Insight Article

Deck load and stability requirements

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From July 1998 a Cargo securing manual will be required for all ships. This is set out in IMO MSC/Circular 745, and consequently there has been an increased focus on securing of load carried on deck. This article will concentrate on the relationship between intact and damage stability requirements and the securing of deck loads.

The basis for all calculations of the main forces acting on deck cargo will be the transverse accelerations that occur including gravity components due to rolling. These accelerations depend on the sea condition, the main dimensions of the ship (length, breadth and height), the shape of the ship, and the metacentric height (GM) ofthe loaded ship. As a rule of thumb we may say that the time for a full rolling period (i.e. for one oscillation "to and fro" port-starboard-port, or vice versa) is proportional to the inverse square root value of the GM.In other words, the greater the GM, the steeper will be the righting arm curve (GZ-curve) and the "stiffer" the ship. Hence, the vessel is subjected to heavy accelerations, is unpleasant for the crew and more demanding on deck load securing systems.

In 1996 several enquiries were received from shipowners and operators concerning the loss of timber loaded on deck and damage to securing equipment as a consequence of the accelerations that had occurred in heavy weather. A contributing factor was that the relatively new ships had to operate according to a minimum GM-curve which was found to give too strict requirements for the minimum GM.

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A typical ship for bulk and general cargo being constructed today has to comply with both intact stability and damage stability requirements set out in internationally adopted regulations. The intact stability requirements for cargo ships have remained unchanged for many years, and are based on evaluation of the values, shape and extent of the curve of the righting arm (GZ) for a given condition. These are normally referred to as the IMO Res. A.167 criteria, which in 1993 were includedin the IMO Code on Intact Stability for all types of Ships covered by IMO Instruments (IMO Res. A.749). Due to the special considerations necessary for the loading of timber on deck, somewhat different criteria have been adopted in the IMO Code of Safe Practice for Ships carrying Timber Deck Cargoes, 1991. The criteria are somewhat relaxed compared with those that apply for other types of load, and reflect the fact that the timber when loaded on deck will provide additional reserve buoyancy. The fact that water absorption will take place in the timber loaded on deck during a voyage has also been reflected in the Code. The requirements and criteria of these regulations are well known and have been in use for several years.

RELEVANT DAMAGE STABILITY CRITERIA

For a bulk carrier or a general cargo ship being constructed today there are two regulations which may apply:

1. Regulation 27 of the International Convention of Load Lines (ICLL)1966

2. SOLAS Chapter II- 1, Part B-1.

The ICLL Regulations have been in use for many years and decide the minimum freeboard 1 that a ship can have. Regulation 27 of this Convention lays down minimum requirements for Type B ships 2 and permits a reduction of this minimum for vessels which meet certain criteria set down in the Regulation, including damage stability criteria. Ships assigned a reduced-type freeboard are commonly known as having a B-60 or B-100 freeboard. The method is purely *deterministic* , which means that the vessel, when homogeneously fully loaded, will be able to survive damage to any one compartment (B-60) or two adjacent compartments (B-100), which for the purpose of the calculations are assumed empty. These damage stability requirements can therefore basically be regarded as constructional requirements only,giving no operational restrictions on the ship. The SOLAS Regulation entered into force on 1st February 1992, and mandatorily applies to all cargo ships above 100 m in length which do not opt for the reduced freeboard permitted under the ICLL, and which are commonly known as having an ordinary B-freeboard. This Regulation requires the vessel to comply with what is known as the Required Subdivision Index. The Regulation states the calculations to be made in order to check an individual vessel□s index (Attained Subdivision Index)against that required. These calculations involve a number of factors including the ship's internal sub-division, its internal watertight integrity (possibility for progressive flooding), its external watertight integrity (the position of external openings such as doors and air pipes and their closing appliances), the probability for damage with a given location and extension to occur (based on statistics from previous collision cases), the probability that the vessel will survive such damage and the *GM* **.** These calculations are carried out for two drafts; the summer draught 3 and the partial draught at 60 per cent difference between the summer draught and the lightship draught. 4 The average figure obtained is the ship's Attained Subdivision Index. Normally the damage stability calculation will be carried out starting with the minimum GM obtained from intact stability calculations at the summer draught obtained as the limiting value, and then through calculations establish the GM value which is necessary at the partial draught in order to obtain a satisfactory attained index. In other words, designers have commonly applied the higher GM value at lower draughts. Thus when designing a ship, or even choosing between similar types for purchase or charter, it is important that the negative effects of operating with high GM value (stiff ship) is taken into consideration.

EXPERIENCE FROM SHIPS CARRYING TIMBER LOADED ON DECK

It may seem strange that the SOLAS Regulation, which was developed in order to provide flexibility when designing ships, created problems for typical bulk carriers. This may however have been caused by limited knowledge of the new regulations and their practical implications among shipowners and their representatives. For a typical ship of those which were reported to experience loss of deck loads in heavy weather, the minimum GM according to the Timber Code could be as low as 0.1 m, but in order to comply with all the requirements of the ordinary intact stability criteria according to the IMO Intact Code a minimum GM of about 0.8 m at the full draught could be expected. The limiting GM curve was then based on the highest GM value, and as a rather low attained index was obtained at the full draught, a rather high GM value had been applied at the partial draught. This lead to a significantly increased required GM at draughts only slightly below the full draught, and this was the main reason for the problems that occurred with consequent loss of deck cargo. A possible solution to this problem is to accept the special characteristics of the timber load and allow the use of a separate limiting GM curve for timber load conditions only, with reference to the Timber Code. In the case of the above-mentioned ships, further steps were taken in order to obtain a limiting GM which could better reflect the operation of the ship with timber on deck. This was obtained by increasing the height of a few air-pipes in the forward part of the vessel, and redefining an ordinary weathertight door to a watertight door with connecting alarm to the bridge and restrictions on use. The buoyancy of the timber on deck can also, if the minimum extent and amount is stated, be taken into account in the damage stability calculations.

GENERAL ADVICE

Since the probabilistic method provides a great flexibility in the design of the ship, it is important that the shipowner or the operator is aware of this flexibility and clearly specifies to the yard or the designer the preferred loading patterns in the form of loading capacity, versus GM at various draughts. Care should be taken to avoid using unrealistic GM values when establishing the limiting curves, just for the purpose of obtaining a sufficient Attained Index. For those operating a ship which has been recently delivered and which may experience difficulties due to having to operate with a relative high GM, it may be advisable to seek advice from a consultant. As we have indicated in this article, major improvements can be obtained by rather simple means.

Footnotes

1. The distance between the assigned load line and the freeboard deck.

2. In general terms, a ship not designed to carry liquid in bulk.

3. In general terms, the distance between the bottom of the ship's hull and its assigned Summer Load Line.

[4] In general terms, the distance between the bottom of the ship's hull and the waterline when the ship has no cargo on board.