Assessment of intact and damage stability to PS and SB in PIAS

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In PIAS, for each particular project of vessel the side of heel for intact and damage stability calculations is user-configurable, where the options are:

1. Portside (PS).
2. Starboard (SB).
3. The side of the statical angle of inclination. With this setting, the side of the worst stability is estimated with this method: if this statical angle is to PS then the calculation is made to that side, otherwise to SB.
4. Portside and starboard. With this setting there will be no *a priori* assumption on the "worst side", instead the stability will be calculated to PS as well as SB, while both sides are fully taken into account in the stability assessment.

The first three options have been available in PIAS from its beginning, the fourth option was added by the end of 2016. Its background and *modus operandi* is the subject of this white paper.

The concept of "worst side"

The concept "worst side of stability" is a popular notion, which is e.g. applied with PIAS' setting "heel to the side of the statical angle of inclination" (the third option in the enumeration above). However, "worst" are only meaningful in relation to a standard, a norm. Without norm, "good", "bad" and "worst" do not exist. So, a stability norm will have to be applicable, otherwise speaking about "worst" is useless. In general, a stability norm is composed of multiple sub-criteria, so it can be that one criterion is more critical with heel to PS, and another more critical to SB. E.g. if in damaged condition the statical angle of inclination if 5^{O} to SB, on SB side an opening is immersed at 30^{O}, while at PS an opening is immersed at 15^{O}. The range to SB is 25^{O} in this case, and to PS 15^{O}. if two stability criteria would be applicable: 1) a maximum angle of heel and 2) a minimum area under the GZ-curve, then heel to SB is critical for the first criterion and heel to PS for the second. These two criteria cannot be combined or be weighed against each other, not in principle, and in particular not in this example because the two criteria have different units. Fortunately, all individual criteria can be used to determine a maximum allowable VCG, which gives us a metric; the side with the lowest maximum allowable VCG is the side of worst stability.

Implementation in PIAS

A first statement to make is that the whole concept of "side of worst stability" plays no role whatsoever in the implementation in PIAS. In the previous paragraph it was just used as illustration, and because it is a frequently used notion, although not the most expressive notion. And secondly it should be emphasized that this PS & SB computation is not specifically a major innovation in PIAS; after all computations to PS and SB have been around for decades, and now the two are glued together and processed commonly.

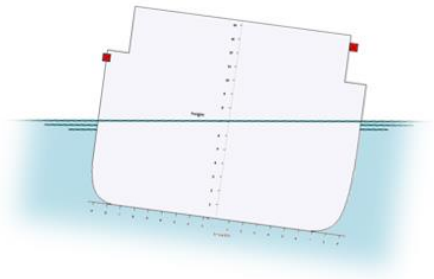
However, although the underlying computations have remained unchanged, there may be some occasional differences in the numerals when PS/SB computations separated are compared with PS & SB combined. The reason is that when evaluating a GZ-curve for compliance, for certain criteria it is necessary also to include the other side. An example is the Intact Stability Code weather criterion — with its rollback angle and comparison of GZ-areas windward and leeward. With just results to a single side available, there is no other choice then to mirror[1] that single GZ to the other side. With a computation to PS & SB there is no need for such an approximation, because the full GZ-curve is available in all its details. So, if there appears to be a difference in the numerals of the processing of some stability criterion, the results of the PS & SB combined computation are arguably more accurate than those of separated PS or SB computations.

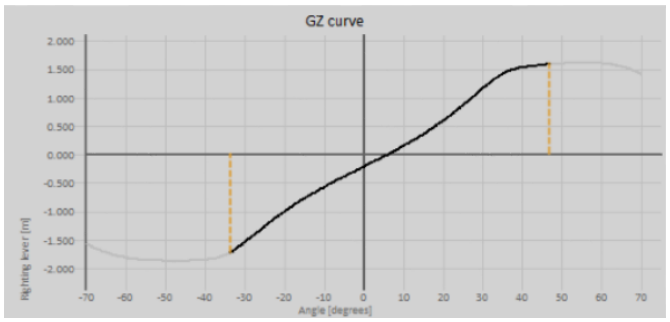
[1] In reality, with a non-zero angle of heel this process contains a few more operations than just mirroring, but that is not relevant for the argument.

Applicable modules

Where relevant, the double computation — to PS as well as SB —is (or will be) included in PIAS. This implies that it surfaces in a number of places, but it is more or less the same at each application: compute to PS and SB, process and present both, and take the most critical result (if applicable). Such as with:

- Maximum allowable VCG, intact as well as damaged. Here for each individual stability criterion the maximum allowable VCG is determined to PS and to SB, with the lowest one presented as most critical value.
- Maximum allowable grain heeling moments.
- Loading conditions and intact stability. Here two GZ-curves are being plotted, and the stability criteria are evaluated to both sides.
- Hopper dredger stability.
- Cross curves, where simply dual tables are computed and printed.
- Probabilistic damage stability.





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