

MA2014-11

**MARINE ACCIDENT
INVESTIGATION REPORT**

November 27, 2014



The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board is to determine the causes of an accident and damage incidental to such an accident, thereby preventing future accidents and reducing damage. It is not the purpose of the investigation to apportion blame or liability.

Norihiro Goto
Chairman,
Japan Transport Safety Board

Note:

This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.

Marine Accident Investigation Report

November 6, 2014

Adopted by the Japan Transport Safety Board

Chairman Norihiro Goto

Member Kuniaki Shoji

Member Satoshi Kosuda

Member Toshiyuki Ishikawa

Member Mina Nemoto

Accident type	Foundering
Date and time	Around 12:38 (local time, UTC+9 hours) on April 30, 2013
Location	Shiomi Quay 4, Sakai Senboku-Ku, Hanshin Port Around 196° in true bearing, approximately 0.85 nautical miles (M) from Senboku Otsu East Breakwater Lighthouse, Izumiotsu City, Osaka Prefecture (approximately 34°30.67'N 135°22.95'E)
Summary of the accident	Cargo ship Favor Sailing, with a master and eight other crew members on board, which listed over and foundered at around 12:38 on April 30, 2013 while moored at Shiomi Quay 4, Sakai Senboku-Ku, Hanshin Port. There were no injuries to the crew.
Process and progress of the investigation	The Japan Transport Safety Board appointed an investigator-in-charge (from the Kobe Office) and an investigator to investigate this accident on April 28, 2013. The Board later appointed an additional investigator-in-charge and an additional investigator. April 28, 30 and October 16, 2013: On-site investigation April 30, May 1, June 21, and October 17: Interviews
Factual information Vessel type and name, Gross tonnage IMO number Owner Management company Classification society LxBxD, hull material Engine, output and date of launch	Cargo ship Favor Sailing (Kingdom of Cambodia) 1,479 tons 8622878 Favor Sailing Shipping (HK) Co., Ltd. (People's Republic of China) Happy Sailing International Ship Management Co., Ltd. (People's Republic of China) Union Bureau of Shipping (Kingdom of Cambodia) 73.51 m x 11.50 m x 7.10 m; steel Diesel engine; 883kW; April 3, 1984
Vessel information	Favor Sailing (hereinafter referred to as "the Vessel") was a 29-year-old cargo ship with an aft bridge. The Vessel was equipped with a forepeak tank and number 1 to number 4 ballast tanks from bow to the stern, and each ballast tank was divided into port and starboard sections by a center guarder (central watertight stringer in double-bottom space). A storeroom was located above the fore part of the number 1 ballast tank and a cargo hold was located above the aft part of number 1 ballast tank and other ballast tanks. The storeroom and cargo hold formed a contiguous space through an opening in the bulkhead. There were bilge wells with a length of approximately 110cm, width of approximately 125cm and depth of approximately 50cm in the four corners of bottom of the cargo hold, for collection of water in the cargo

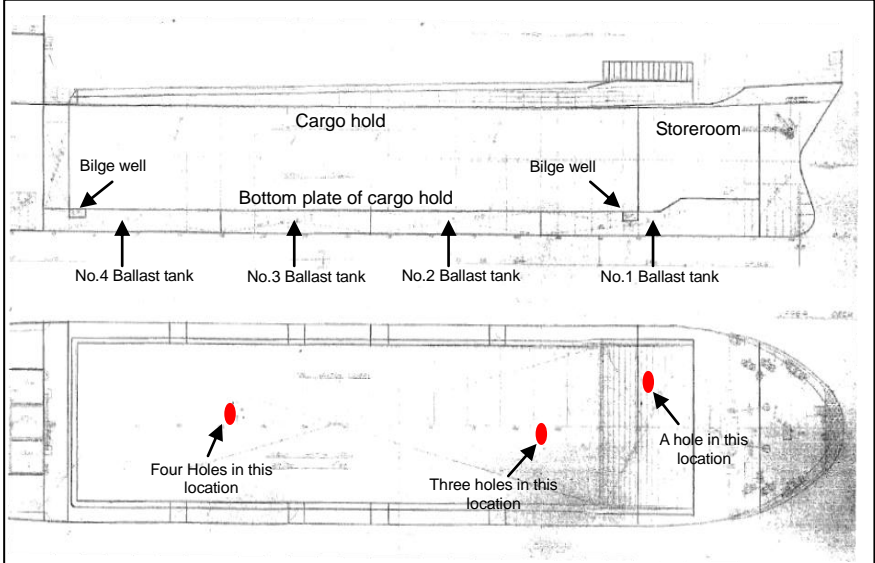
	<p>hold (hereinafter referred to as “bilge”). (See Figure 1)</p>  <p>Figure 1. Storeroom, cargo hold, and locations of holes on the bottom plate of storeroom and cargo hold confirmed after salvage of the Vessel</p>
Crew information	<p>Master (nationality: People’s Republic of China), male, 34 years old Documentary proof of application for an endorsement under STCW regulation I/10: Master (issued by the Kingdom of Cambodia) Date of issue: March 27, 2013 (valid until June 26, 2013) The master had shipped scrap about 60 times by other vessels before serving the Vessel, and joined the Vessel at a dock in Shidao, Shandong Province, China in March 2013.</p> <p>Chief officer (nationality: People’s Republic of China), male, 43 years old Endorsement attesting the recognition of certificate under STCW regulation I/10: Master (issued by the Kingdom of Cambodia) Date of issue: December 6, 2012 (valid until July 23, 2016) The chief officer joined the Vessel around November 2012.</p>
Injuries to persons	None
Damage to vessel	Total loss
Events leading to the accident	<p>The Vessel, manned by the master, chief officer and seven other crew members (all are citizens of the People’s Republic of China) moored the port side at Sukematsu Warf in Hanshin Port, Sakai Senboku-Ku to load nonferrous metal scrap (hereinafter referred to as “scrap”) at around 13:30 on April 26, 2013.</p> <p>As stevedores started to load lighter scrap at around 14:00, the chief officer instructed to load from heavier scrap because he thought if the lighter scrap was loaded first, it would cause the center of gravity of the Vessel to shift higher and would reduce stability. However, the stevedores continued loading of lighter scrap because it would damage the bottom plate of the cargo hold floor if they started loading from heavier scrap, and finished loading for the day at around 17:00. (See Photo 1 and Photo 2)</p>



Photo 1. Cargo hold before loading



Photo 2. After lighter scrap was loaded

The stevedores resumed loading at around 8:00 on the 27th, and at around 10:00, they put a hydraulic power shovel with a weight of approximately 23 tons in the cargo hold and continued loading compressing cargo volume by running the power shovel on the scrap. (See Photo 3)

After the stevedores left the Vessel for lunch break at around 11:00, the ship listed approximately 15° to port. Then, the master instructed the chief officer to correct the list of the hull by ballasting water into the ballast tanks on the starboard.

The chief officer ballasted seawater into the ballast tanks on the starboard and when the list of the hull reduced to approximately 8° to port at around 11:25, then the Vessel suddenly listed approximately 22° to starboard, stopped ballasting and started `transferring seawater of ballast tanks' (hereinafter referred to as "ballast operation") from starboard to port.

When the Vessel reached a list of approximately 2 to 3° to starboard at around 13:00, the stevedores returned from lunch break and unloaded hydraulic power shovel and completed loading at around 13:30.

The Vessel listed approximately 3° to 4° to port at that time and the chief officer continued ballast operation until the Vessel returned to upright position at around 13:50. (See Photo 4)



Photo 3. Scrap being compressed by a power shovel

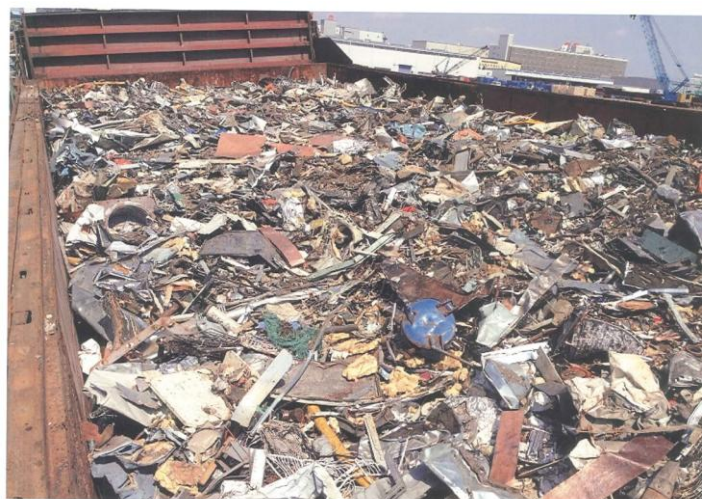


Photo 4. Cargo hold when loading was completed

When the first mooring line was released at around 19:10 for departure, the Vessel listed approximately 4° to 5° to port, and when the Vessel left the wharf at around 19:15, it listed approximately 12° to port.

The master thought there was a problem with the stability of the Vessel, let go the port anchor at approximately 306° in true bearing, approximately 1.6nm from the Senboku East Breakwater Lighthouse, at around 19:40, paid out five shackles of anchor chain and instructed the crew by microphone to correct the list.

The chief officer started ballast operation at around 20:00, and at around 22:00, when the Vessel's list reduced to approximately 8° to 9° to port, then the Vessel suddenly listed approximately 25° to starboard, and generator stopped, making the ballast pumps inoperable.

The master requested rescue to the Japan Coast Guard at around 22:50, and all crew evacuated to patrol boats from around 00:00 to around 03:00 on the 28th.

A towline from a tug boat was attached to the bow and another

towline from another tug boat was attached to the stern of the Vessel at around 08:30, and after the crew who returned to the Vessel cut off the anchor chain at around 10:40, the tug boats started to tow the Vessel towards No.4 Quay, Shiomi Wharf, Sakai Senboku-Ku, (hereinafter referred to as "Shiomi Quay") at around 12:30 and, when moored the Vessel's portside alongside the Shiomi Quay at around 14:00, the Vessel listed approximately 28° to starboard. (See Photo 5 and Photo 6)



Photo 5. The Vessel under towing



Photo 6. The Vessel arriving at Shiomi Quay

The chief officer, after mooring, requested the Vessel's agent to arrange a shore based power source, and started ballast operation at around 16:00 using a mobile power generator.

The boatswain's measured at around 17:00, the depths of bilge at both sides of aft part of the cargo hold were approximately 49cm at the port side and approximately 160cm at the starboard side, however, the chief officer could not find out what caused bilge to come into the cargo hold as much as it overflowed from the bilge wells.

The chief officer tried to pump out the bilge from the cargo hold through the bilge suction line which connected the bilge wells and the engine room but it did not work.

As the list of the Vessel was reduced so that the Vessel's own

generator could be used at around 23:00, and ballast operation was continued with the Vessel's generator from around 23:40.

The list of the Vessel was reduced to approximately 8° to starboard at around 03:00 on the 29th, then the Vessel suddenly listed approximately 22° to port. (See Photo 7)



Photo 7. The Vessel listed to port on the 29th

The chief officer continued ballast operation shifting sea water in the opposite direction, but the list was not reduced, and rather, the Vessel gradually increased port list and, when the Vessel listed approximately 28° to port at around 18:00, the generator stopped and the Vessel further continued to list to port.

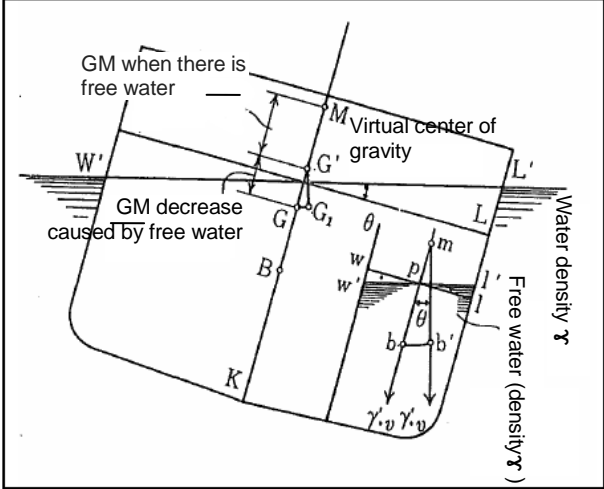
The list of the Vessel reached to approximately 42° to port at around 01:00 on the 30th and, after seawater began to flow into the cargo hold and accommodation space, the Vessel listed approximately 50° to port at around 02:20, and then, the master ordered all crew members to evacuate to shore.

The Vessel rolled over to port and foundered at around 12:38 on the 30th.

(See Photo 8 and Figure 3. Location of the Accident)



Photo 8. The Vessel rolled over and foundered

<p>Weather and sea conditions</p>	<p>Weather conditions Weather: cloudy Wind direction: south Wind force: 3 Visibility: fair Sea conditions Tide: middle of ebbing tide</p>
<p>About free water</p>	<p>According to page 99 of "Theory of Ships (<i>Riron Sen-paku Kogaku</i>), vol. I" (published by Kaibundo Book Company, Inc, written by Prof. Masanobu Ohgushi, 8th Edition), free water refers to liquids within a ship and have a free surface (surface in contact with the air).</p> <p>As the ship lists, if there is free water in a ship, the center of gravity of the ship will shift because of the shift of center of gravity of the liquid</p> <p>When a ship heels at a small angle of θ; angle between water line WL and $W'L'$, as displayed in Figure 2, the free surface of the free water in the ballast tank located in the starboard side will shifts from wl to $w'l'$, the volume wpw' will shifts to lpl' and the center of gravity of the free water will shifts from b to b'. Assuming this ballast tank as a ship, this is just the same as the center of buoyancy shifting from b to b' when it heels from initial floating position of the water line wl to the water line $w'l'$, although the forces of buoyancy and gravity are in adverse direction. m refers to the metacenter of the ballast tank under this assumption.</p> <p>Therefore, when the volume of free water refers to v and its density refers to γ, it can be assumed that the center of gravity of the weight $\gamma \cdot v$ moves from the center of buoyancy b to metacenter m; the center of gravity is a fixed point regardless of the list. In other words, m is the Virtual center of gravity of the free water.</p>  <p>Figure 2. Reduction of GM by free water</p> <p>Where i is secondary moment of the tilt axis p of the free surface wl of the free water, bm is equivalent to the radius of the meta center. $bm=i/v$</p> <p>While the center of gravity G of the entire ship will increase to GG' if the center of gravity of the free water increases to bm, that quantity, in other words the quantity of GM decrease, can be expressed in the following formula. $GG' = bm \cdot \gamma' v / \gamma V = \gamma' i / \gamma V$</p> <p>When the density of liquids inside and outside is equal, $GG' = i/V$ V indicates the volume of displacement of the hull.</p> <p>It should be noted that GG' does not relate to the volume v of the free water, but rather only relates to the form of the free surface.</p>

	<p>Accordingly, even though there is only a small volume of free water, if there is a broad free surface, the stability is significantly reduced.</p> <p>GG' subtracted from GM is referred to as virtual metacentric height (G'M).</p>
Other matters	<ol style="list-style-type: none"> (1) The chief officer had shipped scraps, loaded in Japan to the Haimen Port or the Ningbo Port of the People's Republic of China, four times since he joined the Vessel and knew that holes were made on the bottom of the cargo hold hit by a grab of a crane during discharging. (2) The Vessel entered a dock in March 2013, repaired the bottom of cargo hold, and had a valid Cargo Ship Safety Construction Certificate issued by a classification society. (3) The Vessel, when the ship was anchored at Hanshin Port, Sakai Senboku-Ku, at around 18:05 on April 25, was loaded with approximately 25.6t of fuel oil and approximately 2,200l of lubricating oil onboard. (4) At around 08:00 on the 26th, the depths of the bilge water in the aft part of both sides of the cargo hold were approximately 20cm at the port side and 50cm at the starboard side; the quantities were not as much as they would overflow from bilge wells with the depth of approximately 50cm, and there was no free water in the cargo hold. (5) The Vessel, When carried out initial survey before loading after mooring at Sukematsu Warf in Hanshin Port, Sakai Senboku-Ku, on the 26th, there was no free water in the cargo hold, and the forward draft was approximately 1.70m, and the after draft was approximately 2.88m. (6) When the final survey after loading was carried out on the 27th, the weight of the loaded scrap was approximately 920t, and the forward draft was approximately 3.57m and the after draft was approximately 4.63m. (7) Port state control officers of the Ministry of Land, Infrastructure, Transport and Tourism carried out PSC (port state control) on the Vessel on 29th and observed that, seawater leaked into the cargo hold from a hole with a length of approximately 9cm and a width of approximately 3cm on the tank top of the No. 1 port ballast tank (bottom plate of the store room), the Vessel listed approximately 25° to port, the depth of the bilge was approximately 1.92m when measured at the port side in the aft part of the cargo hold; seawater retained in the cargo hold, and, there was a hole in the center guarder separating the ballast tank into port and starboard sections. The PSC officers instructed the master to find cause of sea water spilt in the cargo hold and the cause of approximately 25° of the listing of the Vessel to port and issued an Order to Conform to Technical Standards concerning repair of the hole. (See Photo 9)



Photo 9. Hole on the bottom of store room

- (8) The master stated that he did not know the causes of this accident and the chief officer stated that the cause was the high center of gravity of the cargo. While both knew that there was bilge (free water) overflowed from the bilge wells in the cargo hold, they did not know of the effect of free water on the stability of a ship.
- (9) There were holes in seven locations on the bottom plate of the cargo hold of the Vessel, which is the tank top of the No.1 and No. 3 ballast tanks, observed after the accident. (See Figure 1)

Analysis

Involvement of crew
 Involvement of vessel, engine and other equipment.
 Involvement of weather and sea conditions
 Analysis of the finding

Applicable

Applicable

Not Applicable

- (1) As the Vessel was 29 years old, and from the conditions of the holes that occurred on the bottom of store room (tank top of No.1 ballast tank), bottom of the cargo hold (tank tops of No.1 and No.3 ballast tank) and the center guarder of No.1 ballast tank, it is probable that the hull had been worn out with age.
- (2) According to the results of the calculation, it is probable that conditions of the Vessel including the stability were as displayed in Table 1.

Timeline			Cargo weight (t)	Ballast weight (t)	Bilge weight (t)	weight of power shovel (t)	Draft forward (m)	Draft aft (m)	List angle (°)	G'M (m)
April 26	14:00	At the time of initial survey	0	406.2	0	0	1.7	2.88	0°	1.59
April 27	11:00	lunch break on April 27	874	550.5	80	23	3.51	4.61	port 15°	0.83
	15:30	At the time of final survey	920	550.5	80	0	3.57	4.63	0°	0.00
	15:30	If there were no bilge at the time of final survey							0°	0.79
	19:15	When the Vessel listed 12° to port after departure	920	525.5	105	0	3.58	4.81	port 12°	0.67
	19:15	If hull were even after departure							0°	-0.30
April 29	15:30	When the Vessel listed 25° to port at the time of PSC inspection	920	485.5	145	0	3.58	4.81	port 25°	0.78
	15:30	If hull were even at the time of PSC inspection							0°	-0.46

Table 1. The results of the stability calculations of the Vessel

- (3) When the initial survey was carried out on April 26, 2013 while the Vessel was moored at Sukematsu Warf in Hanshin Port, Sakai Senboku-Ku, there was no free water in the cargo hold, and in accordance with Table 1, it is probable that the weight of the ballast water was approximately 400t and that the G'M was 1.59m.
- (4) It is probable that, during the loading on the 27th, the scrap was loaded and compressed by the hydraulic power shovel in the cargo hold, and that there was no lateral movement of cargo.
- (5) It is probable that, during loading of scraps, while the stevedores went out from the Vessel for lunch break, the Vessel listed approximately 15° to port, and when the chief officer poured seawater into the ballast tanks on the starboard until the list was reduced to approximately 8° to port, then the list of approximately 22° to starboard occurred.
 As the list of approximately 15° to port occurred while the loading was suspended for the lunch break and there was no movement of cargo that would make the Vessel list, and, the list to starboard occurred during the operations to reduce the list to port, it is probable that there were something that could easily move laterally with the Vessel's list in the cargo hold, and therefore, it is probable that free water occurred in the cargo hold.
- (6) It is probable that, the chief officer, recognizing that the loading was started from lighter scraps, and, to prevent the rise in the height of the center of gravity which would cause reduction of the stability of the Vessel, started ballasting seawater to the ballast tanks from before the lunch break, however, as there were holes on the bottom

	<p>plate of the cargo hold and the store room, water came into the cargo hold, overflowed from bilge wells, retained at the bottom of cargo hold and acted as free water.</p> <p>(7) It is probable that, while the Vessel was heeling to port due to the condition of the loaded cargo and the hydraulic power shovel, during the lunch break, in addition to the reduction of the stability caused by the free water in the cargo hold, the free water moved to port side caused the Vessel listed approximately 15° to port.</p> <p>(8) It is probable that, during the chief officer ballasted seawater into the ballast tanks on the starboard side to reduce the list of 15° to port and when the list was reduced to approximately 8°, as the level of the seawater in the ballast tanks on the starboard side increased, the center of gravity of the free water in the cargo hold which had been on port side moved to the starboard side, and, as, after internal weight of both sides were balanced, the weight of the starboard side began to increase, the hull, after once balanced, listed to starboard and the free water moved to starboard and list reached approximately 22° to starboard.</p> <p>(9) It is probable that when the Vessel listed approximately 22° to starboard, the Vessel stopped listing as the result that the heeling moment of the movement of free water and the stability (righting moment) were balanced.</p> <p>(10) It is probable that, as described in (8), when the list changed sides, the amount of free water in the cargo hold increased as the ballast operation continued by the chief officer to reduce the list.</p> <p>(11) It is probable that, based on the results of the final survey after loading, and from the Table 1, the weight of the ballast was approximately 550t and the G'M was 0.0m.</p> <p>(12) It is probable that after loading, trim of the Vessel caused incline of the surface of the seawater in the ballast tank, and seawater continuously came into the cargo hold from the holes on the tank top (bottom plate of the cargo hold) on the stern side.</p> <p>(13) It is probable that, as the Vessel listed to port immediately after the first mooring line was released at around 19:10, the amount of free water in the cargo hold increased after loading and the value of the G'M became negative.</p> <p>(14) It is probable that, from the Table 1, it is probable that the G'M would be 0.79m at the time of the final survey after loading if there were no free water in the cargo hold.</p> <p>(15) It is probable that, as the Vessel, when left the wharf, listed approximately 12° to port, the master concluded that there was a problem with safety of the Vessel and, after anchoring off Senboku Otsu East Breakwater Lighthouse, instructed the crew to reduce the list. It is also probable that the chief officer started ballast operation and when the list was reduced to approximately 8° to 9° to port, the Vessel listed approximately 25° to starboard, and generator stopped making the ballast pump inoperable.</p> <p>(16) It is probable that, although the master requested a rescue to the Japan Coast Guard and the crew members evacuated onboard patrol boats from around 00:00 on the 28th, the crew members returned to the Vessel afterwards and the Vessel moored on the port side to Shiomi Quay by tug boats on the 28th and the Vessel listed approximately 28° to starboard.</p> <p>(17) It is probable that, after mooring at Shiomi Quay, the boatswain measured the depth of the bilge in the aft of both sides of the cargo</p>
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	<p>hold at around 17:00 and the depth were approximately 49cm at the port side and approximately 160cm at the starboard, however, the reason of bilge came into the cargo hold as much it overflowed from bilge wells was not clear to the chief officer. It is also probable that, efforts were made to pump out the bilge of the cargo hold through the bilge suction line which connects the bilge well and the engine room, it was not possible to pump out.</p> <p>(18) It is probable that, the Vessel continued ballast operation to reduce starboard list by the mobile power generator after mooring at Shiomi Quay, and later, by Vessel's generator and, at around 03:00 on the 29th, when the starboard list was reduced to approximately 8°, it then listed approximately 22° to port.</p> <p>(19) It is probable that, as, during the ballast operation to reduce the list in the lunch break on 27th, even after the starboard list occurred, the Vessel continued the ballast operation, the list was increased, and, as the Vessel further continued ballast operation to reduce the port list at Shiomi Quay, free water in the cargo hold increased, the stability of the Vessel was reduced while the port list continuously increased, and, the generator stopped at around 18:00 on the 29th disabling ballast operation, and, consequently, seawater came into the cargo hold and accommodation space at around 01:00 on 30th, and, after the crew evacuated to shore, the Vessel listed over to port and foundered.</p> <p>(20) It is probable that the master and chief officer were aware that there was bilge (free water) in the cargo hold overflowed from the bilge wells, they did not know of the effect of free water on the stability of a ship.</p>
<p>Probable causes</p>	<p>It is probable that, in this accident, the Vessel, which listed to port while moored at Sukematsu Warf in Hanshin Port, Sakai Senboku-Ku and loading scraps, and, although listed to starboard while the chief officer ballasted seawater into the ballast tanks under the instructions of the master and ballast operation was undergoing, continued ballast operation and caused port list soon after leaving the wharf, and, by ballast operation after anchoring, caused starboard list and, by ballast operation after mooring to Shiomi Quay, caused port list. It is probable that, despite of continued ballast operation, as the amount of free water in the cargo hold increased by the ballast operation that had been done, port list continued to increase, seawater came into the cargo hold and accommodation space, and the Vessel listed over and foundered.</p> <p>It is probable that, free water occurred in the cargo load because, as the chief officer, in the recognition that the loading was started from lighter scraps, ballasted seawater in the ballast tank to prevent reduction in stability due to an increase in the height of the center of gravity of the Vessel, and there were holes on the bottom plate of the store room and the cargo hold, seawater came into the cargo hold and collect on the cargo hold floor, overflowed from bilge wells, and was retained at the bottom of the cargo hold.</p> <p>It is probable that, the chief officer continued ballast operation because, although the master and chief officer were aware of the bilge (free water) in the cargo hold, they did not know of the effect of free water on the stability of the ship, and because the master repeatedly instructed to reduce the list.</p>
<p>Safety actions</p>	<p>Possible actions that could prevent similar accidents include the followings;</p>

	<p>(1) Measures to be taken by crew when free water occurred.</p> <p>When a ship lists not because of the waves or winds, and suddenly changes the sides of the list widely to another side, unless it is a lateral movement of large amount of cargo, it is likely that there is a significant reduction in stability and effect of free water should be considered as a probable cause.</p> <p>In such a situation, crew should take the following measures.</p> <ol style="list-style-type: none"> 1. Measure the depth of the bilge in the bilge well. 2. When measured height of bilge is greater than the height of the bilge well and there is free water, identify the cause of free water by, for example, checking if there are changes in the amount of contents in the adjacent tanks to the cargo hold. 3. Remove free water from the cargo hold. 4. When the cause of free water is unclear, do not take in the ballast water nor do ballast operation. <p>(2) Education of crew</p> <p>The Japan Transport Safety Board request the management company to provide education to crew members on the effect of free water on the ships' stability.</p>
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Figure 3. Location of the Accident

