

The Lashings and Knots of the Chau Tan Shipwreck

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ABSTRACT

The Chau Tan shipwreck is the oldest ocean-going cargo ship yet found in Vietnam dating from around the 8th-9th century CE. It provides a unique opportunity to study the construction methods of a lashed- lug ship from that period. Over 40 of the ship's timbers were retrieved but unfortunately all the lashings connecting the lugs were severed during the salvage and no record was made of the salvage. There was still enough in situ ropes to start to build a small list of the types of simple knots and complicated flat braided lashings that were used in its construction. For this paper ropes were made using simple technology that may have been available at the time the ship was built. The two knots used on the Chau Tan ship are widely used, even today. The braided lashings are a different matter, they do not appear in any maritime archaeology or sailing literature that the author could access. First the author had to work out how the lashing was tied. It was then tested for strength to try and further understand its utility. The results were surprising and emphasised the value of experimental archaeology.

Keywords: Lashed-lug, rope strength, experimental archaeology

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INTRODUCTION

The Chau Tan vessel was carrying a cargo of mainly ceramics from Changsha, Ding and Yue kiln sites in Hunan province, China (Kimura 2015:3; Kimura 2016:51, Giang 2016:74). The shipwreck was discovered close to the village of Binh Chau in the province of Quang Ngai in Central Vietnam in the early 2000's. Severe weather had stripped metres of sand from the seabed, allowing the salvage of its cargo. Over 40 of the ship's timbers were also recovered and sold to a local collector, Lam Du Xenh.

THE LASHINGS

When found, the wreck was in a remarkable state of preservation with nearly all the lashings that held the vessel together intact. Later, the salvors cut the lashings to facilitate the removal of the timbers. The boat's internal structure, such as the frames, thwarts etc. had been removed during salvage operations and not saved.

The few intact lashings were of one type, a woven lashing that may have held longitudinal round battens with a flattened face that may have held some form of caulking in direct contact with and along the join of the hull planks. This lashing has also been found in Thailand on the Bueng Kum shipwreck inspected and recorded in early 2023 by Wongsakorn Rahothon and Naphat Piromrak (2023, 8). These lashings and their position on the timbers can be seen in Figure 1. Most of the lashings are located within 70mm of the corner of each lug. On top of the lashings are overhand knots and a single fisherman's knot (Figure 1 lower right). These helped determine how the lashings were tied.

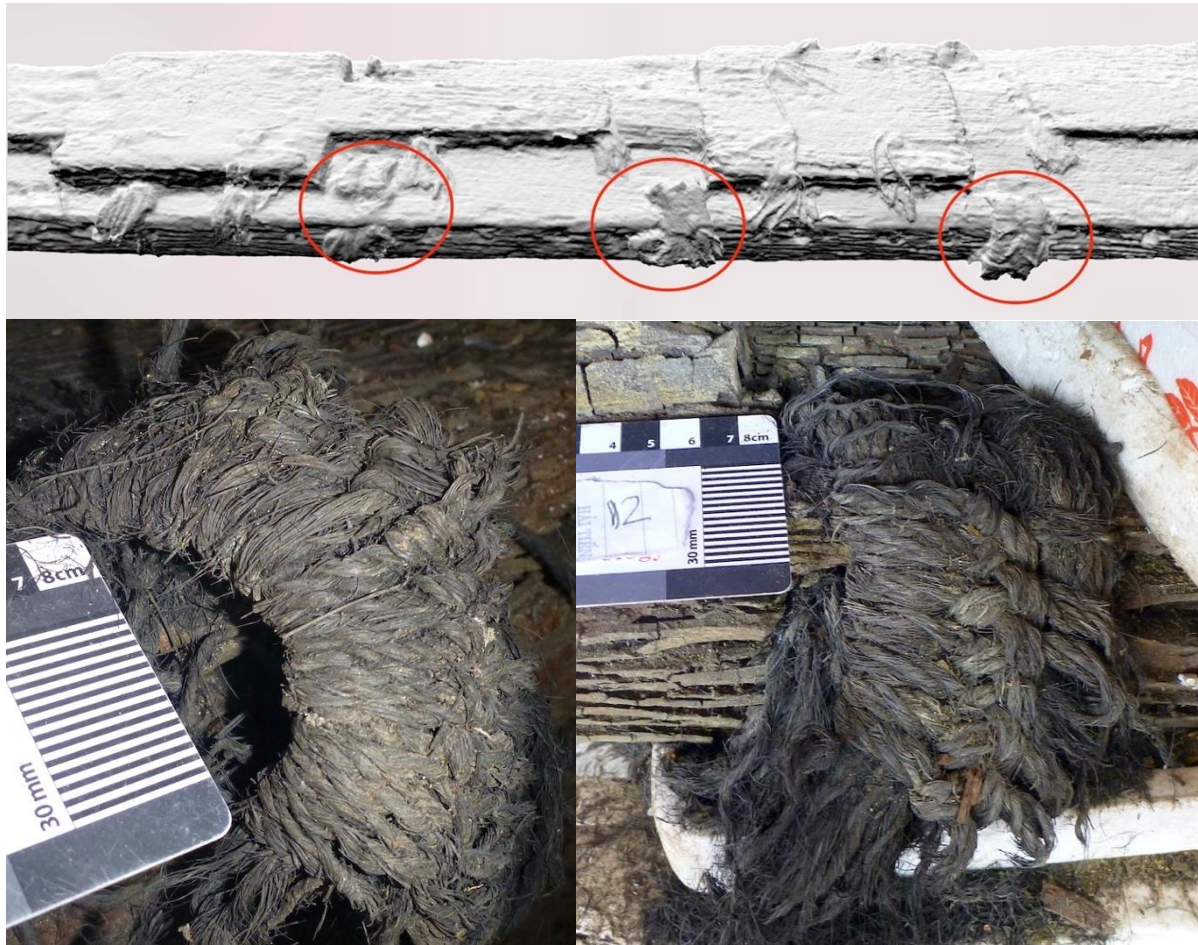


Figure 1. Lashings on timber CT-T3 circled in red and two intact lashings. (Photo Kevin Edward and Author).

Each of the hull timbers have through holes drilled in the face and the side with matching holes on adjacent timbers. During Vietnam Maritime Archaeology Projects (VMAP) fieldwork in 2017 the author selected 26 through holes where the quantity and diameter of ropes that were threaded through the holes were measured. Each of the matched holes has a rope of two strands threaded through them and this rope appears to be one continuous length that is wrapped around from between 18 to 26 times. The difference in the number of wraps is due to the variation in the thickness of the rope, being from between 3.2 mm to 5.49 mm. This variation may indicate that the strands were crudely made by hand or with simple tools.

ROPE HISTORY

Rope has been a staple technology for humans for millennia and rope making techniques, through trial and error, have resulted in different cultures constructing rope in similar ways. The longevity of techniques used in rope making is demonstrated by a painting on a wall in the tomb of Nefer at Saqqara, Egypt, circa 2465–2323 BCE. It shows a method of making ropes using a rope spinner to twist the ropes (Wendrich 2008, 1909). A photograph taken in Egypt before 1916 shows the same process (Mackay 1916, 126). In both illustrations the person making the strands is using a rope spinner. This illustrates an unchanged method of rope making spanning over 4000 years. It is likely that this long use of an unknown rope making methodology has been repeated in the Indo Pacific region. This rope spinner method was chosen by the author to make the ropes due to its longevity of use, not that it may have been a method of rope production used in the Indo Pacific region.

Early rope making in Asia is shown in two photographs from the Bristol Historical Photographs of China website, pictures pa01-24 from the W. Palmer Collection and picture ba05-120 from the Bannister Family Collection. These two photographs show rope being woven by hand from a stiff fibre, possibly bamboo. A 1960s photograph of a Vietnamese rope factory in Qui Nhon in the (Dalby and Thede 1962, A11-18) shows two rope makers extending the length of a thick coiled rope, each working from opposite ends. Again, the material used is a stiff fibre and again the twisting is done by hand. What these three photographs demonstrate is that ropes can be made with basic tools and wherever flora with suitable fibres are found.

ROPE FIBRES

One of the complications of studying flora used to make rope is the lack of a database of identified waterlogged material (Haw 2019, 510). Allied with this is the variety of plant species in each genus. Palm trees are a common source of natural fibre for making ropes but there are between 2400 (Eiserhardt 2011, 1392) to 2600 known species (Baker and Dransfield 2016, 209). Fibres from the palm tree *Arenga pinnata* have been identified by archaeologists as being used on the construction of Southeast Asian boats, (Lacsina 2016, 9; Mochtar 2018, 15). We need to differentiate between palm species as this may help narrow down the geographic region of where the ropes were made and help to determine where the boats using those ropes may have been constructed or repaired. It must also be a consideration that rope may have been traded.

Multiple types of rope fibre have been used, and still used, on boats. Different parts of a palm tree, such as the upper trunk and leaves, will produce a fibre of different colour, the latter being dark and the former being lighter, as well as of different texture and strength. This further complicates species identification. During a visit in 2016 to the island of Taumako in the Duff Island group, the author recorded a recently built Vaka, a large ocean voyaging outrigger canoe. Four different types of rope were used in its construction: two from palm trees, the leaves and upper trunk; one coconut fibre rope and the third, bamboo. After the Vakas first sea trial some palm fibre rope lashings were strengthened using strips of bamboo, indicating that different materials from possibly different locations may be used on any given vessel.

MAKING THE ROPE

In attempting to make rope the author constructed a rope spinner similar to the example seen on the Egyptian tomb and photograph and a simultaneously rotating three-hook system were the rope making 'machines' used. The only fibres that could be sourced were sisal (*Agave saliana*) and hemp (*Cannibis sativa*). Both rope makers worked well with around 10 metres of 3.5mm two strand rope being made in 45 minutes and 30 minutes respectively and with a little practice, a uniform rope could be made.

Two of the most important things learnt by making rope is that a tightly spun, uniform diameter rope will produce a better-quality lashing, and when tightly spun, a rope will expand in diameter and tangle once the rope is released of any tension. If the tension is maintained on the rope for several hours by stretching it between two fixed points, the rope maintains the same diameter, does not tangle and is a stiffer, denser rope. When discussing the modern rope manufacturing process with Kent Mills from WA Ropes and Hardware, he explained that the diameter of a natural fibre rope will expand after manufacture. A 14 mm diameter hemp rope could measure up to 16mm when on a spool, as the diameter of the rope is measured during manufacture when it is still under tension.

LOAD TESTING THE ROPE

A device was set up to measure the breaking strain of the rope. A 5,000 lb capacity analogue Dillion dynamometer to measure the load, and a high ratio yachting winch or a 1,500 kg lever block to apply the load, were used. Ten samples from each batch of two strand rope were tested for their breaking strain. Next the ropes' breaking strain was tested first with an overhand knot and secondly a single fisherman's knot. The figures were rounded to the nearest kilogram. The average breaking strain for the sisal rope was 24kg and for the manila rope, 29 kg. The overhand knot in both the sisal and manila reduced the strength of the rope by an average of 33 per cent, the single fisherman's knot by 21 per cent.

Commercially produced rope made from sisal, manila, jute, bamboo, nettle, seagrass, raffia, Egyptian flax and an artisanal coir rope from Vietnam were also tested. All these ropes had a similar percentage reduction in breaking strains when knotted. Comparing the breaking strains of different ropes made from different materials is problematic. Fibre strength, length and the aging process are a few of the factors that can affect the results. One of the main factors observed during these tests that impacted the breaking strain of the rope is the manufacturing process. Refined rope with a consistent density and diameter, such as the Egyptian flax, nettle and bamboo broke just outside the knot. The Vietnamese coir, handmade sisal and hemp often broke where there was a visible defect in the rope, such as a point where the diameter of the rope was noticeably thinner or where coarser fibres could be seen. To help set some meaningful benchmark strength for the different fibres, the weight of a given section of rope in relation to its diameter was recorded. A 100 mm length of rope from each test was weighed and this provided a strength, diameter and weight ratio. For example, the two-strand spinner made rope, when held under stress after making, would be between 15-30 per cent thinner than when the same type of rope was immediately released from any tension. With the tension released, the rope would tangle and expand in diameter.

REPRODUCING THE LASHING

A wooden model was made by reproducing a section of the hull, the model was made using short timbers and were joined by wooden dowls or treenails with through holes for the lashing. The hull planks were made from a hardwood and the stringer from a softwood. The intact lashings on the Chau Tan wreck had an internal diameter of approximately 47 mm which indicates the diameter of the wooden stringer that it held. A piece of wooden pole representing a stringer was carved to this size for the lashing to be woven around (Figure 2).

The rope made from sisal and made using the rope spinner was chosen to make the lashing. Two 3800 mm lengths of rope were wound around the stringer and through each of the through holes 24 times, creating a continuous bundle of loops that were secured with an overhand knot, (Figure 2 bottom left). Two wooden wedges were placed between the round wooden stringer and the hull planks creating a gap of approximately 10 mm. This gap was needed to allow the binding rope to be fed around the bundles of loops. As the weaving of the lashing progressed, this gap would be gradually reduced to where the lashing had drawn the stringer tight onto the hull planks. Two 1,200 mm lengths of rope were secured to the top of the looped bundles on top of the stringer (12 o'clock) and secured with an overhand knot (A). These ropes were then woven around the bundles as figure two lower left and right. One of the 1200 mm ropes is passed on the inside of the bundles, between the bundles and the stringer (B), over the top of the bundles (C) and fed under itself (D), in effect making an overhand knot (E). The knotted rope is pushed up to the top of bundles (F) then pulled tight. The same process is repeated on the opposite bundle with the same rope. This sequence is repeated until the lashing is formed a quarter of the way around the wooden stringer. Then the second 1200 mm rope is woven from the top down on the opposite side of the stringer until it formed a quarter of the way around the other side of the stringer. Now both 1200 mm ropes are at the maximum diameter of the stringer (three and nine o'clock) and the bundles of loops now are vertically above the through holes. The ropes can be threaded through and

pushed up the lashing as there is a growing gap between the round stringer and the vertical ropes of the loops. The remainder of the 1200 mm ropes are used in the same fashion until the stringer is held tight against the hull timbers. Once the lashing was completed, (Figure 2 top right), the stringer was held fast. A total of 10 metres of rope was needed to make the lashing.

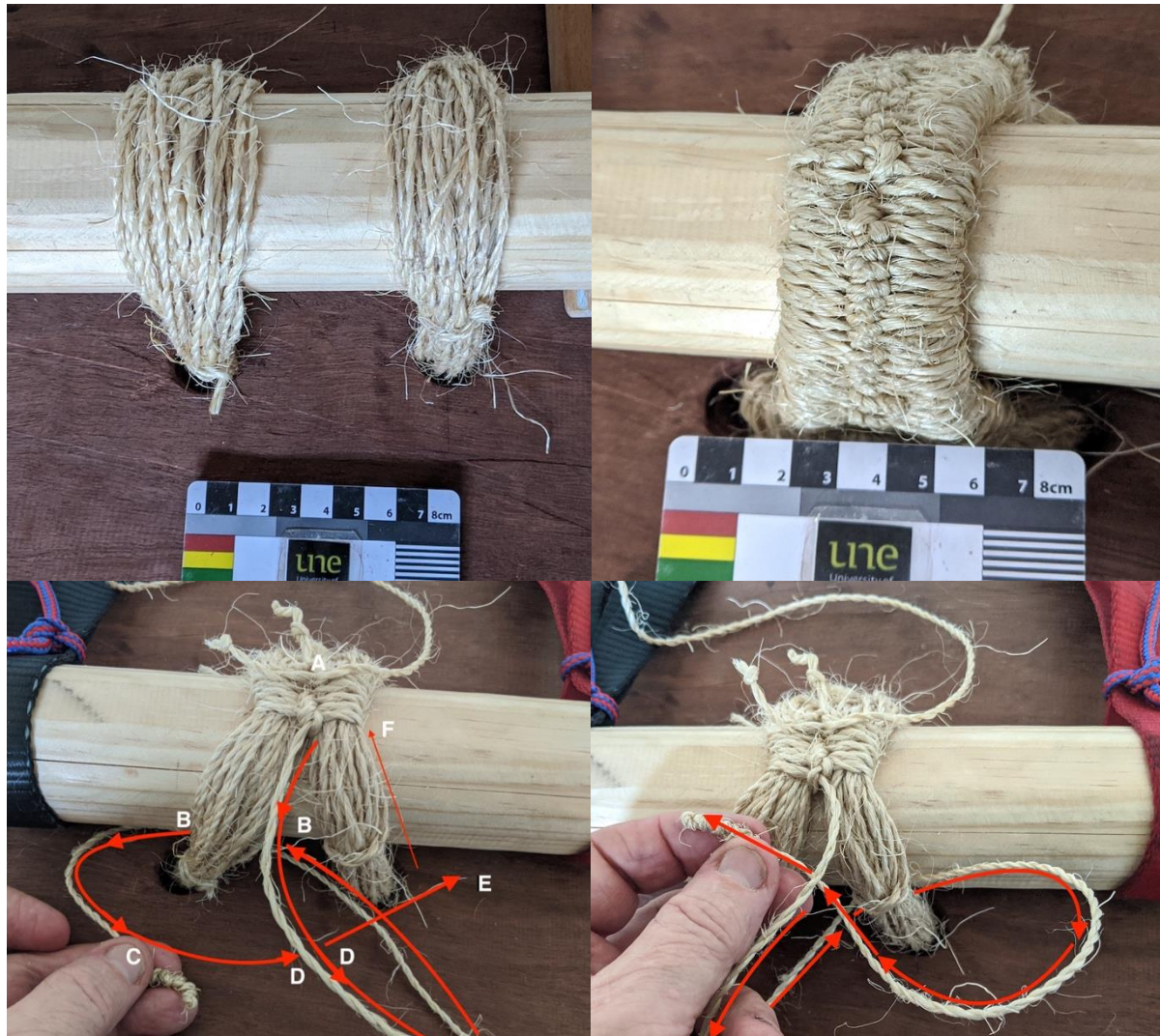


Figure 2. Above left. the lashing loops set up, right the lashing completed, and lower right and left the sequence used to make the lashing.

PURPOSE OF THE LASHING

This lashing appears to perform two functions; it pulls the stringer hard against the hull planks and at the same time, pulls the two planks together.

This is a unique feature of the Chau Tan vessel; other lash lugged vessels have longitudinal stringers sitting on top of the ribs or frames leaving a gap between the stringer and the hull planks. As an intact internal structure from the Chau Tan shipwreck does not exist it is not known if the timbers were stringers or if they serve different functions. Figure 3 is a photograph of a model with a combination of lashings from the Punjulharo boat (1 and 2) with the large frame sitting across lugs and the stringers on top of one of the large frames (Lacsina 2016, 130; Mochtar 2018, 52). The small lashing (1) is securing a small batten that is at 90 degrees to the joins of the hull planks (Manguin 2019, Figure 7, Mochtar

2018, 58). Three and four show how the Chau Tan stringers might have been placed under the frames, between the lugs and in direct contact with the hull planks seams.



Figure 3. Lashing model of some of the Punjulharo lashings (1 and 2) and how the Chau Tan stringer or batten may have been lashed (3 and 4). (Model and photo by the author).

The small lashing (Figure 3, 1) has some of the same physical characteristics as the Chau Tan lashing. Two bundles of loops are threaded through opposite holes on opposing planks. These bundles are then bound together with another rope that passes over a small batten with a continuous loop. The batten is sitting across the hull plank seam and its purpose is to provide a physical link between the two hull timbers and hold them tightly together at that point.

The Chau Tan lashing and stringers also join the two hull planks tightly together, adding strength to the internal frame from the sizable stringer and helping to distribute loads across the internal structure. They could also be used as another system of caulking if the bottom of the round stringer was flattened.

There are examples of battens lashed along the seam lines of a boats hull timbers as part of the caulking system. The bronze age Ferriby boat has a wooden batten or capping lath lashed with yew along the joins of the hull planks, (Wright 2104,16), with caulking moss between the batten and the hull planks. These thin battens would not provide much additional strength to the vessel.

LOAD TESTING THE LASHING

When weaving the lashing four 2,200 kg sewn slings were placed between the stringer and the hull timbers. Two of the tapes were attached to the 1,500 kg lever block and anchor point, the other two to the dynamometer and a second anchor point. This set up was used for the static load test of the lashing. A load was gradually applied until a measurement of 1,160 kg was reached, there was no movement of the lashing and no gap between the stringer and the hull timbers. The test was stopped at this stage due to the lever block starting to malfunction and concern in case the lashing failed as the author had to be close to the test rig to apply the load.

With the testing model intact and with no visible damage a second load test was set up, this time applying a dynamic load. A peak load of 1,270 kg was reached. The lashing was still intact but both sides of the lashing had stretched; the left by 4mm the right by 18mm. None of the fibres had broken; however, where the strands passed over the edge of the wooden holes, a slight flattening of the fibres could be seen. This is the point where the lashing would most probably fail if the lashing was tested to destruction.

The stringer could now be slid out from the lashing, (Figure 4 left) and by cutting two of the bundles of loops the whole knot could be removed from the model (Figure 4 right). This allows the structure of the knot to be clearly seen.



Figure 4. Figure 4. Lashing after the stringer was removed and after the lashing was removed from the through holes.

CONCLUSION

The Chau Tan lashing has been proven to be a very strong lashing and simple to make. The gap between the curve of the stringer and the lashing would allow a rope to be bound around the looped bundles to tighten the lashing if it stretched. If damaged at sea it would be possible to completely replace the lashing whilst underway. Making rope using simple technology is straight forward and surprisingly quick. By following a few basic principles, a uniform rope of good quality can be made. Making rope can be as simple as rolling fibres in the hands to form strands and then twisting those strands to form rope. Alternatively, a simple wooden device, such as a wooden rope spinner, could be used. What this shows is that rope can be made almost anywhere, even on board a sailing vessel, if suitable material is at hand.

More research is needed on identifying the species of plant used to make ropes particularly those that have been waterlogged. A comprehensive comparison of the strength of the different lashings systems in relation to the internal structural configurations of strakes, thwarts, stringers, knees and frames that have been used to construct lash lugged vessels is needed. This will give us a better understanding of the strengths, weaknesses, and flexibility of the lash lugged tradition of boat building.

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