MA2018-12

# MARINE ACCIDENT INVESTIGATION REPORT

December 20, 2018

# MARINE ACCIDENT INVESTIGATION REPORT

| | |
|---|---|
| Vessel type and name: | Cargo Ship REAL |
| IMO number: | 7130153 |
| Gross tonnage: | 1,798 tons |

| | |
|---|---|
| Accident type: | Grounding |
| Date and time: | Around 00:15, October 23, 2017 (local time, UTC+9 hours) |
| Location: | Fushiki-Toyama Port, Toyama Prefecture<br>Around 241° true bearing, 220 m from Toyama East Breakwater Lighthouse (approximately 36°45.9'N, 137°13.5'E) |

December 5, 2018

Adopted by the Japan Transport Safety Board

Chairman Kazuhiro Nakahashi
Member Yuji Sato
Member Kenkichi Tamura
Member Toshiyuki Ishikawa
Member Makiko Okamoto

## SYNOPSIS


**< Summary of the Accident >**

While moored at Public Berth No. 1, Toyama Section, Fushiki-Toyama Port, the cargo ship REAL received the effects of wind and waves occurring with the approach of Typhoon No. 21. Her mooring rope broke and she drifted within the port. Subsequently she attempted to proceed toward the port's exterior using her engine, however ship maneuvering became difficult and, at around 00:15 on October 23, 2017, she ran aground on tetrapods on the east side of the Toyama West Breakwater on the opposite bank of the berth.

REAL's engine room and other areas flooded and she became a total loss. However, there were no fatalities or injuries among her crew.

**< Probable Causes >**

It is probable that, while the cargo ship REAL was moored at Public Berth No. 1, near the port's entrance of Toyama Section, Fushiki-Toyama Port at night, under conditions in which Typhoon No. 21 was approaching, she drifted within the port because her mooring ropes broke and subsequently, although she attempted to head outside of the port using her engine, she came under the effects of the wind and waves, ship maneuvering became difficult, and she drifted and ran aground on tetrapods.

It is probable that REAL's mooring ropes broke because she received the effects of the wind and waves that expedited the hull's motion for the reason that she was using mooring ropes with reduced strength that resulted from fatigue degradation and age degradation, and consequently

load that exceeded the strength of the mooring ropes being used was applied to them.

It is somewhat likely that, although he added additional mooring ropes, the Master's use of multiple mooring ropes of different diameters together and mooring of REAL with ropes made slack contributed to the breaking of the mooring ropes.

# 1 PROCESS AND PROGRESS OF THE INVESTIGATION

## 1.1 Summary of the Accident

While moored at Public Berth No. 1, Toyama Section, Fushiki-Toyama Port, the cargo ship REAL received the effects of wind and waves occurring with the approach of Typhoon No. 21. Her mooring rope broke and she drifted within the port. Subsequently she attempted to proceed toward the port's exterior using her engine, however ship maneuvering became difficult and, at around 00:15 on October 23, 2017, she ran aground on tetrapods on the east side of the Toyama West Breakwater on the opposite bank of the berth.

REAL's engine room and other areas flooded and she became a total loss. However, there were no fatalities or injuries among her crew.

## 1.2 Outline of the Accident Investigation

### 1.2.1 Setup of the Investigation

The Japan Transport Safety Board appointed an investigator-in-charge and two other marine accident investigators to investigate this accident on October 23, 2017.

### 1.2.2 Collection of Evidence

| | |
|---|---|
| October 24-27, 2017: | On-site investigations and interviews |
| November 13-15, and 29, 2017: | Interviews |
| November 20, 27, December 11, 12, 2017, January 24, 25, February 17, and 27, 2018: | Collection of questionnaire |

### 1.2.3 Tests and Research by Other Institutes

With respect to this accident, the JTSB entrusted to the Japan Weather Association the investigations concerning the wind and waves of Toyama Section, Fushiki-Toyama Port, and to Naroc Rope Tech the investigations concerning the residual strength of REAL's mooring ropes.

### 1.2.4 Cooperation with the Investigation

The JTSB received advice concerning the analysis of berth mooring methods from Tokyo University of Marine Science and Technology.

### 1.2.5 Comments from Parties Relevant to the Cause

Comments on the draft report were invited from parties relevant to the cause of the accident.

### 1.2.6 Comments from the Flag State

Comments on the draft report were invited from the flag state of REAL.

# 2 FACTUAL INFORMATION

## 2.1 Events Leading to the Accident

### 2.1.1 The Navigation Track according to the Automatic Identification System

According to the records of the Automatic Identification System (AIS)*[1] data (hereinafter referred to as "the AIS record") received by a data company in Japan, the navigation tracks of the "REAL" (hereinafter referred to as "the Vessel") from 16:49:41 on October 20 to 00:17:25 on October 23, 2017 were as shown in Table 2.1 below.

It should be noted that the positions of the Vessel are the positions of the GPS antenna located on the upper side of the bridge, and the course over the ground and heading are true bearings (hereinafter the same).

Table 2.1 AIS Record of the Vessel (Excerpt)

| Time (HH:MM:SS) | Ship's position | | Course Over the Ground (°) | Heading (°) | Speed Over the Ground (knots [kn]) |
|---|---|---|---|---|---|
| | Latitude (N) (° -′ -″ ) | Longitude (E) (° -′ -″ ) | | | |
| October 20<br>16:49:41 | 36-45-40.8 | 137-13-40.7 | 190 | 189 | 0.0 |
| 16:52:39 | 36-45-40.8 | 137-13-40.7 | 0 | 189 | 0.0 |
| 16:59:46 | 36-45-40.6 | 137-13-40.6 | 37.6 | 359 | 0.0 |
| (Omitted) | | | | | |
| October 22<br>09:05:45 | 36-45-40.6 | 137-13-40.6 | 036.4 | 359 | 0.0 |
| 10:02:47 | 36-45-39.4 | 137-13-40.3 | 000.0 | 359 | 0.0 |
| 11:05:44 | 36-45-39.1 | 137-13-40.1 | 020.9 | 359 | 0.0 |
| 12:11:46 | 36-45-39.3 | 137-13-40.2 | 018.5 | 359 | 0.0 |
| 13:02:46 | 36-45-39.3 | 137-13-40.0 | 023.0 | 359 | 0.1 |
| 14:05:45 | 36-45-39.3 | 137-13-40.0 | 198.5 | 359 | 0.0 |
| 15:02:44 | 36-45-39.3 | 137-13-40.1 | 003.6 | 359 | 0.0 |
| 16:02:44 | 36-45-39.3 | 137-13-40.2 | 052.6 | 359 | 0.1 |
| 17:02:43 | 36-45-39.4 | 137-13-40.1 | 047.7 | 358 | 0.4 |
| 18:02:46 | 36-45-39.4 | 137-13-40.1 | 014.6 | 358 | 0.0 |
| 19:05:44 | 36-45-39.4 | 137-13-40.1 | 014.9 | 358 | 0.3 |
| 20:02:44 | 36-45-39.4 | 137-13-40.1 | 012.1 | 358 | 1.0 |
| 21:02:43 | 36-45-39.4 | 137-13-40.1 | 025.1 | 358 | 0.8 |
| 22:02:43 | 36-45-39.5 | 137-13-40.0 | 354.9 | 358 | 0.7 |
| 22:35:44 | 36-45-39.5 | 137-13-40.0 | 007.0 | 358 | 0.1 |
| 22:45:22 | 36-45-39.6 | 137-13-39.9 | 017.3 | 359 | 0.4 |
| 22:48:25 | 36-45-39.6 | 137-13-39.9 | 160.2 | 359 | 0.9 |
| 22:53:25 | 36-45-39.6 | 137-13-40.0 | 029.0 | 358 | 0.1 |
| 22:56:23 | 36-45-39.7 | 137-13-39.9 | 324.0 | 357 | 0.1 |

[1] Automatic Identification System (AIS) is a device that each vessel uses to automatically transmit and receive information such as vessel identification code, ship type, name, position, course, speed, destination, conditions of navigation, and other information on safety and to exchange information with other vessels or land-based navigation aids.

| | | | | | |
|---|---|---|---|---|---|
| 23:02:22 | 36-45-39.6 | 137-13-39.9 | 007.8 | 357 | 0.3 |
| 23:05:23 | 36-45-39.6 | 137-13-39.9 | 187.2 | 358 | 0.8 |
| 23:08:23 | 36-45-39.5 | 137-13-39.9 | 196.8 | 358 | 0.2 |
| 23:11:24 | 36-45-39.5 | 137-13-39.9 | 157.7 | 358 | 0.3 |
| 23:17:22 | 36-45-39.5 | 137-13-39.9 | 021.3 | 357 | 0.5 |
| 23:20:24 | 36-45-39.5 | 137-13-39.9 | 359.0 | 356 | 0.3 |
| 23:23:24 | 36-45-39.4 | 137-13-39.9 | 342.2 | 357 | 0.4 |
| 23:26:23 | 36-45-39.5 | 137-13-39.9 | 030.2 | 358 | 0.3 |
| 23:29:22 | 36-45-39.5 | 137-13-39.9 | 035.0 | 357 | 0.2 |
| 23:35:24 | 36-45-34.0 | 137-13-35.9 | 192.2 | 290 | 1.0 |
| 23:38:24 | 36-45-28.5 | 137-13-33.9 | 149.0 | 279 | 2.4 |
| 23:41:22 | 36-45-24.5 | 137-13-31.9 | 193.0 | 218 | 0.7 |
| 23:44:25 | 36-45-23.9 | 137-13-34.4 | 173.5 | 205 | 0.6 |
| 23:47:24 | 36-45-25.8 | 137-13-31.8 | 319.0 | 178 | 1.3 |
| 23:50:23 | 36-45-25.7 | 137-13-33.1 | 190.8 | 247 | 0.8 |
| 23:53:22 | 36-45-22.2 | 137-13-29.5 | 199.5 | 286 | 1.1 |
| 23:59:25 | 36-45-25.5 | 137-13-28.0 | 321.6 | 159 | 3.0 |

### 2.1.2 Events leading to the Accident according to the Statements

According to the statements of the Master and Chief Officer of the Vessel and the person in charge at the Vessel's agent (hereinafter referred to as "the Agent") and the video record of a security camera on Public Berth No. 1, Toyama Section, Fushiki-Toyama Port (hereinafter referred to as "the Berth"), the events leading to the accident and subsequent rescue were as follows.

At around 16:00 on October 20, 2017, the Vessel, with a master and 18 crew members (all nationals of the Russian Federation) left Public Berth No. 7, Toyama Section, Fushiki-Toyama Port (hereinafter "Public" and "Toyama Section, Fushiki-Toyama Port" shall be omitted from berth names) and, at around 16:30, moved to the Berth and docked port-side alongside.

From around 12:00 on October 21, approximately 200 tire wheels were loaded onto the Vessel. The Vessel then decided to wait at the Berth for Typhoon 21 to pass until cargo loading scheduled for the next day.

At around 09:00 on October 22, the Vessel received typhoon information and precautions from a Japan Coast Guard employee who visited the Vessel. From around 09:40, the Vessel began preparations for heavy weather. However, the Master thought that the effects of the coming typhoon would not exceed those of his previous experience and therefore he decided to use additional mooring ropes[*2] as per standard practice with five forward mooring ropes and four aft mooring ropes and to increase the number of personnel on watch. The preparations for heavy weather were completed at around 14:00. At this time, the Master thought that applying his previous experience would be sufficient, and he therefore decided to use a mooring method whereby distance with the berth is created by making all of the mooring ropes slack and not coming alongside the berth.

The Vessel began receiving wind and waves from the stern from a northerly wind that began

[*2] "Additional mooring ropes" refers to mooring by increasing the number of mooring ropes compared to normal mooring in order to provide mooring force corresponding to external force caused by heavy weather, etc.

intensifying from around 15:00, resulting in repeated surging of the hull and changes in tension in each of the mooring ropes. The wind began rapidly intensifying from around 22:00.

At around 22:38, the first aft mooring rope broke, and the Master ordered all hands on deck and preparations to start the main engine.

At around 22:44, the second aft mooring rope broke. At around 23:30, the stern and the Berth became separated by approximately 5 to 10 meters, and the hull began rotating in a counterclockwise direction.

At around 23:32, the Vessel's fore-and-aft line and the Berth became roughly perpendicular and the third aft mooring rope broke, after which the fourth aft mooring rope broke at around 23:33.

At around 23:35, the five fore mooring ropes broke one after another. All of the Vessels mooring ropes had broken and the Vessel began to drift.

The Master ordered the port anchor dropped at around 23:36 and full ahead at around 23:40. However, the Vessel continuously drifted toward the back of the port (southerly direction) while heading north. The Master headed the Vessel to the port's entrance in an attempt to exit to the port's exterior by continually using the engine, but at around 23:56, the Vessel drifted close to Berth 5. The Vessel advanced a small amount to the northeast while still being influenced by the wind and waves. However, at around 23:59, the Vessel drifted to the west and approached Berth 8.

At around 00:02 on October 23, the Vessel again began heading toward the port's entrance with a speed of approximately 2.5 kn. However, at around 00:07, the drifting caused by the wind and waves became pronounced, and the Vessel's speed dropped and ship maneuvering became difficult as the Vessel approached the western side of Berth 10.

At around 00:15, the Vessel received a gust from the starboard side, drifted to the west, and ran aground on tetrapods on the eastern side of the Toyama West Breakwater (hereinafter referred to as "the Breakwater").

Shortly after the port side of the Vessel's hull ran aground on the tetrapods of the Breakwater, water began flooding into the engine room and the bow became pointed south. The starboard side of the hull was pushed onto the same blocks and an inclination to port began.

The Master immediately called on the crew to assemble in the messroom by shipboard announcement and instructed them to wear lifejackets.

At around 03:20, the Master gave the order to abandon ship and all crew members, with the exception of the Chief Engineer, escaped from the ship on their own at the starboard bow onto the tetrapods on the land side by using a Jacob's ladder.

At around 05:30, the Chief Engineer was rescued by Japan Coast Guard personnel who had arrived to provide assistance.

The date and time of occurrence of the accident was at around 00:15 on October 23, 2017, and the location was around 241° true bearing, 220 m from the Lighthouse on Toyama East Breakwater of Fushiki-Toyama Port.

(See Annex Figure 1 Outline Map of the Accident Location and Annex Figure 2 Estimated Navigation Routes)

## 2.2 Injuries to Persons

There were no fatalities or injuries.

## 2.3 Damage to Vessel

According to the onsite investigations and statement of the person in charge at the salvage company, the Vessel was a total loss, as the area near the Vessel's midship was fractured to a large extent and there were breaches, cracks, and dents in all parts of the hull. The Vessel was removed from the Breakwater by the salvage company on January 7, 2018.
(See Photo 2.3)

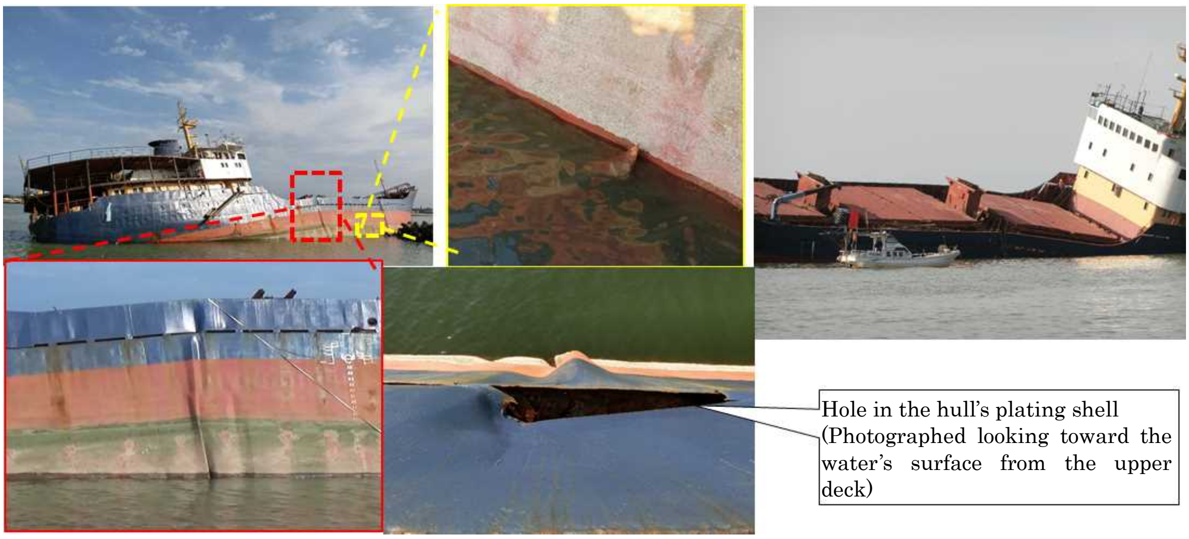


Photo 2.3 Hull Damage

## 2.4 Crew Information

(1) Gender, Age, and Certificate of Competence

1) The Master: Male, 46 years old, national of the Russian Federation

Endorsement attesting the recognition of certificate under STCW regulation I/10: Master (issued by the Republic of Togo)

Date of Issue: August 17, 2017

(Valid until March 10, 2020)

2) The Chief Officer: Male, 36 years old, national of the Russian Federation

Endorsement attesting the recognition of certificate under STCW regulation I/10: Chief Officer (issued by the Republic of Togo)

Date of Issue: September 13, 2016

(Valid until September 26, 2018)

(2) Sea-going Experience, etc.

According to the statements of the Master, and the Chief Officer, these were as follows.

1) The Master

After serving as a master of cargo ships for approximately three years beginning in 2010, the Master came aboard the Vessel as her master around October of 2013 and had approximately four years of experience in this capacity. He had engaged in navigation between Japan and Russia over the 14 years up until the present time and had experienced entering Fushiki-Toyama Port on multiple occasions.

He was in good health at the time of the accident.

2) The Chief Officer

The Chief Officer had served as a chief officer of cargo ships since 2016. He came aboard the Vessel as a second officer in July 2017 and became her chief officer in October of the same year. He had experienced entering Fushiki-Toyama Port on multiple occasions.

He was in good health at the time of the accident.

## 2.5 Vessel Information

### 2.5.1 Particulars of Vessel

| | |
|---|---|
| IMO number: | 7130153 |
| Port of registry: | Lomé (Republic of Togo) |
| Owner: | SEMTOR PROJECTS S.A. (Republic of Panama) |
| Management company: | EAST MARINE CO., LTD (Russian Federation) (hereinafter referred to as “Company A”) |
| Operator: | Company A |
| Classification Society: | Cosmos Marine Bureau INC. (Republic of Korea) |
| Gross tonnage: | 1,798 tons |
| L×B×D: | 82.00m × 12.53m × 6.00m |
| Hull material: | Steel |
| Engine: | Diesel engine × 1 |
| Output: | 1,471 kW |
| Propulsion: | 4-blade fixed pitch propeller × 1 |
| Date of launch: | 1971 |

(See Photo 2.5)

Photo 2.5　The Vessel

### 2.5.2 Hull Structure of the Vessel, etc.

(1) Hull Structure

The Vessel was a cargo ship with an aft bridge. Her bridge and wheelhouse were on the top level of a three-level deck house on the aft deck and her engine room was under the deck house. She had three cargo holds numbered from 1 to 3 in order from the bow situated forward of the deckhouse. One jib crane was installed on the port-side upper deck at the opening/closing section of the No. 1 cargo hold. (See Figure 2.5)

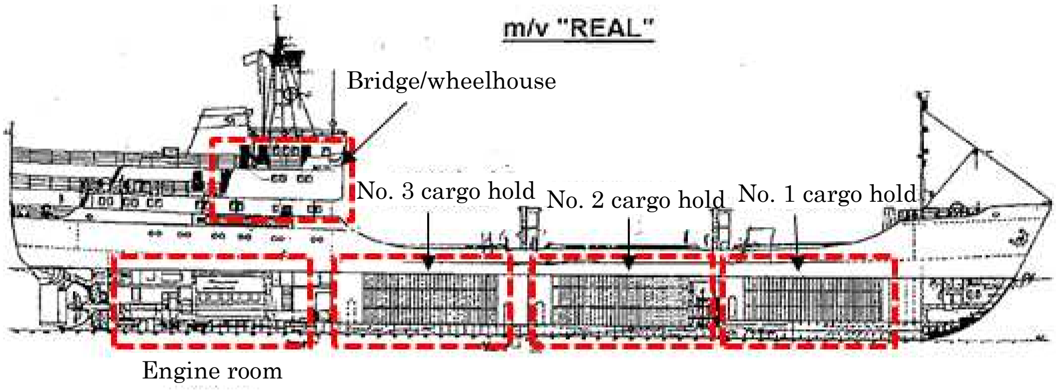


Figure 2.5 General Arrangement Plan

(2) Navigation Equipment, etc., on the Bridge

In the wheel house were arranged a steering stand on the port side and an engine telegraph on the starboard side of a front console. Two radars were suspended from the ceiling above the console. An AIS display device and a GPS display were installed in the center.

2.5.3 Load Condition

According to the statement of the crew members and the logbook, the Vessel was nearly in ballast with a cargo of only approximately 200 tire wheels at the time of the accident.

The draft was approximately 1.80 m at the bow and approximately 4.70 m at the stern.

2.5.4 Other Relevant Vessel Information

(1) According to the statements of the Master and Chief Engineer, there was no malfunction or failure in the hull, engine, or machineries at the time of the accident.

(2) According to the statement of the Master, the video record of a security camera, and the on-site investigation, the Vessel's behavior at the time of the accident and the heading value from the AIS record did not match and, likewise, the Vessel's heading after the accident and the indicated bearing of the compass of the steering stand did not match.

## 2.6 Weather and Sea Conditions

2.6.1The General Situation of Typhoon No. 21

According to the general weather conditions issued by the Japan Meteorological Agency, the situation was as follows.

*Typhoon No. 21, which originated in the sea near the Caroline Islands at 03:00 on October 16, 2017, moved toward the north above the sea east of the Philippines while gathering strength, became a large system and extremely forceful system during the night of October 20, and gradually gained speed and moved toward the north to the south of Japan while maintaining extremely strong force through October 22. After moving north-northeast off of the Tokaido region's coast in the late night of October 22, the system became a super typhoon on October 23 and came ashore near Kakegawa City, Shizuoka Prefecture, while maintaining* *the force of a super typhoon at around 03:00 on the same day. The system subsequently proceeded northeast through the Tokai region and Kanto region while maintaining a storm area, moved to the area offshore of Fukushima Prefecture at around 09:00 on October 23, and became an extratropical cyclone.*

(See Annex Figure 3 “Path of Typhoon No. 21” and Annex Figure 4 “Weather over the Asia-Pacific Region”)

2.6.2 Weather and Wave Observations, etc.

(1) Weather observations

Meteorological observations at the Toyama Local Meteorological Office, which is located approximately 6.5 km south-southwest from the accident site, were as follows.

1) Before and after the accident

October 22

22:00 Wind direction: NNE; Wind Speed: 19.6 m/s (Peak gusts: 32.2 m/s)

22:30 Wind direction: NNE; Wind Speed: 19.3 m/s (Peak gusts: 29.2 m/s)

23:00 Wind direction: NNE; Wind Speed: 17.8 m/s (Peak gusts: 28.7 m/s)

23:30 Wind direction: NNE; Wind Speed: 17.4 m/s (Peak gusts: 26.8 m/s)

October 23

00:00 Wind direction: NNE; Wind Speed: 17.9 m/s (Peak gusts: 27.7 m/s)

00:30 Wind direction: NNE; Wind Speed: 16.3 m/s (Peak gusts: 24.9 m/s)

01:00 Wind direction: NNE; Wind Speed: 16.7 m/s (Peak gusts: 29.5 m/s)

2) Maximum wind speed and peak gusts (period: from 00:00 on October 22 to 24:00 on October 23)

Maximum wind speed

21:58, October 22 Wind direction: NNE; Wind Speed: 20.0 m/s

Peak gusts

21:57, October 22 Wind direction: NNE; Wind Speed: 32.2 m/s

(2) Wave observations

Wave observations at the “Fushiki-Toyama” NOWPHAS[*3] observation point, which is located approximately 1.1 nautical miles (M) west-northwest from the accident site, were as follows.

October 22

20:00 Wave height 3.31 m; Period 7.1 seconds

22:00 Wave height 3.99 m; Period 7.9 seconds

October 23

00:00 No data (missing)

02:00 No data (missing)

04:00 Wave height 4.69 m; Period 9.4 seconds

06:00 Wave height 4.45 m; Period 10.1 seconds

(3) Tide

[*3] “NOWPHAS” (Nationwide Ocean Wave information network for Ports and HarbourS - Ports and Harbours Bureau, MLIT) is a wave information network for Japan’s coastlines that was built and is operated through a collaborative effort by the Ports and Harbours Bureau, MLIT; Regional Development Bureaus, MLIT; Hokkaido Bureau, MLIT: Okinawa General Office, Cabinet Office; National Institute for Land, Infrastructure and Management (NILIM); and Port and Airport Research Institute (PARI).

According to tide tables published by Japan Coast Guard, the tide in the Toyama Section of Fushiki-Toyama Port at the time of this accident was in the mid-stage of an incoming tide and the height of tide was approximately 34 cm.

2.6.3 Observations of Crew Members

(1) According to the logbook of the Vessel, crew members' observations were as follows.

October 22

15:00 Wind direction: North; Wind speed 18.0 m/s; Temperature: 14.0°C; Wave height: no

19:00 Wind direction: North; Wind speed 23.0 m/s; Temperature: 12.0°C; Wave height: 3.0 m; Wave direction: North

22:38 Wind direction: North; Wind speed 35.0-40.0 m/s; Wave height: 2.5-3.0 m

23:00 Wind direction: North; Wind speed 37.0 m/s; Temperature: 12.0°C; Wave height: 3.0 m; Wave direction: North

October 23

00:07 Wind direction: North; Wind speed 38.0-40.0 m/s

(2) According to the statement of the Master, the wind speed was 37 m/s in observations of crew members of another vessel that was moored at Berth No. 8 at around 22:40 on October 22.

2.6.4 Announcement of Warnings and Advisories

According to information provided by the Toyama Local Meteorological Office, a high winds advisory and heavy seas advisory were issued to Toyama City at 08:12 on October 22 and, further, a storm warning was issued at 13:48 of the same day and a heavy seas warning was issued at 18:32 of the same day. All remained in effect at the time of the accident.

2.6.5 Analytical Investigation of Weather and Sea Conditions

An outline of an analytical investigation by the Japan Weather Association of the weather and sea conditions within the Toyama Section of Fushiki-Toyama Port and near the Breakwater at the time of the accident is as follows.

(1) Ocean waves

The ocean waves were intensifying. The wave direction was north-northeast. The wave height was 4 to 5 m outside the port but weakened to around 3 m near the port's entrance due to the effect of the seafloor topography's particularities, and reached a maximum of around 1.5 m within the port. The wave period was at least 8.0 seconds outside the port and between 6.7 and 8.9 seconds within the port. The ocean waves' wavelength was between approximately 71 and 85 m within the port.
(See Annex Figure 5 "Distributions of Wave Height and Wave Direction Outside the Port" and Annex Figure 6 "Wave Height in the Port")

1) Vicinity of the Berth when the first aft mooring rope broke (around 22:38 on October 22)
Wave direction: NNE; Wave height: 0.92 m; Period: 8.2 seconds

2) Vicinity of the port's back area after all of the mooring ropes had broken (around 23:56 on October 22)

Wave direction: NNE; Wave height: 1.16 m; Period: 7.7 seconds

3) Vicinity of the Breakwater several minutes prior to the Vessel's grounding (around 00:11 on October 23)

Wave direction: NNE; Wave height: 1.62 m; Period: 8.9 seconds

(2) Wind

The wind direction within the port was north-northeast. The windspeed began to intensify around 10:00 on October 22, exceeded 20 m/s at around 18:00 on the same day, and continued to intensify until before dawn on October 23.

Winds with speeds exceeding 20 m/s continued for approximately 6 hours. The winds became very strong winds*4 with a speed of between 21.3 and 22.6 m/s between around 22:00 on October 22 and 00:00 on October 23.

1) Around 22:38 on October 22 when the first aft mooring rope broke

Wind direction: NNE. Wind speed: 21.4 m/s

2) Around 23:56 on October 22 when the Vessel reached the vicinity of the port's back area after all of the mooring ropes had broken

Wind direction: NNE. Wind speed: 22.6 m/s

3) Around 00:11 on October 23, several minutes prior to the Vessel's grounding

Wind direction: NNE. Wind speed: 22.6 m/s

(See Figure 2.6)

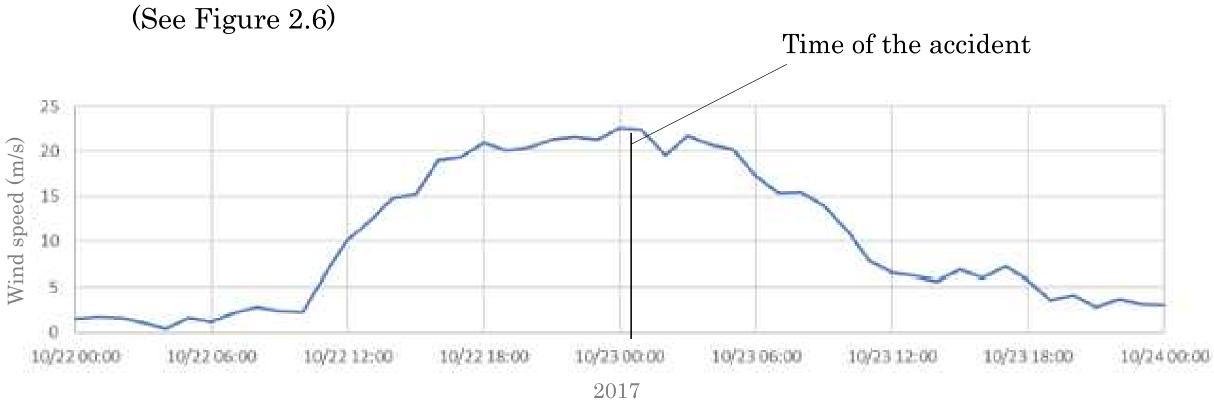


Figure 2.6 Changes in Wind Speed within the Port

2.6.6 Characteristics of Toyama Bay and Fushiki-Toyama Port

According to the sailing directions issued by Japan Coast Guard and Chart 1162A (Toyama, Fushiki-Toyama Port), a general description of characteristics is as follows.

(1) Toyama Bay is an open bay with a mouth of approximately 17.5 M that opens to the north. It is susceptible to the entry of ocean waves. At Fushiki-Toyama Port, which is situated in the southern portion of the bay, swells enter the port if a strong northeasterly wind is blowing.

(2) The sea area extending from the Sea of Japan to the back of Toyama Bay is a deep-sea area with a depth of at least 1,000 m, and therefore the energy of swells weakens little. The depth rapidly shallows near the coast and there is a large difference in water depth between the offshore area and the port's interior, and as a result waves have a tendency to be high within the port.

(3) Topographically, the exterior of Fushiki-Toyama Port and its vicinity plunge rapidly to a

*4 "Very strong wind" is a term for wind strength used by the Japan Meteorological Agency. It refers to wind with a wind speed of at least 20 m/s but less than 30 m/s.

deep depth. Consequently, there are few places for anchoring and therefore care against maritime accidents caused by anchor dragging is required, particularly when a strong northerly wind is blowing.

(4) The depths of the Berth in Toyama Section, Fushiki-Toyama Port, and the vicinity of the Breakwater are approximately 10 m and approximately 11 m, respectively.

## 2.7 Information concerning Berth Mooring

### 2.7.1 Berth Mooring Method

According to Literary Source 1[*5] and Literary Source 2,[*6] the main points of berth mooring are as follows.

(1) Effect of mooring ropes

To hold the vessel in a fixed position by suppressing its motion.

(2) Names and functions of mooring ropes

The names of mooring ropes based on standard terminology of the International Maritime Organization (IMO) and the function of each rope are as described below, and the placement of mooring ropes is as shown in the figure below.

(The numbers appearing in parentheses correspond to the numbers appearing in the figure.)

1) Head line, stern line (1: head line, 6: stern line)

To suppress overall vessel motion and turning movements.

2) Breast line (2: forward breast line, 5: aft breast line)

Primarily to suppress the vessel's lateral motion. To suppress swaying and yawing.

3) Spring line (3: forward spring line, 4: aft spring line)

Primarily to suppress the vessel's back-and-forth motion. To suppress surging.

(See Figure 2.7-1)

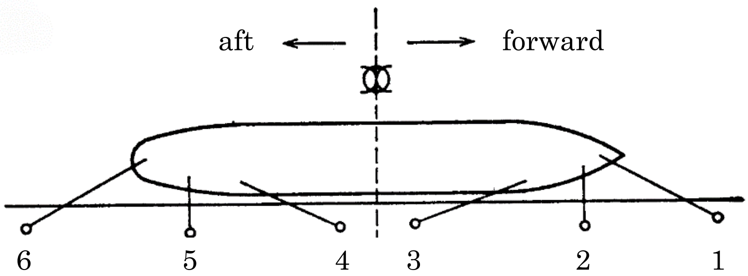


Figure 2.7-1 Placement of Mooring Ropes

(3) General Arrangement of Ropes to Suppress Vessel Motion

*Fore-aft-port-starboard symmetry vis-à-vis the vessel and equal elasticity are desired. Using only the same number of ropes for the head line and the stern line and, likewise, for the forward and aft breast lines and the forward and aft spring lines, each rope being of equal quality and equal length, and providing symmetrical mooring force in the fore-aft direction by making the ropes as equally taut as possible can minimize hull motion during mooring.*

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*5 Literary Source 1: *Sosen Tsuron* [introduction to ship maneuvering] (by Keinosuke Honda; Seizando-Shoten Publishing; published on June 28, 2008)

*6 Literary Source 2: *Theory and Practice of Ship Handling* (by Kinzo Inoue; Seizando-Shoten Publishing; published on March 8, 2011)

2.7.2 Berth Mooring during Heavy Weather

According to Literary Source 1, Literary Source 3,*7 and Literary Source 4,*8 the method is as follows.

(1) *Disperse the load exerted on mooring ropes by adding additional mooring ropes to counteract load and motion resulting from increased wind pressure and the action of the waves and swells. When doing so, it is desirable to increase tension so that the load is borne equally by the ropes as much as possible, and to provide each rope with elasticity to absorb impact force with respect to varying external forces by creating a bight whenever possible.**9

(2) *Use ropes of the same type and diameter for the preventers and add tension equally to prevent unevenness. However, because unevenness will occur in actual conditions, consider mooring force when preventers are applied to decrease by 50% beginning with the third line, meaning that breaking force equivalent to 2.5 lines exists with three lines and equivalent to three lines exists with four lines.*

(3) *At mooring facilities that moor ships even in heavy weather, arrange bollards in locations away from the water's edge so as that a ship's axis and mooring ropes can be made as perpendicular as possible* [omission] *against forces coming from the ship's lateral direction.* [Omission] *It is desirable to place bollards so that the angles formed by head lines and stern lines with the ship's axis are made as small as possible in order to prevent the ship's motion along its axis, but do not let these angles become less than 25 to 30°.*

2.7.3 Circumstances of the Vessel's Mooring Prior to the Accident

According to the statements of the crew members and the video record of a security camera on the Berth, the circumstances of mooring at the Berth immediately prior to the breakage of the Vessel's mooring ropes was as follows.

(1) The Vessel had added two head lines and one stern line in preparation for heavy weather and therefore had attached a total of nine mooring ropes (4 head lines, 3 stern lines, and one forward and aft spring line each).

(2) All of the ropes were made fast in a slack state, and none were taut.

(3) The distance between the hull and the berth was approximately 5 to 10 meters.

(See Figure 2.7-2)

*7 Literary Source 3: *Sosen-ron* [theory of ship maneuvering] (by Satoshi Iwai; Kaibundo; published on April 20, 1980)

*8 Literary Resource 4: *Wan no Shisetsu no Gijutsu-jo no Kijun, Do Kaisetsu* [technical standards of bay facilities with explanation] (The Ports & Harbours Association of Japan; published in July 2007)

*9 "Create a bight" means to pass a mooring rope from a ship around a bitt on the berth (bollards), return the rope to the ship, and then fix it.

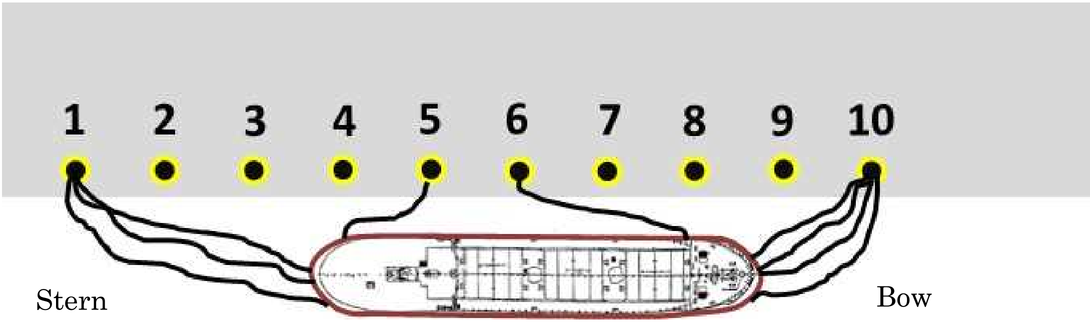


Figure 2.7-2 Mooring Condition of the Vessel (Conceptual Image)

2.7.4 Characteristics of the Hull's Movement

According to Literary Resource 2, the characteristics were as follows.

*Within the six degrees of freedom,*[10] *the generation of one motion will induce other motions. For example, if a ship rocks from side to side due to swinging, this inducing rolling and yawing, and if the ship rocks up and down due to heaving, pitching will be induced. Sometimes this is due to fore-aft asymmetry in the hull's shape or up-down disagreement or fore-aft disagreement between the center of gravity and center of buoyancy; this phenomenon is called "coupled motion."* [Omission] *Additionally, surging and pitching and heaving have a mutually coupled relationship but do not become coupled with other motions.*

## 2.8 Information on the Acquisition of Typhoon Information

### 2.8.1 Information on the Acquisition, Gathering, and Sharing of Typhoon-Related Information

According to the statements of the Master and the person in charge at the Agent as well as information provided by Japan Coast Guard, the circumstances concerning the acquisition of typhoon information and the sharing of information among persons concerned were as follows.

(1) While the Vessel was moored at the Berth, the Master was acquiring weather information from a private weather company via the internet and also making wind observations using an onboard portable anemometer.

(2) An employee of Japan Coast Guard visited the Vessel at around 09:00 on October 22 and communicated information concerning the typhoon's predicted path and precautions.

(3) Fushiki-Toyama Port's harbor master issued a vigilance advisory at 12:00 of October 22 and an evacuation advisory at 18:00 of the same day based on the stipulations of Article 37-4 of the Act on Port Regulations[*11]; however, neither the Agent nor the Vessel were aware of them. The content of the individual advisories was as follows.

[*10] The "six degrees of freedom" refers to the total of six motions within three-axis Cartesian coordinates that originate at the center of gravity as motions of the hull. They are comprised of three translational motions that follow each of the axial directions (motion in which objects move parallelly in the same direction) and three rotational motions around each axis. Individually, the six degrees of freedom are called "surging," which is translational motion concerning the bow-stern axis (X axis); "swaying," which is translational motion concerning the hull's beam axis (Y axis); "heaving," which is translational motion concerning the vertical axis (Z axis); "rolling," which is rotational motion around the bow-stern axis (X axis); "pitching," which is rotational motion around the hull's beam axis (Y axis); and "yawing," which is rotational motion around the vertical axis (Z axis).

[*11] Article 37-4 of the Act on Port Regulations stipulates that "If there is a foreseeable risk of a marine traffic hazard occurring in a Specified Port due to abnormal meteorological or hydrographic conditions, the occurrence of a marine accident, or any other circumstances, and the Captain of the Port finds it to be necessary, the Captain of the Port may recommend any vessel within the Specified Port or in the vicinity of the Specified Port's boundaries to take the measures required to smoothly prevent the hazard."

*Recommendation Due to Typhoon No.21 approaching, vessels in Fushiki-Toyama port are recommended to take following preventive measures pursuant to the Port Regulations Law, Article 37 Paragraph 4, after 12:00 (JST) on 22th* October.*
*1 Check updated weather information. 2 Liaise with your agent/concerned parties timely. 3 Vessels (lying at the pier) should strengthen her mooring condition. 4 Vessels (being at anchor) should pick up her anchor and shift to the outside of the port. 5 Vessels (carrying dangerous cargo) should stop cargo work and prepare for shifting to the outside of the port. 6 Ships under 20G/T should take shelter in a safe place or store the boat in boatyard. 7 Working ships should take shelter in a safe place and check the lashing condition of materials/tools/scaffold.*

22th*: Quoted as is from the original.

*Recommendation Due to Typhoon No.21 approaching, vessels in Fushiki-Toyama port are recommended to take following preventive measures pursuant to the Port Regulations Law, Article 37 Paragraph 4, after 18:00 (JST) on 22th* October.*
*1 All vessels intending to leave port should sail for a safe place as soon as possible. 2 Vessels being remained in the port should keep duty watch and check mooring condition timely. 3 Vessels carrying dangerous cargo should leave port as soon as possible.*

22th*: Quoted as is from the original.

(4) Together with the vigilance advisory and evacuation advisory, the "tsunami and typhoon countermeasures council of Uozu, Himi, Fushiki-Toyama Ports"*[12] (hereinafter the "Typhoon Countermeasures Council") officially announced a Caution at 16:00 on October 20, a Stage of Alert at 12:00 on October 22, and a Stage of Evacuation at 18:00 on October 22, and distributed each to council members, which included the Agent. However, the Agent was not aware of these announcements or their distribution and the announcements were not communicated to the Vessel.

The Typhoon Countermeasures Council had established classifications and announcement criteria for each stage and measures to be taken by ships, etc., as shown in Table 2.8.

(5) The Vessel did not ask the Agent for information concerning the typhoon.

Table 2.8 Classifications, etc., Established by the Typhoon Countermeasures Council

| *Classification* | *Announcement criteria* | *Measures to be taken by ships, etc.* |
|---|---|---|
| *Caution* | *When it is determined that a typhoon may approach Toyama Prefecture, or when it is forecasted that a typhoon's high wind area will reach Toyama Prefecture* | *1) Endeavor to obtain weather information.*<br>*2) Maintain communications with agent/concerned parties*<br>*3) If at anchor, consider evacuation areas, the timing of evacuation, etc.*<br>*4) If a vessel with a gross tonnage of no more than* |

*[12] The "tsunami and typhoon countermeasures council of Uozu, Himi, Fushiki-Toyama Ports" is established for the purposes of discussing necessary matters concerning safety measures to be taken by ships, etc., against tsunamis, typhoons, and high winds occurring with the approach of developed low pressure systems in Uozu Port, Himi Port, and Fushiki-Toyama Port and for executing those matters. It is comprised of representatives of administrative bodies, organizations, companies, and others associated with each port.

| | | |
|---|---|---|
| | | *20 tons, consider unloading or evacuating in a safe location.*<br>*5) If a construction vessel, consider ceasing construction work, evacuation areas, etc., and take measures to prevent scattering of materials and equipment.* |
| ***Stage of Alert (Generally 12 hours before entry into the storm area)*** | *When it is forecasted that a typhoon's storm area will reach Toyama Prefecture* | *1) Endeavor to obtain weather information.*<br>*2) Maintain communications with agent/concerned parties*<br>*3) If moored, make preparations for heavy weather by augmenting mooring ropes, etc.*<br>*4) If at anchor, evacuate outside of the port.*<br>*5) If a hazardous materials carrier, make arrangements for ceasing cargo handling and leaving port.*<br>*6) If a vessel with a gross tonnage of no more than 20 tons, refrain from leaving port and unload or evacuate in a safe location.*<br>*7) If a construction vessel, cease work, evacuate in a safe location and reinforce mooring, and confirm the lashings of equipment and materials.* |
| ***Stage of Evacuation (Generally 6 hours before entry into the storm area area)*** | *When it is determined that the arrival of a typhoon's storm area in Toyama Prefecture is inevitable.* | *1) If planning to evacuate outside of the port, leave port immediately when opportune.*<br>*2) If not evacuating outside the port, implement strict measures, such as periodically confirming the state of mooring, etc.*<br>*3) If a hazardous materials carrier, leave port immediately when opportune and evacuate outside the port.* |

*Storm area: An area around a typhoon where winds with an average speed of 25 m/s or more are blowing or where such winds might blow if topographical or other effects were not present. Its scope is ordinarily displayed with a circle.

### 2.8.2 Awareness of the Master Concerning the Typhoon's Approach

According to the statement of the Master, his awareness and actions concerning the typhoon's approach were as follows.

(1) He was aware that the typhoon was approaching prior to entering Fushiki-Toyama Port.

(2) From the weather information he obtained from the internet, he thought the wind speed in Fushiki-Toyama Port was 17.5 m/s.

(3) He understood as information from Japan Coast Guard that the wind speed at the Berth was around 23 m/s.

(4) He thought the effects of the typhoon's approach would not exceed what he had experienced before.

(5) He thought that adding mooring ropes in the usual manner would be sufficient.

(6) Although he added mooring ropes in preparation for heavy weather, he did not consider evacuating to another location and he continued to moor at the Berth while leaving the mooring ropes slack.

(7) Although he made an attempt to add mooring ropes when the wind and waves intensified and the weather and sea conditions began to deteriorate, he did not complete it because he could not contact the Agent by telephone.

(8) He only began to sense that the situation was out of the ordinary when the mooring ropes broke.

2.8.3 Circumstances of Ships Entering/Leaving the Port and Anchored Ships in Fushiki-Toyama Port Before and After the Accident

According to the statements of the Fushiki Harbor Pilots' Association and port state control officer of the Toyama Transport Branch Office as well as information provided by Japan Coast Guard, the situation of ships anchored in the port, etc., around the time of the accident was as follows.

(1) Ships entering/leaving port with pilot assistance

All ships requiring pilotage in the Shinminato Section (Toyama New Port) had left the port by October 21, the day before the typhoon's approach, out of consideration for the typhoon's approach, and no ships entered the port until October 24.

(2) Ships inside the port

In the Toyama Section, where the Vessel was moored, there was a general cargo ship at Berth 5, which is toward the back of the port from the Berth (to the south), and a RO/RO at Berth 8, which is on the opposite bank from the Berth. Each was moored alongside their respective berths with additional mooring ropes attached. The RO/RO was initially moored at Berth 10, which is even closer to the port's entrance than the Berth, but she moved to Berth 8 following a request by her master out of consideration for the typhoon's approach and made heavy-weather preparations.

## 2.9 Information on the Mooring Ropes used by the Vessel (Results of the Analytical Investigation)

The following describes the main points of an inspection and test of strength, etc., and the results of an analysis conducted by rope manufacturer Naroc Rope Tech (hereinafter referred to as "the Manufacturer") concerning the nine mooring ropes that broke just before the accident and were left at the Berth.

2.9.1 Appearance Inspection

The Manufacturer extended each mooring rope to its full length and then checked and analyzed its state of damage and deterioration.

(1) All of the mooring ropes were synthetic fiber ropes (polypropylene).

(2) The ropes' diameters were largely classified into the 50-mm level, 60-mm level, and 70-mm level. The classifications numbered four ropes, two ropes, and three ropes, respectively.

(3) Fuzzing was observed in all of the mooring ropes.

(4) Six ropes had fuzzing so advanced that the shapes of the strands*13 could not be distinguished.

*13 "Strand" refers to one of the constituent parts of a rope. It is made by twisting several fibers together.

(5) Two ropes had traces of melting.

(6) Two ropes had breaks in the strands themselves.

(See Photos 2.9-1, 2.9-2, 2.9-3, and 2.9-4)

Photo 2.9-1 Fuzzing

Photo 2.9-2 Inability to Distinguish Strand Shapes

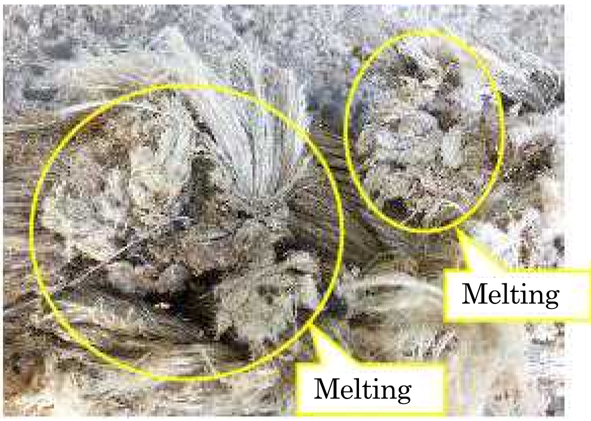


Photo 2.9-3 Traces of Melting

Photo 2.9-4 Broken Strands

2.9.2 Tension Test

For each mooring rope, the Manufacturer took approximately six meters from a section as a test piece for tension testing, spliced eyes on both ends, conducted a rupture test using a tension tester, and then measured the remaining strength. (See Photos 2.9-5 to Photo 2.9-8)


Photo 2.9-5 Before the Test


Photo 2.9-6 During the Test

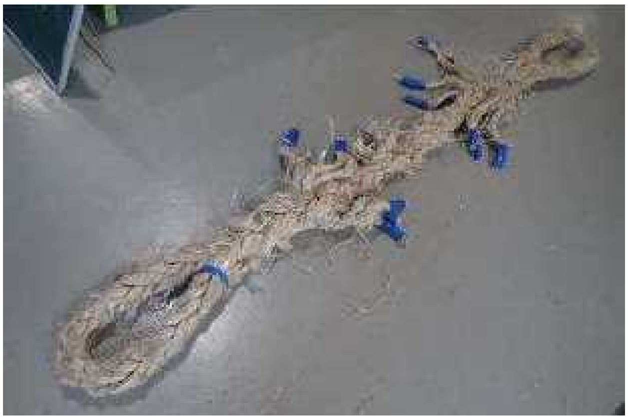

Photo 2.9-7　After the Test

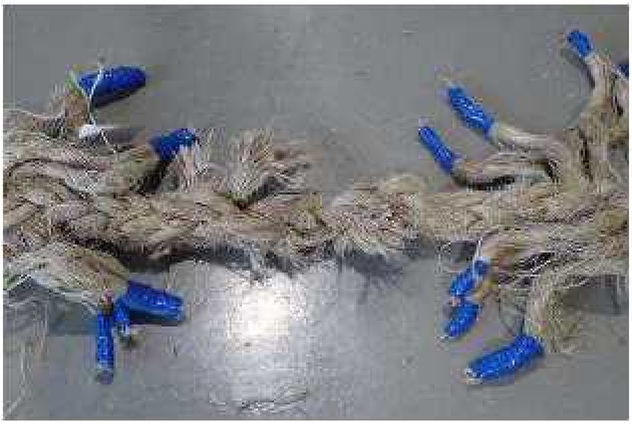

Photo 2.9-8　Breakage

(1) The results of a comparison of the breaking load of individual ropes based on the tension test with the Manufacturer's standard (guaranteed breaking load at the time of manufacture and shipment) for the standard load corresponding to the determined diameter of those ropes are as shown in the Table 2.9 below.

(2) Six ropes fell below a residual rate (breaking load/standard load) of 70% vis-à-vis the Manufacturer's standard, which is generally used as a rough guide for assessing the timing of a rope's retirement or replacement (red areas in the table).

Table 2.9　Tension Test Results

| Mooring Rope | Judged Diameter | | Breaking Load (kN) | Standard Load (Manufacturer's Standard) (kN) | Residual Rate (%) |
|---|---|---|---|---|---|
| | Diameter (mm) | Circumference (inch) | | | |
| 1 | 72 | 9 | 291 | 732 | 39.8 |
| 2 | 56 | 7 | 273 | 446 | 61.2 |
| 3 | 72 | 9 | 311 | 732 | 42.5 |
| 4 | 55 | 6 3/4 | 340 | 430 | 79.1 |
| 5 | 55 | 6 3/4 | 349 | 430 | 81.2 |
| 6 | 56 | 7 | 127 | 446 | 28.5 |
| 7 | 64 | 8 | 452 | 578 | 78.2 |
| 8 | 70 | 8 5/8 | 365 | 691 | 52.8 |
| 9 | 62 | 7 1/2 | 163 | 543 | 30.0 |

### 2.9.3 Opinion of the Manufacturer concerning the Mooring Ropes' Breakage based on the Results of the Appearance Inspection and Tension Test

(1) It is probable that "fatigue degradation," whereby fatigue accumulates in a mooring rope when load is placed on it with each use and with repeated use, resulting in loss of the rope's original ability and quality, and "age degradation," whereby a mooring rope is gradually subjected to ultraviolet rays and other elements with the passage of time after its manufacture, resulting in loss of the rope's original ability and quality, occurred. It is probable that the mooring ropes' breaking strength (load) had fallen as a result of these

types of deterioration.

(2) With the exception of rope 7, the breaking load of the ropes was less than 400 kN. Thus, all of the ropes with the exception of this rope were mooring ropes with low strength.

(3) From the circumstances described in (1) and (2) above, it is conjectured that excessive load was placed on the mooring ropes and that this led to their breaking.

(4) Because mooring ropes of different diameters were used together, it is probable that the breaking strength of the ropes was not uniform and that this led to lower overall mooring force.

## 2.10 Information on Mooring Rope Standards, etc.

### 2.10.1 National Standard

For ships of Japanese registry, the number and strength (in kN) of mooring ropes in accordance with the ship's length, etc., are stipulated in the Rule of Ship Appliance.

### 2.10.2 International Standards

The following standards are provided in the SOLAS Convention[*14] and Maritime Labour Convention[*15]; however, specific judgments regarding responsibility for complying with the two treaties is entrusted to the flag states of ships. Therefore, although regulations concerning mooring ropes are established, there are no criteria (judgment or evaluation standards) having international legal force.

(1) SOLAS Convention (Chapter II-1 Regulation 3-8)

As provided below, "sufficient safe working load" is mentioned in the regulation concerning towing and mooring equipment.

*Regulation 3-8 Towing and mooring equipment*

(Omission)

*2 Ships shall be provided with arrangements, equipment and fittings of sufficient safe working load to enable the safe conduct of all towing and mooring operations associated with the normal operation of the ship.*

(Omission)

(2) Maritime Labour Convention (Title 4 Regulation 4.3)

As stated below, within the non-mandatory voluntary guideline of the code titled "health and safety protection and accident prevention," lines are included as an item that must receive particular attention in national guidelines.

*Guideline B4.3 Health and safety protection and accident prevention*

(Omission)

*2 The competent authority should ensure that the national guidelines for the management*

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*14 "SOLAS Convention" is the abbreviation for "The International Convention for the Safety of Life at Sea" of 1974.

*15 The "Maritime Labour Convention" is a convention that organizes and integrates conventions and recommendations concerning maritime labour that have been adopted since the establishment of the International Labour Organization (ILO). It was adopted at the ILO session of February 2006 and entered into force in August 2013. It is abbreviated as "MLC (Maritime Labour Convention, 2006."

*of occupational safety and health address the following matters, in particular:*
*(a) general and basic provisions;*

(Omission)

*(k) anchors, chains and lines;*

(Omission)

### 2.10.3 Port State Control (PSC)

In view of the circumstances relating to the above-mentioned international standards, there are cases in which safety is problematic for the reason that flag states' control of their flagged vessels is insufficient. To make up for such problems, Port State Control (PSC) is established as a system whereby port states provide supervision concerning compliance with international standards by foreign-flagged vessels that enter their ports and supervise those ships by boarding them, conducting safety inspections, etc.

### 2.10.4 Inspection and Retirement of Fiber Mooring Ropes

According to the Mooring Equipment Guidelines (3rd Edition, 2008) issued by the Oil Companies International Marine Forum (OCIMF) (hereinafter referred to as the "Mooring Equipment Guidelines (3rd Edition)"), a brief summary of inspection and retirement is as follows.

(1) Inspection

Although judging residual strength visually is not recommended when there is no damage or deformation to a fiber mooring rope that is still in use, there is a close relationship between loss of strength and the amount of fiber breakage in the rope's cross-section. Accordingly, periodic appearance inspections should be made to check the conditions of wear, gloss or glaze, or discoloration; changes in rope diameter; and flexibility.

(2) Retirement

When assessing standards for retiring fiber mooring ropes, consideration must be given to frequency of use, wear, erosion by chemical substances, etc. If no other information that can serve as a yardstick for retirement is available, the replacement period occurs when residual strength becomes 75% of maximum breaking load. For ordinary fiber mooring ropes, yarn[*16] damage of 25% in the rope's cross-section signifies a 25% decrease in rope strength.

## 2.11 Information on Safety Management

### 2.11.1 Document of Compliance and Safety Management Certificate

The recognized organization of the Republic of Togo (Cosmos Marine Bureau Inc.) issued a document of compliance to Company A on August 30, 2017, and a safety management certificate to the Vessel on February 28, 2017.

### 2.11.2 Safety Management Manual

According to the reply to the questionnaire by the above-mentioned recognized organization, the SMS Manual was inspected by an inspector of the recognized organization in accordance

[*16] "Yarn" refers to a string that is formed by twisting together fibers. Yarn is a material of rope. Several yarns brought together form a strand.

with the ISM Code[*17] and the recognized organization's regulations.

# 3 ANALYSIS

## 3.1 Situation of the Accident Occurrence

### 3.1.1 Course of the Events

According to 2.1, the following events occurred.

(1) It is highly probable that the Vessel docked port-side alongside at the Berth at around 16:30 on October 20, 2017 with the Master and 18 crew members aboard.

(2) It is highly probable that the Vessel conducted cargo loading from around 12:00 on October 21 and then subsequently decided to wait at the Berth for Typhoon 21 to pass.

(3) It is probable that the Vessel began preparations for heavy weather, added additional mooring ropes, and increased the number of personnel on watch at around 09:40 on October 22, and that she completed this work at around 14:00. It is highly probable that, at that time, the Vessel was in a moored state in which all of the mooring ropes were made slack, the hull had not been brought alongside the Berth, and there was distance between the hull and the Berth.

(4) It is probable that surging of the hull and tension variations on the mooring ropes started occurring repeatedly as the wind speed increased from around 15:00, that the first of the aft mooring ropes broke at around 22:38 and the second rope broke at around 22:44, that the stern and the Berth became separated by approximately 5 to 10 meters and the hull began rotating in a counterclockwise direction at around 23:30, and that Vessel began drifting because all of the forward and aft mooring broke at around 23:35.

(5) It is probable that the Vessel dropped her port anchor at around 23:36 and was set to full ahead at around 23:40, but the Vessel continued to drift toward the back of the port (southerly direction) while heading north, and that the Vessel advanced northeast while headed toward outside of the port, but ship maneuvering became difficult when drifting influenced by the wind and waves became pronounced at around 00:07 on October 23.

(6) It is probable that, at around 00:15, the Vessel received a gust from the starboard side, drifted to the port side (westerly direction), and ran aground on tetrapods on the eastern side of the Breakwater.

### 3.1.2 Date, Time and Location of the Accident Occurrence

According to 2.1.1, 2.1.2, and 3.1.1, it is highly probable that the date and time of occurrence of the accident was at around 00:15 on October 23, 2017, and the location was around 241° true bearing, 220 m from the Lighthouse on Toyama East Breakwater of Fushiki-Toyama Port.

### 3.1.3 Hull Damage

According to 2.1.2 and 2.3, it is highly probable that the Vessel was a total loss, as the area

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[*17] "IMS Code" refers to the International Safety Management Code for the Safe Operation of Ships and for Pollution Prevention. It was adopted at an International Maritime Organization (IMO) convention on November 4, 1993, for the purposes of ensuring the safe navigation of vessels and protecting the ocean environment. It was incorporated into the Annex of the 1974 SOLAS Convention and entered into effect on July 1, 1998, following a revision of the SOLAS Convention in 1994. It applies to all passenger vessels as well as all vessels with a gross tonnage of 500 tons or more that engage in international navigation.

near her midship was fractured to a large extent and there were breaches, cracks, and dents in all parts of the hull.

## 3.2 Causal Factors of the Accident

### 3.2.1 Situation of Crew Members

According to 2.4, it is probable that the situation was as follows.

(1) The Master and the Chief Officer possessed legally valid endorsements attesting the recognition of certificate under STCW regulation 1/10 and were in good health at the time of the accident.

(2) The Master came aboard the Vessel as master in around October 2013 and had experienced entering Fushiki-Toyama Port on many occasions.

(3) The Chief Officer came aboard the Vessel as second officer in July 2017, became her chief officer in October, and had experienced entering Fushiki-Toyama Port on many occasions.

### 3.2.2 Condition of the Vessel

According to 2.5.3 and 2.5.4, it is probable that the situation was as follows.

(1) The Vessel was nearly in ballast at the time of the accident, with a draft of approximately 1.80 m at the bow and approximately 4.70 m at the stern.

(2) There was no malfunction or failure in the hull or machineries on the Vessel at the time of the accident.

(3) There was malfunction or failure associated with the gyro signal on the Vessel at the time of the accident.

### 3.2.3 Weather and Sea Conditions

According to 2.6, it is probable that the situation was as follows.

(1) Ocean waves

Waves coming from the north-northeast were intensifying. In the vicinity of the Berth where the first mooring rope broke (around 22:38 on October 22), waves with a height of 0.92 meters, period of 8.2 seconds, and wavelength of approximately 71 meters were coming in, while in the vicinity of the Breakwater just before the Vessel ran aground (around 00:11 on October 23), waves with a height of 1.62 meters, period of 8.9 seconds, and wavelength of approximately 85 meters were coming in.

(2) Wind Direction and Wind Speed

Within the port, a north-northeasterly wind began to intensify around 10:00 on October 22, exceeded 20 m/s at around 18:00 on the same day, and continued to intensify until before dawn on October 23. Winds with speeds exceeding 20 m/s continued for approximately 6 hours. In particular, very strong winds with a speed of between 21.3 and 22.6 m/s blew between around 22:00 on October 22 and 00:00 on October 23.

(3) Tide

The tide in the Toyama Section of Fushiki-Toyama Port at the time of the accident was in the mid-stage of an incoming tide and the height of tide was approximately 34 cm.

### 3.2.4 Analysis of External Forces within the Port

According to 2.6.5, 2.7.3 and 3.2.3, it is probable that the situation was as follows.

(1) At the time of the accident, intensifying ocean waves were entering all areas of the port

from the port's exterior.

(2) At the time of the accident, the wavelengths of the waves that entered the port were between approximately 71 and 85 meters.

(3) At the time of the accident, northerly winds were intensifying, and winds with a wind speed exceeding 20 m/s had been continuing for approximately six hours.

3.2.5 Analysis of the Effects of External Forces on the Hull and Mooring Ropes

According to 2.7, 2.5.1, 3.2.3, and 3.2.4, external forces had the following effects on the hull, etc., of the Vessel moored at the Berth.

(1) Given that the Vessel was moored port-side alongside at the Berth with her bow pointed south, it is probable that the Vessel was receiving the effects of wind and waves from the stern until the first mooring rope broke and from the bow after all mooring ropes broke and she began drifting with her bow pointed north.

(2) It is probable that the hull, which was receiving wind and waves from the stern, began surging and this induced pitching and heaving.

(3) It is probable that ocean waves with wavelengths of between approximately 71 and 85 meters furthered the hull's surging and that excessive load came to be placed on the mooring ropes in association with this.

(4) Given that the mooring ropes had been made slack, it is somewhat likely that the mooring ropes were not receiving load evenly and, further, that variation in tension on individual ropes became repeated with the hull's motion, resulting in the occurrence of snap loads*18 on the mooring ropes.

3.2.6 Analysis of the Master's Awareness and Actions

According to 2.1, 2.7, and 2.8, the situation was as follows.

(1) Given that the Master planned to conduct cargo handling at the Berth and that he thought that the effects of the approaching typhoon would not exceed those of his previous experience, it is probable that the Master added mooring ropes as he did in previous times of heavy weather but continued mooring at the Berth without considering evacuation.

(2) It is somewhat likely that the Master thought the effects of the approaching typhoon would not exceed what he had experienced before because of the following.

1) He understood as typhoon information from Japan Coast Guard that the wind speed was around 23 m/s.

2) From information he obtained from the internet, he was aware that the wind speed was 17.5 m/s.

3) The vigilance advisory and evacuation advisory from Fushiki-Toyama Port's harbor master and the Stage of Alert and Stage of Evacuation of the Typhoon Countermeasures Council had not been communicated from the Agent to the Vessel.

4) The Master did not personally ask the Agent for typhoon information.

(3) Given that the Master received information from a Japan Coast Guard employee who visited the Vessel and initial typhoon information from the internet, and given that he only became aware that the situation was out of the ordinary when the mooring ropes broke, it is somewhat likely that he did not continuously obtain necessary typhoon information or predict weather and sea conditions based upon it.

*18 "Snap load" refers to a shock load that is applied to a mooring rope by a hull's motions.

(4) Given that when the Master added mooring ropes, all of the ropes were made fast in a slack state and none were taut, it is probable that he did not have accurate knowledge of the berth mooring method in heavy weather.

### 3.2.7 Analysis of the Vessel's Mooring Ropes and Mooring Method

According to 2.5, 2.7, 2.9, and 2.10, the situation was as follows.

(1) Given that, based on the appearance inspection by the Manufacturer, fuzzing was observed in all lines and traces of melting and broken strands were seen in some ropes, and that some ropes had decreased strength with a breaking load confirmed to be at least 30% below the standard load in the tension test, it is probable that fatigue degradation and age degradation had occurred in the mooring ropes the Vessel used at the time of the accident.

(2) It is somewhat likely that the mooring ropes that the Vessel was using at the time of the accident did not have the "sufficient safe working load" stipulated in international standards.

(3) It is somewhat likely that the mooring ropes that the Vessel was using at the time of the accident were not inspected with consideration for the description of inspection and retirement that is provided in the Mooring Equipment Guidelines (3rd Edition).

(4) According to the results of measurement by the Manufacturer, it is highly probable that the diameters of the mooring ropes that the Vessel was using at the time of the accident were between 55 and 72 mm and that ropes of different diameters were used together, and it is somewhat likely that load was not being borne equally by the ropes.

(5) Given that, although additional mooring ropes were added in preparation for heavy weather, the Vessel was moored in a state in which ropes of different diameters were used together and all of the ropes were made fast in a slack condition with none being taut, it is somewhat likely that the addition of mooring ropes was not effective.

### 3.2.8 Analysis of the Mooring Ropes' Breaking

According to 2.6, 2.7.3, 2.8.1, 2.8.3, 3.2.5, and 3.2.7, the situation was as follows.

(1) Given that the Vessel was receiving wind and waves from the stern that expedited the hull's motion for the reason and load exceeding the strength of the mooring ropes being used was being applied, it is probable that the aft mooring ropes broke because the Vessel was using mooring ropes with reduced strength that resulted from fatigue degradation and age degradation while she was moored at the Berth.

(2) It is probable that the aft mooring ropes broke first, which caused the load that was being borne by the broken ropes to be distributed to the other mooring ropes, and said load was joined with the load that was already being applied to each mooring rope, creating a condition of overload, which resulted in mooring ropes' breaking one after another, beginning with the mooring ropes having a low breaking load, until all of the mooring ropes broke.

(3) It is somewhat likely that, although additional mooring ropes had been added under conditions in which external force was being applied by heavy weather, the use of multiple mooring ropes of different diameters and the fact that the Vessel was moored with ropes made slack contributed to the breaking of the mooring ropes.

### 3.2.9 Analysis of Ship Maneuvering after All of the Mooring Ropes Broke

According to 2.1 and 3.1.1, it is probable that the situation was as follows.

(1) At around 22:38, the Master ordered preparations to start the main engine because the first of the aft mooring ropes had broken.

(2) At around 23:30, the Vessel's stern separated from the Berth by approximately 5 to 10 meters and the hull began rotating counterclockwise, and, at around 23:32, the Vessel's fore-and-aft line and the Berth became nearly perpendicular.

(3) At around 23:35, the Vessel began drifting toward the back of the port (southern direction) because all of her mooring ropes had broken.

(4) The Master ordered the port anchor dropped at around 23:36 to suppress the drifting and ordered the main engine set at full ahead at around 23:40. However, the Vessel continued drifting in a southerly direction and drifted near Berth 5 at around 23:56.

(5) The Master attempted to proceed northeast while headed toward the port's entrance by continuing to use engine and rudder as appropriate; nonetheless, at around 23:59, the Vessel drifted to the west and approached Berth 8.

(6) At around 00:02 on October 23, the Master again began heading the Vessel toward the port's entrance and attempted to proceed outside of the port at full ahead with a speed of approximately 2.5 kn. However, at around 00:07, the effect of the wind and waves became pronounced, and the Vessel's speed dropped even more and ship maneuvering became difficult as she approached the western side of Berth 10.

(7) The Master continued attempting to head toward the port's entrance but the Vessel continued drifting toward the west, and, at around 00:15, the Vessel received a gust from the starboard direction, drifted even further to port (western direction), and ran aground on tetrapods.

(See Figure 7 "Outline Map of the Course of the Accident Events")

3.2.10 Analysis of Safety Management

Concerning the provision of information on safety management, it was not possible to determine the circumstances of the Vessel's safety management because cooperation could not be obtained from Company A and sufficient information beyond that mentioned in 2.11.2 could not be obtained from the recognized organization.

3.2.11 Analysis of the Accident's Occurrence

According to 3.1.1 and 3.2.4 to 3.2.9, the analysis of the accident was as follows.

(1) It is highly probable that the Vessel conducted cargo loading and then subsequently decided to wait at the Berth for Typhoon 21 to pass.

(2) Given that the Master planned to conduct cargo handling at the Berth, and that he thought that the effects of the approaching typhoon would not exceed those of his previous experience, without continuously obtaining necessary typhoon information or predicting weather and sea conditions based upon it, it is probable that the Master added mooring ropes as he did in previous times of heavy weather but continued mooring at the Berth without considering evacuation.

(3) It is probable that the Vessel's mooring ropes broke beginning with the aft ropes because she was under the effects of wind and waves from the stern that expedited the hull's motion for the reason, causing load that exceeded the strength of the mooring ropes to be applied to them for the reason that the Vessel was using mooring ropes with reduced

strength that resulted from fatigue degradation and age degradation while she was moored at the Berth in heavy weather caused by the typhoon.

(4) It is probable that the aft mooring ropes broke, which caused the load that was being borne by the broken ropes to be distributed to the other mooring ropes and created a condition of overload, which resulted in mooring ropes' breaking one after another, beginning with the mooring ropes having a low breaking load, until all of the mooring ropes broke.

(5) It is somewhat likely that, although additional mooring ropes had been added under conditions in which external force was being applied by heavy weather, the use of multiple mooring ropes of different diameters together and the fact that the Vessel was moored with ropes made slack contributed to the breaking of the mooring ropes.

(6) Given that the mooring ropes broke, it is probable that Vessel drifted within the port and that subsequently, although she attempted to head outside of the port, using her engine, ship maneuvering became difficult due to the effects of the wind and waves and she drifted and ran aground on tetrapods on the eastern side of the Breakwater.

# 4 PROBABLE CAUSES

It is probable that, while the Vessel was moored at the Berth near the port's entrance at night, under conditions in which Typhoon No. 21 was approaching, she drifted within the port because her mooring ropes broke and subsequently, although she attempted to head outside of the port using her engine, she came under the effects of the wind and waves, ship maneuvering became difficult, and she drifted and ran aground on tetrapods.

It is probable that the Vessel's mooring ropes broke because she was under the effects of the wind and waves that expedited the hull's motion for the reason that she was using mooring ropes with reduced strength that resulted from fatigue degradation and age degradation, and consequently load that exceeded the strength of the mooring ropes being used was applied to them.

It is somewhat likely that, although he added additional mooring ropes, the Master's use of multiple mooring ropes of different diameters together and mooring of the Vessel with ropes made slack contributed to the breaking of the mooring ropes.

# 5 SAFETY ACTIONS

It is probable that, while the Vessel was moored at the Berth near the port's entrance, under conditions in which Typhoon No. 21 was approaching, she drifted within the port because her mooring ropes broke under the effects of the wind and waves caused by the typhoon and subsequently, although she attempted to head outside of the port using her engine, ship maneuvering became difficult and she drifted and ran aground on tetrapods.

It is probable that the Vessel's mooring ropes broke because she was under the effects of external forces for the reason that she was using mooring ropes with reduced strength and because load that exceeded the strength of the mooring ropes being used was thus applied to them, and it is somewhat likely that, although additional mooring ropes were added, the use of multiple mooring ropes of different diameters together and the mooring of the Vessel with ropes made slack contributed to their breaking.

Accordingly, the masters and management companies of foreign-flagged vessels that visit Japanese ports must implement the following measures to prevent occurrence of a similar accident.

(1) For the use of mooring ropes, masters must appropriately conduct maintenance inspections, must not use ropes that have lost strength from degradation, and must not use ropes of different diameters together. Additionally, regarding the berth mooring method in heavy weather, masters must appropriately add mooring ropes by, for example, adding tension so that load is distributed evenly.

(2) When heavy weather attributable to a typhoon or other phenomenon is predicted, masters must

1) Strive to accurately ascertain and predict weather and sea conditions;

2) Accurately ascertain port characteristics; and

3) Based on 1) and 2) above, quickly execute necessary heavy-weather countermeasures, including considering evacuation.

In doing so, masters must be wary against becoming overconfident in their own abilities and experience and easily taking an optimistic view based on assumptions resulting from habit, even in ports in which they have plentiful experience entering and leaving.

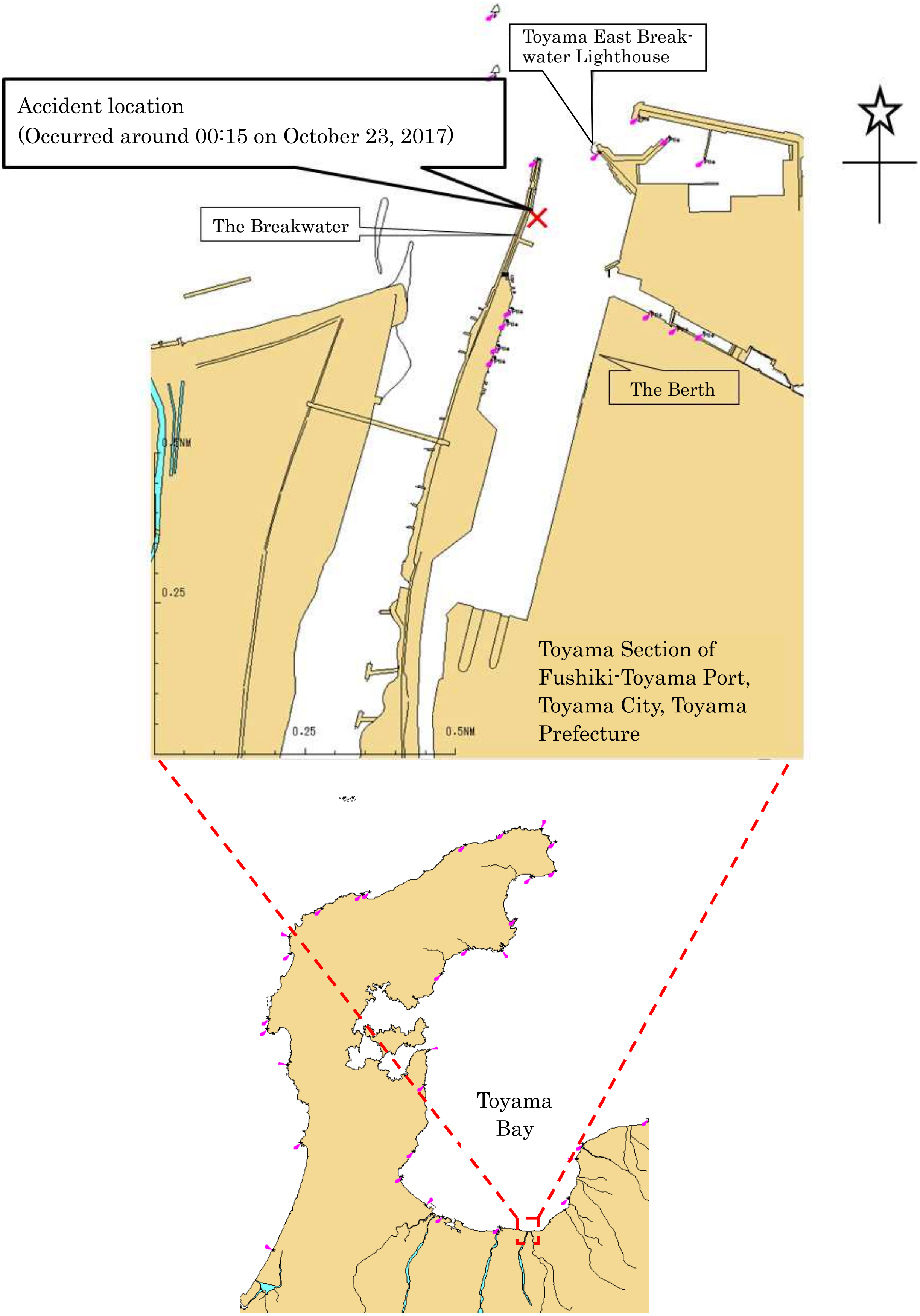
(3) Management companies must fully provide notification concerning the points mentioned in (1) and (2) above to masters and crew members on the ships they manage, using examples of past accidents, including this accident, that have occurred in Fushiki-Toyama Port for illustration. In particular, management companies must provide re-education that addresses the use of inappropriate mooring methods—namely, mooring with slack mooring ropes—and have their masters and crew members act accordingly.

Additionally, when foreign-flagged vessels stop at ports, the personnel concerned should bear in mind the following two points, particularly when heavy weather is predicted.

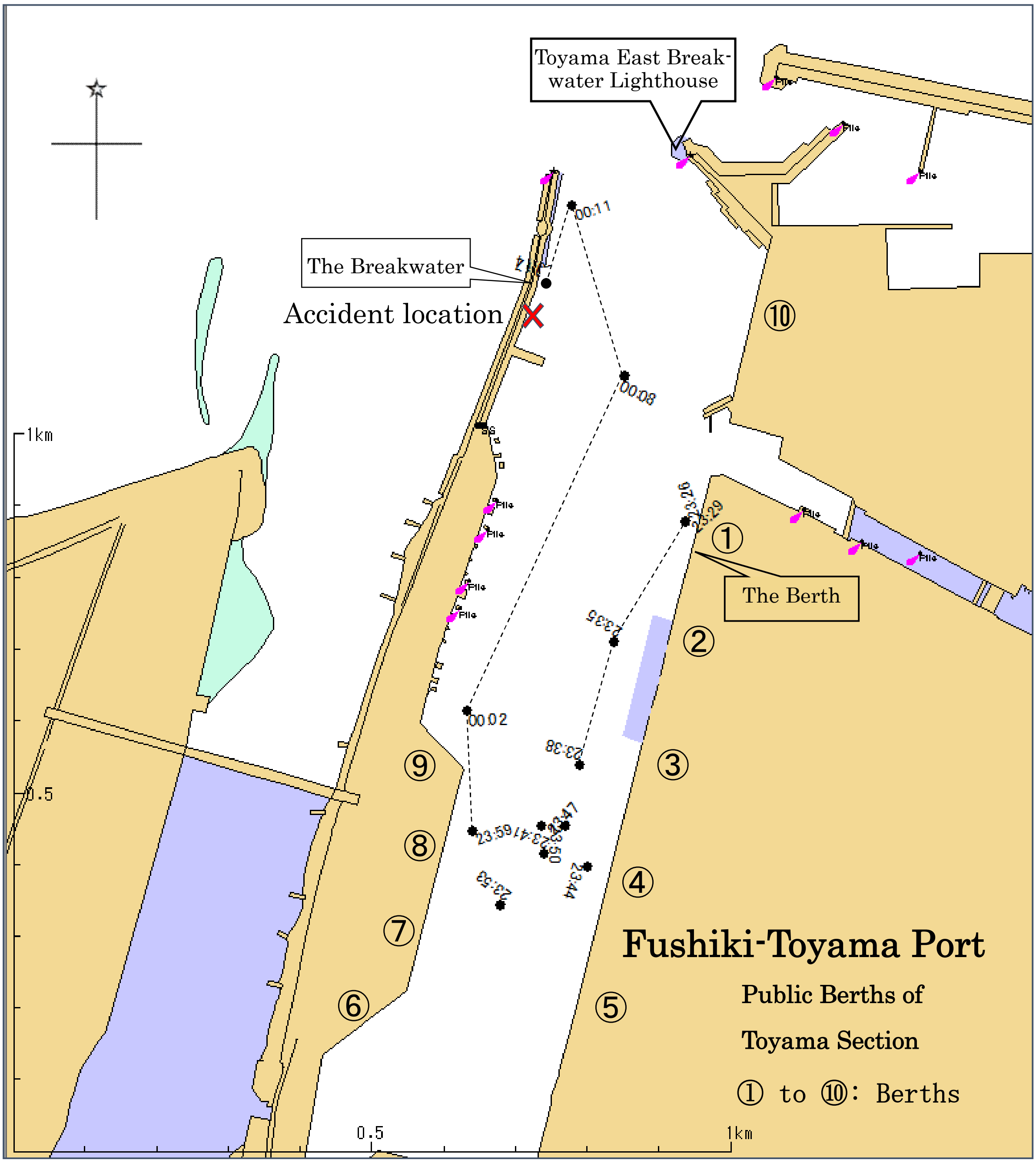
1 Bear in mind that the masters of vessels entering port may not have sufficient experience in evacuating from typhoons, awareness of the dangers of typhoons, or ability to obtain information concerning typhoon courses and sea areas of refuge or to predict them, even if they have plentiful experience entering and leaving the port.

2 Based on 1 above, rigorously maintain a system for the smooth and precise sharing of information on the weather and other matters, for actively providing information to concerned masters and vessels, and for executing evacuations.

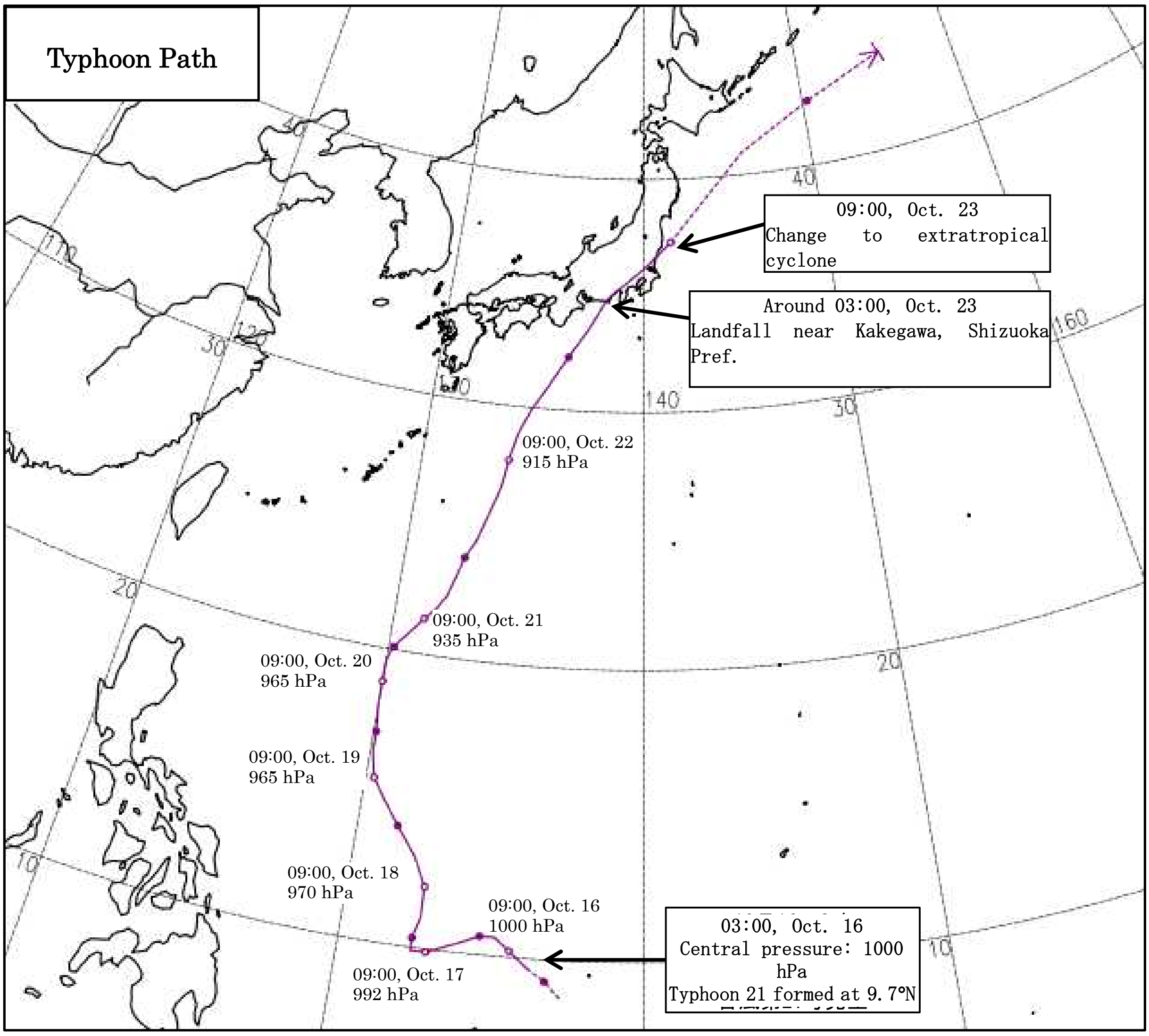
# Annex Figure 1　Outline Map of the Accident Location



# Annex Figure 2　Estimated Navigation Route



# Annex Figure 3　Path of Typhoon No. 21

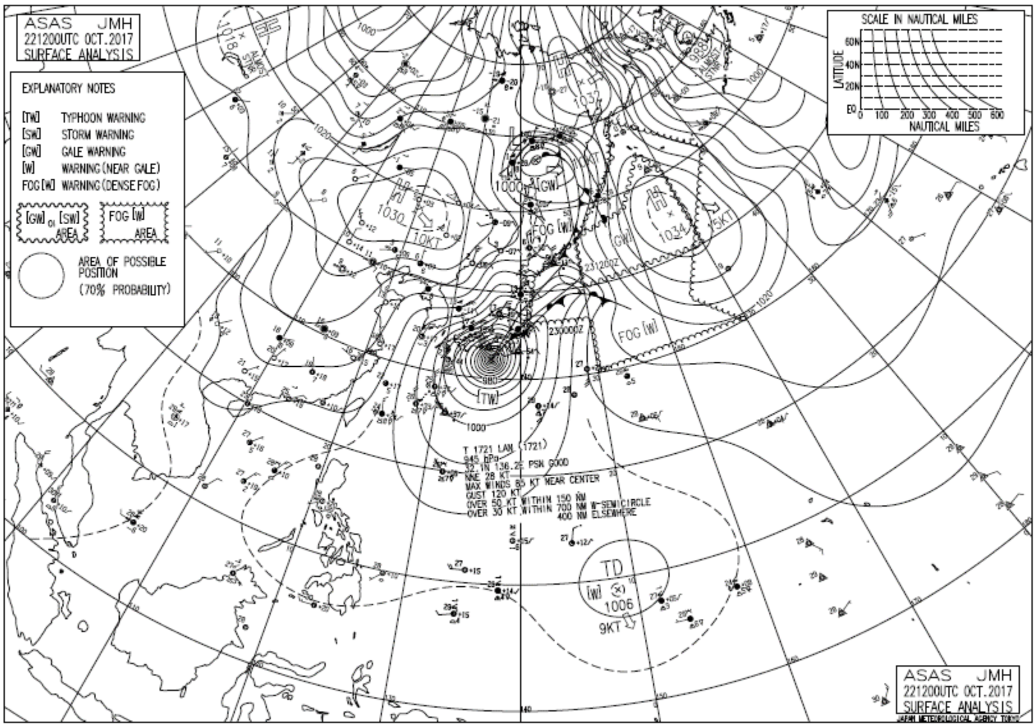



The "○" symbols on the route indicate position at 9:00 am on the date appearing next to the individual symbol and the "●" symbols indicate position at 9:00 pm. The "→|" symbol indicates the system's dissipation.
The solid line on the path indicates the time the system was classified as a typhoon, and the broken lines indicates the times it was classified as a tropical cyclone or extratropical cyclone.

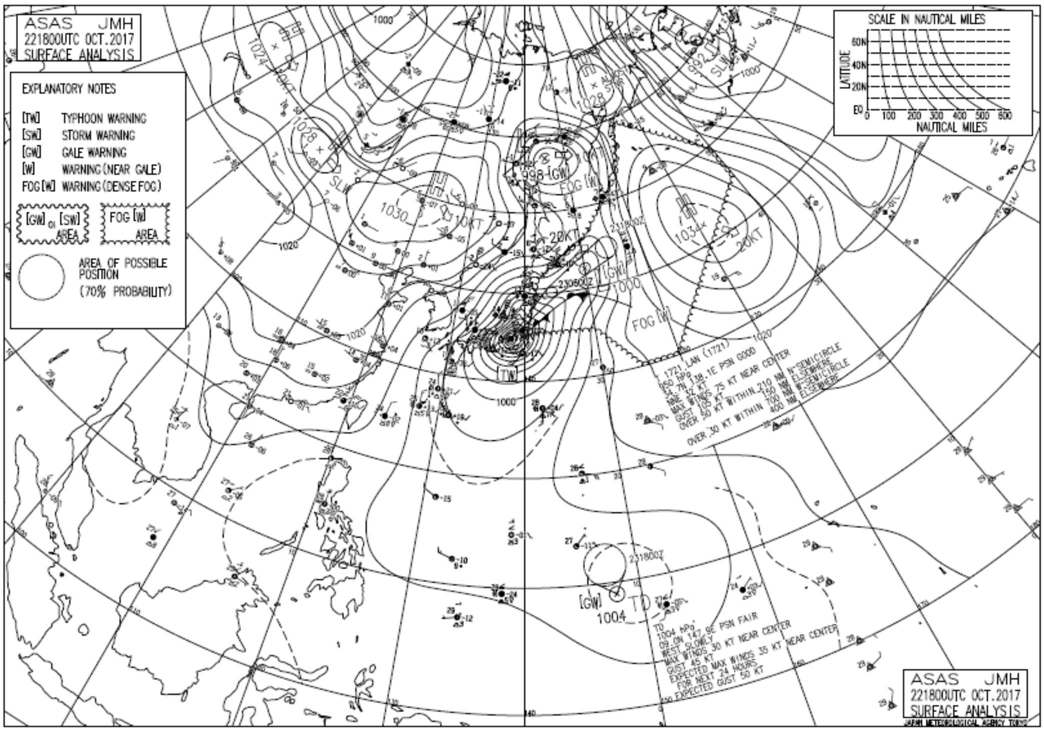
Source: Japan Meteorological Agency

# Annex Figure 4　Weather over the Asia-Pacific Region

21:00, October 22

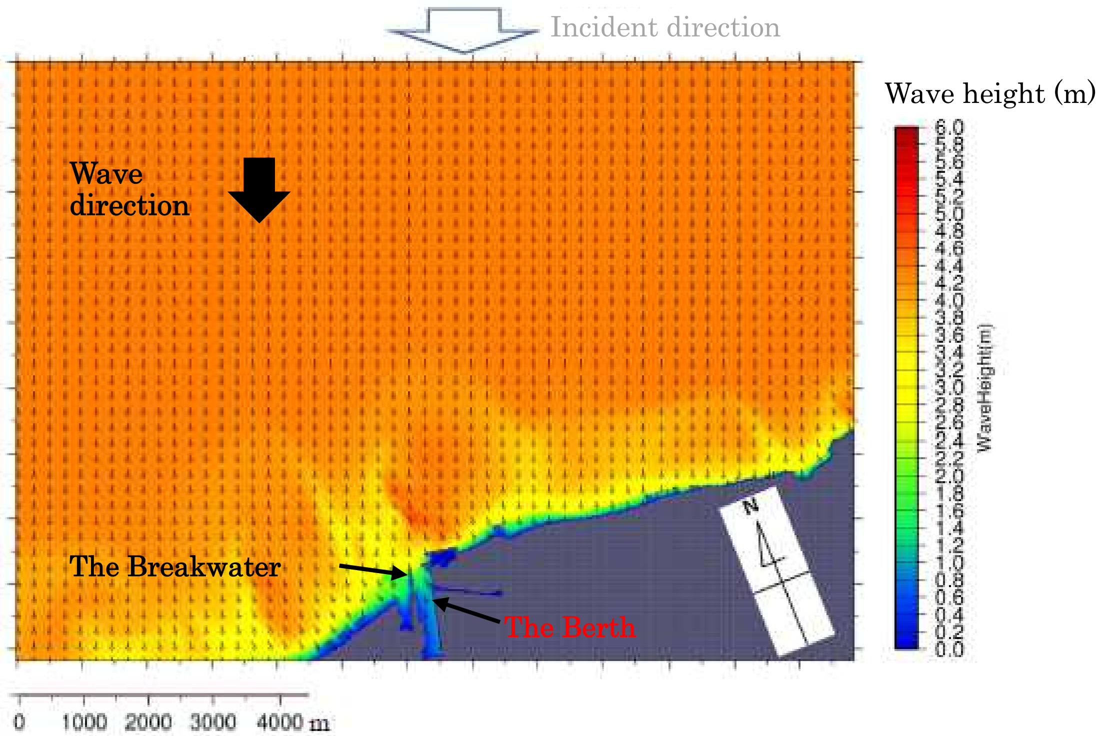



03:00, October 23

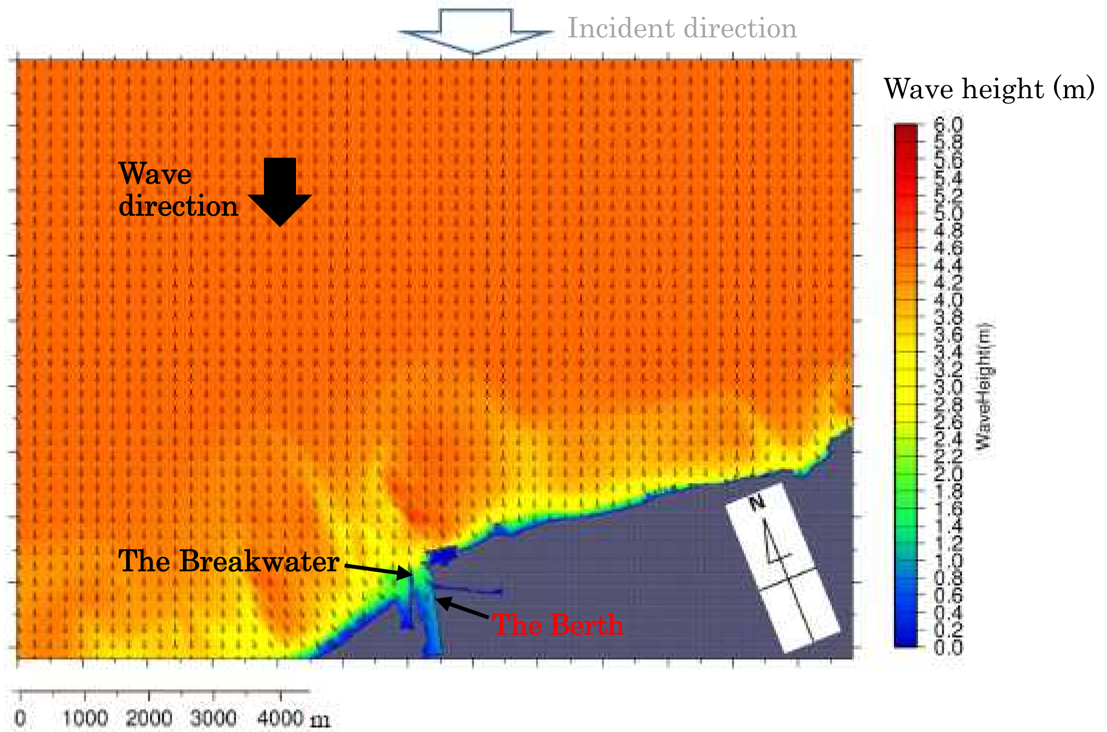



Source: Japan Meteorological Agency

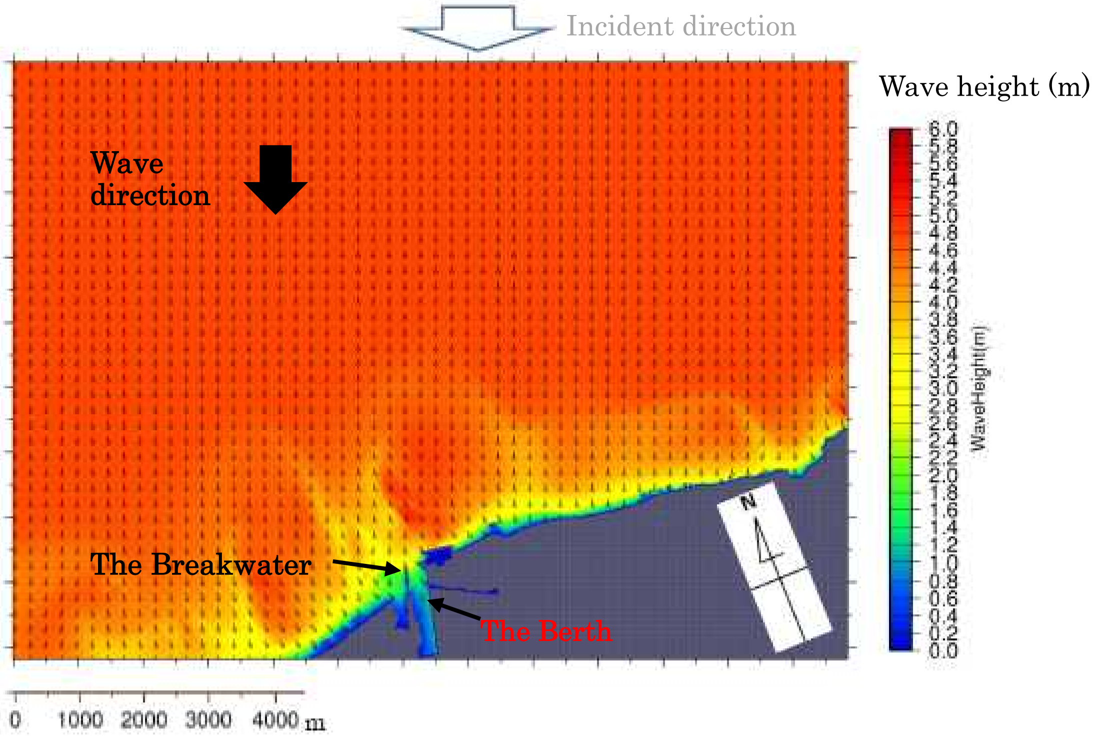
# Annex Figure 5 Distributions of Wave Height and Wave Direction Outside the Port




Distributions of Wave Height and Wave Direction Outside the Port (22:00, Oct. 22)

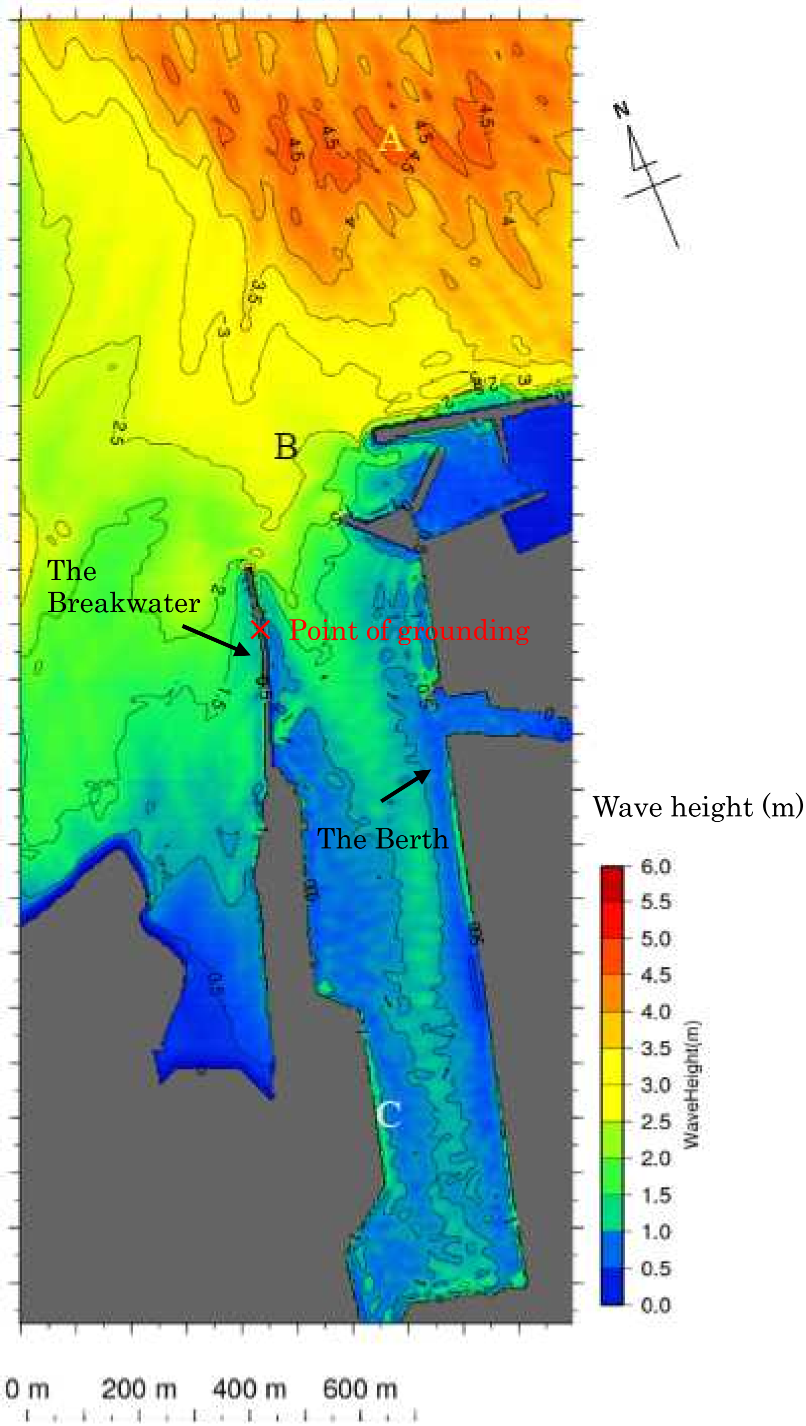



Distributions of Wave Height and Wave Direction Outside the Port (23:00, Oct. 22)

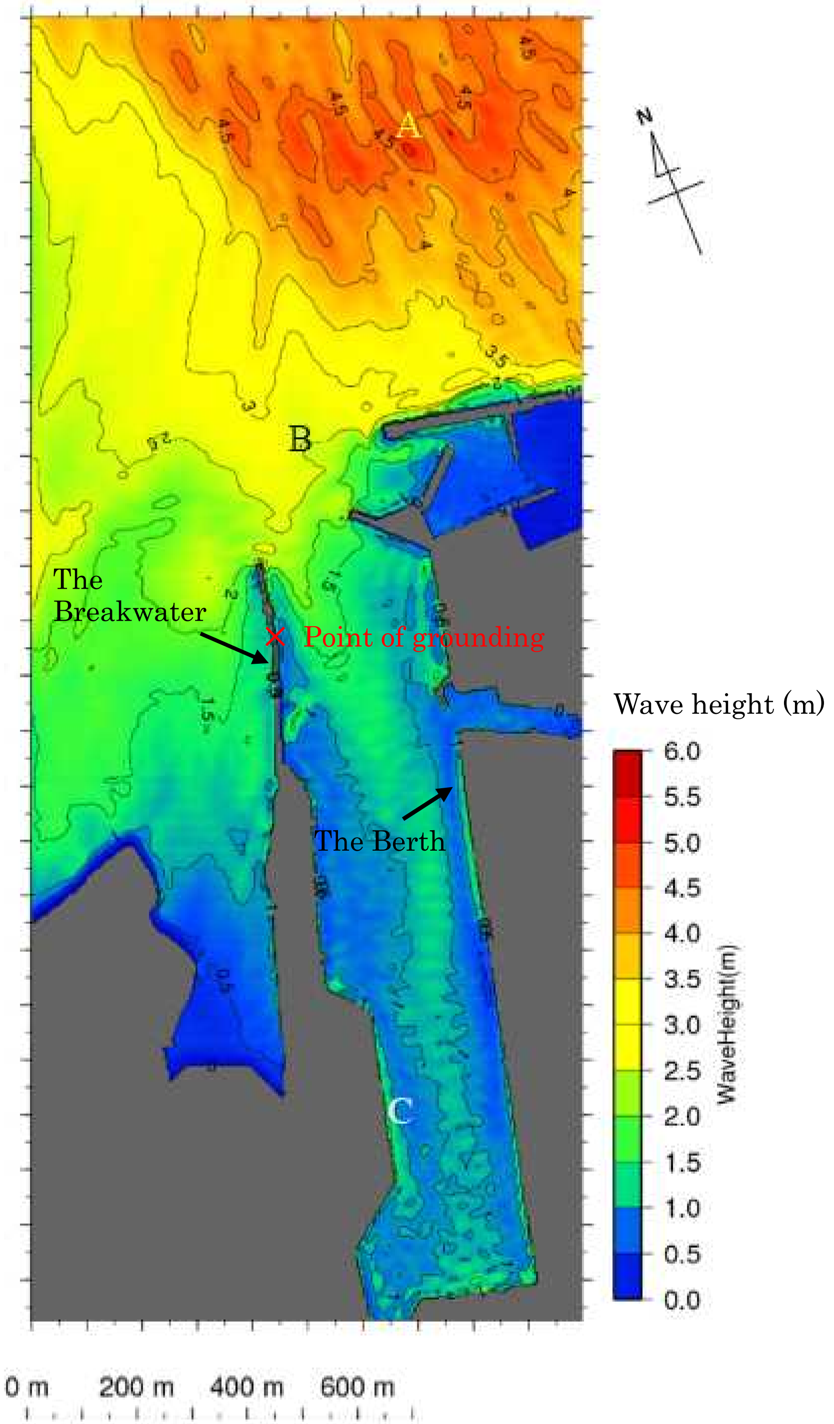



Distributions of Wave Height and Wave Direction Outside the Port (00:00, Oct. 23)

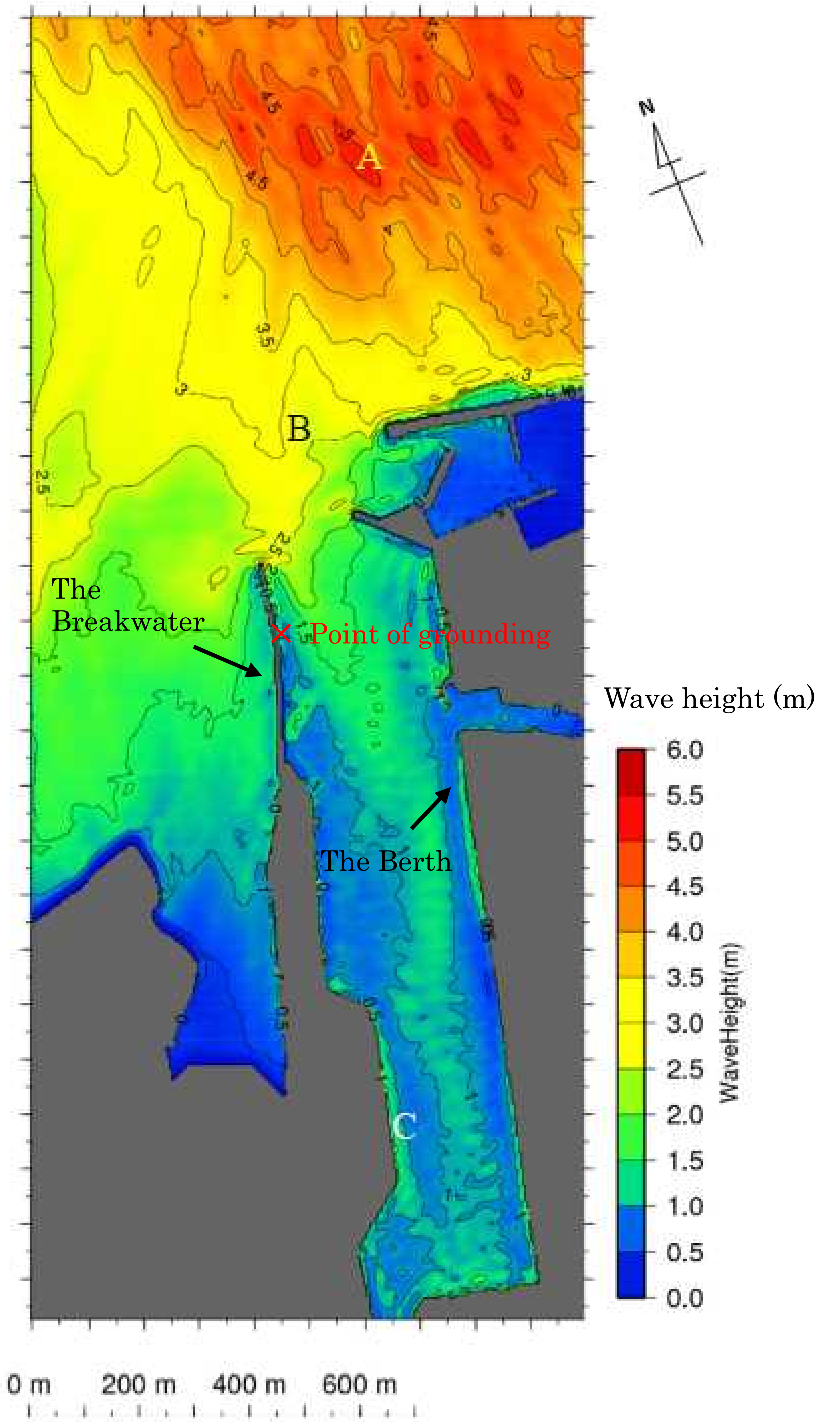
# Annex Figure 6　Wave Height in the Port




Wave Height Inside the Port (22:00, Oct. 22)




Wave Height Inside the Port (23:00, Oct. 22)




Wave Height Inside the Port (00:00, Oct. 23)

## Annex Figure 7　Outline Map of the Course of the Accident Events