Loading of Heavy Steel Coils in Ship's Holds

August 2000

Introduction

Large quantities of steel continue to be carried by sea. Much of this is shipped in the form of coils. In many cases, these steel coils are extremely large – weighing up to 20 tonnes. The loading and stowage of coils of this size present a number of difficulties. It is important that great care is exercised in order to ensure that tank top structures are not overloaded, and that the cargo is adequately secured for the voyage.

In practice the problems of loading very heavy steel coils, with an individual weight in excess of 16/17 tonnes, present themselves only after the vessel arrives at the load berth. Often the objectives of the charterers or shippers, and the owners are opposed; the charterers or cargo interests wish to load a complete deadweight cargo (down to maximum permitted draft) whilst the Master will need to ensure that the maximum tank top load is not exceeded. This may result in the conclusion that stress limitations will not permit the vessel to load anything like the figure sought by the charterers or the cargo interests.

Disputes are then almost inevitable. The cargo plan drawn up by the Master may indicate a lift as little as 80% of the ships full deadweight whilst the shore cargo superintendent has a plan that will lift up to 100% of the available deadweight. Owners and Masters are frequently faced with the dilemma of deciding whether or not the safety of the vessel will be jeopardised through loading the full quantity presented by the shippers or charterers. An unduly cautious approach could result in an expensive dispute, whilst simple acquiescence could result in serious damage to the vessel at best, or even the loss of the vessel in extreme cases. How can something so fundamental be sufficiently unclear to give rise to dispute?

Understanding how the difference between actual and expected cargo lifts arises depends upon understanding how much the tank tops can support. This is an issue that is often not easily resolved by expert advice. There is much literature in circulation stating that coals up to 10 tonnes can be stowed 2 high; coals up to 15 tonnes can be stowed 2 high, and coals heavier than 15 tonnes can only be stowed in a single tier. Whether these statements are acceptable depends upon which side of the force one sits. How the conflict is resolved depends upon many things, most of which are expensive and frequently unsatisfactory. However, compromise is often the best and most satisfactory method both parties have of dealing with the problem.

Problems of this type could be averted by the Chartering Brokers during fixtures negotiations. However, the often adversarial nature of charterparty negotiations does not facilitate this, particularly if the precise nature of the cargoes that are to be loaded is unknown, as may easily be the case in a long term fixture. In practice, the resolution of these problems depends upon the cooperation of practical people on both the Owner’s and Charterer’s sides in order to arrive at a compromise on what the ship can reasonably (as well as safely) load, stow and carry – a practical solution. The following factors should be taken into consideration by both parties.

The Ship

All ships are different – even sister ships. They are built to differing designs, contain different sized components, use different qualities of steel and, probably more important, have suffered varying degrees of abuse throughout their lives – age is very much an issue.

Before the advent of steel the ship builder would select a very large section of tree, how it to shape and set down his “keel”. This keel was, and still is, one of the most important areas of the Ship’s strength. In the modern cargo ship the keel is of steel box shaped construction. It may be singular, down the centre line, or in two parallel sections, equidistant from the centre line, known as side keelboxes. At the bottom of the keel the steel plating projects outward and upward to form the hull and on the top the flat inner plating forms the tank tops. These inner and outer plates are connected together every metre or so by transverse vertical steel plates called “floors”. These floors vary in height depending upon the size of ship but are frequently between one and two meters high on all but the smallest and largest ships.

It is the combination of the bottom plates, number, size and spacing of the floors and the tank top plates that give the ship the majority of its strength and flexibility. Ships must have flexibility to survive in a seaway or otherwise the steel would very quickly fail due to metal fatigue. Any damage to, or over loading of, the tank top is transferred directly to the floors which may buckle and fracture thus seriously weakening the structure. Stresses occasioned by the incorrect loading of heavy bulk cargoes have caused such damage to these structures that ships have subsequently been lost at sea with all hands.

Maximum loads

When an Owner orders a new ship the builder will offer several designs to meet the requirements of trade, cost and delivery time. In practice Owners tend to buy a “pre-designed article” which does not necessarily meet all of their requirements. Inherent in any design are the maximum loads that can be carried and placed upon the structures. The first pre-requisite in loading the ship, with any type of cargo, is that the designed loads must never be exceeded.

Ships are usually built under Class supervision and it is their rules that govern scantlings, quality of steel and thus the permissible structural loadings. To complicate matters, no two classification societies have the same rules. Thus two similar ships built in the same yard but under different “class” will not necessarily have the same cargo carrying characteristics. Furthermore, it is class rules that produce the stability data that governs the carriage of different cargo types (e.g. grain, timber, steel, etc.). Class provide a book of calculations that illustrate the ship’s stability in various conditions of loading with various cargo types. The rules of one such society have produced an example of loading for heavy steel coils that limits the maximum height of stow to one coil – the resultant lift is approximately 60% of deadweight.

Tank top loading

It is safe to start with the premise that the designed maximum tank top load is not to be exceeded. This designed load is expressed as a weight per square metre. Thus, using the formula of load length x load breadth x maximum tank top load in tonnes/m² will give the maximum cargo that the vessel can load when spread evenly over the total tank top area. On bulk carriers the tank top area is often reduced by sloping hopper sides. There is no extra allowance made for hopper sides and this is not an area for compromise. The load arrived at by the above formula is always to be
considered the maximum and this weight should be spread as evenly as possible across the tank top and floors. It should be borne in mind that whatever weight is placed on board, the movements – accelerations – of the ship working in a seaway can only serve to increase that load, and the designed maximum tank top load takes this into account.

Stowage

The problem of spreading the weight evenly across the entire tank top area is not simple when the cargo comprises coils that are stowed on their circumference with their axes horizontal in the fore and aft direction. As already explained, the majority of strength lies in the floors. The average length of a 20 tonne coil is only about 1.3 metres. Thus it is not long enough to straddle three floors. Further, the area of the coil that comes into contact with the tank top, the “footprint” is much less than the projected area of the coil’s profile. Thus, in a fully loaded hold, the area of the tank top in contact with the coils is probably less than 50% of the entire tank top area. If the maximum quantity has been loaded with reference to the maximum permitted tank top load – a virtual "overload" of 100% can easily result. The accepted method of spreading the weight is achieved by laying heavy dunnage in 2 or 3 lines under each row of coils, the coils being loaded, starting from an end bulkhead, in continuous rows right across the hold – wing to wing.

Shippers or charterers are unlikely to want to spend money on what they may consider to be excessive quantities of dunnage that has no market value at the discharge port. Therefore, the number of lines, width and thickness of dunnage boards that need to be used are another area for potential dispute. Three lines of 15cm x 4cm dunnage under each row would be more acceptable than two or three lines of 15cm x 2.5cm timber laid double. The precise quantity that should be used will be a matter for discussion between the Master and Shipper/Charterers taking into account factors such as:

the size of the footprint;
the age of the ship and physical condition of the floors;
the amount, type, availability and cost of timber;
labour charges and loading delay whilst positioning dunnage on the tank tops.

The Master must achieve the best possible spread of weight that can be achieved consistent with against the Shipper’s/Charterer’s ability to supply and pay for the quantity of dunnage required.

Lashings

Once again, Shippers/Charterers are unlikely to want to spend money on lashing materials that will have little or no value at the discharge port. The material requirements for lashing and tonning off the coils must be governed by expected weather conditions on passage, the time of year and on the distance between ports. A full hold, wing to wing and fore to aft, of two or three tiers is very nearly self-locking and will only require minimum timber braces and wire lashings. However, if the stow is only “half hatch” the face of will require substantial securing with lashing wire and rigging screws. Further, a single height stow will require much more lashing material and timber bracing than two tiers of coils.

With the full weight of cargo low down on the tank top, the period of roll will be small and will generate violent “g forces” in heavy weather. The resultant forces, of the ship working in a seaway, will tend to move the bulkheads. Shoul this happen in a “half hatch” stow the lashings will carry away and the top coils will fall onto the tank top with potentially disastrous results. Lashing must be completed prior to starting the sea passage, not during transit.

Carriage

Having agreed on the stowage of the coils, the amount/type of dunnage and lashing materials, the cargo must now be carried safely to the discharge port. Much of the lashing costs are labour costs. Whilst adequate materials may have been supplied at the load port, the Shippers/Charterers may have skimmed on the labour to reduce costs. All lashings must therefore be inspected and tightened daily (and, if necessary, enhanced) during the voyage if conditions permit. If the lashings become loose the coil will start moving, strappings and wrappings will abrade, and the coils could burst open with disastrous results. A coiled 20 tonne steel spring bursting free in a confined space is not a force to be trifled with. Sending men below to re-secure loose or moving coils is the height of folly. Consequently, particular care should be taken to ensure that the risk of a stowage collapse is minimised at the commencement of the voyage.

Members are strongly recommended to contact either the Managers’ London Representatives or the Club’s local correspondents for advice in the event of any difficulties encountered in the loading of heavy steel coils.

Click here to view the April 2002 Steamship website article on this subject.