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THE EFFECTS OF CLIMATE AND ENVIRONMENT ON THE FORMATION AND DEVELOPMENT OF ARCHITECTURE ON THE COASTS OF CHABAHAR AND KONARAK DURING THE ISLAMIC ERA

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Abstract: The diversity of climatic conditions has affected architecture and caused the formation of different types of architecture in Iran. The Makran area is a long plain on the northern shores of the Oman Sea and south of the Makran mountains in Sistan and Baluchistan province, which today includes two counties, Chabahar and Konarak. This area is considered warm and humid in terms of climate. In the present study, we investigate the natural and climatic causes affecting the formation and development of the architectural constructions on the Makran beaches, which appeared during the Islamic era. Therefore, in addition to the field method, documentary studies were used to collect information. First, the architectural samples of Makran beaches in the Islamic era were identified. Then thirteen instances were selected based on the building's architectural features, authenticity, and present condition. These buildings belong to the periods between the Seljuk dynasty and the late Pahlavi period. The questions are, what were the strategies used by the architects to deal with the risks and unfavorable climatic conditions and their environmental effects? What similarities and differences are there between the architecture of the Islamic era of the coasts of the Persian Gulf and Makran? How has been the architectural pattern(s) of Makran coasts influenced by climate? The results of the investigations indicate that Makran architects were fully aware of the limitations and considered climatic factors such as sunlight, wind, temperature, and humidity. In the construction of buildings, they have paid attention to choosing things such as the type of materials, the color of materials, the construction of the building on the platform, the orientation of the building, and the design of the plan in an extroverted manner. This has ensured the comfort of the residents. These architectural principles are more visible in residential and native buildings. However, in buildings with military and administrative use, probably due to the influence of political and cultural factors, such measures have been thought less.

Keywords: Islamic architecture, southeast of Iran, Makran coasts, environment.

چکیده: تنوع عوامل اقلیمی بر شکل‌گیری فضاهای معماری اثر گذاشته و سبب گوناگونی انواع معماری در ایران شده است. سواحل مکران جلگه طویلی در ساحل دریای عمان و جنوب کوه‌های مکران (استان سیستان و بلوچستان) است که امروزه دو شهرستان چابهار و کنارک را در بر می‌گیرد و از لحاظ اقلیمی جزء نواحی گرم و مرطوب محسوب می‌شود. در پژوهش حاضر به بررسی و شناسایی محرک‌های طبیعی و اقلیمی مؤثر بر شکل‌گیری و توسعه معماری در سواحل مکران در دوران اسلامی پرداخته شده است. بنابراین افزون بر روش میدانی از مطالعات اسنادی برای گردآوری اطلاعات استفاده گردید. ابتدا آثار معماری سواحل مکران در دوران اسلامی شناسایی شده و سپس از میان آنها سیزده بنا بر اساس ویژگی‌های معماری، اصالت و سلامت بنا انتخاب شده‌اند. این بناها براساس دوره‌ی زمانی طبقه‌بندی شده است و دوره سلجوقی تا پهلوی را شامل می‌شوند. پرسش‌ها اینست که راهکارهای مورد استفاده معماران به منظور مقابله با مخاطرات و شرایط نامساعد اقلیمی و تأثیرات محیط زیست چه بوده است؟ چه همسانی‌ها و تفاوت‌هایی میان معماری دوران اسلامی سواحل خلیج‌فارس و مکران وجود دارد؟ الگو یا الگوهای حاکم بر سازه در معماری سواحل مکران تحت تأثیر اقلیم چگونه است؟ نتایج بررسی‌ها حاکی از آن است که معماران مکران با علم به محدودیت‌ها و با در نظر گرفتن عوامل اقلیمی همچون تابش خورشید، باد، دما و رطوبت دست به ساخت و ساز بناها زده‌اند و در ساخت بناها به انتخاب مواردی همچون نوع مصالح، رنگ مصالح، ساخت بنا روی سکو، جهت‌گیری ساختمان و طراحی پلان به صورت برونگرا توجه داشته‌اند و همین امر سبب تأمین آسایش ساکنان شده است. این راهکارها در بناهای مسکونی و بومی بیشتر قابل مشاهده است. اما در بناهایی با کاربرد نظامی و اداری، احتمالاً به دلیل تأثیرپذیری از عوامل سیاسی و فرهنگی، چنین تدابیری کمتر اندیشیده شده است.

کلیدواژه: معماری اسلامی، جنوب‌شرق ایران، سواحل مکران، محیط زیست.

I. Introduction

Numerous factors such as the political, economic, cultural, and environmental conditions affect the formation of architectural spaces. Among them, one of the fundamental factors is climatic conditions. Architects are influenced by the conditions and materials arranged by their natural environment. They used them in the design and construction of the building. Architects use mostly local techniques, materials, and traditions.

The climate of an area depends on several major and minor factors. The main factors are sunlight, temperature, humidity, rainfall, and wind. The sub-factors are the latitude, altitude, and distance from the sea (Akhtarkavan *et al.*, 2012: 11). In terms of climate, Makran beaches are considered hot and humid. Due to

its proximity to the sea, it has high humidity in all seasons. During the long summers, scorching and humid weather, and mild winters, a low-temperature difference between day and night (Shahbakhsh, 2002: 49).

In Iranian archaeology, archaeologists pay more attention to the issue of climate and ecology, studying the formation of the settlements and architectural spaces to analyze the behavior of prehistoric cultures. It should be noted that the interaction between humans and their environment has been established from prehistoric times to the present. Due to the importance of the subject, the authors have studied the effect of climatic and environmental conditions on the formation and development of the architecture of two ports on the coast of the Oman Sea. The main purpose of this article is to explain the impact of the natural environment on architecture with the aid of climatic studies and the study of the natural environment. Another goal is to be aware of the solutions used by the architects of the region in adapting the architectural spaces to unfavorable and challenging environment. According to the objectives of this article, we seek to answer two questions; 1- What are the strategies used by architects to deal with hazards and adverse climatic conditions and environmental impacts? What are the governing factors influencing the formation of the architectural structures located on Makran beaches? The data collection method in this article is based on the field and documentary methods, and the research is prepared by applying the descriptive-analytical method. For this purpose, the field study was carried out only by the first author. To accomplish this task, first, the architectural features of the buildings of the Islamic era on the shores of Makran were studied and identified. Then, by recognizing the climatic characteristics of the region, the impact of these characteristics on the architecture was studied. To achieve this end, the study of architectural evidence left over from past eras could open the instigating way for researchers.

II. Background of the research

The majority of cultural studies on Makran have an anthropological and historical approach, and the relationship between climate and architecture in this area received less attention from researchers. In her master's thesis, Keikha studied the architecture of Makran beaches and explained the architectural features of this area (Keikha, 2015). Afshar Sistani, in his book "Chabahar and the Persian Sea" describes and explains the cultural features in the Chabahar region, and the basis of his research is the anthropological study (Afshar Sistani, 1993). In the book "The role of Chabahar in the coastal region of southeastern Iran" Afrakhteh has very effectively introduced Chabahar and its climatic characteristics along with the economic and social situation (Afrakhteh, 1996).

Although independent and specific research has not been done on the relationship between climate and architecture on the Makran coast, we can reach out to some studies on climate-friendly housing design in different parts of Iran. Among them, we can mention Kasmaei (2003), Razjouian (2010), and Ghobadian (2010) studies. In all of these studies, suitable climatic conditions and their relationship with architecture have been analyzed using appropriate climatic diagrams. Kaviani (1993) prepared a bioclimatic map of Iran and studied the climatic conditions using different methods. Alijani (1994) evaluated the role of climate in housing. In that article, by examining the angle of sunlight, he described the various methods for studying climate-friendly housing. Papoli Yazdi and his colleagues (2000) studied the traditional housing of the Turkmen tribes. Archaeological studies on Chabahar and Konarak basins were also carried out by Shirazi (2010) and Talesh (2009).

III. Geographical location

Baluchistan is a part of Sistan and Baluchistan province, which is divided into two regions: the northern region, including Sarhad, Khash, and Zahedan, and the southern region, also called Makran (Borghei, 1973: 4). The study area includes the cities of Chabahar and Konarak on the coast of the Oman Sea and south of the Makran Mountains (Fig. 1). Chabahar city, with an area of about 17,100 square kilometers and an average height of 8 meters above sea level, is located on the southeastern tip of Iran and next to the Oman Sea (Shirazi, 2010: 9). Konarak city, with an area of about 11569 square kilometers, is located on the coast of the Oman Sea and the Indian Ocean and about 30 kilometers distance from the port of Chabahar (Statistics Center of Iran, 2013: 60).

In terms of climate, Makran beaches have had a constant trend since at least 4700 years ago (Motamed and Gharib Reza, 2008: 77-78). This region has long and hot summers and short and temperate winters, with a slight temperature difference between night and day. The climate of the region will be warm from February, and this hot climate will continue until June. The months of July and August have a more balanced temperature than June and the temperature decreases until February. This month is considered the coldest month of the year on the shores of Makran (Shahbakhsh, 2002: 49). The relative humidity is very high throughout the year and varies at different times of the day and in the different seasons of the year. The average humidity is 50-70% in winter and 70-87% in spring and summer. Chabahar and Konarak rainfalls are mainly affected by monsoon winds and Mediterranean currents in summer and winter, and most of the winter

rainfall in the region occurs in January. Rainfall is usually heavy in the fall and spring and becomes little and ordinary during the winter. Snowfall and hail are rarely observed in this unprecedented area (Afshar Sistani, 1993: 98).

Figure 1. Geographical location of Chabahar and Konarak cities (Authors).

IV. Introduction of the studied constructions

Among the identified buildings of the Islamic era on the shores of Makran, thirteen buildings have been selected based on their architectural features, authenticity, and condition of the building. These buildings, according to the chronological division, are classified from the Seljuk to the Pahlavi period.

IV.1. Imamzadeh Seyyed Gholam Rasoul

Imamzadeh Seyyed Gholam Rasoul is located on the eastern side of Shahid Rigi Street in Chabahar. The tomb is attributed to a righteous Shiite man named Seyyedna Muhammad, who was extremely popular among Indian Muslims, to the extent that Indian architecture influenced the architecture of the tomb. This building has a special and unique architectural style, with its white dome, a height of about 11 meters, and belongs to the middle Islamic centuries (Seljuk, Ilkhani, Timurid) (Saadatian, 2013: 1). The tombs of the Ilkhans and Timurids were built in the common Azeri style and exhibit the extrovert design. The plan of the quadrangular tomb is executed in the east-west direction, and its dome is made of brick materials (Klanuri, 2005: 141). Also, it is a double-shell domed type and is in line with the design of onion-shaped domes. This type of dome is one of the main features of the Indian Timurid (Gurkanian) architectural style (Saadatian, 2013: 5 and 4). The tomb is located in the western part of the courtyard and on the plateau one meter high with a stand with four columns (Azadi, 1957: 3). The most important decorative element of the Seyyed Gholam-Rasoul tomb is its white limestone facade, which in addition to creating a beautiful shine and front, protects this structure from the extreme humidity of Chabahar. The materials used in this building are brick, lime, plaster, wood, thatch, and sandstone.

IV.2. Tis castle (Portuguese fort)

The Portuguese castle is located on a rocky hill to the west of the village of Tis, on the left side of the Chabahar-Konarak road, overlooking the Tis fishing pier at the entrance of Chabahar Bay. This castle belongs to the historical period (Parthian), middle and late Islamic centuries (Safavid period) (Shirazi, 2010: 22) and is located at the height of 28 meters above sea level. The plan of the fort is triangular or arrow-shaped, and

its axis of location is northwest-southeast. The structure of the building has different components, the main of which are as follows: 1- The four main walls of the castle (fence), 2- The six semicircular towers, 3- The eleven rooms around the central courtyard, 4- The right and left spaces of the entrance of the castle, 5- The basement, 6- The Alcove (Heydari, 2009: 38). The building materials are carcass stones and cut sand, clay, brick, and gypsum mortar.

IV.3. Gowatr Old Castle

The Gowatr old castle is located in the Chabahar city, Dashtyari district, Gowatr village. The height of this building is 25 meters above sea level, and its direction is east-west. Gowatr Castle is built on a hill 5 meters high, which belongs to the prehistoric period. The castle has three rooms with flat roofs and two courtyards, some of which are lined with white color. There is a watchtower on the eastern side of this castle (Mulazadeh, 2005: 5). The main building materials of the fort are sandy sedimentary rocks found in abundance along the shores of the Oman Sea.

IV.4. Old Gordim 2 building

The old Gordim 2 building is located in the Konarak city, south of the Gordim village. This building is located at a height of 18 meters above sea level. It was built for residential purposes in the Qajar period (Talesh, 2009: 813). This building has a rectangular extroverted plan, and its orientation is in the east-west direction. The rooms are perfectly symmetrical and have entrances, windows, and niches on the southern, western, and northern walls. The materials used are stone, brick walls, and roof trunks (Ibid. 814).

IV.5. Hotan Park Castle

Hotan Park Castle is located southwest of Konarak city and southeast of Chabahar city, in Jahlian village, and belongs to the Qajar period. The castle is positioned on hills filled with sand and river rocks in the middle of a forest growing native trees, and its height is 6 meters above the surrounding grounds and 34 meters above sea level. This castle is built with a rectangular extroverted plan on two floors, and its axis of location is in the east-west direction. The castle consists of interior space with several rooms. The ground floor is built on a platform one meter high and has three rooms with flat wooden covers and niches with truncated arches (Talesh, 2009: 296). The building materials are raw clay and mud mortar. The foundations of the walls were made of stone, and the inner walls of the building were covered with mud. The type of mud used in the building is made of white mud that is present around the building. It seems that this castle was rebuilt in different periods, considering the form of the materials and rooms.

IV.6. Delooshi house 1

Delooshi house 1 was built about 120 years ago by the sheriff of Tis village called Delooshi and with a residential function. The house has a rectangular extroverted plan, and the axis of the building is in the east-west direction. It is built with clay materials on one floor with a brick platform with a height of about one meter (Preliminary Report, the Registration proposal of Delooshi House 1, 2002: 8). The building consists of two rooms and a row of porches with the crescent-shaped arches in front of it. The roof of the rooms is flat, covered with wooden beams and long branches, then covered with thatch.

IV.7. Post office building

The post office building is one of the oldest stone constructions in Chabahar. According to the stone inscription on the facade of the building, it was built in 1869 AD, 1248 A.H., at the time of the Portuguese influence (Preliminary report, the post office registration proposal, 1998: 2). It has a rectangular extroverted plan executed symmetrically on two floors, and the axis of the building is in the north-south direction. The ground floor of the post office, where the administrative activities were carried out, is located on a platform of 60 cm in height. This floor consists of four rooms and a row of stairs leading to the upper floor and has rows of porticoes with crescent arches on the eastern and western fronts. All the rooms have a decorative crescent arch inside and two vents on the eastern and western fronts leading to the roof of the porches. The first floor, which is generally intended for staff accommodation, has two rooms with flat roofs. Materials such as sedimentary stone carcasses, thatch, plaster, and wood were used in this building.

IV.8. Hoseyniyeh Al-Rasoul

Hoseyniyeh Al-Rasoul is located on the Shahid Rigi Boulevard, near the Seyyed Gholam Rasoul tomb. This building was built in the Qajar period to hold religious ceremonies. In the inscription of the building, its construction is recorded by the Hyderabadi family. (Afsar, 2001: 9). This building has a rectangular plan built on one floor in the north-south direction and has a relatively large nave, a backyard, and a room on the northern side. The roof of the main nave rests on four wooden pillars with carved decorations. The constructing materials are sedimentary sandstone, thatch, and lime mortar.

IV.9. Governor's office building

The governorate building is located in the northern part of 22 Bahman Square on the eastern edge of Darya Street in the old part of the city and was built by the British architects during the Qajar period (Preliminary

report, the registration proposal of Chabahar governorate, 2004: 5). It is built on two floors with an irregular extroverted plan, and the axis of the building is in the north-south direction. The ground floor is built on a platform with a height of 1.5 meters. It has nine rooms and three entrances to the south, west, and east (Ibid. 7). The first floor has five rooms and a terrace surrounded by brick columns and wooden barriers. The roof of this part is made of wood, straw, and the date mat covered in the thatch. The total height of the building from the floor is about 10 meters, with materials such as clay and mud, brick, wood, straw, stone, palm leaf, and iron having been used in the construction of the building.

IV.10. Customs office building

The customs building is located in the east of Chabahar city, in the old part of the city, at a distance of about 100 meters from the fishing pier. It was built by British architects between 1882 and 1893 AD (Preliminary report, Chabahar customs registration proposal, 2001: 5). The old customs building with a rectangular plan is built on two floors and is located in the east-west direction. The ground floor is built on a platform with 2.5 meters in height and 14 stone steps. There are six rooms, a storage room and two corridors on this floor. Access to the first floor of the building is through the entrance and stairs in the eastern part of the building. The main materials used on this floor are clay, mud, wood, and especially sandalwood. The thickness of the walls on this floor is between 80 and 95 cm. The first floor was built with a height of 5.5 meters above the ground and had a terrace, three rooms, and a kitchen. The roof is made of wood, straw, and mats covered with thatch (Ibid. 6). The thickness of the walls on this floor is between 55 and 60 cm. The construction of this building is more in line with western architecture, principally the British style.

IV.11. Delooshi house 2

The Delooshi House 2 is located in the old part of Tis village on Masjed Noorani Street. This building dates back to the late Qajar and the early Pahlavi period. It has a rectangular extroverted plan with two floors, and its orientation is in the east-west direction (Preliminary Report, the Registration proposal of Delooshi House 2, 2004: 2). The ground floor is located on a platform with a height of 120 cm with the stairs on both sides. There are 18 rooms on this floor. Three of them are residential and open to the porch with crescent arches. The rooms on the northern front were used for storage and cookery, and access to them was from the western and northern sides, which are now abandoned. Access to the upper floor is through the two rows of stairs. One is located on the western side of the building and the other in the middle of the southern side. Walking to the upstairs, there are three separate rooms. All of them have a similar plan consisting of a room and a portico on the southern front. Each floor is about 4 meters high, and the materials of the walls are raw clay, sedimentary sandstone, and mud. The roof is formed using the trunks of the various trees, including the cactus, palm, turmeric, and poplar.

IV.12. Arian Old House

Arian House, the only building still representing the old quarter of Konarak city, is located at the western end of the Khatam Al-Anbia Street near the old Grand Mosque of this city in a dead-end street (Preliminary report, Arian's house registration proposal, 2002: 4). The plan is rectangular and extroverted, and its orientation is in the east-west direction. The building has two large rooms with a height of 3.5 meters, a large portico with truncated arches, and a staircase which can be seen in the western part of the building. It was built using materials such as clay, mud, straw, reed, palm, and stone.

IV.13. Moradbakhsh Daryanavard House

This house is located in the old part of Chabahar city, behind Hoseyniyeh Al-Rasoul, and was built by Pakistani architects. This house with a rectangular plan was built on two floors in the east-west direction. Its height is about 7.5 meters above the ground. The ground floor is located on a platform with a height of about 50 cm (Preliminary report, the registration proposal of the Daryanavard house, 2004: 15). This floor has two entrances, five rooms, and a corridor, and mainly the sandalwood and iron are used to cover the roof, and the ceiling height of the rooms is about 3.70 meters above the floor. Access way to the upper floor is through the stairs placed on the northern side, and the first floor has three rooms with a corridor ending in a lattice wall. In general, materials such as clay, mud, wood, straw, stone, iron, palm leaf, and cement have been used in their construction (Ibid. 17).

V. Discussion and analysis of the climatic factors affecting the formation of the architectural types on the Makran beaches

The knowledge of the climatic characteristics and their effects on the design and construction of the buildings causes human beings to create the desired shapes out of the architectural spaces in accordance with the climatic conditions, which in turn increases the comfort of residents and adaptation of the man-made spaces to the natural environment. From this perspective, in this study, the effect of climatic elements such as sunlight, temperature, humidity, and wind on the architecture is investigated.

V.1. Sunlight

The sunlight is one of the determining climatic factors in any region that has a great impact on the architecture of that region. Aware of this, architects apply all the relevant strategies to deal with the destructive effects of sunlight and take advantage of its beneficial effects. One of the common solutions to be considered is the orientation of the building, which can determine the amount of sunlight absorption to create a comfortable building. Its location should be designed to provide the best sunlight in the cold seasons and the best cooling within the indoor spaces in the warm seasons of the year (Kasmaei, 2003: 17). On the shores of Makran, the angle of radiation at noon on the first day of fall and spring, when the sun is at the equinox, is 64 degrees. The sun shines obliquely in the winter affecting the southern wall of the building, and in summer, it shines vertically, radiating mostly on the roof. Since at least nine months of the year, the temperature is higher than the comfort level, attention to radiation repulsion is more than its absorption (Saliqeh, 2004: 153-155). For this reason, in order to obtain the minimum radiant energy of the sun during the hottest time of the year, the plan of the building should be rectangular, and in the direction of the east-west axis, and the view of the building should be facing south (Ibid. 167). As seen in Table 1, most buildings' plan is rectangular, which absorbs the least amount of solar radiation energy in summer due to the location of the building. Another solution for architects to deal with the intensity of the sunlight in this area is to use light-colored materials with polished surfaces such as brick and stone, which absorb less heat and is an effective factor in repelling the light and heat. When the intensity of direct sunlight in summer is high, it absorbs only 10% to 15% of heat due to its polished surface and light color. Moreover, if the desired surface material is dark in color and has roughness, it retains up to 95% of light and heat (Zumrashidi, 1989: 2-5). If the materials of the case surface are dark, uneven, and rough, it retains up to 95% of light and heat (Zumrashidi, 1989: 2-5). Table 1 shows that both of the principles were observed in the facade of the constructions in the hot and humid climate of the Makran beaches, and in all the studied buildings, the color of the facade of the building is light with a polished surface. Because the roof of the building is the part that absorbs radiant energy more than other areas of the building, to prevent the sun's radiation, the wide and high porches on and around the building should be built by expanding the roof area more than the floor area (Kamal, 2011: 61). Also, the color of the external surface of the roof determines the amount of solar energy absorbed by the roof during the day (Ibid. 63). According to the given data in Table 1, in all the studied buildings, the roof has a light color, which reflects the sunlight and absorbs less solar energy, and most of the buildings have porches. Another solution for the architects is to use a window that has minimum radiation absorption in summer and maximum radiation absorption in winter. For this purpose, the building should be facing southward (Saliqeh, 2004: 154). Also, the height of the windows on the southern and northern fronts can be high, but placing windows in the eastern and western parts of the buildings is not recommended at all. Windows that allow light into the building must face south (Ibid. 155). Table 4 examines the openings of each building. As can be seen, all buildings on the southern side have tall windows that absorb the minimum radiation in summer and maximum radiation in winter.

V.2. Temperatures

As mentioned, Makran beaches have long hot summers and short, mild winters, and the region's hot season continues for more than nine months a year. Therefore, it is better to use materials with low thermal mass and do not store heat. Because too much heat is one of the climatic problems in the region and storing the heat of the day for the night is not precise. Also, the thickness of the wall prevents the heat from reaching the interior of the building. The main materials used in the construction of Makran beaches are generally sandstone, brick, clay, and wood. The wooden structure transfers heat slowly, and the stored heat remains on the surface of the wood during the day and, with the cool breeze at night, loses its heat (Ghobadian, 2010: 76). Also, the use of thick brick walls, due to the property of heat accumulation and its gradual conduction, acts as a capacitor to maintain heat or coolness inside the room (Tahabaz, 1995: 638). The piece of brick also has the role of thermal insulation that prevents heat and cold from reaching the interior of the building and even prevents the rainwater from reaching into the mud bricks used in the core of the walls (Daneshmand, 2014: 97). Sandy sedimentary rocks are porous and are very good thermal and acoustic insulators (Ghobadian, 2010: 82). Due to the thermal properties of materials used in this area, the thickness of the walls in the studied buildings is from 50 to 100 cm (Table 2). Another factor that is effective in cooling and heating the building is the height of the roof in the architectural spaces. In the past, maintaining the appropriate height of the habitable spaces was one of the effective factors in determining the temperature of the building. In this region, compared to other regions of Iran, the rooms have higher ceilings, so their height sometimes reaches up to 4 meters or higher. The warm air moves to the top of the room, whilst the cold air moves into the lower space of the room, and the hot air is ventilated by the windows under the ceiling. The coverings on the dome are also light thatched coatings, which is a very important factor in preventing the heat and cold from penetrating into

the roof. A side of these roofs is shaded at certain times of the day due to their arched shape, which is effective in lowering the temperature of the building. As presented in Table 2, the buildings on the shores of Makran have high roofs, working out a significant function as the vent system.

V.3. Humidity

The amount of humidity in Makran is very high, and the maximum relative humidity reaches up to 70%. Adjacent to the sea, the vertical rays of 12-14 hours of sunlight from spring to summer can increase the rate of water evaporation in the region (Akhtarkavan *et al.*, 2012: 103). This amount of humidity has a destructive effect on the architecture of this area. Considering the high level of groundwater, the presence of soil moisture has a negative effect on the buildings. Architects have taken some of the applicable solutions and measures to deal with the moisture in the building. They did not build basements. Instead, they built platforms using materials resistant to moisture. Materials such as crumpled sedimentary rocks, sand, and sandalwood (Table 3). Also, to deal with the air humidity, the enclosing walls of the building were shortened so that the building would be away from the stagnant or calm air on the ground and gain the moving upper airflow (Saliqeh, 2004: 158). Another way to deal with the humidity, as mentioned earlier, is the frequent use of openings and adding to the amount of the airflow in the rooms, which causes the humidity in the architectural spaces to disappear a while. As shown in Table 4, all buildings have multiple openings. In this area, sedimentary rocks and sand have been used in the construction of the platforms, and bricks have never been used in these constructions because bricks absorb the moisture causing corrosion in the construction (Daneshmand, 2014: 115).

V.4. Wind

The temperature in Makran is very high in summers, and one of the ways to cope with the hot climate is the current wind usage in such a way that the openings of the building face the pleasant winds. The main winds flowing in the region are the western, south-western, and southeastern winds. Western and south-western winds are the dominant winds in the region, driving from the last days of winter to the last days of spring. The source of these winds is the eastern and southeastern regions of the Arabian Peninsula, which help the temperature regulation in the humid region. Monsoon winds also blow from the southeast in summer from late May to mid-September. These winds are accompanied by rain, lowering the temperature, and air conditioning, and it can be considered the fortune wind in the region. In such a climatic situation, the form of the building should be such that it can easily direct the anticipated wind into the building. The elongation of the plan, open spaces, and the arrangement of the rooms in a row help the wind blow into the building (Saliqeh, 2004: 157). The position of the window in relation to the direction of the wind has a great effect on the condition of natural ventilation situated inside the building. The most important principle in creating effective and usable natural ventilation conditions is that the opening parts of the construction are placed on both sides, facing the wind and behind the wind. In addition to the large windows, the height of the window from the floor should be half to one and a half meters. (Kamal, 2011: 64). In Chabahar, the prevailing wind blows from the west and southwest in winters and the favorable wind from the southeast (monsoon winds) in summers. The worst weather conditions in the region occur in the hot summer season. The windows should be facing south and southeast to use the favorable wind in summers. Also, the placement of the window on the western and south-western sides has a great effect on the ventilation of the building in winters. According to Table 4, in all the studied buildings, openings have been installed on the southern and western fronts in order to make maximum use of both the desired winds and the prevailing winds.

VI. Conclusion

Conscious of the limitations and climatic conditions, the architects on the beaches of Makran, using appropriate solutions, have minimized the difficult natural conditions by providing the best solutions. Regarding the climatic factors, the most important features in most of the residential buildings on the shores of Makran include plans with an east-west orientation, extroverted design, openness and width of the plan, light color of the external walls, placement on the platform, flat roof and use of wooden beams, use of local materials, large and high porches, lack of basement, the height of rooms, and the tall and extended windows. Architectural features are deemed less prominent in official and military buildings. Because in these buildings, the influence of the political and cultural concerns is more than the climatic factors. Although these features are considered as the architectural model limited to the Makran beaches, generally, they indicate similarities with the Iranian architectural models. Thus, we cannot separate them from the Iranian architecture.

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Table 1. The sunlight effect on the architecture of Makran beaches (Authors).

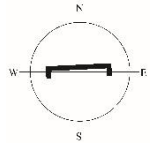
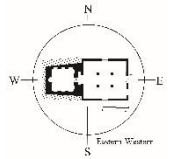
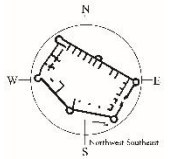
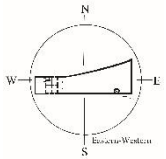
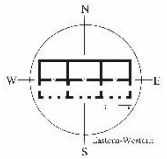
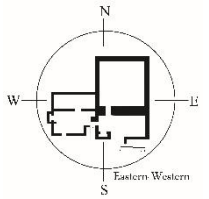
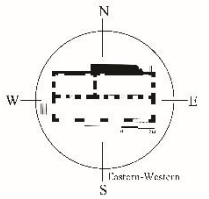
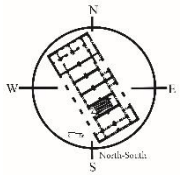
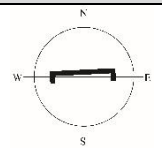
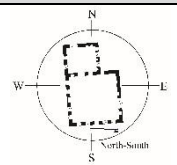
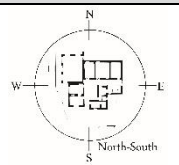
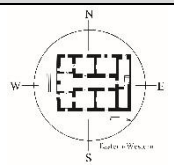
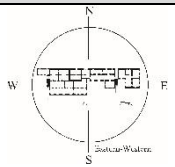
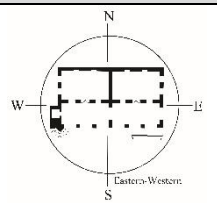
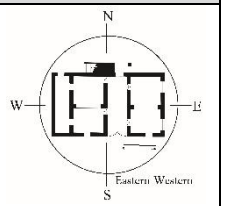
Suitable for this climate			Imamzadeh Seyyed Gholam Rasoul	Tis castle (Portuguese fort)	Gowatr Old Castle	Old Gordim building 2	Hotan Park Castle	Delooshi house 1	Post Office
Impact on the plan orientation									
Impact on the materials	Type	-	Lime	sediments	sediments	Mud bricks	Mud bricks	Mud bricks	Sediments
	Color	Bright	White	Light brown	Light brown	Light brown	Gray	Light brown	White
	Texture	Polished	Polished	Polished	Polished	Coarse	Coarse	Coarse	Polished
Impact on the coverage	Type	Arched & Flat	Arched	-	-	Flat	-	Flat	Flat
	Color	Bright	White	-	-	Light brown	-	Light brown	White
	Texture	South	-	-	-	South	-	South	East-West
Suitable for this climate			**Hoseyniyeh Al-Rasoul**	**Governor's office building**	**Customs office building**	**Delooshi house 2**	**Arian Old House**	**Moradbakhsh Daryanavard House**	-
Impact on the plan orientation									
Impact on the materials	Type	-	Lime	Cement	Mud brick	Mud brick	Cement	Cement	-
	Color	Bright	White	White	Light brown	Light brown	White	Gray	-
	Texture	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	Smooth	-
Impact on the coverage	Type	Arched &Flat	Flat	Flat	Flat	Flat	Flat	Flat	-
	Color	Bright	White	Light brown	Light brown	Light brown	Light brown	Gray	-
	View	South	-	S&N&W	-	South	South	-	-

Table 2. The effect of temperature on the architecture in Makran (Authors).

Site	Material	Thickness cm	Roof Height cm
Imamzadeh Seyyed Gholam Rasoul	Brick, Gypsum, Lime, Thatch, Wood	50-100	Arch11, Flat5
Tis castle (Portuguese fort)	Sedimentary stone, Brick, Clay, Gypsum mortar	60	4
Gowatr Old Castle	Sedimentary rock, Mud mortar, Lime mortar	60	4
Old Gordim building 2	Stone, Clay, Wood	60	3/5
Hotan Park Castle	Stone, Raw clay, Mud mortar, Wood, Mat, Turmeric	40	7
Delooshi house 1	Brick, clay, wood, thatch	50	4
Post Office	Sandalwood, Sandstone, Thatch, Gypsum	70	8
Hoseyniyeh Al-Rasoul	Wood, Sedimentary rock, Thatch, Lime, Gypsum	60	3
Governor's office building	Clay, Brick, Wood, Straw, Stone, Palm leaf, Iron, Plaster, Thatch	60	10
Customs Office	Clay, Brick, Sandalwood, Straw, Stone, Palm leaf, Plaster, mat, Thatch	55-95	9
Delooshi house 2	Raw clay, Wood, Cement, Mat, Plaster, Sedimentary Sandstone	55	8
Arian Old House	Clay, Straw, Wood, Stone, White cement	60	3/5
Moradbakhsh Daryanavard House	Clay, Sandalwood, Bamboo straw, Stone, Iron, Palm leaf, Cement, Mat, Thatch	65	7/5

Table 3. The effect of humidity on the architecture of Makran beaches (Authors).

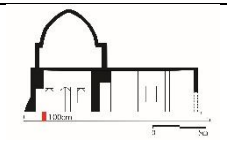
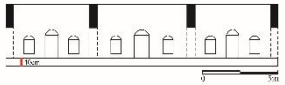
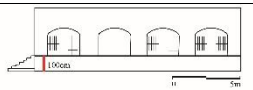
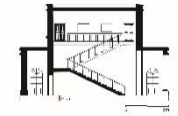
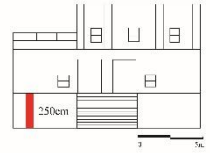
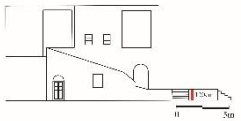
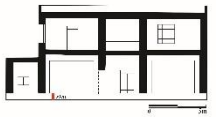
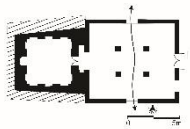
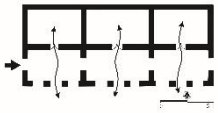
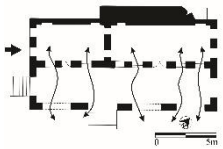
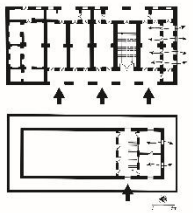
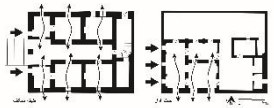
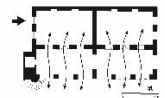
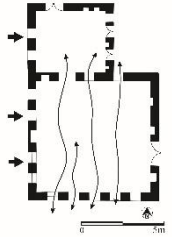
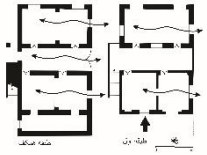
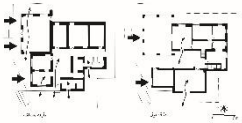
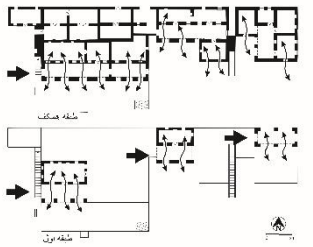
Site	Imamzadeh Seyyed Gholam Rasoul	Tis castle (Portuguese fort)	Gowatr Old Castle	Old Gordim Building 2	Hoseyniyeh Al-Rasoul	Delooshi house 1	Post Office
Ground Connection	Platform	Natural rocks	Hill	platform	Ground	Platform	Platform
Platform height	100	-	500	40	-	100	60
Platform material	Sediment	Sediment	-	Sediment	-	Brick	Sediment
Floors	1	1	1	1	1	1	2
Barrier	+	-	-	-	-	-	-
Section		-	-		-		
Site	Governor's office building	Hotan Park Castle		Customs Office	Arian Old House	Delooshi house 2	Moradbakhsh Daryanavard House
Ground Connection	Platform	Hill		Platform	Ground	Platform	Platform
Platform height	150	600		250	-	120	50
Platform material	Brick	Sediment		-		Sediment	Sediment
Floors	2	2		2	1	2	2
Barrier	+	+		+	+	+	-
Section		-			-		

Table 4. The Effect of Sun and Wind Radiation on the Architecture of Makran Beaches (Authors).

Site	Gowatr Old Castle	Hotan Park Castle	Imamzadeh Seyyed Gholam Rasoul	Old Gordim Building 2	Delooshi house 1	Post Office	Customs Office
Orient	-	-					
Pic							
Site	**Tis castle (Portuguese fort)**	**Arian Old House**	**Hoseyniyeh Al-Rasoul**	**Moradbakhsh Daryanavard House**	**Governor's office building**	**Delooshi house 2**	
Orient	-						
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