RISK ALERT

STEAMSHIP MUTUAL

Grounding and Loss of a RoRo

Introduction

The UK Marine Accident Investigation Branch (MAIB) has recently published its report on the loss of the 6,000 GT RoRo trailer ferry "Riverdance" on 31st January 2008. This vessel encountered stability problems in heavy weather during the course of a voyage across the Irish Sea towards the UK, and ultimately foundered on a beach on the UK coast. The severe weather prevented her being refloated and salvage became impossible, with the result that the vessel was broken up in-situ. All of the 19 crew and 4 passengers were successfully rescued by helicopter, and no pollution incident occurred. Although this vessel was not entered with Steamship Mutual, the causes of the grounding and loss of this ferry, which are many and varied, may be of general interest and are discussed in detail in this issue of Risk Alert.

Summary

The vessel was proceeding on a night crossing of the Irish Sea in heavy weather with a west south westerly wind of Beaufort force 9 to 10 and a following sea that was travelling slightly faster than the vessel. The passage had been uneventful with the vessel's movement being described as comfortable. As she approached port, one hour's notice was given to the engine room. As shallower water was encountered, the sea state deteriorated considerably and the rolling of the vessel increased. The vessel then experienced a series of large rolls causing two trailers to slip from their trestles loosening their lashings. The rolling then decreased for a short period and it was noted the vessel had developed a slight port list. The vessel then experiencing more extreme rolling with the vessel hanging to port after a particularly large roll. At this point cargo on trailers started to shift, and some trailers themselves shifted slightly. The Master then attempted to turn the vessel back into the westerly wind by turning rapidly to starboard in order to try to reduce the rolling. This manoeuvre exacerbated the port list still further such that it was reported that the list approached 50° and the deck edge on the port side became immersed. The vessel was brought head into the wind, however, due to the large list, the port engine then failed. On just one engine the vessel was unable to keep her head into the wind and soon found she was drifting beam on to the weather towards the shore with a 40° port list. A team entered the engine room and attempted to re-start the port main engine, and also to re-distribute ballast, however the latter was not possible as the ballast pump could not be primed. The Master had issued a Mayday call and as a rescue helicopter arrived on scene the heeling pump was started prior to the engine room being abandoned. Pumping reduced the list over the next 30 minutes to about 20°. At this stage the 4 passengers and 4 non-essential crew were evacuated to the helicopter, although it was considered too dangerous to deploy the anchors to stop the vessel's drift and make the evacuation of personnel slightly easier. With a reduced list a further attempt was made to start the engines which had both stopped by this time. However, before this could be done the vessel grounded. A further 6 crew were evacuated at this stage leaving a skeleton crew of 9 onboard.

After grounding, the vessel returned towards upright, and it was decided to re-float the vessel on the rising tide. Whilst aground the heeling tank contents were pumped over to starboard. Number 2 and 8 starboard side tanks were to be filled, and no.3 port side tank was to be pumped out to bring the vessel upright upon re-floating. However, the stability of the vessel prior to sailing had not been determined so the ballasting operation was based upon the Master's estimation. It was not possible to pump ballast into number 2 starboard tank due to a valve problem, but it was believed the ballasting undertaken would suffice to bring the vessel upright, although as the sounding pipes were on the main deck and access was dangerous, it was not possible to verify the contents of any of the ballast tanks. The plan was to start both engines and the bow thruster and manoeuvre the vessel clear of the shore once she became afloat, even though suitable tugs were not available to assist. Those trailers on the upper deck which had shifted were re-secured, however, it was too dangerous to enter the main deck, but a limited visual inspection revealed that only a few trailers had shifted, but several had lost their loads.

Upon initially re-floating, the vessel used both engines and the bow thruster in an attempt to manoeuvre clear of the beach; however, in the strong winds she drifted closer to the shore and grounded again. As the waves and seas broke against the vessel she rolled to starboard eventually settling at 30°, and with the cooling water sea chest brought clear of the water, the generators tripped with the emergency generator taking over. The remaining crew were then winched off having abandoned ship. It was later found that it would not be possible to salvage the vessel, she was therefore declared a total loss, and was broken up.

Causation

Freight charges were based on trailer length rather than weight, so there was little incentive for the weights declared by drivers to be checked for accuracy. It was usual for the shipper to rely on the premise that empty trailers weighed 6MT and full trailers 30MT, even thought they could legally weigh up to 36MT. On this occasion the loading list

provided to the vessel contained no weights. The stowage plan was based on the height and declared weights of trailers, and slots were assigned either on the main or upper decks, with the lower hold not being in use. If a tractor unit was seem to be labouring with a trailer it would normally be allocated a slot on the main deck to assist with the stability of the vessel. For operational reasons trailers were often substituted and shipped in place of those declared on the manifest, and on this voyage four such substitutions had taken place. It is not clear if the loading plan was amended accordingly to reflect the change. Therefore the information available to the vessel on the precise details of the cargo loaded was scant. With no weights or plan of trailer positions being provided, an accurate assessment of the stability of the vessel could not be made.

In line with the requirements of the vessel's Safety Management System (SMS), stability was to be calculated prior to each departure; however this was largely being ignored. Instead a worse case stability scenario had been developed onboard and it was considered the vessel would have an adequate reserve of stability in excess of that shown on the worse case scenario under all foreseeable loading conditions. Although the calculation had been approved by the managers, it had not been fully verified and checked against the load line stability requirements. Only two side ballast tanks were normally kept full, and along with the heeling tanks, were the only ballast tanks in use. Displacement was checked prior to departure from Ireland with the draughts corresponding to the weight of cargo loaded. However, no accurate assessment of stability was undertaken.

During the hanging roll to port, some cargo and trailers shifted to port, causing a residual list of about 10°. The cause of the vessel seeming to hang to one side, as though the righting lever was greatly reduced from that which was expected, can be attributed to the following seas. As the crest of a wave travels along the length of the vessel the metacentric height (GM) is reduced as a function of the loss of waterplane area. The magnitude of the loss of GM depends on several variables; wave height relative to the draught, and wave length relative to the length of the vessel being the most notable factors. It was calculated that the GM in this case could have been reduced to as little as 10cm as the crest of the wave passed amidships. Consequently any external heeling moment would incline the vessel and possibly cause it to hang to one side until the wave had passed further along the hull, increasing the GM and the righting lever, which in turn would cause the vessel to return towards the upright. A succession of such waves would result in the vessel making a number of slow rolls to either side, increasing in magnitude.

The Master instigated a turn to starboard in order to come into the wind and waves to reduce the rolling. However, the heel to port was greatly exacerbated as a result of the rapid turn to starboard, and there are two most likely scenarios that caused this.
Firstly the vessel may have broached as she turned to starboard, increasing the heel. Alternatively, if not broached, then due to the speed of the turn the heel would have increased. In both instances the strong wind on the starboard beam acting upon the superstructure would have caused the heel to increase further to port. Simulations of these scenarios concurred with witness statements and found that an angle of heel of up to 50° to port would have been experienced. Such an angle led to the deck edge becoming immersed and flooding occurring. The most likely entry point for water flooding into the internal spaces following the deck edge becoming submerged was the vents to the lower hold. Although these were fitted with watertight flaps these were still open and these vents were seen to be submerged by waves breaking on the deck. During the incident water was sighted in the lower hold and heard in the vicinity of the main deck vehicle space, although the quantity in the latter was not determined and it is not clear how it got there. The presence of this additional water and its free surface effect further reduced the vessel's residual stability; however, no attempt was made to pump this water out.
The second possible cause for the excessive angle of heel that was attained related to the heeling tanks. These tanks were used for automatically keeping the vessel upright whilst the vessel was alongside with cargo operations ongoing. The system consisted of a reversible pump with non-return valves in the line to prevent migration of water from one side to the other when the pump was not in use to counter its minimal resistance to the passing of water. The system also had isolation valves in the lines as the non-return valves could also become ineffective at resisting the transfer of water at large angles of heel. The usual procedure was for the isolation valves in the lines to be opened during arrival standby; however, in this instance they were opened earlier once one hour's notice of arrival had been given to the engine room. During the demolition of the vessel it was found that some of the non-return valves fitted in the piping arrangement were found to be seized in a partially open position.
During the turn to starboard, the starboard heeling tank would have been above the port tank. The isolating valves being open, the partially open seized non-return valves and the minimal resistance given by the pump meant water could have migrated from the starboard to the port tank. Due to the size of the pipe (30 cm diameter), a substantial quantity of water could have transferred between the tanks at this time. The possibility was also considered that the heeling pump was intentionally, but incorrectly operated to correct the list. The duty engineer had only recently joined the vessel, and the capacity of the pump was such that the entire contents of one tank could be transferred to the other in approximately 10 minutes. If the system was operated incorrectly with the water being pumped the wrong way, this would have exacerbated the list; although this scenario was

considered highly unlikely.
Upon completion of the turn to starboard, a combination of the shift of cargo and one of the foregoing possibilities would have meant the vessel completed the turn with a list of between 30° and 40°.This led to the stoppage of the port engine and the subsequent inability of the vessel to maintain her head to wind, and subsequently drifting aground.

As the vessel lay aground it was decided to ballast the vessel such that she would refloat upright. Ballasting while aground was based on an estimation of the stability situation. As no stowage plan was available, an accurate assessment of the vessel's stability could not be made. It was decided that one of the port side tanks would be emptied and one of the starboard side tanks would be filled. A second starboard side tank was not filled due to problems with the hydraulic control system to the valves on this tank. The contents of the heeling tanks was also pumped from port to starboard. Even though the ballasting operations undertaken were less than originally planned, it was later calculated that had the vessel been floating freely she would have assumed a starboard list of 30°, excluding the effect of any further shifts of cargo. Therefore the ballasting operations that were estimated to bring the vessel upright had quite the opposite effect, giving the vessel the large starboard list with which she eventually grounded for the final time.

As the vessel refloated she could not be turned head to wind and waves, and she therefore drifted further up the beach. Anchors had not been deployed, suitable tug assistance was not available, and the weather conditions had also not improved. As she moved up the beach she lay beam on to the weather and eventually grounded again and progressively rolled further and further over to starboard, with more shifting of cargo being heard. The vessel eventually became hard aground with a list of up to 100° to starboard and was declared a total loss and was broken up in situ.

Conclusions

1. No consideration was given to taking on additional ballast for the expected heavy weather in line with good seamanlike practice. Ballast was never normally adjusted regardless of the cargo or weather.

2. The Safety Management System contained no guidance or checklists on how the vessel was to be operated in heavy weather conditions.

3. Hatches and vents were not secured prior to the onset of heavy weather, leading to water flooding into internal spaces once the deck edge became immersed and seas were breaking on deck.

4. It is not a requirement in the UK that trailer cargo for this class of RoRo vessel be weighed, therefore only the drivers' declared weights were used, and if not available then an assumed weight was used depending on whether the trailer was empty or loaded.

5. Trailer weights were found to be generally under declared on a snapshot of two sets of trailers presented for transport, with under declarations of 7.8% and 17.5% being found.

6. A detailed stowage plan was not made available to the vessel.

7. Information on the distribution of the cargo onboard was often incorrect, with trailers regularly being substituted. In this case it was found that 4 trailers on the loading plan were found to have been replaced with alternative cargo.

8. The calculation of stability prior to every voyage, as required by the vessel's Safety Management System was not being carried out.

9. The worse case scenario stability condition used as the basis for ensuring the vessel had sufficient residual stability in all foreseeable loading conditions was fundamentally flawed. In this condition, the vessel in fact did not comply with load line minimum stability requirements in a number of areas with regard to the area under the GZ curve, and the size of the maximum righting lever. The worse case stability scenario calculations had also not been checked by the ship operator. However, it was later calculated that upon departure the vessel had complied with the load line stability requirements.

10. The isolation valves in the heeling pump piping system were opened earlier than usual, possibly allowing the cross flooding of water from one side of the vessel to the other, resulting in a list.

11. It had not been detected that some of the non-return valves in the heeling system were seized partially open.

12. Changes in the ballast arrangement after the vessel grounded were not based on any sound assessment of the vessel's stability and ballast situation; rather they relied on the Master's estimate.

13. When the vessel was aground the anchors were not used to help hold the vessel and bring her head to wind when she

refloated, and possibly allow more time for suitable measures to be taken to determine the stability and ballast situation, await tug assistance and await an improvement in the weather conditions.

14. The cargo securing arrangement on curtain sided trailers (tautliners) are not particularly suited to restraining the cargo whilst the vessel is at sea. This resulted in several loads shifting on their trailers during the incident. However the lashings applied between the trailer units and the decks were found to have held extremely well, with only 1 trailer unit being lost over the side during the incident, and many trailers remaining in position at the extreme angle of heel the vessel achieved once fully aground.

15. The Crisis Management Team (CMT) ashore had limited information available on the loading and stability status of the vessel. If this had been available the CMT would have been better positioned to provide assistance to the Master.

16. Due to the company involved being a small operation, it was difficult to appoint internal Safety Management System auditors who were sufficiently removed from the day to day operations of the vessel to remain impartial and therefore raise non-conformities as may be required. It was also not noted during the audits of the vessel that calculations of the vessel's stability were not being made in line with the requirements of the SMS.

Recommendations

1. Vessels' Safety Management Systems should contain detailed guidance including checklists for heavy weather operations, stability problems and grounding.

2. The weights of units presented for transport should be ascertained as accurately as possible; weighbridges should ideally be used.

3. Hauliers need to be made aware of the requirement for cargo on trailers presented for shipment to be adequately secured such that it can withstand the forces to be expected when shipped by sea.

4. Vessels need to be provided with an accurate stowage plan including locations and weights of units to be shipped.

5. Masters should calculate the stability prior to every voyage to ensure compliance with load line requirements.

6. Heeling systems which are designed such that they can cross flood should be isolated so far as possible until the vessel is alongside ready to commence cargo operations.

7. Internal SMS auditors should be sufficiently removed from the day to day activities of the area that they are auditing such that they can provide an independent objective audit report.

8. The CMT should be provided with suitable documentation for the vessels under their control so that they can provide the greatest assistance possible from ashore in the event of an incident.

9. Operators / Ship Managers should consider the use of Emergency Response Services as offered by several Classification Societies and consultancies to assist in the event of an incident occurring to their vessels.

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Tel: +44 20 7247 5490
Email: loss.prevention@simsl.com