TECHNICAL REPORT

Examination of Salvaged Bow Ramp, m/s Estonia

Translation to English of TEK23-0101

ELEMENT MATERIALS TECHNOLOGY AB

For

Swedish Accident Investigation Authority

TEK24-0010

Edition 1

2024-02-08

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Summary

On behalf of the Swedish Accident Investigation Authority a visual examination of the salvaged bow ramp belonging to Estonia has been carried out on site in Estonia.

The purpose of the investigation was primarily to match the appearance and damage of the bow ramp with the event description according to the technical report: " M/V ESTONIA Bogarrangemanget kollapsar - Händelseförlopp". Gothenburg, November 2007, Jan-Ove Carlsson.

In addition to this, the parts of the railing that remain on the bow ramp and the area where the bow ramp has separated from the wreck while the wreck has been lying on the seabed were examined.

Nothing has been found in the review/investigation on site that contradicts the description of the sequence of events described in the documentation, except that the ramp locking hooks are assessed to have been latched at the time of the accident.

The separation of the railing most likely occurred as a part of the accident.

No evidence is noted suggesting that the bow ramp, or the railings has been separated from the hull by machine tools or thermal cutting.

Order data

Client:	Statens Haverikommision Box 6014 102 31 Stockholm
Order No:	Avrop S-200/20
Date:	2023-09-18
Purchaser:	J. Zachau
Technical reference:	J. Zachau

Internal data

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Ao No:	A15811-1
Id No:	-
File name:	TEK2024-0010-1.DOCX

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1 Introduction

On behalf of the Swedish Accident Investigation Authority a visual examination of the salvaged bow ramp belonging to Estonia has been carried out on site in Estonia.

The purpose of the investigation was primarily to match the appearance and damage of the bow ramp with the event description according to the technical report: " M/V ESTONIA Bogarrangemanget kollapsar - Händelseförlopp". This report is based on video and photography from dives at the wreck and to see if there was damage that deviates from this description. In addition to this, the parts of the railing that remain on the bow ramp and the area where the bow ramp has separated from the wreck while the wreck has been lying on the seabed were examined.

2 Document

"M/V ESTONIA Bogarrangemanget kollapsar - Händelseförlopp", Göteborg, nov 2007, Jan-Ove Carlsson med bilagor (CAD-filer och bilder, ej video)

3 Investigation

The investigation has been limited to visual examination and documentation on site in Estonia. In the investigation, damage to the bow ramp has been matched against the damage that would be consistent with the description of the course of events given in the document " M/V ESTONIA Bogarrangemanget kollapsar - Händelseförlopp ", in addition to this, major damage was sought that would not be consistent with the description of the event.

Attempts to produce replicas of the fracture surfaces on remaining sections of the railing were made but the very thick layer of corrosion and deposits made the replicas unusable.

4 Results

In general, it is noted that the bow ramp is in some parts in relatively good condition considering the long time on the seabed, this applies primarily to painted parts. When it comes to fracture surfaces and exposed metal, the environmental damage is so extensive that fractographic studies of fracture surfaces are not possible. This means that the information that can primarily be obtained from the bow ramp is fracture positions and overall deformation.

During this investigation, a laser measurement of the bow ramp was taking place, on some of the photographs below white sticky note markings are visible, these are reference points for the laser measurement.

Nothing was found during the on-site review/investigation that contradicts the description of the process as described in chapter 4 "Bogrampen öppnas helt" in the document. Some of the parts that were examined are briefly summarized below.

Ramp locking hook bracket:

It is concluded that the locking hooks have been latched at the time of the accident as the bracket on the starboard side has separated from the bow ramp (missing), see Figure 1 and on the port side the bracket is very severely deformed, see Figure 2.

Figure 1. Missing bracket for the ramp locking hook on starboard side.

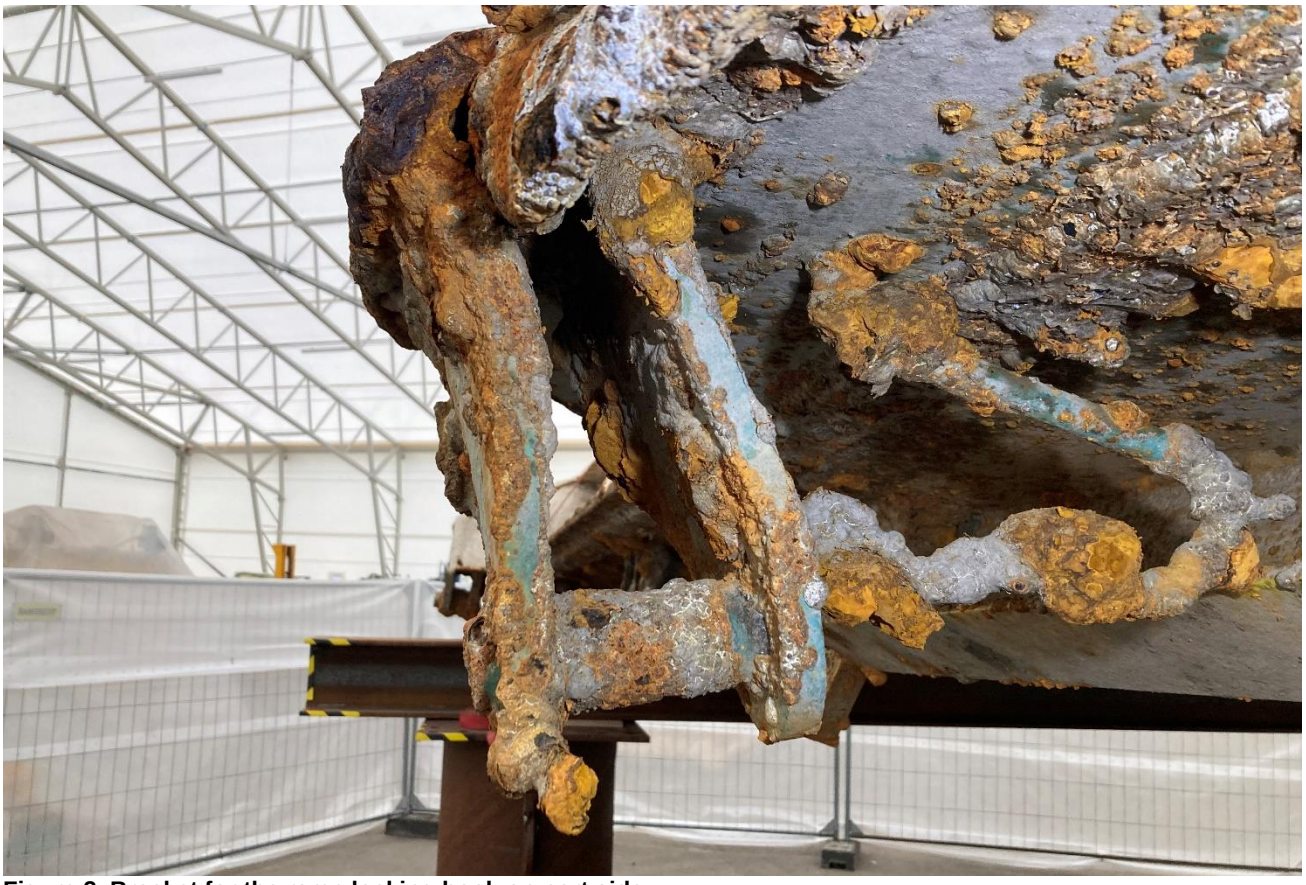

Figure 2. Bracket for the ramp locking hook on port side.

Ramp side lock boxes:

The lock boxes on the port side have failed with more bending than on the starboard side. Figure 3 and Figure 4 show the port side lock boxes and Figure 5 and Figure 6 show the starboard side lock boxes. On the starboard side, it looks like the lock boxes has had a evenly distributed pressure against the inside of the lock boxes and pulled the boxes off in a straight direction. This may be because, as stated in the documentation, that the lower lock piston on the port side has not been fully extended.

It may also be a consequence of the sequence in which they fracture which is as follows. First, the locks on the port side breaks because of the bow visor not hitting the upper edge of the ramp quite evenly.

When the port side locks are broken, lateral movement/tilting of the ramp is permitted. This movement causes the starboard side lock pistons to slide out of the lock box slightly before they fracture due to overloading. As a result the force against the lock box also gives rise to a torque that bends the lock housing down before the fracture occurs.

Figure 3. Port side upper ramp side lock box.

Figure 4. Port side lower ramp side lock box.

Figure 5. Starboard side upper ramp side lock box.

Figure 6. Starboard side lower ramp side lock box.

Major damage on the sea side and sides of the bow ramp:

Damage on the sea side of the bow ramp is consistent with the description given in the document with damage both from impacts into the bow visor and bulb stem. Damage from when the bow visor falls back to its closed position also matches the description in the document, Figure 7 shows an overview of the damage to the upper part after hitting the ship's bulb.

Figure 7. The sea side of the bow ramp seen from the hinge side, transverse beams 3, 4 and 5 marked.

Railings:

The railing on the bow ramp is assessed to have separated from the bow ramp in the accident and not cut or dismantled in any other way before/after the accident. This assessment is based on the deformation (occurrence of bending and shearing of the remaining parts) that does not occur when cutting with machine tools or thermal cutting. The damage is consistent with the protruding locking bolts holding the railing in place when the bow ramp is fully opened as described in the documentation. The surrounding structure also has severe deformation in several of the positions from being hit with great force by other parts and the railing may also have been broken off during these hits.

It is also an indication that they ruptured in relatively different ways, two of the examples below have, for example, ruptured in the weld against the bow ramp where it would not be natural to cut the railing for access reasons. Seven of the attachments are seen in Figure 8 to Figure 16.

Figure 8. Three attachment positions for railing on the starboard side.

Figure 9. Starboard uppermost attaching position for railing (1 in Figure 8).

Figure 10. Starboard attaching position for railing (2 in Figure 8).

Figure 11. Starboard attaching position for railing, only the weld fillet remains on the bow ramp (3 in Figure 8).

Figure 12. Four attachment positions for railing on the port side.

Figure 13. Port side attaching position for railing (1 in Figure 12).

Figure 14. Port side attaching position for railing (2 in Figure 12).

Figure 15. Port side attaching position for railing (3 in Figure 12).

Figure 16. Port side attaching position for railing, no part of the railing remains, the weld has been somewhere below the heavily corroded area (4 in Figure 12).

Area where the bow ramp has separated from the hull during the time on the seabed:

Damage in the area where the bow visor has detached from the vessel while lying on the seabed has been investigated. Here, some broken surfaces are noted that are less corroded, but there are no signs of thermal or mechanical cutting in the area.

5 Conclusions

Nothing has been found in the review/investigation on site that contradicts the description of the sequence of events described in the documentation, except that the ramp locking hooks are assessed to have been latched at the time of the accident.

The separation of the railing most likely occurred as a part of the accident.

No evidence is noted suggesting that the bow ramp, or the railings has been separated from the hull by machine tools or thermal cutting.

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