WOLFSON UNIT
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Technical Note

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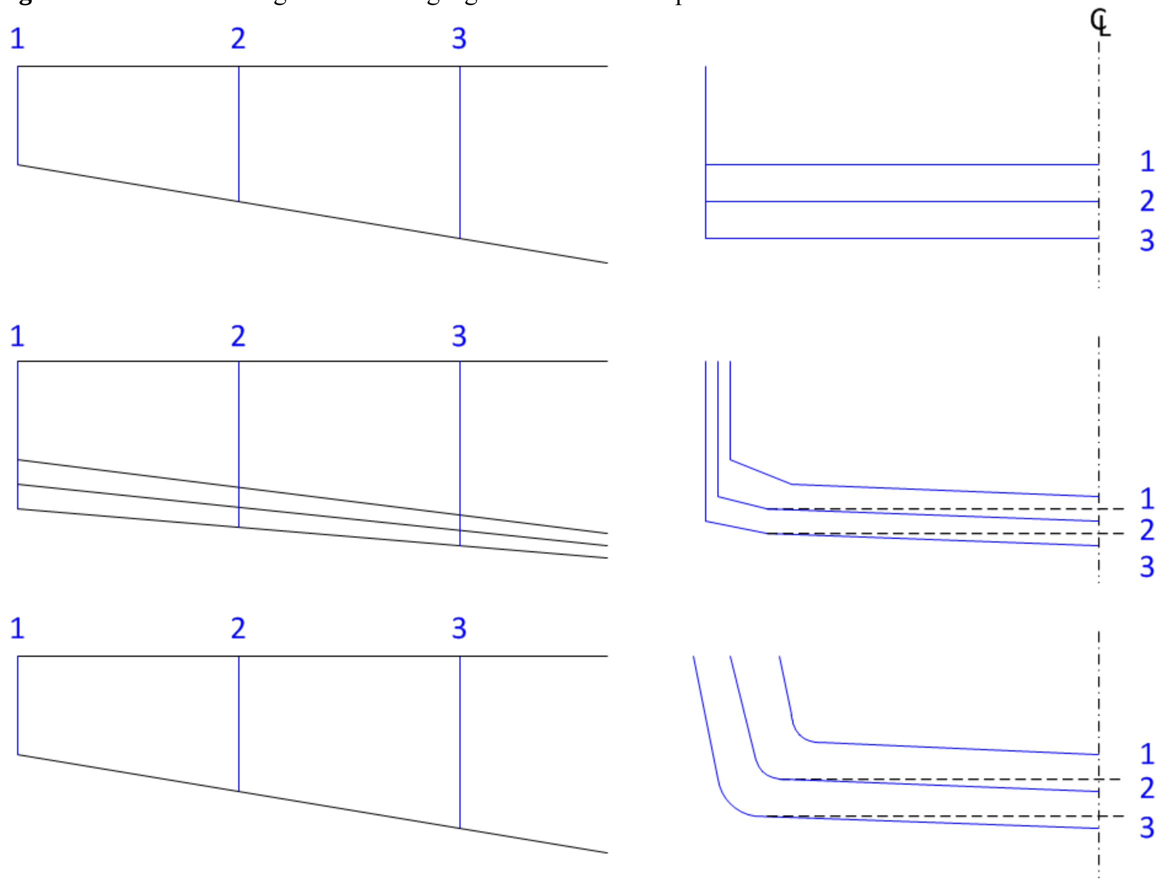
Subject: Swim end modelling in HST / HST2

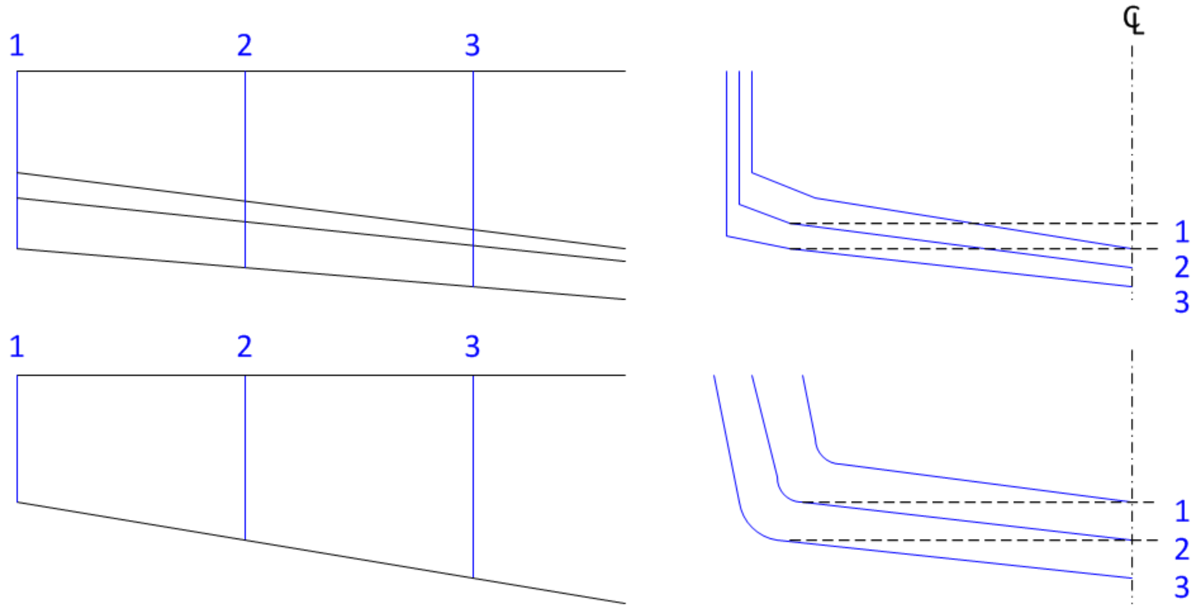
Owing to the way in which the computer performs longitudinal integrations, care must be taken when a vessel has a swim end or ends. This problem is not only associated with barges, but may also be encountered in small coasters with double chines aft, high speed round bilge vessels or sailing yachts with shallow sections aft. The figure shows examples where the problem may be encountered, when a waterline drawn from the turn of bilge does not cut the rise of floor of the previous section (at the aft end, and following section at forward end) in the interval.

Figure 1 – sections' arrangement causing significant swim end problems



Here are some examples of a double chine craft and a round bilge vessel where the swim end problem is not significant, since the waterline drawn from the turn of bilge cuts the rise of floor of the previous section in the interval.

Figure 2 – swim end problem not significant



If a swim end problem exists there are three ways that the errors may be reduced to insignificant amounts, and a combination of these methods is recommended where possible.

1. Close section spacing.
2. Select the correct draught for a given section spacing.
3. Use section triplets at waterline.

The recommended method is to have **close section spacing**. The more sections used to define a swim end the better. The maximum error that may be encountered will be in the MCT, KML, IMMERSION and LCF calculations. The percentage error that may be expected will be of the order of the section spacing to ship length ratio. Thus if quarter station spacings are used then the error may be up to 2%, similarly 1/10th station spacing may yield a 1% error.

The second method relies on selecting the **correct draught for a given interval definition**. For example on the straight-sided, swim end barge of Figure 3, the draught values input to the hydrostatics program depend on the longitudinal integration method. For an accurate trapezoidal integration, the waterlines selected for hydrostatics calculations should bisect the profile between each section. At these locations the actual and calculated waterplane areas are the same. For a parabolic integration over three evenly spaced stations S0 (aft), S1(mid) and S2 (fwd) the waterlines should intersect the profile at *h/3* and *5h/3* forward of station S0, where *h* is the section spacing. Again, no errors are introduced.

The third method is to have **three evenly spaced sections straddling the waterline**, with the middle section located where the profile intersects the waterline and an arbitrarily low spacing. Figure 4 shows that, assuming that a parabolic integration is performed, and that hydrostatics are calculated at a waterline WL1, the contribution to waterplane area between S2 and S4 is 2*(A-B).

Figure 3 – straight-sided, swim end barge

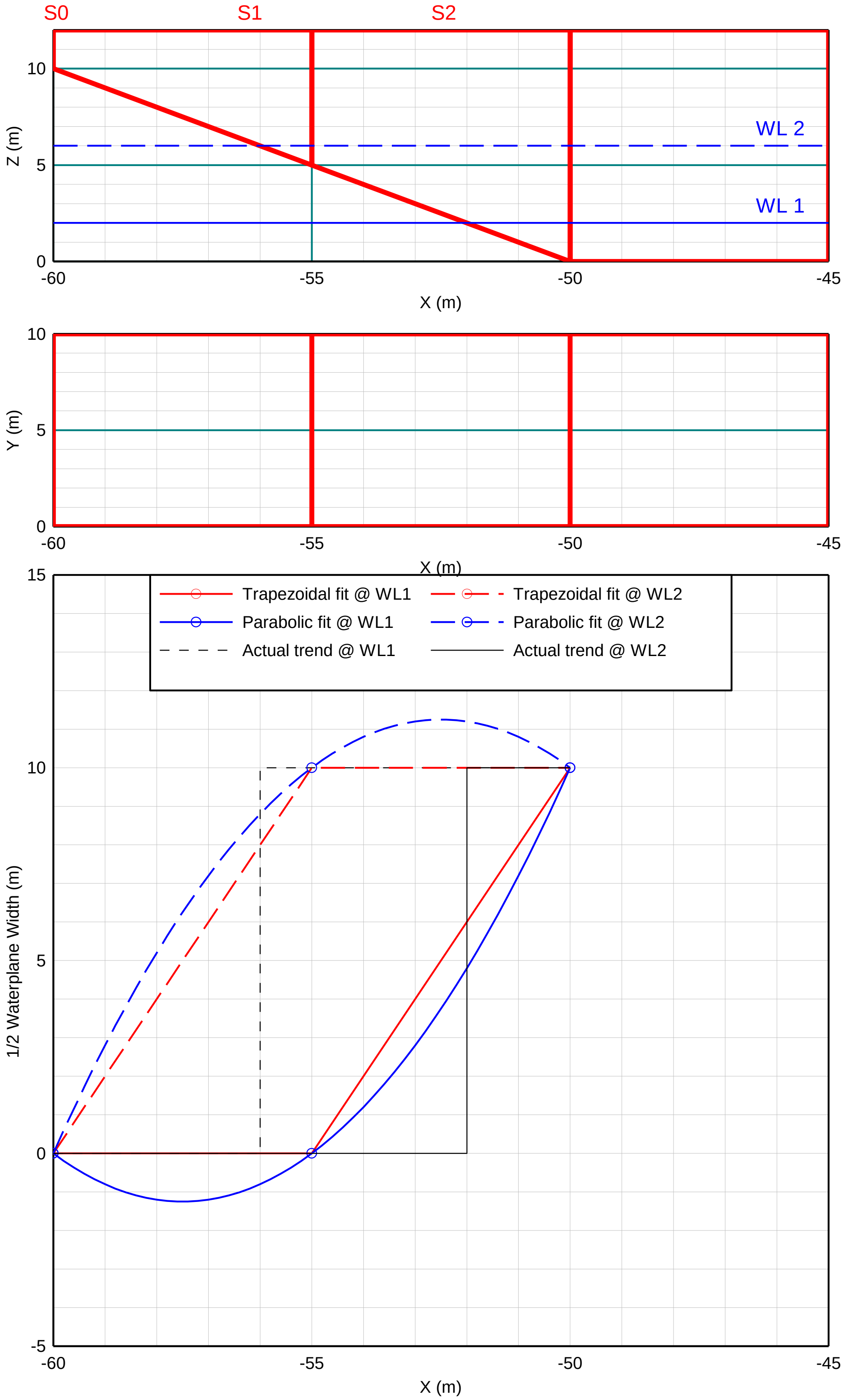
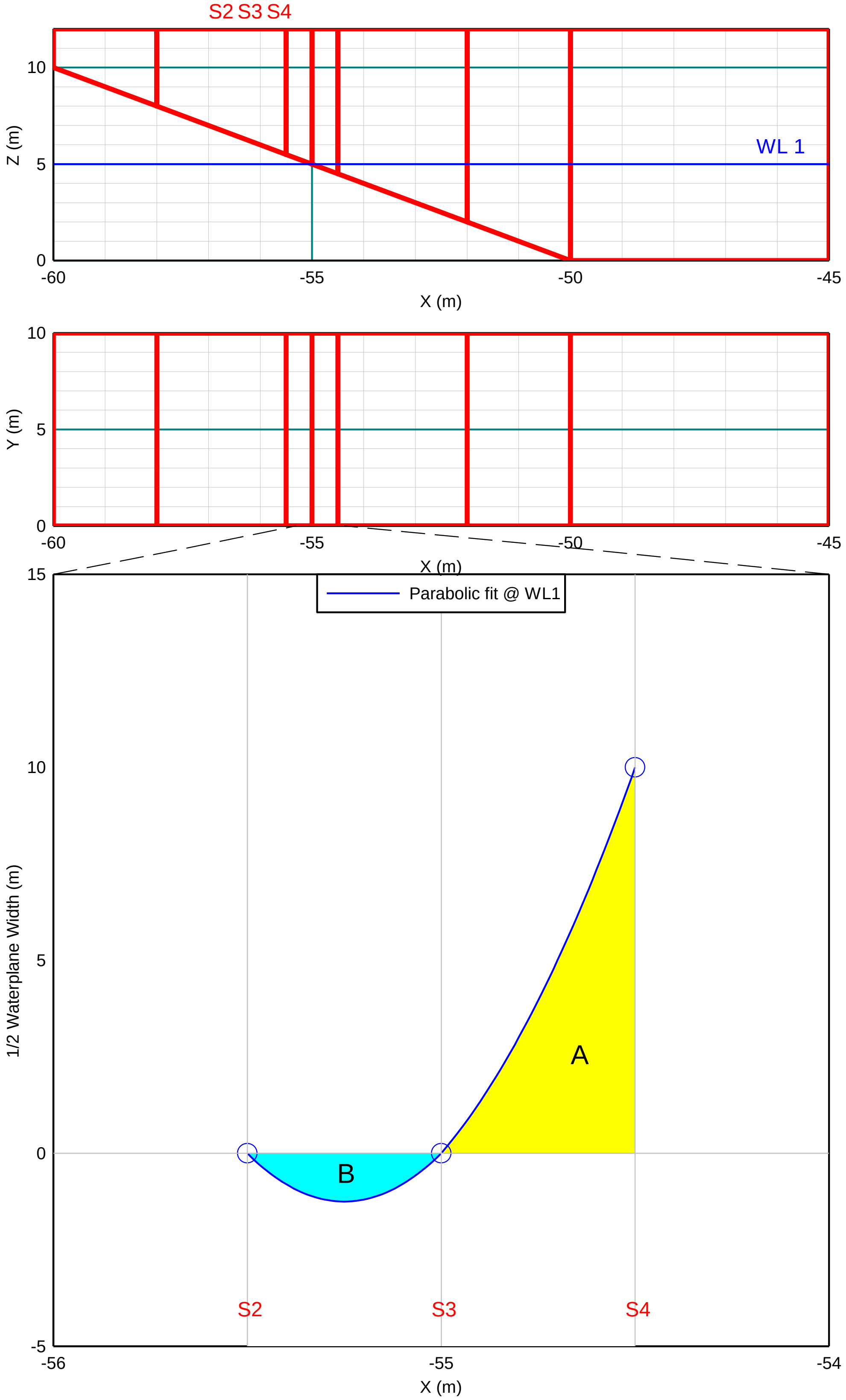


Figure 4 – use of section triplets for minimising swim end problems



In some circumstances it is not possible to arrange the sections to suit the draughts (methods 2 and 3 above), particularly when a vessel has a swim at both ends, or when trimmed hydrostatics are required, since the waterlines may now intersect the swim at different positions. Thus a compromise must be made on the number of sections required.

When the results from the hydrostatics program are finally plotted, problems with swim ends will show up as steps in the MCT, KML, IMMERSION and LCF curves, in the extreme case, or irregularities; and thus when drawing a fair curve through these points they should be smoothed out. Care must be taken, however, not to fair out any discontinuities in the slopes that are features of the vessel's design.

Example: straight-sided, twin swim end barge

LOA = 120m; Beam = 20m;
Aft swim end definition as in Figure 3;
Swim ends symmetrical about midships section.

Aft Draught Marks X = -50m; Fwd Draught Marks X = 50m.

WL1 @ 2m above datum; WL2 @ 6m above datum.

Waterline beams are integrated over the vessel's length to derive the waterplane area.

Assuming a parabolic longitudinal integration is performed, at all draughts below 5 metres the solid blue curve of Figure 3 is integrated using Simpson's 1st rule and the calculated waterplane area of the swim end is therefore Spacing x Beam /3. At draughts of 5 meters and above, the dashed blue curve of Figure 3 is integrated, which yields a swim end waterplane area of 5 x Spacing x Beam /3 ie 5 times as much. This causes a step change in waterplane area at a draught of 5 metres, which affects KML, MCT and TPC. LCF is not affected by swim end errors and is positioned amidships at all draughts, as the vessel has twin swim ends.

The steps in the MCT and TPC curves are shown in Figure 5.

NOTE: when analysing MCT results, it should be borne in mind that HST uses the following formulae, which are also given in HST Help > Glossary > MCT:

In metric units:
MCT = (moulded displacement x (KML - VCG)) / (100 x (Fwd Marks X – Aft Marks X))

In English units:
MCT = (moulded displacement x (KML - VCG)) / (12 x (Fwd Marks X – Aft Marks X))

The ship's trim length is set in the Draught Marks dialog, and the ship's VCG used in hydrostatics calculations is set in the Hydrostatics page of the Hydrostatics and Stability dialog.

Figure 5 – Hydrostatics: variation of MCT and TPC vs draught