Ballast

From Narciki

Ballast

Deballasted cargo ship

Lack of propeller immersion

Ballast is weight used to control bouyancy, trim and/or heel. Most ships will have some form of permanent ballast installed, i.e. concrete or lead poured in the bottom of the vessel; however, an excessive amount may imply a poorly done weight study. Sailboats often have large ballasts, located below the hull, as in a bulb attached to a strut, which counteracts the lateral force and moment of wind on the sails.

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History

Historically, empty (*deballasted*) ships would carry heavy items of convenience if sailing unladen. To this end, many former British colonies are strewn with (often broken) bricks, which were cheap and readily available in Britain. More typically today, ballast tanks are used, allowing a measure of control, though there are environmental concerns regarding the introduction of species across geographical areas.

Use in New Builds

The use of ballast is generally avoided, where possible, when designing new vessels. Permenant ballast reduces a vessels deadweight, without providing a means for revenue or return. It is often more elegant & economical to re-distribute bouyancy or move large weight components in the design process to attain the

same goals. This does not preclude some situations, however, where it remains unavoidable or even practical to consider ballast: machinery arrangements, exhaust restrictions, draught limitations, or configurable designs made trade ballast installation for rapid design, or an operational compromise.

Use in Retrofits

The use of ballast is particularly common in retrofitted vessels, for example, the Anne S. Pierce is a former dragger which has been converted to research vessel use. To maintain its' design waterline, the fish holds have poured concrete ballast. Changes in outfit, machinery, and typical loading conditions for a vessels new role may be more easily compensated for with permanent ballast than by structural or hull form changes.

Failure to Properly Ballast

Failure to properly ballast a ship can lead to large induced loads from static loading. A vessel trimmed by the stern may experience excessive pounding in the fore when engaged in a seaway, while a vessel trimmed by the bow may experience a lack of propeller immersion. A ship with a short roll-period, as can occur with excessive amounts of low ballast, weight, or loading, is known as stiff & can be exceedingly uncomfortable for passengers and crew.

Placement

The placement of permanent ballast varies with the desired correction to the vessel. Where the goal is a lowering of the VCG, high density ballast (such as lead) will be placed as low in the vessel as practicable, where the resulting righting moment and VCG decrease will be the largest. The lateral position may be symmetrical, or may be arranged to eliminate a state of vessel list; similarly, the longitudinal position will be chosen for the resultant effect on trim. Where the VCG is adequate, permanent ballast may be spread out over a number of decks or locations, where application is convenient to the ships operation. In the event of a stiff vessel, permanent ballast may be located high in the vessel, even as high as the superstructure.

Alternatives

When used to correct an unladen vessels attitude, the use of ballast tanks can be reduced by arranging the vessels operational profile such that it carries cargo continuously along its' operational routes; however this is unlikely to reduce the requirements of water ballast, as the vessel will still be required to meet stability conditions & may be re-purposed in the future. Where time permits, trim can be removed by adjusting the hull forms fore & aft prismatic coefficients (though resistance and capacities must be watched with this method). List can be adjusted through adjustments to the general arrangement, ideally with a complete weight study for guidance.

Where VCG is found to be too high, an alternative to permanent ballast is weight reduction. Common forms of weight reduction are the use of aluminum superstructures on a steel vessel, the use of composite superstructures on an aluminum vessel, or the careful evaluation of outfit & machinery for weight. While more expensive, topsides reduction also decreases displacement - this can have secondary benefits to vessels with limited large-angle stability, freeboard limitations, or draught constraints. For a mass-limited vessel, such as a bulker, the topsides weight reduction can translate directly into a greater cargo capacity.

Permanent Ballast Materials

Where used, permanent ballast materials will be chosen for their density, longevity, and cost (cheap). Common materials are lead, concrete or permanent water tanks (or compartment flooding). Care must be taken when calculating permanent ballast within tanks, as the effective density of the ballast must be reduced by the density of the fluid carried within the tank (as the ballast will displace a certain amount of the fluid).

Lead

Leads high density, relative cheapness (for a high-density material), longevity, and ease to work with make it an ideal ballast material; however, there are environmental and health concerns involved with its use. As such, lead shot is no longer as prevalent, though it remains common in the external bulbs of sailboats (where increased size is detrimental to performance).

Concrete

Concrete or cement is cheap, easily poured, fits around structure, and virtually maintenance proof over its lifetime. It has supplanted lead in most vessels today. It is also common to include scrap steel or excess rebar to increase density, with the concrete poured overtop of it.

Permanent Water

Flooding a compartment is a tempting choice, particularly for a retrofitted vessel. Designers must be mindful of some potential complications, however. The tank should be coated, water treated, or both, to reduce corrosion as much as possible. Fresh water is used, though a tempting shortcut is just to bilge the compartment. The structure of the tank or compartment must be able to withstand increased loadings from a head of water, including decks used as the tanks crown. Calculations must be mindful of the induced free surface moment.

External links

- Earthcore Industries [1] *(re-use old ballast bricks)*