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Probabilistic Damage Stability

WÄRTSILÄ

Maximizing the attained index by analyzing the effects of changes in the arrangement for offshore vessels

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Introduction

Naval Architects are in most cases prone to time pressure when designing a vessel. Design companies are working on the so called “no cure, no pay” agreements, which entails them to run many projects simultaneously. Designing a vessel is complicated and it is difficult to comprehend the results for hydrodynamic and stability calculations beforehand. Naval architects wants to do few iterations in the design process to save time. Stability regulations are one of the factors that determines how the vessel will be and the calculations are time demanding. In order to cut down on the iterations, the ship designer has to rely on previous experience in the early stages of the design process, to know whether the vessel will fulfill the damage stability regulations.

The regulations regarding probabilistic damage stability are very complicated, and few have taken the time to fully understand how the calculations are conducted. The effects of changes in the arrangement is not easy to comprehend, due to the multiple factors that impacts the results. Since the probabilistic damage stability requirements are relatively new for offshore vessels, there are limited research on how changes in the arrangement affects the attained index for these vessels. The attained index is a measure for safety. If two ships has the same attained index, they are considered to be equally safe. A higher attained index, means that the ship can withstand damages better.

Objective

The objective of this report is to study how changes in the arrangement affects the results of the total attained index for different vessels. As well as how the placement of longitudinal bulkheads affects the attained index for different arrangement configurations.

Method

In order to increase survivability of damaged ships after damage, the placement of the longitudinal wing tank bulkhead in the mid-ship section will be studied. There are two focus areas that has been analyzed in the thesis, the effect of U-shaped double bottom tanks, and the placement of the longitudinal wing tank bulkhead in the mid-ship section. It will be checked for a correlation between the placement of the longitudinal wing tank bulkhead and different ship sizes. The development of the attained index for two different arrangement configurations, when the longitudinal bulkhead is moved, will be compared to see if there is a correlation between different arrangement configurations as well. One of the arrangements will have U-tanks in the entire mid-ship section. And the other will have a longitudinally divided double bottom with no U-tanks. Probabilistic damage calculations will be conducted for the two different arrangement configurations, on four ships, with different placements of the longitudinal wing tank bulkhead.

Results

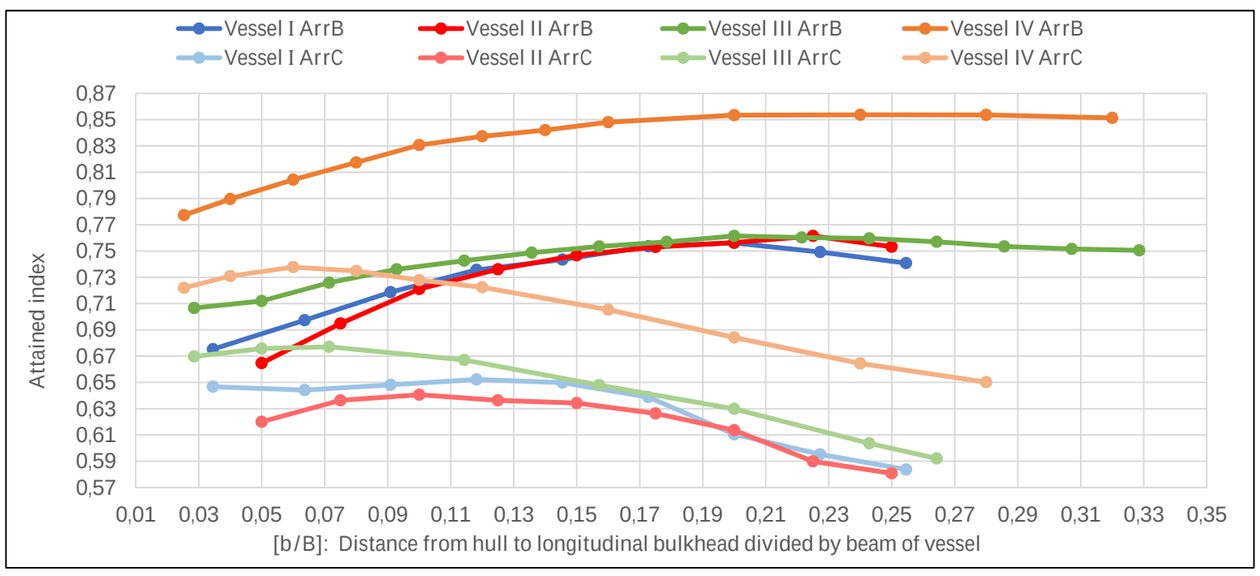


Fig 1: Attained index for the four vessels with different arrangements and placements of the longitudinal wing tank bulkhead

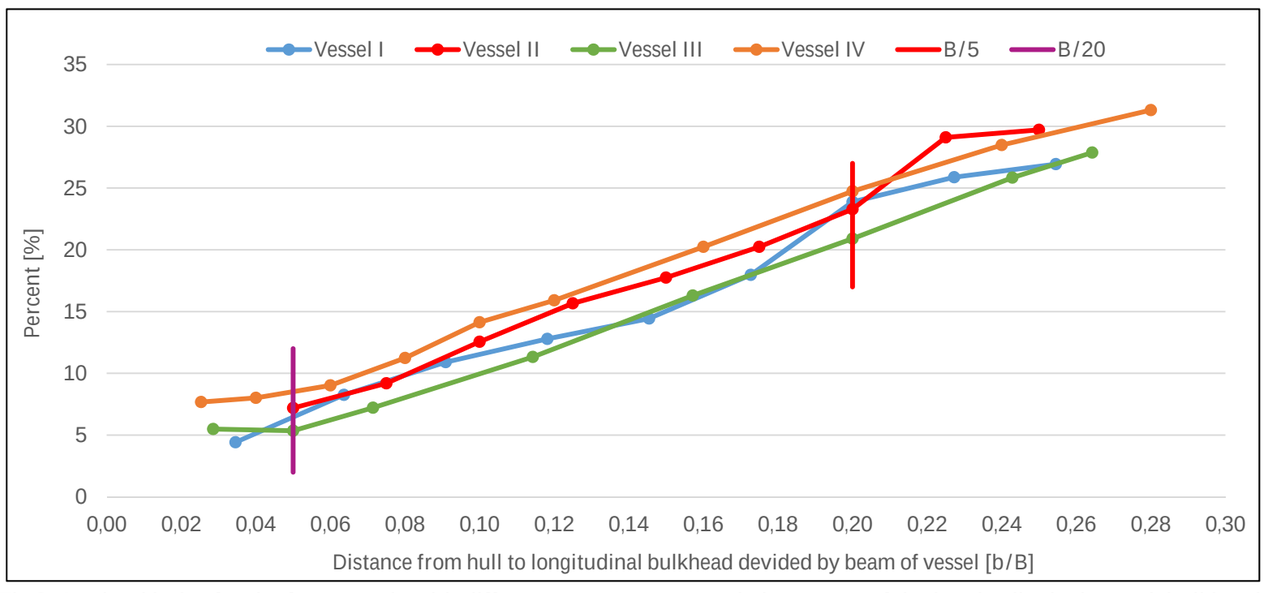


Fig 2: Attained index for the four vessels with different arrangements and placements of the longitudinal wing tank bulkhead

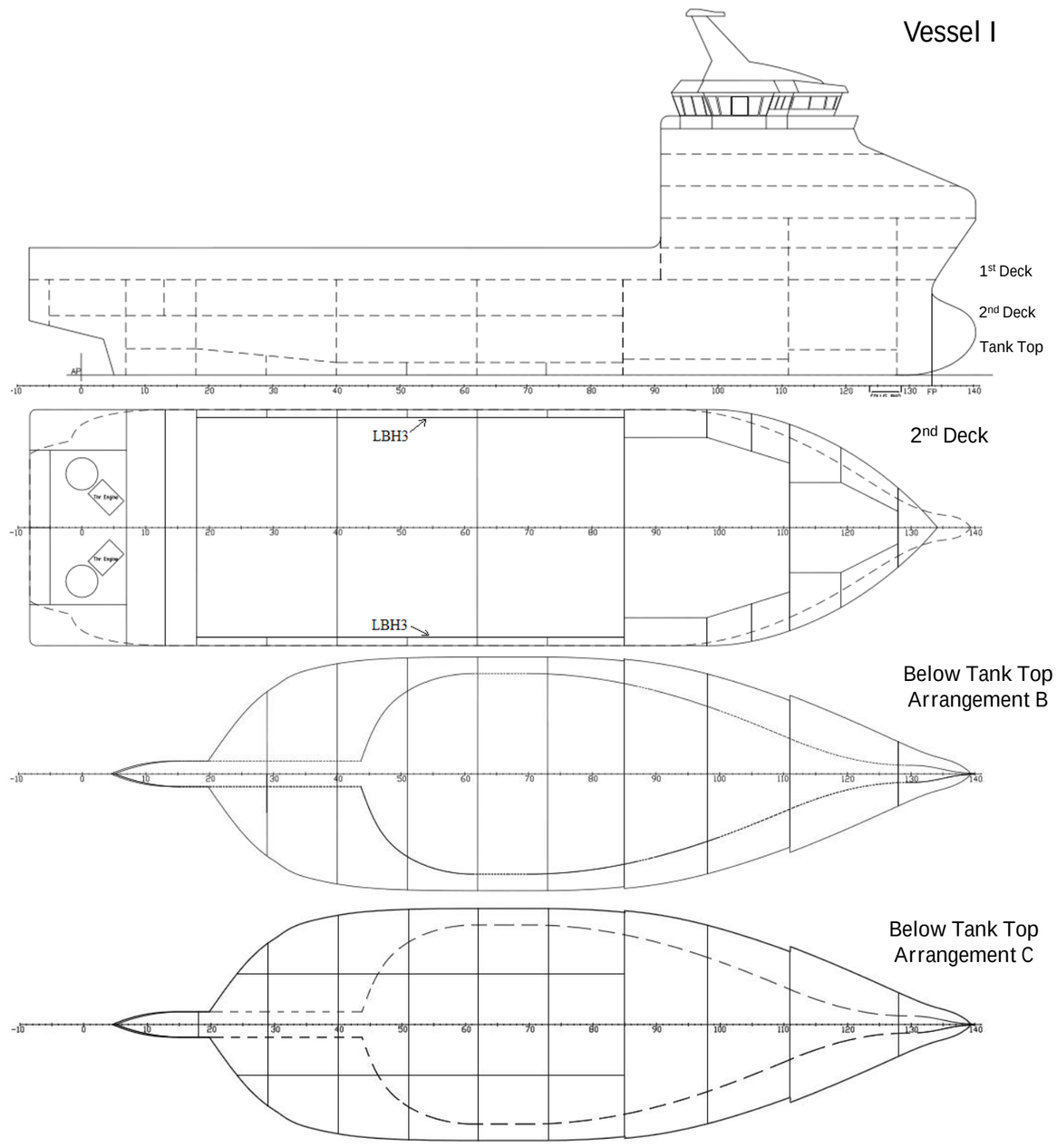
Vessels of study

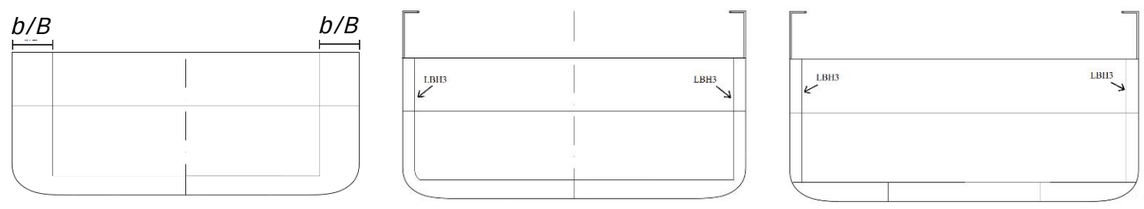
Table 1: Main dimensions

Vessel	Lpp [m]	Beam [m]	Draught molded [m]	Draught [m]
I – PSV	80.1	22	9	7.2
II – PSV	95	24	9.6	7.4
III – OCV	118	28	12	8.5
IV – OCV	130	30	12.5	8.6

Table 2: GM-values

Vessel	Lightest service draught, Dl	Partial subdivision draught, Dp	Deepest subdivision draught, DS
I – PSV	1.6 m	1.6 m	2.3 m
II – PSV	1.6 m	1.6 m	2.3 m
III – OSV	1.8 m	1.8 m	2.5 m
IV – OSV	1.8 m	1.8 m	2.5 m





Distance from LBH3 to hull is given as b/B

Frame #50 Arrangement B with U-tanks

Frame #50 Arrangement C without U-tanks

Conclusion

Figure 1 shows that the results for the development of the attained index varies according to the arrangement configuration. The chosen GM values and draughts for the different vessels will significantly influence the results for the attained index. The development of the attained index is therefore of the main interest and the specific value is not important. The development of the attained index is not proportional for all vessels with the same arrangement, but the overall development is similar. When the longitudinal wing tank bulkhead is moved towards the centerline the attained index increases for arrangements with U-tank configuration, (arrangement B). The attained index does not increase for vessels with longitudinal bulkheads in the double bottom, as the wing tank bulkhead is moved towards the centerline (arrangement C).

Figure 2 shows the difference between the attained index for the two arrangement configurations with different placements of the longitudinal bulkheads. It can be seen that vessels with U-tank configuration has a higher attained index compared to vessels with no U-tanks. The attained index is 5-30 % better for arrangement B compared to C, depending on the placement of the longitudinal wing tank bulkhead in the mid ship section.