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A Possible Medieval Period Lighthouse at Mul Dwarka (Kodinar), Saurashtra coast, India

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Abstract

An ancient structure, circular in shape and tapering upward was observed during a recent archaeological exploration at Mul Dwarka (Kodinar). This is made well dressed limestone blocks. The shape and placement at the highest point on the coast suggest the possible use of this structure as lighthouse which might be the oldest lighthouse so far recorded on the Saurashtra coast. This lighthouse, locally known as *Diva Dandi* (Gujarati word for lighthouse), is 4 m high and ~ 2 m in diameter and constructed with well-dressed limestone blocks. The construction pattern suggests a possible date between the 12th and the 15th century AD. The SEM-EDS elemental oxide analysis of the binding material (lime mortar) suggests that calcium oxide (lime) comprises about ¾ of total composition followed by other major constituents: silicon dioxide (silica) 19-23% and aluminium oxide (alumina)~ 4%.

Introduction

There are ample evidences to show overseas maritime trade and commerce of India with it's cotemporary civilizations. A large number of artifacts of the Indus Valley origin have been found in Oman and the other Gulf Countries (Cleuziou, 1992 and Ratnagar, 2004), indicating an overseas trade contact with them in the third millennium BC. Excavations of several Harappan sites in coastal Gujarat indicate that people of this region were actively involved in maritime practices (Gaur, 2000). The excavators of Lothal (Rao, 1979) and Kuntasi (Dhavalikar et al., 1996) identified a few structures as dockyard and jetty respectively. Later, when Roman traders landed on the Indian shores, they noticed a well established system of maritime activities, for instance the author of the *Periplus of Erythrenean Sea* mentions that navigators in India have effectively utilizes the natural phenomena of the sea such as tide, current and wind (Panikkar, and Srinivasan, 1971). It further mentions that the King of the region appointed pilots (Schoff, 1912:40) to help foreign navigators to enter in the Gulf of *Barygaza* (identified

with Bharuch). In the medieval period (between 8th and 14th century AD) Indo-Arabia trade was at zenith as evidenced from the discovery of a number of archaeological artifacts suggesting maritime activity (Gaur et al., 2005). Marine archaeological explorations along the Saurashtra coast revealed the large number of stone anchors at Dwarka, Bet Dwarka, Miyani, Visawada, Somnath, Mul Dwarka, Hathab and Ghogha, which indicate the existence of several ancient ports and anchoring points along the coast.

The lighthouse is an important aspect of the advance navigation and they were existed a few centuries earlier to the Christian Era (Beaver, 1971). Regarding the early type of lighthouses, Vann (1991:124) mentions "the first lights were probably fires on shore that directed fishermen home after a night's work. But as trade developed, creating networks between different regions a more permanent system of communication perhaps in the form of free-standing tower or columns, replaced the ad hoc system of fires on the beach or nearby hill-tops". There are numerous references and archaeological records on the lighthouses of Roman period on the Mediterranean coast such as at Alexandria and Portus (Blackman, 1982). According to Williams (1976:75) the "modern lighthouse falls in two categories and all of them serve as guides to navigation but some are built on headlands, islands and particularly on isolated rocks as warning, to keep well clear of these dangerous places; while others notably those at the entrance to harbour are markers to be approached rather than avoided".

Though, there is not much information on the lighthouses of the Bronze Age in India but interestingly, a structure at a Harappan site at Kuntasi has been identified as watch tower and excavator does not rule out its use as the oldest light house of the world (Dhavalikar, et al., 1996:52), the author further add that initially we took it to be a bastions, but since it is the only one of its kind and the other corner do not have it, it could only have been a watch tower for keeping an eye on boats coming to Kuntasi through the Gulf of Kachchh. An ancient Tamil text dated to 3rd- 4th century AD '*Silappatikaram*' mentions the existence of lighthouse (in Tamil as *Kalangrai Vilakku*) at Poompuhar (Pillai, 1989:20). There are remains of lamp posts all along the Orissa coast and they are called as "*batti*" the use of them have been suggested as light house during the historical period (Patnaik, 2003:206). A monolithic pillar on a hillock along the Chilika coast known as "*deepa dandi*" has been identified as lighthouse (Tripati and Patnaik, 2008). The site may be dated back to historical and medieval period. There is a reference of a lighthouse at Mahabalipuram on a temple known as Olakkaneswar or Olakkanath (means 'flame eye') which is situated on a hill top (Ramaswami, 1980). On the roof of the temple there is a shallow

depression which is believed to be used for keeping a pot of 1.5 feet height with oil and every evening the oil was set on fire, the light of the fire used to guide the mariners during night navigation. This system was prevailing till the construction of lighthouse on the same roof of the temple (Tripati, 2009).

The present paper deals with an ancient lighthouse situated on the coast of Mul Dwarka (Kodinar). This is the earliest evidence noticed along the Gujarat coast and is well preserved. Marine archaeological explorations around Mul Dwarka yielded a large number of stone anchors besides 2 coastal archaeological sites (Figure 1).

Lighthouse at Kodinar

Mul Dwarka, one of the claimants for original Dwarka of Mahabharata period on the Saurashtra coast, is situated about 7 km from Kodinar town. Presently, Mul Dwark serves as a fishing harbour and most of the residents of this village are fishermen. On the western side of the harbour a temple dedicated to the lord Krishna is situated on an ancient mound. Presently, the temple is not worshipped. On the basis of construction style and sculptural remains the temple is datable to the 10^{th}-11^{th} century AD (Sompura, 1968). Close to the temple, there is an isolated circular structure of about 4 m in height constructed with similar type of dressed limestone blocks (Figure 2) as of the temple, is standing on the highest part of the mound. The structure has been partially eroded on the southeastern side. Altogether, it has 25 courses and slightly tapers upward. The maximum diameter at base is about two meter whereas diameter at the top of the structure is about 1.5 m. Locally, this structure is called as *Diva Dandi* a term used for a lighthouse. This is a solid structure and top portion is flat with a few stones are displaced due to installation of modern flag. The elevation of the top portion of the structure from high water line is about 10 m (33 ft). The external shape of the structure is very similar to those lighthouses which the European introduced during the18^{th}-19^{th} centuries along the Indian coast and even a few of them have a similar height. Brown (1902:22) has mentioned 6 lighthouses around Calcutta and among them height of two lighthouses at Diamond harbour and Fishermen Point light is 14 ft from high water. Similarly, a web site of Government of India[1] mentioned a beacon of the early 20^{th} century AD at Antarvedi (Narsapur in AP) with a height of just 2.5 m. Thus, a 4 m height of the structure is suitable to use as lighthouse.

To climb on the top of the structure for lighting the lamp there were some stones projected outward which has been damaged significantly but a few remains may be observed (Figure 3 & 4). There are

instances in the surrounding areas where isolated structures with low heights such as Kodinar structure projected steps were used to climb on it. Interestingly, in the year 1982 a severe cyclone[2] damaged a major part of the structure including steps and brazier. However, there are some marks in circular form on the top of structure (Figure 5) which may be the remains of brazier. Regarding the light in early lighthouses, Beaver (1971:10) mentions 'the lights were provided by wood fires that burned in iron braziers in the form of interlaced dolphins suspended from the towers with long poles." In the brief description and history of each lighthouse along the Indian coast the website of Government of India gives the reference of the use of ordinary oil lamp, oil wick lamp and DA gas light for flashing the light. But these references are from the early 19th century AD. However, in case of lighthouse at Kodinar, the wood fire or *Mashaal* (several layer of cloth tied in a thick wooden pole and socked in oil and it burns for a few hours) might have been used.

The distance to which navigator can observe the light depend on the total height from the sea level and power of the light. There are ample references of the lighthouses of the late 19th and the early 20th century with wicked oil lamp (Brown, 1902). As stated earlier that the height of the two 19th century lighthouses in Calcatta was 14 feet (4.25 m) from high water line, are noticeable from 2 to 3 miles (3-4) km during clear weather. Similarly, a lighthouse at Gopalpur was elevated to 54 ft (16.4 m) from high water line could be sighted about 10 miles (15 km) during clear weather. The elevation of Kodinar structure is 9-10 m from high waterline and with the help of above reference it may be safe to argue that light from this structure could be noticed 4 to 5 km from the sea. This may be the appropriate distance from the coast in which ancient ships/boats use to sail in this region.

Offshore and onshore explorations around Mul Dwarka revealed the existence of ancient port at Kanjetar, Mul Dwarka and Chhara. Though due to the development of new port at Mul Dwarka the remains of ancient port have been destroyed and very few remains in the form of stone anchors (Figure 6) were noticed in this region.

Possible date of the lighthouse

Archaeological artifacts from the Saurashtra coast indicate an active maritime practice dating back to the third millennium BC (Rao, 1979), during historical period Saurashtra coast remained focal point of maritime activities (Gaur, et al., 2006) and further it peaked during the medieval period (between 8th century AD and 14th century AD). Except some vague identification of Kuntasi structure as watch tower

for boats coming from Gulf of Kachchh (Dhavalikar et al., 1996), none of the coastal structures have been identified as watch tower or lighthouse. Therefore the earliest lighthouse on the Indian coast may be the structure at Mul Dwarka (Kodinar). The structure of Mul Dwarka is situated close to a 10^{th} -11^{th} century AD temple and construction pattern appears to be same but the structure of lighthouse is comparatively better preserved which may suggest a later date than that of the temple. Therefore the possible time bracket for the light house may be suggested between the 12^{th} and the 15^{th} century AD.

There is not much information available on the construction pattern of lighthouses prior to the 19^{th} century AD in India and the lighthouses of this period are build in various shape and sizes based on the availability of material and place. For instance many lighthouses are of brick masonry and are square in shape whereas several lighthouses are made of circular and with locally available stone like granite at Mahabalipuram, and limestone used for most of the lighthouses along the Saurashtra coast. The binding material for the construction of the structure is lime mortar may place the date of structure between the 12^{th} and the 15^{th} century AD. The fact remain that the maritime activities during this period was at peak along the Indian coast, which necessitated the construction of such structure and elsewhere tall coastal monuments and temples on the hills might have served as marker of the port.

The role of coastal monuments as marker for navigation

Archaeological investigations along the southern Saurashtra coast suggest a large number ports existed in the past for instance, Bet Dwarka, Dwarka, Miyani (Harshad), Visawada (Mul Dwarka), Porbandar, Madhavpur, Veraval (Somnath), Mul Dwarka (Kodinar), Gopnath, Hathab and Ghogha during the historical and the medieval periods.

Interestingly, except Ghogha all other ports on the Saurashtra coast have important monuments juxtaposing to the coast, which are dating back to the early (8^{th} to 11^{th} century AD) to the late medieval (12^{th} to 15^{th} century AD) period. This may be logical to argue that these coastal monuments served as marker points for the navigators and may be some kind of lighting was used at the top of these monuments to mark the coast in the night. Dwarkadhish temple at Dwarka has a height of 78 m and sighted at least 20 km distance from the sea. Similarly, temple on hill at Harshad Mata served marker of the Miyani Port (40 km east of Dwarka) during the medieval period. There is a reference that a mosque (called as Anda Masjid) in Dabhol on the Maharashtra coast was used as marker point of the port by the

navigators (Nairne, 1896). A 13th century Sun temple at Konark was used as marker point by the sailors coming from Bali, Java and Sumatra.

Microscopic and Elemental oxides analysis of binding material (Mortar)

Various chemical analyses for understanding the composition of ancient mortars are generally carried out to find mainly the percentage of CaO, SiO2, Al2O3 and other elemental oxides. A small quantity of fresh sample of mortar was collected from the lighthouse structure for microscopic studies and Scanning Electron Microscope (SEM) and Energy Dispersive Spectrum (EDS) analysis (Figure 7a & b).

To understand the textural properties of binding material, a chunk of mortar is observed under microscope. Even though, the binding material looks cream or grayish white in colour to the naked eye, but shows a finer grain matrix with lots of black grains under microscope. The size of these black materials varies widely and round to sub-rounded in shape. The black grains are spread throughout and occasionally range up to 2-3 mm size.

The matrix characteristics viz., grain size distribution and its surface area, provides strength to final mortar. This kind of lime mortar is not very strong but is denser and resists water penetration to deeper levels allowing moisture to escape by evaporation from its surface.

Primitive mortars include mud (used during Egyptian and Indus civilizations), soft bituminous clay (Greeks) and bitumen (Mesopotamians) and had several forms in medieval times. The first evidence of man using a form of mortar was at a temple tower (Ziggurat) of the ancient Mesopotamia (Woolley, 1939). Then lime mortars were used in the masonry work worldwide from ancient times until usage of modern cements (Portland) in the late 19th century.

SEM-EDS analysis of the sample suggests that the major component of the binding material is calcium oxide, commonly known as lime, and comprised of more than ¾ of the total composition and followed by silica and alumina. Other elements such as Iron, sodium, and magnesium are present in insignificant quantity. The composition in modern Portland cement includes two third parts calcium oxide and ~20 % of silica. However, while preparing cement mortar a certain proportion of sand is added whereas lime mortar was directly used for construction purpose in ancient times. This mortar is perhaps obtained by grinding and mixing of limestone with some assorted sands/clays and finally mixed with water to get workable mortar paste. Many times, limestone often contains variable quantity of silica (chert or flint)

and clay, silt and sands. This kind of lime mortar with silica and alumina, known as semi-hydraulic, sets slowly and hardens by absorbing CO2 from the atmosphere/air.

Table 1. The weight percent of elemental oxides in binding material collected from the lighthouse at Mul Dwarka.

Elements	***Weight in percentage binding material from lighthouse***
Na2O	2.46
MgO	1.29
Al2O3	4.27
SiO2	15.59
CaO	75.16
FeO	1.23

Conclusions

Marine archaeological investigations along the Saurashtra coast revealed a great deal of antiquity related to maritime activities, which include port installation, jetties and stone anchors. The explorations around Mul Dwarka (Kodinar) yielded a few stone anchors besides a circular structure near the temple on the coast. The structure might have served as lighthouse in the past. The possible date of this structure may contemporary or slightly later date of the existing temple at Mul Dwarka and a date between the 12th and the 15th centuries AD may be assign to this lighthouse. This may be the oldest surviving structure related to the lighthouse along the Saurashtra coast. The SEM analysis revealed that lime mortar was use for the construction of this lighthouse, which was commonly used during the medieval period.

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Note

1. Website of the records of lighthouses along the Indian coast maintained is: http://www.dgllnoida.gov.in

2. Website of the records of cyclones in the Arabian sea: http://www.imd.ernet.in

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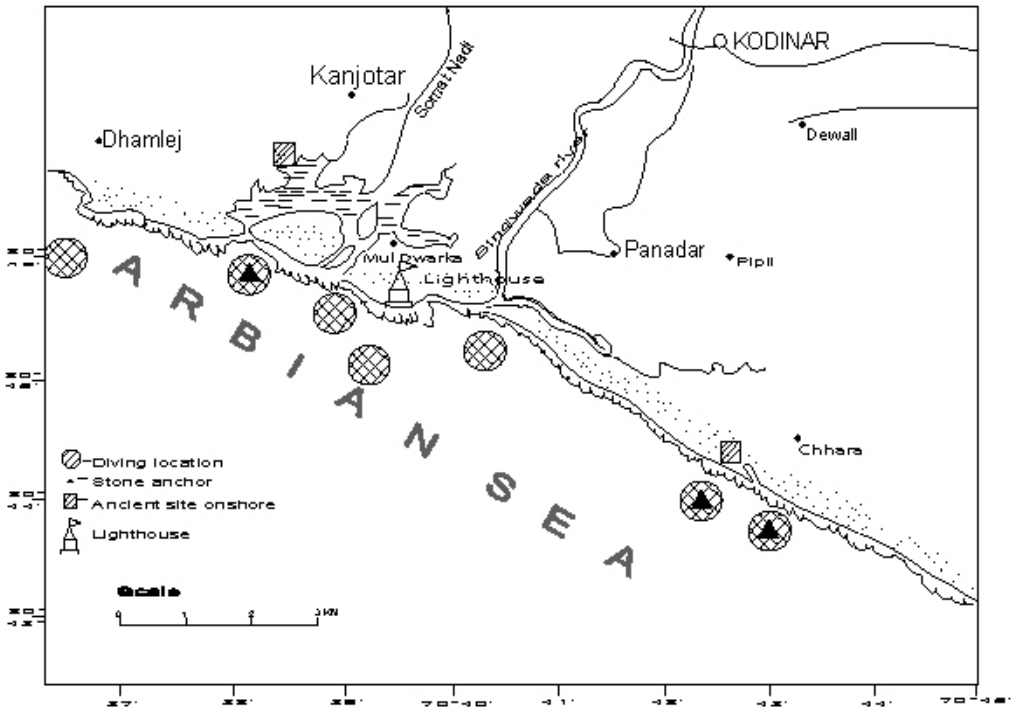

Figure 1. Location of sites around Mul Dwarka on Saurashtra coast (Drawing: S.B. Chitari)


Figure. 2. Lighthouse on Mul Dwarka (Kodinar) coast (Photo: Sundaresh).

Figure 3. Arrow marks indicating the damaged projecting steps to climb on the top of structure (Photo: Sundaresh).

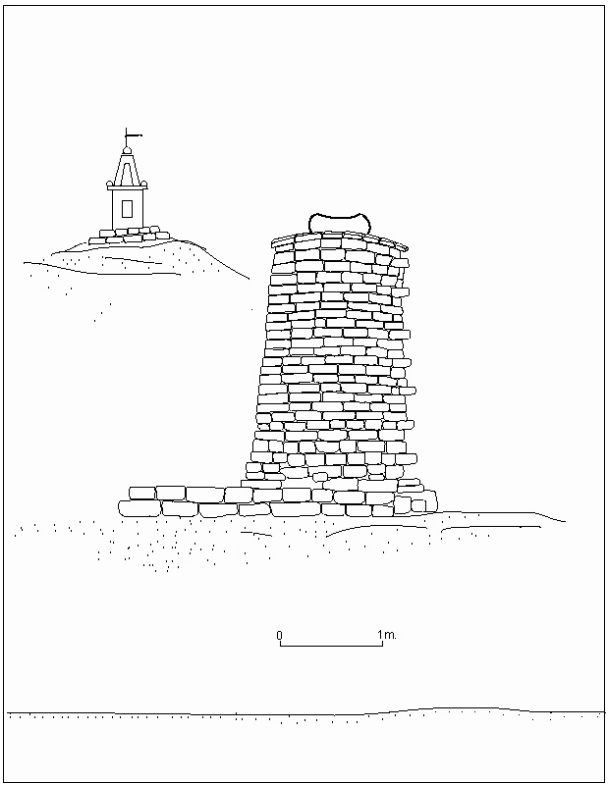

Figure 4. A reconstruction of lighthouse with showing steps and brazier (Drawing: S.B. Chitari).


Figure 5. Arrow mark indication some remains of brazier on the top of structure damaged during 1982 cyclone (Photo: A.S. Gaur).

Figure 6. Stone anchor from Mul Dwarka area (Photo: Sundaresh).

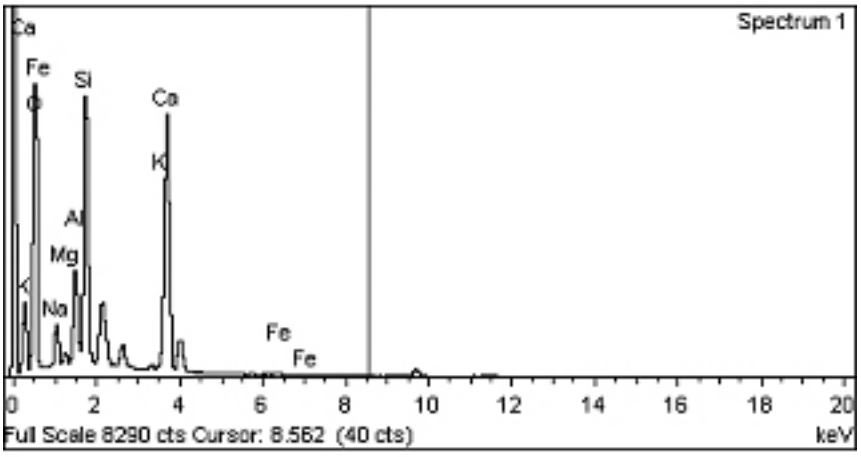

Figure 7. Microscopic and Elemental oxides analysis of binding material (Photo: V. Khedekar)