Bundesstelle für Seeunfalluntersuchung
Federal Bureau of Maritime Casualty Investigation
Federal Higher Authority subordinated to the Ministry of Transport
and Digital Infrastructure

ADOMS
Antigua & Barbuda
Department of Marine Services
and Merchant Shipping

INSPECTION & INVESTIGATION DIVISION

Investigation Report 342/13

Serious Marine Casualty

Stability-related accident involving the MV ROSEBURG in the Kieler Förde on 5 November 2013

20 October 2014

The following is a **joint report** by the German Federal Bureau of Maritime Casualty Investigation, as lead investigating authority, and the marine casualty investigation authority of the flag State Antigua & Barbuda. The two bodies have conducted this investigation jointly and in accordance with the IMO Casualty Investigation Code (Resolution MSC.255(84)). The working language used for the joint investigation was German.
The investigation was conducted in conformity with the Law to improve safety of shipping by investigating marine casualties and other incidents (Maritime Safety Investigation Act - SUG) of 16 June 2002, amended most recently by Article 16(22) of 19 October 2013, BGBl. (Federal Law Gazette) I p. 3836.
According to said Act, the sole objective of this investigation is to prevent future accidents and malfunctions. This investigation does not serve to ascertain fault, liability or claims (Article 9(2) SUG).
This report should not be used in court proceedings or proceedings of the Maritime Board. Reference is made to Article 34(4) SUG.
The German text shall prevail in the interpretation of this report.

Issued by:
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1 Summary

The Antigua & Barbuda flagged ship ROSEBURG arrived at the Kiel-Holtenau roadstead late afternoon on 5 November 2013. The ship left the port of Riga fully laden with timber three days earlier. The voyage passed without any incidents.

There were plans to anchor in the Kiel-Holtenau roadstead for an hour to carry out minor repairs in the engine room before starting the passage through Kiel Canal. While turning in the anchor position at 1653[1], the ROSEBURG suddenly listed to starboard. All the deck cargo started to slide, a reasonable number of lashing straps broke, and more than half the wood pallets fell overboard. This caused the ship to list briefly at up to 40°. Situated in the starboard wing, the chief mate was unable to keep his footing and also fell into the water. He held on to some floating timber until he was picked up by a pilot boat that had rushed to assist.
He was taken to hospital for observation but suffered no lasting injuries. The timber that fell overboard was recovered over the next few days but had to be declared cargo damage.

Since the ROSEBURG sailed under the flag of Antigua & Barbuda, a joint investigation was carried out with ADOMS IID[2]. This concluded that a ship may not begin her voyage when she is overloaded and thus compromises the safety of her and her crew.

[1] Unless stated otherwise, all times shown in this report are local = UTC +1.
[2] ADOMS IID: **A**ntigua & Barbuda **D**epartment **o**f **M**arine **S**ervices and Merchant Shipping **I**nspection & **I**nvestigation **D**ivision.

2 FACTUAL INFORMATION

2.1 Photo

© Hasenpusch Production

Figure 1: Photo of ship

2.2 Ship particulars

Name of ship:	ROSEBURG
Type of ship:	Cargo ship
Nationality/Flag:	Antigua & Barbuda
Port of registry:	Saint John's
IMO number:	8817370
Call sign:	V2PS2
Owner:	Sirius Shipman Ltd.
Year built:	1990
Shipyard/Yard number:	Ferus Smit BV Foxhol
Classification society:	Lloyds Register
Length overall:	82.05 m
Breadth overall:	12.57 m
Gross tonnage:	1,999
Deadweight:	3,026
Draught (max.):	4.94 m
Engine rating:	1,290 kW
Main engine:	CATERPILLAR 3606 DI-TA
(Service) Speed:	11.5 kts
Hull material:	Steel
Hull design:	Double hull

2.3 Voyage particulars

Port of departure:	Riga, Latvia
Port of call:	Barrow Haven, United Kingdom
Type of voyage:	Merchant shipping International
Cargo information:	3,068 m^3 of sawn timber
Manning:	8
Draught at time of accident:	5.0 m
Pilot on board:	No
Canal helmsman:	No
Number of passengers:	0

2.4 Marine casualty information

Type of marine casualty:	Serious marine casualty/loss of stability with person overboard
Date, time:	05/11/2013, 1653
Location:	Kieler Förde
Latitude/Longitude:	φ 54°22.7'N / λ 010°10.7'E
Ship operation and voyage segment:	Harbour mode/arrival
Place on board:	Main deck/bridge
Consequences (for people, ship, cargo, environment, and other):	One person hypothermic, loss of cargo, minor damage to the main deck

Excerpt from Nautical Chart DE110000.000, BSH

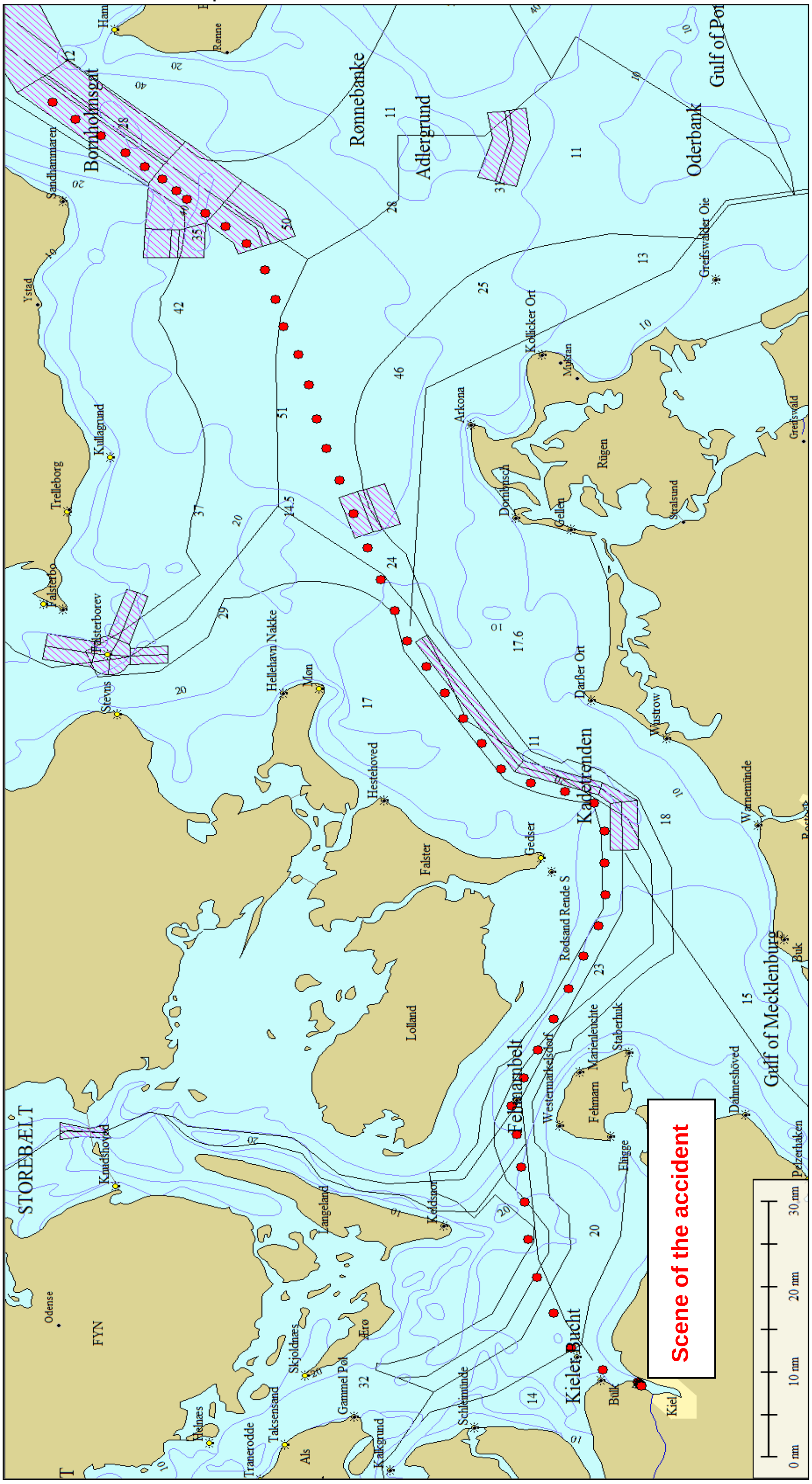


Figure 2: Nautical chart showing the course of the voyage

2.5 Shore authority involvement and emergency response

Agencies involved:	Vessel Traffic Service Travemünde, MRCC Bremen, Waterway Police Kiel, Ship Safety Division (BG Verkehr)
Resources used:	Pilot Boat STEIN, MV SCHARHÖRN, Customs Cruiser SCHLESWIG-HOLSTEIN, Tug HOLTENAU, WSP Boat NEUMÜHLEN, Rescue Cruiser BERLIN
Action taken:	The person overboard was picked up by the STEIN and taken ashore by the NEUMÜHLEN. An ambulance took him from there to a hospital in Kiel. The other vessels secured the floating timber
Results achieved:	No lasting injuries. The timber was recovered

3 COURSE OF THE ACCIDENT AND INVESTIGATION

3.1 Course of the accident

On 2 November 2013, the ROSEBURG left the port of Riga in Latvia fully laden with 3068.827 cbm of sawn timber and 16 cable reels. Her destination was Barrow Haven in the United Kingdom. 609.976 cbm of timber was stowed on deck. The crew of the ship lashed the cargo supervised by the chief mate. According to statements given by the ship's command, the GM[3] was 0.87 m. The forward and aft draught reportedly stood at 4.90 m and 5.00 m respectively. The lashings were reportedly checked regularly and tightened if necessary by the chief mate and the crew during the voyage across the Baltic Sea to Kiel. By all accounts, the weather conditions during the voyage were moderate; reportedly, the ship hardly rolled at all.

Friedrichsort Lighthouse was passed at 1638 on 5 November 2013 and contact was made with the locks in Kiel and the pilots. The ship's command requested permission to drop anchor in the roads at Holtenau first so as to carry out a repair on the cooling system. The ROSEBURG arrived at the anchorage shortly after. The master and chief mate were on the bridge. The latter was in the starboard wing when the ship made the intended turn to starboard to let go the anchor. According to the ship's command, a sudden gust of wind from south-south-east reportedly inclined the ROSEBURG to a list of 15° to starboard, which reportedly caused the deck cargo to shift to starboard. This reportedly caused the inclination to increase until a list of some 40° was reportedly reached. At that moment, more and more lashings reportedly broke, causing a large part of the deck cargo to slide into the water.

Furthermore, the chief mate fell from the wing into the water because of this sudden heavy inclination. Afloat in the water, he was able to hold onto the timber.

When the deck cargo was off the ship, she righted herself and then remained at a lower inclination. This list could be offset shortly afterwards by transferring ballast water.

The master reported the incident to Vessel Traffic Service Kiel on VHF at 1653, stopped the main engine immediately, and gave instructions to drop the port anchor. Numerous vessels were listening in and offered assistance. Pilot Boat STEIN was still in the vicinity because she originally intended to take a pilot to the ROSEBURG. At 1710, she reported to the VTS that the person overboard had been rescued. WSP Boat NEUMÜHLEN collected the casualty and took him ashore, where he was collected by an ambulance and taken to the University Hospital in Kiel. He suffered no lasting injuries.

[3] The distance from the center of mass G to the metacenter M is called metacentric height GM. The center of mass G of a floating body is vertical below the metacenter provided that no external forces or moments act on the body. This means, the body moves until this condition is met. The metacentric height is of importance for the assessment of the stability with small heeling angles. It can be determined by a heeling test, so that the position of the center of mass can be established. An estimation of the metacentric height can also be done by the rolling period (rolling test). (Source: Wikipedia dated 25 September 2014).

3.2 Investigation

The safety investigation was jointly conducted with the marine casualty investigation authority of the flag State Antigua & Barbuda. After consultation, the BSU assumed the role of lead investigating state within the meaning of the Casualty Investigation Code of the International Maritime Organisation (IMO)[4] and the German Maritime Safety Investigation Law (SUG)[5].

3.2.1 Damage

The chief mate fell from the starboard wing into the water because of the sudden list. He was able to hold onto parts of the timber cargo that had also fallen into the water until found and picked up by Pilot Boat STEIN. He was taken to hospital for observation but suffered no lasting injuries.
At the same time as the chief mate fell, numerous lashings on the deck cargo broke and about 75% of the cargo slid into the water.
Figures 3 to 7 illustrate the condition on the day after the accident.

© ADOMS IID

Figure 3: Damage photo 1

[4] See Part II, Chapter 7 of the Code of the International Standards and Recommended Practices for a Safety Investigation into a Marine Casualty or Marine Incident (Casualty Investigation Code) of 16 May 2008, Annex to Resolution MSC.255(84).

[5] See Article 16 of the Law to improve safety of shipping by investigating marine casualties and other incidents (German Maritime Safety Investigation Law) of 16 June 2002, as amended 22 November 2011.

© WSP Kiel

Figure 4: Damage photo 2

© WSP Kiel

Figure 5: Damage photo 3

© WSP Kiel

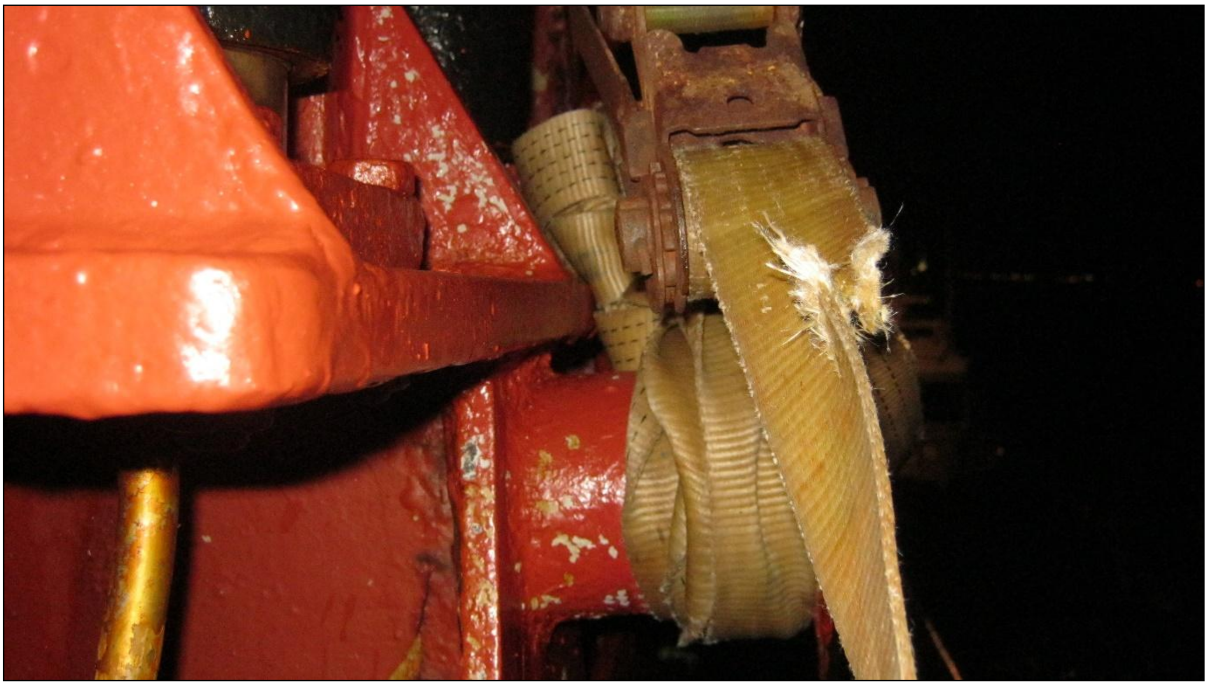
Figure 6: Damage photo 4

© WSP Kiel

Figure 7: Damage photo 5

3.2.2 Lashing

According to the Timber Cargo Securing Manual, 41 polyester straps with a breaking load of 15,000 kg should have been used on board the ship. However, during the survey shortly after the accident on 5 November 2013, the waterway police found only 18 straps with a breaking load of 20,000 kg and 17 with a breaking load of 5,000 kg. Of the former, six were only tied to the ship and not attached with a hook. In the case of the smaller straps, several older cuts and abrasions were found, meaning it can be assumed that these would not even have reached a breaking load of 5,000 kg.



© WSP Kiel

Figure 8: Knotted lashing strap

3.2.3 AIS data

The ROSEBURG is a cargo ship of less than 3,000 GT. Therefore, she is not required to operate a voyage data recorder (VDR) under Chapter V Regulation 20 SOLAS. Since there were no electronic recordings on board either, the BSU referred to the AIS recordings[6] of the Federal Waterways and Shipping Administration. Figure 9 shows most of the course of the voyage taken by the ROSEBURG from Riga to Kiel. The positions, speed and course were correlated with the detailed weather report in section 3.2.4 and influenced the final assessment of the stability report in section 3.2.5 thus.

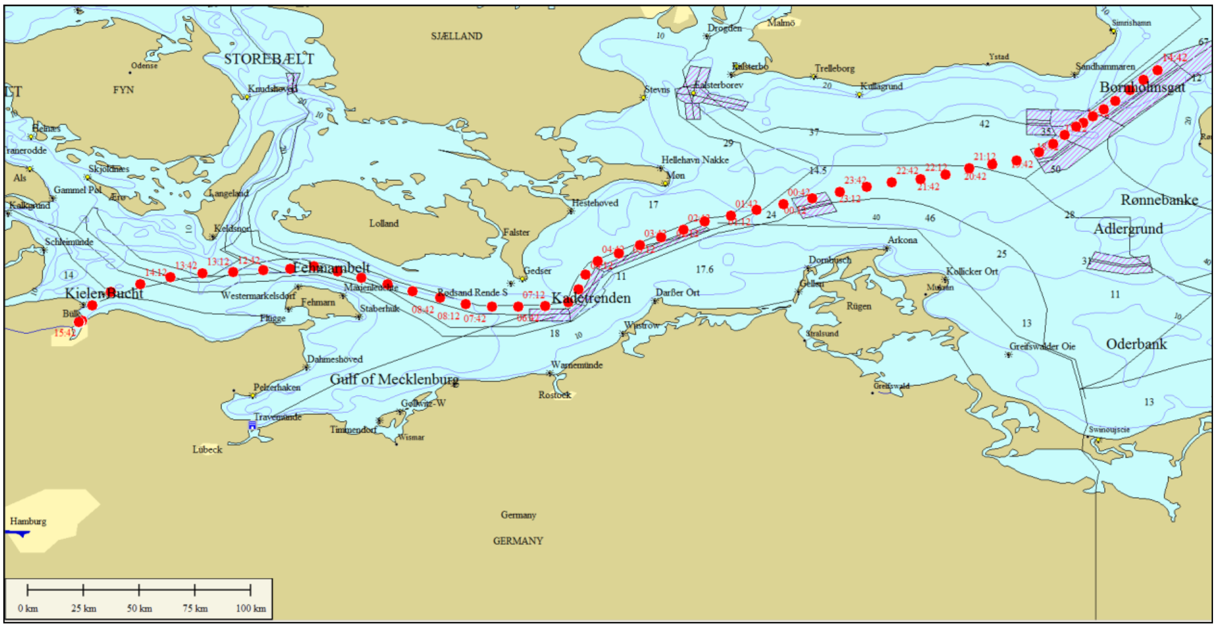


Figure 9: AIS data 1

All the times shown in figures 9-14 are based on UTC.

Figure 10 shows the arrival at Kieler Förde . Figure 11 shows the anchor manoeuvre at the time of the accident, 1553 UTC (1653 LT).

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[6] AIS: Automatic Identification System.

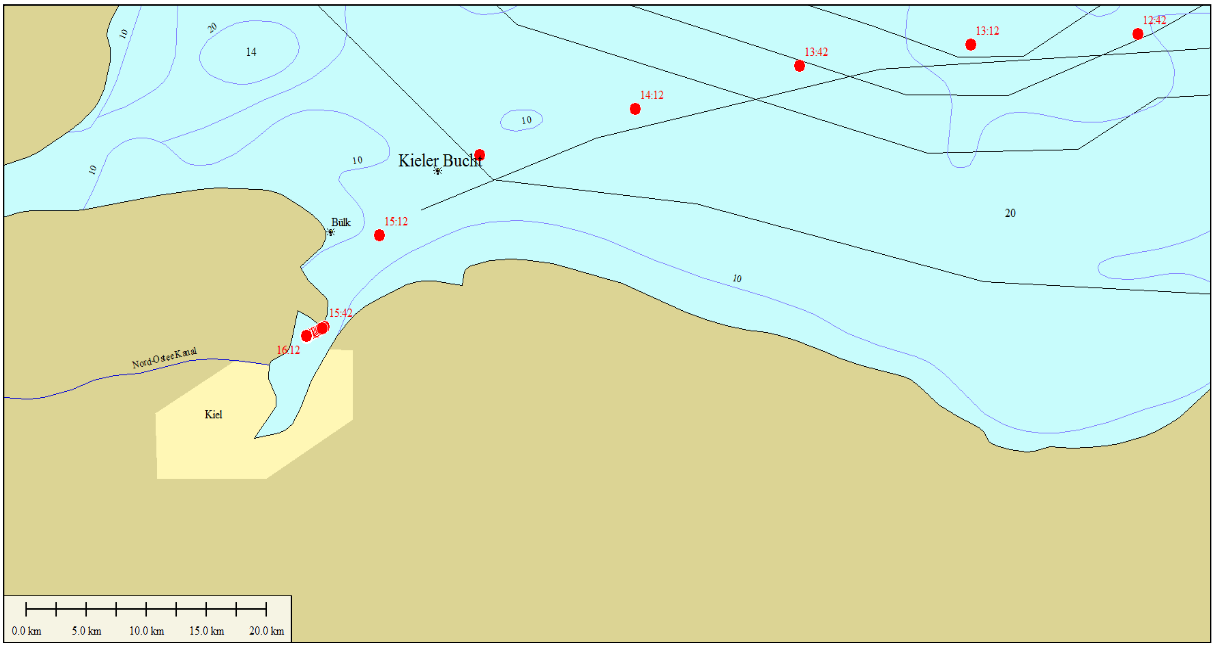

Figure 10: AIS data 2

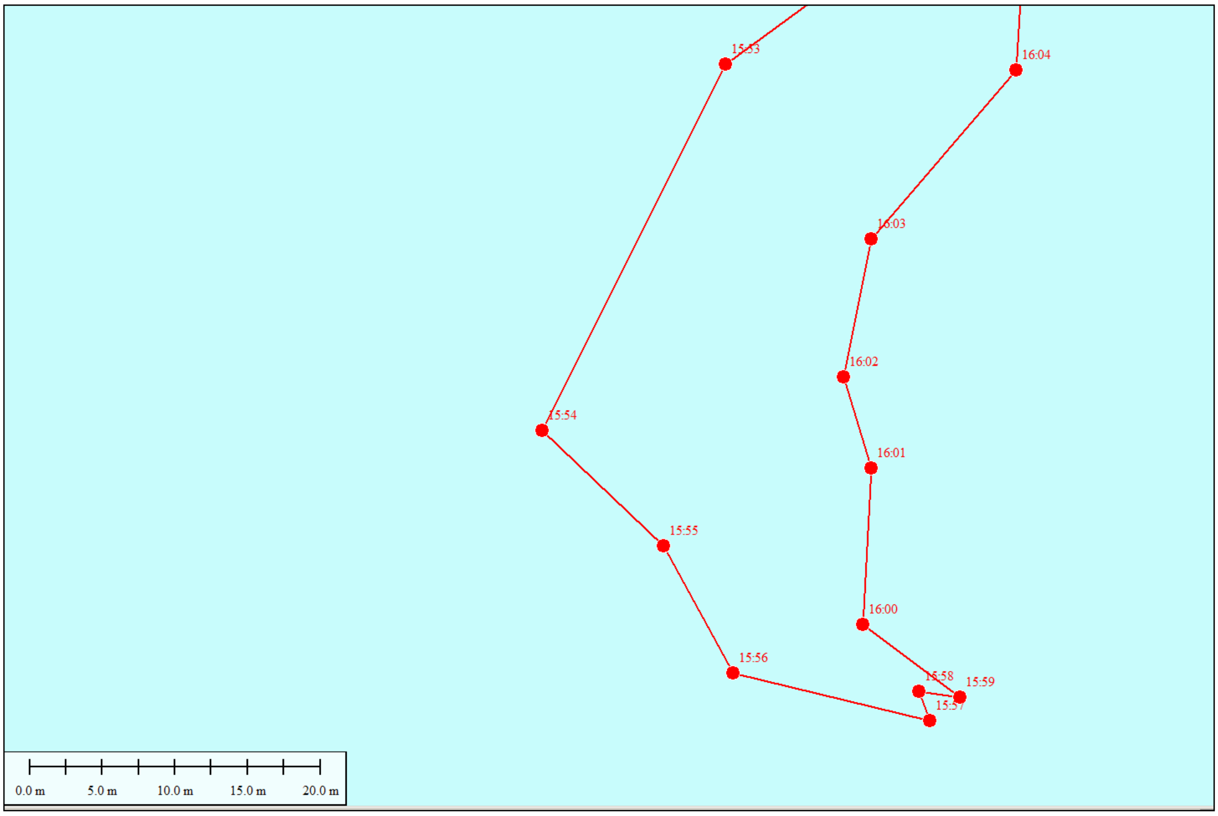

Figure 11: AIS data 3

3.2.4 Weather report

The BSU requested from Germany's National Meteorological Service (DWD) a detailed weather report describing the conditions in the Baltic Sea that the ROSEBURG had to pass through after leaving the last port of loading in Riga up until the time of the accident at the roadstead in Kiel. This report was subsequently considered in the stability assessment of the Hamburg-Harburg Technical University (TUHH) and is reproduced in an editorially revised form below.

3.2.4.1 Underlying data

The DWD has at its disposal measurements and observations from the surrounding stations for the Baltic Sea area. Some of these stations are not manned permanently. Analyses of the DWD in Offenbach and the American Global Forecast System (GFS model) were used to map the weather conditions. Forecasts of the European Centre for Medium Range Weather Forecast (ECMWF, based in Reading, England) global weather forecast model, the DWD's GME global weather forecast model, as well as the COSMO-EU and COSMO-DE regional weather forecast models, also from the DWD, were considered. Satellite images and rawinsondes were also analysed.

3.2.4.2 Weather situation in the Baltic Sea from Saturday 2 November to Monday 4 November 2013

Saturday 2 November 2013

A wedge from a weak south Russian high swung towards the north-east as the day progressed. A low pressure system of 999 hPa over the southern part of the North Sea moved into the south-eastern part of the Baltic Sea by the evening.

Sunday 3 November 2013

This low pressure system was filling as it tracked across the Baltic States to Belarus. At the same time, there was a heavy storm front of 975 hPa over the northern part of the North Sea, which tracked slowly towards Norway. In the process, its frontal fringes swung into the Baltic Sea up until midday.

Monday 4 November 2013

A low pressure system of 984 hPa subsequently formed over Estonia. Another storm front of 980 hPa developed on the southern edge of the Norwegian storm front (977 hPa) in the southern part of the North Sea, which then tracked rapidly across northern Germany up to the Stockholm area. As the day progressed, a wedge from a weak south-east European high of 990 hPa swung mainly over the central parts of the Baltic Sea.

3.2.4.3 Weather and sea state in the Baltic Sea from 2 November to 4 November 2013

Saturday 2 November 2013

Wind, sea state and current:

A south-westerly wind of about 25 kts (6 Bft) prevailed in the area of the central and northern Baltic Sea. In the southern Baltic Sea, in particular, the wind dropped significantly by the evening with baffling winds.

Sea state initially stood at 1.5-2 m in the northern part of the Baltic Sea and in the Gulf of Riga but dropped to less than 1 m in places by the evening. It was mainly generated by wind, meaning the swell was generally insignificant. Current was negligible.

Weather and visibility:
There were scattered clouds in the central and northern parts of the Baltic Sea only initially; however, they quickly took over and brought rain and drizzle from the west. Visibility was generally in the range of 4-10 km. However, in the rain poorer visibility of 1-4 km in places was reported.

Sunday 3 November 2013
Wind, sea state and current:
The fringes of the Norwegian storm front moved into the western part of the Baltic Sea. In the process, the wind in the northern and eastern half turned east to south-east and increased to between 25 and 30 kts (6-7 Bft) in places. Sea state of 1.5-2 m developed. There were initially winds of 3 Bft from various directions in the rest of the Baltic Sea. The wind turned across the south in westerly directions later and freshened up to 30-35 kts (7-8 Bft). Gusts of up to force 10 Bft were registered in the western part of the Baltic Sea.
Sea state increased to 2 m and was mainly generated by wind, meaning the swell was insignificant. Current was negligible.
Weather and visibility:
Dense clouds with a rainband quickly formed in the north and east, which gradually spread to the east. At the same time, the clouds in the west dispersed and there was a transition to squally weather. At 10-20 km, visibility was generally good and only dropped to 4 km in places in the rainband.

Monday 4 November 2013
Wind, sea state and current:
The westerly wind of 30-35 kts (7-8 Bft) prevailed throughout and turned southwards by the evening. West to north-westerly winds formed only over the western part of the Baltic Sea when the new 980-hPa storm front approached over northern Germany.
Sea state generally stood at 2-3 m. It was mainly generated by wind, meaning the swell was insignificant. Current was negligible. (See Fig. 12.)

Weather and visibility:
A weak high wedge brought a little sunshine to the south-eastern and central Baltic Sea. Tracking in a north-easterly direction as the day progressed, dense clouds and some rain still prevailed in the north-east. At the same time, dense clouds and rain slowly spread from the western to the central part of the Baltic Sea. It remained mostly dry until the evening in the north-east. Visibility was generally good and only dropped to 2-4 km in the areas of rain.

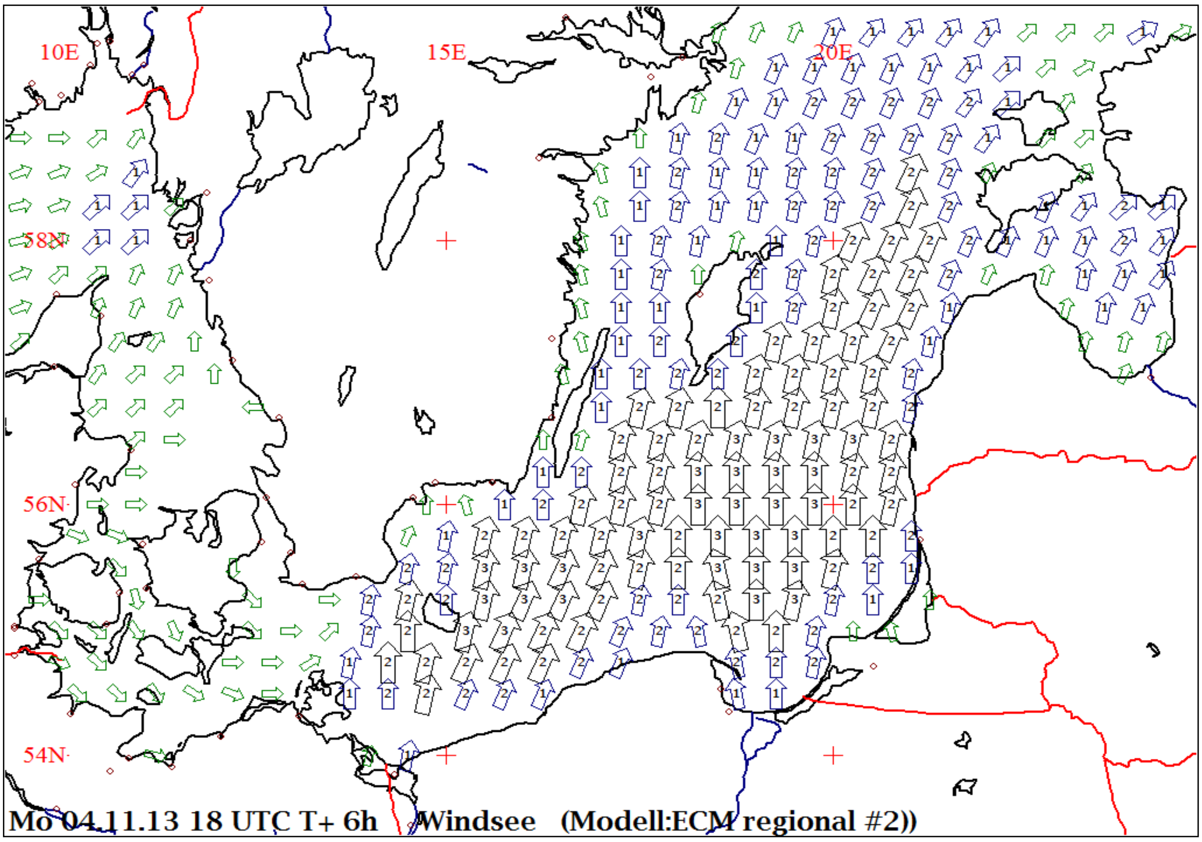

Figure 12: Wind sea forecast of the global ECMWF model for 4 November 2013 at 1800 UTC

3.2.4.4 Weather situation on 5 November 2013 at 1700 CET

Figure 13 shows the GODEHARD 1 and the HORST low pressure systems with core pressures of 975 hPa and 970 hPa respectively. The first low pressure system mentioned tracks to southern Finland by the evening, while the HORST remains in the area south-west of Iceland. In the process, colder air flows into the region and briefly falls within the influence of an interim high wedge, causing the onset of slightly more moderate weather. At the same time, a fringe from the HORST stretches into the western part of the North Sea. A secondary depression forms around this in the Dover area and subsequently tracks across the North Sea.

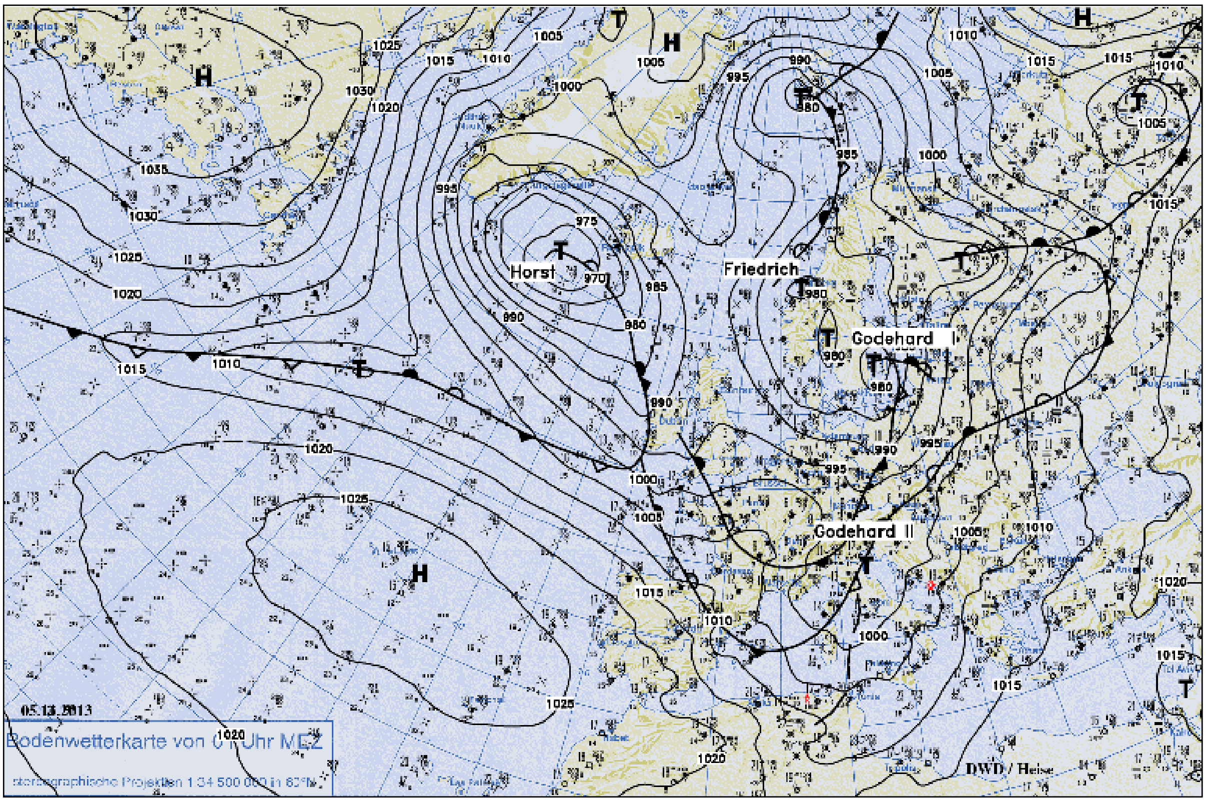

Figure 13: Weather chart

Wind:
A south-west and later south wind prevailed in the area of the Kieler Förde at the time of the accident. 8-10 kts (3-4 Bft) were measured in Kiel; however, the wind increased slightly on the open water. Data for the vicinity indicate 14-16 kts (4-5 Bft) for the area of the open Kieler Förde . At the same time, gusts of between 25 and about 30 kts (6-7 Bft) were widespread.

Weather and visibility:
The morning of 5 November 2013 began with a little sunshine. However, it was mostly heavily overcast at the time of the accident but there had still been no precipitation. Rain from the low pressure system at Dover was already looming over Lower Saxony. For the most part, visibility stood at 20-30 km.

Temperature:
Air temperature stood at 8-9°. Moreover, water temperatures of 11° were measured.

Current:
The velocity of flow in the area of the accident at the layer between a depth of 0 and 5 m stood at 0.1-0.2 kts from west-south-west at the time the damage occurred.

3.2.5 Stability report

The BSU commissioned the TUHH's Institute of Ship Design and Ship Safety with the delivery of an explanation of the course of the accident based on theoretical calculations. The corresponding report is reproduced below in an editorially revised form.

3.2.5.1 Ship, hull shape and load condition

The multi-purpose cargo ship MV ROSEBURG was delivered in 1990 as the MV BALTICBORG by the shipyard FERUS SMIT BV in Hoogezand, Holland. Its yard number was 257. The ship's call sign is V2PS2. The MV ROSEBURG is classified at Lloyd's Register, Rotterdam. The ship is designed for timber and grain loads. Her permissible deadweight is 3,005 t and she was registered in St. John's at the time of the accident.

According to the documentation on hand, the principal dimensions of the MV ROSEBURG are as follows:

Length (overall)	*:78.00 m*
Moulded beam	*:12.50 m*
Draught at summer load-line	*: 4.953 m*
Height of freeboard deck	*: 6.600 m*

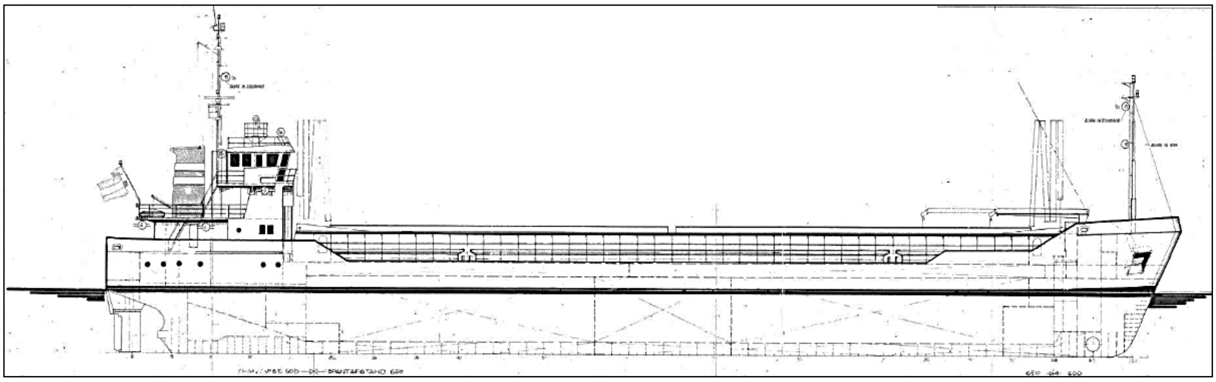

Figure 14: Side view of the MV ROSEBURG

The BSU submitted the ship's general arrangement plan and stability booklet. These data were fed into the E4 calculation software at our institute. A computational model for the relevant theoretical questions relating to the ship was generated from that. The following figure shows the computational model of the MV ROSEBURG generated from the documents submitted:

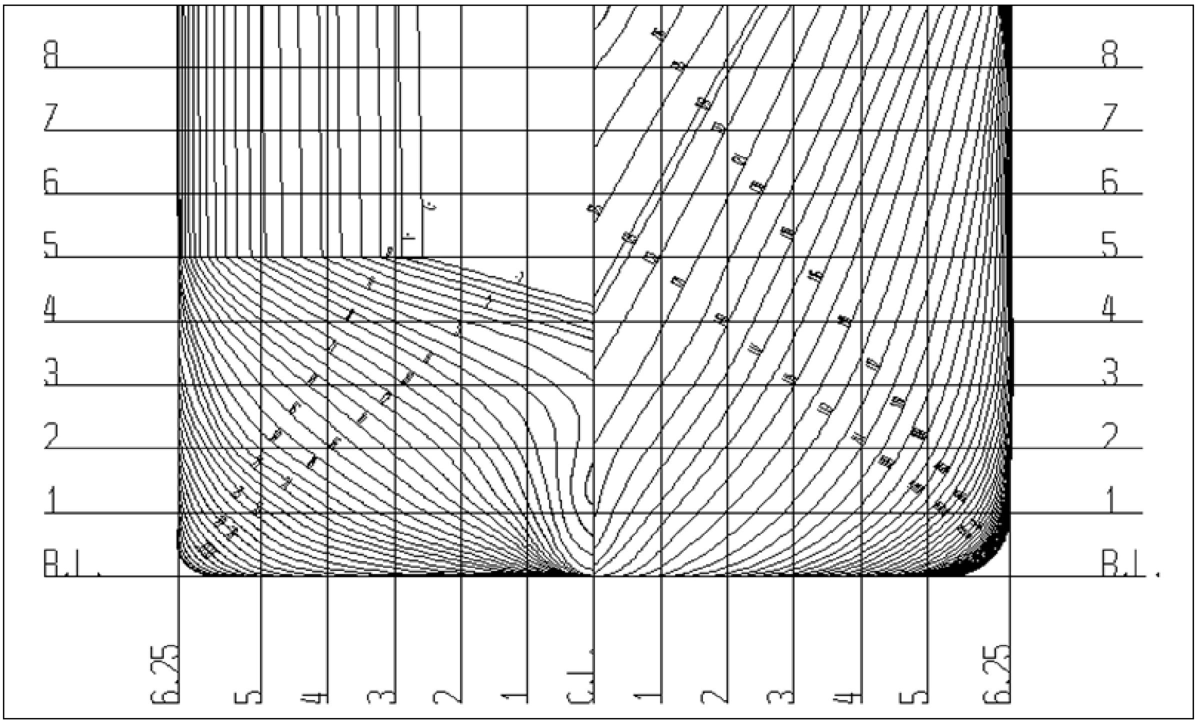

Figure 15: MV ROSEBURG's framing plan after conversion

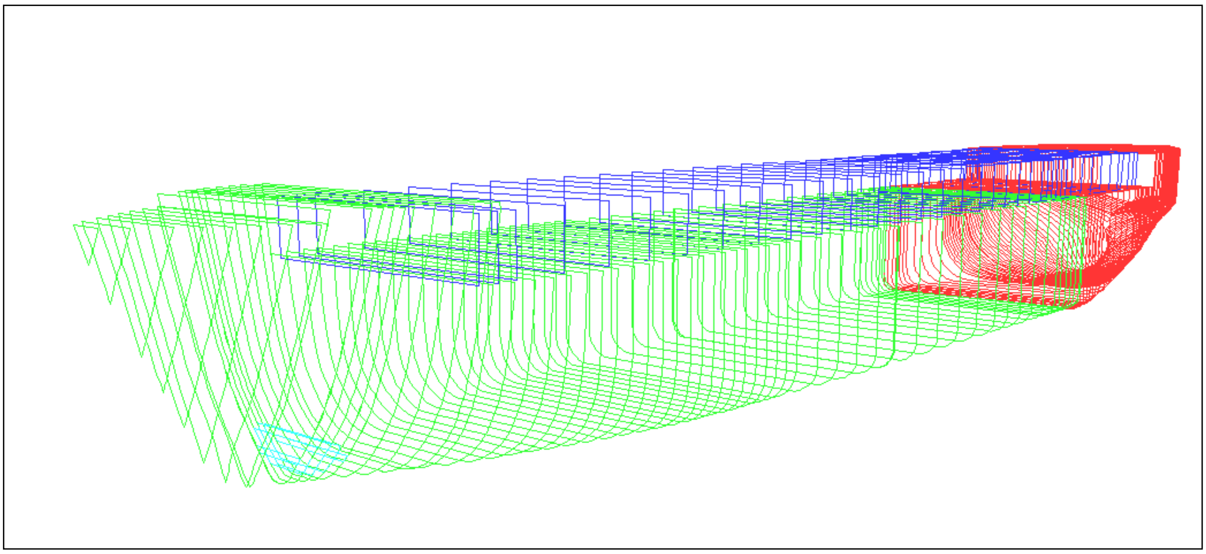

Figure 16: Computational model of the MV ROSEBURG

The computational model consists of the fore and aft section geometry up to a height of 8.8 m (height of hatch cover); the sheer strake does not contribute to buoyancy. The deckhouse is not taken into account because this only meets the water at a heeling angle of more than 45°, meaning it is not relevant to the investigation.

3.2.5.2 Reference load case from the stability booklet

For purposes of control, we reproduced a load case from the stability booklet (Timber length packages Departure) to make a comparison between the calculated and given hydrostatic parameters and centres of gravity. Here, we arrive at almost identical values for the equilibrium position. Specifically, the following was shown for the discussed load case according to our calculations and the stability booklet:

MV ROSEBURG's 'Timber length packages Departure'.

	TUHH	*Stability booklet*
Displacement	*4,037.000 t*	*4,037.070 t*
Draught at the aft perpendicular	*4.923 m*	*4.928 m*
Draught at the forward perpendicular	*4.949 m*	*4.950 m*
LCG of AP	*39.742 m*	*39.739 m*
VCG & base	*4.922 m*	*4.931 m*
GM	*0.449 m*	*0.454 m*
GG'	*0.030 m*	*0.038 m*

Figure 17: Comparison of the hydrostatic parameters for the load case

The values are practically the same. Therefore, it must be assumed that our model reflects the conditions correctly.

3.2.5.3 Load case on departure from Riga

A shipboard computer printout of the MV ROSEBURG's load condition when she left the port at Riga (Figure 18) is on hand. The surveyor on board seized this.

M.v. "Roseburg" trim and stability

VOY № 39/13 from: Riga to. Barrow have CARGO: Sawn timber in packages
DEPARTURE 02.11.2013 b 2232 mts
dockwarter= 1 2440 packs - 3068,827,00 cbm

Designation		Volumne		Weight	LCG	P*LCG	VCG	P*VCG	B*gam	status
Light ship				1032,880	35,87	37049,4	4,95	5112,6		
Balast water		gamma =	1,000							
No.1 F.P	0,089	64,27	0,09	0,09	75,30	6,7	4,25	0,4	38,0	1
No.2 Deeptank	0,91	76,33	0,91	0,91	71,93	65,5	3,65	3,3	75,0	1
No.27 DB. Tank 1 s	2,892	68,26	68,26	68,26	64,35	4392,5	0,54	36,9	0,0	1
No.28 DB. Tank 1 p	2,892	68,26	68,26	68,26	64,35	4392,5	0,54	36,9	0,0	1
No.29 DB Tank 2 s	3,687	76,97	76,97	76,97	46,30	3563,7	0,46	35,4	0,0	1
No.30 DB Tank 2 p	3,687	76,97	76,97	76,97	46,30	3563,7	0,46	35,4	0,0	1
No.31 DB Tank 2 c	4,266	76,80	76,80	76,80	46,30	3555,8	0,45	34,6	0,0	1
No.32 DB Tank 3 s	2,833	67,61	67,61	67,61	25,44	1720,0	0,47	31,8	0,0	1
No.33 DB Tank 3 p	2,833	67,61	67,61	67,61	25,44	1720,0	0,47	31,8	120,0	1
No.35 DB Tank 4 c	2,620	51,72	51,72	51,72	20,00	1034,4	0,46	23,8	76,0	1
No.51 Lower Wing 1 s	1,299	100,67	1,30	1,30	56,36	73,2	3,40	4,4	76,0	1
No.52 Lower Wing 1 p	1,299	100,67	1,30	1,30	56,36	73,2	3,40	4,4	26,0	1
No.55 Lower Wing 3 s	1,241	99,57	1,24	1,24	24,65	30,6	3,41	4,2	26,0	1
No.56 Lower Wing 3 p	1,241	99,57	1,24	1,24	24,65	30,6	3,41	4,2	56,0	1
No82 AP	0,052	11,63	0,05	0,05	-0,47	0,0	4,80	0,2	56,0	1
No83 Tunnel tank	3,047	26,63	3,05	3,05	2,72	8,3	3,77	11,5	264,0	1
Total		1133,54		563,38	43,01	24231	0,53	299	813,0	

KG' = 4,55
KG = 4,33
LCG= 39,28
LCB= 39,56
IB gama= 877,00
GG' = 0,22
KM = 5,42
MCT= 5404,00
Trimm= -0,28
trimm A 0,00
trimm F 0,00
Mw = -1499,35
Tsumm 4,95 SW
Tm = 4,950
LCF= 37,40
GM = 1,09
GM' = 0,87
Fore = 4,90
Aft = 5,00

Fuel Oil* cbm gamma = 0,836

No. 6 Fuel oil Fo'csle	1,39	1,1	1,00	74,55	74,6	7,05	5,5	0,0	0
No.53 st. Lower Wingtank	49,04	5,0	18,00	40,45	728,1	3,34	60,1	22,0	1
No.54 p. Lower Wingtank	49,04	5,0	17,00	40,45	687,7	3,34	56,8	22,0	1
No.77 Wingtank E.R. aft	31,14	0,0	0,00	6,64	0,0	4,15	0,0	8,0	1
No.78 Wingtank E.R. aft	31,14	2,5	4,50	6,64	29,9	4,15	18,7	2,0	1
No.79 Wingtank E.R. fwd	5,87	2,0	4,00	11,83	47,3	3,97	15,9	6,0	1
Gas oil total	167,6		44,50		1567,5		154,8	60,0	

Lub.oil gamma = 0,890

No.80 ME oil tank	5,9	0,500	1,23	9,31	11,5	2,43	3,0		
No.81 Dirty oil tank	5,8	0,500	0,45						
No.85 Oil tank aux.eng.	1,6	0,200	0,18						
Fresh Water	gamma =	1,000							
No.34 DB Tank 4 c	27,1	27,0	16,00	13,75	220,0	3,73	59,7	4,0	1
Const.		29,0	29,00	10,00	290,0	6,30	182,7		
Total FW/stors			46,85		510,0		242,4	4,0	

CARGO		sf	0,66 t/m3	weight	LCG	Mx	VCG	Mz	GRAND TOTAL
				0,0		0,0		0,0	
GenCargo	Deck	0,000		0,0	30,00	0	9,00	0	
GenCargo	Hold	2151,000		0,0	30,00	0	3,00	0	
TOTAL		**2232 Tons**		**2232,00**		**90642**		**11149**	**Disp 3920,8 4018,9**

154011,1 Mx
16960,69 Mz

	cbm	cbft								
Deck	609,976	0,000	0,000	0,0	0,00	0	0,00	0		
		0,000	0,000	0,0	39,60	0	10,80	0		
		0,000	0,000	87,0	31,00	2697	9,80	853		
Hold	2458,981	42557	2151,000	2145,0	41,00	87945	4,80	10296		
		160378								

IMO stability request

phi		10*	20*	30*	40*	50*	60*			
sin phi		0,174	0,342	0,500	0,642	0,766	0,866			
Cross curve	kn	0,941	1,857	2,687	3,532	4,196	4,530			
KG*sin phi		0,792	1,556	2,275	2,921	3,485	3,940			
h=hk-KGsinphi		0,149	0,301	0,412	0,61	0,711	0,590			
summ h		0,149	0,600	1,314	2,337	3,659	4,960			
0,0873xsum h		0,013	0,052	0,115	0,204	0,319	0,433			

1.GM> 0,3 ok!
2.hmax> 0,2 ok!
3.phi.ma 30 ok!
4.phi.ran 60 ok!

ALL IS CORRECT!

** - storage on arrival to discharging port*

Figure 18: Excerpt from the shipboard computer when the MV ROSEBURG departed

The ship has a deadweight of 2,886 t on the shipboard computer's load case. This is below the permissible deadweight of 3,005 t. The associated righting lever arm curve is shown in Figure 19. The ship has adequate stability in this condition. Applicable intact stability criteria are complied with. According to the data on the shipboard computer and our own calculations, the draughts during the approach stood at 5.00 *m aft and 4.90 m fore. Therefore, the mean draught was 4.95 m. Accordingly, the ship was just short of being overloaded because the maximum permissible draught would have been 4,953 m.*

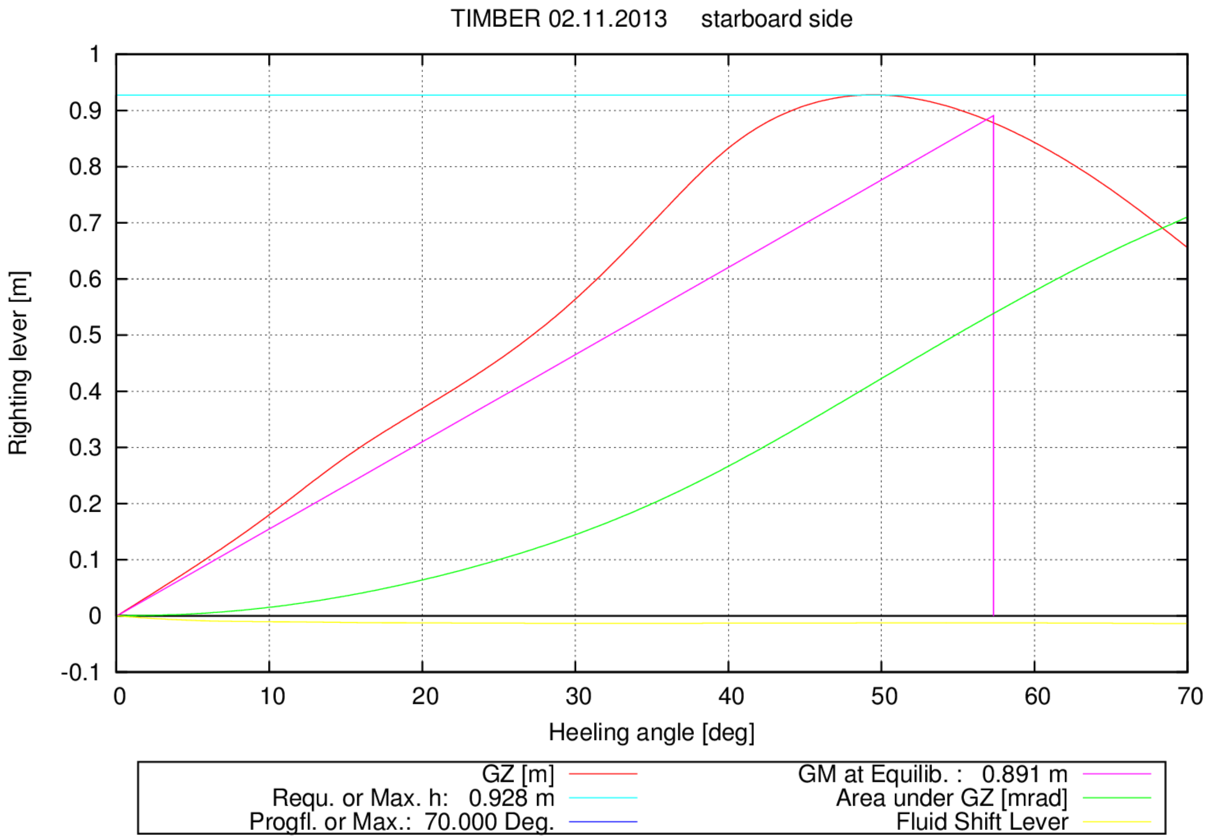

Figure 19: Righting lever arm curve for the condition on departure from Riga

*It is conspicuous from the shipboard computer's data that the deck cargo is only specified with volume but not weight or centre of gravity. Moreover, the documents indicate that the deck cargo is included in the weight specified for the **cargo hold**. However, the corresponding **centre of gravity** was **not adjusted for the deck cargo**. The timber load's centre of gravity is quoted at 4.8 m in the load case. This cannot be correct because deck cargo was also stowed on the hatches. Therefore, the centre of gravity indicated for the cargo in the departure load case is definitely wrong.*

Consequently, we made a new calculation with a revised centre of gravity for the timber cargo. Here, 1,845 t was first placed in the cargo hold and 300 t on deck. This reduces the ship's initial stability from 0.891 m to 0.412 m (see Figure 20 and Figure 21). According to our calculations, the ship still complies with the applicable intact stability criteria under these conditions (see Fig. 21).

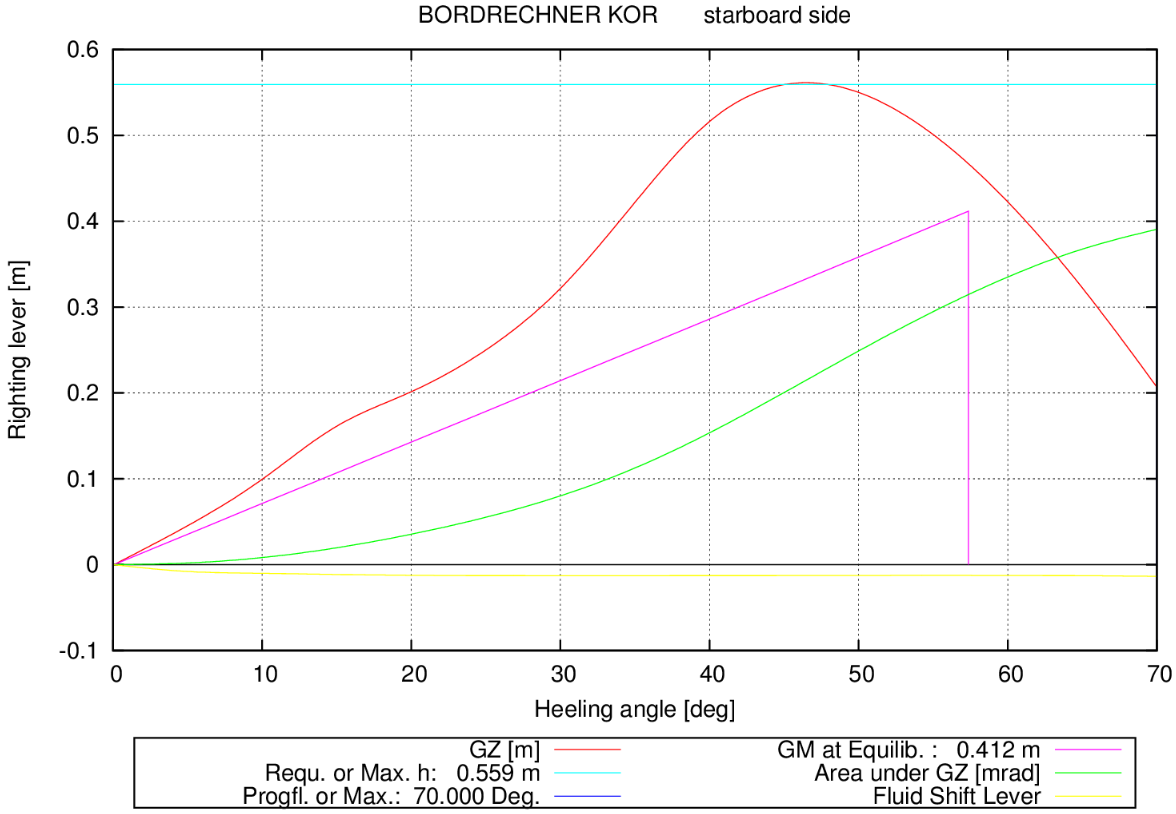

Figure 20: Righting lever arm curve for the condition on departure from Riga according to the shipboard computer's data on 2 November 2013 with the centre of gravity corrected for the deck cargo

3.2.5.4 Load case at the end of the voyage according to the owner

*Following a corresponding request, the owner prepared an additional load condition (Figure 22), which was supposed to correspond with the load condition on **arrival** at the Bay of Kiel. We have also examined this load case. It was not seized by the surveyor on board but produced by the owner later.*

It follows that the specified gross weight of the timber cargo of 2,555 t in this load case from the owner is 323 t greater than the data from the shipboard computer (2,232 t). The data on the centres of gravity are meaningful here and correspond with the figures of the reference load case from the stability booklet. This indicates that when the ship started her voyage she would have proceeded with a deck cargo of about 323 t more than the load computer printout.

It is apparent that another difference to the shipboard computer's load case is that the amount of ballast water is now only 250 t instead of 563 t previously. The difference in ballast water is missing in the double bottom tanks. The draughts in this load case are 5.18 m aft and 4.90 m fore. The mean draught is then 5.04 m. Technically, this means the ship would have been just overloaded.

However, the additional deck cargo and omission of ballast water have a serious impact on the stability, as shown in Fig. 21.

The applicable intact stability criteria are clearly no longer met for the ship at this load condition.

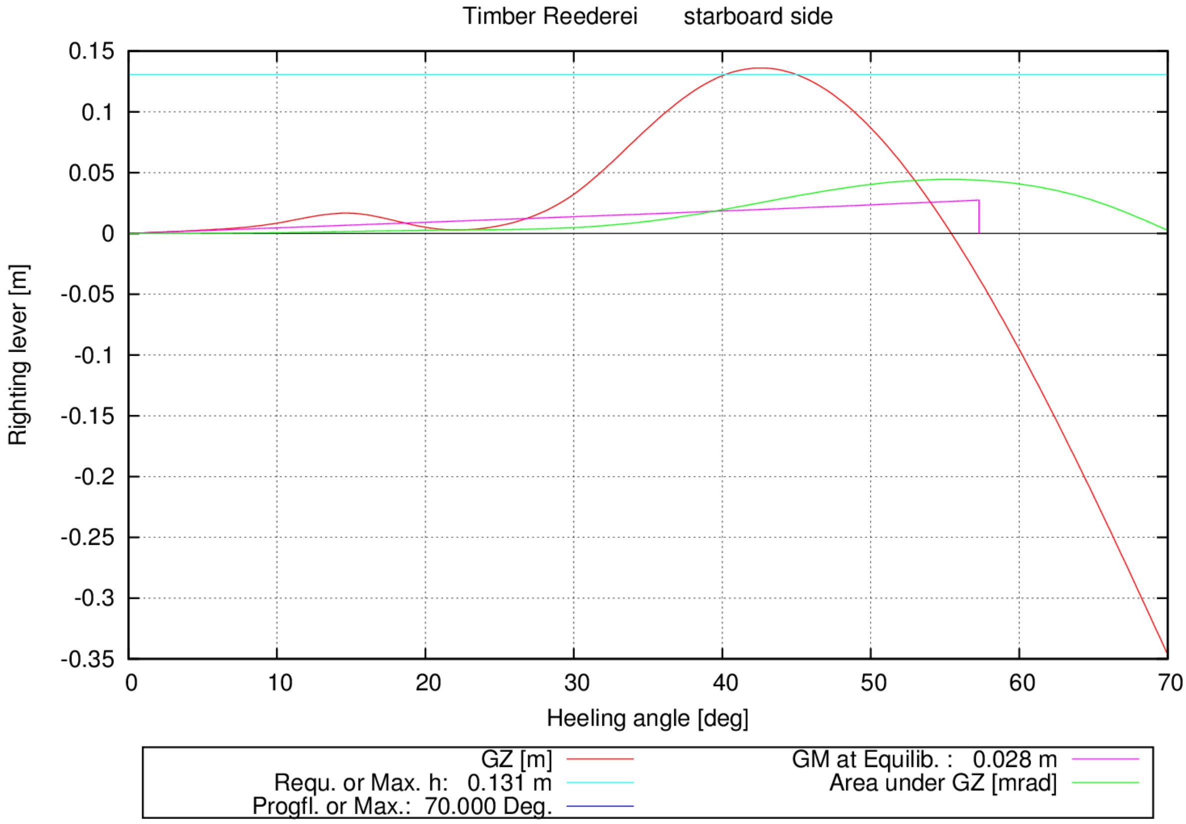

Figure 21: Righting lever arm curve for MV ROSEBURG's load case from Riga to Barrow Haven according to information given by the owner

It is now highly likely that the stability condition as shown in Figure 21 led to the observed course of the accident: the ship just has a positive initial stability but only very low heeling moments lead to the first local maximum being exceeded, causing the onset of an equilibrium position of about 20°. If the deck cargo then starts to slide or goes overboard, then the ship would incline further. When a sufficient amount of deck cargo has gone overboard, the ship becomes more stable, partly rights herself again, and finally remains in an inclined position.

Therefore, due to the course of the accident, we take it as given that the ship must have had a stability condition that roughly corresponded with the condition specified by the owner. Otherwise, the course of the accident is not technically feasible. That also becomes clear from the remainder of the investigation.

It remains unclear why it was not noticed that the stability was definitely insufficient in the stability assessment of this condition by the owner.

m/v ROSEBURG *Voyage 39/13*

Расчёт статической остойчивости

Voyage: Riga - Barrow haven - Gunness 02.11.13

Cargo: Sawn Timber + Cable reels - 2555,957 mt, 3068,827 m3 *Dfore= 4,9 m* *Daft= 5,18 m*

Item	Weight,t(P)	LCG,m	VCG,m	P*LCG,t/m	P*VCG,t/m	FSM tm
Light ship	1032,88	35,87	4,97	37049,406	5133,414	
Crew and stores	5,00	5,00	5,50	25,000	27,500	
Constant	113,00	35,87	4,97	4053,310	561,610	
Fresh Water Tank						
34DBTank 3 Centr	21,00	31,35	0,38	658,350	7,980	33,16
M.D.O. Tanks(0,85 t/cbm)						
6 Fuel Oil tank Forecs.	0,00	74,55	7,05	0,000	0,000	
53 Lower Wingtank s/s	20,95	40,45	2,27	847,428	47,557	0,42
54 Lower Wingtank p/s	20,95	40,45	2,27	847,428	47,557	0,42
77 Settl E.R.aft p/s	0,00	6,64	4,15	0,000	0,000	
78 Settl E.R.aft s/s	0,00	6,64	4,15	0,000	0,000	
79Daily E.R.fwd p/s	5,60	11,83	4,99	66,248	27,944	0,12
Total:	47,50			1761,104	123,058	
Miscellaneous(0,92t/cbm)						
76 DBtank E.R.sewage	5,00	10,34	0,12	51,700	0,600	21,06
80Wing ER fwd Luboil	1,67	12,19	0,12	20,357	0,200	2,14
81WingDirty oil tank p/s	0,00	12,03	1,91	0,000	0,000	
85Wing ER fwd Luboil	0,00	12,30	1,83	0,000	0,000	
Total:	6,67			72,057	0,800	
Ballast						
1 Fore peak	0,000	75,30	4,25	0,00	0,000	
2 Deep tank1	0,000	71,93	3,65	0,00	0,000	
27 DB tank1 s/s	0,000	64,35	0,54	0,00	0,000	
28 DB tank1 p/s	0,000	64,35	0,54	0,00	0,000	
29 DB tank2 s/s	0,000	46,30	0,46	0,00	0,000	
30 DB tank2 p/s	0,000	46,30	0,46	0,00	0,000	
31 DB tank2 center	76,800	46,30	0,45	3555,84	34,560	113,63
32 DB tank3 s/s	67,710	25,44	0,47	1722,54	31,824	119,98
33 DB tank3 p/s	67,710	25,44	0,47	1722,54	31,824	119,98
35 DB tank4 center	0,000	20,00	0,46	0,00	0,000	0,00
51 Lower Wingtank s/s	0,000	56,36	3,40	0,00	0,000	
52 Lower Wingtank p/s	0,000	56,36	3,40	0,00	0,000	
55 Lower Wingtank s/s	0,000	24,65	1,74	0,00	0,000	
56 Lower Wingtank p/s	0,000	24,65	1,74	0,00	0,000	
82 Afterpeak	11,630	-0,47	4,80	-5,47	55,824	53,48
83 Tunneltank	26,630	2,72	3,77	72,43	100,395	18,51
Total:	250,480			7067,88	254,427	
TOTAL SHIP:	1476,53			50687,11	6108,789	
Cargo holds						
Hold	1959,401	41,71	4,85	81726,62	9503,095	
Hatchcover	348,556	41,75	10,27	14552,21	3579,670	
	248,000	41,75	9,77	10354,00	2422,960	
				0,00	0,000	
Cargo:	2555,957			106632,83	15505,725	
Displacement	4032,49	39,013	5,360	157319,94	21614,514	482,90
GG' correction	0,12					

Chief mate:

Master

Figure 22: Owner's printout of the MV ROSEBURG's load condition

3.2.5.5 *The deck cargo on the MV ROSEBURG*

Due to the inconsistencies concerning the timber cargo between the shipboard computer's data and that of the owner, application of the load plan is of crucial importance for the load condition of the ship. The load plan is shown in Figure 23. It may first be noted that a comparison of the load plan documents and data from the shipboard computer reveals no deviation between each other. The deck cargo is also already included in the data for the cargo in the hold here. As previously stated, this caused an incorrect centre of gravity to be considered when the ship departed.

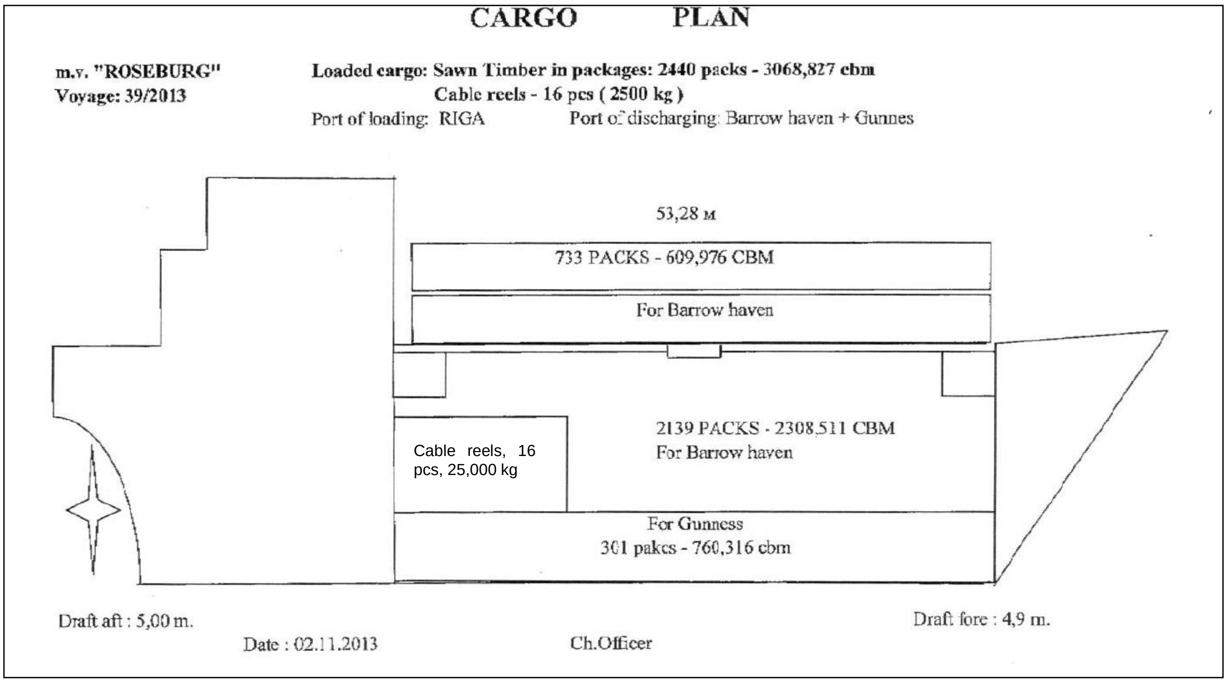

Figure 23: MV ROSEBURG's load plan during the voyage from Riga to Barrow Haven

Documentation from the BSU shows that the waterway police stated the cargo loss was about 700 packages of timber. No more than 75% of the cargo went overboard according to witness statements, however. It follows that the calculated minimum number of packages of timber carried on the deck would be at least 933. According to the load plan, it was only 733 packages, however. Furthermore, Sartori & Berger (the agency responsible) stated that timber weighing some 750-800 t was recovered from the water. Taking into account the fact that the timber recovered was saturated with water and thus about 1.7 times heavier than dry timber, the resulting loss of cargo is 440-470 t. If we now assume that the weight of the lost deck cargo is approximately 75%, the total deck cargo amounts to 587-626 t. The scale of these values corresponds with the weight of the deck load specified in the owner's load case (596 t).

The load plan (Figure 23) indicates a timber volume of 609 cbm on the deck. This corresponds to a weight of about 300 t.

From that and the above deliberations, it immediately follows that the load case printout from the shipboard computer cannot have taken the entire load of timber into account, as about 300 t, which the ship must have additionally carried on deck, is missing.

*This now means that the ship must have been **overloaded** when she started her voyage if the amount of ballast water additionally specified would have been taken on. For the ship was still just overloaded when entering the Kieler Förde even with partly drained ballast water tanks. It is quite unlikely that the ship actually set sail with a stability condition corresponding to Figure 22, otherwise a stability-related accident would have occurred much earlier.*

We will review this assumption below and also compile the most probable load case when the ship departed and arrived. The load case on departure is adjusted by the missing deck cargo of 323 t below. The previously incorrectly specified centre of gravity of the deck cargo originally recorded is also corrected. The specified ballasting is applied without any changes.

3.2.5.6 Most likely load condition on departure from Riga

The above deliberations indicate that the deck cargo was specified incorrectly both in terms of centre of gravity and weight. Therefore, the load case that corresponds to the shipboard computer printout is corrected according to the preceding investigations. This load case is then considered the most likely load condition on departure from Riga.
The corrections include the right centre of gravity for the volume of timber on deck and the missing weight. As an estimate, an additional deck load of 320 t will be applied. This value arises from the difference between the owner's timber cargo data and that of the shipboard computer. Moreover, it was previously calculated that it was approximately the weight of the lost timber cargo that was missing from the shipboard computer's data. The associated centre of gravity is set at 10.27 m according to the value of the reference load case.
Taking into consideration this cargo, the resulting deadweight is now 3,206 t. This means that the permissible deadweight of the ROSEBURG of 3,005 t was exceeded by 201 t in this load condition. Based on these factors, the ship was overloaded. The draughts would then be 5.524 m aft and 4.985 m forward, resulting in a mean draught of 5.255 m. The maximum permissible draught is only 4.953 m, however.
The associated righting lever arm curve is shown in Figure 24. In this condition, the applicable intact stability criteria are not complied with.
The following criteria are not complied with:

- *the lever at 30° is 0.18 m instead of 0.20 m;*
- *the area up to 30° is only 43 mm rad instead of 55 mm rad, and*
- *the area up to 40° is only 85 mm rad instead of 90 mm rad.*

*Consequently, the ship **would not have been permitted to start** the voyage for reasons of stability.*

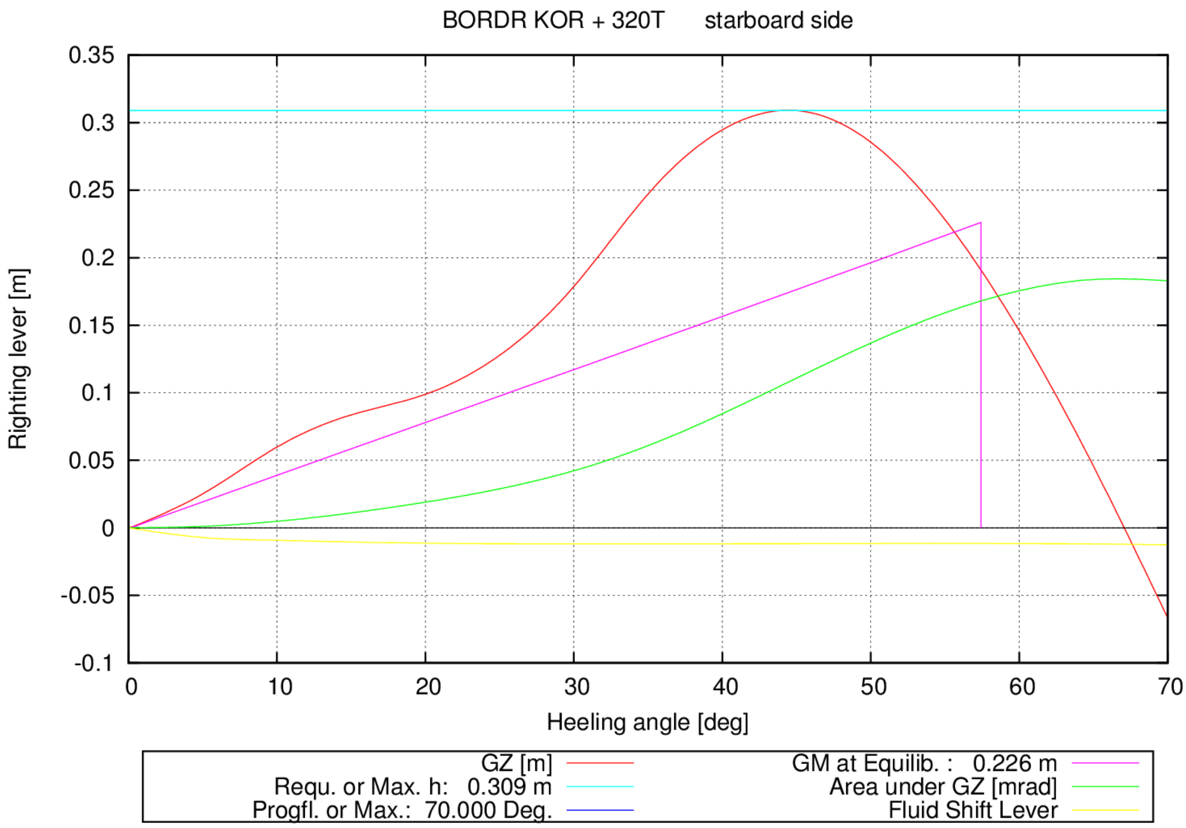

Figure 24: Righting lever arm curve for the condition on departure from Riga according to our calculations

According to the load case of the stability booklet (Timber length packages Departure) to be applied for comparison, the ship would have to be loaded as follows to comply with all the stability limits and at the same time not exceed the maximum draught:

Name	***$M_{Stability\ booklet}$ [t]***	***$M_{Load\ case}$ [t]***	***$ZG_{Stability\ booklet}$ [m]***	***$ZG_{Load\ case}$ [m]***
Timber in cargo hold	*1,694*	*1,952*	*4.8*	*4.8*
Timber in deck cargo	*532*	*600*	*10.46*	*10.69*
Ballast water	*564*	*563*	*0.49*	*0.49*
Gross weight	*4,037*	*4,240*	*4.93*	*5.03*

It can be seen from the above list that the ship had more displacement in the condition on departure when the centre of gravity is 10 cm higher.

Using dynamic calculations, the roll behaviour is now checked for whether

- *the accident could have happened with the stability condition determined by us;*
- *the ship was able to reach Kieler Förde from Riga with the load case presumed most probable without a loss of cargo or other stability impairments occurring.*

3.2.5.7 Dynamic analysis of the rolling motion at the time of the accident

Using a dynamic calculation of the rolling motion at the time of the accident, we have now reviewed whether the stability condition determined by us for the time of the accident could also lead to the course of the accident observed. To achieve this, we created a computational model for sea state calculations and allowed the ship to roll freely in calm water after applying a defined heeling moment. Fig. 25 once again shows the righting lever arm curve calculated by us in the presumed accident condition (the same as Fig. 21).

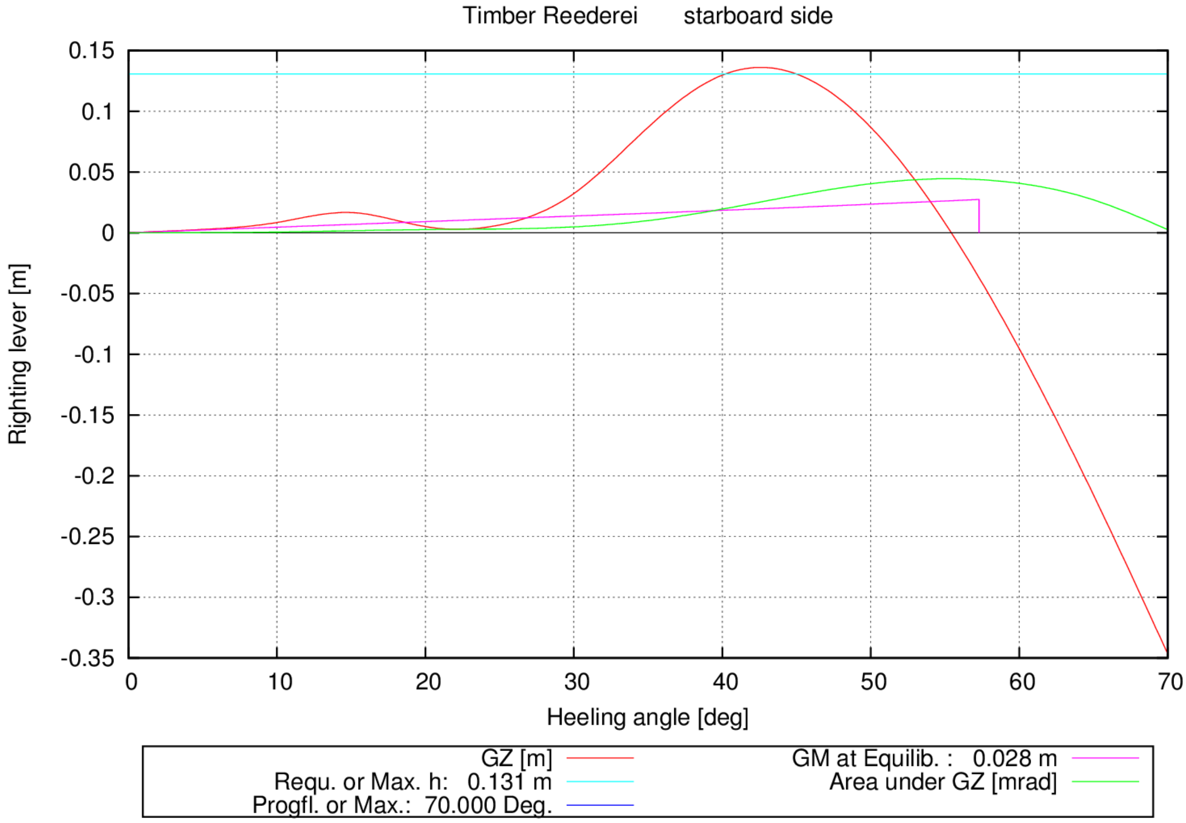

Figure 25: Righting lever arm curve for the probable accident condition

This shows that the ship has reached a limit in terms of stability. If there are no heeling moments, then the ship will be able to maintain an upright position. Minor heeling moments initially cause the ship to roll close to an upright position. Here, there is a maximum heeling moment when the ship rolls beyond the initially existing positive stability and then assumes a position of equilibrium at about 25°. In application of this stability condition, we determined this maximum moment by applying a heeling moment starting from the upright position. We then calculated the ship's rolling motion thus. The result is the maximum roll angle, the static end position, and the resulting maximum acceleration during the rolling motion.

We applied the heeling moment such that we have shifted the ship's centre of gravity transversally by dycg. The results are summarised in the following table:

dycg [mm]	***M_{kr} [mt]***	***Φ_{max} [deg]***	***Φ_{stat} [deg]***	***A_y [m/s²]***
1	*4*	*9.5*	*3.8*	*1.6*
2	*8*	*10.7*	*5.1*	*1.8*
3	*12*	*12.1*	*5.9*	*2.0*
4	*16*	*13.6*	*6.6*	*2.2*
5	*20*	*15.4*	*7*	*2.5*
6	*24*	*19.0*	*7.8*	*3.2*
7	***28***	***28.2***	***8.4***	***4.5***
8	*32*	*29.5*	*9*	*5.0*
9	*36*	*30.4*	*9.8*	*5.1*
10	***40***	***31.1***	***25.5***	***5.3***
11	*44*	*31.8*	*25.8*	*5.5*

The results confirm our earlier assumptions.
When low heeling moments are applied, the ship first rolls gently and the accelerations are still moderate. At a heeling moment of 28 mt (7 mm lateral shift in the centre of gravity), the ship rolls heavily because the first level of positive stability is passed. The ship then rolls back again and assumes a position of equilibrium of 8.4°, provided the cargo did not slide. Here, an acceleration of 4.5 m/s² occurs. At a heeling moment of 40 mt (equivalent to a 10 mm shift in the centre of gravity), the ship remains static at 25°. The acceleration then only increases moderately because the heeling angle reached while rolling is not much higher than before. If we assume that the cargo is lashed down properly, then the roll acceleration occurring at the presumed heeling moment of 28 mt would roughly correspond to the load assumptions for the lashing. Of course, it is also conceivable that the lashing failed earlier. The heeling moment to be applied would then be lower. If we start at the observations (a static list of 10-15° is mentioned in the witness statements), then a static initial moment of 20 mt would also have been enough to cause the accident if the lashing failed at an acceleration of 2.5 m/s². If the lashing fails, then instead of righting herself again as shown in our calculations, the ship inclines further.

The calculations clearly show that at the presumed stability condition the accident would definitely have unfolded in exactly the manner observed if a heeling moment of more than 28 mt had acted on the ship. We will continue by showing it is highly probable that such a moment actually occurred at the time of the accident.

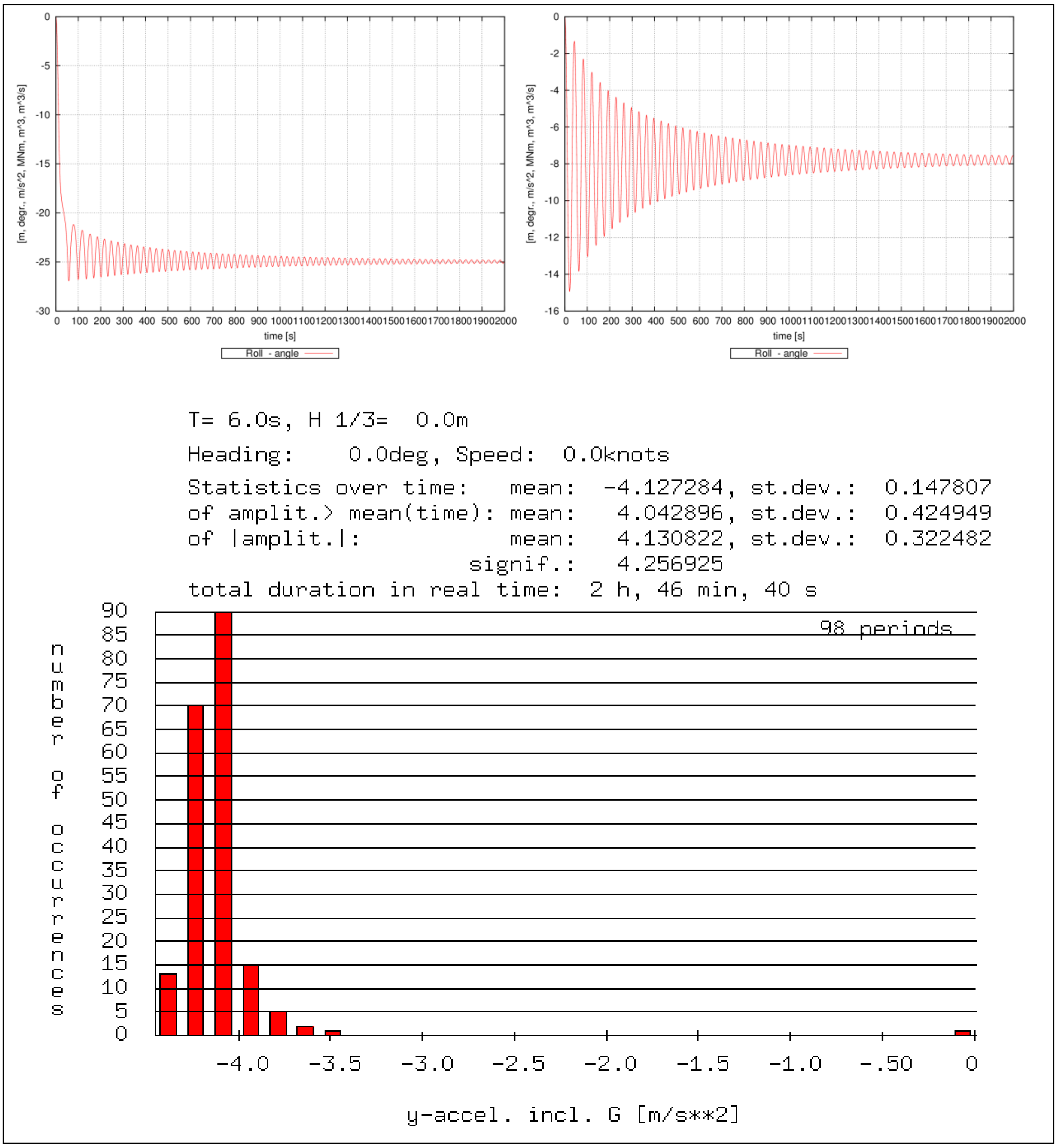

Figure 26: Calculated chronological sequence of the roll angle for a heeling moment of 28 mt (top left) and 24 mt (top right), as well as histogram showing the transverse accelerations for a heeling moment of 28 mt

All the information about the sea and weather conditions is taken from the weather report for Kieler Förde from the DWD, which was commissioned by the BSU and is based on measurements and observations from the surrounding stations at Kiel Lighthouse, Brodersby, Hohwacht and Fehmarn. Ship reports and analyses of satellite images and rawinsondes were also taken into account.

At the time of the accident, the significant wave height is specified at 0.5 m and the wind force at 4-5 Bft from the south-south-east with gusts of 6-7 Bft. A wave period is not indicated by the DWD.

To begin with, we want to calculate the wind moment on the ship, partly because the crew stated that the ship was hit by a gust. The fact that the lateral wind area of the ship is increased and her centre of gravity shifts further upwards because of the additional deck cargo complicates this. We have determined that the lateral wind area is 490 m²; its centre of gravity stands at 8.50 m above base if the ship had no deck cargo at all. With deck cargo in the accident condition, we obtain a lateral wind area of 600 m² with a centre of gravity of 9 m above base. Assuming the lateral centre of gravity underwater is at half draught, this results in a wind lever arm of 6.50 m.

It follows that the maximum moment of 28 mt is achieved solely by lateral wind pressure if the wind speed is 10.7 m/s. That would be the case at a wind force of just 5.5 Bft. The weather report of the DWD confirmed this. If we took into account the influence of the waves or other influences, then the necessary wind speed would be lower, of course.

This showed that – with properly lashed cargo – the accident could certainly occur in precisely this manner in the assumed stability condition and with the prevailing environmental conditions. Of course, the accident would have also occurred in this manner if the lashing failed earlier – but then at a lower wind speed.

However, these calculations also show that the ship would not have been able to carry out the voyage at the stability condition during the accident. This is because heeling moments, which would have led to a loss of cargo, would then have occurred during the course of the voyage.

Therefore, we have calculated the accelerations in natural swell for the probable stability condition of the ship on ***departure*** *determined by us. Assuming the cargo goes overboard in transverse acceleration of 4.5 m/s², then polar coordinate diagrams can be calculated for the necessary significant wave heights. Such a polar diagram is shown as an example of the significant periods of 7.5 s and 8.5 s in Fig. 27. Here, the sea state is generated by a JONSWAP spectrum[7].*

[7] JONSWAP spectrum: JOint North Sea WAve Project spectrum – the name of the research project in which that was developed.

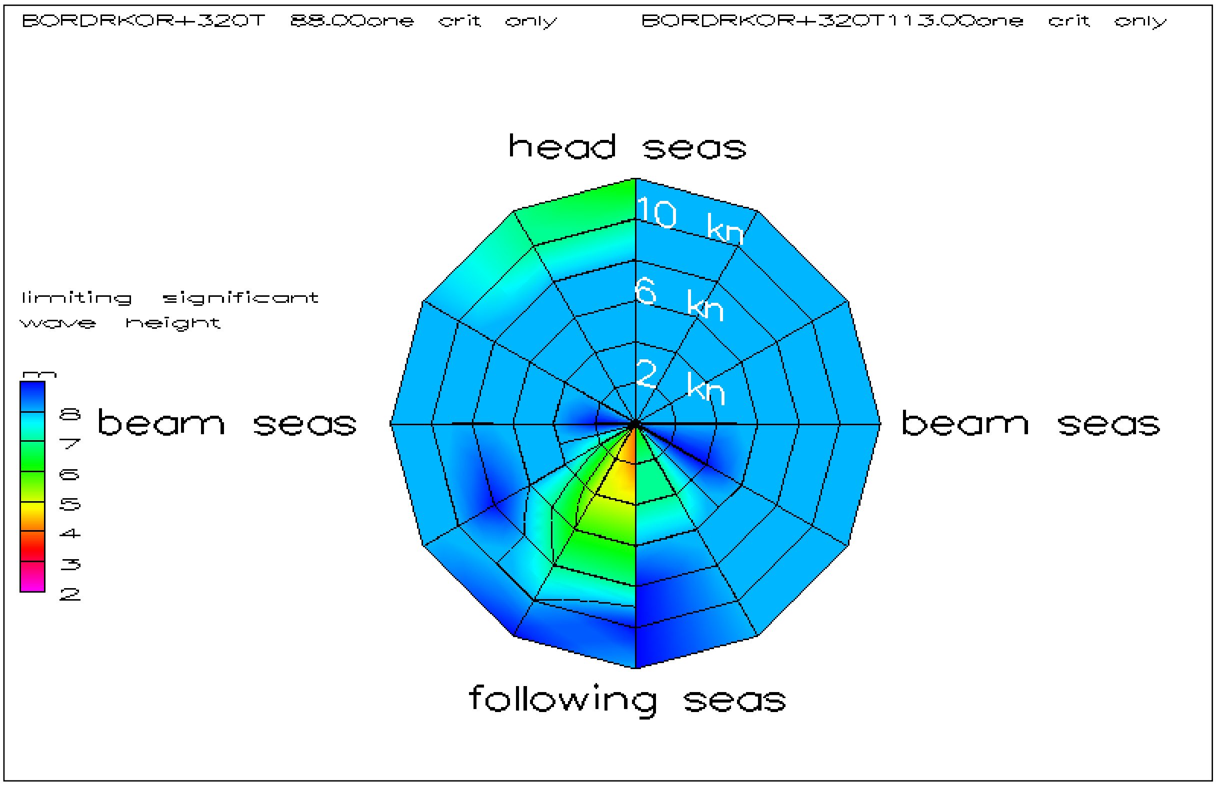

Figure 27: Polar coordinate diagram showing the significant wave heights necessary for reaching a transverse acceleration of 4.5 m/s² at significant periods of 7.5 s (left) and 8.5 s (right).

It can be seen that significant wave heights of at least 5 m would have had to occur to cause a loss of cargo. However, it is highly unlikely that these occurred during the voyage. This shows that the ship must have started the voyage with ballast water, as the ship would never have reached the Bay of Kiel without losing cargo in the accident condition.

However, in this context we point once again to the fact that according to our calculations the ship was probably overloaded in her condition on departure. Moreover, she would also not have reached the internationally required minimum values for stability.

4 ANALYSIS

The calculations have shown that the MV ROSEBURG left the port of Riga on the evening of 2 November with enough stability for the voyage to be made to within the Bay of Kiel without incident. That is indicated by the analysis of the submitted load cases, even though there are inconsistencies in their documentation. A passage to the Bay of Kiel was possible at the load case calculated for when the ship departed because even though the applicable intact stability criteria were not met on departure, the associated righting lever arm curve ensured sufficient floating stability under the circumstances. The accident was the result of the ship being overloaded with deck cargo, meaning stability could only be established if ballast water was taken on. However, that resulted in the permissible draught being exceeded when the ship departed.

Based on the calculations, it is highly likely that the course of the accident is as follows:

- the deck cargo was too heavy by about 300 t when the ship left the port of Riga. To ensure the stability of the ship, ballast water was taken on board in accordance with the requirements in the stability booklet. However, it is highly probable that the permissible draught was exceeded on departure because of that;

- in spite of falling below the required stability values, no heeling angles or lateral accelerations that would have led to a (partial) loss of cargo occurred during the voyage to Kiel;

- ballast water was drained on arrival at the Bay of Kiel because it would have been evident that the maximum permissible draught was exceeded when entering Kiel Canal;

- the ship's stability with drained ballast water tanks was now so severely diminished that the initial stability just barely existed;

- at the reduced stability, a low heeling moment of 28 mt instantaneously led to a heeling angle of 28° or more;

- due to the weather conditions at the scene of the accident, this heeling moment of 28 mt could be applied simply by lateral wind pressure in a gust of 5.5 Bft;

- the lashing straps tore because of the heel. This was facilitated by straps that to a certain extent were incorrectly dimensioned and had improvised attachments. The ship heeled further to about 40° and lost a large part of the deck cargo in the process;

- due to the loss of deck cargo, the ship had sufficient stability again; she was heeling but stable.

5 CONCLUSIONS

Based on the calculations of the TUHH, the accident was clearly due to the ship having insufficient stability at the time of the accident. According to the prescribed limit values, the stability was most likely insufficient when the ship departed. However, the presumed existing stability was sufficient to approach Kieler Förde safely in the prevailing weather conditions.

The reason the stability of the ship was impaired was that the crew had taken so much deck cargo that a proper stability condition could only have been established by means of ballast water; however, this would have caused the ship to be overloaded. A great many indications point to the ship having a greater draught than would have been permissible on departure from Riga, as the crew must have taken on ballast water because otherwise the ship would not have reached the Bay of Kiel without losing cargo.

However, it would have been evident that the permissible draught was exceeded on entering the canal lock. It is reasonable to conclude that the crew tried to reduce the draught by draining ballast water to the extent that the ship was just short of being overloaded.
In the process, a stability condition was then reached that triggered the actual accident. At some point during the draining operation, a low heeling moment occurred because of wind pressure, which then triggered the accident. The accident was also facilitated by the fact that the additional deck cargo increased the lateral wind area and the heeling wind lever, and the ship was sailing in a semicircle during the anchor manoeuvre.
Had the ship met the applicable stability rules at the time of the accident even remotely, then it is almost certain that the accident would have been avoided. Therefore, incorrect implementation of the stability requirements for the ship by the crew caused the accident.

The BSU notes explicitly that crews must respect applicable stability rules.
That the ship would have encountered a situation during the passage that could have led to a far more serious hazard for ship and crew cannot be ruled out. Moreover, that the ship would have been lost if most of the deck cargo had not gone overboard cannot be ruled out, either. If the deck cargo had only shifted, then the ship would have remained at a list of more than 28° and there is no guarantee that the ship's watertight integrity would have ensured that she would then not continue to flood completely. The ship's stability condition in the accident situation was extremely dangerous in any case and comparable stability conditions have led to the loss of ships in the past. In principle, the stability of the ship could have reduced further during the voyage had the timber cargo on deck become saturated with water. Similar cases in the past have also resulted in serious stability-related accidents.

Once again, it must be concluded that a ship should not be permitted to set sail if she is overloaded and thus directly endangers her and her crew's safety.

The BSU would like to thank the ship's command, the ship's management, and the marine casualty investigation authority of Antigua & Barbuda for their excellent co-operation during the review of this incident. It means that this report will certainly contribute to the prevention of such incidents in the future.

6 SAFETY RECOMMENDATION(S)

The following safety recommendations do not constitute a presumption of blame or liability in respect of type, number or sequence.

6.1 Ship's management, Sirius Shipman Ltd.

The Federal Bureau of Maritime Casualty Investigation and ADOMS IID recommend that the ship's management, Sirius Shipman Ltd., urge its ship's commands to comply with the procedures defined by the ship's management and the ISM Code by not taking any risks.

6.2 Ship's command of the MV ROSEBURG – stability

The Federal Bureau of Maritime Casualty Investigation and ADOMS IID recommend that the ship's command of the MV ROSEBURG desist from taking risks and give absolute priority to the safety of the ship. This includes, in particular, sufficient ship stability.

6.3 Ship's command of the MV ROSEBURG – lashing

The Federal Bureau of Maritime Casualty Investigation and ADOMS IID recommend that the ship's command of the MV ROSEBURG desist from taking risks and give absolute priority to the safety of the ship. This includes secure cargo and a sufficiently intact lashing system in accordance with requirements.

7 SOURCES

- Enquiries by the waterway police (WSP)
- Written statements
  - Ship's command
  - Ship's management
- Witness accounts
- Nautical charts and ship particulars, Federal Maritime and Hydrographic Agency (BSH)
- Official weather report by Germany's National Meteorological Service (DWD)
- AIS and VHF recordings of the ship safety services/vessel traffic services
- Stability report on the accident involving the multi-purpose cargo ship MV ROSEBURG in the Bay of Kiel on 5 November 2013 prepared by Prof. Dr.-Ing. S. Krüger, director of the Institute of Ship Design and Ship Safety, and
  Adele Lübcke, M.Sc., research assistant at the Institute of Ship Design and Ship Safety