Safety of bulk carriers

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In this issue we concentrate on bulk carriers and the carriage of bulk cargoes. In recent years there has been increased legislative activity in relation to bulk carriers and the cargoes they carry.

THE BULK CARRIER CONCEPT

The bulk carrier may be called the workhorse of the oceans. Due to the never ending need for iron, ore, coal, grain and a variety of other commodities, this type of vessel has become an essential link in the world economy. There is no rest for bulk carriers; these vessels are pushed hard on both cargo and ballast voyages, often trading in the most adverse weather routes of the oceans. Time for loading and discharging has constantly been reduced as cargo terminals and equipment have grown in size and efficiency. The bulk carrier receives her cargo so quickly and forcefully that her hull aches from the strain. At the time of discharge her tanktops, bulkheads and sideshell have to endure the action of heavy bulldozers, grabs and pneumatic hammers. Asset play, influenced by low scrap prices and high new building costs, has also extended the life expectancy of the vessels. Some ships could not stand the pressure and gave up their hard way of life by foundering. Since 1980 some 160 bulk carriers have been lost at sea, along with the lives of 1,200 sailors – a situation which must be addressed.

The term "bulk carrier" refers to vessels of single skin/single deck construction, having holds specially designed for the efficient transport of dry bulk cargo. Bulk carriers have large hatch openings and obstruction free cargo holds with sloped topside and hopper tanks to ease loading and discharging operations. This type of ship originated on the Great Lakes of the United States of America where large shipments of raw materials were needed for the development of its central and northern plains. Single deck bulk freighters with machinery aft were already in existence at the turn of the century.

From the 1950s the bulk carrier started to be deployed in deep sea trading, competing with the closed shelter deck cargo ships. Since then bulk carriers have grown in size and numbers. While only 25 per cent of all bulk cargoes were carried in bulk carriers in 1960, almost all such cargoes have been carried in dedicated bulk carriers and combination carriers since 1980. Remarkably, however, while ships over the past 20 years grew more than 10 times in carrying capacity, the design basically remained the same. The midship section of an early 20,000 tons deadweight bulk carrier is quite similar to the section of the world` s largest bulk carriers of 250,000 tons deadweight.

The bulk carrier is an optimised cargo carrier, but it has been shown to be vulnerable to the ingress of sea water. It is worth nothing that today` s modern bulk carriers have less sub-division by bulkheads than the early ones. Today the typical "handysize" bulk carrier of 40,000 tons deadweight has five cargo holds, a "Panamax" vessel of 70,000 tons deadweight has seven and the "Capesize" of 135,000 tons deadweight has nine. So has also the world` s largest bulk carrier of 250,000 tons deadweight.

In the years up to the end of 1990, the Institute of London Underwriters had declared 216 bulk and combination carriers as total losses. In 1990 and 1991 a further 40 bulk carriers went down, costing 300 lives. More than half the casualties were hull related. Some of the vessels foundered in heavy weather, but there were also ships that disappeared in calm seas. Something was obviously very wrong. At this stage shipping organisations and every shipping paper had started to comment on the accidents, and to discuss in detail the various reasons and possible remedies. Six of the vessels that sank in 1990 and 1997, did so following loading ore cargo in Australian ports. The loss of 130 lives on these vessels alone prompted the Australian authorities to start an investigation of the standard of bulk carriers. The Australian report, issued in 1992 called "Ships of Shame"speeded up the bulk carrier safety debate.

In this article we summarise the main points which have been discussed during the debate on bulk carrier safety and report on action taken to improve the position.

CLASS SOCIETIES AND IACS

The role of the class societies as a certifying authority was discussed at the end of the 1980s. More and more the initial beneficiaries of the class system, the insurance companies, started to question the quality of class surveys. Hull and Machinery underwriters as well as P&I clubs built up their own technical departments and introduced pre-entry condition surveys as a necessary tool to avoid insuring sub-standard ships.

The increase in bulk carrier losses in the early 90s forced the international class societies to take a much closer look at the vessels, and at their own survey routines. More than 90 per cent of the world bulk carrier fleet is classed with members of the International Association of Classification Societies (IACS). IACS had to recognise that this type of vessel had a totally unacceptable history of casualties. Stronger and more precise requirements for annual and intermediate surveys were established, and the hull continuous survey system was abandoned. The continuous survey system worked well for a vessel` s machinery, but it was not a good idea to have the "special survey" of an old hull distributed over a five-year period carried out by a number of different surveyors. The position of IACS, was strengthened, an important step that lead to a better co-operation among class societies. When the societies agreed to a unified policy on the "change of class" procedure, it became more difficult for sub-standard owners to change class for the purpose of avoiding class requirements.

Following work by International Maritime Organisation (IMO) committees, IACS introduced in 1993 the Enhanced Survey Programme, which included more extensive surveys of all oil tankers and bulk carriers regardless of size and date of construction. For bulk carriers the Enhanced Survey Programme was made applicable to all vessels primarily intended to carry dry cargo in bulk, including ore carriers and combination carriers. The new rules required a specific survey programme to be worked out by the owner in co-operation with the class, in advance of the renewal survey of the hull, thereby establishing an agreement for providing sufficient means of access and cleanliness to allow a close-up inspection.

IACS` casualty records show that since 1980 approximately 60 single-side skin bulk carriers above 20,000 tons deadweight have been involved in casualties, where structural failure was the clear or probable cause of the accident. The average age of these vessels was 18 years, and so was also the average age of

some 40 vessels that had suffered serious structural damage, but survived.The Enhanced Surveys did not save all bulk carriers even if extensive repairs had been carried out after such surveys.

IACS research showed that many of the vessels had carried heavy cargo and had been in bad weather at the time of accident. The sequence of events for a majority of the bulk carrier casualties was identified as water ingress to cargo holds and progressive flooding through the collapse of bulkheads. In more than 40 per cent of the casualties, water was known to have entered the No. 1 cargo hold. In such a situation, with the loss of freeboard at the forward end of a fully loaded ship, the pressure on the aft bulkhead of hold No. 1 may lead to a collapse. Following a subsequent flooding of hold No. 2, a fully loaded vessel is likely to sink as a result of loss of buoyancy, or by collapse of the hull girder due to excessive hogging. Such a scenario is believed to progress very rapidly, leaving the crew with very little warning and time to abandon the ship. As such a scenario is most likely to develop in bad weather, sometimes at night, it may not immediately become apparent to those on the bridge. On larger vessels the bridge may be as much as 200 metres away from the forward part of the vessel, and crossing of the deck may be an impossible task. Some of the fully laden bulk carriers which disappeared, did so without any emergency call. IACS studies showed that the most cost efficient way of increasing the safety of existing bulk carriers, would be to require higher reserves of strength in the bulkhead between cargo holds Nos. 1 and2.

STRESS AT CARGO TERMINALS

The master has the overall responsibility for the safety of his vessel, crew and cargo. Yet there are situations where masters are put under pressure to compromise their own judgment.

At some loading terminals for bulk cargo, masters have been forced to accept loading plans that give higher priority to the speed of the operation than to minimising the stresses on the hull.

Amendments to the Safety of Life at Sea Convention (Solas) Chapter VI, whichentered into force on 1st January 1998, address the interaction between the ship and the bulk cargo terminal. These regulations will require a safety check list to be completed by the master and the terminal manager to ensure that loading and discharging of bulk carriers are carried out in a safe manner. In addition to the importance of allowing the master' s loading plan to be followed, one issue of concern should also be the possible overloading of individual cargo holds. In large loading terminals, where the speed of loading is very high, it can be difficult to stop the cargo transport system fast enough to avoid overloading a particular hold. A 10 per cent overload in one hold could increase the shear forces by up to 20 per cent and the still water bending moment by up to 40 per cent of allowable values. Brazilian and Australian ports have loading rates of up to 15,000 tons/hour for a capesize vessel that can carry 15,000 tons in each hold – a 10 per cent overload can be achieved in only six minutes.

The lighter bulk cargoes, like grain and coal, are carried homogeneously distributed in all cargo holds. A high density cargo such as iron ore is, however, carried in alternate holds, which raises the centre of gravity, making the vessel less stiff. Bulk carriers which carry cargo in alternate holds have been specially strengthened and given a class notation which specifies the holds that may be empty. The shear forces and the bending moments on the hull girder are important, and all vessels classed with IACS societies are assigned permissible still water shear force and still water bending moment values. It is a requirement of the International Load Line Convention that the Master has sufficient information available to load and ballast his ship without causing inaccessible stresses to the structure. According to Solas VI part B, Regulation 7, which enters into force on 1st July 1998, the ship must have a booklet containing information on stability data, ballasting and deballasting rates and capacities, the maximum allowable load on the tanktop plating and per hold, general instructions on loading and unloading with regard to the strength of the ships' s structure, restrictions on operating conditions and the means to carry out any necessary strength calculations.

The vessel' s loading manual has to be approved by the vessel' s class society and is complemented by a loading instrument. The loading instrument provides a means of calculating the forces acting on the hull in any load and ballast condition and comparing these with the maximum allowable values. It is important that loading instruments have been approved by the class societies.

ATTACKS BY GRABS AND BULLDOZERS

During the discharge of bulk carriers, hull structures often receive heavy blows from grabs and bulldozers. From the stevedores' perspective such violent attacks may be necessary in order to remove cargo remains stuck between sideframes, ladders and pipes. Heavy grabs may also damage the tanktop plating at the end of discharge, as do the wheels of heavy bulldozers. This may cause damage to the steel structure, and affect the speed of corrosion, as scales fall off to expose new steel surfaces.

Stevedores could use less heavy equipment and pay more attention to the well-being of the ship, but it is difficult to see how they can avoid rough movements altogether. Dislodged cargo has to be removed, and the manual operation often represents a risk to the personnel. Removing cargo remains by imposed vibrations is a new method that appears to be effective, but its effect on the hull has not been studied.

CORROSIVE CARGOES

Focusing on the bulk carrier losses has also drawn attention to the fact that some cargoes are more corrosive than others, resulting in accelerated corrosion which may lead to structural collapse in some vessels. It is now a class requirement that sideshells and bulkheads of bulk carriers are coated, with a coating suitable for the intended cargoes. In the past little attention was paid to the fact that cargo hold coatings were not only exposed to wear and tear from the loading and unloading of the cargoes, but also to chemical reactions. Coal may give off sulphuric acid; there may be alkaline salts in various ore cargoes. As the surface of ore cargoes often just reaches the level of lower sideframe brackets, an accumulation of water at this level may explain the heavy corrosion often seen in this area. The coating of cargo holds and the maintenance of such coatings are important steps improving the safety of bulk carriers. Class surveyors are now being trained in evaluating the quality of coatings, and paint manufacturers are investing in research into the production of more lasting and cargo-compatible paint products.

AGE FACTOR

Owners of old vessels may argue that it is unfair to judge vessels by age alone. There are well maintained old ships, especially vessels which have had their full lifetime with one or few owners. Statistics show however, that a vessel' s age is a risk to consider. In the document "Bulk Carriersan update 1995", Lloyd' s Register listed 88 bulk vessels, which were lost due to suspected structural failure or which had suffered serious damage during the five preceding years. 42 other vessels were above the age of 20 years. At that time, the average age of the bulk carriers world fleet was 14. Since then the age profile of the existing bulk carrier fleet has continued to increase.

THE HIGH TENSILE STEEL

The common use of high tensile steel in shipbuilding started in the 1970s and increased considerably in the 1980s. Stronger than ordinary mild steel, the high tensile steel offered large weight reductions, so shipyards were able to offer more cargo loading capacity at lower costs. Depending on the amount of high tensile steel used, weight reductions of up to 30 per cent were common.

Class societies carried out thorough tests on welding procedures for high tensile steels, but experience showed that too little attention was paid to the details of construction. Higher stress levels in the steel construction increased the possibility of fatigue cracks. The use of thinner steel in construction also removed millimetres of corrosion allowance, which in turn made a thorough maintenance programme a necessity. The coating of the steel was, however, largely left to the owner` s discretion, as class societies paid very little attention to the quality and maintenance of coatings. Class rules required steel to be replaced when it had been reduced to a certain thickness, regardless of whether the process was fast or slow. Class societies even created a special class notation for vessels with no or very little corrosion allowance. Such class notation required approved coating systems to be applied, but they often did not receive the required attention at class surveys.

There is nothing wrong with the use of high tensile steel in shipbuilding, as long as the necessary attention is given to details of construction. The saving of steel weight by using a reduced thickness of materials, however, must be compensated by effective anticorrosive measures and a life-long inspection system.

SUB-STANDARD FLAG REGISTERS

Shipowners` moves from the registers of traditional flag states to the open and off-shore registers have certainly not strengthened the survey performance and supervision of the safety of ships. Many flags of convenience registers have not shown any ability to screen the vessels seeking entry, and appear not to have the means or interest to sufficiently investigate accidents. When it comes to the making of new international regulations, however, these flag states, through their votes at IMO, may negatively influence the process of improving ships safety and design. Some actors within the shipping industry, such as Port State Control and some insurance companies, have started to give flag states a rating.

NEW IMO REGULATIONS

The year 1994 was another very bad year for bulk carriers. Twelve bulk carriers were lost, plus one OBO, one ore/oil and one ore carrier. In the case of bulk and ore carriers, navigation-related losses and sinkings each accounted for five ships, while engine room accidents accounted for three. Both the OBO and the ore/oil vessels lost, were attributed to sinkings.In response to the worsening figures of bulk carrier casualties the safety of these vessels was put high on the agenda of the Maritime Safety Committee of IMO (MSC), spurred by the initiative of the IMO Secretary General. In 1996 MSC adopted amendments to Solas Chapter VI, which will enter into force on 1st July 1998, and which address the interaction between the ships and the bulk cargo terminals. A new Solas Chapter XII, "Safety measures for bulk carriers", was approved by the Solas Conference of November 1997. The new regulations contained in this Chapter focus on structural issues, and will enter into force on 1st July 1999, while new IACS rules will be implemented one year earlier.

The new Solas Chapter XII will affect the world fleet of approximately 4,500 bulk carriers. A majority of these vessels will need to be assessed, in order to establish what cargoes they can load and what reinforcements will be necessary. Existing bulk carriers, when loaded to the summer load line, must be capable of withstanding the flooding of the foremost cargo hold and remain afloat in a satisfactory condition of equilibrium. The bulkhead between the two foremost cargo holds and the associated double bottom structure, are required to have sufficient strength to withstand flooding of the hold, taking into account the dynamic effects of the water. The specific IMO standards for the structural assessment of existing ships have been based on the relevant Unified Requirements of IACS. For new bulk carriers it is a requirement that the vessel can withstand the flooding of any one hold and remain afloat. All bulk carriers are to be provided with a loading instrument capable of providing information on hull girder shear forces and bending moments. An important requirement is also that ships are not allowed to load high density bulk cargoes until their cargo holds have undergone an enhanced survey. As an alternative to structural reinforcements, an option for homogeneous loading has been provided.

The very important work carried out by IACS, major international class societies, IMO and national maritime authorities, in order to improve the safety of bulk carriers, is a step in the right direction. It is, however, important to recognise that the new rules for the strengthening of existing bulk carriers represent a compromise. Not all old bulk carriers sink due to the flooding of the No. 1 hold, and the new IMO regulations only deal with bulk carriers of over 150 metres in length. The infamous bulk carrier "LEROS STRENGTH", had passed her Enhanced Survey but nevertheless sank outside the Norwegian coast in February 1997, with the loss of everyone on board. The "LEROS STRENGTH" had a length of 146 metres and would not have been structurally affected by the new IMO rules.

THE DOUBLE HULL SOLUTION

Most types of new vessels are built with some kind of double hull. For oil tankers and chemical tankers such a design has the purpose of avoiding pollution by hindering the escape of cargo. Bulk carriers of today are single hull ships with a problem of keeping water out. The "double hull bulk carrier" is actually already in existence; in the shape of the ore carrier. It may not be a popular proposal to cost-conscious shipowners, but the solution to the vulnerability of today` s bulk carriers, could be found in requiring future bulk carriers to have a double hull. Such a solution would not only add strength to the ship and safety against flooding, but also solve the problem of dislodged cargo between sideshell frames.

As the new rules for single hull bulk carriers will result in a higher steel weight for new ships, the newbuilding costs will be more equal for a double hull and a single hull vessel, than is the case today.

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