Clinker & carvel. A mid-16th century wreck find from Terschelling, the Netherlands

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Abstract: During a stormy night on February 12, 2020, a large ship fragment appeared on the North Sea shore of the Dutch island of Terschelling. The timbers turned out to have belonged to a wooden ship, of which the lower strakes were lapstrake built, and the upper strakes were flush-laid. The clinker strakes were interconnected with rivets as well as small wooden plugs, and both clinker and carvel parts were built shell-first. The aim of this paper is to present the latest results of the research, and to place the wreck find in a wider context of European shipbuilding traditions.

Keywords: clinker, carvel, 16th century, 3D-photogrammetry, shipbuilding developments

1. Introduction

Beachcombing has been a tradition in the Dutch coastal communities for centuries, especially on the Dutch Wadden islands. After every northwesterly storm, locals roam the beaches for washed up goods and driftwood, to use as building materials or for decorating their houses and gardens. Often single ship timbers are discovered, but sometimes more substantial wreck parts emerge on the shore. After a storm in February 2022, a large hull fragment from a wooden ship was discovered on the North Sea shore of Terschelling, between two kilometre markers on the beach, *Paal* (Post) 9 and 10 (Fig. 1, Fig. 2).

Although the find was reported to the Dutch Cultural Heritage Agency (RCE) on the day of discovery, unauthorised excavation by locals could not be prevented. While attempting to salvage the wreck with a crane, they broke the hull fragment into several fragments. The informed police decided to gather all the fragments and fence the site off. Unfortunately, the rising tide scattered the remains a second time. After consultation with the RCE the remains were transported to the municipal yard. The main reason for this was the remarkable construction method of this fragment: the lowest part of the hull was clinker-built, while the upper part was carvel-laid. This indicated a date of origin in the 16th century, a period of change from clinker- to carvel-built ships, during which shipbuilders experimented with several variations (Overmeer 2017: 199).

Because of the fascinating construction method, the RCE decided to document the wreck parts, and assess their archaeological value. A team of three maritime archaeologists travelled to Terschelling to document the remains, with help of local volunteer Nico Brinck.

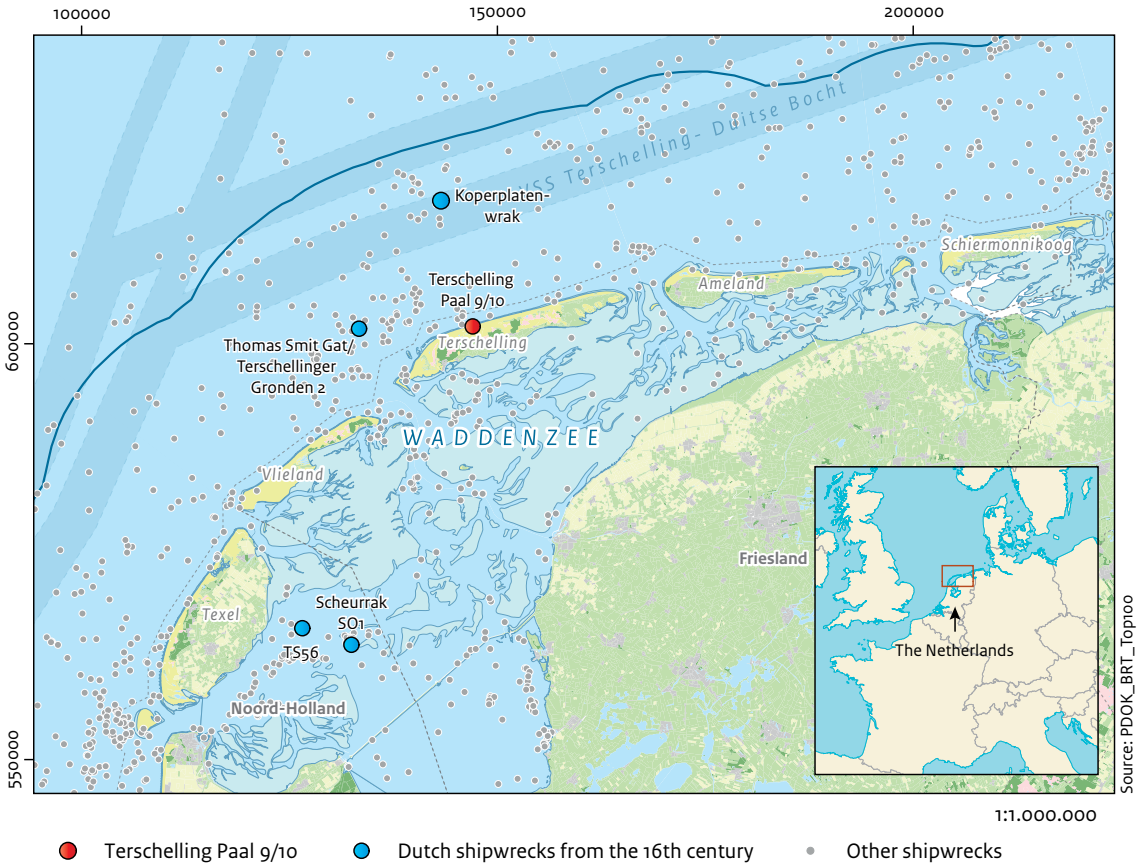

Fig. 1 Location of the wreck find 'Terschelling Paal 9/10' on the island of Terschelling, the Netherlands, with an overview of other shipwrecks in the area (map: Cultural Heritage Agency - RCE)

Fig. 2 The shipwreck on the day of the discovery, on the North Sea beach of Terschelling (photo: S. Kok, ROSE photography, Terschelling/Omrop Fryslân)

2. Documentation

2.1. Manual Documentation

A single day was available for recording all the wreck parts. Therefore, the focus was on obtaining information on the size, building details, and preservation of the timbers. The primary method of documentation was 3D-photogrammetry. In addition, the wreck parts were manually documented through measuring, sketching, and describing the parts (Fig. 3).

During documentation it became clear that almost half of the observed wreck was missing. Only the elements described in this paper survived the looting and the flood, a total of eighteen different parts.

Fig. 3 Manual documentation of the remaining wreck parts (photo: L. Conijn, Laura Conijn Fotografie, Terschelling)

2.2. 3D-Photogrammetry

In addition to the manual documentation, thirteen of the eighteen constructional elements were completely or partially photographed or filmed, in order to generate 3D-models. These thirteen elements were selected according to their size, preservation, special features, or composite nature, i.e. consisting of several planks, or planks connected to frames.

Photographs were taken using primarily a Nikon D850 photo camera, and additionally an iPhone XR. The RAW photographs and video frames were optimized using the photo-editing software Lightroom. The basic values that were adjusted include chromatic aberration, dehaze, white balance, clarity, exposure, highlights, and shadows. Among these, reducing overexposure was a large adjustment in a few photo assemblages. While taking photos at the open spaced yard, we were not equipped to move the larger constructional elements or to create shadows. This problem could be easily solved in Lightroom.

After adjustments, the images were uploaded to the 3D-photogrammetry software Agisoft Metashape. The process of generating a 3D-model followed the general procedure of alignment up to creating textures, and orthomosaic images. In between steps the emerging models were cleaned, i.e. the surroundings of the constructional elements were removed. For this case study, attention was particularly paid to the larger wreck parts consisting of several strakes of hull planks. These were placed on their sides, in order to create sufficient overlap for smooth alignment of the photographs. Due to their disarticulation from the shipwreck and flexible nature, the planks tended to bend slightly. They were nevertheless accurately generated as high quality 3D-models in Agisoft.

Smaller constructional details, which are discussed below (the so-called *spijkerpennen*), are also visible on the 3D-models, and beautifully demonstrate the strength of combined digital and manual documentation methods. These tiny features and their patterns might not have been evident had we relied solely on digital documentation.

3. Results

3.1. General

The ship fragment on the beach was about 13.40 m long and 5 m wide (Overmeer, Coenen, Vink 2024). A sketch of the fragment was made, based on the photos taken right after discovery (Fig. 4). The fragment consisted of ten hull strakes, 20 frames and one inner strake. During documentation we observed that only half of the fragment was left (Fig. 4, dark coloured part). It was broken into 18 different parts: loose futtocks and planks, but also larger fragments of still connected strakes. Two loose planks, positively belonging to the wreck, washed ashore a few days later, and were included in this study. All elements were made of oak.

The most striking feature noted from the wreck fragment is the construction of the hull. The seven lower strakes were clinker-built, while the three upmost strakes were flush and carvel-laid.[1]

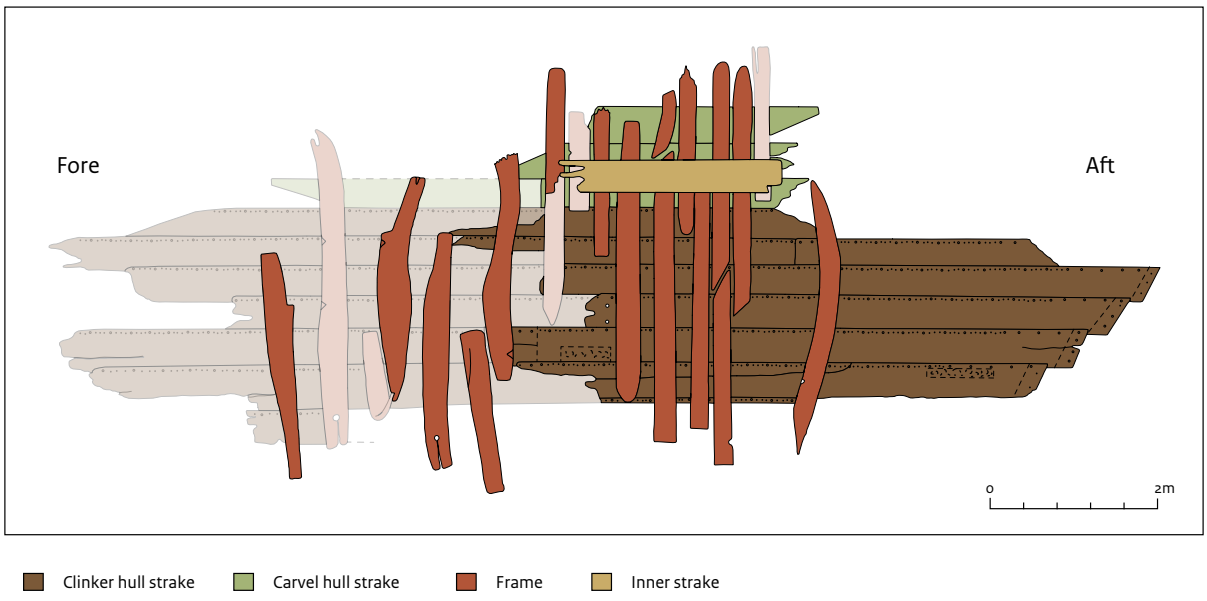

Fig. 4 Reconstruction sketch of the ship fragment on the beach, based on photos of the discovery. The dark coloured parts indicate the elements that remained after the looting and flooding (after A. Overmeer & T. Coenen, Cultural Heritage Agency - RCE).

[1] It is subject to debate whether the eighth strake of the fragment belonged to the clinker part of the hull or to the carvel part, since the lower seam of this strake was lapstrake-laid and the upper one was flush-laid. According to our interpretation, this strake is considered part of the carvel part of the ship.

3.2. The clinker-built part of the hull

The lower, clinker-built strakes consisted of several planks, connected by simple flat scarfs. The planks had widths varying between 31 and 45 cm and thicknesses of 5 to 6 cm. In between the scarf tables, moss had been applied to make the structure waterproof.

The strakes overlapped 7 to 9 cm, and on the land, they were interconnected with both rivets and small wooden pegs. Between each two rivets, which were spaced 24 to 30 cm, two to three wooden pegs were placed (Fig. 5). The pegs had a diameter of 1.5 cm and were wedged on the inboard side. Simple lines were carved at the spots where the pegs were meant to be placed.

The overlapping strakes were luted with moss, covered by a mosslath, and secured with so-called *sintels*, small iron cramps. The sintels were not preserved, only the holes of the lugs were visible in the hull planks.

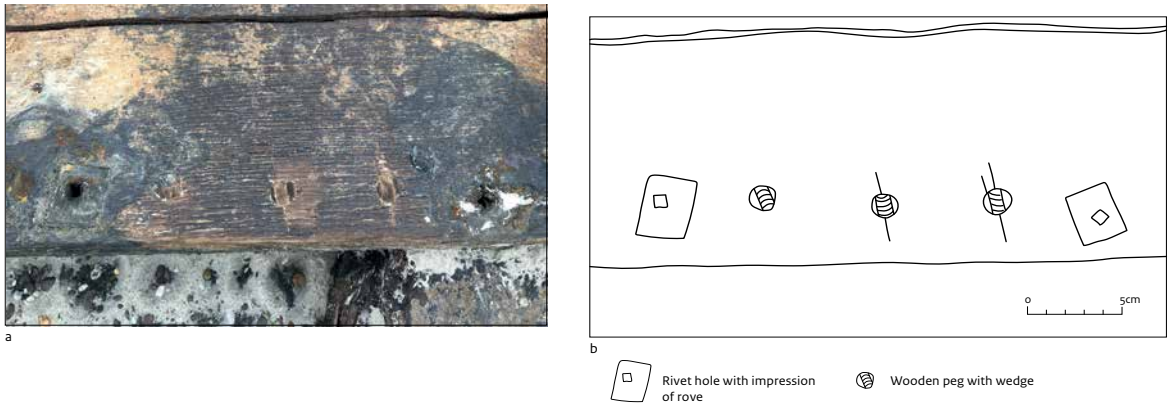

Fig. 5 Combination of rivets (square impressions) and small wooden pegs in the clinker strakes of the ship fragment of Terschelling Paal 9/10. The shipbuilder has scratched in guide lines to indicate the position of the wooden pegs (after Overmeer, Coenen, Vink 2024, Fig. 21).

On four hull strakes the original end had been preserved. The planks were bevelled at an angle ranging from 123° to 127°. Originally, these hood ends fell into individual rabbets in the sternpost or stem. Given the position of the scarfs in the hull planks, they most likely fitted to the sternpost, and therefore the ship fragment concerns the aft part of the starboard side.

The hull had also been repaired on the inside. The actual repair planks (63 × 13 cm and 20 × 10 cm) have not survived, but the nail holes and caulking material were still present.

3.3. The carvel-built part of the hull

The upmost three strakes of the ship fragment consisted of carvel-laid planks, placed side-to-side. The strakes originally consisted of multiple planks, connected by diagonal nibbed scarfs of 64 cm long, completely different from the scarfs in the lapstrake part. There is no evidence these scarfs were waterproofed with any kind of luting or caulking material. The planks were 37 to 46 cm wide and 6 cm thick.

The three carvel strakes were not interconnected, they were only fastened by treenails to the framing. The lowest carvel strake was connected to the upmost clinker strake by means of rivets and small wooden pegs.

The clinker part of the hull was built shell-first, and the carvel planks also show indications of shell-first construction. In all three carvel strakes, square wooden plugs of about 6 by 8 mm were found (Fig. 6). These wooden plugs are a well-known phenomenon in Dutch shipbuilding and are related to the bottom-based construction method.[2] During the assembly, the planks were laid side to side, and were held together by temporary clamps. These clamps were removed when the frames were inserted, and the remaining nail holes were filled with square wooden plugs, in Dutch *spijkerpennen*.[3] The *spijkerpennen* in the Terschelling wreck find were found on the inboard side as well as on the outboard side, implying that the clamps had been placed on both sides of the hull.

[2] This way of bottom-based building, which seems to have been often used in the Netherlands, is called 'Dutch flush' by Thijs Maarleveld (Maarleveld 1994: 155).

[3] The term *spijkerpennen* was first mentioned by Van Yk in his book about Dutch shipbuilding of 1697 (Van Yk 1697: 41). However, the earliest *spijkerpennen* have already been observed in the thirteenth-century cog-like ship NA57 (see Oosting 1987: 59). They have even been found in nineteenth-century wrecks (see: Oosting, Vlierman 1990: 16). See also Lemée 2006: fig. 4.1.16 for the sequence of the building concept.

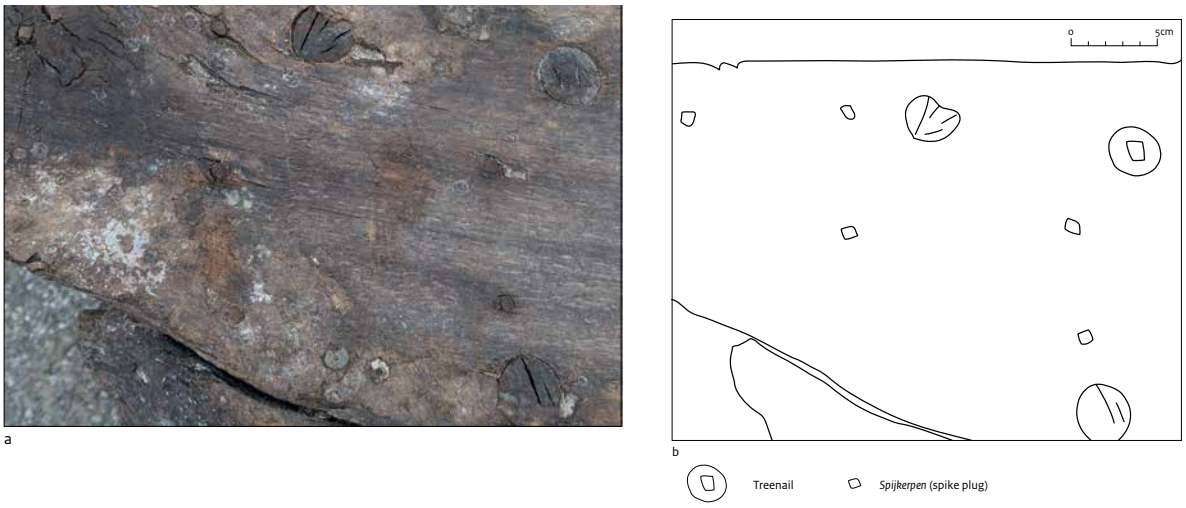

Fig. 6 Small wooden plugs, so-called spijkerpennen, on the outboard side of the carvel hull part of Terschelling Paal 9/10 (after Overmeer, Coenen, Vink 2024, Fig. 33)

3.4. The framing

Of the 20 frames visible on the discovery photographs, only 17 survived. These were all futtocks, placed directly next to each other, or with small interspaces. They were fastened to the hull with treenails with a diameter of 3 to 3.5 cm and wedged on the inboard side. The aftmost futtocks have a significant S-shape, implying the stern was very sharp below the waterline, and became fuller above the waterline (Fig. 7).

Most futtocks were notched on the lower part to fit the clinker strakes, and were smooth in shape on the upper part (see Fig. 7). There are no indications that the upper parts of the futtocks were notched in an earlier phase, and later planed to fit a carvel hull. Therefore, it is likely that the ship was originally designed with this combined clinker and carvel construction.

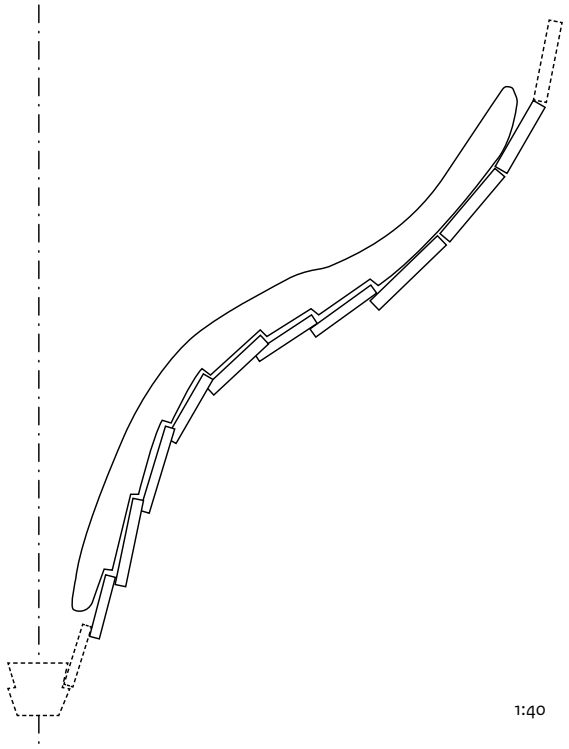

Fig. 7 Reconstruction of the stern, approximately 5 m from the stern post. The dotted parts have not been found (after Overmeer, Coenen, Vink 2024, Fig. 47).

3.5. The inner strake

On the inside of the ship, an inner strake had been applied to the futtocks. This one plank had a remaining length of 237 cm, a width of 33 to 36 cm, and a thickness of 8.5 cm. It might have been a ceiling plank, but it is quite heavy for this purpose. It possibly served as a beam shelf (although notches for deck beams are lacking) or as a lower beam clamp. It was attached to the underlying frames by treenails.

4. Dating & provenance

A total of 13 wood samples for dendrochronological analysis were taken from the timbers. Eight of them provided enough rings for dating. One sample had a felling date of spring AD 1546. The other samples had felling dates supporting this dating (Doeve 2020: 4). The geographical origin of the trees from two clinker planks lies in Westphalia or Lower Saxony in Germany. For the other samples a direct region of origin could not be determined, only a larger area of origin that includes eastern Belgium, eastern Netherlands, and central Germany (Doeve 2020: 4).

5. Preservation and post-depositional processes

The ship's timbers were in remarkably good condition. No shipworm infestation was observed. All iron elements on the other hand, such as rivets and sintels, had become heavily concretized or had even completely disappeared. Dark discolorations of the oxidized iron could be seen everywhere on the wood. This indicates sulfide corrosion, which occurs in marine contexts without oxygen. It can be concluded that this wreck part has been buried deep in the seabed all this time.

6. Interpretation & Comparison

The ship fragment found on the North Sea shore of Terschelling concerns the aft part of the starboard side of a mid-sixteenth century seaworthy ship. Based on the size of the fragment, it is thought that the ship was originally at least 22.5 to 30 m long, approximately 7.5 m wide and over 5.5 m high. The ship was originally built in a combined clinker and carvel construction. The combination of a lapstrake hull in the underwater ship and flush strakes above the waterline had not yet been found in the Netherlands before. A few examples are known from Germany and Scandinavia (Tab. 1).

Wrecksite	Date (dendro)	Provenance	Dimensions	Specs	Literature
Terschelling Paal 9/10 (Netherlands)	spring AD 1546	Germany	13.4 x 5 m (max. 22.5-30 m?)	Lower planking: clinker-built, rivets & wooden pegs; upper planking: carvel-built, spijkerpennen; all elements of oak	Overmeer, Coenen, Vink 2024
Åkroken-wreck (Sundsvall, Sweden)	summer AD 1577	Sweden/Finland	14.3 m (max. 16-17 m)	Lower planking: clinker-built; upper planking: carvel-built	Eriksson 2010
Japsand wreck (Hallig Hooge, Germany)	after AD 1617	Sweden	12 x 2.5 m	Lower planking: clinker-built, rivets; upper planking: carvel-built, no spijkerpennen; all elements of oak	Zwick 2024
Gröna Duvan (Sweden)	AD 1730's	?	16 m	?; all elements of oak	Erikson 2010
Bockholmen wreck (Åland, Sweden)	AD 1788-1790	?	25 x 8.5 m	Lower planking: clinker-built, nails; upper planking: carvel-built; all elements of pine	Lindholm 2002
Engman wreck (Axmar, Zweden)	about AD 1810	Sweden	28-29 x 8 m	Lower planking: clinker-built, double bent nails; upper planking: carvel-built; all elements of coniferous wood	Alopaeus *et al.* 2011
Märsman (Rödlöga, Zweden)	no dendro (1800-1850)	?	23 m	Lower planking: clinker-built, nails; upper planking: carvel-built; all elements of pine	Eriksson 2010
Ågabet wreck/Pettu (Denmark)	AD 1865	Swedish eastcoast, Finnish mainland	24 m	1st layer: lower planking: clinker-built, wooden pegs; upper planking: carvel-built; 2d layer: carvel-built; all elements of pine	Auer *et al.* 2013

Table 1 Ship finds in Europe with a combination of clinker and carvel hull

The hitherto oldest example is the Åkroken wreck, dating to 1577 (Eriksson 2010). The Japsand wreck, discovered off the shoals of Hallig Hooge in the North Frisian Wadden Sea, is also built in a similar manner, and dates after AD 1617 (Zwick 2024, in this volume). There are more wrecks found, mainly in Scandinavia, but most are dated to the 18th and 19th centuries. With its date of AD 1546, the Terschelling Paal 9/10-wreck is currently the oldest known ship built in this manner. Olof Hasslöff (1972) refers to this particular construction as 'half-carvels'. Eriksson and Zwick have put forward that both clinker construction and half-carvel construction were primarily associated with small-scale shipping in rural communities, and regarded as indigenous, old-fashioned, and obsolete. Carvel-built ships on the other hand were considered as modern, and were fiscally privileged (Eriksson 2010; Zwick 2024). Following Hasslöff, the term 'half-carvel' is now often used for ships with mixed planking. However, it is uncertain if this was a commonly used term at the time, and it should therefore be used with caution.[4]

Besides the clinker-carvel combination, there have been other variants of clinker construction, including vessels built with alternating strakes of clinker planking (e.g. the Björns wreck, the Melböda wreck), or ships which originally had a clinker hull, but in a later phase were converted to carvel ships by applying an extra carvel layer (e.g. B&W6, the Maasilinn wreck, FPL77 and the recent ship find Bispevika 19 in Oslo; Belasus 2014: 251–254; Lemée 2006; Belasus 2014: 258–263; Steen 2019).

The mixture of clinker and carvel hull is not the only striking aspect of the wreck. The presence of combined rivets and small wooden pegs is also interesting. Thus far this method of joining strakes is only known from four other early 16th-century wrecks. One of them was found in Køge harbour in Denmark (AD 1520–1530; Færch-Jensen, Daly 2023); three other wrecks were found in the Netherlands, and had wrecked in the former Zuiderzee. The Dutch ships, named NE159 (AD 1500–1512), OM11 (AD 1531–1533), and the 30m-long OU34 (AD 1522–1537), were all completely clinker built (Overmeer 2017).

Conclusions

The preliminary results indicate that the ship fragment found on the beach of Terschelling was a large, seaworthy ship, built with a combination of clinker strakes below the waterline, and carvel strakes in the upper part of the vessel. Both parts were built shell-first. Due to the presence of wooden pegs combined with rivets in the clinker part, and *spijkerpennen* in the carvel part, this ship might well have been built in the Netherlands. Together with the other ship finds with mixed planking in the several above mentioned variants, the Terschelling wreck exemplifies and contributes to a growing body of evidence demonstrating that shipbuilding in the 15th and 16th centuries was far from standardized.

Economic, political, and social developments in this era, mainly driven by the need and desire of different European sea powers to obtain resources, and later on also to conquer territories and establish colonies, created an increasing demand for larger cargo vessels, and the need to carry guns aboard. To meet these requirements, much changed in the way ships were conceptually and physically built. The Terschelling Paal 9/10 wreck is one example that this change was not linear or unambiguous, but rather inventive and adaptive.

[4] Personal comment Thijs Maarleveld †.

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