# Nickel ore, a liquid threat to dry cargo vessels

The ill-fated Emerald Star.Stellar Ocean Transport Llc

Across the merchant marine community, fingers have been pointed at the cargo that the ill-fated *Emerald Star* was carrying — 55,000 tonnes of nickel ore.

While there is no official communication yet on what led to the disaster — an inquiry is under way by Hong Kong authorities — many experts have cited previous instances of sinking of ships carrying nickel ore due to a process called cargo liquefaction. “We suspect the reason for capsizing was cargo liquefaction triggered by rough weather,” said a spokesperson of Vridhi Maritime, the manager of the vessel.

“Under certain conditions [fine particle cargo, containing high levels of moisture], nickel ore may become like a semi-solid or liquid, in a process termed as liquefaction. Then it starts moving like liquid inside the hold [cargo area] of a ship. If the hold is partly filled in such a condition, the effect [free surface effect] on ship stability will be bad. In this context, it may be noted that liquid cargo in bulk is carried by tanker ships, which are specially designed, considering safety requirements,” says P. Krishnankutty, Professor, Department of Ocean Engineering , IIT-Madras.

Survivors recalled that the *Emerald Star* , carrying the nickel ore bound for Lianyungang, a key port for Chinese nickel ore imports from Buli in Indonesia, sank in about 10 minutes. The accounts also speak of the vessel developing a high list or tilt on the port side before sinking: the vessel tilted to its left because of a rearrangement of cargo. The suddenness of the event is also typical of other nickel ore-related capsizes, experts say.

**Certificates in order**

DNV GL, an international accredited registrar and classification society that certifies that a ship is built and maintained as per set standards and is seaworthy, has acknowledged that the *Emerald Star* was DNV GL class. A DNV spokesperson, responding on email to *The Hindu* , said the ship “had a clean class record at the time of the incident.”

In shipping parlance, “clean class” would mean the ship had no deficiency and all its certificates and surveys were in order. This lends credence to the opinion that structural deficiency was likely not an issue, especially since the *Emerald Star* , built some seven years ago, was a relatively young ship.

In a 2015 paper, DNV lists six accidents due to nickel ore and notes that they coincide with the period when South East Asia sees storms. Three of them happened in 2010 and two in 2013, and all the ships were carrying nickel ore from either Indonesia or Philippines.

Earlier this year, *Stellar Daisy* , with a cargo capacity of 2,66,000 tonnes, sank off the coast of Uruguay, reportedly after the iron ore it was carrying liquefied.

**Cargo caution**

The DNV paper notes that nickel ore is 99% clay-like soil and the ore is likely to liquefy under the impact of a ship’s motion if the moisture exceeds a certain level. It also notes recent changes to international codes governing such cargo. A Transportable Moisture Limit (TML) is specified to limit the maximum moisture content ores can have before loading on a ship, but the paper notes that the moisture level of the ores can change after measurement in laboratories.

The paper also talks about on-board moisture tests, that can be done by ship staff. It recommends having an independent surveyor.

**Centre of gravity**

When the cargo liquefies, the dry cargo ship is not designed to handle it, says Prof. Krishnankutty. “When the ship rolls to one side (say, starboard side), the liquefied cargo will shift to that side and when it rolls to the other side the cargo may not shift fully. This may happen in most of the cargo holds resulting in the ship’s centre of gravity (CG) shifting to one side. Thus, the ship inclines to the side where CG has shifted,” he says.

A merchant ship’s structure is supported by a steel base, the keel. If the cargo loaded or unloaded at a port causes a list to one side then on-board staff take in or pump out sea water from various ballast tanks to even the keel. Out at sea, the impact of waves can create rolling, pitching and other motions. A ship is designed to have a large self-righting capacity so it doesn’t capsize even during heavy rolling or pitching. “But a high list reduces the reserve stability considerably, which may lead to a sudden capsize of the ship,” points out Prof. Krishnankutty. On Oct. 13, the *Emerald Star* was battling a typhoon that typically causes much rolling and pitching. The vessel had developed a high list too.

Carrying a cargo like nickel ore, a prudent action would have been to change course — termed as weather routing. Questions on weather routing, and issues such as whether the cargo moisture level was monitored, tests were conducted by ship staff, and if the captain was under pressure to carry the cargo may be answered at the Hong Kong inquiry. The captain can refuse to carry any cargo he deems unsafe. “The crew did their due diligence and all norms were followed. The cargo was loaded based on the standard operating procedure of the supplier submitting three certificates to guarantee against liquefying: Shipper declaration, TML and Flow Moisture Point. The ship staff did perform relevant tests and the cargo in a few loading barges was rejected based on these. Weather routing was indeed done but the rough weather the ship faced was unexpected,” said Vridhi Maritime’s spokesperson.

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