Inquiry MO-2014-202: lifting sling failure on freefall lifeboat, general cargo ship *Da Dan Xia*, Wellington, 14 April 2014

Final Report

Marine inquiry MO-2014-202
lifting sling failure on freefall lifeboat,
general cargo ship *Da Dan Xia*, Wellington
14 April 2014

Approved for publication: February 2015

Transport Accident Investigation Commission

About the Transport Accident Investigation Commission

The Transport Accident Investigation Commission (Commission) is a standing commission of inquiry and an independent Crown entity responsible for inquiring into maritime, aviation and rail accidents and incidents for New Zealand, and co-ordinating and co-operating with other accident investigation organisations overseas. The principal purpose of its inquiries is to determine the circumstances and causes of the occurrences with a view to avoiding similar occurrences in the future. Its purpose is not to ascribe blame to any person or agency or to pursue (or to assist an agency to pursue) criminal, civil or regulatory action against a person or agency. The Commission carries out its purpose by informing members of the transport sector and the public, both domestically and internationally, of the lessons that can be learnt from transport accidents and incidents.

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Important notes

Nature of the final report

This final report has not been prepared for the purpose of supporting any criminal, civil or regulatory action against any person or agency. The Transport Accident Investigation Commission Act 1990 makes this final report inadmissible as evidence in any proceedings with the exception of a Coroner's inquest.

Ownership of report

Citations and referencing

Information derived from interviews during the Commission's inquiry into the occurrence is not cited in this final report. Documents that would normally be accessible to industry participants only and not discoverable under the Official Information Act 1980 have been referenced as footnotes only. Other documents referred to during the Commission's inquiry that are publicly available are cited.

Photographs, diagrams, pictures

Unless otherwise specified, photographs, diagrams and pictures included in this final report are provided by, and owned by, the Commission.

The *Da Dan Xia* in Wellington, April 2014

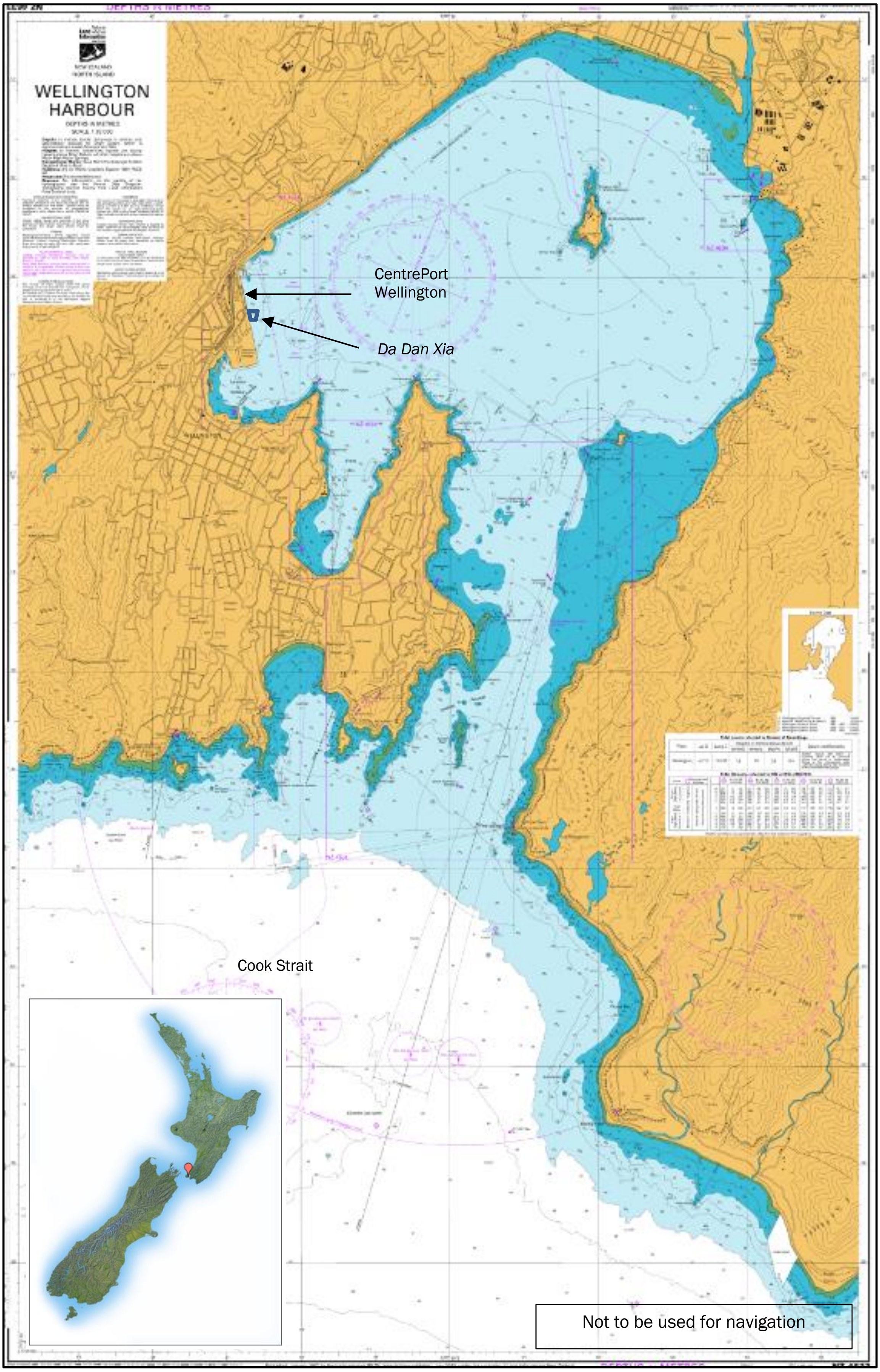

Chart NZ 4633 Wellington Harbour

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Abbreviations

IMO	International Maritime Organization
SOLAS	International Convention for the Safety of Life at Sea, 1974

Glossary

boatswain	an experienced petty officer who is foreman of the seamen
davit	a steel fitting on a ship for the attachment of tackle for hoisting and lowering a lifeboat
factor of safety	a term describing the structural capacity of a system beyond the expected load or actual load; essentially, how much stronger the system is than it usually needs to be for an intended load
falls	a rope by which a boat is hoisted or lowered
ferrule	a circular clamp used to hold together and attach wires
freefall lifeboat	an enclosed lifeboat that is designed to slide down a ramp and off the ship when the lifeboat's securing hook is disengaged
gelcoat	a material used to provide a high-quality finish on the visible surface of a fibre-reinforced composite material
Polymer	A polymer is a natural or synthetic compound that consists of large molecules made of many chemically bonded smaller, identical molecules, such as nylon and some other plastics.
thimble	a metal insert fitted to the inside of an eye formed at the end of a rope to prevent the rope chaffing when attached to another object

Data summary

Vehicle particulars

Name:	*Da Dan Xia*
Type:	general cargo ship
Class:	09R0175
Limits:	SOLAS
Classification:	China Classification Society
Length overall:	159.3 metres
Moulded breadth:	27.4 metres
Gross tonnage:	20,949
Built:	31 July 2008
Propulsion:	one direct-drive, single-screwed, reversible crosshead diesel engine: Man B&W 6S40ME-B9
Service speed:	15.2 knots
Owner/operator:	COSCOL (HK) Investment and Development Co. Limited
Port of registry:	Hong Kong
Minimum crew:	14

Date and time	14 April 2014, 1100[1]
Location	Wellington, New Zealand
Persons involved	four
Injured	one
Damage	lifeboat lifting sling parted

[1] Times in this report are New Zealand Standard Time (co-ordinated universal time + 12 hours), and are expressed in the 24-hour format.

1. Executive summary

1.1. On 14 April 2014 the general cargo vessel *Da Dan Xia* was berthed at the port of Wellington, New Zealand, preparing to load a cargo of logs. The crew were conducting a launch-and-retrieval drill for the vessel's freefall lifeboat[2], using the "alternative" launching and retrieval davit[3].

1.2. The lifeboat was lowered into the water with no crew on board. Four crew members then boarded the lifeboat and manoeuvred it around the harbour for 10 minutes before connecting it back to the retrieval davit. A purpose-built lifting sling made up of four wire rope pennants was used to connect the lifeboat to the retrieval davit. Once the crew were seated with their restraints fastened, hoisting the lifeboat from the water commenced. The lifeboat had been hoisted to about deck level when first one and then the remaining three wire pennants parted and the lifeboat fell several metres back into the sea.

1.3. Meanwhile, one of the crew members had released his restraints in anticipation of disembarking the lifeboat. He was thrown clear of his seat and sustained a cut to the head, requiring overnight hospitalisation. None of the other three crew members was seriously injured. The lifeboat was undamaged.

1.4. The Transport Accident Investigation Commission (Commission) found that the wire pennants parted under tensile overload because they had all been significantly weakened by severe corrosion. Corrosion had gone undetected inside a plastic sheathing that the manufacturer of the lifting sling had placed around the wire pennants.

1.5. The presence of the plastic sheathing encasing the wire rope meant that neither the crew nor the various surveyors tasked with inspecting the launching system could inspect and maintain the wire rope as required by the International Maritime Organization Convention for the Safety of Life at Sea, 1974.

1.6. The Commission found that encasing steel wire in plastic sheathing when it is to be used in the marine environment has significant implications for maritime safety, especially when the wire must be regularly inspected and maintained in order to remain fit for purpose. A recommendation was made to the Director of Maritime New Zealand to raise this safety issue through the appropriate International Maritime Organization safety committee.

1.7. The Commission also recommended that the manufacturer of the lifeboat and the lifting sling cease the practice of totally encasing wire rope pennants with plastic, and inform all owners and operators using its system of this accident and the danger of leaving the wires encased with plastic sheathing.

1.8. The operator of the *Da Dan Xia* took the safety action of removing the plastic sheathing from all similar lifting slings in its fleet of ships.

1.9. A key safety lesson arising from this inquiry is that seafarers and surveyors alike must not make assumptions about the condition of any wire or other equipment that they cannot see, especially when the wire or other equipment has a safety-critical purpose and is required by rules, regulations or procedures to be thoroughly examined.

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[2] A freefall lifeboat is an enclosed lifeboat that is designed to slide down a ramp and off the ship when the lifeboat's securing hook is disengaged.

[3] A davit is a steel fitting on a ship for the attachment of tackle for hoisting and lowering a lifeboat.

2. Conduct of the inquiry

2.1. Maritime New Zealand notified the accident to the Transport Accident Investigation Commission (Commission) at about 1400 on 14 April 2014. The Commission opened an inquiry under section 13(1) of the Transport Accident Investigation Commission Act 1990, and appointed an investigator in charge.

2.2. Two investigators from the Commission boarded the ship the same day, to gather evidence and become familiar with the ship's freefall lifeboat and associated equipment.

2.3. The master of the ship was interviewed the following day, 15 April 2014, and copies of relevant documents were obtained from the ship.

2.4. The Commission retained the damaged wire slings for metallurgical analysis and engaged the New Zealand Defence Technology Agency to determine the failure mode of the wire slings.

2.5. Data was also sourced from the manufacturer of the freefall lifeboat, the ship's owner and the ship's classification society.

2.6. Global research was conducted to identify other occurrences involving the failure of plastic-encased wire rope.

2.7. On 19 November 2014 the Commission approved a draft final report for circulation to interested persons.

3. Factual information

3.1. Narrative

3.1.1. On 11 April 2014 the general cargo ship *Da Dan Xia* arrived at the port of Wellington. The ship was due to load a cargo of logs before departing for China.

3.1.2. The master had obtained prior permission from the harbourmaster to conduct a routine lifeboat-launching exercise while the ship was berthed in Wellington. The exercise was scheduled for 14 April 2014.

3.1.3. On the morning of 14 April 2014, the master and 10 crew members prepared the ship's freefall lifeboat for the scheduled exercise.

3.1.4. The lifeboat was designed to slide down a ramp and fall freely into the water (freefall launching). However, for training purposes it could also be lowered into the water using a galvanised wire lifting sling arrangement (see Figure 1).

3.1.5. The wire used to make the lifting sling had a fibre rope core and was galvanised. Each wire rope terminated in an eye passed around a thimble[4] and fastened with a circular ferrule[5] clamp. The length of the wire rope between the clamps was encased in a polymeric[6] sheathing. This sheathing was provided to stop the steel wire scratching and damaging the lifeboat exterior.

3.1.6. On the day of the accident, because of the proximity of the wharf and nearby ships, the master decided against using the freefall launching method, opting to lower the lifeboat into the water using the lifting sling.

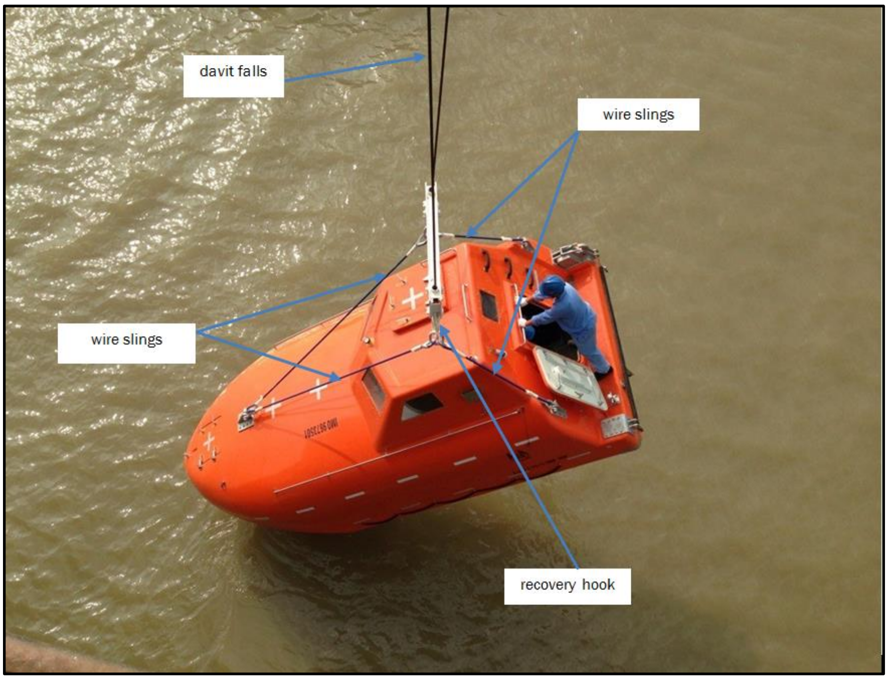


Figure 1
Location of wire slings on a similar lifeboat
(photo courtesy of Jiangyinshi Beihai LSA Co., Limited, China)

[4] A thimble is a metal insert fitted to the inside of an eye formed at the end of a rope to prevent the rope chaffing when attached to another object.
[5] A ferrule is a circular clamp used to hold together and attach wires.
[6] A polymer is a natural or synthetic compound that consists of large molecules made of many chemically bonded smaller, identical molecules, such as nylon and some other plastics.

3.1.7. The wire slings were attached to the lifeboat and connected to a spreader bar connected to the ship's lifeboat davit. The ship's boatswain[7] was assigned to operate the lifeboat davit, which would swing the lifeboat clear of the ship side (see the location of the davit in Figure 2). This method did not require any crew members to be on board until the lifeboat was floating in the water.

3.1.8. Before the operation commenced the master inspected the launching equipment, including the wire slings, recovery hook and high-pressure piping of the hydraulic davit.

3.1.9. At about 1100 the lifeboat was lowered into the water. The chief officer, third officer, fourth engineer and an able-bodied seaman then climbed down the embarkation ladder and boarded the lifeboat.

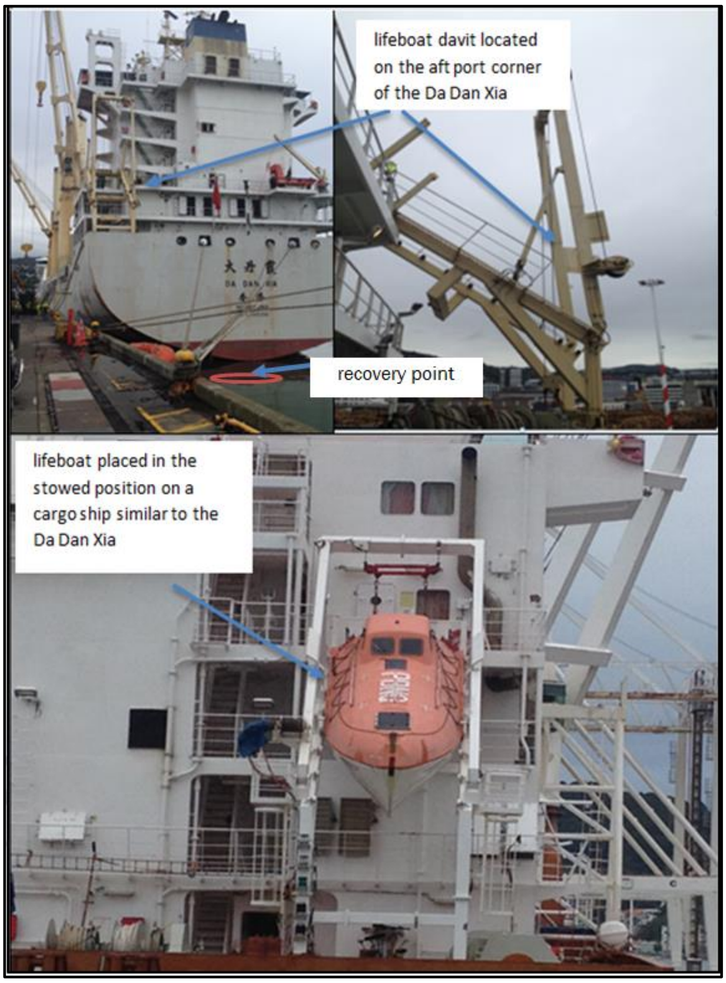


Figure 2
General arrangement of davit and freefall lifeboat

3.1.10. The lifeboat was manoeuvred within the harbour for about 10 minutes then returned to the recovery point (see Figure 2). Once the wire slings were connected to the lifeboat davit, the chief officer radioed the master and informed him that the crew were secured by their restraints and that the lifeboat was ready to be hoisted.

3.1.11. The boatswain then raised the lifeboat just clear of the water. The master made a final check to ensure that the wire slings and davit hooks were all properly connected before instructing the

[7] A boatswain is an experienced petty officer who is foreman of the seamen.

boatswain to hoist the lifeboat back into its cradle. The lifeboat crew remained on board during the entire recovery operation.

3.1.12. The lifeboat was just clearing railing at the stern when one of the four wire slings parted, followed immediately by the three remaining wire slings in quick succession. The lifeboat fell several metres to the water.

3.1.13. Some time before the wire slings parted, the third officer had removed his restraints in preparation for disembarking. When the lifeboat fell to the water the third officer was thrown off his seat and sustained a head injury. The able-bodied seaman suffered a minor injury to his thumb. The remaining two crew members were unharmed.

3.1.14. The lifeboat crew disembarked on their own and were helped ashore by port staff and the ship's crew. A member of the port staff who had witnessed the incident requested an ambulance to be dispatched.

3.1.15. At about 1140 an ambulance arrived and the injured third officer and able-bodied seaman were transported to hospital. The able-bodied seaman was discharged the same day. The third officer required 12 stitches to his head and stayed overnight in the hospital before being discharged.

3.2. Launching a freefall lifeboat

3.2.1. The International Maritime Organization (IMO) International Convention for the Safety of Life at Sea, 1974 (SOLAS) requires a freefall lifeboat to be lowered from its cradle at least once every three months. All crew members are required to board the lifeboat, secure themselves in their seats and commence launch procedures, but are not required to be actually launched. The lifeboat should then be either freefall launched with only the minimum required operating crew on board, or lowered into the water by the secondary means of launching, with or without the minimum operating crew on board.

3.2.2. At intervals of not more than six months, either the lifeboat has to be launched by freefall with only the minimum operating crew on board or a simulated launch must to be conducted in accordance with the guidelines developed by the IMO.

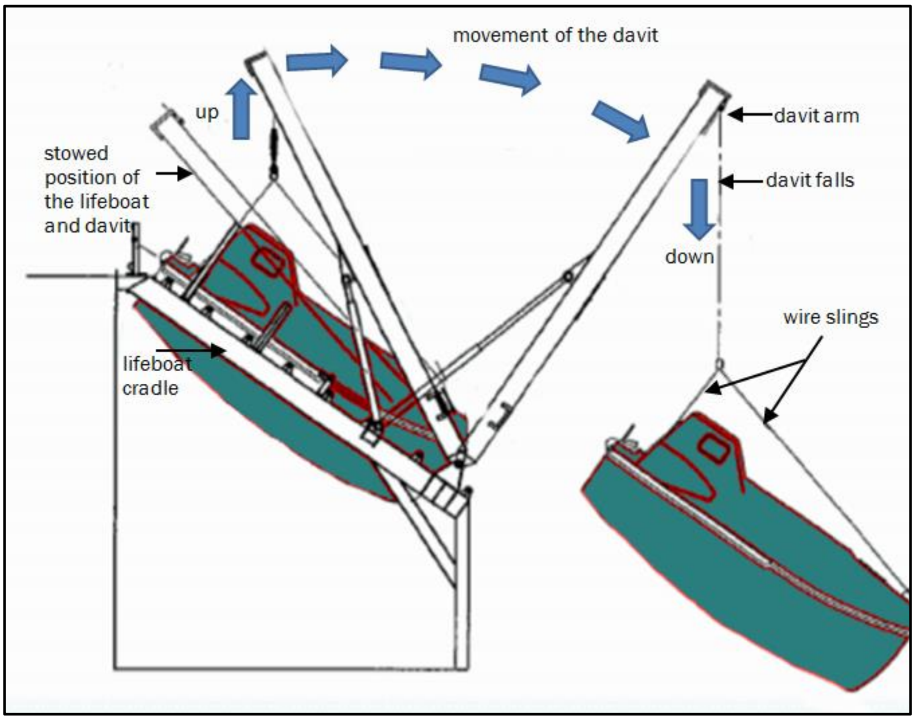


Figure 3
Lowering a freefall lifeboat by the secondary means of launching

3.2.3. The master of the *Da Dan Xia* was conducting a routine three-monthly lifeboat-launching drill. He had decided to lower the lifeboat by the designated secondary means for launching.

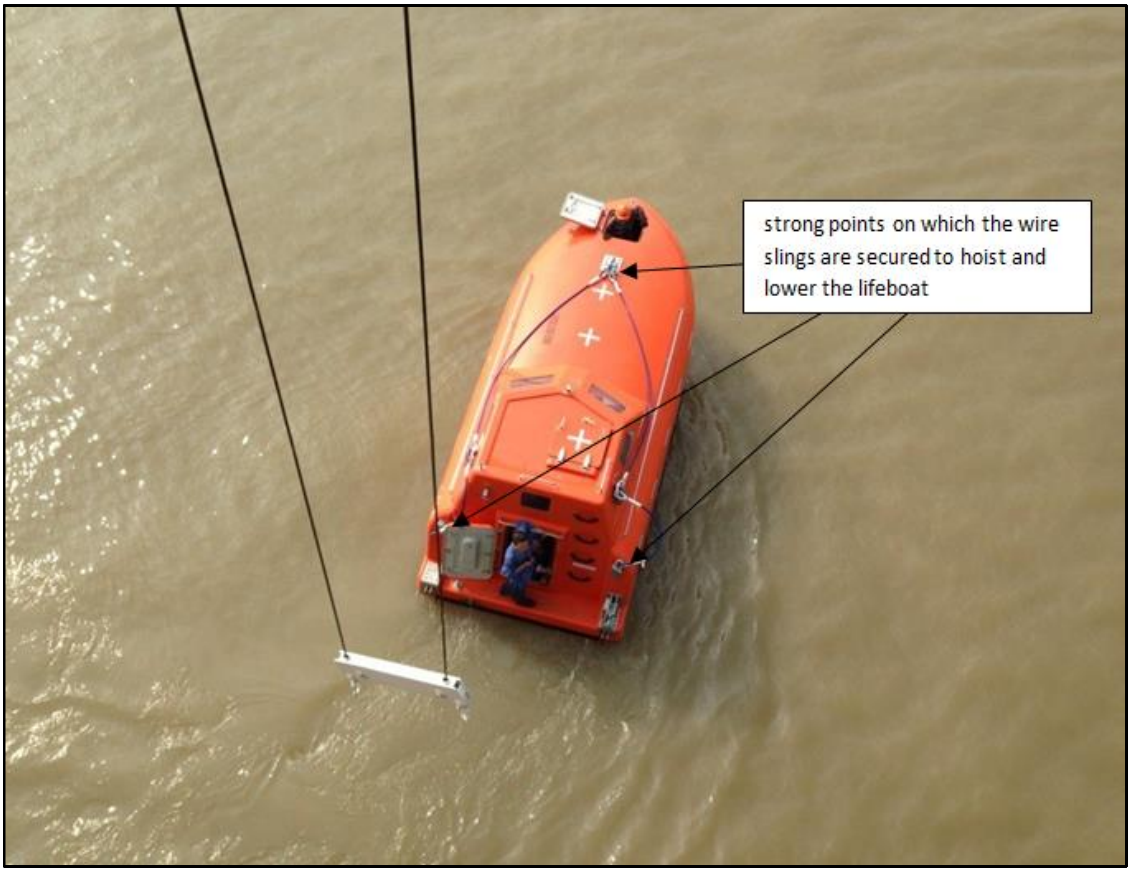


Figure 4
Location of strongpoints on the lifeboat
(photo courtesy of Jiangyinshi Beihai LSA Co., Limited, China)

3.2.4. This operation required four wire slings to be attached to three strongpoints on the lifeboat, two on the aft and one on the forward of the lifeboat. The wire slings would then be hooked on to the lifeboat davit spreader bar, which could be hoisted and lowered by the davit winch. Once the lifeboat connections had been made ready, the hydraulically operated davit would pivot about its fulcrum, swinging the lifeboat clear of the ship's stern. The procedure for recovering the lifeboat was the same in reverse (Figures 3 and 4).

4. Analysis

4.1. General

4.1.1. Lifeboat accidents are an ongoing safety concern in the maritime industry because of their potential to cause serious injury and loss of life. Although new initiatives from the IMO have made significant inroads into addressing these safety concerns, launching a lifeboat still remains a fundamentally high-risk operation.

4.1.2. The freefall lifeboat has been generally regarded as a safe means of abandoning a ship. It is designed to escape the vicinity of the ship without the need for the traditional side-launching appliances and the inherent risks associated with them. A freefall lifeboat simply requires the crew to secure themselves on board and activate a lever that disengages a release hook. The lifeboat then slides down a ramp and falls into the water by gravity. A freefall lifeboat can also be lowered into the water by a secondary means involving a crane, a method that is often utilised during training drills as an alternative to freefall launching. Although this method allows the lifeboat to meet the testing requirements of SOLAS, it does reintroduce some of the inherent risks associated with the traditional side-launching davit systems, such as being susceptible to a single point failure.

4.1.3. The following analysis discusses what caused the wire lifting sling to fail. It also discusses a broader safety issue of manufacturers encasing wire ropes in plastic or similar materials, and also the importance of proper documentation for the design and testing of safety-critical arrangements such as lifting slings.

4.2. Why the wire lifting slings failed

4.2.1. The Defence Technology Agency conducted metallurgical and fractographic analyses of the damaged components of the lifting sling shown in Figure 5.

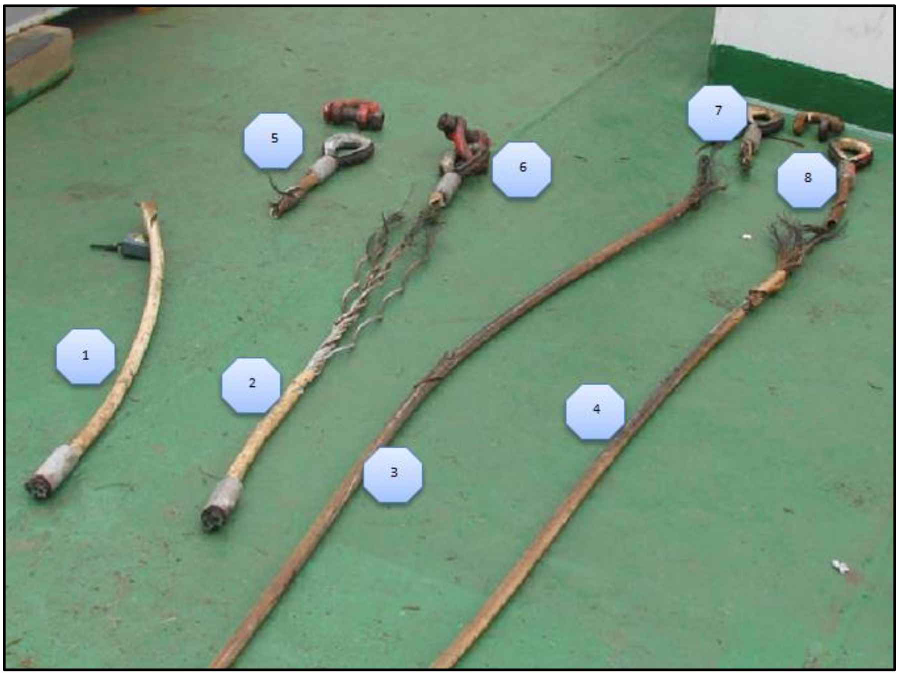


Figure 5
Eight failed parts of the four wire slings
(photo courtesy of Maritime New Zealand)

4.2.2. The full report on the failure by the Defence Technology Agency can be seen in Appendix 1. The report concluded that all four wire components of the lifting sling had been significantly weakened by severe corrosion. Salt water had penetrated the plastic sheath that encased the wire rope and wasted the galvanising on the steel wire, which then allowed corrosion of the steel wire itself. The weakened wire ropes then failed by tensile overload during the lifeboat-recovery operation (see Figure 6).

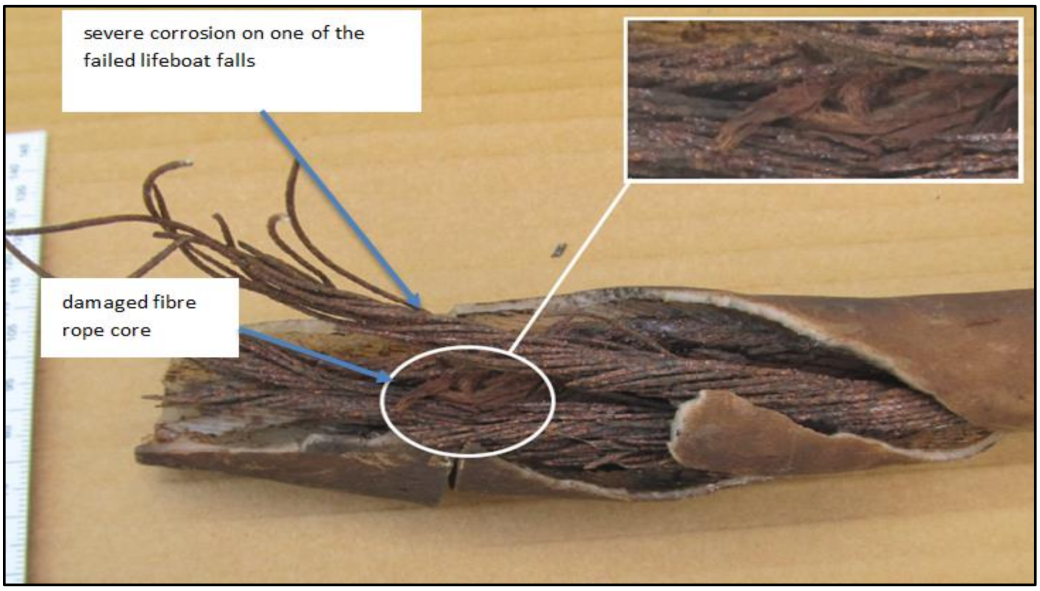


Figure 6
Severe corrosion on a failed wire sling
(photo courtesy of Defence Technology Agency)

4.2.3. The wire rope, where it had been encased in the polymeric sheathing, was totally devoid of any lubrication or other corrosion-inhibiting substances. Grease had been applied to the eyes of the wire rope where it was not encased in the polymeric sheathing (see Figure 7).

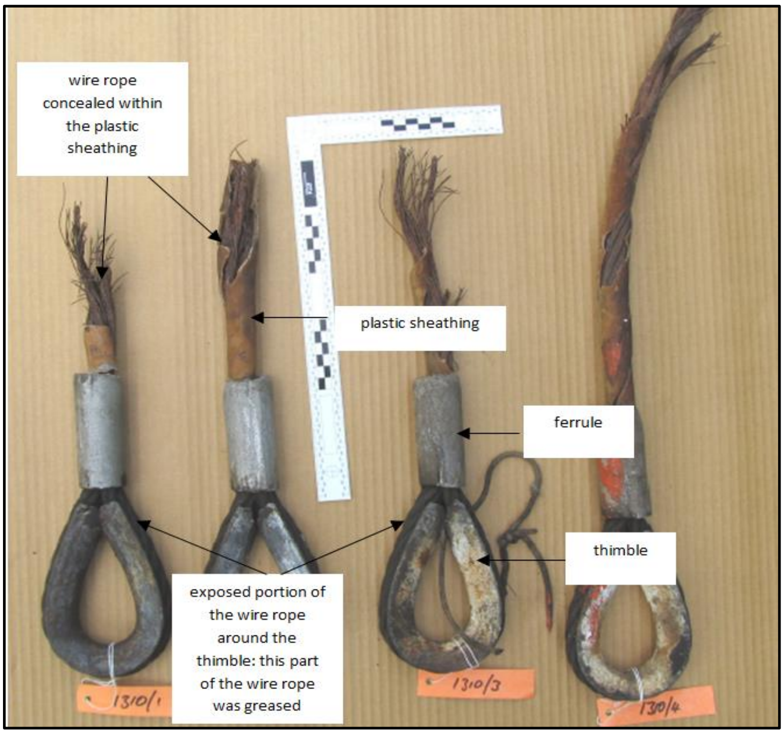


Figure 7
Parts of the wire slings
(photo courtesy of the Defence Technology Agency)

4.2.4. The lifeboat manufacturer supplied the Commission with a copy of the specification and test certificate for the wire that it used for constructing the wire lifting sling (see Appendix 2). The certificate stated that the wire rope was an 18 x 19 steel wire rope (18 strands of 19 wires each) with a fibre rope core and a diameter of 20 millimetres. However, the failed wire slings were made from wire rope of 6 x 37 construction (six strands of 37 wires each) with fibre rope core and a diameter of 18 to 18.5 millimetres (see Appendix 1 for details). According to the vessel's owner, the wire lifting slings had not been replaced since the ship was new, although this could not be verified from records on board the ship. The specifications mentioned in the product certificate did not match the wire sling that was fitted and used at the time of the incident.

4.2.5. As can be seen in Figure 3, the angle at which the lifeboat sat when being lifted required the components of the lifting sling to be different lengths. The vector of forces on the lifting sling when supporting the fully loaded lifeboat meant that the forces were greater on the longer components of the lifting sling. Calculations and drawings provided by the lifeboat manufacturer showed that the maximum load on the longer components of the lifting sling was about 22.9 kilonewtons[8] (refer to Appendix 3 for the manufacturer's calculations). The Defence Technology Agency report said that a reduction of two millimetres in wire rope diameter equated to about a 20% reduction in breaking load. The 20-millimetre wire rope for which a test certificate was supplied had an (as tested) breaking load of 232 kilonewtons. This meant that the smaller-diameter (18 to 18.5 millimetres) wire rope would have had a breaking strain of 185.6 kilonewtons, assuming the two wire ropes were of the same or similar grade and quality of steel[9].

4.2.6. The wire that was used to manufacture the lifting sling therefore was still about 25% stronger than that which would have been needed to achieve the factor of safety[10] of six required by SOLAS.

4.2.7. It is nevertheless a concern that the wire stated by the lifeboat manufacturer as having been used to construct the lifting sling was different from that actually used. This is discussed further in the following sections.

Findings

1. All four wire pennants on the lifting sling for the *Da Dan Xia*'s freefall lifeboat parted under tensile overload because they were significantly weakened by severe corrosion.
2. The corrosion was mainly caused by salt water penetrating and accumulating around the steel wire under a plastic sheathing that had been placed around the wire pennants when the lifting sling was manufactured. The plastic sheathing also prevented the crew applying anticorrosive compounds to the steel wire.
3. The steel wire making up the four pennants of the lifting sling had a smaller diameter and was of a different construction from that which the manufacturer said had been used during construction. However, it would still have been of sufficient strength (when new) to support the weight of the loaded lifeboat with the requisite factor of safety.

[8] A kilonewton is a unit of force commonly used for structural calculations.
[9] It was not possible to determine the grade of the strength or the quality of the steel used to manufacture the failed samples.
[10] A factor of safety is a term describing the structural capacity of a system beyond the expected load or actual load; essentially, how much stronger the system is than it usually needs to be for an intended load.

4.3. Plastic (polymeric) coating of steel wires in the marine industry

Safety issue – Encasing wire rope in plastic sheathing prevents the wire being lubricated, maintained and inspected, and can accelerate the onset of corrosion through the retention of salt water within the core of the wire rope.

4.3.1. The wire lifting sling was manufactured by the freefall lifeboat manufacturer, Jiangyinshi Beihai LSA Co., Limited, China. It had enclosed the wire rope in a plastic sheathing. The freefall lifeboat and the wire lifting sling were then supplied by the lifeboat manufacturer to the Haunghai Shipbuilding yard, China, to be fitted on board the *Da Dan Xia*. This lifeboat manufacturer has produced more than 600 freefall lifeboats, all of which have been installed with the same type of wire sling that parted during this accident.

4.3.2. The wire slings were secured on the exterior of the lifeboat canopy and were exposed to the elements. Seawater ingress would have taken place over time through the ends of the plastic sheathing, and through any cracks or gaps that developed in the plastic sheathing as it aged and wore. Once salt water penetrated the wire through the plastic sheathing, the sheathing would aid the corrosion process by retaining the salt water around the wire (see Figure 8).

4.3.3. The plastic sheathing may also have aided in entrapping the seawater and accelerating corrosion, ultimately resulting in the weakening and failure of the slings.

4.3.4. The existing IMO regulations for the periodic testing of lifeboats require each launching appliance to be so constructed that all parts requiring regular maintenance by the ship's crew are readily accessible and easily maintained.

4.3.5. The non-transparent plastic sheathing on the wire slings concealed the galvanised steel wire rope, making it neither easily accessible nor maintainable (see Figure 8). This meant that the crew had no way of visually determining whether the wire rope remained fit for the purpose of lowering and recovering the freefall lifeboat, other than by removing the plastic sheathing. Encasing the wire rope in plastic served no purpose other than to protect the gelcoat[11] of the glass-reinforced plastic of the lifeboat canopy, although the wire eyes, thimbles and lifting rings would still have caused this problem anyway. Since the incident the manufacturer has ceased the practice of enclosing wire ropes in plastic sheathing. Instructions have also been issued to all its service stations to replace the plastic-sheathed wire ropes on existing lifeboats.

4.3.6. There are other cases where a wire rope being encased in plastic sheathing has been a factor contributing to the failure of the wire. One such case was a freefall lifeboat incident discussed in a report released on 29 August 2013 by the maritime administrator for the Republic of the Marshall Islands. In this accident a corroded wire sling was used to secure a lifeboat while the crew performed maintenance operations on the lifeboat-securing hook. The wire sling subsequently parted, allowing the boat and unprepared crew members to fall into the water. The investigation determined that the corrosion on the wire sling encased in a plastic sheathing had not been previously detected. (Refer to Appendix 4 for the full report.)

4.3.7. The Commission has recommended that the Director of Maritime New Zealand make a submission to the IMO for the relevant subcommittee to start the process of preventing the use of plastic sheathing on steel wire that is likely to be exposed to the weather or is likely to require ongoing inspection and maintenance.

[11] Gelcoat is a material used to provide a high-quality finish on the visible surface of a fibre-reinforced composite material.

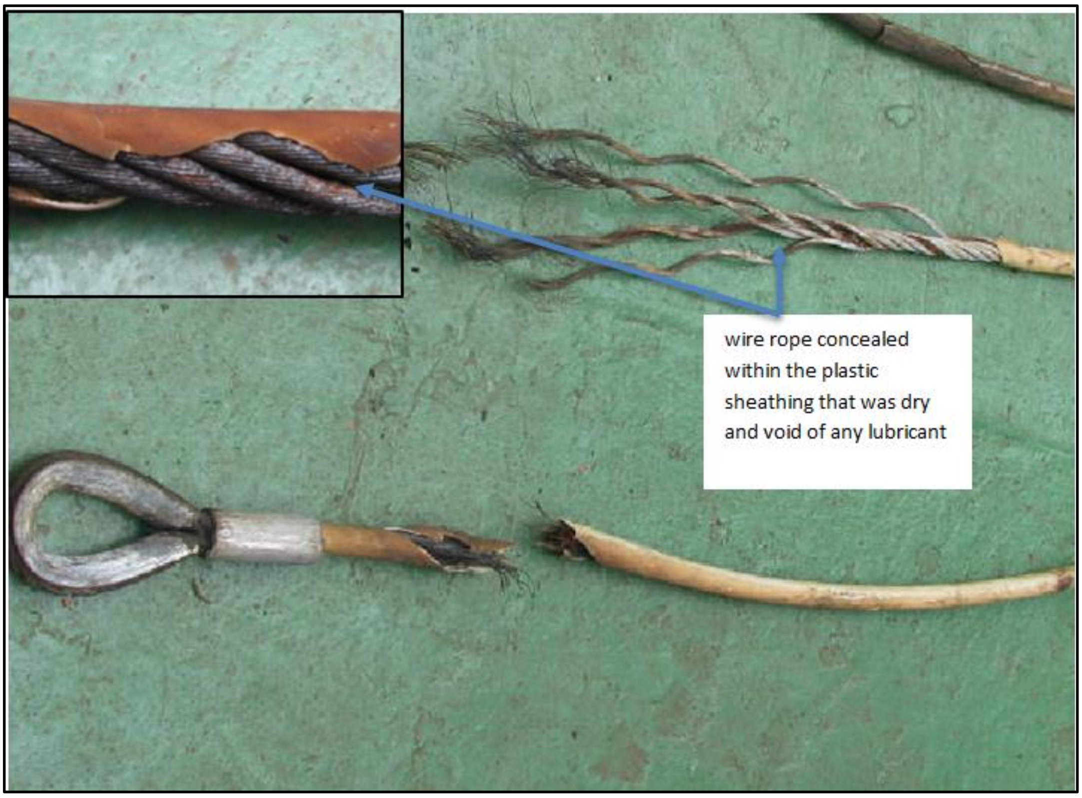


Figure 8
Wire rope concealed within the plastic sheathing

Findings

4. The plastic sheathing that had been placed around the wire on the lifting sling by the manufacturer prevented the crew and surveyors inspecting and maintaining the lifting sling to the standards required by the International Maritime Organization Convention for the Safety of Life at Sea (SOLAS).

5. Totally encasing steel wire in plastic sheathing when it is to be used in the marine environment has significant implications for maritime safety, especially when the wire must be regularly inspected and maintained in order to remain fit for purpose.

4.4. Certification, inspection and maintenance of the wire lifting sling

4.4.1. Each lifting appliance on board a ship is provided with a product certificate that details the design specifications of the appliance. The IMO's International Life-Saving Appliance Code requires a minimum factor of safety of six to be applied to suspension chains, links, blocks and falls[12], including wire slings. For this purpose various tests and inspections are conducted before a lifting appliance is initially certified by a competent authority. This certificate must be kept on board and made available for inspection.

4.4.2. The manufacturer had calculated the required load capacity for the lifting sling. It had produced a test certificate and a drawing for it as well. However, neither the test certificate nor the drawing had been supplied to the vessel. At the time of the incident there was no certificate on board for the wire slings and none of the crew was aware of this.

[12] A fall is a rope by which a boat is hoisted or lowered.

4.4.3. As a general rule the maintenance and inspection of safety equipment must be carried out in accordance with the manufacturers' instructions and safety precautions. A poorly drafted manufacturer's instruction manual can compound the difficulties in maintaining and operating any equipment. The *Da Dan Xia* had been provided with a detailed instruction manual by the manufacturer of the freefall lifeboat. The manual covered six main topics, of which the last two were on the maintenance procedures and schedules for the lifeboat and its associated equipment.

4.4.4. The section on maintenance procedures had nine subsections, including a topic titled "Lubrications and greasing points. Anticorrosion maintenance". However, there was no mention of any specific maintenance plan or recommended renewal period for the wire slings. Consequently the ship's planned-maintenance programme did not address this issue either. The manufacturer has since addressed this safety issue (refer to the "Safety actions" section of this report).

4.4.5. The safety management systems on board the *Da Dan Xia* had procedures in place to test and maintain the freefall lifeboat and its associated launching appliances. They included weekly visual inspections and monthly greasing routines for both the lifeboat davit falls and the wire slings. There was evidence that the crew had greased the exposed areas of the wire slings around the thimble and ferrule, but not the areas concealed within the plastic sheathing. Despite their inability to inspect a large portion of the slings visually, the crew continued using the wire slings assuming they were still fit for purpose.

4.4.6. Notwithstanding the absence of guidance from the lifeboat manufacturer on the inspection, maintenance and replacement of the lifting sling, it was clearly an item that needed maintaining and inspecting in accordance with best international standards of seamanship.

4.4.7. The lifeboat and its appliances had been inspected and serviced annually by a specialist service provider approved by the manufacturer. Inspecting the condition of the wires for damage such as corrosion was part of the service. However, the specialist service provider raised no concerns regarding the plastic sheathing, which would have been preventing his properly inspecting the wires making up the lifting sling.

Findings

6. The manufacturer of the lifeboat did not provide adequate advice on the arrangement and construction of, or the maintenance and replacement requirements for, the lifeboat lifting sling.
7. Neither the ship's planned-maintenance system nor the surveyors of the lifeboat-launching system appear to have recognised the safety-critical function of the lifting sling, and the fact that it could not be properly inspected and maintained in accordance with the relevant SOLAS requirements.

4.5. Mitigating the risk of lifeboat drills

4.5.1. Launching and retrieving a lifeboat are high-risk activities, but with proper training a ship's personnel can attain the required level of familiarity to identify and overcome the potential risks. The crew of the *Da Dan Xia* were aware of the lifeboat-launching and -recovery procedures, including the need to secure themselves in their seats once on board the lifeboat.

4.5.2. In this incident the third officer released his safety harness before the lifeboat was secured to its cradle. Once the wire ropes parted, the third officer, now unrestrained, was thrown to the forward end of the lifeboat and suffered a head injury.

4.5.3. The commander of a lifeboat is responsible for all operations connected with the lifeboat and the safety of the lifeboat crew on board. It is important that he ensure that all crew members remain seated with their restraints securely fastened at all times.

4.5.4. Some consideration was given to the risk of retrieving the lifeboat with the minimum crew still on board. This risk would have been offset by the risk of removing the crew from the waterborne lifeboat by rope ladder.

4.5.5. The IMO published guidance to consider when conducting drills using lifeboats lowered by falls (Measures to Prevent Accidents with Lifeboats, MSC.1/Circ.1206/Rev.1). The circular recommended that before performing drills with persons in a lifeboat the boat be first lowered and recovered without persons on board, and that when the actual drill was performed the boat be lowered into the water with only the number of persons on board necessary to operate the boat.

4.5.6. In this case the master did order the boat to be lowered to the water with no crew on board, which had the effect of testing the functioning of the lifeboat-launching system. Rather than retrieve the boat again to place the crew on board, they boarded by ladder. He had in effect tested the proper functioning of the launching and retrieval system.

4.5.7. As it happened, the lifting sling failed with the boat at a lesser height than it normally would have, had it been launching in the freefall mode. The issue was not so much the decision to leave the crew on board during the retrieval process, but the fact that the third officer removed his restraints before the boat had been secured in its cradle, thereby causing him to be injured. The master's decision to retrieve the lifeboat with the minimum boat crew on board was reasonable.

Finding

8. The third mate was injured when the lifeboat fell to the sea because he had prematurely released his restraints before the lifeboat was securely locked into its stowed position; otherwise, the manner in which the lifeboat drill was conducted was reasonable.

5. Findings

5.1. All four wire pennants on the lifting sling for the *Da Dan Xia*'s freefall lifeboat parted under tensile overload because they were significantly weakened by severe corrosion.

5.2. The corrosion was mainly caused by salt water penetrating and accumulating around the steel wire under a plastic sheathing that had been placed around the wire pennants when the lifting sling was manufactured. The plastic sheathing also prevented the crew applying anticorrosive compounds to the steel wire.

5.3. The steel wire making up the four pennants of the lifting sling had a smaller diameter and was of a different construction from that which the manufacturer said had been used during construction. However, it would still have been of sufficient strength (when new) to support the weight of the loaded lifeboat with the requisite factor of safety.

5.4. The plastic sheathing that had been placed around the wire on the lifting sling by the manufacturer prevented the crew and surveyors inspecting and maintaining the lifting sling to the standards required by the International Maritime Organization Convention for the Safety of Life at Sea (SOLAS).

5.5. Totally encasing steel wire in plastic sheathing when it is to be used in the marine environment has significant implications for maritime safety, especially when the wire must be regularly inspected and maintained in order to remain fit for purpose.

5.6. The manufacturer of the lifeboat did not provide adequate advice on the arrangement and construction of, or the maintenance and replacement requirements for, the lifeboat lifting sling.

5.7. Neither the ship's planned-maintenance system nor the surveyors of the lifeboat-launching system appear to have recognised the safety-critical function of the lifting sling, and the fact that it could not be properly inspected and maintained in accordance with the relevant SOLAS requirements.

5.8. The third mate was injured when the lifeboat fell to the sea because he had prematurely released his restraints before the lifeboat was securely locked into its stowed position; otherwise, the manner in which the lifeboat drill was conducted was reasonable.

6. Safety actions

General

6.1. The Commission classifies safety actions by two types:

(a) safety actions taken by the regulator or an operator to address safety issues identified by the Commission during an inquiry that would otherwise result in the Commission issuing a recommendation

(b) safety actions taken by the regulator or an operator to address other safety issues that would not normally result in the Commission issuing a recommendation.

Safety actions addressing safety issues identified during an inquiry

Safety actions taken by the lifeboat manufacturer

6.2. The lifeboat manufacturer has updated the maintenance manual with instructions for renewing the lifting slings every three years or when their condition is observed to be unsatisfactory. All new lifeboats produced by the manufacturer will now be supplied with the latest version of the maintenance manual. A copy of the new manual was sent to the owner of the *Da Dan Xia*.

6.3. Since the incident, the manufacturer has ceased the practice of enclosing wire ropes in a plastic sheathing. Instructions have also been issued to all company service stations to replace plastic-sheathed wire ropes on existing lifeboats.

Safety actions taken by the owner of the Da Dan Xia

6.4. The owner of the *Da Dan Xia* operated 22 other ships fitted with freefall lifeboats similar to that on board the *Da Dan Xia*. As a result of this incident the owner issued a circular to all ships in its fleet with the following instructions.

- check the condition of the lifeboat's lifting wire slings
- any plastic sheathing encasing the lifting wire slings must be cut in half (removed)
- renew the lifting wire slings every 2.5 years. A certificate is required to be obtained when renewing the lifting wire slings.

Safety actions addressing other safety issues

6.5. None identified.

7. Recommendations

General

7.1. The Commission may issue, or give notice of, recommendations to any person or organisation that it considers the most appropriate to address the identified safety issues, depending on whether these safety issues are applicable to a single operator only or to the wider transport sector. In this case recommendations have been issued to the Director of Maritime New Zealand.

7.2. In the interests of transport safety it is important that these recommendations are implemented without delay to help prevent similar accidents or incidents occurring in the future.

Recommendation 1

7.3. The wire pennants parted under tensile overload because they had all been significantly weakened by severe corrosion. Corrosion had gone undetected inside a plastic sheathing that the manufacturer of the lifting sling had placed around the wire pennants.

The presence of the plastic sheathing encasing the wire rope meant that neither the crew nor the various surveyors tasked with inspecting the launching system could inspect and maintain the wire rope as required by SOLAS.

Encasing steel wire in plastic sheathing when it is to be used in the marine environment has significant implications for maritime safety, especially when the wire must be regularly inspected and maintained in order to remain fit for purpose.

On 26 February 2015 the Commission recommended that the Director of Maritime New Zealand, through the port and flag state control programme, verify that wires that require regular inspection and maintenance by a ship's crew and surveyors are readily accessible and easily maintained as required by Chapter VI of the International Life-Saving Appliance Code. (001/15)

7.3.1. On 11 February 2015, Director and Chief Executive of Maritime New Zealand replied:

> This recommendation will be incorporated into our PSC mentoring and oversight program. We anticipate this will be integrated into our standard PSC inspections by the end of 2015.

Recommendation 2

7.4. The wire pennants parted under tensile overload because they had all been significantly weakened by severe corrosion. Corrosion had gone undetected inside a plastic sheathing that the manufacturer of the lifting sling had placed around the wire pennants.

The presence of the plastic sheathing encasing the wire rope meant that neither the crew nor the various surveyors tasked with inspecting the launching system could inspect and maintain the wire rope as required by SOLAS.

Encasing steel wire in plastic sheathing when it is to be used in the marine environment has significant implications for maritime safety, especially when the wire must be regularly inspected and maintained in order to remain fit for purpose.

On 26 February 2015 the Commission recommended that the Director of Maritime New Zealand submit this report to the International Maritime Organization and raise the implications that plastic-sheathed wire ropes have for maritime safety through the appropriate International Maritime Organization safety committee for its consideration. (002/15)

7.4.1. On 11 February 2015, Director and Chief Executive of Maritime New Zealand replied:

> I can confirm that this recommendation is already on the Domestic and International Policy team international register of work and initial consideration has commenced.

As soon as Maritime NZ receives from TAIC an electronic PDF copy of the final report we can upload this to the IMO's GISIS website, thus completing the initial part of this recommendation.

More detailed consideration is required of the second part of the recommendation as this has an impact on resources and budgets, which must be considered against other work items. In addition the timeline for the range of options to close out the second part of the recommendation varies greatly and thus it is not practicable to confirm the date when the recommendation will be fully implemented.

8. Key lessons

8.1. A key safety lesson arising from this inquiry is that seafarers and surveyors alike must not make assumptions about the condition of any wire or other equipment that they cannot see, especially when the wire or other equipment has a safety-critical purpose and is required by rules, regulations or procedures to be thoroughly examined.

8.2. It is important for crew members to remain secured in their seats during lifeboat-launching and recovery operations.

Appendix 1: Defence Technology Agency report

Security Classification: Unclassified

Report C1310
Page 1 of 5

dta
Defence Technology Agency

AVS Group Technical Memorandum

C1310 Da Dan Xia Lifeboat Wire Rope Slinger Failure

21 May 2014

Defence Technology Agency NZ Defence Force, Private Bag 32901, Auckland Naval Base, AUCKLAND
Ph (09) 445-5902 Fax (09) 445-5890

File Ref:	3739/5	Contact Ph No:	(09) 445 - 5823
Project No:	141		
Work Requested:	Examination of failed lifeboat wire rope slingers		
Task Reference:	TAIC Memo dated 5 May 2014		
Report to:	Transport Accident Investigation Commission PO Box 10323, Wellington 6143		

Introduction

1. On 14 April 2014 a routine lifeboat launching exercise was conducted on board the vessel Da Dan Xia whilst at Port Wellington. The Transport Accident Investigation Commission (TAIC) opened an inquiry after the slingers attaching the lifeboat to the davit failed.

2. TAIC engaged DTA to provide initial metallurgical and fractographic services and advice in support of the TAIC inquiry, including a visual inspection of the failed wire ropes, determination of the failure mode and to confirm if the slingers matched the specified requirements. DTA was supplied with the fractured ends of the four failed wire ropes and some supporting documentation.

Examination

3. The eight failed halves of the four ropes were not identified with their respective matching halves. The failed ropes as received are shown in figures 1-3.

4. Corrosion in each portion was immediately evident extending a minimum of 200mm from the failure locations. Wires had been galvanised, as evidenced by the lower rope in figure 2. However, there was none remaining on any rope in the immediate vicinity of the failures. Each rope was sheathed with a polymeric material which was discoloured, cracked and brittle. Grease was evident around each thimble eye but none was evident beneath the sheathing.

5. Construction of each rope was 6x37 with fibre rope core, right hand regular lay. Rope diameter was found to generally be 18-18.5 mm. The fibre rope core was observed to be darkened and discoloured (rust coloured). Figure 4 shows an example of the rope with the core exposed.

6. One hundred percent of the wires (in the vicinity of the failures) were affected by corrosion to some degree, ranging from light to extreme. Figure 5 shows an example where some wires have been corroded in the extreme, as evidenced by the needle-like points. Evidence of tensile failures of wires was also observed in each rope. These exhibited the waisting and 'cup & cone' features characteristic of tensile overload.

Figure 1. Four portions of the failed wire ropes as received.

Figure 2. Failed ropes as received.

Figure 3. Failed ropes as received.

Figure 4. General view of one of the failures. Note the overall corrosion, the fibre rope core (circled and inset) and brittle fracture of the sheath.

Figure 5. Failure (typical) close up showing severe corrosion of the wires (needle-like points).

Discussion

7. The poor condition of the ropes has not allowed determination of which rope(s) may have fractured first in the failure sequence. What can be stated with a high degree of certainty is that corrosion significantly reduced the load carrying capacity of all four ropes. Although this has not been fully quantified, at least 15% of the wires in each rope were significantly corroded (≤ 10% of the original cross sectional area remained prior to final failure by overload). In addition to the quantified 15% minimum corroded through, most of the individual wires exhibited reduced cross section due to corrosion.

8. The corrosion is almost undoubtedly due to the action of salt water on, firstly the galvanising, and ultimately, the steel wires. It is considered that presence of the sheathing on the ropes has had a significant impact on this in two ways. Firstly, the condition of the ropes cannot be visually inspected, and secondly, the sheathed areas cannot be maintained adequately by the application of corrosion preventive measures (e.g., grease). The sheathing may also have helped to entrap sea water.

9. As stated above, the rope construction is 6x37 (six strands of 37 wires each) with fibre rope core, with a diameter of 18-18.5 mm. This is not consistent with the rope specified in reference A, which calls for 18x19 20 mm rope (fibre core). The significance of this is not clear. The two rope types may have differing flexibilities, but, more importantly, for the same grade of steel wire used in the rope construction, an 18 mm rope will have a lower load carrying capacity than a 20 mm rope. Reference B indicates that 2 mm reduction in diameter may result in up to a 20% lower breaking strength.

Conclusions

10. Technically, the wire ropes failed by tensile overload. Each rope, however, was significantly weakened by severe corrosion damage caused by sea water.

11. The sheathing on the ropes prevented both adequate inspection and maintenance.

12. The ropes in service did not match the steel wire rope specified. Significantly, the rope diameter appears to have been smaller than specified.

Recommendations

13. The adequacy of relevant inspection, maintenance and replacement policies and procedures should be reviewed.

14. The impact of the use of unspecified wire ropes should also be reviewed.

References

A. Drawing – JYB66FC-GA(EX)-01-00 General Arrangement (EX) Jiangyinshi Beihai LSA Ltd

B. Specification D.G. Ships 165A Steel Wire Rope, General and Special Purpose Ropes, Ministry of Defence, July 1976

Appendix 2: Lifting wire rope product certificate

钢丝绳产品质量证明书
PRODUCT CERTIFICATE OF STEEL WIRE ROPE

生产许可证号(Product Certificate No):XK05-005-00013

中国船级社认可证书编号:CQ06W00014
CCS Approval Cert No:CQ06W00014
质证书编号（Cert. No）：C09-0271

产品标准：CCS规范 GB/T20118-2006
Product Standard：CCS Rule GB/T20118-2006
产品编号（Product No）：09B3761

订货单位:贵州钢绳股份有限公司上海销售公司 Customer: GUIZHOU WIRE ROPE INC SALE DEPARTMENT SHANGHAI BRANCH	合同号(Contract No): 2009-上海-50
钢丝绳结构(Construction of Wire Rope): 18×19S+FC-ZS(右交互．R.H.R.Lay)	钢丝绳直径(Diameter): 20.00 mm
钢丝绳强度级(Grade of Strength): 1770 N/mm²	镀锌层级别(Grade of Galvanization): CCS3级(Grade 3)
钢丝绳韧性(Tenacity): 合格（OK）	钢丝绳长度(Length): 1010 m
钢丝绳毛重(Gross Weight): 1720.0 kg	钢丝绳净重(Net Weight): 1626.0 kg

拆股钢丝试验结果 (Test Result of Each Strand)

钢丝破断拉力总和(Aggregate breaking load of individual wires)
规定值(Required): 282.00kN
实际值(Actual): 323.00kN

钢丝公称直径(Nominal dia. of wire)	0.55 mm		0.58 mm		0.96 mm		1.00 mm		——	
试验项目(Item of Test)	最大值 Max.	最小值 Min.	最大值 Max.	最小值 Min.	最大值 Max.	最小值 Min.	最大值 Max.	最小值 Min.	最大值 Max.	最小值 Min.
抗拉强度Tensile strength(N/mm^2)	2110	1920	2090	1920	1910	1790	1910	1830	——	——
弯曲次数Number of bending(次/180°)	22	16	21	13	16	12	21	16	—	—
扭转次数Number of twists(次/360°)	44	34	41	33	44	33	38	31	—	—
打结率Knotting rate (%)	——		——		——		——		——	
镀锌层试验 Zinc coating test: 镀锌层重量Weight(g/m^2)	≥ 50		≥ 50		≥ 70		≥ 80		——	
镀锌层试验 Zinc coating test: 芯棒直径(mm) Diameter of mandrel(mm)	1.10	结果(Result): 合格(OK)	1.16	结果(Result): 合格(OK)	1.92	结果(Result): 合格(OK)	2.00	结果(Result): 合格(OK)	——	结果(Result): ——

说明(Explanation):

备注(Remarks):
铭牌和绳尾铅封上标有:
On the nameplate and seal of rope end stamped with :

公司质监部门印章
Stamp of Q.C. Dept

此证书复印无效
Copy will be null

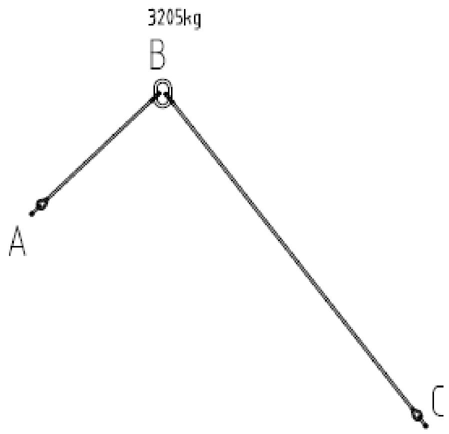
员：
or：

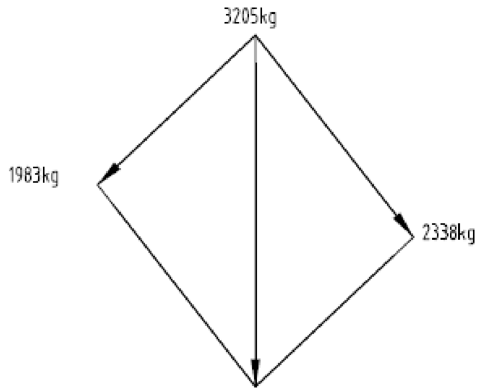
质检员：
Inspector

Appendix 3: Stress analysis of lifting wire sling

1、受力分析（平行四边形法） Stress analysis for parallelogram law

根据吊点位置进行受力分析 According to hangs a position to carry on the stress analysis





A

Pull for AB(wire rope) $F_1 = 1983kg = 19.4kN$

Pull for BC(wire rope) $F_2 = 2338kg = 22.9kN$

2、 Strength calculation of wire rope:

The type of wire rope: 18×19-20-1770.

Break pull of wire rope: $Pe = 232kN$

Based on rules request. The safety factor $s = 6$

$$[P\max] = \frac{Pe}{s} = \frac{232}{6} = 38.7kN$$

Appendix 4: Safety Advisory No. 52-13, Republic of the Marshall Islands

Republic of the Marshall Islands
Office of the
MARITIME ADMINISTRATOR

11495 COMMERCE PARK DRIVE, RESTON, VIRGINIA 20191-1506
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MARINE SAFETY ADVISORY NO. 52-13

To: **Regional Marine Safety Offices, Nautical Inspectors, Masters, Owners/Agents**

Subject: **FREEFALL LIFEBOAT CASUALTIES - SAFE WORK PRACTICES**

Date: **29 August 2013**

The Maritime Administrator has recently conducted marine safety investigations into two Freefall Lifeboat (FFLB) incidents that were near miss Very Serious Marine Casualties. In both cases the FFLB was unintentionally released and fell to the water while crewmembers were inside the boat performing maintenance. The crewmembers were seriously injured in both incidents.

Based on the Maritime Administrator's review and analysis of the available information the identified lessons learned can be categorized as follows:

- Adherence with Lifeboat Maintenance Procedures
- Adherence with Lifeboat Securing Procedures
- Adherence with Safe Work Practices
- Inadequate identification and evaluation of potential risks

A brief synopsis of the two marine casualties is as follows:

FFLB Marine Casualty No.1: The ship's Third Officer and Second Engineer along with a service technician were performing the FFLB annual inspection. The FFLB was secured to the davit using its aft lashing cables, i.e., maintenance wires, when the Third Officer entered the FFLB to charge and activate the FFLB's release hook mechanism. When the FFLB hook was released, the aft lashing cables, which were later found corroded, parted, allowing the boat and unprepared crewmember to fall into the water. During the investigation the following determinations were made:

- prior to entering the FFLB an SMS-required tool box meeting and task risk assessment were not performed;
- although part of the FFLB's maintenance checklist, the corrosion on the aft lashing cables, which were covered with plastic sheathing that was cracked and deteriorated due to weather exposure, was not previously detected; and,
- the FFLB was not connected to the davit launching/retrieval cable as per the manufacturer's procedures.

Broken lashing cables, i.e., maintenance wires

Recent Marine Occurrence Reports published by the Transport Accident Investigation Commission

11-204	Container ship MV Rena grounding, on Astrolabe Reef, 5 October 2011
13-201	Accommodation fire on board the log-carrier, Taokas Wisdom, Nelson, 11 July 2013
13-202	Bulk carrier, *IDAS Bulker*, pilotage incident Napier, Hawke's Bay, 8 August 2013
12-202	Fishing vessel *Torea*, collision with uncharted rock, Foveaux Strait, 24 August 2012
09-210	Bulk carrier, *Taharoa Express*, cargo shift, Port Taharoa, 16 December 2009
10-204	Inquiry 10-204: Bulk carrier *Hanjin Bombay*, grounding, Mount Maunganui, 21 June 2010
10-202	*M.V. Anatoki*, grounding, off Rangihaeata Head, Golden Bay, South Island, 6 May 2010
11-204	Interim Report Marine inquiry 11-204 Containership MV *Rena* grounding on Astrolabe Reef 5 October 2011
09-202	Marine Inquiry 09-202: Passenger vessel *Oceanic Discoverer* Fatal injury, Port of Napier 19 February 2009
11-201	Passenger vessel *Volendam*, lifeboat fatality,Port of Lyttelton, New Zealand, 8 January 2011
10-203	*Marsol Pride*, uncontrolled release of fire-extinguishing gas into engine room, Tui oil and gas field, 27 May 2010
09-204 and 09-207	Coastguard rescue vessel *Dive! Tutukaka Rescue* collision with rocks, Taiharuru River entrance Northland, 4 March 2009; Coastguard rescue vessel Trusts Rescue, heavy weather encounter,Manukau Bar, 31 May 2009
10-201	Bulk carrier *TPC Wellington*, double fatality resulting from enclosed space entry, Port Marsden, Northland, 3 May 2010
09-201	Collision: private jet-boat/private watercraft, Kawarau River, Queenstown, 5 January 2009
08-209	Loss of the rigid inflatable boat *Mugwop*, off the entrance to Lyttelton Harbour, 28 October 2008
11-201	Interim Factual report - Passenger vessel *Volendam*, lifeboat fatality, port of Lyttelton, New Zealand, 8 January 2011
08-205	Fishing vessel, *San Cuvier*, dragged anchor and grounded, Tarakeha Point, Bay of Plenty, 27 July 2008
08-206	Passenger ferry *Monte Stello*, collisions with wharfs, Picton and Wellington, 8 and 9 August 2008

Price $16.00

ISSN 1173-5597 (Print)
ISSN 1179-9072 (Online)