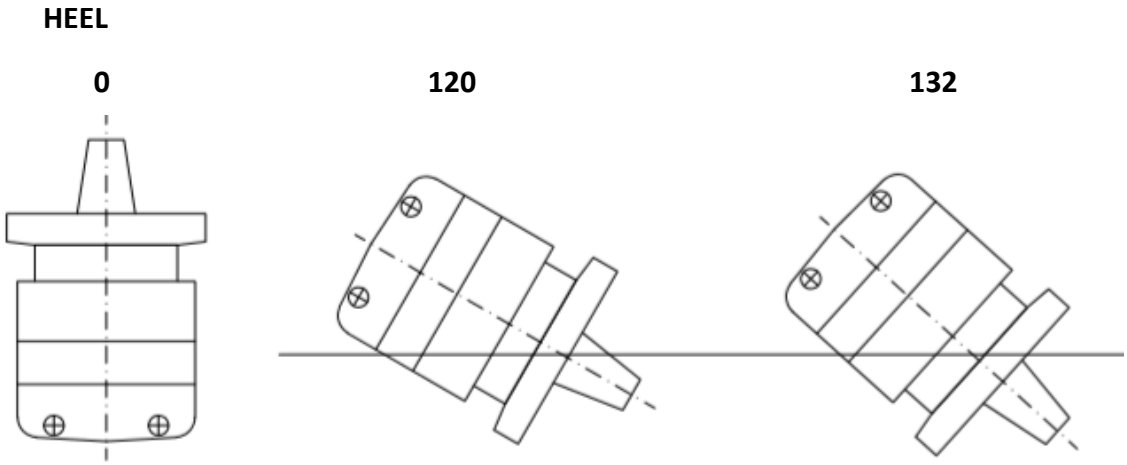
Viewing of the ROV video to MS Estonia

Date and location: 18.09.2020. Oslo, Norway

Observations

An ROV (*remotely operated vehicle*) video from the starboard side of MS Estonia was presented together with several other videos, where the findings were interpreted by an ROV expert and a professor of naval architecture.

Initially the videos that will be publicly released on 28th of September were shown. Video starts with the claim that after the accident MS Estonia was laying at the sea bottom with the list of 120 deg and by now, the list is has increased to 132 deg, see the figure below. Thus, the starboard side of the ship has been partly lifted from the sea bottom and the starboard can be observed with ROV.



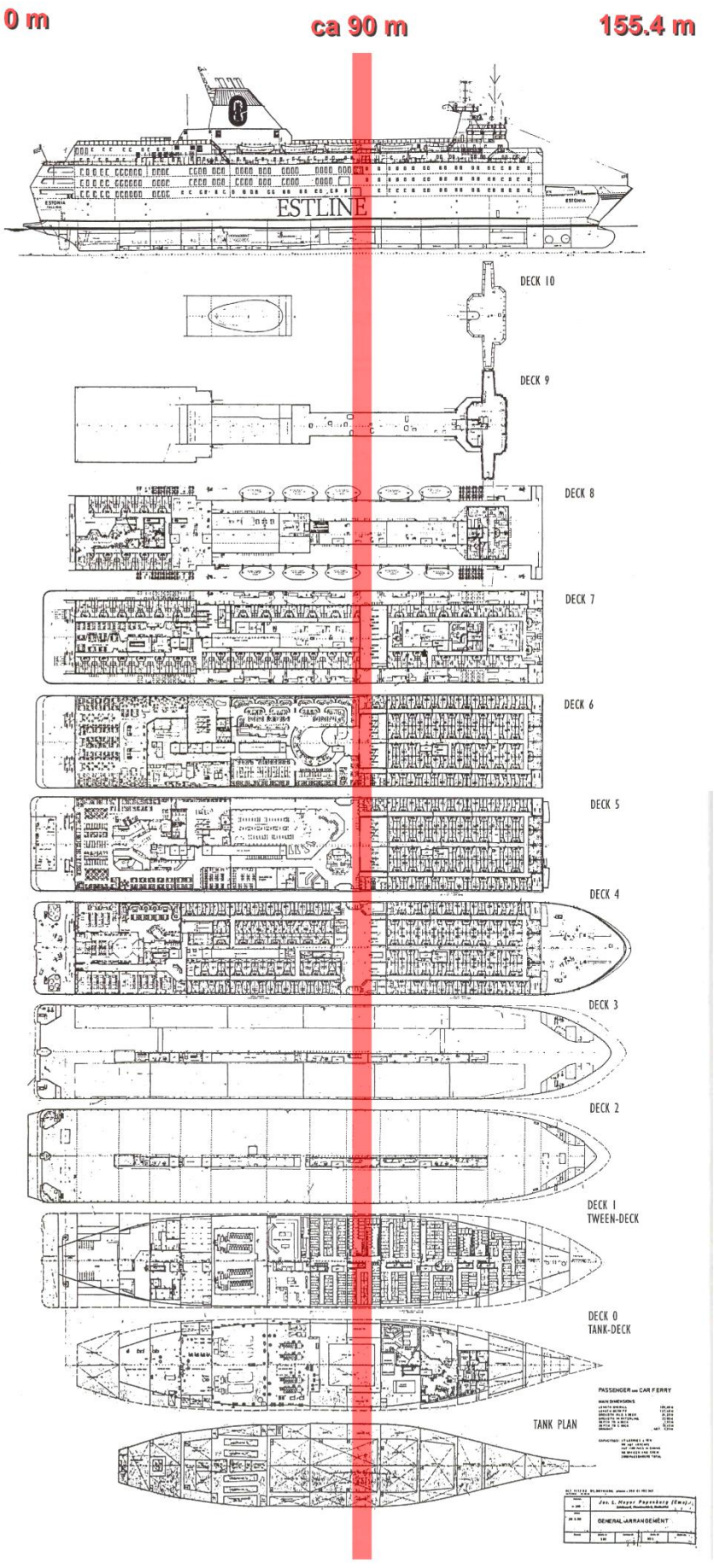
In the video, the ROV was moving along the ship hull, seemingly approaching from the bow towards the amidships. The camera was roughly moving along the side fender (*põrkepruss*) i.e. at the height of the car deck. **In the region indicated by red cross/line in the figure below, a penetration damage no 1 appeared.** The position was claimed to be about 98 from the aft of the ship, even though more realistic value seems to be about 90 m.

Depth of the penetration dent was claimed to be about 1.2 m and an obvious fracture was present. The fracture was a relatively straight vertical line with the height of about 4 m. Fracture seemed to follow a strong structural element such as web frame (*raamkaar*). According to ship profile view, the fracture extended from the car deck to the tween deck. In the middle of the vertical fracture, roughly at the location of the side fender and the car deck, the opening had a horizontal extent, which length was not directly presented, but appeared to be around 1 m. The penetration direction pointed slightly towards the bow. The penetration shape appeared to be kind of triangular, more arbitrary than symmetrical. Narrow strip of the steel structure had been bent outwards the ship hull. Based on the ROV images, a 3D expression of the damage opening and the fracture were constructed. In the vicinity of the damage opening, obvious longitudinal scratch marks were not noted.

While only very little of sea bottom was seen in the video, the bottom appeared relatively hard and solid without apparent larger rocks.

In another video prof. Amdahl from NTNU presented a simple structural assessment and claimed that the force required to cause such damage is about 500-1000 tonnes.

Unofficially we were briefly shown a raw ROV footage that will not be a part of immediate public release. However, the ROV footage presented additional important evidences. ***Sea bottom was clearly seen and at least in one section an assembly of larger rocks was seen in the video****. Also pile of rocks that were sunk after the accident were clearly seen in the video.* ***Towards further aft (ahtri suunas) of the ship, at the other end of ESTLINE text, another opening appeared (indicated by horizontal orange line)****. The plating was thorn open, most probably along a longitudinal weld line. Web frames (raamakaared) had been thorn from the weld connection and were clearly visible. Obvious local denting was not observed and it seemed that loading has been more evenly distributed compared to the first damage, where a local dent was obvious.*


0 m
ca 90 m
155.4 m
ESTLINE
DECK 10
DECK 9
DECK 8
DECK 7
DECK 6
DECK 5
DECK 4
DECK 3
DECK 2
DECK 1
TWEEN-DECK
DECK 0
TANK-DECK
TANK PLAN
PASSENGER and CAR FERRY
GENERAL ARRANGEMENT

Possible causes/Interpretation

(This discussion excludes the second damage opening and only focuses on the local penetration damage no 1)

Penetration damage no 1 has been caused by a force or object outside the ship causing the dent in the ship side structure. Steel plating was bent inward, except a narrow steel stripe that was bent outwards.

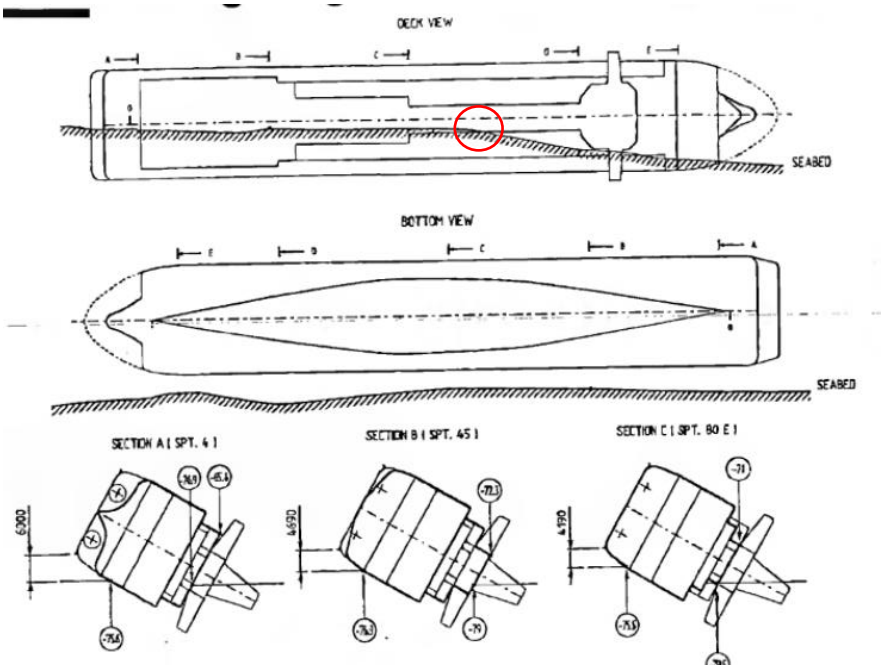
The characteristics of the penetration dent and the fracture were not typical for a blast opening nor for a man-made cut opening.

It is unlikely that the damage has been caused due to a collision at the sea surface. Direction of the penetration dent pointed slightly towards the bow. To cause such a damage, the penetrating object should have approached the ship from the stern (*ahter*), with its direction oblique (about 45 deg) with respect to MS Estonia. Also, the speed of the penetrating object should have exceeded the speed of MS Estonia.

Possible explanation for such damage could be a contact with an underwater object such as a seabed rock. Ship mass (12 000 ton) significantly exceeds the force required for the opening (500-1000 ton). Thus, an uneven surface under the ship side could introduce concentrated forces that could lead to penetration damages.

Survey report from 1994 presents the ship's position as it lays sideways at the sea bottom, see below. This position indicates that the slope of the sea bottom changes at about 1/3 ship length from the bow. This change in slope introduces higher loads in the region, where the damage was observed.

In any scenario, the size of the visible damage opening cannot be the reason, why the ship sank at the known time frame.



Suggestions

The findings cannot change the conclusions presented in the final report of JAIC as the opening of such size cannot be the reason to sink the MS Estonia in the known time frame. Thus, further investigation for the reason of sinking of MS Estonia does not seem reasonable.

However, additional investigation could explain the reasons for the local penetration damage opening.

- Detailed scanning or video material from the sea bottom could reveal whether the bottom includes rocks of the size required to cause the damage (indication that such rocks exist in the bottom was revealed in the unofficial video footage).
- While relatively good image of the damage opening exists, more detailed information could be obtained by divers to measure and scan the damage opening.
- Numerical simulations can be conducted to analyse and explain the local penetration damage at the sea bottom.
- To exclude the surface collision scenario, plausible scenarios could be constructed that could lead to observed damage (establishing of relative directions and velocities between MS Estonia and penetrating object, and the required mass of the penetrating object). This would allow to assess, whether such collision scenario would be theoretically possible.

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PS! Prof. Jaan Metsaveer, former member of JAIC, has also seen the video prior to us and asked to point out that he agrees and supports the conclusions drawn here.