U.S. COAST GUARD

SAFENET Advisory

FOUNDED 1862 ABS
AMERICAN BUREAU OF SHIPPING & AFFILIATED COMPANIES

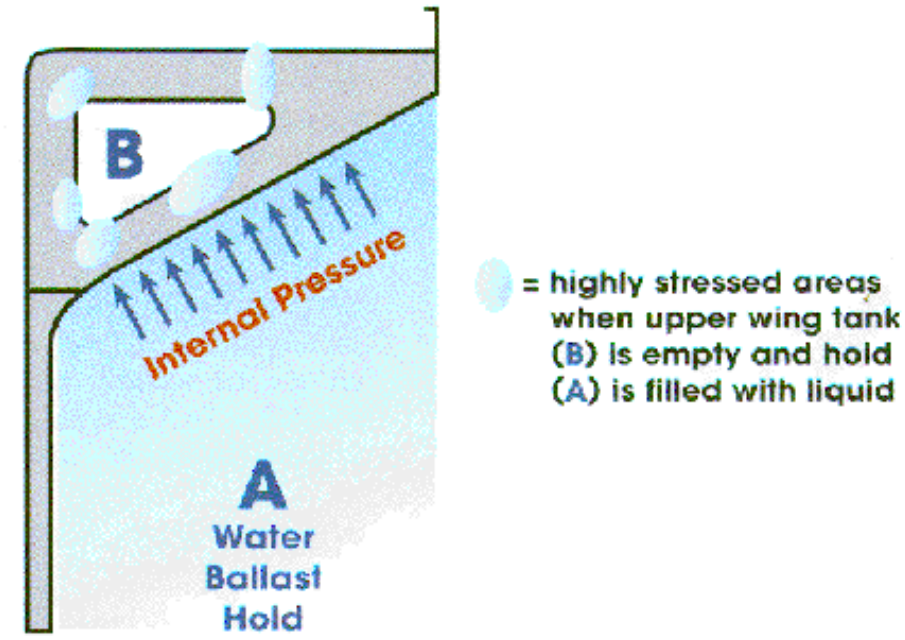
BUCKLING OF TRANSVERSE WEB FRAMES IN THE UPPER WING TANKS OF BULK CARRIERS

BACKGROUND

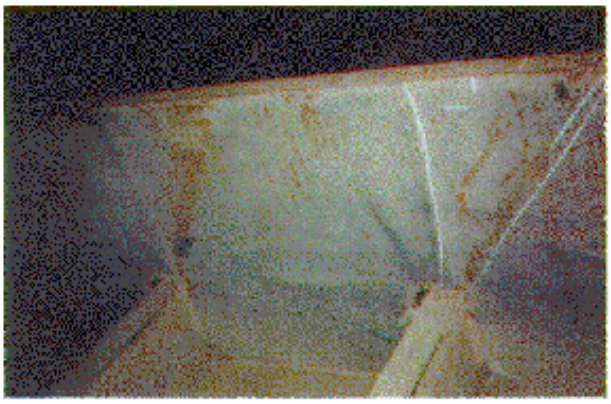
Through the years there have been incidents of damage to the upper wing tank transverse web frames of several midsize bulk carriers. Buckling has occurred on the deck, sloping bulkhead, and side transverses, along with fractures along the radii (see illustration and photos). Speculation as to the cause of these damages includes improper air-pipe venting during ballasting operations, inappropriate design or workmanship of structural details, and improper loading.

LIKELY CAUSE

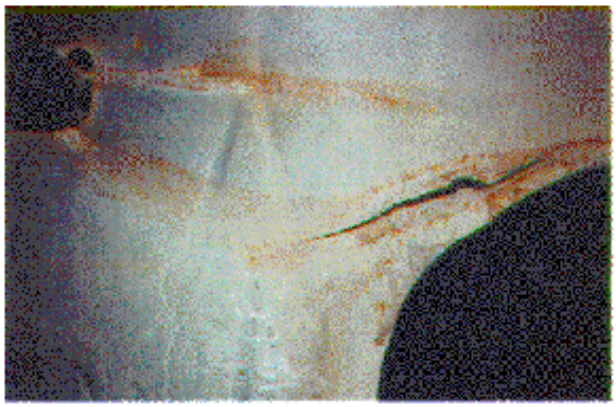
Although many factors may contribute to transverse web frame failures, ABS has identified an important factor in the failure of the upper wing tank transverses. During the development of the SafeHulls criteria for bulk carriers, extensive research was conducted on the behavior of web frames under various loading conditions. It was found that when a cargo tank is used as a ballast hold and the topside tank is left empty, high bending stresses can occur on the transverses (see illustration) These stresses may be very close to the yield stress and may exceed the ultimate strength of the plate panel.



JULY 1997
VOL. 1
NO.1



Typical buckling



Fractured radii

PREVENTION BASED ON EXPERIENCE GAINED

If a cargo hold of a bulk carrier is to be used for water ballast, it is important to assess the strength of the upper wing tank structure for the pressures induced by this loading. During the design phase of new bulk carriers, the depth of the transverses and the web plating thickness are often increased in the upper wing tank transverses.

In the 1997 ABS Rules for Building and Classing Steel Vessels, specific formulations (Part 5, Section 3A.4.4.4d) for the calculation of section modulus, web sectional area, and depth of transverses in upper wing tanks in way of ballast or liquid cargo holds provide a strength check to account for the effects of internal pressures exerted by liquid on an empty wing tank. The imposed loads are accounted for in the nominal pressure calculation.

In the past, the dynamic and static components of ballast loads may not have been considered during the design. Therefore, for existing ships it is particularly important to monitor corrosion rates and thoroughly inspect the condition of the structure in way of the ballast hold. A revised ballast condition, in which the topside tank and ballast hold are fully loaded, will reduce the stresses on the transverses. Additionally, a SafeHull or DLA analysis is a good way to assure the adequacy of this structure.

FUTURE DEVELOPMENTS

In some incidents of vessel failure, the surveyor reported that damage to wing-tank transverses is more severe, or only occurred, on one side of the vessel. This may be due in part to the pattern of environmental forces for a particular trade route. The wave-induced forces on the sideshell may result in carry-over moments to the transverse web frames. These forces, coupled with the internal pressure of the water ballast, can increase the probability of structural failure.

ABS is currently developing an environmental wave database that recognizes wave directionality for fatigue analysis. This will allow a more precise structural evaluation for a particular trading environment. In keeping with Rules 2000, the analysis of ship structures based on a first-principles evaluation with various loading patterns was a major advancement to understanding the behavior of ship structures. The environmental wave database study is continuing this evolution.

As one of the world's leading ship classification societies, ABS is in a unique position to obtain information about ship structural failures and other incidents for various vessel types. Much of this information will soon be shared with the industry via SafeNet, the groundbreaking life-cycle ship-management and information network that has been sucessfully piloted and is now being made available to ABS owners. On a regular basis, Safenet Advisory will illustrate the type of information owners will be able to accumulate and analyze using the SafeNet system.

The ABS Vessel Incident Group has been formed to collect reports and analyze trends in ship accidents. By disseminating the findings of this data to ship builders, shipowners, and ship operators, we hope to alert the marine industry to common failures, thereby aiding in the prevention of similar occurences and increasing safety. We hope that you find these report s useful.

Send questions or comments to -
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PREVENTION THROUGH PEOPLE

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Created 9/18/97
Updated