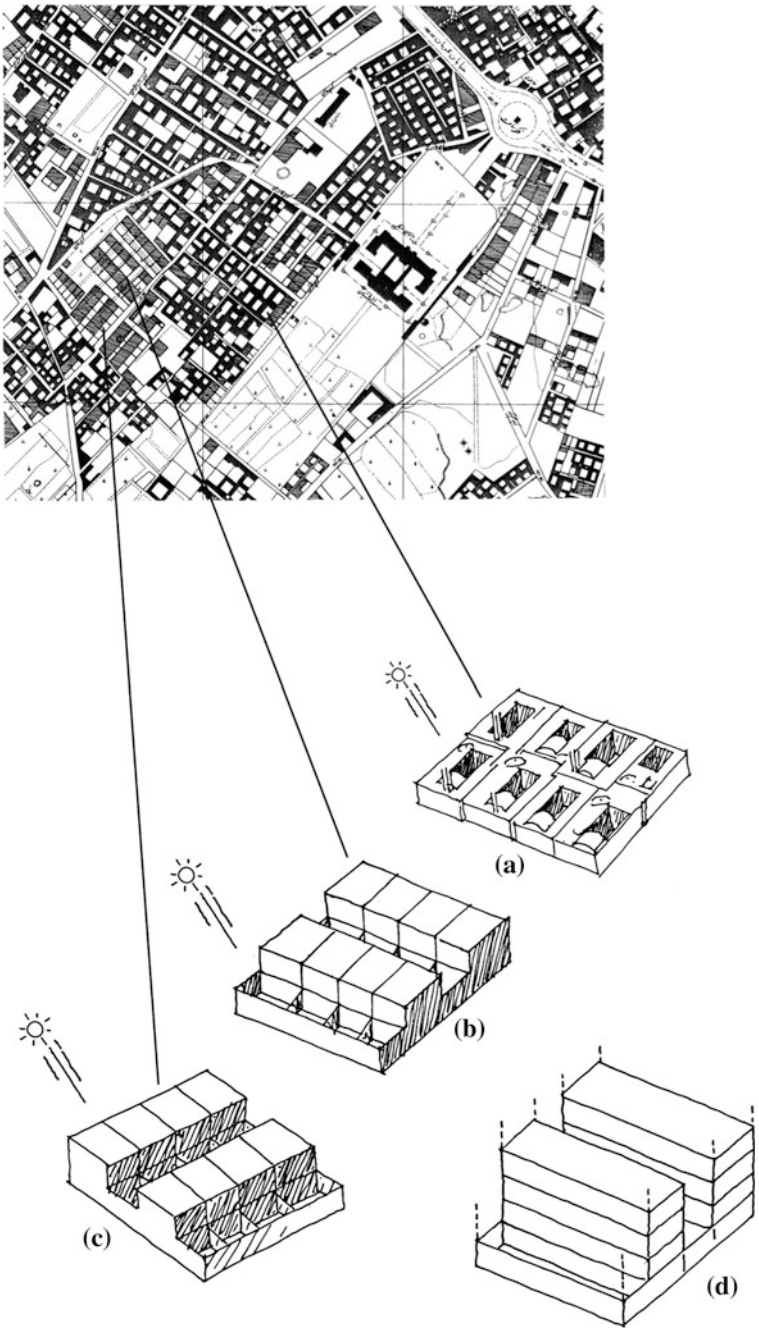


Fig. 9.29 Yazd. Transformation of urban blocks from courtyard houses to row houses and to high-density blocks: **a** Semi-old urban block with central courtyard houses mainly built in the first decades of the twentieth century. **b** Row houses' urban block with courtyards on the one side of the plots, mainly built in 1960s. Because of the problem of land division, some of these blocks are arranged wrongly and exposed to the hot summer afternoon sun. **c** Blocks with houses back to the hot afternoon sun. **d** Gradual transformation of two- or three-story blocks to high-density blocks

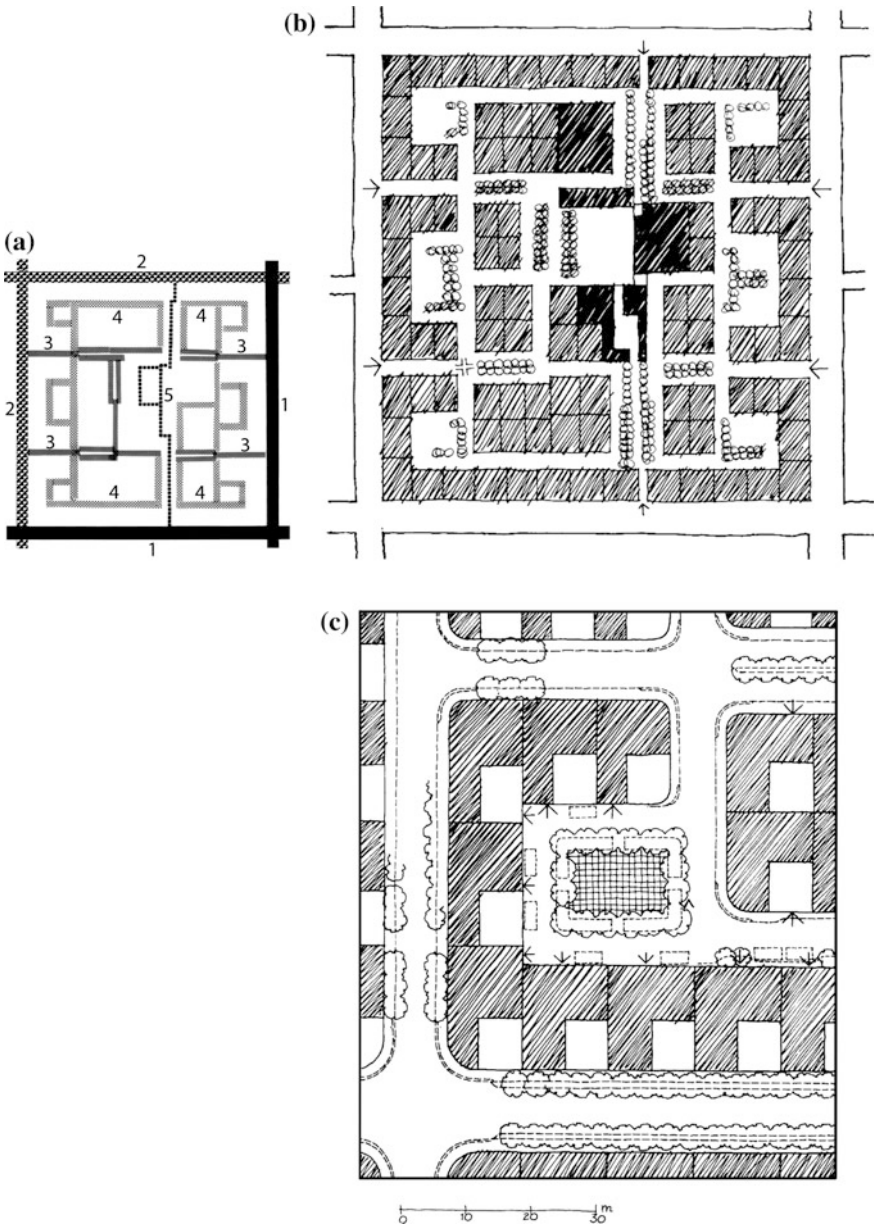


Fig. 9.30 Design of a 5 acres residential complex/blocks mixed with local elements such as shops. **a** Road type: (*1*) Local distributor 1. (*2*) Local distributor 2. (*3*) Internal access 1. (*4*) Internal access 2. (*5*) Pedestrian. **b** The complex with four vehicular access from east and west streets. **c** Courtyard houses surrounding the semi-public courtyard/square

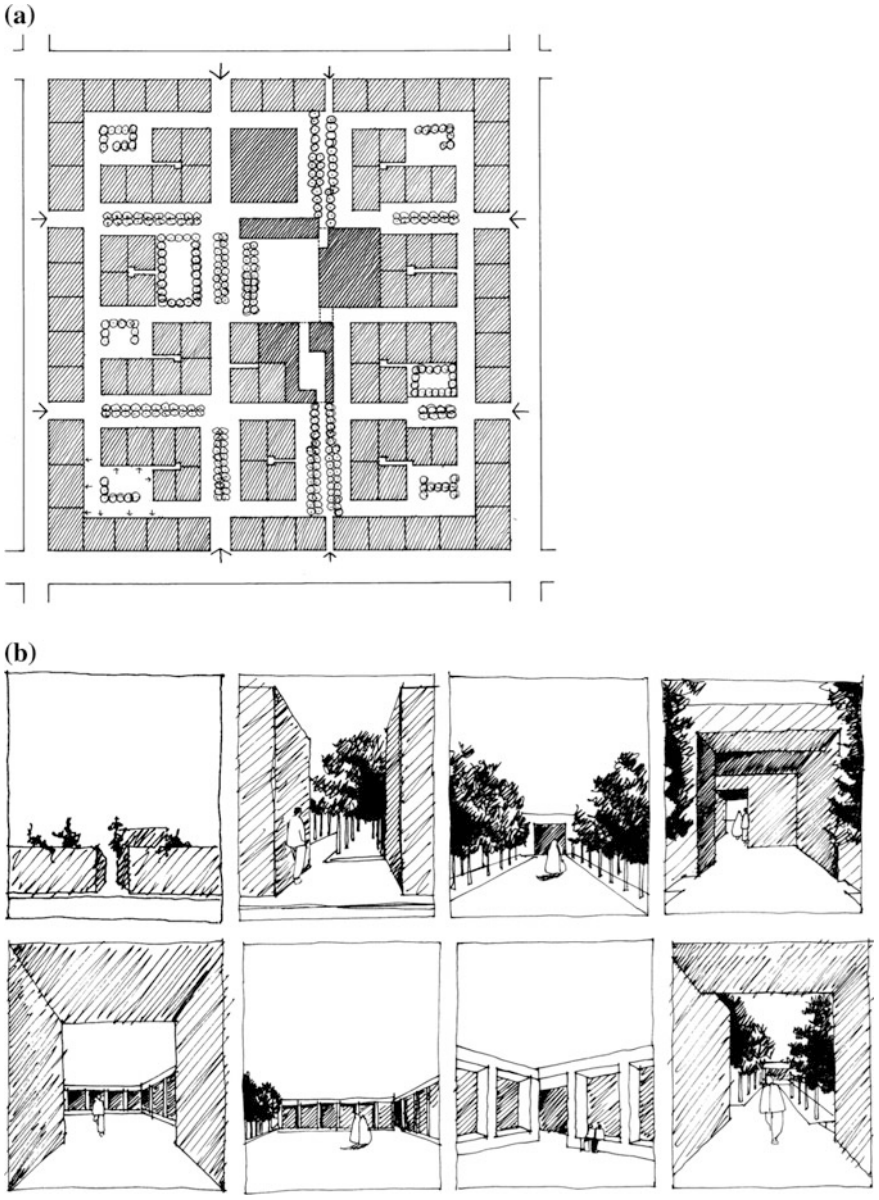


Fig. 9.31 **a** The residential complex previous page, with six vehicular access from surrounding streets. **b** Serial vision across pedestrian access

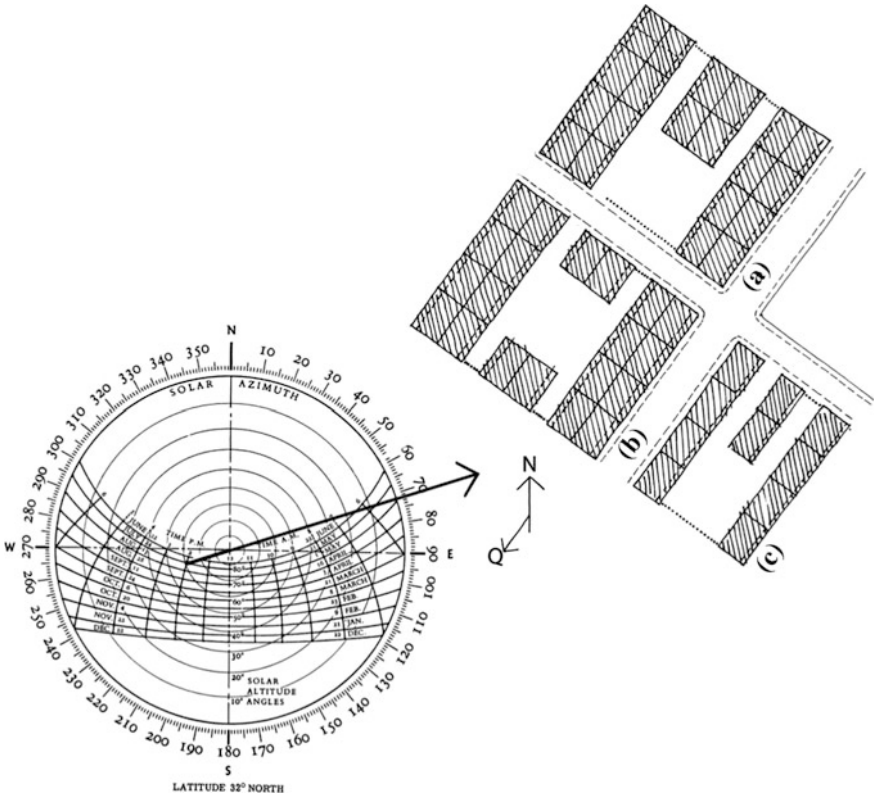


Fig. 9.32 New 3–5-story urban blocks, the potential for change in the new developments in the outer areas, and small infillings in the derelict parts of the inner areas. The sketches aimed at first promoting, socializing, and opening the old compact inward-looking structure, second—minimizing the effects of earthquake, and third—use of natural energy. The structure comprises three types of urban blocks, prevents the intrusion of direct sun, and enjoys favorable winds

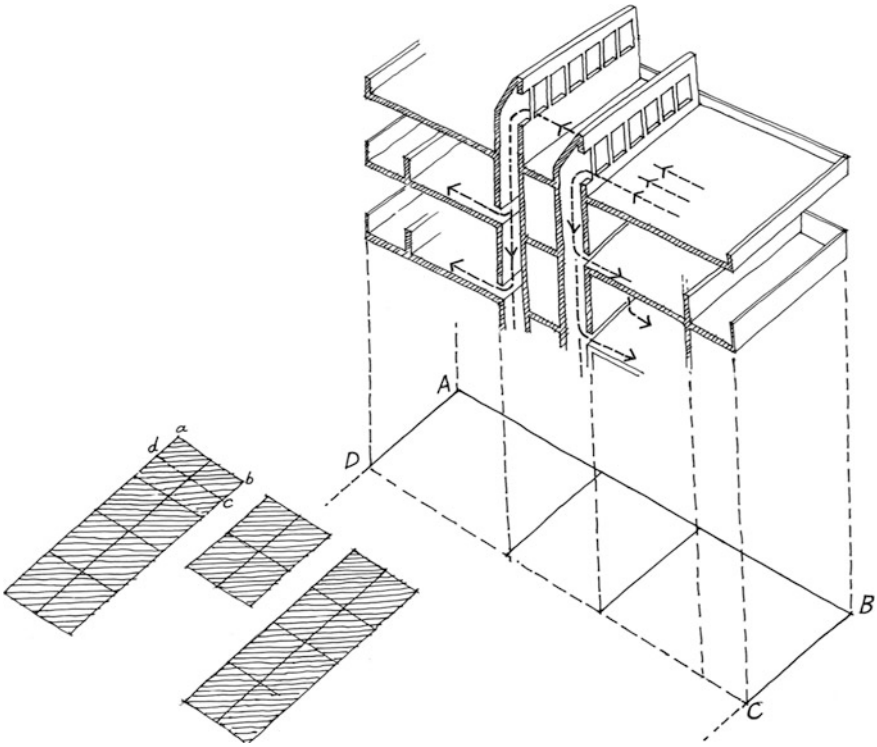


Fig. 9.33 The arrangement of apartments on both sides, with internal passage and unidirectional wind catcher (see Tabas, a typical house in Fig. 8.11, and *Climate and House Design* p. 46)

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Appendix A
Climatic Characteristics and Classification of Iran, Studies of the Hot Arid Zone[1]

Climate

Iran is located in the arid belt of eastern hemisphere, in the West Asia borders the Caspian Sea in north and Persian Gulf in the south. Two ranges of high mountains, Alborz in the north and Zagros in the west, have the basic role in preventing the Mediterranean and Caspian winds to the central plateau, which is the prime determinant of creating urban and architectural form in the hot arid regions (Fig. A.1). The desert area comprises several parts, especially a characteristic triangular shape including salt desert and low areas of Kerman and Yazd, which is about 300,000 km^2. All of the studied cities and villages in the present book are located in the different regions of the hot arid zone of Iran.

Considering atmospheric pressure, Iran is located in a low-pressure area and accordingly current of air from north and northwest regions (Fig. A.2). Among the wind systems in Iran, one of the most important and consistent seasonal winds which have influenced urban and architectural form is 120-day wind/bad-i sad o bist rooze known as Levar. This wind blows regularly southward from the Qizil-Qum steppes in Turkmenistan toward Kurasan, Sistan and Baluchistan, from about mid-May until September. The mud-brick wind mills that we discussed before are located in these regions. Olgyay writes (Fig. A.3):

> …There are many systems for classifying (climate zones) but W. Koppen's is generally accepted. Using the relation of climate to vegetation as a criterion, he determined five basic climate zones: tropical-rainy, dry, warm-temperate, cool-snow-forest, and polar.

In W. Koppen's classification, a considerable part of the Iran falls into two important categories, semiarid (BS) and arid (BW) (Fig. A.4b). In the more refined research based on Koppen's classification, A.H. Adl has made a detailed study (Fig. A.5).

[1]Appendix A is mainly extracted and analyzed from the works of distinguished Iranian professors at Tehran University. See A. H. Adle, *Climatic regions and vegetation of Iran,* University of Tehran, 1960. and M.H. Ganji, Geography of Iran, in *Iranshahr vol. 1*, UNESCO, Iran, 1962.

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The Urban Book Series, DOI 10.1007/978-3-319-39098-7

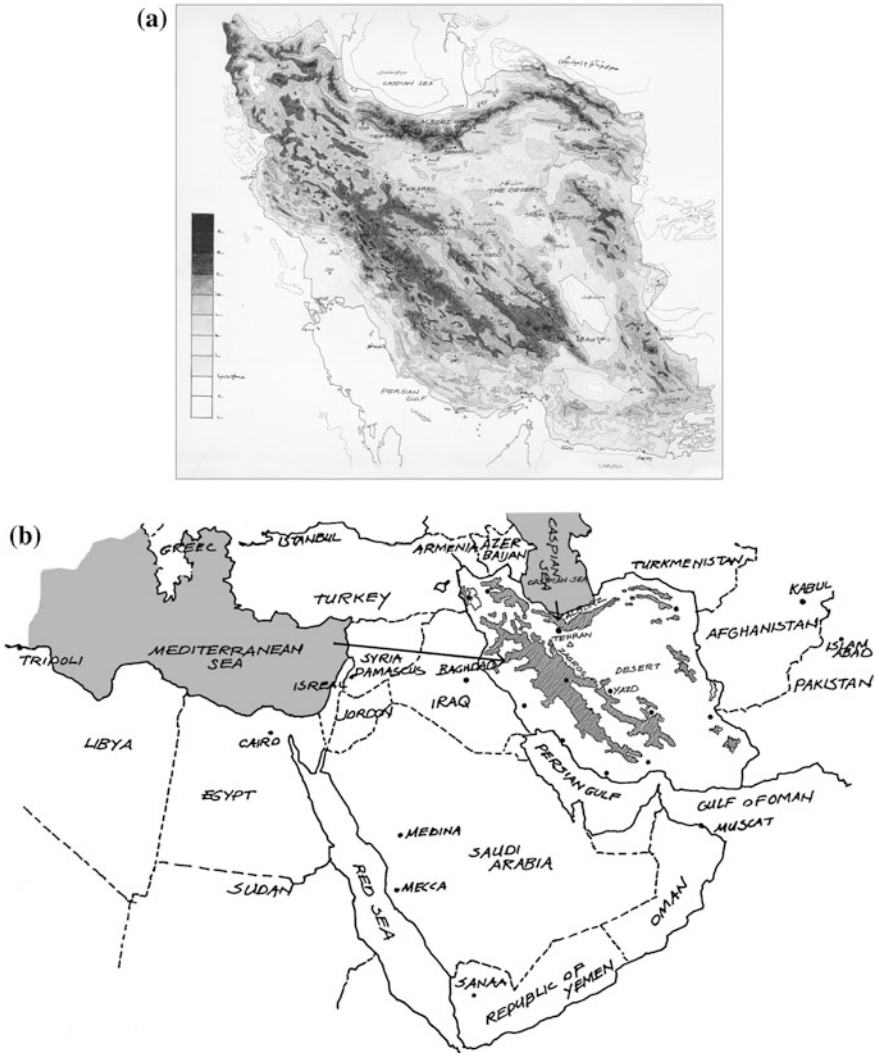

Fig. A.1 **a** The Iran highlands. **b** The position of Iran in the Middle East Region, and the two high barriers Alborz and Zagros mountain ranges prevent moist Mediterranean and Caspian winds from reaching the central plateau and have the basic role in creating the hot arid regions

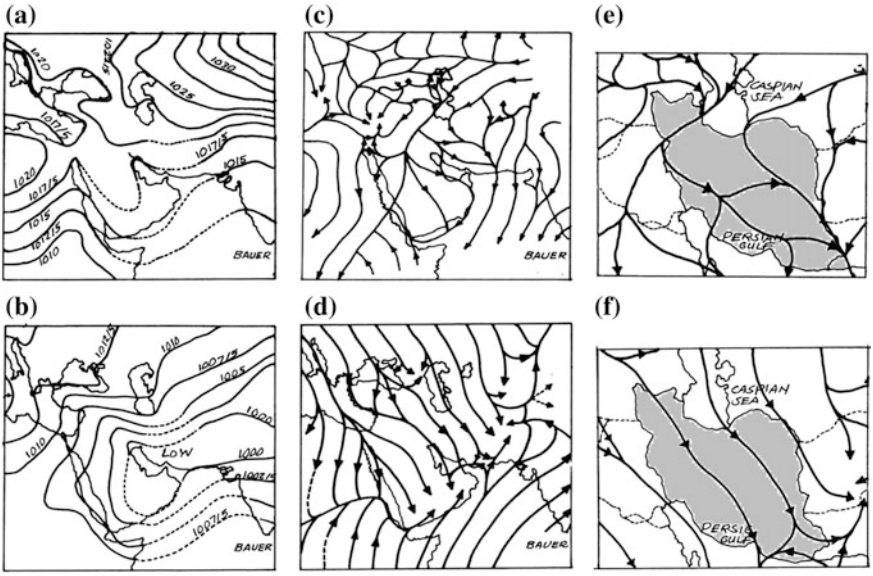

Fig. A.2 Atmospheric pressure and air movement: **a** Western Asia in winter. **b** Western Asia in summer. **c** Western Asia in winter. **d** Western Asia in summer. **e** Iran in winter. **f** Iran in summer. (redrawn from Adl)

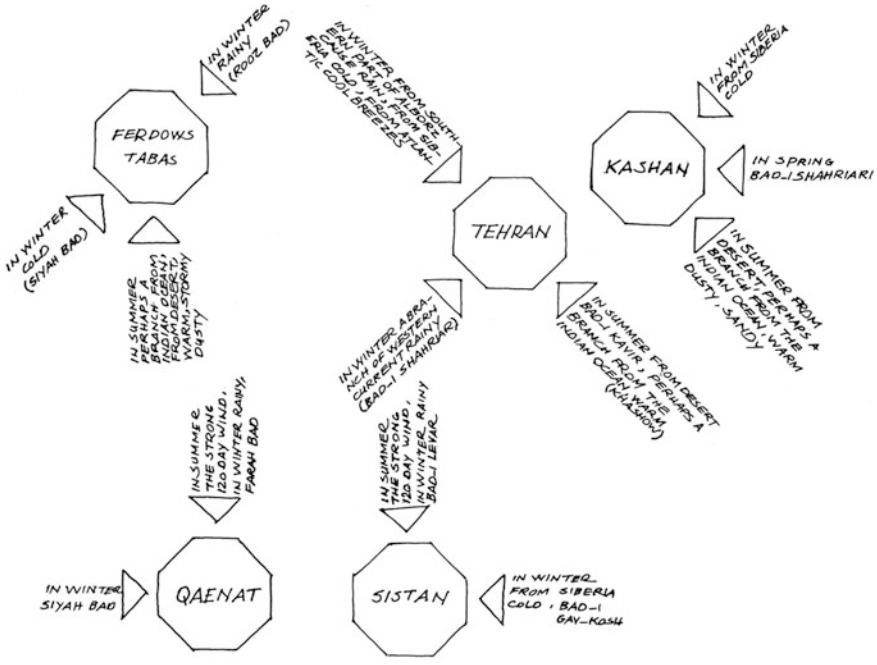

Fig. A.3 Direction and types of wind movement in several cities

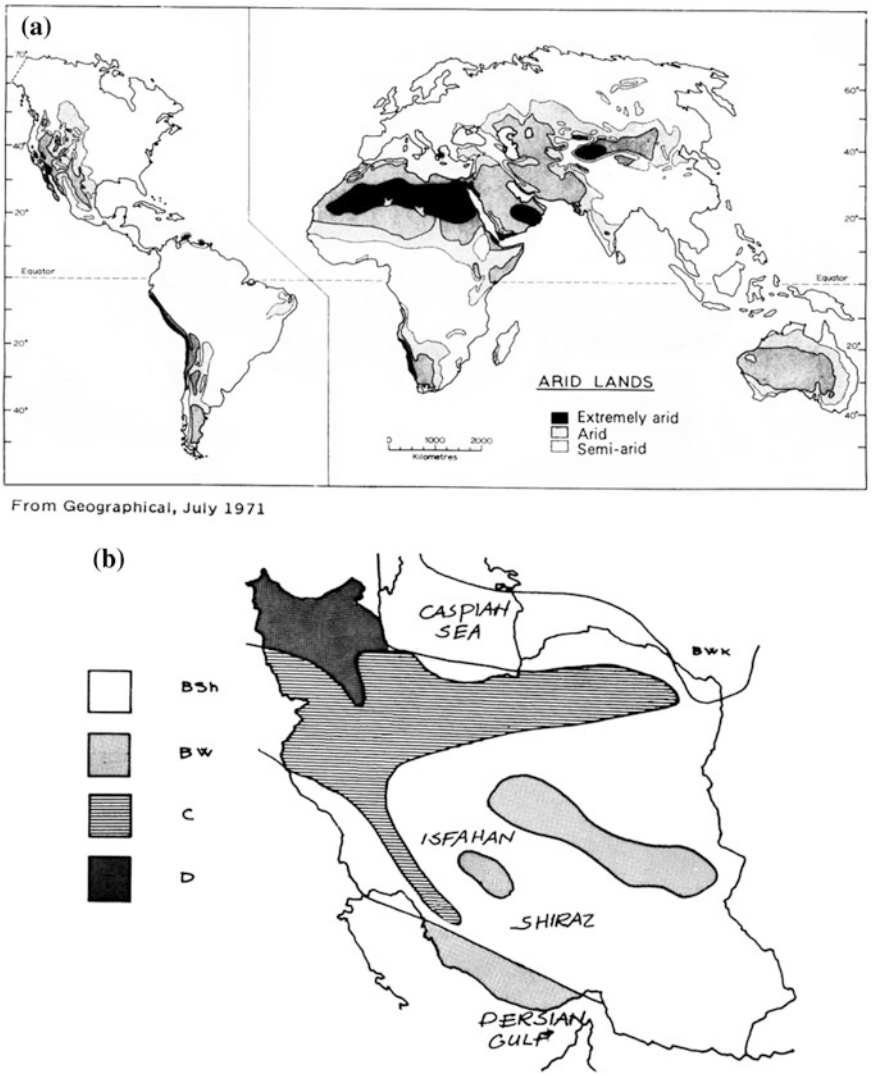

Fig. A.4 **a** Arid lands, from Geographical, July 1971. **b** W. Koppen's classification, Iran, (redrawn from Adl 1960)

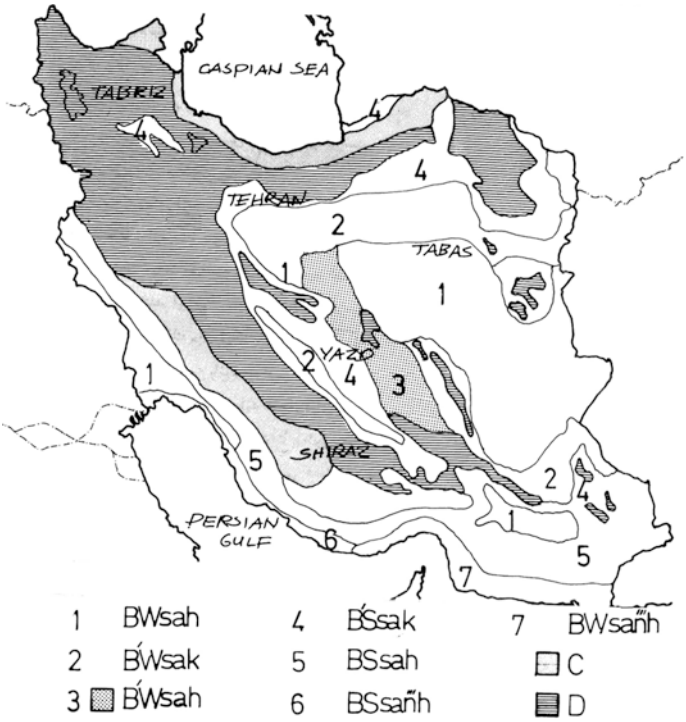

Fig. A.5 Adl's classification 1960. Here only information about hot arid zone included

Letter symbols for maps by Koppen and Adl: (includes only information about the hot arid zone).

h temperature equal or greater than 18 °C,
k less than 18 °C,
s dry summer,
a temperature of the warmest month 22 °C or above,
n''' mist, high moisture, summer temperature more than 28 °C,
C mild climate, and
D cold.

Appendix B
Scientific Consideration, a Comparative Study Between Phoenix Arizona and Yazd Iran[2]

Appendix B and Appendix C are structured on the system of research and findings and methods of Victor Olgyay in *Design with Climate* and a United Nations report on *Climate and House Design*. Here, I have carried out an examination and an analytical comparative study between the Yazd region in Iran and Phoenix Arizona, using the methods described by Olgyay. He was the first scholar to propose design in the process of climatic consideration. His method is based on a bioclimatic chart founded on the comfort zone structure. Considering comfort zone, he writes:

> Some writers consider sunstroke or heat stroke as the upper temperature limit for man's existence, with the freezing point as the lower limit. The ideal air temperature assumed to be midway between these extremes.

After discussing several sources as a basis for the outline of the comfort zone he constructs his bioclimatic chart, considering the integrated effects of climatic elements on comfort (Fig. B.1).

Climatic elements includes the following:

- Air movement
- Vapor pressure
- Evaporation
- Radiation effect

From the bioclimatic chart and its use, Olgyay writes:

> The effects of the climatic elements can now be assembled from these separate studies into a single chart. This chart shows the comfort zone in the center. The climatic elements around it are shown by means of curves which indicates the nature of corrective measures necessary to restore the feeling of comfort at any point outside the comfort zone. … No corrective measure are necessary for any point of known dry-bulb temperature and relative humidity which falls within the boundaries of the comfort zone. For any point falling outside zone, corrective measures needed to restore the feeling of comfort can to taken

[2]Appendixes B & C are structured on the system and methods in Olgyay's book: *Design with Climate*, and a United Nations report: *Climate and House Design.* Information and climatic data about Yazd In Iran (Appendix A), have been collected, depicted, analyzed, and comparatively studied with Phoenix in Arizona.

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The Urban Book Series, DOI 10.1007/978-3-319-39098-7

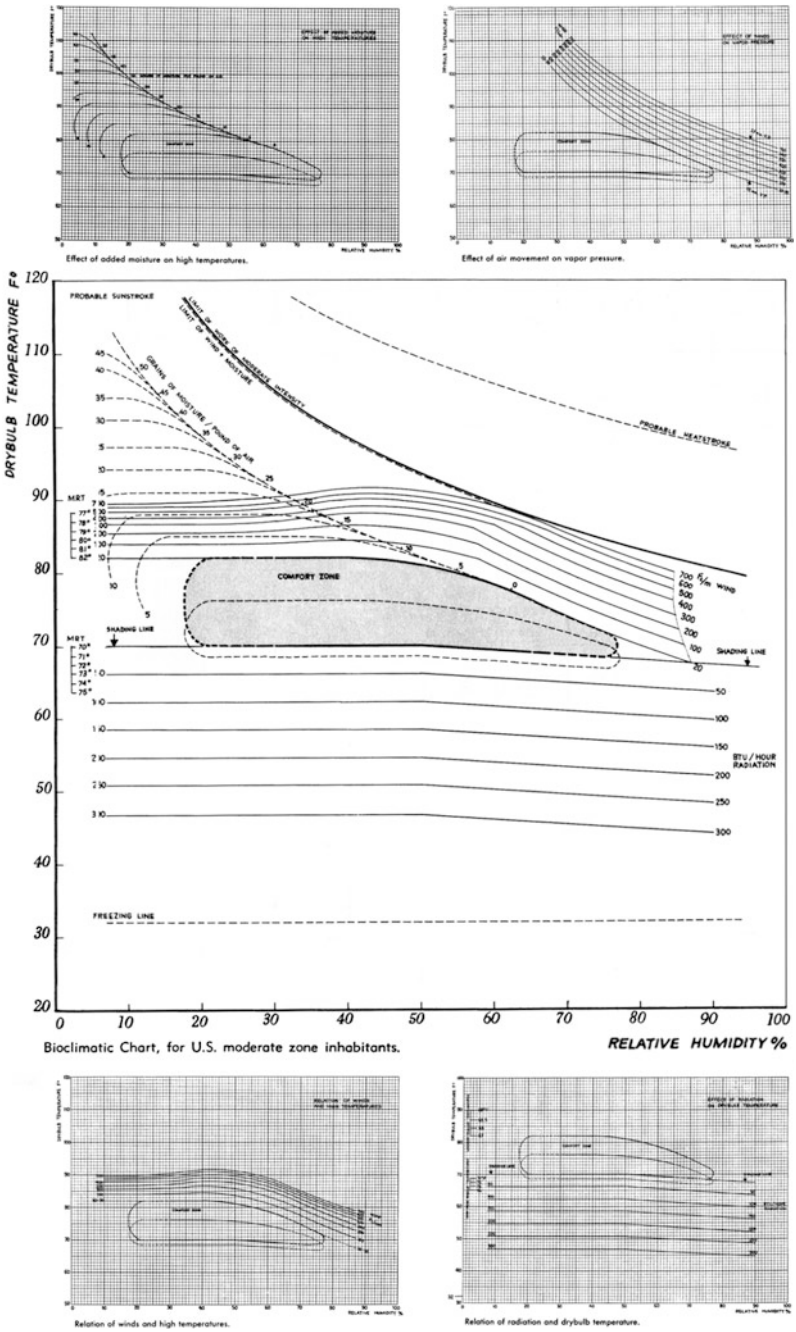

Fig. B.1 Olgyay's bioclimatic chart, structured on the basis of the relation of climatic elements to comfort

> directly from the chart. For example, at dry-bulb temperature, 75 °F; relative humidity, 50 %, Need is: none, the point is already in the comfort zone. At dry-bulb temperature, 75 °F; relative humidity, 70 %, Need: 280 fpm wind to counteract vapor pressure. …

Bioclimatic evaluation is the starting point for any architectural design aiming at environmental climate balance. Prevailing climatic condition can easily be plotted on the chart and will show the architect what corrective measures are needed to restore comfort conditions. A good many of these measures may be achieved by natural means, that is, by adapting architectural design to utilize the climatic elements. Other problems which fall outside natural possibilities will have to be remedied by mechanical means, such as air-conditioning. It is the task of the architect to make utmost use of the natural means available in order to produce a more healthful and livable house, and to achieve a saving in cost by keeping to a minimum the use of mechanical aids for climate control.

The bioclimatic chart maps the problems and describes the counter measures for human comfort in varying climatic conditions. To apply this, to evaluate the climatic situation of a given locale, a detailed analysis covering the complete yearly cycle is necessary.

Climatic Evaluation of the Yazd Region, Bioclimatic Registration of Climatic Data, and Timetable of Climatic Needs

Local weather data supplied by meteorological stations for Yazd Region, including thermal, humidity, precipitation, and wind, has been collected, charted, and analyzed (Figs. B.2, B.3, B.4, and B.5).

The climatic situation of a typical average day of each month is plotted on the bioclimatic chart. The 24-h data of the mid-month show as closed curves. These

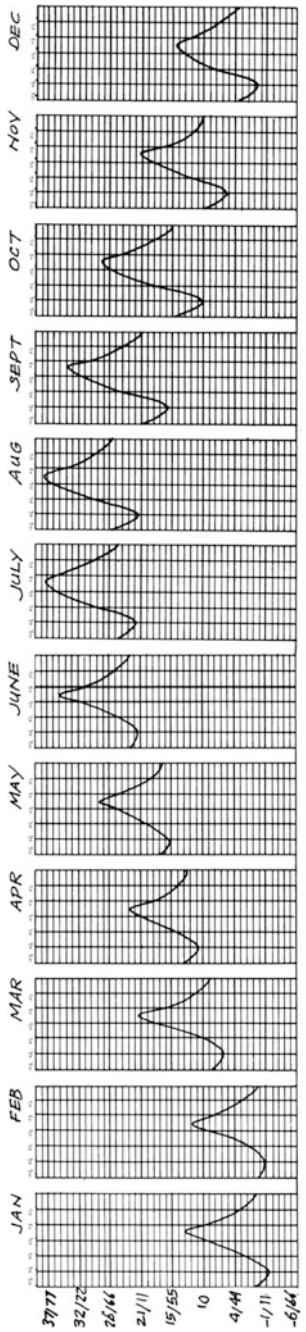

Fig. B.2 **Yazd**. Temperature analysis

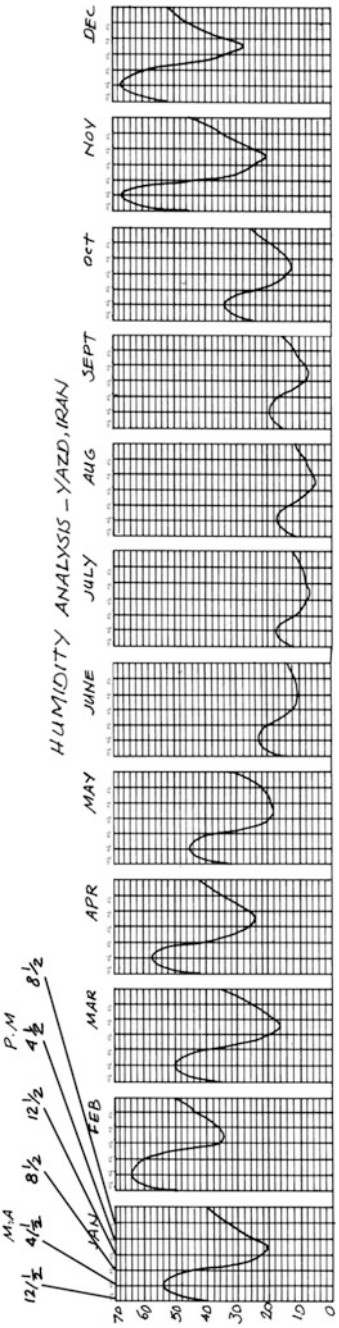

Fig. B.3 Yazd. Humidity analysis

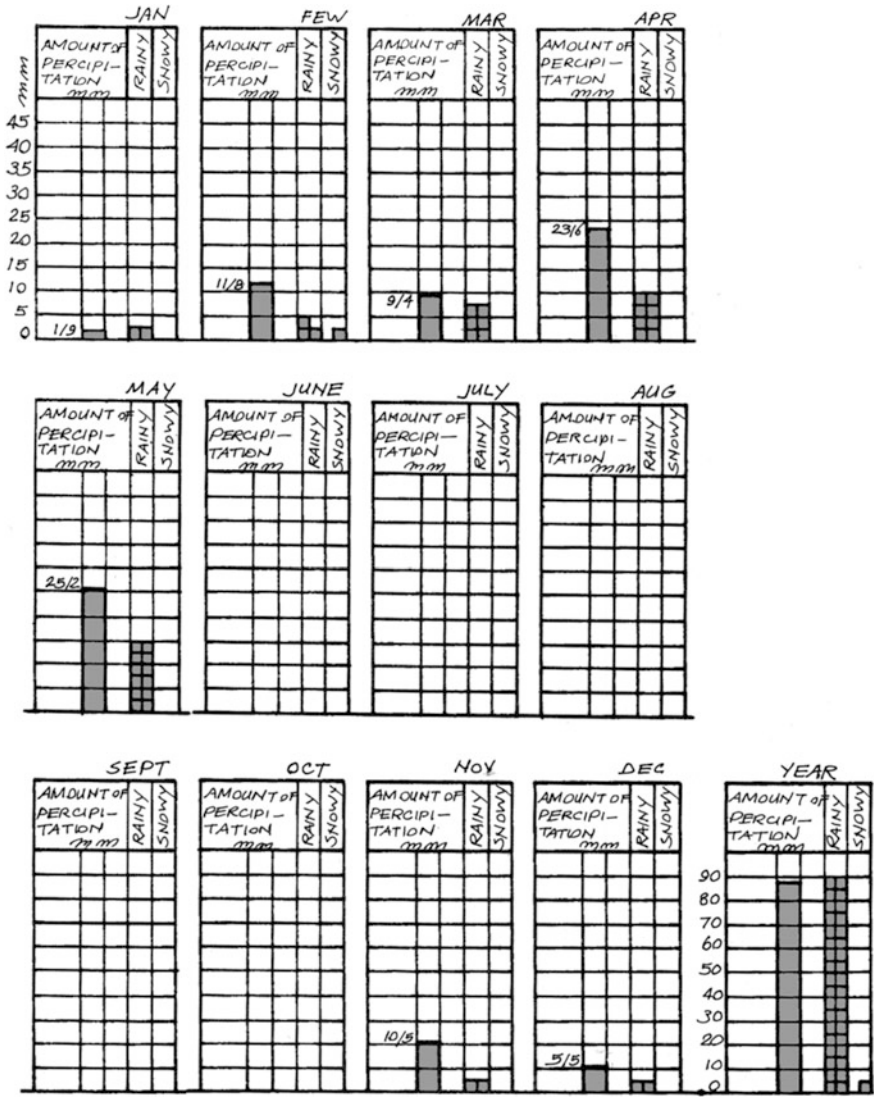

Fig. B.4 **Yazd**. Precipitation analysis

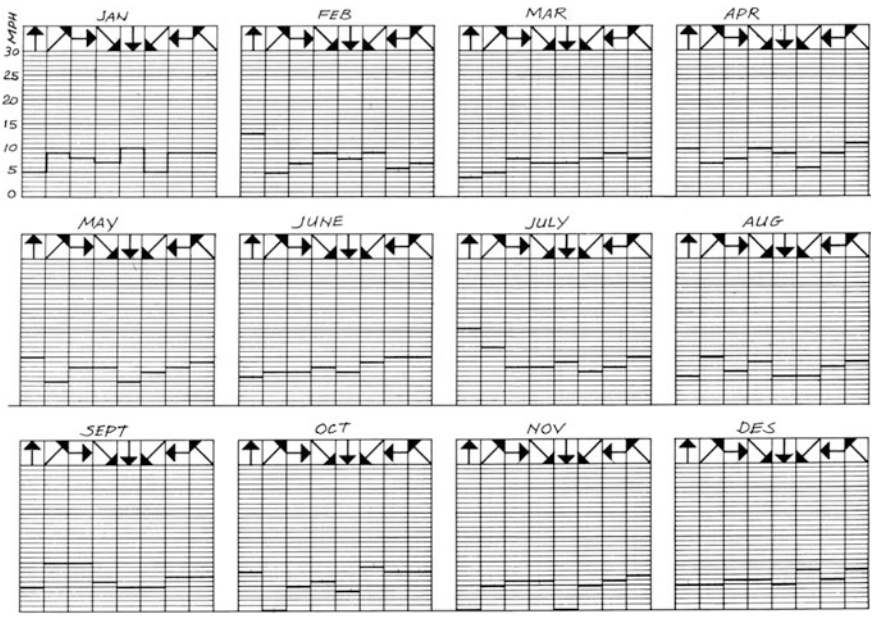

Fig. B.5 **Yazd**. Wind analysis

curves are selected intervals of a continuous spiral which would upward until July and then descend till January (Fig. B.6). When the bioclimatic analysis is transferred to yearly chart, then the needs are transferred into a timetable (Fig. B.7), where the varying climatic elements of any day in the year can be read vertically. With such "diagnosis of the region," the relative importance of the various needs, such as radiation (indicated in full lines up to 300 Btu/hr intensities) and shading (dotted area, overheated period), or wind effects (lined indication), can be evaluated. The result of Yazd can be compared with Phoenix (Figs. B.8 and B.9).

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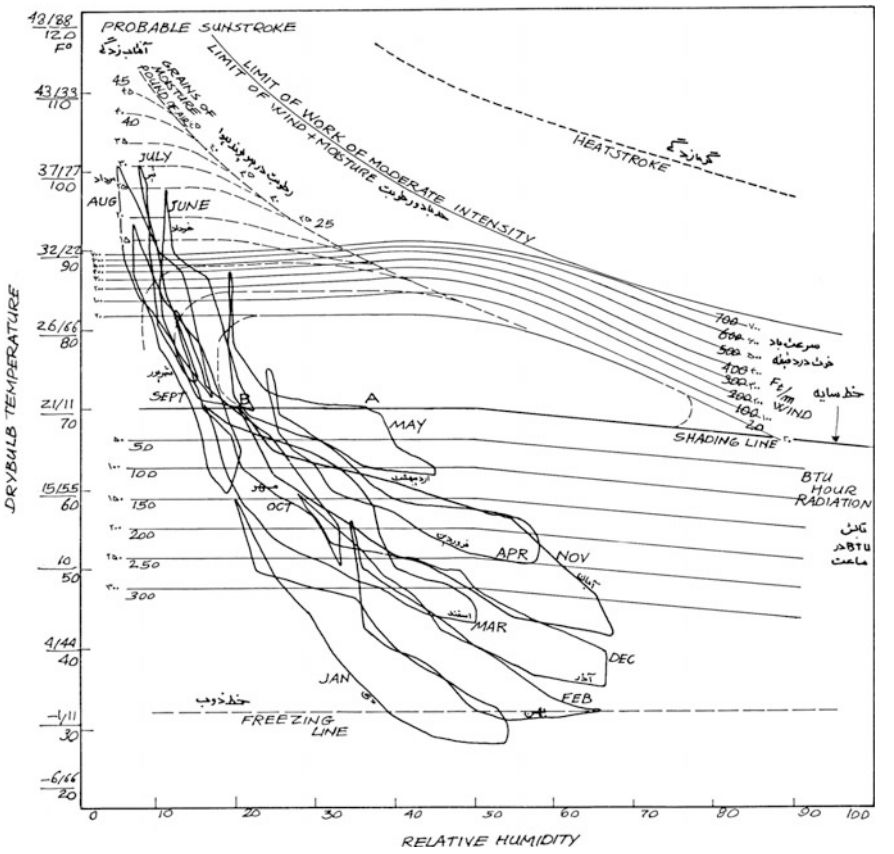

Fig. B.6 **Yazd**. Bioclimatic registration of climate data

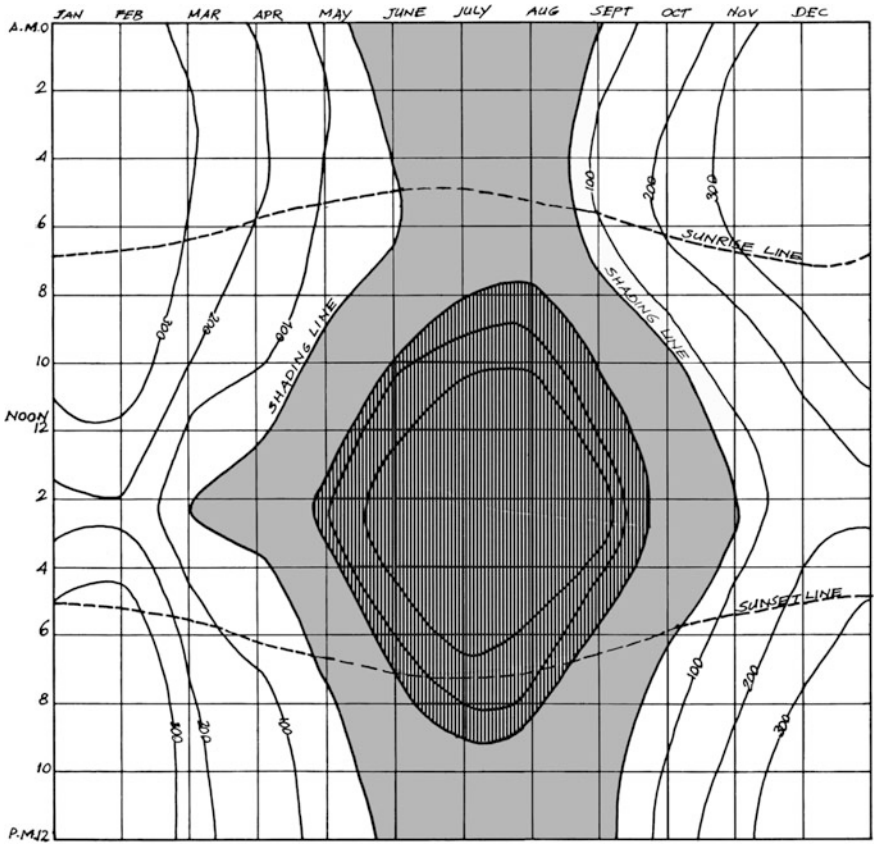

Fig. B.7 Yazd. Timetable of climatic needs

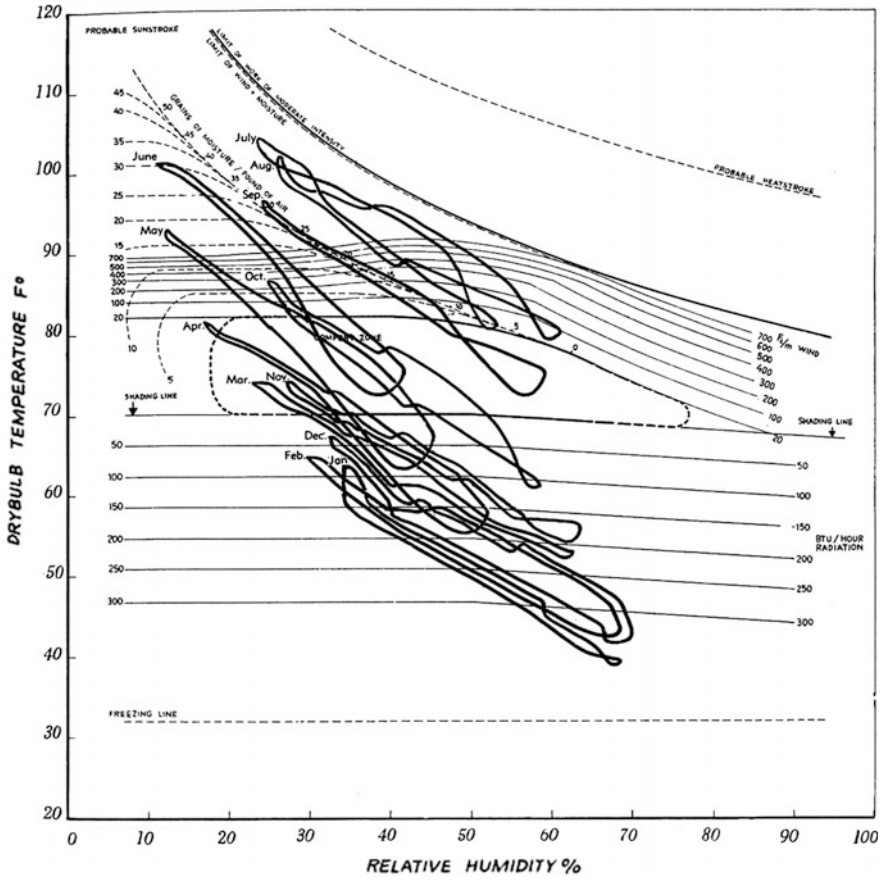

Fig. B.8 **a** Evaluation of Phoenix, Ariz. Bioclimatic registration of climate data (from Olgyay)

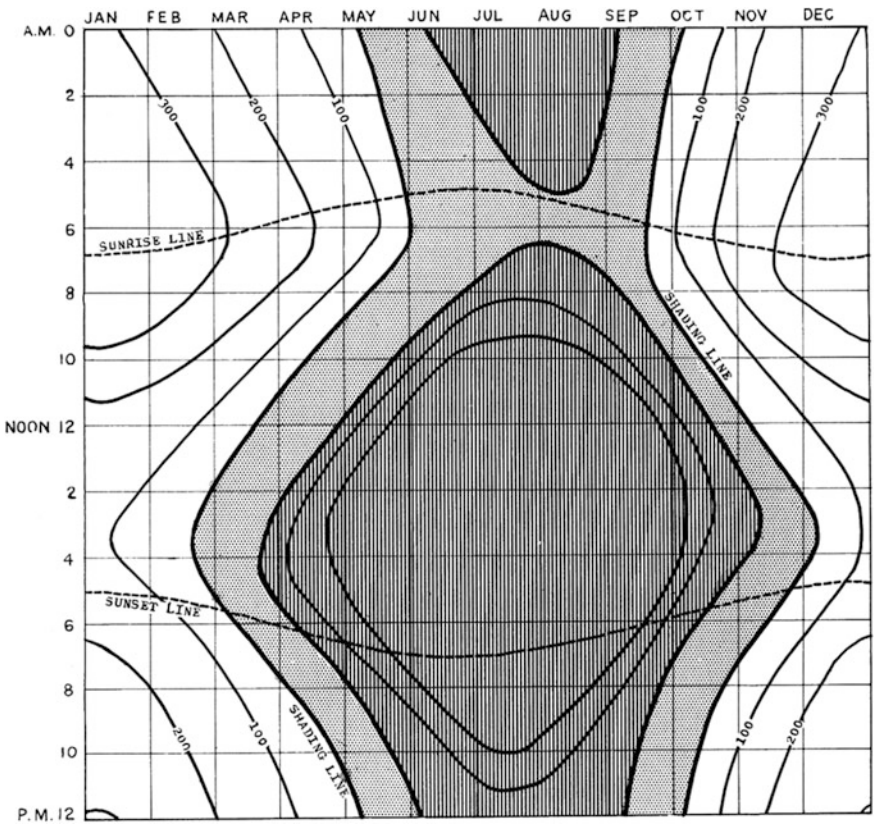

Fig. B.9 Timetable of climatic needs (from Olgyay)

Appendix C
Overheated Period in Yazd[3]

In order to protect building elements, especially the openings, against direct solar radiation, we need to know overheated periods and transfer them to sun path diagrams.

Sun Path Diagram and Shadow Angle Protractor (from *Climate and House Design, United Nations*)

Solar radiation is welcome when the weather is cold and unwelcome when it is hot. The information in this annex explains how the architect can protect buildings, especially the openings, against direct solar radiation and how he can encourage sun penetration when it is needed to warm the interior. The sun's position as it moves across the sky can best be shown on a map of a sky, the sun path diagram. This diagram consists of a circle, the periphery of which represents the horizon, while the center represents the zenith directly overhead.

The two coordinates are needed to a position in the sky. They are called azimuth and altitude. In the sun path diagram, the azimuth is shown on an angular scale 0–360 around the circle. It is measured clockwise from the north. The altitude of the sun's position is shown by a series of concentric rings, and is measured upward from the horizon (0) to the zenith (90).

[3]Appendixes B & C are structured on the system and methods in Olgyay's book: *Design with Climate*, and a United Nations report: *Climate and House Design.* Information and climatic data about Yazd In Iran (Appendix A), have been collected, depicted, analyzed, and comparatively studied with Phoenix in Arizona.

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The Urban Book Series, DOI 10.1007/978-3-319-39098-7

Sun's Path and Hour Lines

The path of the sun across the sky is shown by a series of lines which start at the eastern edge of the circle (sunrise) and finish on the western edge (sunset). The northernmost line represents the sun's path on June 22 (the summer solstice) and the southernmost line represents it on December 22 (the winter solstice). The lines between represent the sun's path at intervals throughout the year. Each of these lines represents the sun's path for 2 days of the year, 1 day during the period from January to June, when the sun's path moves further to the north each day, and the second during the period from June to December when the sun's path moves back to the south.

The shorter lines that cross the sun's path represent the hours of the day. They show that the sun rises around six o'clock in the morning, crosses the line due north–south at mid-day, and sets in the evening around six o'clock. The times given are solar times, which may vary slightly from local time, but the designer can safely ignore this difference. The effect of the difference is negligible (Fig. C.1).

Shadow Angle Protractor

The shadow angle protractor is used to find the sizes of vertical and horizontal projections (or reveals) which are to exclude the sun when it is not needed. The shadow angle protractor consists of two series of lines marked on a transparent semicircle which has the same diameter as the sun path diagram. The first series of lines are curved and show the vertical shadow angles. The second series of lines, which radiate out from the center, show the horizontal shadow angles. The diameter of the protractor is called the base line.

The curved lines represent a number of hypothetical sun paths. If the sun were to follow these paths, it would always appear to have the same altitude when seen in section perpendicular to the base line. The angle of the sun seen in section is the vertical shadow angle. It is measured from the horizon (0) up to the zenith (90). It should be noted that the sun's vertical shadow angle is equal to the solar altitude only when the sun's rays are perpendicular to the base line.

The shadow angle protractor is placed on the sun path diagram and rotated so that the base line and the curved line, which represent the vertical shadow angle, cover the area of sky obscured by a horizontal projection. The extent of the projection is determined by the vertical shadow angle which is measured in a vertical section at right angles to the wall. It is the angle between the horizontal and a line drawn from the edge of the projection to the sill or the lower edge of the opening.

It is not always possible to exclude the sun by horizontal projections alone. The second series of lines can be used to find the horizontal shadow angles. The horizontal shadow angle is the angle shown on the plan between a line from the inner edge of the opening to a vertical projection beyond it and a line perpendicular to the base line (Fig. C.2).

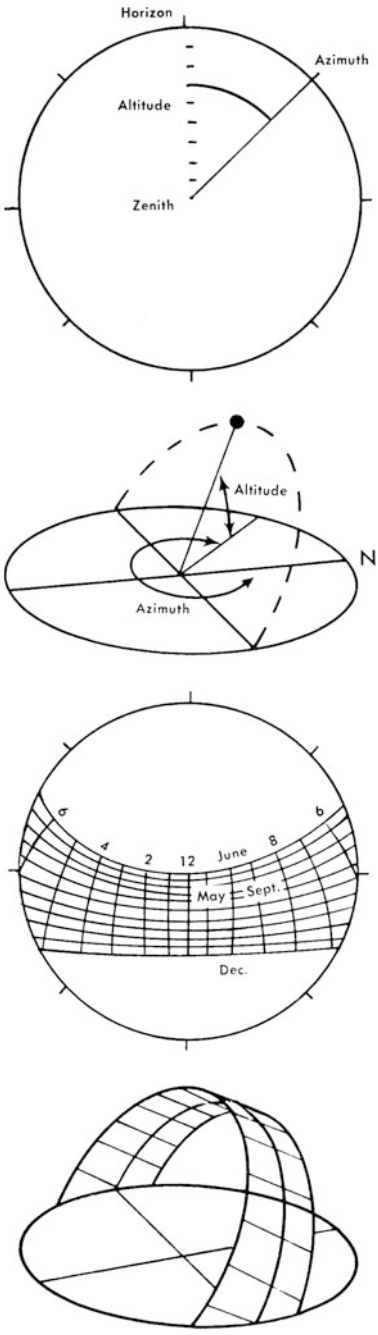

Fig. C.1 Sun path diagrams (from United Nations, 1971)

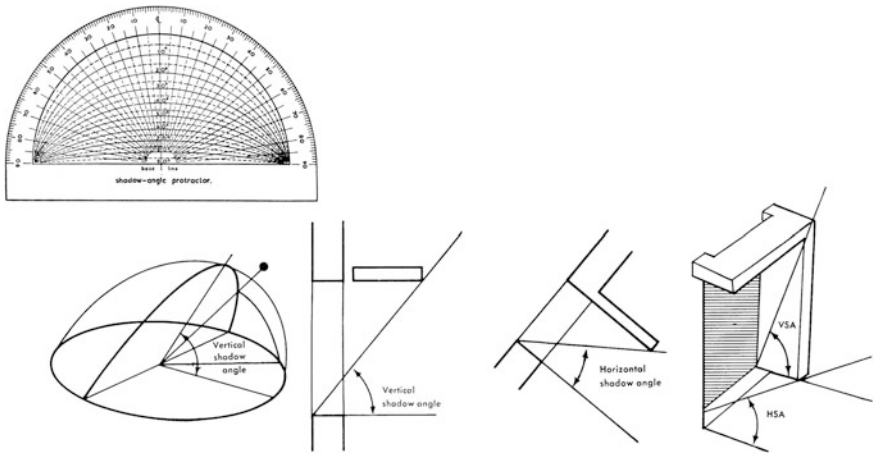

Fig. C.2 The shadow angle protractor and sun path diagram, determining the horizontal and vertical shadow angles (from United Nations, 1971)

From the timetable of climatic needs of Yazd (Fig. B.7), we can determine the overheated period or the times when shading is needed. Overheated periods must be transferred to sun path diagrams. By plotting protractor on the sun path diagram, we can determine the type and position of a shading device for overheated periods (Figs. C.3 and C.4).

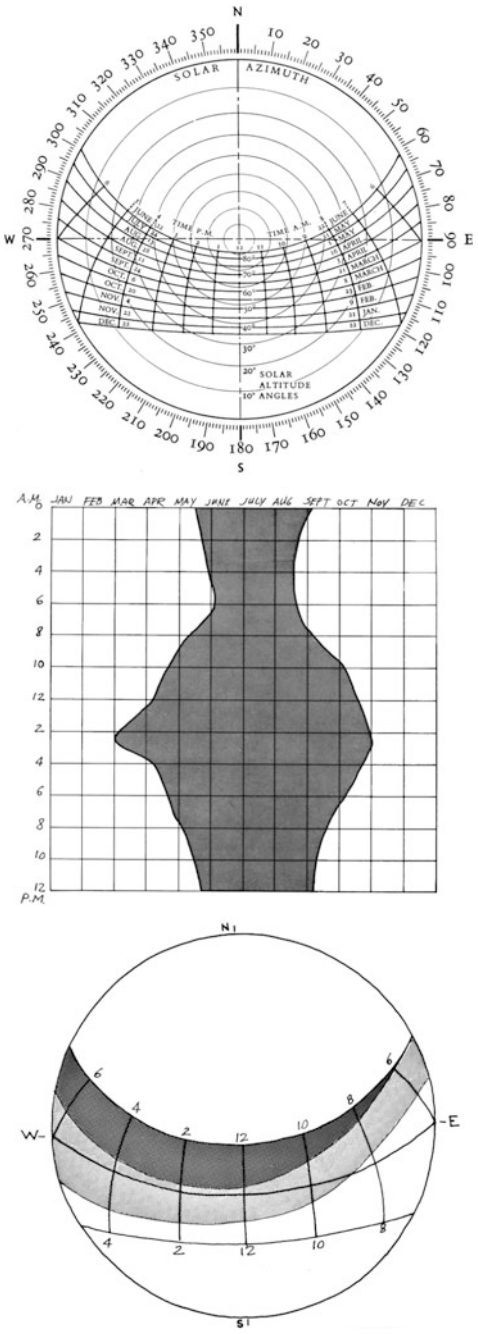

Fig. C.3 Yazd. Overheated periods (Fig. B.7) which is transferred to sun path diagram, determines the position of the sun when shading is needed

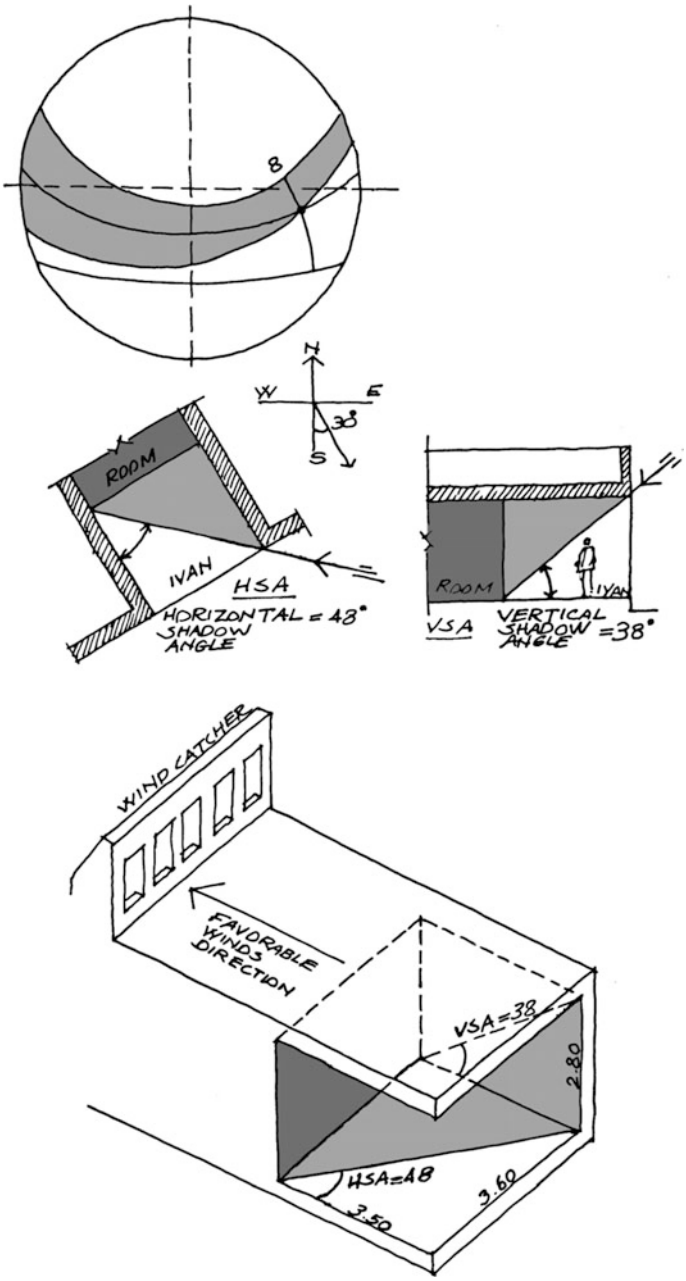

Fig. C.4 Determining the HSA and VSA for an ivan, a semiopen space, latitude 32° north (Yazd), orientation 30° south toward east, summer mid-September, eight o'clock morning, HSA = 48°, if we choose the width of ivan 3.60 m, the depth will be 3.50 m, this dept with VSA which is 38°, determines the height which is nearly 2.80 m. Accordingly, the back room of the ivan avoids the early morning hot sun

Glossary

madrasah "place for lessons an institution associated with the mosque and which developed into a university for religious sciences but also for many of the intellectual sciences" from Nasr *Islamic Science*, p. 248.

bazaar In the cities studied here, it is a part of a complex, a center at the city scale, which not only included commercial areas, but also integrated with mosques, madaris (plural of madrasah), shrines, and other elemental structure.

bazaarchah It is a part of a complex, a center at neighborhood scale including commercial areas integrated with other elements at neighborhoods scale.

bagh Garden, in Iranian knowledge, has a profound meaning. Persian garden originated in ancient times. "In the prehistoric Samarra pottery we find the typical garden lay-out, based on the *chahar-su* the crossing of two canals… The gardens of the Achaemenid empire were carefully designed with rectangles alleys and symmetrical trees. By the time of the Sasanian empire, gardens were of vast extent… In Islamic times huge gardens were symmetrically laid out in relation to the main axis of the building. The terminal points were marked by pavilions." from Pope, *Persian Architecture*, pp. 111–112. For the shaping principles see the present book, p. 46.

badgir wind catcher, climatic responsive element interconnected and functions with other architectural elements, and also a characteristic and symbolic urban element.

gunbad dome.

hammam bath.

husayniyyah a square, a covered space, usually at neighborhood scale, used most often for religious ceremonies.

ivan a semiopen space, portico, usually on the axe and looking onto a courtyard.

caravanserai caravan stop, hostel for travelers.

jami congregational mosque.

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khanaqah Sufi center initiatic and spiritual practices where esoteric and sometimes exoteric sciences are taught. *Zawiyah* in Arabic from Nasr, *Islamic Science*. p. 248.

mahalleh an area, "The Moslem city as a collection of homogenous areas" from Rapoport, Human Aspects of Urban Form. p. 252. "Town and cities were usually divided into different neighborhoods comprised of different social classes, different religious groups, and different handicraft producers. Each neighborhood was an economic component or administrative part of the city." from Tavassoli, City Planning… p. 122.

maydan public square.

qalah fortress, citadel.

qanat underground water channel, an innovative method for collecting subterranean water and bringing it to surface.

takyah a square, a covered space, usually at city scale, used most often for religious ceremonies.

chahar su four arched, usually domed space at the intersection of two bazaar lanes.

chahar taq a fire temple form with dome resting on a square of four arches.

musalla "simply means 'a place for prayer' and it appears to have been a large open space totally devoid of constructions, although one can suppose that it had some kind of boundaries." from Grabar, The Formation of Islamic Art. p. 103.

qiblah the direction of Mecca.

timchah usually a small caravanserai, a space for commercial affairs.

qaysariyah usually a roofed space connected with the bazaar, for selling similar merchandize.

ashura the greatest mourning day of the Shiite Muslim, the day of martyrdom of Imam Husayn, see also p. 37.

haydari and nemati see n. 47, p.198.

kalantar, bailiff, and kalu leader of groups or neighborhood organizations who supported the rulers, defended the city wall and gates, or sometimes acted against and did treachery to the rulers. See also Zarin kub, As Kucheh-yi Rendan, first chapter, and Limbert, Shiraz in the Age of Hafez, p. 36 & p. 89.

nakhl symbol of coffin of Husan ibn Ali, third Imam of Shiism, an element decorated and move it around the square on the 10th day of Muharram, see also M. Moin, The Persian Dictionary.

patoq an spatial element of city and neighborhood centers for gathering of chivalrous people, see also p. 26.

saqayeh public fountains which endowed by rulers and other wealthy benefactors fed by underground channels (qanats), see Limbert, Shiraz in the Age of Hafez, p55.

sara in persian it has several meaning, for example as a suffix it is added to the end of the word, caravan. Here it can be considered as a space like caravanserai. See M. Moin, The Persian Dictionary.

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