Thinking from a sea bauxite accident

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Abstract. In this paper, a typical case of transporting bauxite ore on the ship is studied. From the perspective of maritime safety, the bauxite is studied in the classification of goods in the IMSBC rules and the improvement measures in the current transportation process are proposed to provide the maritime transport, So as to provide reference for maritime transport and reduce the recurrence of such accidents.

1. Introduction
In recent years, with the rise of domestic industry demand and insufficient resources. The large import of bauxite has become a necessary trend. However, in the process of transporting the bauxite from the oversea, many accidents occurred. On January 2nd, 2015, the JUPITER ship of the Bahamas flag bulk carrier, which was built in 2006 and occupied by GEARBULK. The ship loaded 46,400 tons of bauxite mine and was on its way from Southeast Asia to China and sank from the sea 150 nautical miles in Vung Tau, Vietnam. According to the maritime investigation and analysis, the ship carried out the requirements of such goods in strict accordance with the IMSBC rules [1]. And after the loading is completed, all processes are recorded in the logbook rigorously and carefully [2]. Leave the wharf without confirmation. When the ship is on the way to the voyage, 18 people were died and a major safety incident occurred in there. After investigation, although the ship encountered heavy wind and waves in the coastal areas at that time, but there was no danger of overturning with the design and construction specifications of the ship, At least the shipwreck finally happened. What is the cause leads the navigation danger? The cause of the accident will be analyzed in detail below.

2. The accident analysis
Alumina bauxite is also known as aluminous soil or bauxite. It has high value to the industry. The ore composed of gibbsite, boehmite or diaspore, which is the main mineral making the aluminum products in China. Since 2010, the domestic economy has developed rapidly and the demand for aluminum ore has increased greatly. Therefore, overseas imports have become an inevitable trend. Bauxite resources are widely distributed around the world, so domestic imports are diversified [3]. At the time of increasing imports of ore, there is a danger of shipping. After a preliminary understanding of the basic information, we started a comprehensive analysis to find that which one leads the question. It is dangerous to start a comprehensive analysis of which causes.

2.1. Human factors
Throughout the loading and transportation process, through the maritime investigation, it was learned that the ship's personnel were performing normal strength operations without fatigue. Therefore, it can be judged that the accident has nothing to do with human factors.
2.2. Ship management
Check the cargo management information provided by the ship.

2.2.1. Before loading
- The ship first trained the crew on the safety awareness of the transported goods, and arranged for the commissioner to review the dumping site of the ore, carefully inspect the ship's equipment and ensure that everything is normal.
- The owner of cargo has provided the ship with relevant information and proof of the goods at a considerable time in advance, and the data obtained by the ship has also been reviewed and approved by the authoritative official organization.
- According to the data, the ship has formulated a stowage plan in strict accordance with the cargo category in the IMSBC rules, and determined the loading sequence and the loading rate based on the damage strength of the ship.
- Control the source of supply. Accompanied by experienced tripartite personnel, the ship’s officer carried out a safe sampling of the loaded goods. The goods were completely carried out in accordance with the requirements of the IMSBC Rules. The sampling was carried out in three zones, three times, under the designated area. After the sampling is completed, the test shows that the goods are not contaminated by other substances and are basically consistent with the attributes of the goods described in the data. During the verification period, the weather was in good condition and the cargo was not affected by the weather. The verification is completed.

2.2.2. loading period
During the loading period, the weather was good and there were no unforeseen circumstances, such as rain, storm and so on. According to the loading requirements, workers completed the loading task regularly and safely.
When the loading plan is about to be completed, the ship has carried out, such as trimming, a series of operations

2.2.3. sea navigation
The shipment of the goods was completed. According to the weather forecast given by the gas guidance company, the ship planned a safe route, and was driven from Malaysia to the country under the driving of experienced senior crew.

Therefore, it can be judged that the accident has nothing to do with ship management.

2.3. Goods themselves attributes
Check out the current IMSBC rules as shown in Table 1:

| Angle of repose | Bulk density (kg/m3) | stowage factor |
|-----------------|---------------------|---------------|
| Not applicable  | 1190 to 1389        | 0.72 to 0.84  |
| Size            | category            | group         |
| 70% to 90% agglomerate 2.5mm to 500mm | Not applicable | C             |

Table 1. Basic data of bauxite
Description: Brownish yellow clay and earthy minerals, water content: 0% to 10%, insoluble in water. As can be seen from the above, bauxite is defined in the IMSBC rules as a solid bulk cargo that is neither fluidizable nor chemical hazardous. During the shipment, no other requirements requiring special attention were given in the rules. This means that such goods can be transported safely as normal solid bulk cargo.

In the case of everything that seems to be safe, there was an accident. What caused the accident? In the process of analyzing the problem, we found two factors, we should take a caution about such circumstances:

2.3.1. Ore particle size

When domestic buyer purchase bauxite ore, the imported ore is marked with some particle size requirements in order to reduce the production cost of aluminum. Therefore, the goods are pretreated by the supplier before shipment, first, the machine remove particles and agglomerates exceeding 10 cm by coarse filtration. Then, the large particles are pulverized by the corresponding machine to make the particle size smaller. Therefore, when transported by barge to the cargo ship, the percentage of the size of the cargo powdery particles seen by the ship is likely to have exceeded the range defined by the particle size of Class C bauxite in the IMSBC Code, That is to say, the powder particles from 2.5mm to 500mm may be greater than thirty percent.

2.3.2. Ore moisture content

- The domestically imported bauxite is produced in Malaysia. The local climate is tropical rain forest climate. The air is humid all year round and the rainfall is huge. The production area has just experienced heavy rainfall during the monsoon season. This leads to an increase in the water content of the ore.
- The bauxite imported from Malaysia is mainly composed of red mud, which contains a large amount of iron oxide (about 60%). This material is highly fluid and may itself be in a liquid state.
- In order to reduce the environmental hazard caused by the dust of the goods and response to the needs of the government, the workers carry out high-pressure flushing when the goods were crushed, so that the water content of the goods was further increased. It can be judged from the above three points that when the goods are finally delivered to the cargo ship, the surface of the goods appears to be dry, but the inside actually contains more water, and even in some places, it is muddy. After testing by the authority, the moisture content of the goods has exceeded 10%, and some locations have reached about 12%.

3. The Accident Analysis Conclusion

According to the above analysis, the bauxite transported, in this voyage, from Malaysia to China has increased the content of fine granular ore during transportation and contains a certain amount of water. The goods as a whole have not met Class C goods in the IMSBC Code, and the goods at this time have shown a tendency to fluidize and thus have characteristics similar to those of Class A goods. At the same time, in the process of shipping, encountering wind and waves, small particles of minerals sinking and compacting (as shown in Figure 1), water produces free liquid so heavy that surface cargo develops flow [4]. Meanwhile, the decrease or loss of ship stability results in ship capsizing.

Figure 1 Schematic diagram of the flow of bauxite
Therefore, it can be inferred that the cause of this danger is that the cargo has a tendency to fluidize under certain circumstances. It is similar to class A cargo, that is, fluidization goods. As far as the above information is concerned, it should be recognized that the fine-grained cargo of any moisture content specified in the IMSBC Code is potentially mobile and therefore needs to be tested [5]. According to the current version of the IMSBC Code Appendix 3, paragraph 2.1. Many fine-grained cargoes are easy to flow if they have a high water content. Therefore, wet goods containing a certain proportion of fine particles should be tested before loading.” At the same time, from November 9, 2011, the Ministry of Transport issued the “Regulations on the Safety Management of Fluidized Transporting Solid Bulk Goods”, which further clarified the definition of easy-to-fluid solid bulk cargo. The goods mentioned above are in full compliance with the standards defined for the easy-to-fluid cargo. This makes it clearer that if the goods have the conditions described above, the shipment management should be carried out in accordance with the shipping standards for the Class A goods.

4. The response plan

4.1. Measures for ship safe loading

The owner shall provide proof of the ship's cargo to the ship’s officers before loading the cargo, which shall include not only the information required by the IMSBC Code, but also a valid proof of the strength of the cargo granules, the exact composition of the cargo, and the moisture content of the cargo. The shipowner may encounter one of the following situations during the verification process and should treat it separately.

During the certificate verification process, the ore's water content shall not exceed 10%, and the rest of the requirements shall be in full compliance with the standards defined by the IMSBC Rules for Class C goods. If the final inspection is correct, the goods may be shipped in Class C cargo.

If the particle size and water content provided on the certificate are just at the edge of their definition of Class C goods, they are discussed in two cases.

If the cargo granularity meets the requirements, but the water content is higher than 10%, the owner shall be notified to exchange the goods, or the goods shall be air-dried, and the water content shall be reduced to within the standard before loading.

If the particle size does not meet the requirements, but the water content is less than 10%, according to the current version of the IMSBC Rules Section 1.3.1.1, Chapter VII, Section 7-5, paragraph 1.7.5. "1.3.1.1 When it is assessed that the solid bulk cargo to be transported, as defined in 1.7 below, may have the hazard as defined in the Group A or Group B cargo, it is necessary to consult the port of discharge and the competent authority of the flag State. The three competent authorities will provide temporary and appropriate conditions for the carriage of the goods.

1.7.5 Fluidizable cargo means a cargo containing a certain proportion of fine particles and a certain amount of moisture. Such cargoes may be fluidized if they are shipped with water content exceeding their transportable moisture limit.”

The above goods have signs of suspected Class A goods. As described in the rules, temporary suitable conditions should be established for the goods before shipment.

If the data provided on the certificate is completely inconsistent with the definition of Class C goods in the IMSBC Code, it shall be shipped in accordance with the shipping standard of Class A goods. When the surveyors carry out the sampling test in the on-site, the way, such as CAN TEST approved in the rules [6], hand kneading method, baking test and other methods, should detect the moisture content of the goods (in the test process must pay attention to the limitations of various test methods, and the above several detection methods can be used interchangeably, can also be used alone). If the test result is within the scope of service, the goods are loaded in Class A. If the test result is unqualified, that is, if the water content is too high, the goods are directly rejected.

Shipment operations may also be carried out when the relevant authority officially evaluates that the goods do not have the characteristics of Class A goods.
Even if the certificate provided meets the standard, the shipowner should carefully review the accuracy and timeliness of the certificate, the authenticity of the goods, and whether there is a means of renaming the goods to cover up its true nature, etc. whether there is a concealment or deception of the goods. If abnormal conditions are found, the goods should be refused and wait for the more authoritative inspection agency to complete the inspection before deliberation.

4.2. Management of the ship on the voyage

During the period of transporting, the ship should try to optimize the route and collect meteorological information in time to prevent the ship from tilting. Especially in Southeast Asia, tropical cyclones are more in summer and climate change is too fast. It is easy to cause danger of navigation. In case of emergency, there must be sufficient countermeasures [7]. If the conditions permit, the goods can be unpacked and aired, and the goods should be inspected regularly for safety.

5. Conclusion
In summary, the article analyzes the classification of bauxite in the IMSBC rules. It is concluded that bauxite should be transported in a manner that is easy to fluidize when it meets certain condition, which can reduce the similar sea transporting of dangerous accident.

6. References

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