Transport Accident Investigation Commission

Final Report

Marine inquiry MO-2019-203
Bulk log carrier *Coresky OL*
Crew fatality during cargo-securing operation, Eastland Port, Gisborne
3 April 2019

June 2020

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 occurrences with a view to avoiding similar occurrences in the future. It is not the Commission's purpose 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. However, the Commission will not refrain from fully reporting on the circumstances and factors contributing to an accident because fault or liability may be inferred from the findings.

Figure 1: The *Coresky OL* alongside in Gisborne on the day of the accident (Credit: Gisborne Herald)

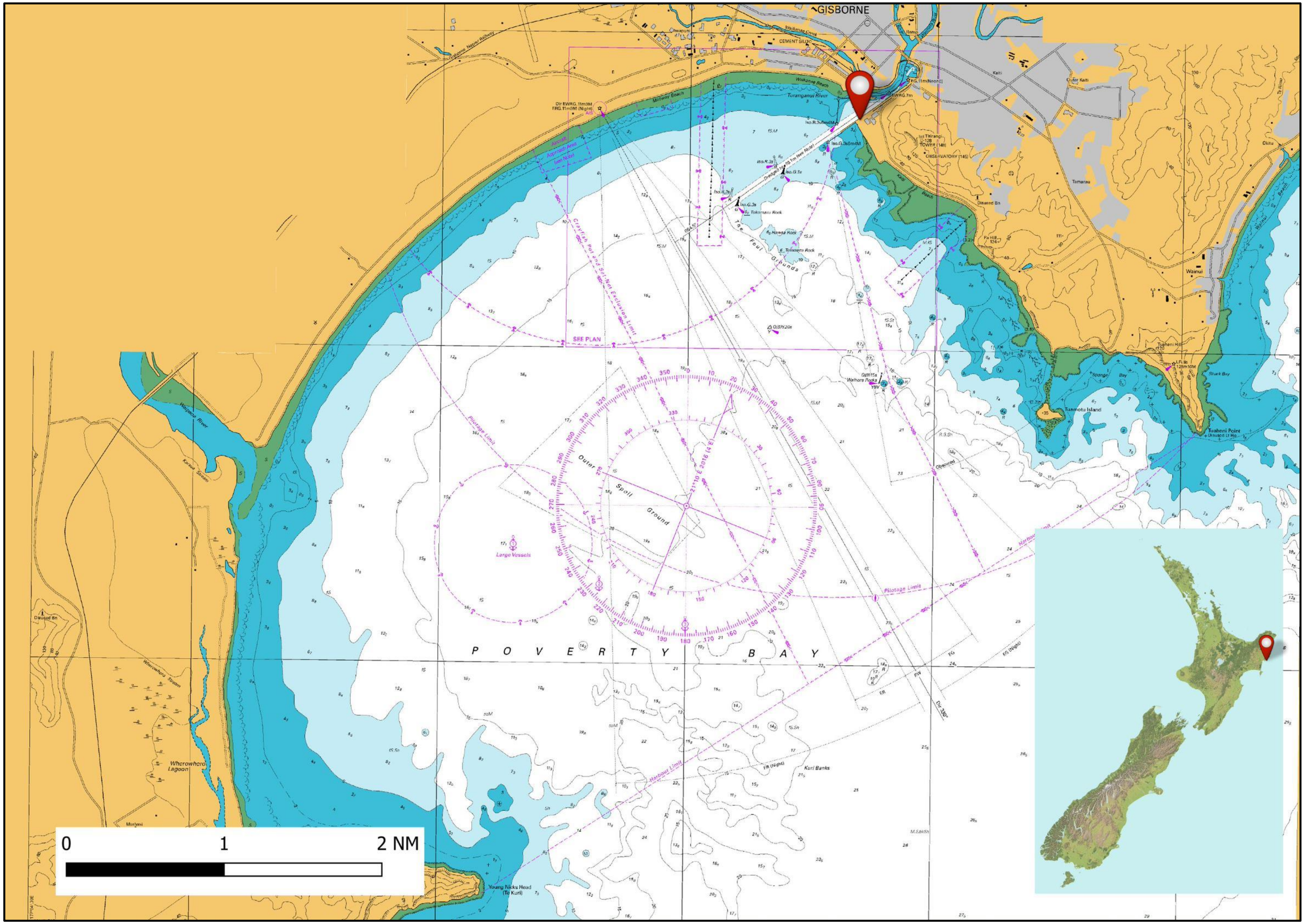

Figure 2: Location of accident plotted on NZ5571 Poverty Bay and Approaches to Gisborne
(Credit: Land Information New Zealand)

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1 Executive summary

What happened

1.1 At approximately 2130 on 2 April 2019, the bulk carrier *Coresky OL* completed loading logs in Eastland Port, Gisborne. Shortly afterwards the crew commenced securing the logs that were stowed on deck.

1.2 At 2341 the chief officer, boatswain and two able-bodied seamen had just completed securing the logs stowed on top of number one hatch and were commencing to lash the logs stowed on top of number two hatch. It was dark but the deck was well lit by both the ship and shore floodlights.

1.3 The chief officer was operating a crane, which was being used to tension the wiggle wire. Both able-bodied seamen were standing close to the wire to monitor its tension, when the boatswain signalled to the chief officer to stop heaving[1] on the crane's lifting wire.

1.4 As the heaving stopped, a wire parted and caused the securing equipment to recoil towards the able-bodied seamen. One of the able-bodied seamen was struck by part of the securing equipment and later died of their injuries.

Why it happened

1.5 The crew did not identify the hazards associated with wires under tension and had not implemented mitigation measures prior to undertaking the operation.

1.6 The load being applied by the crane, combined with the configuration of the blocks used to tension the securing wires, was sufficient to part the foot wire.

1.7 Turnbuckles were not rigged between the wiggle wire and foot wires, which meant that the crane was used to tension the wiggle wire. This required both able-bodied seamen, whose role it was to monitor the tension being applied, to be in a hazardous area close to a wire under tension.

1.8 The operator's safety management system did not include a safety assessment of cargo-securing operations. As a result, no information on the hazards associated with wires under tension was available to the crew, and the cargo securing manual did not provide guidance on a safe system of work for cargo-securing operations on the vessel. As a result, the Transport Accident Investigation Commission made a **recommendation** that Shih Wei Navigation Company Limited (Taiwan) carry out a comprehensive safety assessment of vessels engaged in carrying and securing deck log cargo. The assessment should result in appropriate procedures and guidance being contained in the safety management system and ensure that a safe system of work is established.

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[1] To lift or to haul

What we can learn

1.9 Securing logs can be a hazardous operation that should be fully risk assessed. Only then will comprehensive procedures and instructions be developed to help create a safe system of work.

1.10 Those involved in a securing operation need to be aware of the likely loads involved and the potential dangers to which they may become exposed. In addition, relevant information needs to be recorded in the cargo securing manual for future reference.

Who may benefit

1.11 Flag administrations, classification societies, ship operators and crew members may all benefit from the information in this report.

2 Factual information

Narrative

2.1 The *Coresky OL* was a Panamanian registered geared[2] bulk carrier engaged in shipping logs from New Zealand to South Korea.

2.2 At about 1950 on 30 March 2019, the vessel was made fast (secured) alongside the number eight berth in Eastland Port, Gisborne. Shortly afterwards the loading of logs began. The intention was for the vessel to sail on the high tide on the morning of 3 April.

2.3 Prior to entering the port, the crew had carried out a visual inspection of the loose-cargo-securing gear[3] and then made it ready for securing the logs that were to be stowed on top of the ship's hatches.

2.4 At 2030 on 2 April 2019, the loading of the logs was complete. A total of 34,000 tonnes of logs had been loaded into all five holds of the vessel and onto the tops of the hatches.

2.5 At 2341 the chief officer, boatswain[4] and two able-bodied seamen (ABs)[5] had just completed securing the logs on the number one hatch and were about to start securing the logs on top of the number two hatch.

2.6 Figure 3 shows the system the crew were using to secure the cargo. The securing system involved the use of foot wires[6], snatch blocks[7] and a wiggle wire[8].

2.7 There was a very light wind and it had just stopped raining. Although it was dark, the deck was well lit by the ship's own floodlights and the floodlights on the wharf. The crew were wearing personal protective equipment, which included boot spikes to reduce the risk of slipping on top of the wet logs, and safety helmets.

2.8 The chief officer was operating the number one crane, which was being used to tension the wiggle wire, and the two ABs were standing close by, checking the tension. The boatswain who was in charge of the securing operation (see Figure 3) was communicating with the chief officer using hand signals. This was due to the boatswain's hand-held very high frequency radio having been lost overboard earlier while securing the logs on number two hatch.

[2] Capable of loading and discharging using the vessel's own cargo-handling equipment.

[3] Off-the-shelf equipment including, but not limited to, shackles, chain, hooks, connecting links, turnbuckles, binders, sheave blocks, and swivels used in an assembly to suspend, secure or lift a load.

[4] The 'supervisor' of the deck crew.

[5] An able-bodied seamen is a sailor able to perform any of a deck crew's duties.

[6] A foot wire is a wire with one end secured to the vessel's deck and the other end securing a block used for guiding the wiggle wire then holding it in place.

[7] A snatch block is a block that can be opened on one side to receive a bight of rope.

[8] A wiggle wire is a continuous wire rope used to tighten the log cargo by passing the wire from side to side over a log deck cargo and through a series of blocks held in place by foot wires.

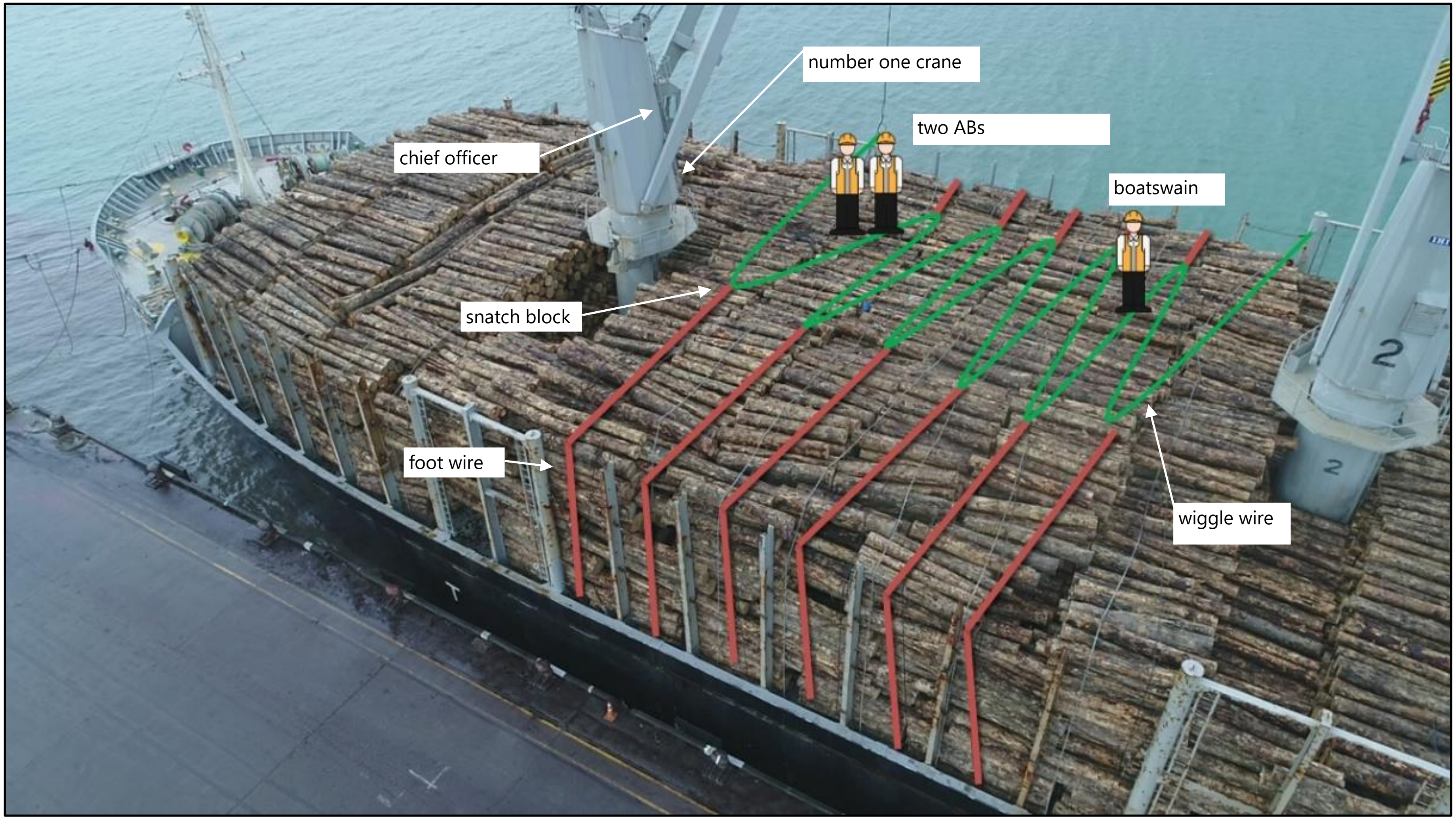

Figure 3: Diagram of the accident site
(Credit: Eastland Port)

2.9 At about 0140 the chief officer commenced heaving[9] on the wiggle wire. At this time the boatswain was walking away from the number one crane and had their back to the chief officer. The boatswain then turned around and signalled to the chief officer to stop heaving.

2.10 The chief officer stopped heaving on the wiggle wire almost immediately. The boatswain started to walk back towards the two ABs in preparation for attaching bulldog grips[10] to secure the tensioned wire.

2.11 As the boatswain walked back in the direction of the number one crane, a foot wire directly in front of the two ABs parted[11]. The rapid release of tension allowed a block, which was secured to the foot wire, and the wiggle wire to recoil toward the two ABs.

2.12 One of the ABs was struck by part of the securing equipment and later died in Gisborne Hospital. The other AB was hit on the legs by the wiggle wire and sustained minor injuries.

Site examination

2.13 An inspection of the vessel showed a parted foot wire on the port side and a wiggle wire complete with snatch block, shackle and wire eye[12] just to starboard of the vessel's centreline.

2.14 The crane and securing equipment that were in use at the time of the accident were inspected by a specialist crane engineer, whose report was obtained by the Transport Accident Investigation Commission (Commission). The engineer was requested to attend the accident scene by Maritime New Zealand, and the subsequent report identified that the crane and its rigging were in good working order.

2.15 Both sections of the parted foot wire were removed from the vessel for further testing.

Tests and research

2.16 An expert metallurgist engaged by the Commission examined the parted wire and provided a report. Part of this report can be found in Appendix 1.

2.17 The parted wire was also tested to breaking point on 7 August 2019 at Cookes New Zealand Limited, in accordance with the Japanese classification society Nippon Kaiji Kyokai's (NKK).'Rules and Guidance for the Survey and Construction of Steel Ships (Part L: Equipment)'. A copy of the test certificate can be found in Appendix 2.

Cargo-securing documentation

2.18 The International Convention for the Safety of Life at Sea requires each vessel engaged in the carriage of bulk cargo to carry a cargo securing manual on board. The manual should cover all relevant aspects of cargo stowage and securing.

2.19 An important function of the manual is to provide officers with an awareness of the magnitude and direction of the forces involved in securing cargo and the limitations of

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[9] Lifting or hauling.
[10] A bulldog grip is a device used to clamp two pieces or sections of wire together.
[11] To separate or break a rope or wire
[12] A loop of rope or wire, usually spliced or clamped with a ferrule.

securing devices and equipment. It should also show the correct application of securing devices and equipment and provide advice to the ship's crew for securing cargo.

2.20 The cargo securing manual should also contain, in part, identification markings and certification showing test results and the maximum securing loads of all cargo-securing equipment.

2.21 The cargo securing manual supplied to the *Coresky OL* had been approved on behalf of its flag administration by Nippon Kaiji Kyokai.

2.22 In addition to the cargo securing manual, the International Maritime Organization (IMO) produces a Code of Safe Practice for Ships Carrying Timber Deck Cargoes. The code provides:

- guidance for safe transportation
- methodologies for safe stowage
- design principles for securing systems
- guidance for developing procedures to be included in the vessels' cargo securing manual.

2.23 The code is non-mandatory and applies to ships of 24 metres or more in length carrying timber deck cargoes. A copy of the code was contained in *Coresky OL*'s cargo securing manual.

Documented method for securing deck log cargo on the *Coresky OL*

2.24 The documented method for securing deck log cargo on board the *Coresky OL* was laid down in the vessel's cargo securing manual and supplemented by the guidance provided in the IMO Code of Safe Practice for Ships Carrying Timber Deck Cargoes, 1991. The method can be seen in the simplified diagram in Figure 4. It required a combination of wiggle wires, foot wires and turnbuckles[13] to secure the deck logs in position.

2.25 A wiggle wire, secured at one end to a deck fitting, was required to be run through a series of snatch blocks, which were secured to foot wires on one side of the vessel and to turnbuckles on the other side (see Figure 4).

2.26 Although there was no specific guidance on how to tighten the wiggle wires, once the appropriate tension was achieved the wiggle wires were secured in position using bulldog grips.

2.27 When the vessel was on passage, the turnbuckles were to be used to tighten the wiggle wires further if movement of the deck logs had created slack.

[13] A screw device used for adjusting the tension or the length of ropes, cables, tie rods and other tensioning systems.

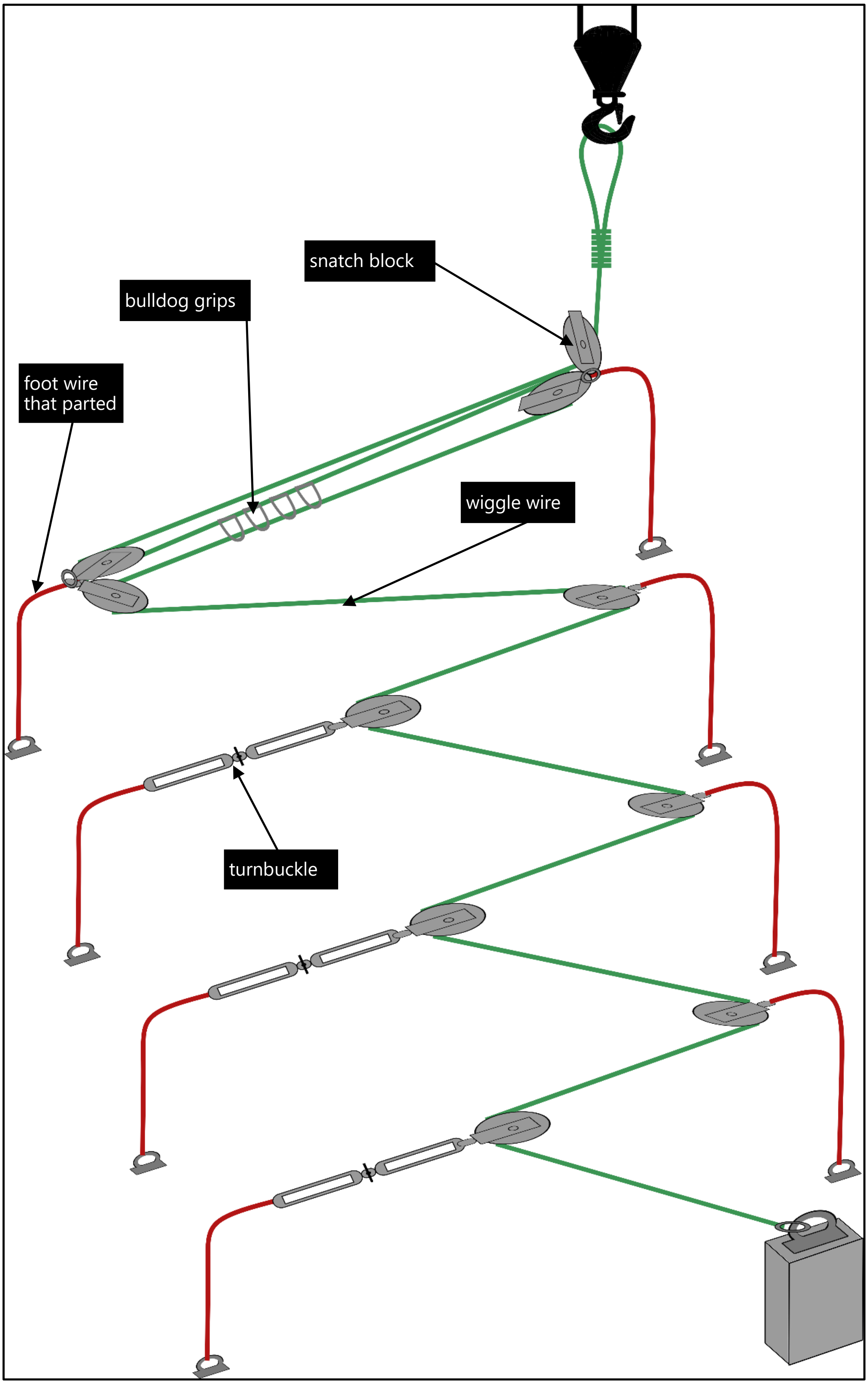


Figure 4: Simplified securing layout as described in the vessel's cargo securing manual

The foot wire specification

2.28 The foot wire that parted was constructed from a coil of wire manufactured by Nantong Steel Wire Rope Group, China in May 2014.

2.29 The wire was 24 millimetres in diameter and made from hot galvanised steel, with six strands of 24 wires containing fibre cores. It was certified as having a minimum breaking load of at least 269 kilonewtons, equivalent to 27.4 tonnes. The foot wire was 15.5 metres long and had an eye constructed using a steel thimble[14] and an aluminium ferrule[15] at each end (see Figure 5).

2.30 The vessel's cargo securing manual defined the maximum securing load of re-usable wire ropes, such as foot wires, to be 30% of their breaking strength. By calculation, the maximum securing load of the foot wire that parted was 8.22 tonnes.

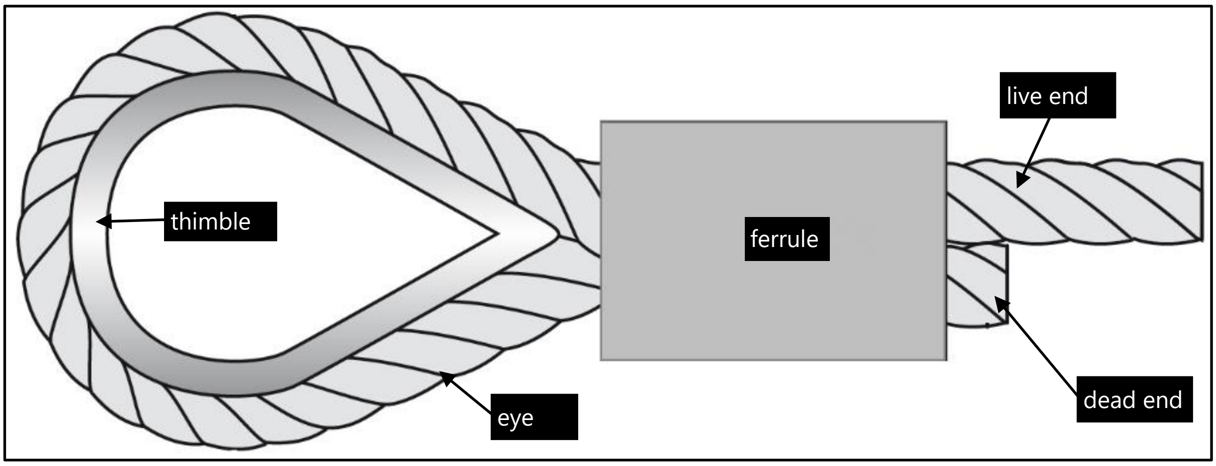


Figure 5: Diagram of the end of a foot wire

Inspection and maintenance of wire ropes

2.31 The cargo securing manual required regular routine visual examinations to be carried out on all portable cargo-securing devices, and periodic examinations/re-testing as required by the flag administration.

2.32 If a visual inspection identified a permanent deformation or break, the device was to be removed from service.

2.33 The cargo securing manual also required that all inspections be recorded and kept with the manual.

2.34 The cargo securing manual on the vessel showed that the crew routinely visually inspected all loose-cargo-securing devices for any obvious defects before entering a port and preparing the securing equipment for use.

2.35 Prior to entering Gisborne on 31 March 2019, the crew visually inspected all the loose-cargo-securing equipment and recorded that all equipment was "sound".

[14] A metal ring with concave sides into which a rope may be spliced or seized. The thimble can then take a shackle pin, hook or rope without chafing rope into which the thimble is fitted.
[15] A circular clamp used to hold together and attach fibres, wires or ropes, generally by crimping, swaging or otherwise deforming the ferrule to tighten it permanently onto the parts that it holds.

Drug and alcohol

2.36 The Commission received evidence showing that after the accident the crew underwent testing for alcohol using an onboard breath analyser. The results were negative (clear) for all crew members.

2.37 A toxicology test carried out by the Institute of Environmental Science and Research (New Zealand) on the deceased AB showed a negative (clear) result for alcohol and drugs.

3 Analysis

Introduction

3.1 Securing logs on the deck of a ship can be a hazardous task that requires good communication and co-ordination of skills between the people involved.

3.2 At the time of the accident, the chief officer and the boatswain were being assisted by two ABs to secure the deck log cargo above number two hatch.

3.3 The team securing the deck logs had all completed the task numerous times before. Both the chief officer and the boatswain were charged with overseeing the operation and had considerable experience.

3.4 The two ABs who were struck by the securing equipment had been tasked with checking when the tension in the wiggle wire was sufficient.

3.5 The following section analyses the failure of the foot wire and the subsequent fatality of the AB. It also examines the conduct of the cargo-securing operation and associated procedures.

Failure of the foot wire

3.6 Both sections of the foot wire that parted were removed by the Commission from the vessel. Experts were appointed to conduct a thorough metallurgic examination of the parted wire (see Figure 6) and to carry out a destructive load test on the remaining section of the foot wire.

Metallurgical examination

3.7 The foot wire was inspected by a metallurgic engineer, who concluded in part:

> The failure of the rope most likely occurred as a result of overload. The failed wires exhibited necking and a cup and cone fracture face that is typical of this type of failure.
>
> Although some corrosion had occurred it is considered unlikely that corrosion of the rope was the primary cause of the failure.

3.8 The elements of the failure mechanism described by the engineer can be seen in Figure 7, and the relevant section of the report is contained in Appendix 1.

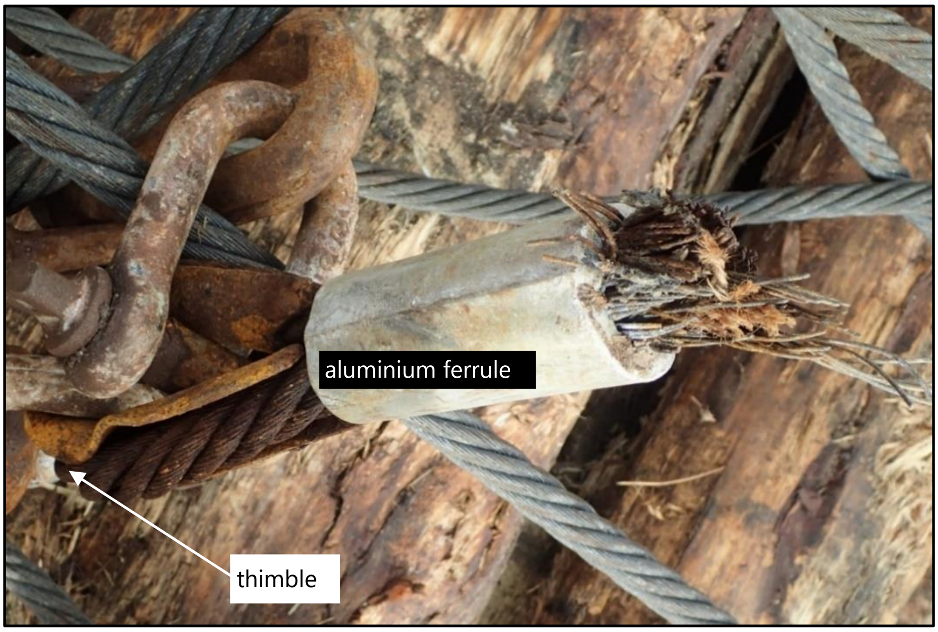


Figure 6: Photograph of the parted wire rope after the accident

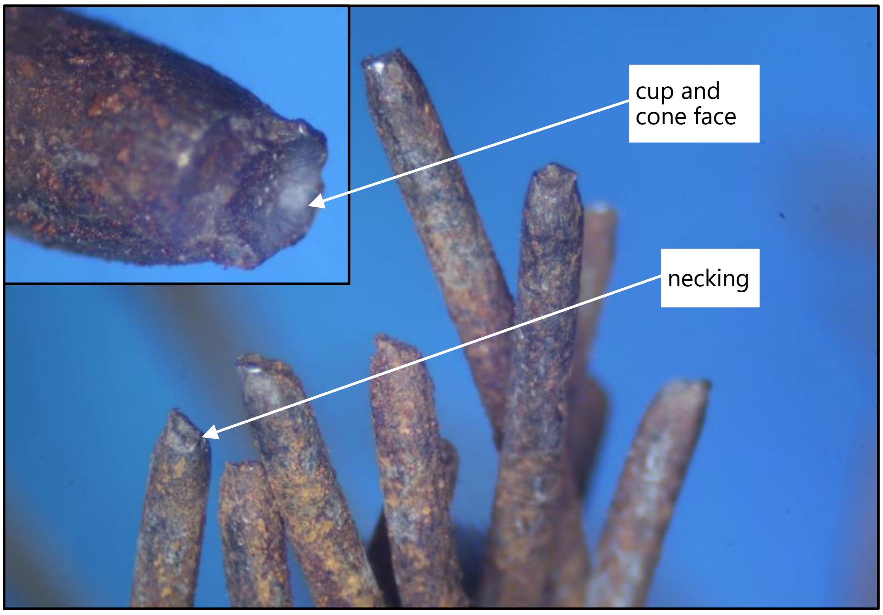


Figure 7: Macro photograph of the failed foot wire showing reduction (necking) and cup and cone failure face

Destructive test

3.9 On completion of the visual examination, the foot wire was tested to destruction[16] to determine its breaking load at the time of the accident. This test concluded that the load required to part the wire was 26.21 tonnes. The certificate of testing can be found in Appendix 2.

3.10 The Commission found that the breaking strength of the parted foot wire at the time of the accident had not been significantly reduced since its manufacture in 2014.

[16] Parted under controlled conditions

3.11 In the absence of any defect being identified in the foot wire, it was likely that the crane was applying a load that resulted in the foot wire being overloaded and parting.

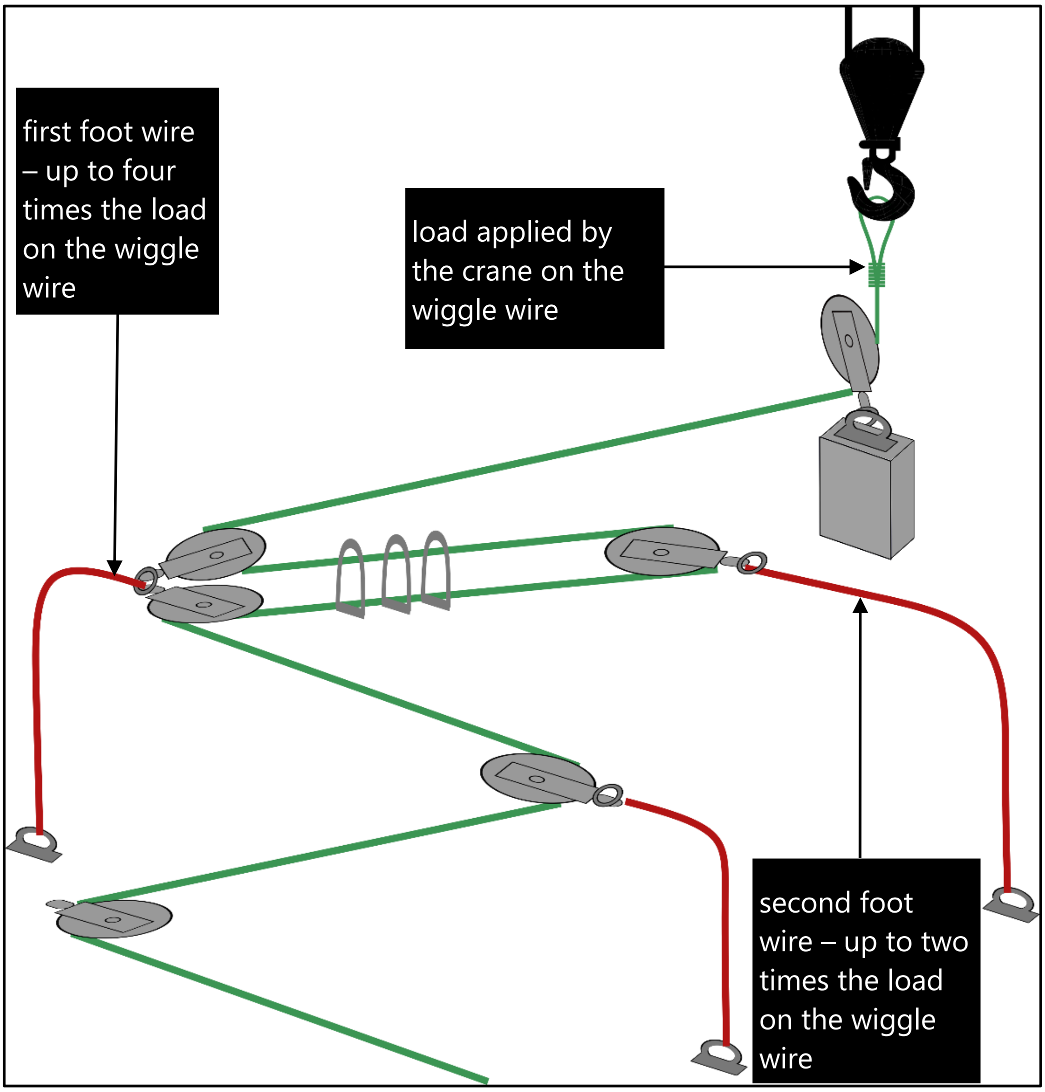


Figure 8: Diagram showing the configuration of the blocks on the day of the accident

Why the foot wire was overloaded

3.12 An overload of a wire occurs when the axial load exceeds the breaking load[17]. The vessel's cargo securing manual stated that to minimise the likelihood of wire overload occurring, re-useable wires were considered to have a maximum securing load of 30% of their certified breaking load. In the case of the foot wire this was 8.2 tonnes, which allowed a margin of safety of 19.2 tonnes. The maximum securing load of the foot wire was not recorded in the vessel's cargo securing manual and the crew were unaware of the value when interviewed. This increased the risk of the crew inadvertently exceeding the breaking load of the foot wire.

3.13 The cargo securing manual on the *Coresky OL* also showed how the securing equipment (see Figure 4) was to be configured to apply a binding effect on the logs.

3.14 At the time of the accident, the securing equipment was configured to allow the crew to attach bulldog grips and secure the tensioned wiggle wire between the first and second

[17] Verreet, R. and Ridge, I., 2005. Wire rope forensics.

foot wires (see Figure 8). The first foot wire had two blocks attached to it. This resulted in the first foot wire having a load of three to four times the load being applied by the crane to the wiggle wire (see Figure 8). Therefore, the crane needed to apply between 6.55 and 8.7 tonnes to the wiggle wire to overload the foot wire. The crew were unaware that the foot wire was experiencing a load three to four times greater than the load being applied by the crane. This increased the risk of the crew inadvertently exceeding the breaking load of the foot wire.

3.15 The diagram in the guidance material also showed turnbuckles (see Figure 4) between the wiggle wire and the foot wires. Turnbuckles allow tension to be increased or decreased manually in a controlled manner. However, at the time of the accident turnbuckles had not been rigged between the wiggle wire and the foot wires. Instead, blocks had been attached directly to the foot wires. As a result, it was not possible to increase the tension in the wiggle wire manually after the initial tension had been applied. If turnbuckles had been rigged, it would have been unnecessary for the crane to apply more than just the initial tension and reduced the likelihood of a foot wire becoming overloaded.

3.16 By not rigging turnbuckles on the day of the accident, it was necessary for the crew to use the ship's crane to apply sufficient tension in the wiggle wire to bind the logs securely. The ABs, whose role was to monitor the tension, had no way of determining how much tension was in the wire other than by feel. This required them to 'step' on the wiggle wire. For the two ABs to be able to 'step' on the wiggle wire, it was necessary for them to stand in a hazardous area close to a wire under tension. This exposed them to considerable risk from the failure of any part of the securing equipment that was under tension.

3.17 It is usual, before commencing work of this sort in a hazardous environment, for the person in charge of the operation to hold a pre-work safety meeting or 'toolbox talk'. Such meetings were not routinely held on board the *Coresky OL*. Had a meeting been held before this securing operation commenced, it would have provided an opportunity for the team to discuss the safety implications of crew standing in hazardous areas where wires and associated securing equipment were under tension. Although the crew had carried out this task many times before, a pre-work safety meeting might have prompted them to think of alternative solutions to standing in a hazardous place, including the recommended use of turnbuckles to reduce the amount of tension required in the wiggle wire.

Safety management

Safety issue: The operator's safety management system was not supported by an effective safety assessment of log-cargo-securing operations, which should have identified the hazards present. This resulted in ineffective controls to mitigate the risks to crew when completing these tasks.

3.18 A safety management system (SMS) is defined in the International Safety Management Code as "a structured and documented system enabling company personnel to implement effectively the company safety and environmental protection policy". A mature SMS should include but not be limited to:

- operating procedures
- role responsibilities
- review and audit requirements

- training requirements
- identifying risks to personnel and establishing appropriate safeguards.

3.19 Incorporated within the operator's SMS was the vessel's cargo securing manual, which contained technical instructions for the crew in respect of securing deck log cargo.

Operating procedures for securing cargo

3.20 The cargo securing manual contained a copy of the IMO's 'Code of Safe Practice for Ships Carrying Timber Deck Cargoes – 1991'. However, the most current version of the code had been adopted on 30 November 2011.

3.21 A number of changes had been made to the code between 1991 and 2011. Significantly, the 2011 version of the code explained:

- the need for turnbuckles to be rigged between wiggle wires and foot wires
- that a crane or winch was to be used only to apply the initial tension to wiggle wires.

3.22 An extract from the 2011 edition of the code, explaining the arrangement for wiggle wires, is shown in Figure 9.

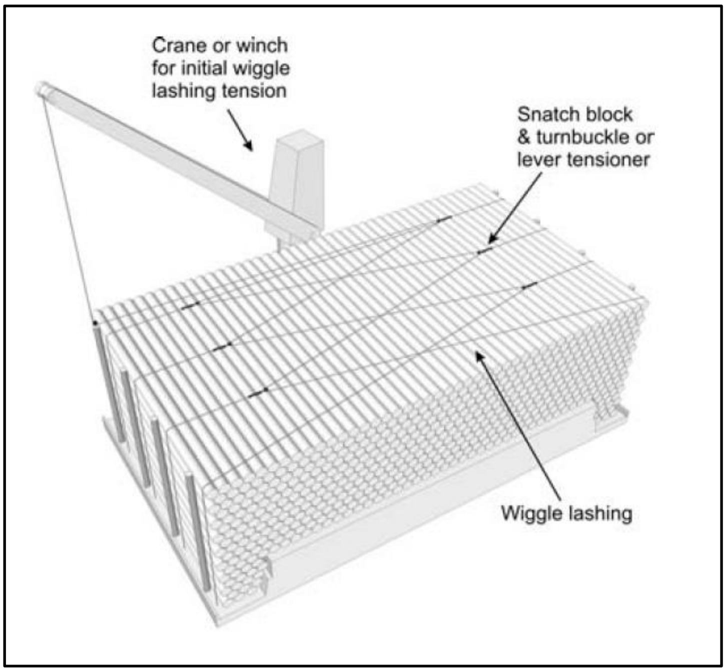


Figure 9: Extract from the 2011 Code of Safe Practice for Ships Carrying Timber Deck Cargos

3.23 The explicit reference to apply only the initial tension would have provided the crew with the guidance necessary to minimise the likelihood of inadvertent overload and reinforce the need to use turnbuckles, which would have allowed the crew to better assess the amount of tension throughout the securing system.

3.24 The implementation of the 2011 version of the code, and the procedural changes contained within it, would have also prompted the operator to conduct a review of the log-securing operation and update procedures and instructions within the SMS.

3.25 Although the vessel's SMS had been audited by the classification society and by internal auditors, the audits had not identified that the vessel was using an out-of-date IMO Code of Safe Practice for Ships Carrying Timber Deck Cargoes. As a result, the amendments contained in the 2011 code, which would have made the operation safer, had not been incorporated into onboard procedures.

Risk-assessing the log-securing operation

3.26 The operator's SMS required the crew to undertake an initial risk assessment before securing the deck log cargo. The SMS instructed the crew to carry out a second, detailed risk assessment if the initial risk assessment identified any "significant risks".

3.27 Evidence showed that previous initial and detailed risk assessments carried out by the crew for deck log cargo operations had each identified the same hazards. The assessments carried out on the day of the accident were no different. The detailed risk assessment, of which an extract is shown in Table 1, did not identify any additional hazards.

Hazard	Mitigation	Likelihood	Consequence
Skids and falls when lashing logs	Crew to wear steel spiked shoes and safety helmet on deck Carry out safety meeting before operation Chief Officer in command at scene	Unlikely	High
Foot trapped between timber	Work carried out by experienced crew Ensure logs are loaded tight and securely Crew to wear steel spiked shoes	Unlikely	High
Logs become loose after sailing	Comply with lashing handbook Ensure lashing tools in good order	Unlikely	High

Table 1: 'Detailed risk assessment' content from vessel

3.28 There were more significant hazards present in the securing operation that were not identified, such as the potential hazard of wires under tension parting.

3.29 Although the cargo securing manual provided technical guidance and drawings on how log cargo was to be secured on the deck, it did not provide a safe operating procedure for the crew to follow. The development of a safe operating procedure was the responsibility of the operator and should have involved a fulsome risk assessment. Because the operator had not undertaken such an assessment for log-securing operations, there was no guidance contained in the SMS about the dangers associated with wires under tension, the potential for load multiplication, snap back zones[18] or safe areas to stand when a crane was being used to heave on the wiggle wire. This likely contributed to the crew involved in this accident not identifying this hazard during their risk assessments or implementing appropriate mitigations.

[18] The predicted trajectories of lengths of rope or wire from their points of failure.

3.30 A fulsome assessment by the operator would have likely provided it with the opportunity to implement more effective mitigation measures for the hazards of the log-cargo-securing operation. Doing so would have helped to ensure that a safer system of work was established and that the crew were exposed to fewer risks. The Commission has therefore made a recommendation to the operator to carry out such an assessment.

Provision of information to crew

3.31 The cargo securing manual provided the crew with some of the information they required. However, the crew would still have had to calculate the safe working load of loose-cargo-securing gear calculate the load being applied to the foot wires through the configuration of the blocks, and then produce a risk-mitigation plan.

3.32 This was a task more suited to being conducted by the operator, before the vessel commenced operations, using experts familiar with the methodology of the securing operation and the loads likely to be imparted.

4 Findings

4.1 A foot wire parted, causing part of the securing equipment to strike an able-bodied seaman.

4.2 The crane and its rigging were found to be in good working order.

4.3 The failure of the foot wire occurred as a result of overload.

4.4 The load being applied by the crane when multiplied by the configuration of the blocks was sufficient to overload the foot wire.

4.5 Turnbuckles were not rigged between the wiggle wire and foot wires, which meant the crane was used to tension the wiggle wire.

4.6 The crane operator had no indication of the load that was being applied to the lifting wire.

4.7 The crew did not identify the hazards associated with wires under tension and had not implemented mitigation measures.

4.8 The operator's safety management system did not include a safety assessment of cargo-securing operations. As a result, no information on the hazards associated with wires under tension was available to the crew and the cargo securing manual did not provide guidance on a safe system of work for cargo-securing operations on the vessel.

5 Safety issues and remedial action

General

5.1 Safety issues are an output from the Commission's analysis. They typically describe a system problem that has the potential to adversely affect future operations on a wide scale.

5.2 Safety issues may be addressed by safety actions taken by a participant, otherwise the Commission may issue a recommendation to address the issue.

Operator's safety management system

5.3 An SMS enables company personnel to implement the company's safety policy and ensure that operations on board a vessel are undertaken safely without risk to crew. The underpinnings of an effective SMS are safety assessments, which examine the tasks being undertaken on a vessel to identify the hazards present. This ensures that appropriate safeguards are put in place.

5.4 The operator's SMS was not supported by an effective safety assessment of log-cargo-securing operations, which should have identified the hazards present. This resulted in ineffective controls to mitigate the risks to crew when completing these tasks.

5.5 The ship operator, Shih Wei Navigation Company Limited, provided the Commission with the following list of safety actions taken:

- The company shared an internal investigation report, as to the lessons learnt, to the fleet for all crew's attention.
- The Company revised the relative SMS procedures and checklists according to the findings of internal investigation, including:

  Carrying Timber Deck Cargoes
  Crew Re-Training Report for familiarization with safe Cargo Securing Operations engaged by ship's crew
  Checklist of Check Points & Typical Damages
  Permit to work for deck timber lashing
  Record of Personal Protective Equipment (PPE) on board.

- The company required the crew to examine all cargo securing equipment, with defective equipment found removed from service. The Company also supplied some new securing materials in next port of call, Zhenjiang, China after Incheon.
- The company enhanced the education and training of newly joined crewmembers, especially for log carried [sic].
- The company issued a fleet circular (E-Circular 20-11/ Attention for the lashing of timber loading on deck and risk assessment) on 8th April 2020 for the crew's attention on lashing of timber on deck.

5.6 The Commission welcomes the safety action to-date. However, it believes more action needs to be taken to ensure the safety of future operations. Therefore, the Commission has made a recommendation in Section 6 to address this issue.

6 Recommendations

General

6.1 The Commission issues recommendations to address safety issues found in its investigations. Recommendations may be addressed to organisations or people, and can relate to safety issues found within an organisation or within the wider transport system that have the potential to contribute to future transport accidents and incidents.

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

6.3 In this case, a recommendation has been issued to Shih Wei Navigation Company Limited (Taiwan), with notice of the recommendation given to the General Director of the Panama Maritime Authority.

New recommendation

6.4 **On 21 May 2020 the Commission recommended that Shih Wei Navigation Company Limited (Taiwan) carry out a comprehensive safety assessment of vessels engaged in carrying and securing deck log cargo. The assessment is to result in appropriate procedures and guidance being contained in the safety management system and ensure that a safe system of work is established. (004/20)**

On 5 June 2020, the Commission received a response to the recommendation stating Shih Wei Navigation Company Limited had since issued a circular to their fleet - 'E-Circular 20-11 – Attention for the lashing of timber loading on deck and risk assessment'.

The Commission notes that the response was not from Shih Wei Navigation Company Limited but from the new management company of the vessel, Oceanlance Maritime Co, Limited. As Shih Wei Navigation Company Limited remains the beneficial owner of *Coresky OL*, and continues to operate similar vessels, the Commission's recommendation remains directed at Shih Wei Navigation Company Limited.

7 Key lessons

7.1 Securing logs can be a hazardous operation that should be fully risk assessed. Only then will comprehensive procedures and instructions be developed to help create a safe working environment.

7.2 Those involved in a securing operation need to be aware of the likely loads involved and the potential dangers to which they may become exposed. In addition, relevant information needs to be recorded in the cargo securing manual for future reference.

8 Data summary

Vehicle particulars

Name:	*Coresky OL*
Type:	bulk carrier
Class:	Nippon Kaiji Kyokai (Japan)
Length:	179.96 metres
Breadth:	30 metres
Gross tonnage:	21,561
Built:	2015
Propulsion:	Man B&W 6S46ME-B8.3
Service speed:	14.4 knots
Owner/Operator:	Shih Wei Navigation Company Limited (Taiwan)
Port of registry:	Panama
Minimum crew:	14

Date and time	3 April 2019 0141
Location	Eastland Port, Gisborne, New Zealand
Persons involved	two
Injuries	one fatal, one minor
Damage	one parted wire rope

9 Conduct of the inquiry

9.1 On 3 April 2019 Maritime New Zealand notified the Commission of the occurrence. The Commission subsequently opened an inquiry under section 13(1) of the Transport Accident Investigation Commission Act 1990 and appointed an investigator in charge.

9.2 On 4 April 2019 the Commission informed the Panama Maritime Authority of the accident and invited the authority to participate in the investigation.

9.3 On 1 May 2019 the Commission was informed that the Panama Maritime Authority would be conducting an independent parallel safety investigation.

9.4 On 19 February 2020 the Commission approved a draft report for circulation to four interested persons for their comment.

9.5 The Commission received a submission from one interested person. Any changes as a result of the submission have been included in the final report.

9.6 On 21 May 2020 the Commission approved the final report for publication.

10 Report information

Abbreviations

IMO	International Maritime Organization
SMS	safety management system

Glossary

able-bodied seaman (AB)	a sailor able to perform any of a deck crew's duties
boatswain	the most senior rating of a deck department and responsible for the components of a ship's hull. The boatswain supervises the other members of the ship's deck department
bulldog grip	a device used to clamp two pieces or sections of wire together
chief officer	a licensed mariner and head of the deck department of a merchant ship. The chief officer (or chief mate) is customarily a watch stander and is in charge of the ship's cargo and deck crew
dead end (rope or cable)	the end of a rope that does not take any load after being spliced or clamped with a ferrule
eye	a loop of rope or wire; usually spliced or clamped with a ferrule
ferrule	a circular clamp used to hold together and attach fibres, wires or ropes, generally by crimping, swaging or otherwise deforming the ferrule to permanently tighten it onto the parts that it holds
foot wire	a wire secured at one end to a vessel's deck and the other to wiggle wires
heaving	lifting or to hauling
live end (rope or cable)	the end of a rope that takes the load after being spliced or clamped with a ferrule

loose-cargo-securing gear	off-the-shelf equipment including, but not limited to, shackles, chain, hooks, connecting links, turnbuckles, binders, sheave blocks, and swivels used in an assembly to suspend, secure or lift a load
part	separate or break
Shackle	A bowed metal fitting closed with a pin through the ends, used for ease of attachment of ropes, wires and chains.
snatch block	a block that can be opened on one side to receive a bight of rope
toolbox talk	an informal safety meeting that focuses on safety topics related to a specific job, such as workplace hazards and safe work practices
turnbuckle	a screw device used for adjusting the tension or the length of ropes, cables, tie rods and other tensioning systems
wiggle/bonding wire	a continuous wire rope used to tighten the stow by passing it from side to side over a log deck cargo and through a series of blocks held in place by foot wires

Citation

Verreet, R. and Ridge, I., 2005. Wire rope forensics. *The document is available online at:* https://www.ropetechnology.com/bro_engl/wire_rope_forensics_a4.pdf

11 Notes about Commission reports

Commissioners

Chief Commissioner	Jane Meares
Deputy Chief Commissioner	Stephen Davies Howard
Commissioner	Richard Marchant
Commissioner	Paula Rose, QSO

Key Commission personnel

Chief Executive	Lois Hutchinson
Chief Investigator of Accidents	Aaron Holman
Investigator in Charge	Richard Ford
General Counsel	Cathryn Bridge

Citations and referencing

This final report does not cite information derived from interviews during the Commission's inquiry into the occurrence. Documents normally accessible to industry participants only and not discoverable under the Official Information Act 1982 are referenced as footnotes only. Publicly available documents referred to during the Commission's inquiry are cited.

Photographs, diagrams, pictures

The Commission has provided, and owns, the photographs, diagrams and pictures in this report unless otherwise specified.

Verbal probability expressions

This report uses standard terminology to describe the degree of probability (or likelihood) that an event happened or a condition existed in support of a hypothesis. The expressions are defined in the table below.

Terminology*	Likelihood	Equivalent terms
Virtually certain	> 99% probability of occurrence	Almost certain
Very likely	> 90% probability	Highly likely, very probable
Likely	> 66% probability	Probable
About as likely as not	33% to 66% probability	More or less likely
Unlikely	< 33% probability	Improbable
Very unlikely	< 10% probability	Highly unlikely
Exceptionally unlikely	< 1% probability	

*Adopted from the Intergovernmental Panel on Climate Change

Appendix 1: Quest Integrity visual and metallographic examination

1 Introduction

The Transport Accident Investigation Commission (TAIC) contracted Quest Integrity NZL Limited (Quest Integrity) to carry out a preliminary investigation of a failed wire rope. The wire rope was used for moving logs on board the bulk carrier Coresky OL and failed on the 3rd of April 2019 at Eastland Port in Gisborne.

The failed rope was the foot rope from hatch number 2. The rigging plan with the location of the failure marked is shown in Figure 1.

The following samples were supplied for investigation as shown in Figure 2:

- The eyelet side of the failed rope including the associated eyelet fitting (thimble and crimped on aluminium ferrule).
- The opposite side of the failure and about 4m of rope.
- A reference section of wire rope about 1.2m long with an eyelet fitting that had not failed that had also been installed at hatch 2 on Coresky OL.

The aim of the preliminary investigation was to determine the likely cause of the failure. TAIC stipulated that the investigation needed to be completed without disturbing the failed area of the wire.

2 Scope of Work

The following scope of work was undertaken:

- Visual examination and photography of the samples with the aid of a binocular microscope and measurement equipment.
- Removal of 100 mm from the cut end of each rope away from the failure. Examination of the individual wires in one of the 6 strands to determine the typical degree of corrosion present.
- Creation of a metallographic cross section of the wire that failed, away from the fracture, to determine the degree of corrosion loss and thickness of any galvanising present.
- Hardness testing of the wire strands in the metallographic cross section and estimation of the tensile strength of the strands based on the hardness.

3 Wire Rope

The failed wire rope sections supplied had a nominal outside diameter of 24mm. The wire rope was made up of 6 strands wound around a fibre core. Each strand was made up of 8 wires of around 1.25mm diameter wound around a fibre core. The wire had a right hand regular lay. Figure 3 shows the construction of the wire rope. The wires for the rope were hot dip galvanised at manufacture. The reference sample was assumed to be a section of rope with the same specification.

At the eyelet fitting adjacent to the failure the rope had been looped over a steel thimble and this had been secured in place with a crimped on aluminium ferrule to create the fitting. It should be noted that the rope was doubled back through the ferrule when it was put on so that the cut ends protruded from the ferrule.

A China Classification test certificate dated 12 May 2014 was supplied (see Appendix A). It is assumed that was a witness of testing carried out at the Nantong Steel wire rope Company factory for batch testing of 8000m of rope. Typically this would be a batch test when the wire was being made. This indicated that the wire rope had a specified breaking load of ≥269kN (27 tonnes). The wire tensile strength was listed as 1670 N/mm^2 (1670 MPa). It was not clear from the certificate whether this was a minimum specified value, or a test result.

4 Visual Examination

The supplied sections of wire rope were visually examined. The following was noted:

- The failure occurred adjacent to the ferrule holding the thimble onto the end of the rope (see Figures 4 – 6). Note, half the wires protruding from the ferrule were cut ends, not in-service failures.
- The failed wires angled away from the ferrule (see Figure 5). This suggests that the rope was being pulled away from the ferrule at an angle at the time of failure and the load was not acting directly in line with the eyelet. This might indicate that the eyelet was twisted or stuck at an angle to the rope when the failure occurred.
- The rope had partially unravelled for a length of around 250mm from the failure (see Figure 6. Typically, when an evenly loaded wire rope fails in overload the broken wires release like springs and there is extensive unravelling extending for a long distance along the rope. In this case, the unravelling was only over a relatively short distance, suggesting that the wires preferentially failed at the back of the ferrule. This could possibly be due to bending occurring in the rope adjacent to the eyelet

- The thimble in the eyelet adjacent to the failure was significantly deformed. The end of the thimble was pinched in, possibly where it had been contacting the pin of a shackle. The sides of the thimble had been pressed out of shape, possibly where they had contacted the sides of a shackle when the eyelet or shackle had twisted (see Figures 4 and 5). The deformation to the thimble probably occurred as a result of uneven loading due to bending at the eyelet.
- The thimble in the eyelet of the unbroken reference sample rope had similar deformation to that seen in the eyelet that was adjacent to the failure. This indicates that the deformation to the thimble was probably commonly seen.
- The failed rope had some general corrosion product present along the length. However, there was residual galvanising still visible in many places. On the unbroken reference rope there was no galvanising still visible and was completely covered in corrosion product. Figure 7 shows a comparison of typical wires from the two ropes.
- There as an area of significant corrosion product present on the rope where it passed into the ferrule. This was both corrosion product from the wire and from the aluminium ferrule (see Figures 8). This was present on both the failed rope and the unbroken reference rope.
- There was no sign of grease or oil on the ropes at any location. The internal fibre packing of the rope was noted to be very dry and friable, with no indication of any residual oil or grease.
- There was 40 strand turns per meter on both the failed and unbroken wires. There was no significant variation between the lay of the two ropes that would indicate either rope had been stretched.
- Away from the main failure there was no evidence of additional strand failures or signs of wear on the failed rope or on the reference sample rope.

The failure area on both sides of the failure was closely examined with the aid of a binocular microscope. The following were noted:

- All of the broken wires that could be examined appeared to have failed via tensile ductile overload. There was diameter reduction near the failure area (necking) and a 'cup and cone' type failure face, see Figure 9. The degree of necking seen adjacent to the failures was relatively high indicating that there was no significant embrittlement of the material.

- A small number of the broken wires on the eyelet side of the failure were obscured by corrosion product and it was difficult to visually determine the type of failure. These were mostly the wires that had broken very close to the ferrule, see Figure 10. However, since all the corresponding wires on the rope end appear to have failed via overload it can be assumed these obscured wires did too.
- There was no visual evidence that the wire strands in the area of the failure had lost any cross section due to corrosion or wear prior to the failure. This indicates that it unlikely that there had been an issue with hydrogen embrittlement of the wire strands.

5 Diameter Measurement

The overall diameter of the ropes along the length was measured with a caliper. The diameters ranged between 23.8 and 24.3mm. There was no significant variation along the length or between the failed and the unbroken ropes.

The diameter of the broken wires near the failure was measured with a micrometre. The diameters ranged between 1.22mm – 1.50mm. There was no obvious significant loss of section measured. The wires with diameters above 1.30mm were typically those that had some corrosion product on the surface, which increased the measured diameter.

One strand of wires was removed from the unbroken end of the failed rope and one from the intact reference sample. The strands were unravelled and the diameters of the wires measured with a micrometre. The diameters ranged between 1.25 and 1.33mm. There was no significant difference between the wires from the failed sample and the wires from the intact reference sample.

6 Metallographic Examination

A sample was cut from the unbroken end of the failed wire. This was mounted in resin and polished to a 1µm finish.

Figure 11 shows the cross section of the mounted wires and close view of a typical wire. There was no indication of significant corrosion or loss of section seen in this cut section. Some minor deformation of some of the wires was noted, likely caused by the wires pressing together.

Some wires appear slightly oval in the images of mounted samples (Figures 11). This is an artefact caused by the wires being at a slight angle in the mounting, No actual significant ovality was observed in any of the wires.

Residual galvanising was present around most of the wires to a thickness of around 5-10µm (see Figure 12). The exact galvanizing standard used for this rope is not clear from the manufacturing test certificate supplied (Appendix A). However, typically galvanizing on wire ropes would be in the order of 20 – 60µm thick when newly applied [1] so it is likely the coating is near end of life. Even so, the residual zinc would still be providing some degree of corrosion protection to the steel wire.

The sample was etched with 1% Nital and the microstructure examined. The microstructure was typical of a cold drawn, high carbon steel. This was consistent with the expected microstructure for wire rope material.

7 Hardness Testing

Vickers hardness testing was performed on ten wires from the failed rope and ten from the unbroken reference sample. The hardness measurements ranged between 489 – 557HV1. The average recorded hardness was 516HV1. There was no significant different in hardness between the failed rope and the unbroken reference rope.

As per ASTM A370 [2], 516HV is typically equivalent to a tensile strength of around 1820MPa for ferritic steels. The Cookes Wire Rope Handbook [3] indicates that hardness of 460 – 570 HV is typical for wire with a tensile strength of 1770MPa.

The tensile strength listed on the manufacturing test certificate was 1670MPa (Appendix A). The hardness testing results indicate that the wire tensile strength was likely similar to this value.

8 Discussion / Conclusion

The failure of the rope most likely occurred as a result of overload. The failed wires exhibited necking and a cup and cone fracture face that is typical of this type of failure.

The deformation of the thimble and the way the failed wires angled away from the ferrule suggest that the rope was pulling at an angle to the eyelet fitting at the time of failure. This could have caused the rope to fail at a lower load than it would have if the load had been applied directly in line with the eyelet and all the wires shared the tensile stresses evenly.

Although there was some corrosion product present around the failure site there was no significant loss of cross-section of wires measured or observed. Some degree of residual galvanising was still present in most areas examined. The unbroken reference rope sample was more corroded than the failed sample. It is considered unlikely that corrosion of the rope was the primary cause of the failure.

The microstructural and hardness results are consistent with the manufacturing test certificate supplied and with typical literature values for wire used in wire rope. There was no evidence to indicate that the wire rope was not made correctly.

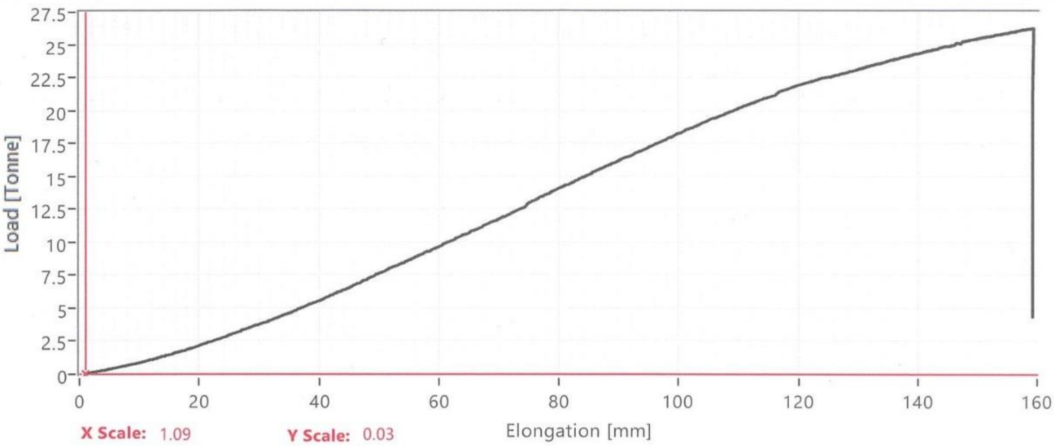
Aside from the failure, the only difference noted between the failed rope and the unbroken reference sample was that the degree of corrosion on the reference sample was more extensive than on the failed rope

Appendix 2: Cookes' destructive testing certificate

CERTIFICATE OF TESTING

Cookes
6-10 Greenmount Drive
East Tamaki
Auckland 2013

Customer:	Maritime New Zealand	**Test Report #:**	080719005
Address:	Level 11 Grey Street	**Test Type:**	Break test
		Peak Load:	26.215 Tonne
Customer PO #:		**Peak Elongation:**	159.41 mm
Order #:		**Test duration:**	00:02:02
Item Serial #:	203005	**Test Standard:**	EN 13411-3:2004 and class NK 4 4.1.6
Test Date:	7/08/2019	**W.L.L. :**	5
Test Time:	10:14:34 AM	**Comments:**	
Description:	24mm sling with 500mm soft eye each end		
Customer Note:			



☒ **Acceptable**
☐ **NotAcceptable**

Test operator:

TAIC Kōwhaiwhai - Māori scroll designs

TAIC commissioned its kōwhaiwhai, Māori scroll designs, from artist Sandy Rodgers (Ngati Raukawa, Tuwharetoa, MacDougal). Sandy began from thinking of the Commission as a vehicle or vessel for seeking knowledge to understand transport accident tragedies and how to prevent them. A 'waka whai mārama (i te ara haumaru) is 'a vessel/vehicle in pursuit of understanding'. Waka is metaphor for the Commission. Mārama (from 'te ao mārama' – the world of light) is for the separation of Rangitāne (Sky Father) and Papatūānuku (Earth Mother) by their son Tāne Māhuta (god of man, forests and everything dwelling within), which brought light and thus awareness to the world. 'Te ara' is 'the path' and 'haumaru' is 'safe or risk free'.

Corporate: Te Ara Haumaru - The safe and risk free path

The eye motif looks to the future, watching the path for obstructions. The encased double koru is the mother and child, symbolising protection, safety and guidance. The triple koru represents the three kete of knowledge that Tāne Māhuta collected from the highest of the heavens to pass their wisdom to humanity. The continual wave is the perpetual line of influence. The succession of humps represent the individual inquiries.

Sandy acknowledges Tāne Māhuta in the creation of this Kōwhaiwhai.

Aviation: ngā hau e whā - the four winds

To Sandy, 'Ngā hau e whā' (the four winds), commonly used in Te Reo Māori to refer to people coming together from across Aotearoa, was also redolent of the aviation environment. The design represents the sky, cloud, and wind. There is a manu (bird) form representing the aircraft that move through Aotearoa's 'long white cloud'. The letter 'A' is present, standing for aviation.

Sandy acknowledges Ranginui (Sky father) and Tāwhirimātea (God of wind) in the creation of this Kōwhaiwhai.

Marine: ara wai - waterways

The sections of waves flowing across the design represent the many different 'ara wai' (waterways) that ships sail across. The 'V' shape is a ship's prow and its wake. The letter 'M' is present, standing for 'Marine'.

Sandy acknowledges Tangaroa (God of the sea) in the creation of this Kōwhaiwhai.

Rail: rerewhenua - flowing across the land

The design represents the fluid movement of trains across Aotearoa. 'Rere' is to flow or fly. 'Whenua' is the land. The koru forms represent the earth, land and flora that trains pass over and through. The letter 'R' is present, standing for 'Rail'.

Sandy acknowledges Papatūānuku (Earth Mother) and Tāne Mahuta (God of man and forests and everything that dwells within) in the creation of this Kōwhaiwhai.

Transport Accident Investigation Commission

Recent Marine Occurrence Reports published by the Transport Accident Investigation Commission

MO-2018-205	Fatality on board the factory trawler *San Granit*, 14 November 2018
MO-2019-202	Fatal jet boat accident, Hollyford River, Southland, 18 March 2019
MO-2019-201	Jet boat Discovery 2, contact with Skippers Canyon wall, 23 February 2019
MO-2018-202	Accommodation fire on board, fishing trawler *Dong Won 701*, 9 April 2018
MO-2018-203	Grounding of container ship *Leda Maersk*, Otago Lower Harbour, 10 June 2018
MO-2018-204	*Dolphin Seeker*, grounding, 27 October 2018
MO-2017-204	Passenger vessel *Seabourn Encore*, breakaway from wharf and collision with bulk cement carrier at Timaru, 12 February 2017
MO-2017-203	Burst nitrogen cylinder causing fatality, passenger cruise ship *Emerald Princess*, 9 February 2017
MO-2017-205	Multipurpose container vessel *Kokopo Chief*, cargo hold fire, 23 September 2017
MO-2017-202	Passenger vessel *L'Austral*, grounding, Milford Sound, Fiordland, 9 February 2017
MO-2016-206	Capsize and foundering of the charter fishing vessel *Francie*, with the loss of eight lives, Kaipara Harbour bar, 26 November 2016
MO-2016-202	Passenger ship, *Azamara Quest*, contact with Wheki Rock, Tory Channel, 27 January 2016
MO-2017-201	Passenger vessel *L'Austral* contact with rock Snares Islands, 9 January 2017
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MO-2016-205	Fatal fall from height on bulk carrier, *New Legend Pearl*, 3 November 2016
MO-2015-201	Passenger ferry *Kea*, collision with Victoria Wharf, Devonport, 17 February 2015
Interim Report MO-2017-203	Burst nitrogen cylinder causing fatality on board the passenger cruise ship *Emerald Princess*, 9 February 2017

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