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Iran

THE VERNACULAR ARCHITECTURE OF IRAN

By Miles Lewis

Introduction

We have received a very interesting and well documented article from our Australian colleague and Historian Architect Miles Lewis. This paper seems very appropriate at this moment when ICOMOS CIAV it is going to celebrate the next conference and meeting in Tabriz, Iran.

I hope you'll enjoy this article which it is part of our communications through the CIAV Newsletter.

Valeria Prieto

THE VERNACULAR ARCHITECTURE OF IRAN

Miles Lewis

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[illustrations by the author unless otherwise indicated]

The author:

Miles Lewis is an architectural historian specializing in the cultural history of building - meaning the way in which building practices evolve and are transmitted between cultures. His topics have included the evolution of the lehmwickel technique in northern Europe from about the 5th century BCE; the transmission of the Syrian monolithic arch to Europe in the 7th century; the dragon beam in Renaissance carpentry; the revival of pisé de terre in the 17th and 18th centuries; the spread of traegerwellblech fireproof construction from Germany in the nineteenth century; and the evolution of the Marseille tile pattern in France and its dissemination to northern Africa, South-East Asia, Latin America and Australia. Lewis is an emeritus professor of architecture at the University of Melbourne and a former vice-president, and now honorary life member, of the CIAV.

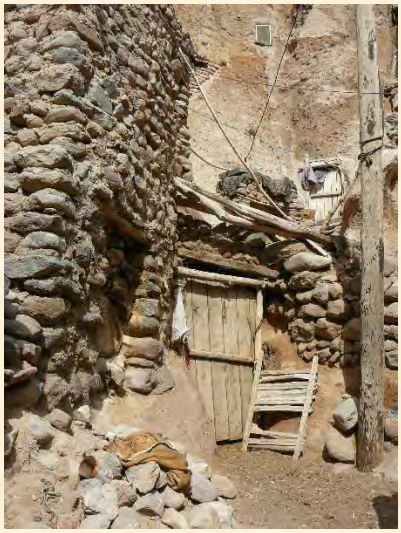
geography & climate

Iran is a very big country with very varied climate and terrain, and its traditional architecture is correspondingly varied. Cyrus the Great once commented that at one end of his kingdom his subjects might be dying of cold, while at the other they were being suffocated by intense heat.[1] Accordingly, there is not one form of vernacular architecture but many. That in the north relates to Turkey and Azerbaijan and that in the south-west to Arabia, whereas that of the desert to the east is more distinctively Iranian

The cliffs at Bisotun: Miles Lewis

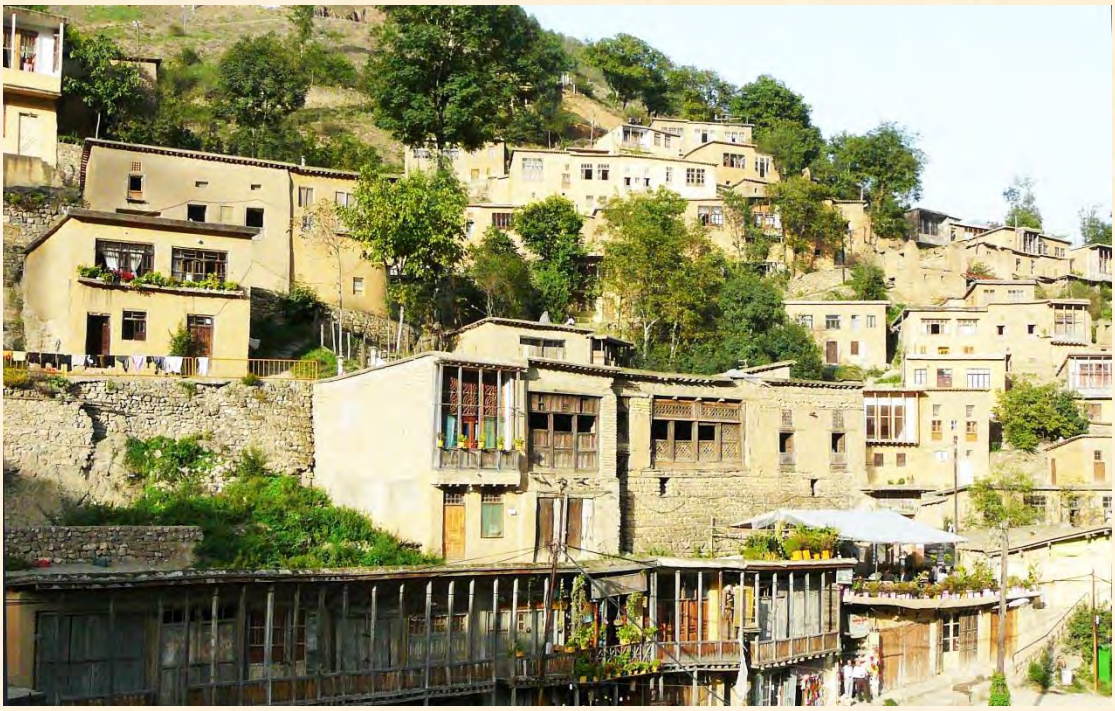
[1] Blunt, *Isfahan,* p 23.

Kandovan, a village of cliff dwellings.



Cliff dwellings, Kandovan.

Kandovan, south of Tabriz, is a village of houses and barns largely carved out of the rock face, reminiscent of the rupestrian dwellings of Cappadocia.



Masuleh

But the heart of Iran is a vast desert covering many thousands of square kilometers at a height of between 500 and 1500 meters above sea level. This desert is crossed by few tracks, and is shunned even by the nomads. Yet on the edge of this desert most of the great cities of Iran have flourished, from Siyalk [Sialk], in about 4000 BC, to modern Tehran. The desert and its raised rim constitute the Iranian plateau, which is bounded on the north by the Alborz range, on the west by the Zagros mountains, and on the south by the wide belt of mountains that shut off Kerman from the Persian Gulf and the Gulf of Oman. On the higher mountains the snow falls in winter, building up a reserve of moisture for the dry summer months; there are also winter and spring rains. All of the larger centers of population and the majority of the smaller ones are situated near or in the mountains because of the availability of water, and many settlements obtain this by means of the *qanats,* without which human settlement would be impossible. The best-known and most distinctive vernacular is the mud brick architecture of the desert, where timber and stone are so scarce as to play no significant role.

Towns like Nishapur, Damghan, Saveh, Qum and Kashan grew up on the routes connecting the principal settlements. Scattered thinly near the foot of the mountains, and where the distance on a caravan route across the desert demanded that travelers should find shelter and refreshment, are villages. The various settlements knew little of each other until the second half of the twentieth century, which brought electric light and television to their tea-houses and linked them with the large towns by bus and lorry. Another reason for the sparseness of settlements on the eastern edge of the plateau is the nineteenth-century Turkmen raids, which ravaged villages more slowly and systematically but just as effectively as those of their Mongol predecessors. The supine

attitude of the peasantry and of the Qajar government enabled these horsemen to sweep down from Khiva on *razzias* for several hundred miles across the Persian frontier, carrying off animals and prisoners to the slave markets of central Asia.

Since raiders depended upon surprise they travelled too fast to transport artillery, so the crenellated mud brick towers of Bam, for example, were able to withstand several Afghan attacks in the 1840s. In smaller villages the peasants would roll into place a across the entry a great stone disc, like a giant millstone. Unlike wooden gates this could not be set alight nor easily battered down by determined bandits.[2] Moreover it required neither heavy timber nor elaborate hinges and ironmongery. But it is by no means a distinctly Iranian element. Such rolling stones were used to defend the underground settlement of Kaymakli in Cappadocia, which dates back probably to the sixth century AD, and possibly very much earlier. The rolling stone or *Abu badd,* at Mount Nebo in Jordan is Byzantine in date and about three meters in diameter. The ornamental qualities of the buildings derive from such elements as the *bad-girs* or wind towers, discussed below, and the perforated grilles which are the local manifestation of the decorative screens found across the Islamic world.

In the Caspian provinces north of the Alborz mountains, such as Gilan, the conditions are very different from those of the dry and largely treeless central plateau. Accordingly the roofs of the houses, instead of being flat and made of dried mud, are high-pitched and covered with wooden shingles, tiles or thatch.[3] Indeed wood is the main structural and decorative material, and the frame contains no metal components but is assembled with bark fibre bonds, with the components rebated and interlocked.[4] In appearance the buildings and villages are not unlike some found in the Balkans and elsewhere in Europe. But in the Alborz spurs, step villages are situated on the slopes exposed to the south and are built following the contour lines. Houses are made of unburnt brick, their foundations and outbuildings of stone. The beams rest directly on the walls and are covered with a grid of branches; the whole of the building is covered with pug. The flat roofs of the lower houses are used as terraces and streets for the upper houses.[5]

Ābyāneh is an ancient village at the foot of Mt Karkas, with steep twisting lanes and red mud brick houses with lattice windows and wooden balconies.[6] It was almost completely Zoroastrian until the time of the intolerant Safavid Shah Ismail I, in whose reign most of the inhabitants emigrated to India or to Yazd. The costumes and way of life of those remaining are largely unchanged,[7] and they still speak Middle Persian, a form of Farsi otherwise long extinct.[8]

Elsewhere the population is nomadic, in the central Asian tradition. The Yamut Turcomans, in the region east of the south-east corner of the Caspian, live in

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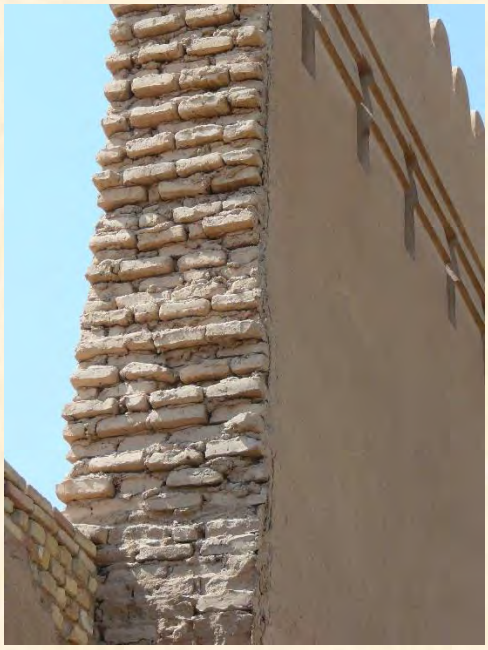
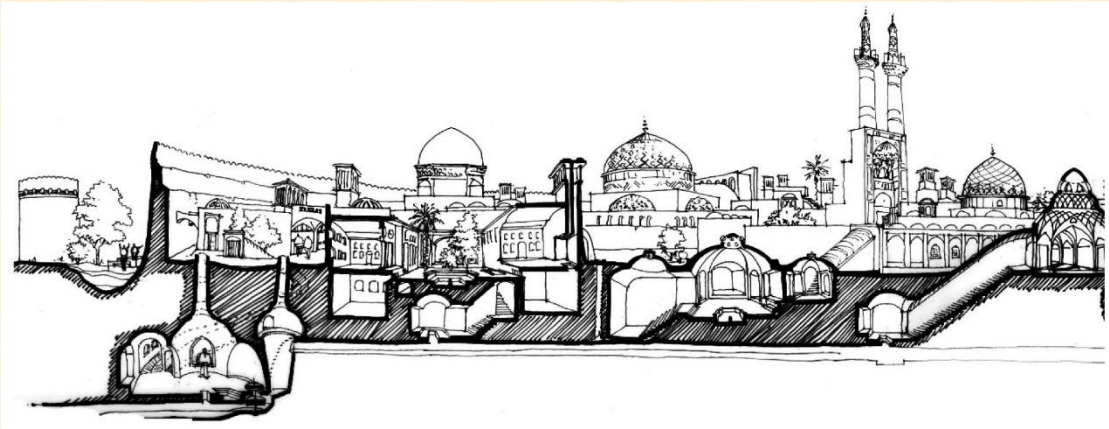
2 Beazley & Harverson, *Living with the Desert,* p 8.
3 Lockhart, *Persia,* p 36.
4 Yavari, 'Traditional Architecture', p 28.
5 Yavari, 'Traditional Architecture', p 29.
6 Burke & Elliott, *Iran,* pp 231-2.
7 Matheson, *Persia,* p 296.
8 Burke & Elliott, *Iran,* pp 231-2.

yurts. These are circular like all yurts, but their form and construction are distinctive. The frame is of wicker or wood, which is vertical for about 1.8 meters, then curves inwards to a ring or hoop at the center, leaving a circular opening which functions as a chimney and ventilator. The structure is clad in thick felt and the inside lined in carpet or felt. The door is left open in summer, and in winter is swathed in thick rugs or felt.[9]

Yazd

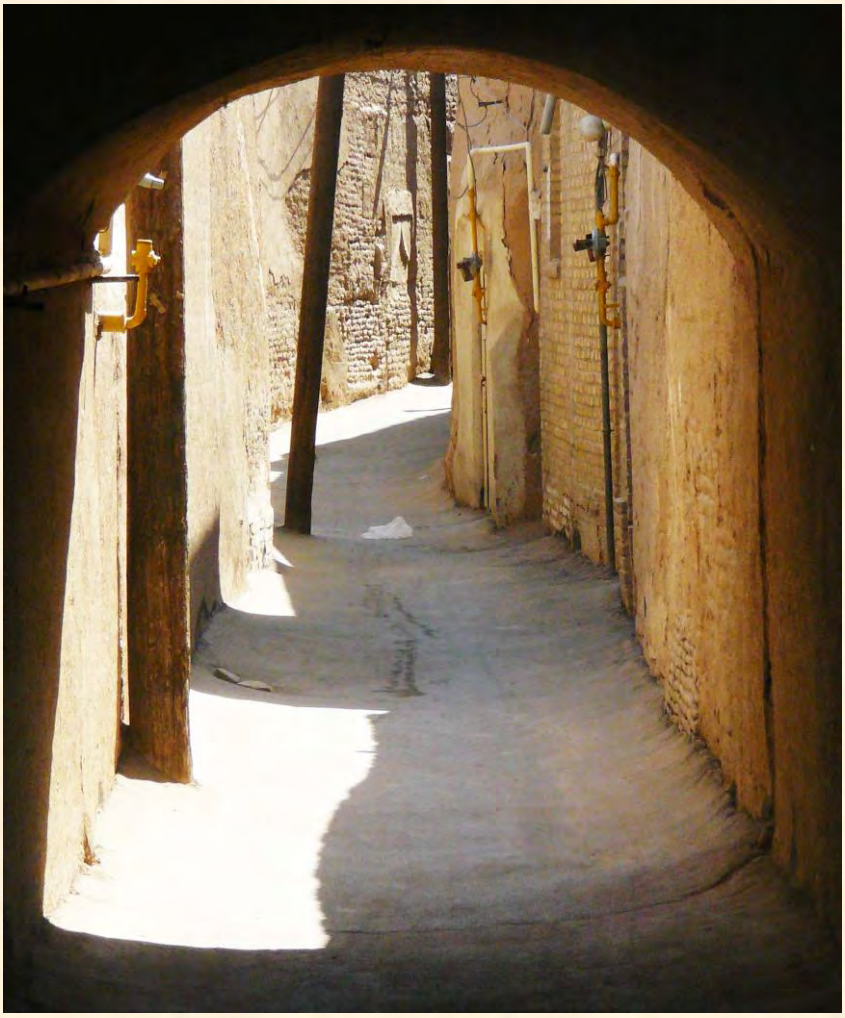


The walls of Yazd.



Schematic cross-section of Yazd. 'Historic City of Yazd' [World Heritage nomination], p 233.

[9] Lockhart, *Persia,* p 36.



A Yazd street.

The chief of the desert cities is Yazd. Its age is unknown, but the extravagant claim that it is 'the oldest living city on earth' has not been substantiated, and indeed it seems to be no older than the 10th century CE. Yazd is surrounded by desert, but the lofty Shir Kuh range to the south provides water through qanats up to fifty kilometres long.[10] Its existence has depended upon the water supplied by these *qanats.* as further discussed below, and upon fortification walls. Life within it was made tolerable by *badgirs* or wind towers, and associated cooling devices like underground chambers and cooling tunnels, and by the narrow shaded streets. The mud brick old town, as it survives today, has an intricate street pattern and a forest of *badgirs*.[11] Older houses in Yazd have *khasinair* baths, with fire chambers heating the water from beneath.[12]

10 Lockhart, *Persia,* p 40.
11 Modarres, *Modernizing Yazd,* p 6.
12 Kremmer, *The Carpet Wars,* p 377.

building types

Islamic structures of a religious character include the mosque, the madrasa and the mausoleum. Secular structures, other than domestic and vernacular, include palaces and caravanserais dating from the Il Khanid period onwards. The standard mosque, although it began to take shape in the Saljūq period, and the first complete example dates from 1135, did not become common until after the end of the fourteenth century, in monuments of the Timūrid and Safavid periods. In its fully developed Iranian form it is characterized by a longitudinal axis from the entrance to an īvan portal opening a courtyard. The arcades surrounding the court are interrupted by three more īvāns, on the longitudinal cross axes, and there are prayer halls in back of the arcades. The elevations of the Seljūq īvāns are massive and broad, while in the Il Khānid period they become narrower and higher. The major īvān, on the longitudinal axis opposite the entrance opens into a square sanctuary chamber crowned by a dome and with a mihrāb, or prayer niche, in the rear wall of the chamber at the end point of the longitudinal axis.

The standard plan of the madrasa is so close to that of the mosque, in spite of the different functions of the two types, that the Iranian version has been called the madrasa-mosque plan. The normal plan of the caravanserai is very like the madrasa-mosque, but with a larger court, around which are living chambers (of which more below). Mausolea include two categories, the square chamber crowned by a dome, and the tomb tower. Most, of both types, are imamzadas, – an imamzada being a tomb shrine in honour of a so-called ‘son of Islam’. More than half contain mihrabs, and burial is in a central sarcophagus or in a crypt beneath.

The bazaar at Yazd.

Commercial buildings include caravanserais, khans, timchehs, bazaars, shops, and chabar su (domed street crossings). The caravanserai or khan was a combination of motel and wholesale house. Merchants brought goods for sale and might remain with them,[13] especially in the caravanserai, which was often in an isolated situation along one of the great trade routes, as opposed to the khan, which is a more condensed urban form, usually with trading spaces grouped around a smaller court. The timcheh seems to have been a smaller kiosk form, exclusively for shops.[14]

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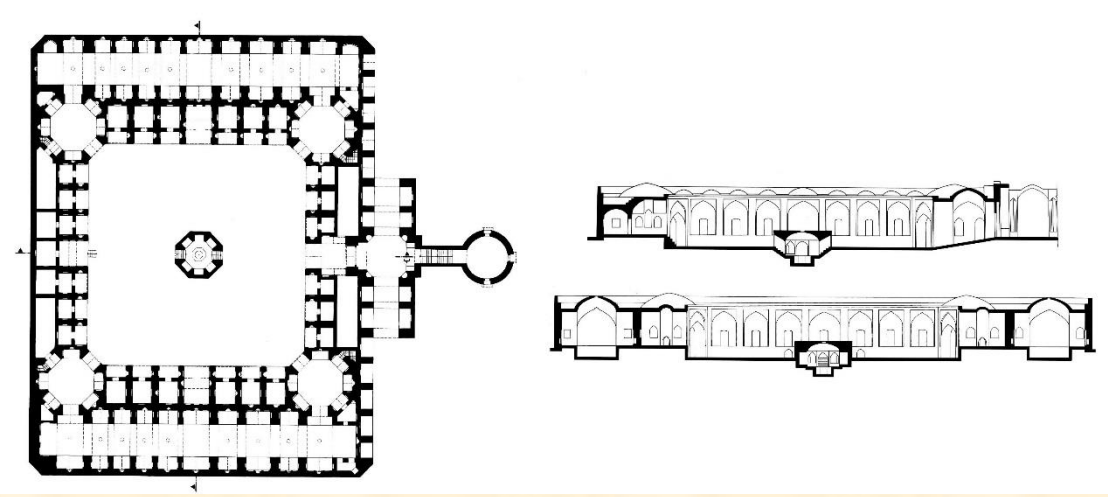
13 Golombek & Wilber, *Timurid Architecture,* p 16.
14 Golombek & Wilber, *Timurid Architecture,* p 16.



Shah-'Abbasi Caravanserai, said to date from 1654, plan and sections. Haji-Qassemi, *Caravansaries*, p 29.

Caravanserais were simple unpretentious buildings. The typical caravanserai is a squares plan around a courtyard with four iwans, an elaborate portal at the front, and stables at the back. Four long, tall, windowless walls, four corner towers, and occasionally two towers in the middle of its long walls, gave a caravansary a fort-like appearance. The building's only decorated exterior element is its portico, a tall, protruding or recessed, structure.[15] In colder mountainous regions there might be no courtyard, but a complete vaulted roofing system.[16] Octagonal courtyard plans occur but are rare, and circular caravanserais are extremely rare.[17]

Behind the portico stood the *hashti,* the main entrance vestibule, which was the caravansary's most important and most elaborate area. The *hashti* usually formed an independent structure flanked by guard rooms and other lodgings. This area was usually covered by a tall and ornate ceiling. The heart of the caravanserai was the *sahn,* or main courtyard, which had a regular, geometric, usually rectangular, shape. The *sahn* was encircled by chambers and each chamber was usually fronted by an *eivancheh,* a semi-open area at the disposition of its residents. In almost every caravansarai, *eivans* rose in the middle of the courtyard's four sides. Behind the attractive regular facades of the courtyard stood the stables, which were usually reached from the corners of the courtyard. [18]

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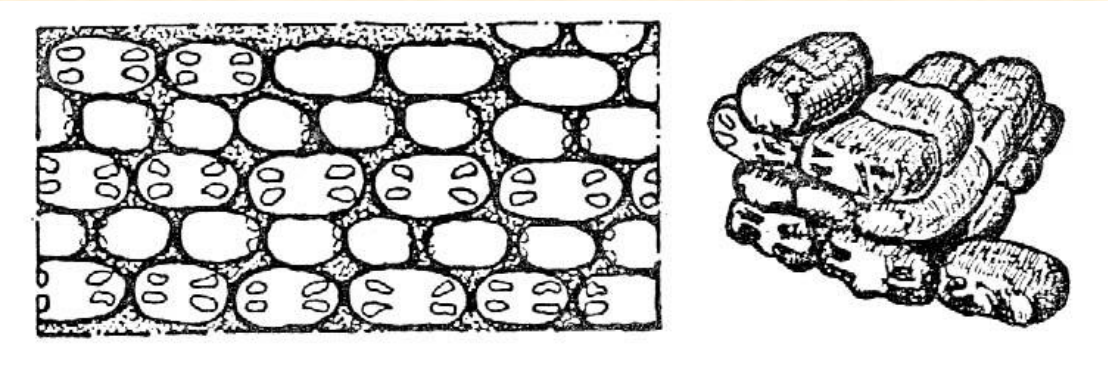
15 Haji-Qassemi, *Caravansaries,* p *9*.
16 Kleiss, 'Safavid Caravanserais', p 28.
17 Kleiss, 'Safavid Caravanserais', p 30.
18 Haji-Qassemi, *Caravansaries,* p 9.

earth construction



Sialk, sun-dried bricks of the 6th millennium BCE: A U Pope, *Introducing Persian Architecture* (Soroush Press, Tehran 1976 [1969]), p 7.

Iran is one of the major earth building nations. The great poet, Firdausi, in his epic, the *Shahnahmeh* describes how the hero Jamshid (son of the first man) 'taught the unholy demon tribe to mingle water and clay, with which formed into bricks, the walls were built, and then high turrets, towers and balconies, and roofs, to keep our rain and cold and sunshine'.[19] Consistent with this the oldest physical remains of buildings at Sialk, which in the sixth millennium replaced huts made from tree branches, are of mud brick. These are not rectangular, but oval and irregularly formed by hand, with thumb prints which Pope naively interprets as a device to improve the bond of the mortar.[20] They are broadly comparable with examples from Jericho, of the seventh millennium, and Mureybet, of the sixth millennium BC.

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[19] Beazley & Harverson, *Living with the Desert,* pp 12-13.
[20] Pope, *Persian Architecture,* p 15.

Mud brick in the hunting park wall, Kermanshah.

The Meybod fortress.

Old and new mud bricks at the Meybod fortress.

Shuttered cob walling at the Meybod fortress.

Meybod, view from the fortress.

Mass mud (or cob) and mud brick (or adobe) are the usual forms of earth building, both of which are used in the town of Meybod and its great fortress, For cob walls (*gel*) the earth is very thoroughly mixed with the water and with short bits of straw by being trodden by bare feet. Or the mud may be made into balls which are tossed up and packed together on the wall (and in rare instances in the Khorasan the mud balls are contained in timber formwork).[21] Surprisingly, this system of tossing up mud balls is much the same as was traditionally done in the Marche region of Italy.[22] *Pisé de terre* or rammed earth is not an Iranian tradition, and references to this construction are erroneous.

Earthen walls are particularly vulnerable to attacks of various sorts. From ancient times until the Qajar era buildings were constructed without excavated foundations, and with no protection against rising damp. This resulted in salt penetration and the destruction of the mortar, and sometimes the bricks, causing the gradual ruin of many buildings.[23] Earthquakes have been a major source of destruction, and for this reason lengths of timber are sometimes built into adobe walls to take tensile stresses,[24] just as is done in southern Turkey. Since the destruction of Bam by earthquake in 2003, the adobe citadel of

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21 Beazley & Harverson, *Living with the Desert,* p 17.
22 Quagliarini, 'Earth Constructions in the Marche Region', p 2567.
23 Kleiss, 'Safavid Caravanserais', p 31.
24 Beazley & Harverson, *Living with the Desert,* p 20.

Rayen, the Arg-e Rayen, has taken its place as the prime adobe monument in Iran

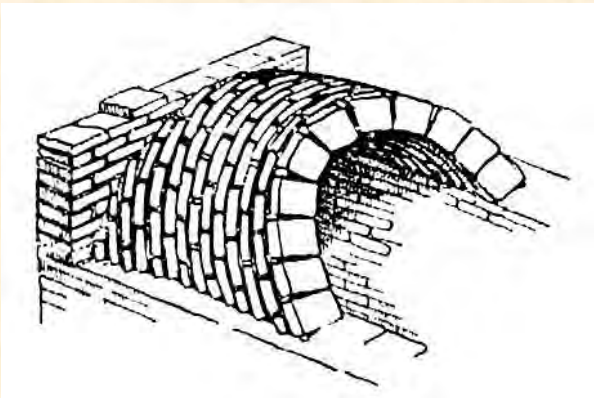
Baked bricks generally follow the form of unbaked bricks. The standard or common bricks, continuing into the twentieth century were square, though with a considerable variation in sizes as well as variations in color.

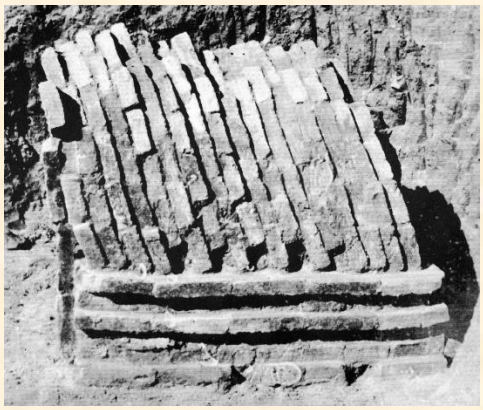
gypsum & lime

Historically gypsum (plaster of Paris) or *gach* was apparently much preferred to lime for mortar, partly because it gave a more rapid set for arches and vaults, and that preference continue into modern times.[25] But lime was also used, and Jean Chardin described a durable waterproof mixture:

> In all houses, and even in the meanest, there are Basons of water, the Make whereof is very strong, build with Bricks, overcast with a cement call'd *Ahacsia* [*ahak e siyah*], i.e. black Lime, which, in process of time, becomes harder than Marble; They make that Cement with very fine Ashes, taken out of the Hearths of Baths, mix'd with half the Quantity of quick Lime, and with a kind of Down beaten very well together for a whole day, as tho' they would make an Amalgamation; that Down grows on top of some Reeds, and it is so light, that it is carried away with a Breath.[26]

vaults





Pitched vault, as at Khorsabad, 8th Century BC. Michell, *Islamic World,* p 140.
Medeo-Elamite tomb with a pitched barrel vault at the donjon, Susa, Iran excavations of R de Mecquenem, 1937: Amiet, *Elam,* p 449.

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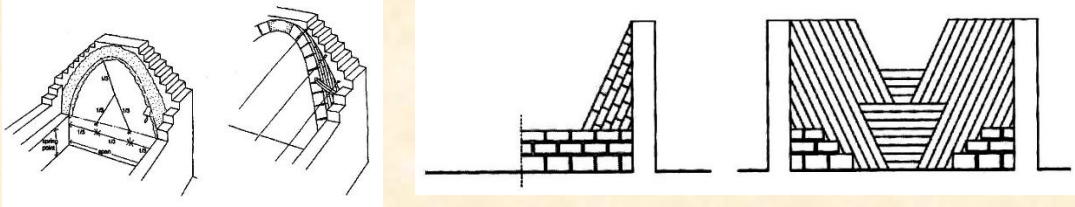
25 Golombek & Wilber, *Timurid Architecture,* p 94.

26 John Chardin, *Travels in Persia 1673-1677* (1720), p 262, quoted in Porter, *Palaces and Gardens,* p 34.

Double pitched vault, Dakmeh-ye Zartoshtiyun. Yazd.



Building a pitched vault, successive views and side elevations: Gargiulo & Bergamasco, 'Earth in the Architecture', p 1216.

Side of a vault, Dakmeh-ye Zartoshtiyun, Yazd.

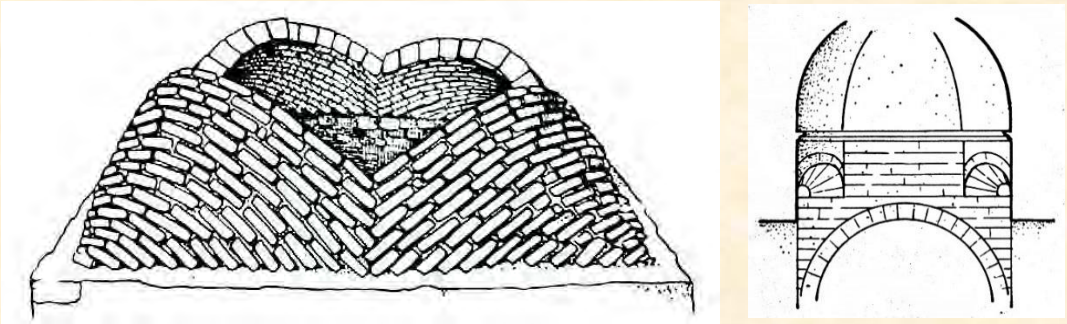
In a desert region without much timber or stone, as is true of much of Iran, the roofing of a space is the biggest technical challenge – far harder than the spanning of a door or window. An orthogonal barrel vault is effective in brick, or even in mud brick, but requires centering of timber or other materials not available in desert areas. The solution is the pitched barrel vault, which is self-supporting during construction. It is not surprising that it is found in ancient Egypt and Mesopotamia, and at later dates in Iran and elsewhere in the Islamic world. It may be built from one end only, or from both ends, meeting in the middle.

Pitched vault and vaulted spandrels at Abarkūh: Miles Lewis.

Anar Caravanserai: a vaulted spandrel passage from above and from below: Miles Lewis

Stages in the construction of a space filling structure [kaneh-poosh]. Meybod: Mohammed Reza Bazldjou.

Above a barrel vault the aim was generally to establish a flat surface for the floor above, or for the roof, and rather than fill the sides with a heavy mass of material solid it was usual to fill the spandrels with subsidiary barrel vaults, or to create a space filling structure or *kaneh-poosh* consisting of transverse walls.



Iranian square vault: Michell, *Islamic World,* p 140'
The squinch: Hamlin, *Forms and Functions,* p 541.

The same principle of pitching can be used to cover a square bay, by building pitched arches in from each corner, creating four intersecting conical or trumpet shapes. Quadripartite vaults built without centering are said to be unique to

Iran.[27] These trumpet shapes may be the origin of the *squinch*, which in the Islamic world is the normal means of effecting the transition from a square or polygonal base structure to the circle of a dome (as distinct from the *pendentive* of the classical tradition. True hemispherical domes were also generally built of pitched courses (that is, angled, but not so steeply as the radius of the dome) forming self-sustaining horizontal rings as the structure rose.[28]

Muqarnas in the hammam of the Bazaar-e Khan, Yazd (today a restaurant).

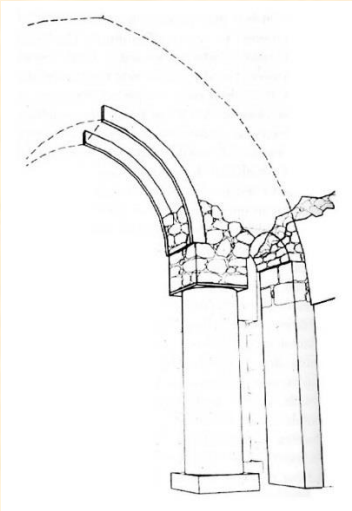
27 Michell, *Islamic World,* pp 115, 140.
28 Golombek & Wilber, *Timurid Architecture,* p 109.

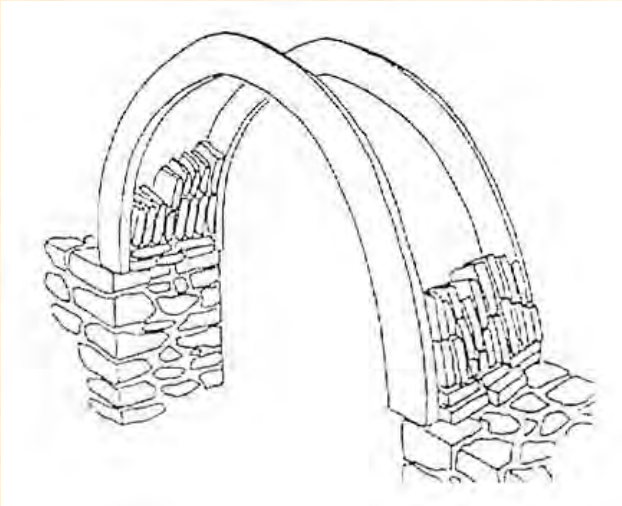
Poles to support the temporarily removed muqarnas in the bazaar at Kirman.

The Islamic squinch is commonly hollow in the inner exposed face, and if you build one upon another you get the decorative form known as muqarnas. This soon ceased to be a structural brick shell, and became instead a plaster shell supported on poles from the true vault behind it. If this muqarnas is continued across a ceiling it becomes a stalactite vault. Stalactites had been used in a rudimentary form on the Gunbad-i-Qābūs of 1007, and stalactite vaults increased in popularity in the Il Khanid period. They even reached the west as in the Cappella Palatina, Palermo, but they seem to have been uncommon in monumental architecture in Persia itself.[29] The inverse of the stalactite vault is a more simple and abstract form looking like origami, and this more closely resembles the cellular Gothic vaults of central to eastern Europe.

[29] Golombek & Wilber, *Timurid Architecture,* p 110.

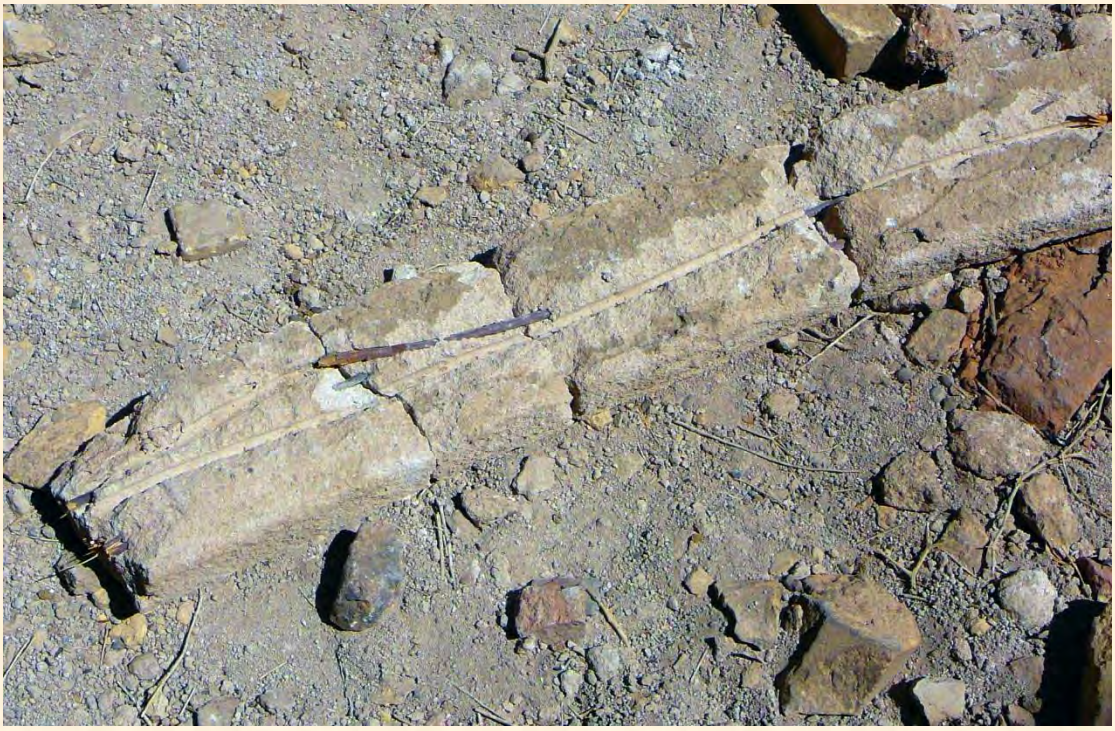
arches





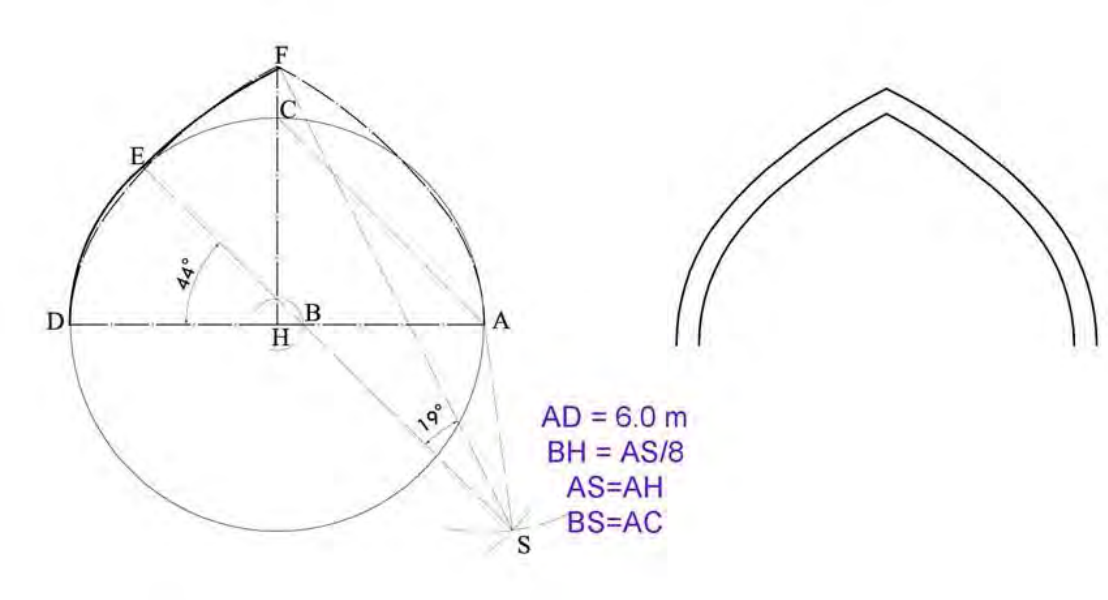
Gypsum ribs at the Umayyad Palace of the citadel, Amman, Jordan, AD 7th century: Ignacio Arce, ' Diaphragm Arches to Ribbed Vaults', p 230.
Arch with precast gypsum ribs, Ukhaidir, Iraq, 774-5 O Reuther, *Ocheïdir* [Leipzig 1912] reproduced in Arce, p 197.

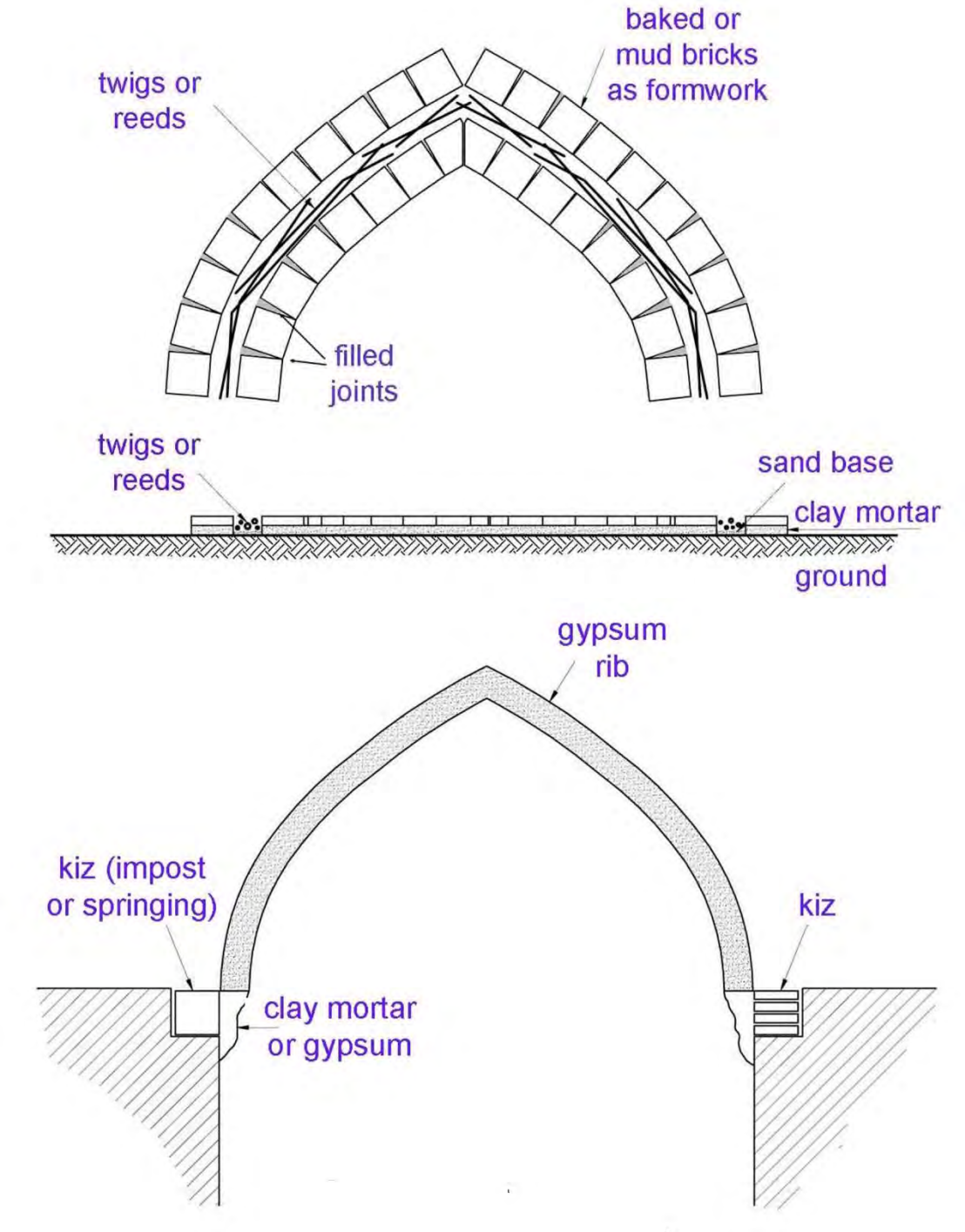
Arch at the Anar Caravanserai, Iran, 19th century.



Gypsum rib at the Anar Caravanserai, Iran, 19th century.

The problem of constructing an arch in a region with virtually no timber was solved by the use of gypsum ribs, which were once common in the region and have been used Iran from Sassanian times almost to the present day.




baked or
mud bricks
as formwork
twigs or
reeds
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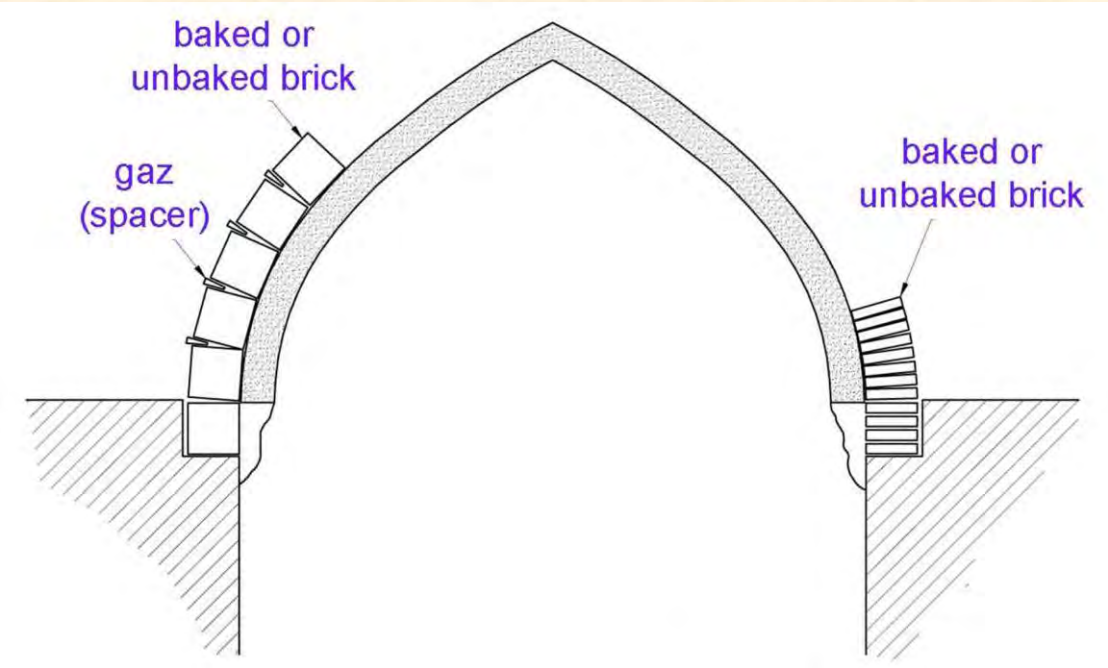
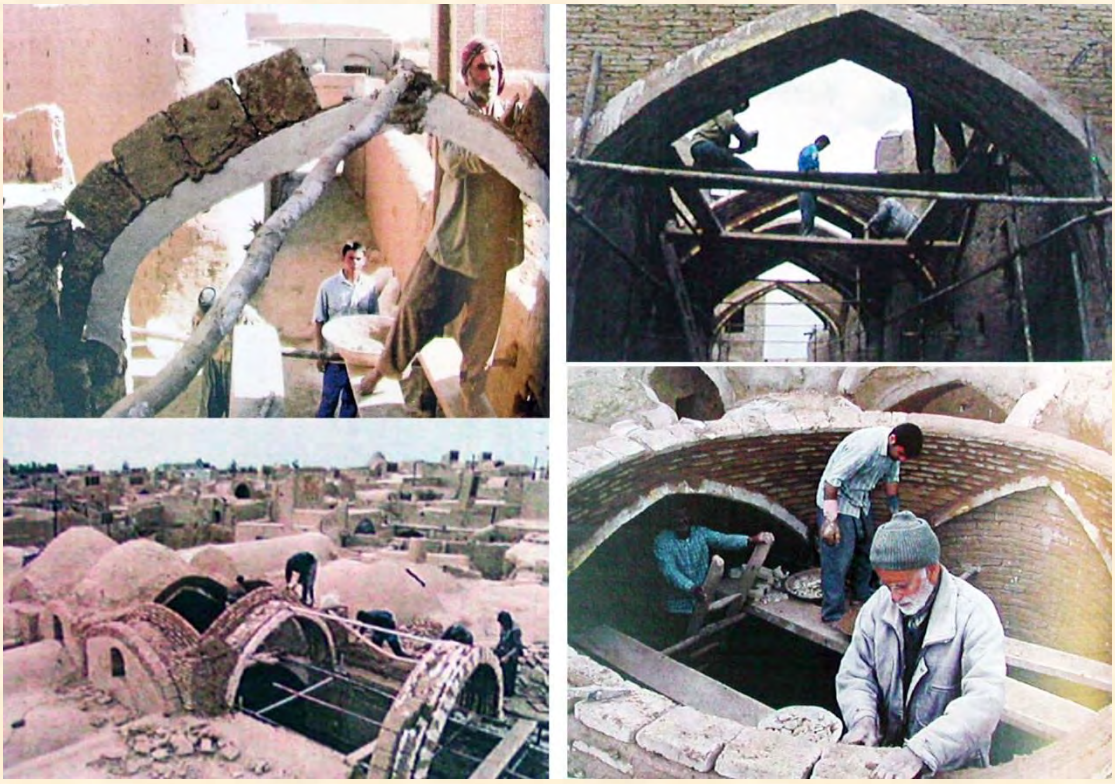
clay mortar
or gypsum



Fabrication and use of gypsum ribs: Mohammedreza Bazldjou [recaptioned]

The arch is set out on the ground using simple geometry, then formed between lines of mud bricks by pouring in gypsum over reeds or other reinforcing material. It is than installed in the required position and used to construct a lightweight mud brick arch, over which in turn more solid masonry is built until the gypsum rib can be removed.



Use of gypsum ribs at Meybod: courtesy Mohamedreza Bazldjou.

Gypsum ribs are also used to support vaulting of various forms.

the flat roof & the balcony

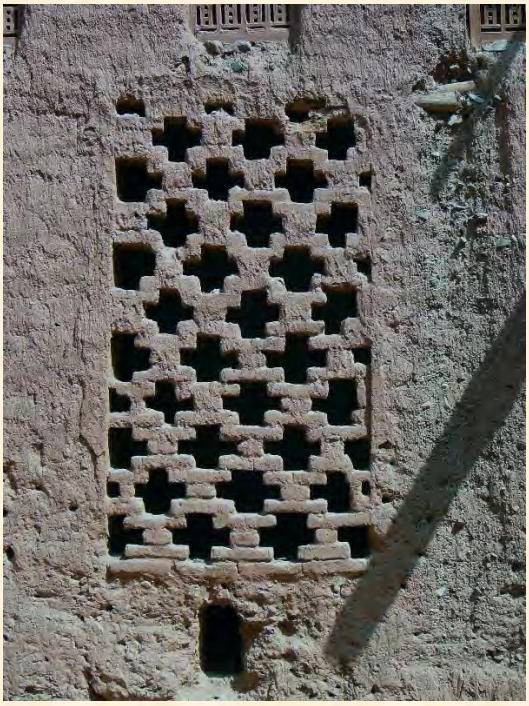
Where timber is available, flat roofs are built with timber joists supporting thick layers of mud on boarding. As elsewhere in the Middle East they are used for sleeping in hot weather, and they are also used for drying fruit and vegetables. The timber-framed flat roof is found in the step villages, discussed above, but the very different steep shingled roof, seemingly European in character, occurs in the Caspian region.

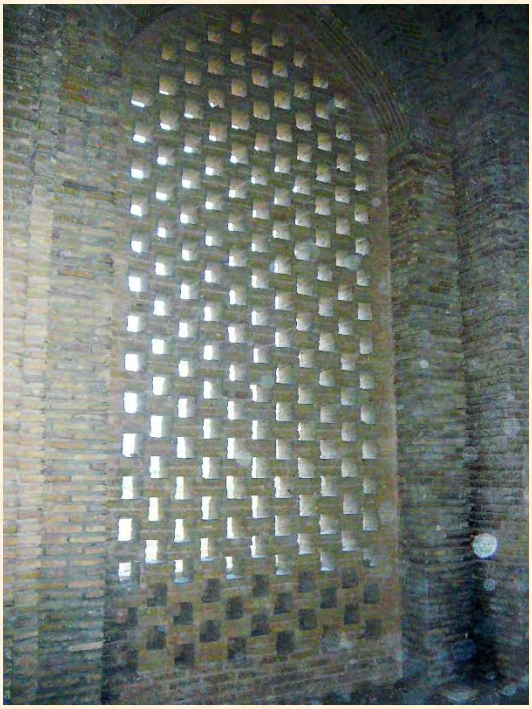
The flat roof for food drying fruit drying; drying on round trays; both in Abyāneh: Miles Lewis

The cantilevered balcony occurs in the same timbered areas, usually roofed, and sometimes partly enclosed, in the Ottoman manner

The oldest house in Abyaneh; another balcony in Abyazneh: Miles Lewis.

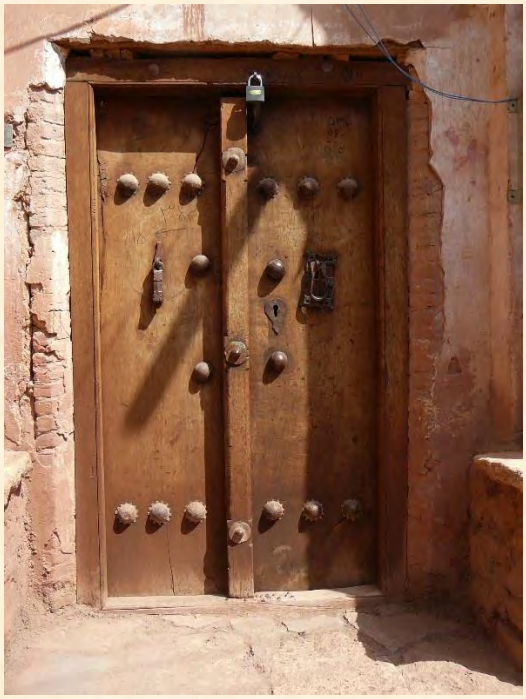
the grille or screen





Brick grilles at a house in Abyaneh and the mosque at Aziran: Miles Lewis

doors and door furniture



Doors in Abyaneh: Miles Lewis

Door at the Lari-Ha House, Yazd, and detail of the serrated latch.

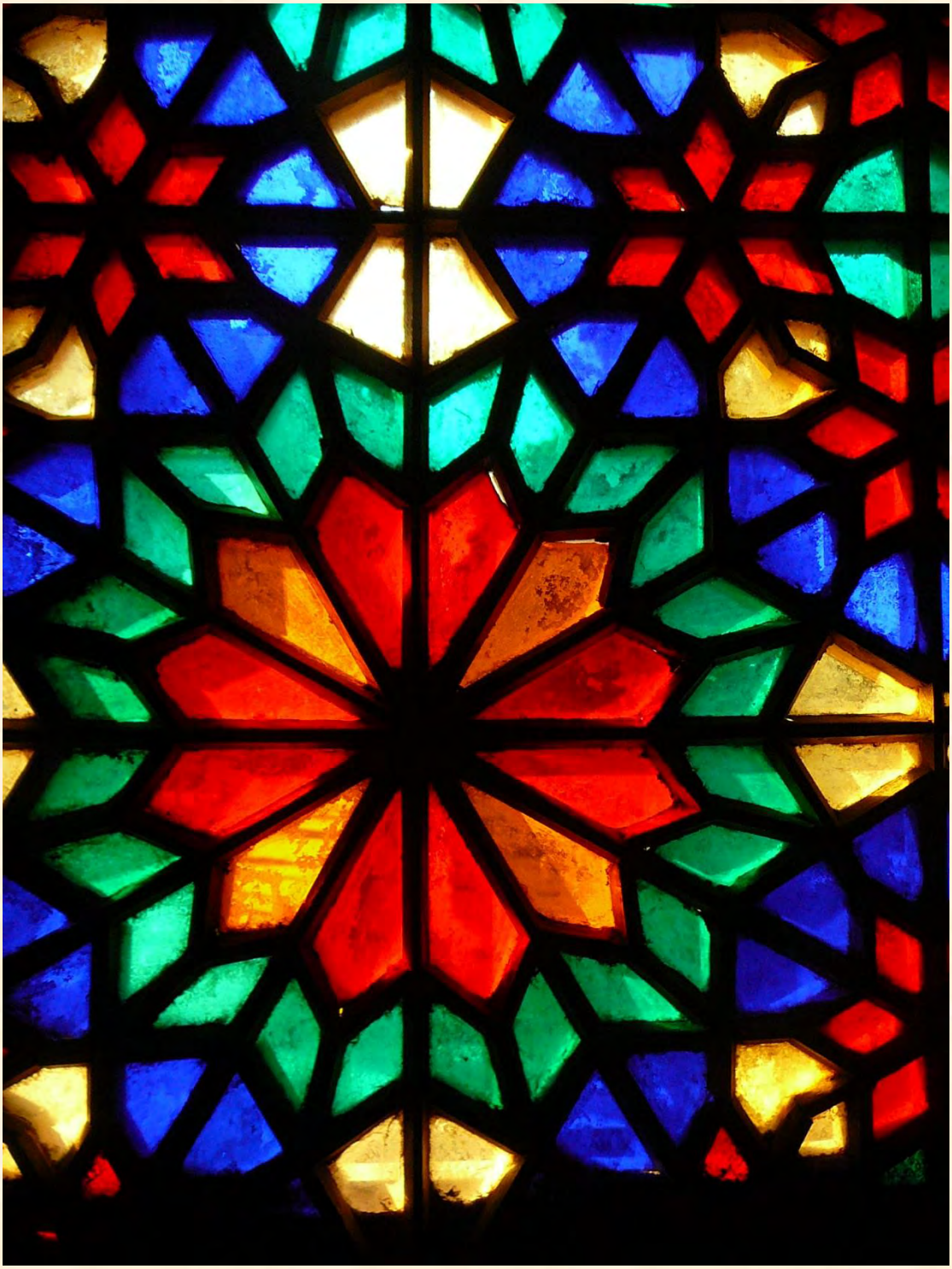
Gendered door knockers, Yazd, the symbolic female door knocker on the left, and the male knocker on the right: 'Historic City of Yazd' [World Heritage nomination], p 430.

It was the convention, at least in Yazd, that a male could be let into the house only by a male and a female could be let into the house only by another female. Thus designated male and female door knockers might be provided.[30]

glass & stucco

Colored glazing at the Lari-Ha House, Yazd.

[30] 'Historic City of Yazd' [World Heritage nomination], p 450, quoting Alexandria Mackinnon, 'Persian Patterns', p 175.



Coloured glass at the Bagh-e Dowlatabad, Yazd.

In 1905 Napier Malcolm (writing from his experience in Yazd) wrote:

> You will find three styles of wall in Persian houses. Sometimes the rough mud is coated over with a smoother surface, either clay and chopped straw, or clay and sand, and the brown colour is left unchanged. In fairly good houses this style is often thought good enough for the summer portico. Very often the angles of the mouldings are pointed with white

> gypsum, and when ornamental designs in the same fashion are added, the effect is exceedingly pretty. But generally the living rooms in a Persian house are entirely whitened with gypsum, and a moulded design, about an eighth of an inch thick is made in the centre of the ceiling. These complicated and accurate designs are produced by the natives with no better tools than a chisel and a bit of string.,.[31]
>
> The semi-circular fanlight consists of pieces of glass fixed together in a wooden lattice. The lattice at a distance resembles fret-work, but is really elaborately pieced together. Some of the older windows contain exceedingly fine work, but even when it is well done it is not very durable … The French window itself consists of two doors which are supposed to meet in the middle. There are no hinges, but each door has a wooden foot which turns in a mud socket. The arrangement of the coloured glasses which form the panes is extremely artistic. The same sort of wooden lattice is used but the pattern is much larger than the pattern of the fanlight.[32]

the qanat

The *qanat* is a tunnel which collects water from an aquifer in a mountainous region and takes it into the desert to supply settlements there. It has been essential to the settlement of much of Iran, and it is commonly claimed to be an Iranian invention, but this is untrue. Romantics and nationalists have taken any historical reference to a tunnel or an irrigation channel to mean a qanat, which is quite unwarranted, because there were many such works in the ancient world.

The history of irrigation begins (so far as the Middle Eastern and Mediterranean region is concerned) in Mesopotamia. Simple 'fan irrigation' was in use at Choga Mami on the western side of the Zagros Mountains by the first half of the sixth millennium BC, and substantial lateral canals were drawn off the river by 5000 BC. By the Achaemenid period sophisticated water management had reached Iran. Deep canals, a stone causeway-weir and other works are found in the Marvdasht, the Plain of Persepolis, and open channels, partly rock-cut, at Achaemenid sites throughout Fars.[33] But there is no ground for Hobhouse's claim that the ancient Persians and Medes invented qanats,[34] or for Wilber's assertion that the qanat 'appears' to date back to the Achaemenian period.[35]

It has also been claimed that the qanat developed in north-western Persia (part of ancient Armenia) to drain mine workings, and to became common by the C6th BC.[36] But whether or not this is factually true, it is another misinterpretation. Tunnels dug in such a way, by boring between vertical shafts, were widespread in the ancient world. Roman aqueducts are largely of

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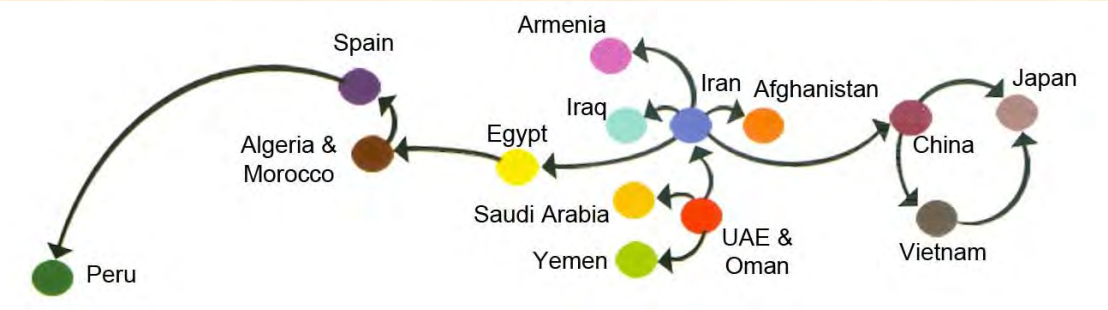
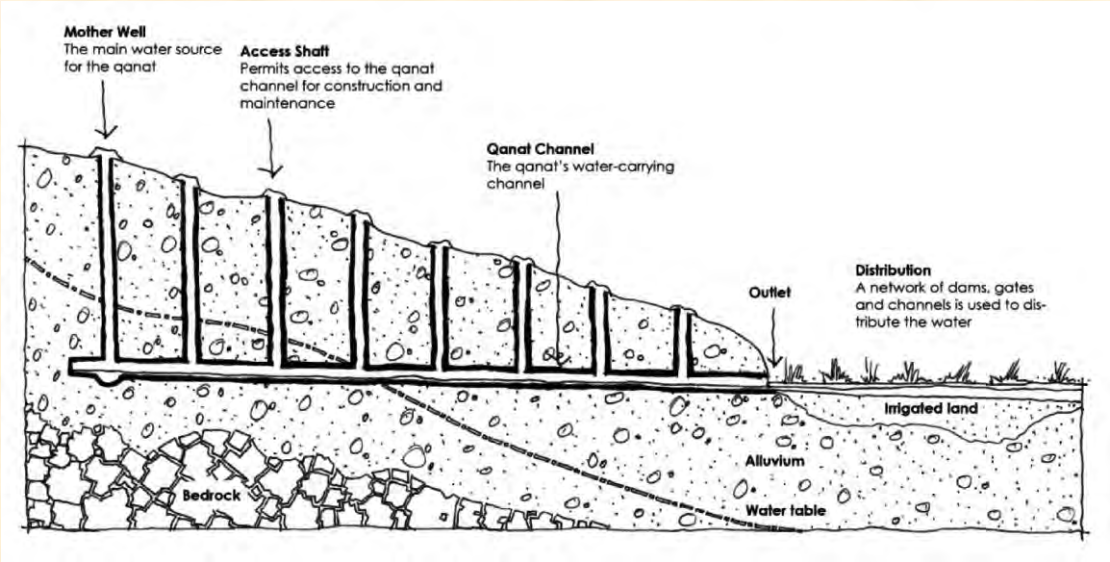
31 Malcolm, *Five Years in a Persian Town,* pp 16-17.
32 Malcolm, *Five Years in a Persian Town,* pp 18-19.
33 Stronach, 'Parterres and Stone Watercourses', p 3.
34 Beazley & Harverson, *Living with the Desert,* pp 35-8.
35 Wilber, *Persian Gardens,* p 4.
36 Beazley & Harverson, *Living with the Desert,* p 38.

this type, and the arcaded superstructures to cross valleys actually account in most cases for a small proportion of their length (those supplying the city of Rome are an exception).



Al Tikitri, *Archaeoloy of the Falaj,* p 140.

The oldest known qanat (or *falaj,* as it is better known there) is that at sites Hili 14 and 15 the United Arab Emirates, and is about three thousand years old.[37] Most Iranian qanats cannot be dated by either documentary or physic evidence, but the existence of qanats by about the 10th century BCE can be inferred from the establishment of settlements in the desert, which must have depended upon them.



Principle of the qanat: 'Historic City of Yazd' [World Heritage nomination], p 442.

[37] Al Tikitri, *Archaeoloy of the Falaj,* pp 67-80.

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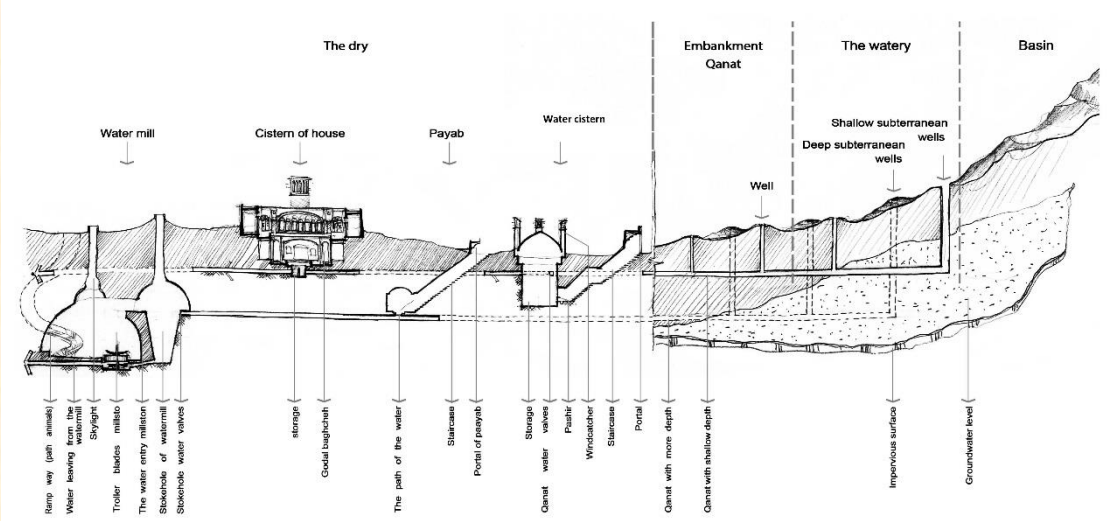
Aerial view of a qanat near Yazd: 'Historic City of Yazd' [World Heritage nomination], p 19.



Cross-section of a qanat system and its constituents, HCY Archive: 'Historic City of Yazd' [World Heritage nomination], p 20.

Iranian Qanats are typically five to eight kilometers in length,[38] but one at Yazd extends 120 km from its source well, 116 m deep, to its mouth.[39] A water finder locates a source, a trial shaft is dug, and the successful shaft becomes the mother well. A depth of fifteen to twenty-five meters is considered reasonable, and ninety metres the maximum, but at Gonabad there are three wells dug in the 13th century which are said to be 300 metres deep. A surveyor supervises the digging of guide shafts at 200-300 meter intervals. Then the diggers begin burrowing between them, bringing the soil up the vertical shafts by bucket and windlass. The tunnel usually begins at the outlet so that diggers can work in dry conditions. It is reported that very deep qanats may be ventilated by pairs of shafts, with a lamp at the bottom causing the air to rise in one, and creating a downdraft in the other.[40] But while this might well be required during the

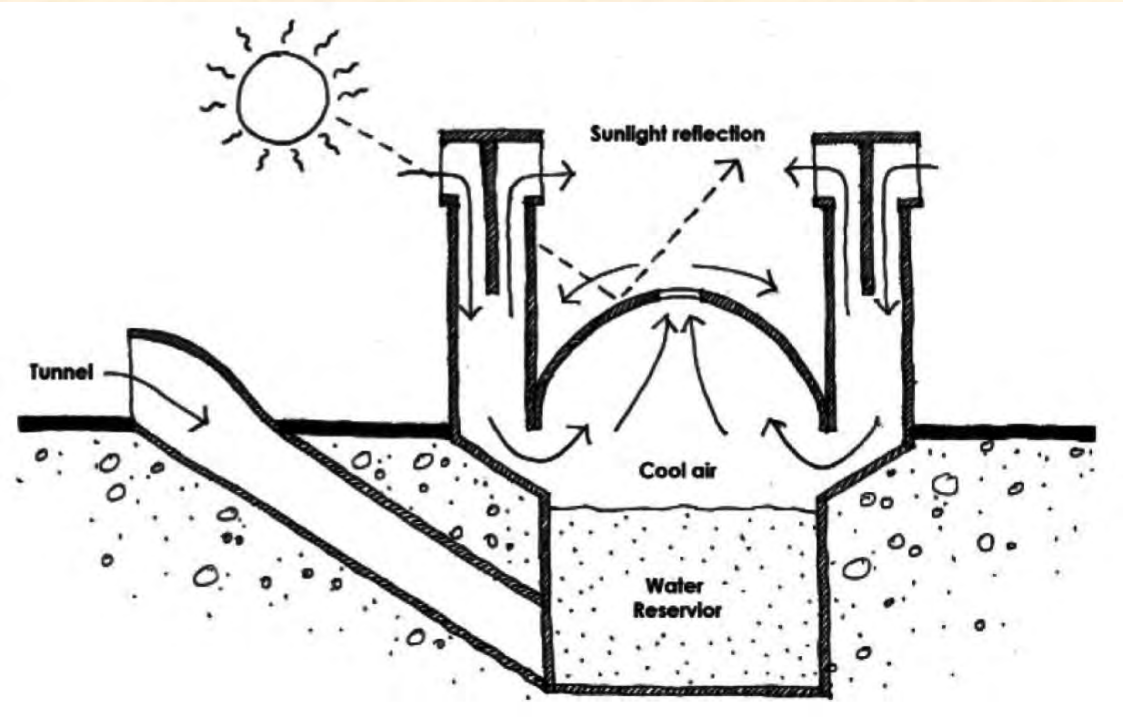
38 Hobhouse, *Gardens of Persia,* p 19.
39 Porter, *Palaces and Gardensa,* p 22.
40 Hobhouse, *Gardens of Persia,* p 19.

excavation of the tunnel, it is difficult to believe that a lamp would be maintained on a continued basis. The geographer Henri Goblot estimated that by 1950 there were 40,000 qanats on the whole plateau, producing 600,000 liters per second. And with a total length of 400,000 kilometers, one and a half times the distance from the earth to the moon.' [41] In In 1965 there more than 600 qanats at Qum alone, although their length was only from one to ten kilometers.[42]

wells & underground chambers

The *badgirs* of an underground cistern, Yazd.

41 Porter, *Palaces and Gardens,* p 22.
42 Porter, *Palaces and Gardens,* p 22.

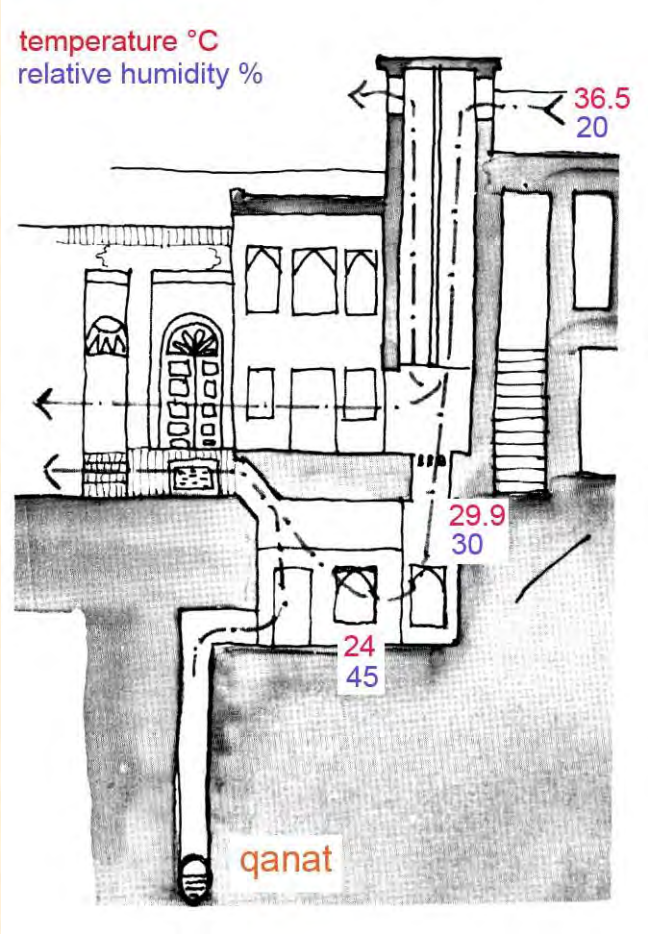


Section of an underground reservoir cooled by *badgirs*: 'Historic City of Yazd' [World Heritage nomination], p 441.

Cisterns are used in towns to store rain water or water supplied by qanats, and they are typically round, five to six metres deep, with domed tops.[43] They may be cooled by *badgirs,* as discussed below.

Stair leading down to an underground chamber and pool at the Lari-Ha House, Yazd.

[43] Beazley & Harverson, *Living with the Desert,* p 39.

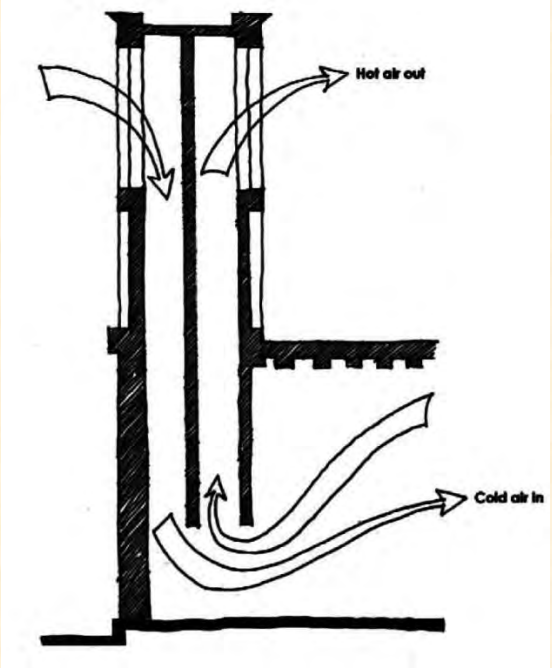


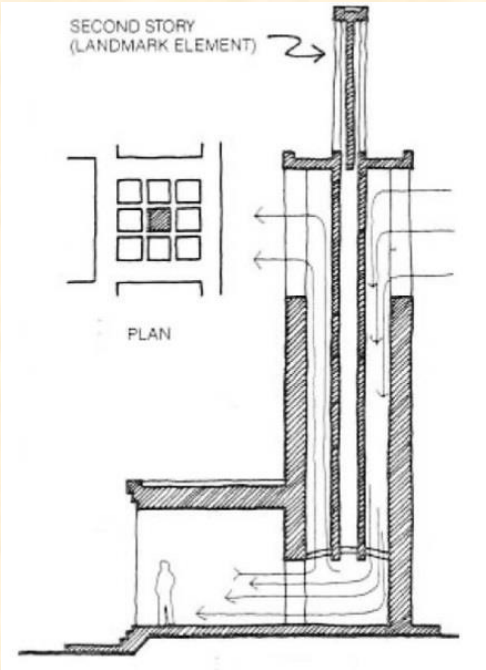
Basement cooled by a qanat: Beazley & Harverson, *Living with the Desert,* p 69

Middle class residences often have a partially buried room which opens onto a courtyard up a flight of steps. This cellar, called a *sardab* (literally 'cold water') has its own basin, and receives air from *badgirs*. As it flows over the chilled water the air is cooled, exiting through interior conduits up to the rooms above.[44] In orher cases the air passes directly over a qanat.

[44] Porter, *Palaces and Gardens,* p 40.

the badgir





Badgirs or wind catchers: 'Historic City of Yazd' [World Heritage nomination], pp 441, 444.

The *badgirs* or wind towers catch the slightest breeze and direct it into the rooms below. They range from two to six shafts. The trunk contains these vertical shafts, with air shelves to impede hot air from descending. The currents are often directed across a pool of water, which humidifies but also cools it. The warm air rises through a different shaft.[45] The biggest wind catcher in Iran, 33 metres high, is that on the Khan's pavilion at Bagh-e Dowlatabad, Yazd, but it collapsed in the 1960s and the present tower is a reconstruction,[46]

45 Burke & Elliott, *Iran,* p 257.
46 Burke & Elliott, *Iran,* p 260.

Inside a wind tower at Abyāne. Khansari & Yavari, *Espace Persan* p 39.
Badgir at the Lari-Ha house, Yazd.

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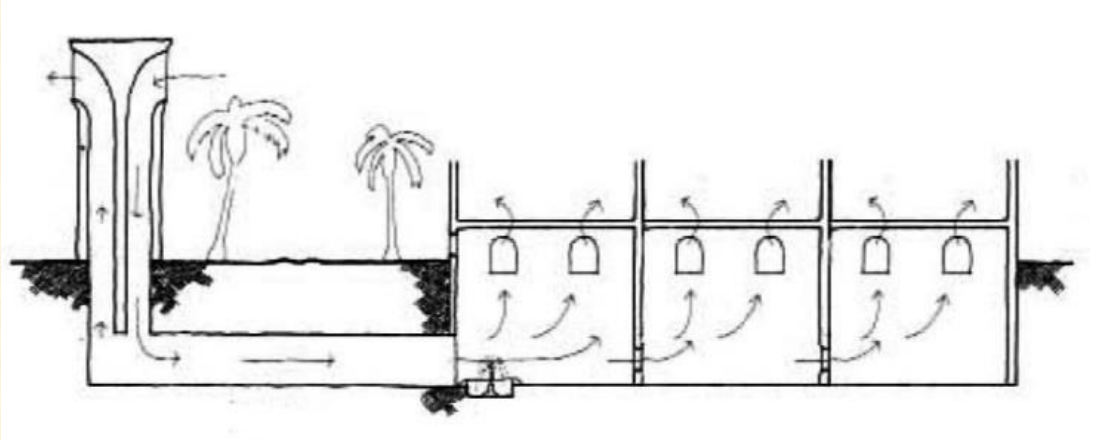
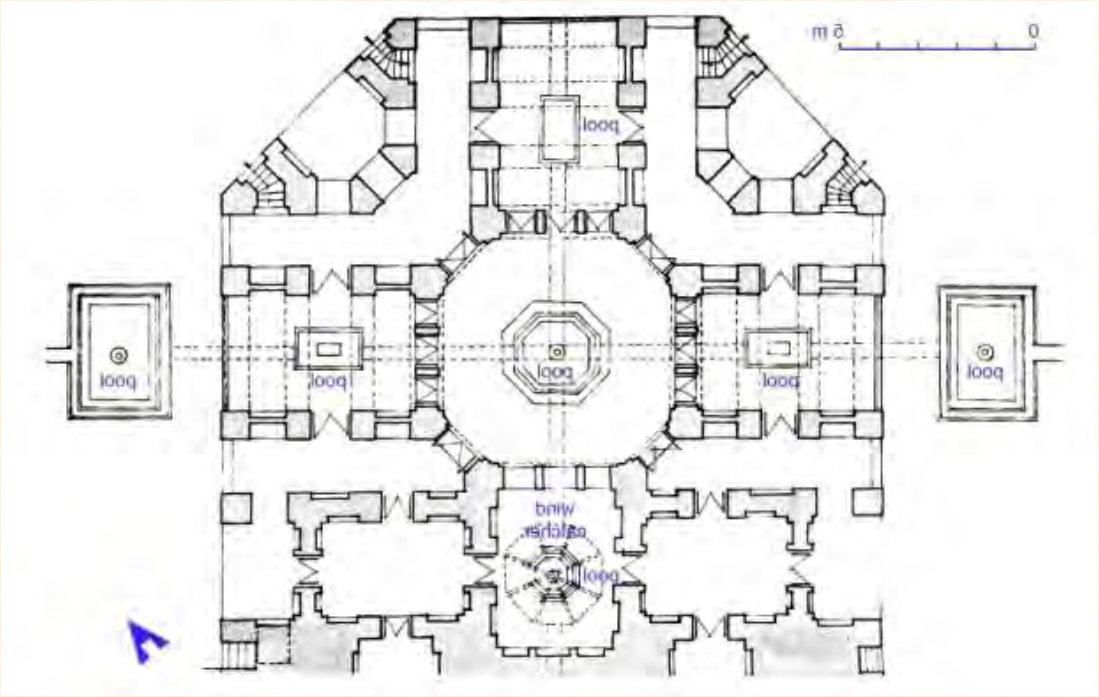
***b**adgirs* at Yazd.



Badgir cooling a basement: 'Historic City of Yazd' [World Heritage nomination], p 445.

The biggest wind catcher in Iran, on the Khan's pavilion at Bagh-e Dowlatabad Yazd.

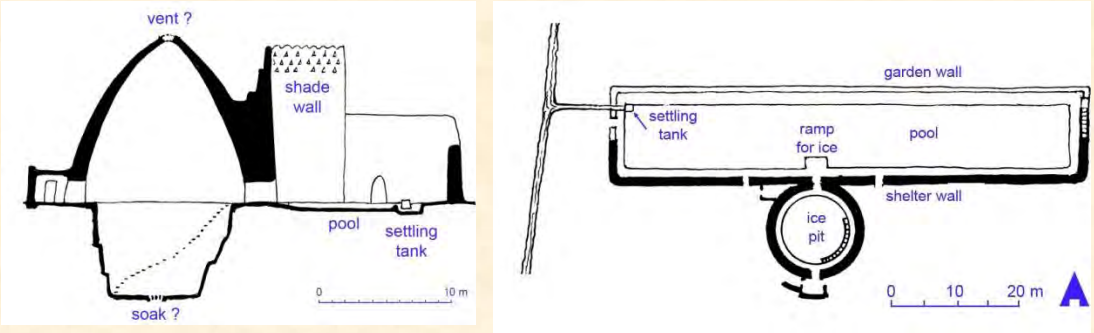


Plan of the wind catcher at the Bagh-e Dowlatabad. Beazley & Harverson, *Living with the Desert,* p 62.

The base of the wind catcher at the Bagh-e Dowlatabad, showing the eight triangular ducts..

The *badgirs* or wind towers catch the slightest breeze and direct it into the rooms below. They range from two to six shafts. The trunk contains these vertical shafts, with air shelves to impede hot air from descending. The currents are often directed across a pool of water, which humidifies but also cools it. The warm air rises through a different shaft.[47]

the ice house



An ice house near Yazd in plan and section. Beazley & Harverson, *Living with the Desert,* pp 51, 52

No country is more interesting than Iran in its traditional methods of trapping wind, ventilating, cooling spaces, and supplying water, but the creation and storage of ice is particularly ingenious. An east-west wall is built, and on the north or cool side of it side is created a shallow pool, or a series of shallow channels. When the temperature is cold enough ice forms it in overnight, and in the morning this is cut out and taken down a ramp into to the adjoining ice house for storage. This contains a well for the ice, with provision for draining off the melt, and above is a domed or conical chamber which maintains a reservoir of still air above the ice. As it warms up the warmest air escapes from a vent at the top, and the chamber as a whole remains cold for a long period. In a purely architectural sense these chambers are dramatic and remarkable.

[47] Burke & Elliott, *Iran,* p 257.

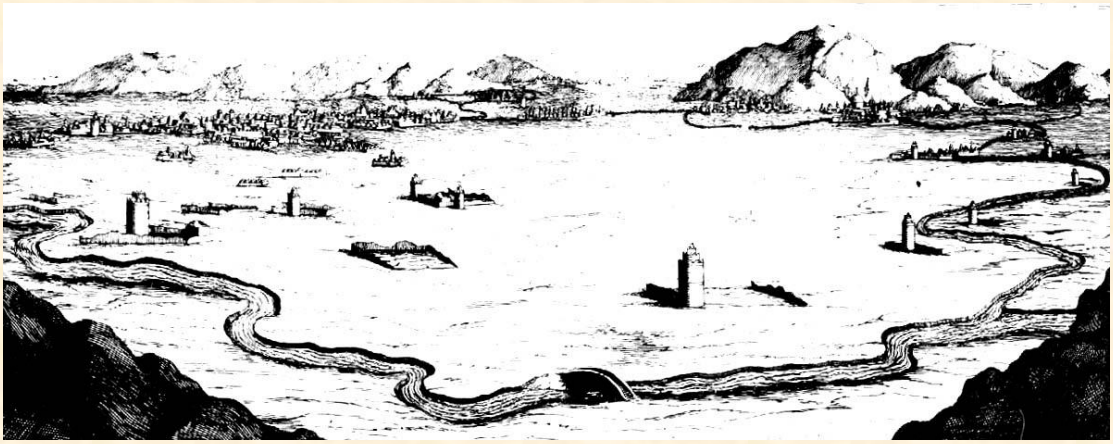
The Zerifs ice house, Kirman.

Moayedi ice house or Yakh-chal at Kirman. Michell, *Islamic World,* p 189.
The (unfortunately over-restored) ramp of the Moayedi ice house, Kirman.

The ice house at Abarkūh with its shade wall.

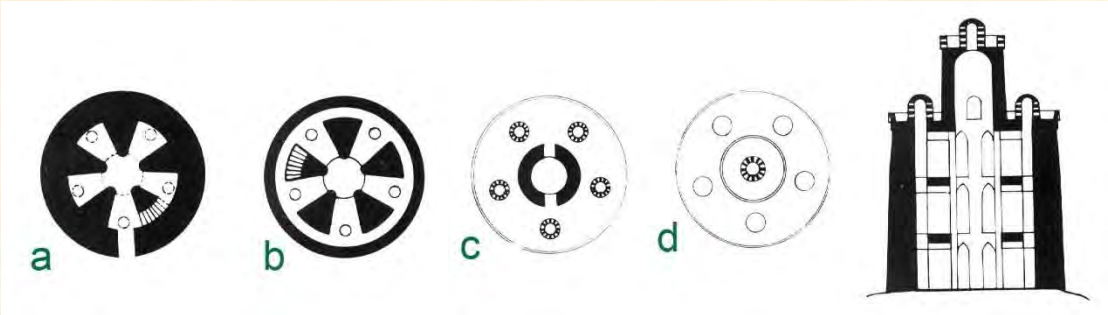
Interior of the ice house at Abarkūh looking upwards

the pigeon tower



Pigeon towers near Shareza in the 17th century. Chardin, *Voyages,* III.

Pigeon towers at Khorasegan.



Typical pigeon tower, in plans and section. Beazley & Harverson, *Living with the Desert,* p 106.

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Pigeon towers are not typical of the Iranian Plateau in general, but they have long been features in the Esfahan oasis, on the Zayandeh River, south of Ateshkadeh, and at other locations such as the fields surrounding surrounding Bonab, near Tabriz.[48] The pigeon house was designed to provide roosting spaces beyond the reach of predators, notably snakes and rats. These squat circular towers each housed about 14,000 pigeons, and supplied guano to fertilise the watermelon fields, though since the advent of chemical fertiliser they are unused.[49] Surprisingly, from a western point of view, the birds, although perfectly edible, were not used for food. Dating of the structures is difficult (the only two to which a period is ascribed are in the great royal gardens of the Hazar Jarin), but they have highly developed plans, and are likely to be the result of a considerable tradition.[50]

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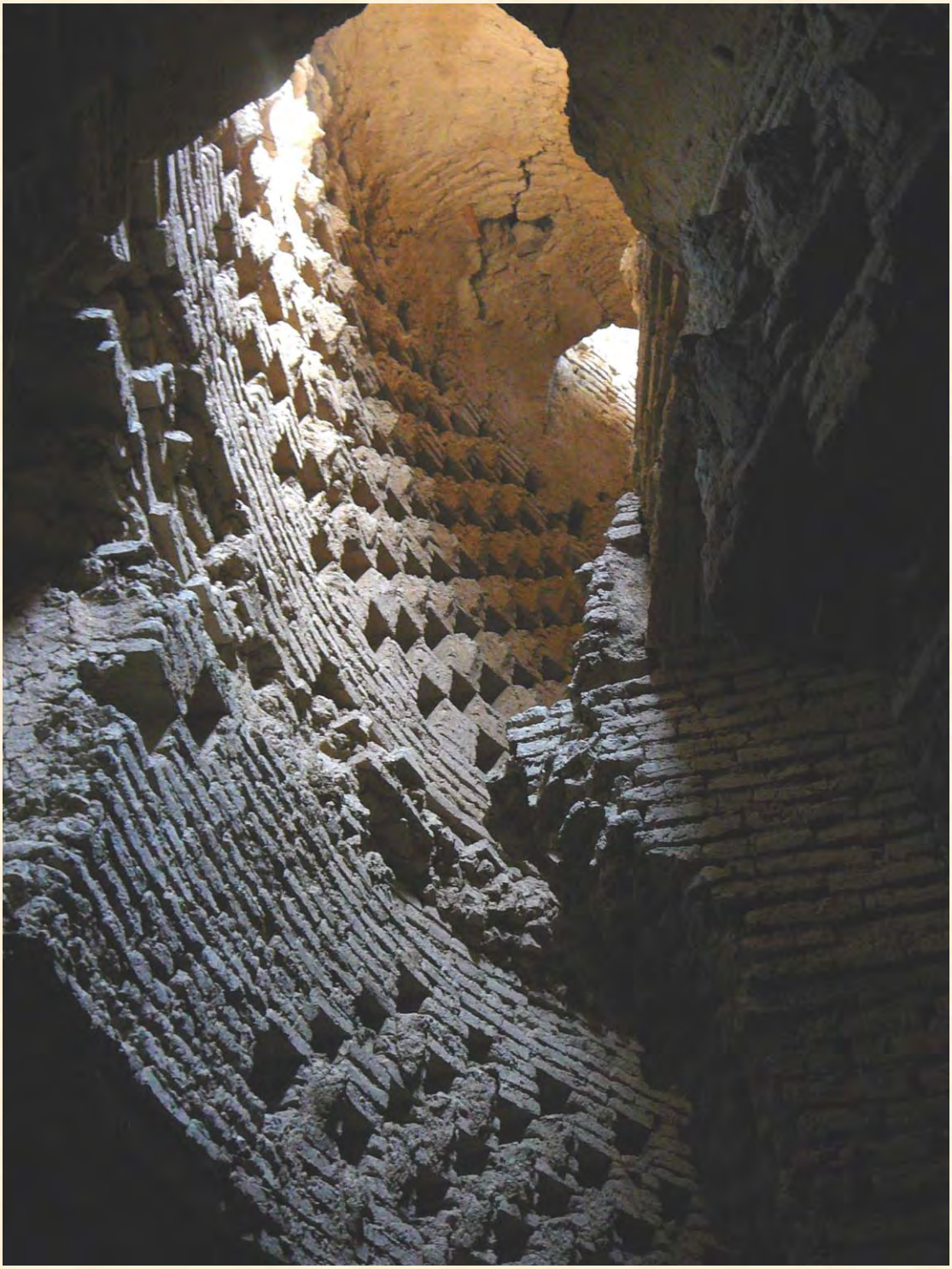
48 Matheson, *Persia,* p 97.
49 Burke & Elliott, *Iran,* pp 244-5.
50 Beazley & Harverson, *Living with the Desert ,* p 103.

Pigeon house at Khorasegan.

Pigeon house at Khorasegan: the central space.



Pigeon house at Khorasegan interior detail.

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