Maritime Archaeology of Ships of Indian Ocean, Southeast Asia and East Asia, the question of bulkheads

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Abstract

This paper will discuss the maritime archaeological work that has been carried out in the region, looking at shipbuilding construction and what has been learned through this work. In Southeast Asia the excavations in the 1980s by the Department of Archaeology of Thailand and the Western Australia Museum on the Pattaya and Ko Si Chang 3 sites will be examined, with a discussion on the construction techniques. In East Asia the significance of the Song dynasty ship from Quanzhou will be discussed in relation to the Southeast Asian ship construction.

The whole of the geographical region dealt with in this paper is faced with the challenge of dealing with treasure hunting and the exploitation of underwater cultural heritage for financial gain. While maritime archaeological projects in the region have been limited, there is a need to encourage countries to understand and protect their cultural heritage. This can only be done through archaeological work, as there can be no real benefit from working for commercial salvage. The paper will discuss the relative merits of archaeological investigations of shipwrecks in the region compared with that of commercial salvage.

Introduction

The purpose of this paper is to demonstrate that simple archaeological methods, when applied to shipwrecks, can produce important information. The paper centres on the Pattaya shipwreck, a site in the Gulf of Thailand that was completely looted in the 1970s. By examining the hull of the vessel a number of important conclusions were made about the construction of Southeast Asian ships. This was the first site in Southeast Asia where the construction of a vessel was published. Comparisons can be made with the Song dynasty shipwreck from Quanzhou, China. It is surprising that in spite of a number of non-archaeological projects involving Southeast Asian vessels, almost no information has been forthcoming on the construction and building of these vessels. It seems that the commercial companies involved in these operations, even when they employ an archaeologist, have neither the interest nor the inclination to study this aspect of the site. No doubt based on the commercial consideration that such work has no financial benefit.

Historical evidence

Needham (1971), in his encyclopaedic work *Science and Civilisation of China (Volume 4: Physics and Physical Technology, Part III: Civil Engineering and Nautics*) stated that 'Geographical factors have had considerable influence in differentiating the craft found along the coasts of China…Hsieh Chan-Jen, commenting on a passage in the *Jih Chih Lu* (Daily Additions to Knowledge) of Ku Yen-Wu, itself finished in +1673, wrote as follows:

> The sea-going vessels of the Jiang-nan are named 'sand-ships' (*sha chuan*) for as their bottoms are flat and broad they can sail over shoals and moor near

> sandbanks, frequenting sandy (or muddy) creeks and havens without getting stuck…But the sea-going vessels of Fujian and Guangdong have round bottoms and high decks. At the base of their hulls there are large beams of wood in three sections called 'dragon-spines' (*long gu*). If (these ships) should encounter shallow sandy (water) the dragon spine may get stuck in the sand, and if the wind and tide are not favourable there may be danger in pulling it out. But sailing to the South Seas (Nan-Yang) where there are many islands and rocks in the water, ships with dragon-spines can turn more easily to avoid them. (Needham 1971, Vol. 4.3: 429).

It is unclear from this passage if Needham has confused the strengthening wales with the true keel of deep hulled vessels. The earlier passage clearly indicates this error, since it refers to the *long gu* getting stuck in the sand. Needham (1971:409) also refers to the Tien Gong Wu (Exploitation of the Works of Nature) by Song Ying Xing in 1637. Here a description of a canal grain-carrying vessel is given and then his description of the shipyards:

> The construction of the boat begins with the bottom. The strakes of the hull are built up on both sides from the bottom to a height (equivalent to that of the future) deck. Bulkheads are set at intervals to divide the vessel (into separate compartments), [we may interpret this statement as an indication that the vessels were built shell-first] and (the holds have) sheer vertical sides which are called *qiang*…The horizontal bars (*heng mu*) which grasp the mast's foot below this are called 'ground dragons' (*di long*), and these are connected by components called 'lion-tamers' (*fu shi*), while underneath them lies another called a 'lion-grasper' (*na shi*). Under the 'lion-tamers' are the 'closure pieces' (*feng tou mu*) otherwise known as triple tie-bars (*lian san fang*)…

Another important source from the Song Dynasty is Marco Polo who resided in China between 1275 and 1292. He wrote about Chinese river shipping and also on sea-going vessels of Guangdong and Fujian. There are interesting variations in the translation of *The Travels of Marco Polo*. The version translated by Latham (1958) gives the following account at the beginning of Chapter Six: From China to India:

> They are built of a wood called spruce or fir. They have one deck; and above this deck, in most ships, are at least sixty cabins, each of which can comfortably accommodate one merchant. They have one steering oar and four masts.

Needham (1971) gives an alternative and unreferenced translation that will be quoted here in full. Note the differences between the two versions:

> …the merchants go and come into India through the Indian Sea. Now you may know that those ships are made in such a way as I shall describe unto you.
> I tell you that are mostly built of the wood which is called fir or pine.
> They have one floor, which with us is called a deck, one for each, and on this deck there are commonly in all the greater number quite 60 little rooms or cabins, and in some, more, and in some, fewer, according as the ships are larger or smaller, where, in each, a merchant can stay comfortably.
> …Some ships, namely those which are larger, have besides quite 13 holds, that is, divisions, on the inside, made with strong planks fitted together, so that if by accident that the ship is staved in any place, namely that it either strikes on a rock, or a whale-fish striking against it in search of food staves it in. And then the water

> entering through the hole runs to the bilge, which never remains occupied with things. And then the sailors find out where the ship is staved and then the hold which answers to the break is emptied into the others, for the water cannot pass from one hold to another, so strongly are they shut in; and they repair the ship there and put back the goods which were taken out.
> They are indeed nailed in such a way; for they are all lined, that is, that they have two boards above the other.
> And the boards of the ship, inside and outside, are thus fitted together, that is, they are in the common speech of our sailors, caulked both outside and inside, and they are all well nailed inside and outside with iron pins. They are not pitched with pitch, because they have none of it in those regions, but they oil them in such a way as I shall tell you, because they have another thing that seems better than pitch. For I tell you that they take lime and hemp chopped up small and they pound it all together, I tell you that becomes sticky and holds like birdlime. And with this thing they smear their ships and this is worth quite as much as pitch.
> Moreover I tell you again that when the great ships wish to be decorated [?], that is to be repaired, and it has made a great voyage or has sailed a whole year or more and needs repair, they repair it in such a way. For they nail yet another board over the aforesaid original two all round the ship without removing the former at all, and then there are three of them over the whole ship everywhere, one nailed above the other, and then when it is nailed they also caulk and oil it with the aforesaid mixture and this is the repair which they do. And at the end of the second year at the second repair they nail yet another board leaving the other boards so that there are four. And this way they go each year from repair to repair until the number of six boards, the one nailed on the other. And when they have six boards the one upon the other nailed then the ship is condemned and they sail no more in her on too high seas but in near journeys and good weather and they do not overload them until it seems to them that they are of no more value and that can make no more use of them. Then they are dismantled and broken up.

Marco Polo is the origin of the theory that Chinese ships had bulkhead compartments that were completely watertight. Later writers, up to and including Needham followed this suggestion. However, every Asian vessel with bulkheads that has been archaeologically excavated shows evidence that the bulkheads, although sealed with luting, had limbers to allow water to flow between the compartments. Additionally, there has been no evidence of stoppers or bungs in the limbers, indicating at the time of sinking the limbers were open. The statement about the multiple planking provides historical evidence for a technique that would be hard to understand from the archaeological evidence alone.

Ibn Battutah (Gibb 1958), who was in China in 1347, noted that:

> The Chinese vessels are of three kinds; large ships called chunks [in other translations jonouq, in Needham chuan]…These vessels are built in the towns of Zaytún and Sín-Kalán. The vessel has four decks and contains rooms, cabins, and saloons for merchants; a cabin has chambers and a lavatory, and can be locked by its occupant…This is the manner after which they are made; two (parallel) walls of very thick wooden (planking) are raised and across the space between and longitudinally and transversely by means of large nails, each three ells in length. When these walls have thus been built the lower deck is fitted in and the ship is launched before the upper works are.

Southeast Asian examples of bulkheads

The Pattaya Pottery Site, in the Gulf of Thailand was discovered in about 1976 by sports divers and was the subject of continual looting. Howitz (1977: 14) reported:

> …to a very large extent treasure hunters had already looted valuable and good-quality items and had, as well, seriously damaged the remains of the ship itself. There is evidence that they had used explosives to enter the cargo compartments, and an airlift to blow away the mud and sand.

In 1982 a joint Thai–Australian team of maritime archaeologists carried out an excavation of the site (Green & Harper 1982). It provided, for a looted wreck site, a large body of information. Evidence of looting included recently broken stoneware storage jars littering the site and holes dug around the site. What was of particular interest was the remaining hull structure, about 9 meters by 4 meters, which was protruding from the seabed. The excavation revealed a remaining hull structure composed of eight strakes on either side of the keel, six bulkheads and a mast step. The planking was edge joined with dowels, consisted of three layers, an inner layer 70 millimeters (mm) thick and two outer layers of 40 mm. Six bulkheads, with two limbers 110 mm in diameter cut in the base next to the keel, were supported by light frames. The bulkheads consisted of parallel planks 70 mm thick, edge-joined with dowels. The frames were nailed to the bulkhead and to the hull, with lateral and vertical iron nails. A mast step consisting of large block of wood, shaped to fit the bottom of the vessel, sat across the keel against the sixth bulkhead also had two limber holes.

The excavation also showed some evidence as to how the cargo was arranged on the ship. Between bulkheads three and five on the starboard side of the vessel was a very large concretion that was confined to a line 300 mm off the centre line of the vessel. There was also evidence of bamboo dunnage protruding from the concretion. The concretion appeared to be confined by a partition to the starboard side of the vessel that may suggest internal arrangement and explain the function of the watertight bulkheads and the limbers. It is unclear why one would go to such lengths to seal the bulkheads while having large limbers on the bilge. Marco Polo's statement that the compartments were watertight has been taken in the past to mean that the compartments were sealed. However, every vessel with bulkheads has been found to have open limbers. Some rational explanation is required to explain the presence of sealed bulkheads with open limber holes. If the cargo completely filled the compartment, how then does this work?

The evidence on this site that there was a space in the centre of the compartment, about 600 mm wide that was kept clear. Presumably there was some form of longitudinal partition to confine the cargo space. This would then provide a narrow, but clear access to the limbers at the bottom of the bulkheads. One possibility is that in the event of the vessel springing a serious leak, the crew could gain access to the limbers and block them so that the leak could be confined to the hold affected. In normal circumstances the limbers were free to allow the movement of bilge water to the lowest point where it could be bailed or

pumped out. If there were no limbers then the bilge water would collect in each compartment, necessitating a bilge pump to be located or used in each compartment.

However, this was not always the case. In the Ko Si Chang Three site (Green, *et al.* 1987), a large concretion of iron and storage jars was located over the keel area in one compartment, thus blocking the access to the limbers within that compartment. Possibly, depending on the nature of the cargo and loading arrangements, access (in these cases) was provided on alternate sides of the bulkheads.

Chinese bulkheads

The Song dynasty shipwreck found near Quanzhou, in Fujian Province of China (known as the Quanzhou Ship), has been the subject of a number of studies. It was the first Chinese vessel to be completely excavated and as such it is extremely interesting in relation to the question of bulkheads. In the Song ship the bulkheads are constructed from planks about 80 mm thick, skew nailed together. The skew nails were driven downwards and were inserted from both forward and aft faces of the bulkheads. Unlike the plank shell skew nails, they are very irregularly spaced (<100 mm–400 mm). The few scarfs in the planks that make up the bulkheads are complex and carefully made.

On the side of each bulkhead closest to mid ships there are half frames. The half frames are on the aft side of bulkheads 1–6 and the forward side of bulkheads 7–11. There are no half frames at bulkhead 12. One immediately obvious difference in the construction of the bulkhead is the presence of iron brackets, that are cut through the hull and serve to support the bulkheads on the opposite to the frames. Brackets have not been found on any Southeast Asian vessel (defined by edge joining with dowels), but are common on Chinese vessels (Ningbo (Shimin 1991), Fa Shi (Yingfan 1985) and Shinan (Green 1983) ships).

Limbers are about 250 mm high and 90 mm wide and their presence make it clear that neither the bulkheads nor the frames could have been strongly fastened to the keel; therefore, it is highly unlikely that they were set up before the plank shell was assembled. Remains of a layer of lime putty, containing very fine jute fibres, inside and out of the hull. This once again raises the question of the function of the limbers in relation to the bulkheads. Every Asian shipwreck with bulkheads has been found with open limber holes. There is conflicting evidence in the two Southeast Asian vessels, where in one case, at least one compartment between the bulkheads was completely filled with cargo, and in the other there is evidence that a central area between the two sides of the compartment was kept clear.

Discussion

The evaluation of the sites discussed suggest the following:

- Both Chinese and Southeast Asian vessels shared common features, in particular the bulkheads and the frames that supported the bulkheads.

Bulkheads were luted to make them watertight but had limber holes that were open at the time of the loss of the vessels.

- Southeast Asian vessels were edge joined with dowels whereas Chinese vessels were fastened with iron nails.
- Chinese vessels often had a form of stiffeners that penetrated the hull and attached to the opposite of the bulkhead to the frames to support the bulkheads.
- The main mast step was similar in both Chinese and Southeast Asian vessels, indicating a tabernacle arrangement.
- The location of the frames against the bulkheads, on either side of the mast step was similar in both Chinese and Southeast Asian vessels.
- There is evidence for multiple layers of planking, with the innermost layer being the thickest, in both Chinese and Southeast Asian vessels.
- There is evidence that both Chinese and Southeast Asian vessels were built shell first with the bulkheads inserted after the construction of the main hull shell.

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