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Original Article

The role of coral in art and architecture: An overview

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Abstract: Coral is one of the richest ecosystems in the world and divided into two major groups. First group consist of soft corals living in tropical and semitropical oceans and seas. People in the past used these kinds of coral to make jewelry and decorative objects. Second group contains hard coral which have been used as construction material in coastal zones. This paper presents the role of corals in art and architecture in four southern Islands (Qeshm, Hormoz, Hengam and Larak) of the Persian Gulf by studying objects in some museums around the world and some ancient Iranian jewelry manuscripts. The results showed that despite references made about corals, especially the red one, in jewelry and historical books and in Persian literature, there have never been any traces of an object made by coral in the Persian Gulf. In scientific researchers, there is no report on red coral in the Persian Gulf and studies indicate that red coral as a jewelry and decorative objects were exported to these Islands via India and Africa. Instead three groups of Coral reefs, Lumashell and Coquina were used as construction materials in these Islands mostly in historical, religious, hydraulic and offshore architectures.

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Introduction

Coral reefs are among the most diverse underwater ecosystems held together by calcium carbonate structures (limestone) secreted by corals in shallow tropical seas over thousands of years (Hickman et al., 2015). Coral reefs from some of the world's most productive ecosystems, providing complex and varied marine habitat that support a wide range of other organisms. Reefs are home to a large variety of animals, including fish, seabirds, sponges, cnidarians, worms, crustaceans, mollusks, echinoderms, sea squirts, sea turtles and sea snakes. A few of these varied species feed directly on corals, while others graze on algae on the reef. Reef biomass is positively related to species diversity.

Coral reefs provide essential services to humans. Large human populations live on islands built solely by coral reefs or by coral reefs in conjunction with other marine sediments. To many coastal and island communities, particularly in the developing countries of central America, the Caribbean, Africa and Asia, coral reef biota are important sources of food and of reef limestone, sands, rubble and blocks for use as building materials. The physical barriers provided by coral reefs protect coasts from erosion by storm waves. Tourism associated with coral reefs provides many countries with significant foreign exchange earnings. Beyond these perhaps obvious benefits, reefs have been effective tools in art and architecture of many nations. The case which has not been highlighted in the Persian Gulf region where harbors extensive coral growth in one of the highest latitude locations in the world.

I therefore have the opportunity to provide an overview on the role of corals in art and architecture of propel especially those, which are living in coastal area and islands of the Persian Gulf.

Materials and Methods

This work has been compiled by examination of

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available coral objects in the museums around the world including; Victoria and Albert Museum, British Museum, Metropolitan New York Museum, Hermitage Museum, Coral Museum of Naples, Coral Museum of Alghero, Italy and Pepoli Trapani Musuem of Sicily, Italy. Also this paper is compiled from the works listed in the references and case study of different villages of four southern islands (Qeshm, Hormoz, Hengam and Larak) in the Persian Gulf.

Results and Discussion

Coral in different beliefs and cultures: The origin of the name 'coral' is generally attributed to the Greek word for pebble ('korallion'), but hebrew ('goral', meaning small pebble), Arabic ('garal', small stone) origins are also possible, maybe due to the names given to them by early traders travelling between Europe and the Middle East (Hickson, 1924). Also in Persian, coral was called Bessad, Bousad, Vasad, Kameh, Khoruhak and red ink and In India called Munga and sometimes Kameh (Noorbakhsh, 1991).

From archaic times, the coral in the Persian Gulf and other seas was known as a kind of plant. In 1700s, naturalists believed that coral is a kind of sea plant turning into stone once it comes out of the water. Furthermore, different cultures describe coral as stone, plant, animal and a creature of half- plant half-human (Noorbakhsh, 1991).

In Iranian writings left about jewelry like Arayes Al-Jawahir and Nafays Al-atayb by Al-Kashani and Gvhrnameh by Mohammad Ibn- Mansour, there are four species of coral; red, white, black and dark black. All of them can be found at sea in white, however they take different colors when they are extracted and petrified. Nonetheless, a different viewpoint is also seen in these Epistles regarding different species of coral with different colors in the sea (Al -Kashani, 2007; Ibn-Mansour, 1976).

From old times, it was believed that corals were effective in curing dementia, increase of wisdom, disinfection, decrease of aggression and anxiety, increase of positive social activities, and increase of immunity gainst plague and dangers derived from it. They also believed that carrying coral causes

Figure 1. Amulet, silver set with red coral, Spain, 1800-1850, Victoria and Albert Museum.

Figure 2. Amulet, made by fossil of coral Traunstein, Germany, 1800-1850, Victoria and Albert Museum.

travelers to cross the seas and rivers safely (Figs. 1, 2).

In different cultures of different tribes from the past up to the present, it is believed that corals protect their owners from evil eye and bad omen (Figs. 3, 4); this is still common among children and young women to wear coral necklaces to protect themselves. In china, coral is the symbol of life span and it is considered as one of the eight treasures. Coral is one of the three groups of Japans Tajara-Mono, where it is considered as a symbol that removes badness. Protective powers were also

Figure 3. Amulet white coral, Bavaria, Germany, 1800-1850, Victoria and Albert Museum.

attributed to black coral. The name Antipathes translated from Latin means 'against disease', and Albertus Magnus (Catholic saint, 1200) mentioned corals used as cures (Tsounis et al., 2010). According to Indonesian folklore, a black coral bracelet worn on the right arm increases virility, whereas on the left it cures rheumatism (Wells, 1983).

A coral necklace is the sign of Africa, one of the four parts of the world. In the Vedas (Hindu scripture in Sanskrit), part astrology, red coral is associated with the planet Mars (Hall, 2010). Coral is one of the five sacred stones of Tibetans and American Indians and it represents energy, force and life (Chkrn, 2001).

Coral necklaces or coral branches are an element in many works of spiritual or religious art, such as the works of the fifteenth century Renaissance artists piero della Francesca and Andrea Mantegna (Tsounis. et al., 2010).

Figure 4. Shoulder brooch, red coral, Algeria 1800, Victoria and Albert Museum.

In the treatise, Arays Al-Jawahir and Nafays Alatayb, by Kashani (2007) and Gvhrnameh by Mohammad Ibn-Mansour (1976), carrying a branch of coral around the neck will be useful for those suffering from epilepsy, gout and stomach ailments. They considered coral as a kind of medication for heart disease and treating shortness of breath and swelling of the spleen and stomach. Review of literatures revealed that the coral has been used to improve hearing and relief of dental pain (by putting some erosion of coral on gum). Coral was used to brush the teeth and recover the gums. Coral can also stop the bleeding from the throat and the chest (Al-Kashani, 2007; Ibn-Mansour, 1976).

Nowadays, most corals have commercial values. They are being used not only in the aquarium business, but also they are used in pharmaceutical industry, manufacturing ophthalmic lenses, bone marrow transplantation and many others (Ellis and Sharron, 1999). In medicine, chemical composition of coral is used in treating diseases such as cancer, AIDS, pain and other disease. For example, Isididae coral skeletons are used in bone grafts in humans (Ehrlich et al., 2006). In Sanskrit, Coral Claw is

called Praval Bhasma that is widely used in traditional Indian medicine as an adjunct in the treatment of bone defects and disorders associated with calcium deficiency (Reddy et al., 2003).

Today, the usage of corals as an amulet or in indigenous medicine is rare in the villages of the four studied Islands (Qeshm Hormoz, Hengam and Larak) in the Persian Gulf, and other kinds of amulets are ingrained with them such as; the speech of Holy Quran, salt and pottery beads and so on.

Coral in the arts, including jewelry: Use of ornaments and jewelry is as old as human history. Most people were naked cavemen and they often used tattoos and painted some pictures on their bodies, women adorn themselves with necklaces and bracelets and earrings from the seeds of plants and birds, ivory, shell, or colorful marble (Ravandi, 1977).

It seems that Stone Age people like people of thousands of years later used decorative objects for two purposes of ornament and amulet. In the civilizations of Egypt and Mesopotamia, hanging jewelry was considered as a symbol to express power, a sign of the privileged class of people. This symbolic role, sometimes using jewelry for immunity from disease is linked to the growth of superstitious interests (Ghirshman, 2005).

In Iran, from the start of its history, the use of ornaments was common. In addition to the existence of some Iranian jewelry in museums around the world, different books including Shahnameh of Ferdowsi are replete with names of different jewelry and ornaments that our ancestors have invented and used. Similarly, famous books written in different periods after prominent Iranian kings are a proof for the same (Wilson, 1987).

Coral is one of the several jewelries labeled as organic gemstone like pearl, shell, ivory and amber. The findings of perforated red coral beads with Paleolithic human remains demonstrates that corals have been treasured by humans for at least 25,000 yr (Tescione, 1973; Skeates, 1993). Probably red coral with amber was common currency for trade by Paleolithic humans (Grigg, 1993).

Figure 5. Dorsal view of bracelet made with red coral, Victorian School, 1850, Italy, Victoria and Albert Museum.

Figure 6. Whole view of bracelet made with red coral, Victorian School, 1850, Italy, Victoria and Albert Museum.

The excavations carried out in the period Neolithic, 8000 BC, the ancient artifacts including pieces of coral in the Mediterranean city of Çatalhöyük, Turkey, (Central Anatolia) and Amulets made of red coral from Switzerland are found (Grigg, 1993).

In the ancient Egypt, coral jewelry has been very popular for two thousand years (until Ptolemy in the second century AD). Also red coral developed a tremendous cultural importance, as its appearance in decorative arts of the Minoan and Mycenean civilization documents (Tescione, 1973).

Almost every civilization that lived in the vicinity of shallow seas with warm water or has had an advanced business has eagerly used coral. For centuries Italian commercial road, was the main place for transportation of corals to other parts of the

Figure 7. Precious or red coral, *Corallium rubrum*.

world (Tescione, 1973). In the nineteenth century, the Victorian corals (Figs. 5, 6) were very popular and they were engraved with elegant roses with jeweled and featured designs (wood engraving). Since the late 1800s, American Indians mixed red coral with many of their jewelry designs. Today, coral has an equal value with other jewelry.

Precious and semi-precious corals: One of the new sciences in the gem and jewelry industry is Gemology. This science mainly deals with classifying, identifying and evaluating parts and pearls used in jewelry. Four gems like diamonds, rubies, sapphires and emeralds and other precious stones are considered ornamental stones and all other ornamental stones are considered semi-precious stones. Features that make mineral or organic precious gems be placed in the category of precious gems are beauty (shining and nice luster), durability (strength), scarcity, color and portability.

Although corals are among the semi-precious stones, according to Grigg (2002), they can be placed in two categories: precious and semi-precious corals. He describes; those corals precious that are rigid and can easily be polished and semi-precious term is applied to the coral with skeleton that has pores and filler must be used while producing the jewelry (Grigg, 2002).

Precious corals belong primarily to three orders of the class Anthozoa (phylum Cnidaria), which are the Gorgonacea, Zoanthidea (subclass Hexacorallia; Cairns et al., 2002), and Antipatharia (subclass Ceriantipatharia; Cairns et al., 2002).

Figure 8. Live black corals, Antipatharia.

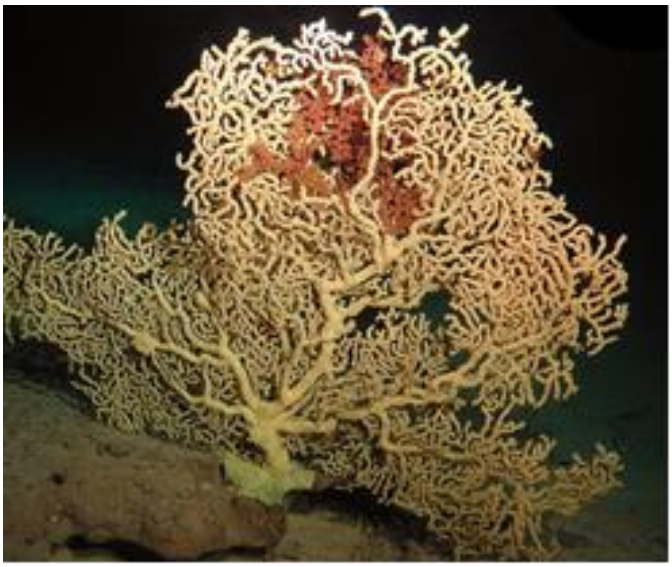

Figure 9. Hawaiian-gold-coral.

The most valuable species are red and pink corals of the genus *Corallium* in the order Gorgonacea, such as the legendary Mediterranean red coral (*Corallium rubrum*, Fig. 7), as well as the pacific species *Paracorallium japonicum*, *Corallium elatius*, *C. konojoi* and *C. secundum*. Another important group of precious corals are black corals in the order Antipatharia (Fig. 8). At least 10 species (mostly from the genus *Antipathes*) from the 150 species known worldwide are used in the jewelry industry.

Other gorgonians used for jewelry are gold corals from the families Gerardiidae and Primnoidae (*Primnoa resedaeformis*, *P. willeyi*, *Narella* spp., *Callogorgia* sp.), as well as bamboo corals in the family Isididae (*Acanella* spp., *Keratoisis* spp., *Lepidisis olapa*) (Fig. 9).

Semi-precious species, *Allopora* (now *Stylaster*)

Figure 10. Blue coral, *Heliopora coerulea*

in the class Hydrozoa, blue corals (*Heliopora*: Anthozoa), the organ pipe coral, (*Tubipora*: Anthozoa) and several gorgonians (sea fans) in the family Melithaeidae, are used for jewelry to some extent but are of low value due to their skeleton quality (Fig. 10). Reef-building stony corals (Madreporaria or Scleractinia) are also of commercial value, but generally not within the jewelry industry (due to their pores) and are thus not considered as precious corals.

Precious corals are non-reef-building deep corals. Deep corals live mainly in continental shelves, slopes, canyons and seamounts, in depths of more than 50 m (although some species also extend into shallower water). Deep corals are slow growing, long-lived organisms with low growth rates and low reproductive rates and their skeletons consist of a complex of proteins or calcium carbonate (Baco et al., 2006).

Red coral is one of the most thoroughly studied gorgonians because it has been of interest to science since the controversies over whether it should be included in the plant or animal kingdom (Marsili, 1707). Lacaze-Duthiers's pioneering (1864) study on the biology of red coral started a series of studies on its reproduction, growth and population dynamics. In addition, because red coral has been used as a jewelry and amulets and of course for decoration by human for centuries around the world, is discussed in continuous section.

Figure 11. Earrings made by red coral, 19th century, Victoria and Albert Museum.

Red-pink coral or precious coral: The red coral are also known with different common names such as angel skin coral, midway coral, midway deep-sea coral, noble coral, red coral, pink color, red coral of commerce, and sardinia coral. The genus *Corallium* along with the genus *Paracorallium* (Bayer and Cairns, 2003) belong to the family Corallidae and contain the most valuable precious corals due to their hard calcium-carbonate skeleton.

Thirty-one *Corallium* species are known, of which seven species are currently used for jewelry (Cairns, 2007): *Corallium secundum*, *C. regale*, *C. elatius*, *C. konojoi*, *C.* sp., *C. rubrum*, and *Paracorallium japonicum* (Figs.11, 12).

Corallium species are found throughout the world in tropical, subtropical and temperate oceans (Grigg, 1993; Bayer and Cairns, 2003), including five species in the Atlantic, two from the Indian Ocean, three from the eastern Pacific Ocean, and 15 from the western Pacific Ocean (Grigg, 1993; Cairns, 2007). They have also been found on seamounts in the Gulf of Alaska (Baco and shank, 2005; Heifetz et al., 2005), the Davidson seamount off the California

Figure 12. Necklace, Central Asia, 19th century, gold, silver, coral, pearls, turquoise, beryl and glass, Hermitage museum.

Figure 13. *Corallium rubrum* after polish.

coast (Devogeleare et al., 2005) and the New England seamounts in the Atlantic (Morgan et al., 2006). Red corals are found at depths ranging from

Figure 14. Carving on coral, Alghero Coral Museum, Italy.

7 to 1,500 meters (Anon, 2009).

Colonies of Coralliidae are branched and fan-like or bush-shaped, giving them the appearance of small trees. Colonies may reach a size of 50 cm across (Anon, 2009; Pedersen, 2004; Dridi, 2009). The Coralliidae have a solid axial skeleton that is made primarily of calcium carbonate (85 percent of the wet weight) in the form of calcite (Fig. 13), plus a small amount of other elements in an organic matrix (Anon, 2009; Allemand and Bénazet-Tambutté, 1996; Dridi, 2009; Pedersen, 2004).

The history of precious corals starts with the Mediterranean red coral, the precious coral par excellence and it was used in the production of jewelry, religious objects and medical objects and some bowls and ornaments (Magsaysay, 2013) (Fig. 14). In ancient times, Mediterranean red coral was collected when washed up on beaches after heavy storms had broken off branches in shallow water. These nations separated the healthy and good corals, eroded with a rasp, polished with sandpaper, submerged in steel and dipped with wax to create valuable jewelries (Tsounis et al., 2010) (Fig.15).

For centuries; on one hand, corals were transferred via the Italian commercial road, (a place where main workshops of coral has been built), to the center of Europe, Siberia and the other Celtic countries and on the other hand they were transferred via the Indian Ocean in Asia to Tibet and Mongolia.

Figure 15. Brooch, red coral, Algeria, 1800-1850 Victoria and Albert Museum.

Figure 16. Pendant, made by silver, gold, pearl and red coral, 1500, Germany, Metropolitan Museum.

Marco polo reported, red coral has been found as far away from the Mediterranean as ancient Tibetan temples. It has also been used as a decoration in Chinese clothes dating back several millennia

Figure 17. Netsuke: Seawids and Branch of Coral, Japan, early 19thcentury, Hermitage Museum.

Figure 18. Snuff bottle with boy flying a bird, China, Qing dynasty, Metropolitan Museum.

(Knuth, 1999). According to Al- Kashani (2007) the best coral is red one and grown in the west (Farangestan) sea. The importance and value of red coral has been nicely given in the poems too:

به بحر عمان زان رخش صاف شد لولو

به بحر مغرب زآن جوش سرخ شد مرجان (عنصری)

(The Sea of Oman is smooth and white because of pearl and the Sea of West is red because of coral, Unsuri, 1986) (Fig.16).

Red coral from Indian Ocean was the other famous source for making jewelry. Pliny mentioned trade of red coral from India (Tsounis et al., 2010). Ibn-Mansour (1976) noted that, coral was used in making handles for knife, which are very valuable good in India and China (Figs. 17, 18). Most of the adorned idols and beautified faces of these lands are made of corals. Abu Rayhan Biruni (973 AD) in his

Figure 19. Clothes made by red coral, Benin city, Edo state, Nigeria, ca. 1898 or earlier British Museum.

Figure 20. Hat made by red coral.

book "Al-Jamahir fel Marafet Al-javahr" wrote about red coral and its fishing method; Stone tree is a kind of tree which is called coral and grows in deep water. Whenever the sun shines at it, it turns red (Biruni, 1995).

In the tenth and eleventh centuries, Marsa'el Karez on the northern African coast was the largest coral port and trade centre. In the fourteenth century, Barcelona was famous for its coral art (Lieonart and Camarassa, 1987); later, the main activity shifted to Lisbon and in the seventeenth century to Marseille. In the treatise of Gvhrnameh Mohammad ibn-Mansour, red coral grows in sea of Africa, where it is called Mursi Al-Khor, as well as in the West Sea in deep waters. He mentioned African people sent raw coral from Africa to Alexandria, and then in Alexandria they were engraved and polished. After being polished, their price was specified based on their beauty, color, and size (Ibn-Mansour, 1976) (Figs. 19, 20).

Few records on the use of corals in the jewelry

Figure 21. Bird and Rabbit, Made by Francesco Degni, 1933, Coral Museum, Naples, Italy.

industry in the coastal area and islands of the Persian Gulf have been documented in the gemology books e.g., "Al-Jamahir fel Marafet by Al-javahr Rayhan Biruni (973 AD), Arays Al-Jawahir and Nafays Alatayb, by Kashani (14th century) and Gvhrnameh by Mohammad Ibn- Mansour (15th century) and in different poems in Persian literature. These books show that corals especially red coral was the most famous one among people and was transported from India (Indian Ocean) and Africa to different Persian Gulf Islands.

Red coral is therefore a symbol of rebirth, dependence and altruism. Greek mythology originally elevated red coral to magical status (Fig. 21). In Iranian beliefs, red coral protects against lightning and storms (Kosuge, 1993), so red coral used as an amulets in the past. The attractive blood red color made it a symbol for the blood in different cultures, for example in Persian literature; poets used the red color of red coral in their poems;

تن ترک بدخواه بی جان کنم

زخونش دل سنگ مرجان کنم (فردوسی)

(I am killing malevolent enemy and made hard coral with his blood, Ferdowsi, 2013).

Figure 22. Spoon, Holland, 1600-1650, Victoria and Albert Museum.

Figure 23. The Museum of Coral, Naples, Italy.

تا مورد سبز باشد چون زمرد

تا لاله سرخ باشد چون مرجان (فرخی)

(Till the green Mort (scientific name: Myrtus) is like emerald and till the red tulip is like coral, Farokhi, 2015).

لب رستم از خنده شد چون بسد

چنین گفت نیکی ز یزدان رسد (فردوسی)

(The lips of Rostam are like Besad due to smile and said goodness come from God in this way, Ferdowsi, 2013).

According to Noorbakhsh (1991) local fishers sometimes cut little parts of corals collected from the Persian Gulf and sale them in the local markets. People use them just for decoration (without polish or carving) in shops or exported to big cities like Tehran (Noorbakhsh, 1991) (Fig. 22).

From 1100 to 1600, Torre del Greco established a firm position in the coral-fishing business and remains the main centre of *Corallium rubrum* jewelry manufacture (Tescione, 1973). Sunny Torre Del Greco, small town on the coast of Naples, Italy, is known as the capital of precious red coral since the year 1400 AD. Moreover, Italy is the main production location objects made of red coral and until 1980; it was the largest storage and harvest of the coral (Figs. 23, 24).

Figure 24. Detail of the Museum of Coral, Naples, Italy.

Figure 25. Necklace, red coral, 20th century, Algeria, British Museum.

In the 1950s, coral beads were still widely used as ornaments in different countries (Liverino, 1983) (Fig. 25). Pink coral is also highly paid attention by jewelry industry as it has relatively high density and hardness. This coral is able to cover a wide range of corals from bright pink to red coral. In addition, the

live coral of Coralloid whose fossil is called Sciacca, also, is widely used in jewelry and harvested in the Mediterranean (Cicogna and Cattaneo-Vietti, 1993; Tsounis et al., 2010).

Corals grow very slowly so that the growth of red coral in the Mediterranean is 1 mm and Pacific species grow between 3 and 8 mm per year. They also have relatively long life so that some of them are over 75 years and one meter tall. Mediterranean red coral grow at depths of 10 to 280 meters, often in caves and crevices and gaps, while red and pink corals grow at depths of 350 to 1,500 meters in the West Pacific. They prefer areas with moderate to strong water flow (Pedersen, 2004).

Because of its slow growth, high commercial value and uncontrolled exploitation in the jewelry industry, Coralliidae is very vulnerable and the population of both Mediterranean and Pacific corals in the last 20 years has declined about 66 percent (Pedersen, 2004).

Coral and its Role in Architecture: In the preceding era, essential construction materials were obtained locally. Mud and rough coral rag in costal places are used as a source of building material. In many towns houses were abutted or backed onto each other and remained single-storied and rectangular, though usually there was more use of dressed coral blocks and limestone mortar. Plaster made from coral lime was used frequently to cover walls and pave floors (Pouwels, 2002).

Also ancient (fossil) coral limestone, notably including the Coral Rag Formation of the hills around Oxford (England), was once used as a building stone, and can be seen in some of the oldest buildings in that city including the Saxon tower of St Michael at the Northgate, St. George's Tower of Oxford Castle, and the mediaeval walls of the city (Horsfield, 2011).

Based on the field studies carried out in 2015 and 2016, coral was virtually one of the important construction materials available in the four Islands of Qeshm, Hormoz, Hengam and Larak and Corals have been mined in these Islands for decades. Coral mining are widespread in different places like Holor village in Dargan, near Qeshm city, in Salakh, Laft and other villages. Coral blocks have been historically used for more important constructions such as historical, religious, hydraulic and offshore (artificial maritime) in the Qeshm and Hormoz Islands.

Therefore, the role of coral in the four Island's Architecture can be divided into three groups in terms of hardness and raw materials and type of materials used in different structures.

1. Coral reefs in architecture: Corals habitats of the Persian Gulf can withstand temperatures much higher than coral reef ecosystems from many other similar zones (Harrington, 1986), therefore it is considered that The Persian Gulf is the hottest Coral Sea in the world. It means some corals in the Persian Gulf can stand summer temperatures up to 10°C higher than corals elsewhere (Coles and Riegl, 2013).

The coral reefs ecosystems of the Persian Gulf, Iranian waters are not very diverse compared to other tropical areas such as Red Sea, due to fluctuation of ecological condition and environmental stress (ROPME, 1999). Only about 10% of the species that occur in the Indo-Pacific are found in the Persian Gulf, and community species compositions substantially differ from assemblages that normally dominate Indo-Pacific reefs (Coles and Riegl, 2013). The use of coral rock in the construction of stone buildings goes back many centuries, notably in houses along the Red Sea, the East African coast, Maldives and so on (Spalding et al., 2001). In addition, residents of the four Islands (Qeshm, Hormoz, Hengam and Larak) use coral stone in architecture. As Pedro Tiksara from Portugal in his book "print ties" in 1610 wrote about the coral reefs of the waters of the Hormoz Strait and building material: "buildings have been built well. Construction material include a kind of stone that is not very hard and is found in the Island as well as malarial extracted from seabed. He also says: in Pars Sea near the island of Hormoz under the sea there are a few quarry rocks from which some stone is extracted. Because this stone is very malleable,

Figure 26. Figure 26. Basement of Portuguese Castle in Hormoz Island (Photographed by: Morteza Golzari).

Figure 27. Coral reefs in arch, Naderi Castle, Laft (Photographed by Zohreh Moradi).

people use it and it is called Sangmay. Its distinctive feature is that it is found in seabed and is light and it grows in the places it was removed or extracted" (Noorbakhsh, 1991).

Base on observation in 2015-2016, the residents of the four islands of the Persian Gulf have used coral reefs not only due to their lightness and protection from earthquake but also due to the coral reefs power to treat water. In the historical architectures; such as Portuguese Castle in Qheshm and Hormoz Islands (Fig. 26) and Naderi Castle in Laft (Fig. 27), in the religious architectures like; Bibi Maryam shrine (Pir E-Tom Seniti, Bibi Maryam) (Figs. 28, 29) in Tom Seniti village and Saydan Tomb in Laft, and also in hydraulic constructions like round cisterns (Berkeh) in all four islands (Figs. 30a-d); Coral reefs used as a construction material. Coral reefs only used in dome and arch parts of these architectures due to

Figure 28. Bibi Maryam shrine, Tom Seniti village (Photographed by Zohreh Moradi).

Figure 29. Coral reef in the dome of Bibi Maryam shrine (Photographed by Zohreh Moradi).

their lightness and steadiness.

Unfortunately, these days not only, these valuable works of architecture is being misused but also we are witnessing the destruction of the species due to human activities, temperature rise and water pollution. Excessive water turbulence, sudden changes in water temperature due to indiscriminate visiting of tourists will intensify the destruction of these vital ecosystems.

2- Lumashell: Today earth has many limestone-forming environments. Most of them are found in shallow water areas between 30 degrees north latitude and 30 degrees south latitude. Limestone is forming in the Caribbean Sea, Indian Ocean, Persian Gulf, Gulf of Mexico, around Pacific Ocean islands and within the Indonesian archipelago.

Limestone lumashell is an important source of

Figure 30. (a) Berkeh (Cistern), Department of the Environment, Hormoz Island, Ghazal Esmaeili, (b) coral reefs, (c) fan coral reefs and (d) brain coral reef.

stone for construction of some important structures such as sea breakwaters and other structures in the southern ports of Iran. Lumashell is a sedimentary biodegradable rock and it includes materials that are extracted with ease and great abundance in stone equerry located in the southern coast of Iran and has been developed in Miocene to Pliocene formations (Tlkhablv et al., 2007).

This type of rock, unlike other limestone that has chemical origin, has a destructive source. Destructive particles forming this rock was formed from the remains of crushed shells of marine organisms which often are combined with calcite or aragonite that have been connected to each other with sea cement lime (Hosseini et al., 2006). Lumashell or the limpet is one of 64 types of minerals found in Iranian mines. The mineral is composed of the fossilized shells of marine organisms and is rich in calcium, therefore it is used as a dietary supplement in livestock and poultry breeding industry.

In fact, the limpet mines have been accumulated from the remains of marine organisms in the course of life, In this way, they are first developed from fault layers and long and short hills in the deep sea and Over millions of years that had been buried under the sand, they reached the land with the retreat of the sea into dry land. The hills affected by natural disasters such as wind and rain were eroded over time and provided the opportunity to use this valuable resource. In lumashell, there is a wide variety of animal species such as corals, clams, snails and gastropods that can help separate the mines. For example, some mines consist only of coral and some others are a mixture of clams and snails. Also, in other mines of lumashell, the same amount of oysters - snails and corals are found. Of course, there are mines, the biggest constituent of them is mussels and snails and corals constitute a small percentage of them. The high percentage of calcium and nutrients in the mines that have been mostly comprised of shells and snails has given them an advantage over coral mines. If lumashell is highly purified and micronized, it can be used in pigment, petro-chemical, pharmaceutical and other industries. Also, if it has low rate of limestone in the shell, it can be used in the manufacture of white cement.

Lumashell, which is a sedimentary biodegradable

Figure 31. Lumashell, Khamir Port breakwater (Photographed by Zohreh Moradi).

Figure 32. Lumashell in tombston, Ramkan, Qeshm Island village cemetery (Photographed by Zohreh Moradi).

rock, is a kind of material that is easily extracted and can be found in abundance in stone equerries located in the southern cost of Iran in Mishan and Aghajari formations.

Some local formations in Qeshm, Larak and Khamir are stretched along the coasts of Persian Gulf (Fig. 31). Also lumashell is used in some historical buildings like Portuguese castle in the Qeshm Island (Fig. 32) and some tombstones in cemeteries (Fig. 33).

3-Coquina: Coquina is mainly composed of the mineral calcite, often including some phosphate, in the form of seashells or coral. Coquinas dating from the Devonian period through to the much more recent Pleistocene are a common find all over the world.

The stone makes a very good material for forts, particularly those built during the period of heavy cannon use. Because of coquina's softness,

Figure 33. Wall of Portuguese castle, Qeshm Island (Photographed by Zohreh Moradi).

Figure 34. Coquina in tombstone, Tomseneyti Village, Qeshm (Photographed by Zohreh Moradi).

cannonballs would sink into, rather than shatter or puncture, the walls of the Portuguese castle of Qeshm and Hormoz Islands were built of coquina. Given the potential of the quarries in the coastal areas of the country and particularly the four Islands, it is usually impossible to find high quality stone. Therefore, given the lack of high quality stone material, coquina is used a lot, examples of that are seen in the local houses in four Islands, stones of the

Figure 35. Details of tombstone. Ramkan, village, Qeshm (Photographed by Zohreh Moradi).

Figure 36. Details of tombstone. Ramkan, village, Qeshm (Photographed by Zohreh Moradi).

Figure 37. Building made by Indian people in Safavid Era, Basaidu village, Qeshm Island (Photographed by Zohreh Moradi).

graveyards of villages of Gorbehehdan, Kosheh,

Figure 38. Using coquina in diagonal line, Bassidu village, Qeshm Island (Photographed by Zohreh Moradi).

Figure 39. Coral and shells in coquina, Basaidu, village Qeshm Island (Photographed by Zohreh Moradi).

Turian, Towla and other villages in Qeshm and the other Island's cemeteries (Figs. 34-36) and historical (Figs. 37-39), religious and hydraulic constructions. Due to solidity in the buildings, people in these islands used Coquina in diagonal lines and then cover them with coral lime. Lime, cement or concrete are used to bond the coral pieces together to form walls and other building structures. In the four islands, coral and coral debris collected from the reefs crushed by manual labor into irregular and smaller pieces and then burnt in a pit in the ground with locally available firewood. Corals are converted to lime by this high heat treatment and are used to bond coral pieces to build houses and other constructions.

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