For Bigger Speeds of Ships with Small Water-Plane Area

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Abstract: *The reasons of speed restriction of ships with small water-plane area and usual shape. New hull shape; results of towing and seakeeping tests; some examples of conceptually designed ships of the proposed shape hulls.*

Setting up a problem

Usually today the main under-water volume of a hull of ship with small water-plane area (SWA ship) is a cylindrical body with semi-sphere or semi-elliptical bow and semi-conical stern. And all SWA ships have small enough longitudinal stability.

A SWA ship has big dynamic trim to stern at high enough Froude number by a hull length, Fig. 1.

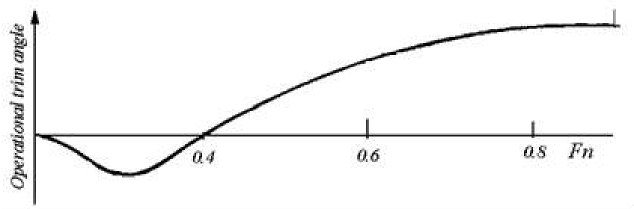


Fig. 1. *Dynamic trim of a SWA ship [1].*

The bluff enough shape of the usual hulls of SWA ships and big enough trim mean the flow separation, if the bow is bare, and the not permissible growth of towing resistance. It means, usual shape of SWA hull is the reason of a sufficient restriction of the achievable speeds of such ships.

1. Problem solving.

The new shape of SWA ship hull is proposed for decreasing of the maximal speeds of SWA ships: flat vertical bow and flat horizontal stern, Fig. 2.

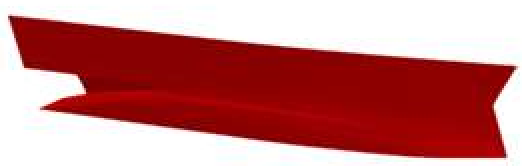


Fig.2. *The proposed shape of high-speed SWA ship hull [1].*

Smooth enough bow does not generate flow separation, i.e. bare bow is not a reason of big added resistance. And vertical force, which generates trim to stern, and stern vertical force from the added flaps ensure sufficient decreasing of dynamic draft, therefore, wetted area, i.e., drop of towing resistance.

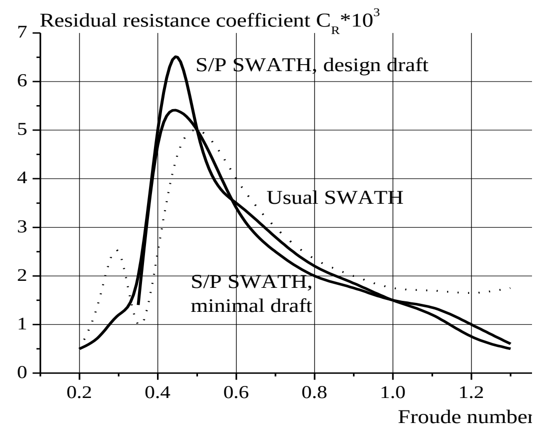
The proposed shape allows speed growth up to begin of planing regime, i.e. Froude number by a hull displacement about 3.0; the ships with such shape were named as "semi-planing" ones, S/P SWA ships.

Test results.

Residual resistance coefficient of tested model with the shown shape can be seen at Fig. 3.

Fig. 3. *Test result of the SP SWA twin-hull model (constant wetted area is supposed).*

As it is noted, the model with the examined shape has the residual resistance coefficient, which drops at big enough relative speeds.



But less dynamic draft means bigger influence of waves; therefore, S/P SWA ships have slightly bigger motion at a comparison with usual SWA ships, see Fig. 4.

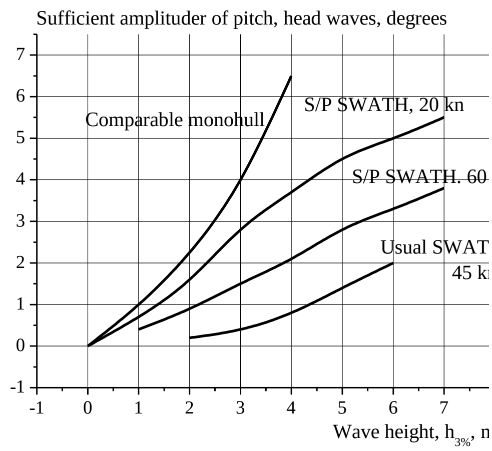


Fig. 4. *Pitch amplitudes of some ships of the same displacement: a mono-hull, S/P SWA and usual SWA ship [2].*

Bow vertical accelerations of some ships with the same displacement are shown by Fig. 5.

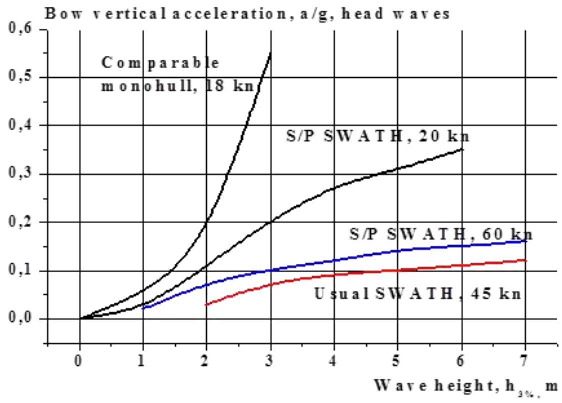


Fig.5. *Bow vertical acceleration of ships with equal displacement [2].*

It seems evident, the S/P SWA ship motion in head sea is slightly worse, than usual SWA ships, but better, than the mono-hulls.

2. Some examples of conceptually designed S/P ships.

The new shape can ensure growth of achievable speeds of SWA ships of various purposes. Some examples are shown below.

Fig. 6 shows a S/P SWA ship as a mini-ferry.

Fig.6. *Mini-ferry, 20 persons, deadweight 6 t, 30 knots, Sea State 3 for full operability.*

S/P SWA ship as a patrol vessel with a helicopter is shown by Fig. 7.

Fig. 7. *S/P SWA ship as a patrol vessel, the helicopter mass 5 t, deadweight 30 t, 40 knots, Sea State 4 for full operability.*

S/P SWA ship as attack corvette is shown by Fig. 8.

Fig. 8. *Attack corvette, 400 t, 45 knots, helicopter mass 16 t, Sea State 5 for full operability.*

A general positions of S/P SWA ships at the graph “speed-length” are shown by Fig. 9.

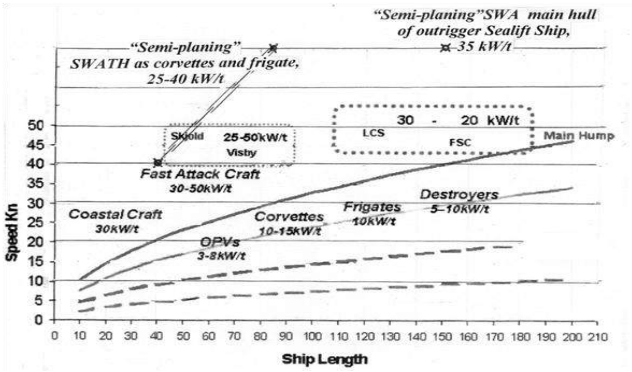


Fig.9. *A general comparison of S/P SWA ships with battle mono-hulls. Froude numbers of the mono-hulls are shown as solid (Fn = 0.5) and dotted (Fn=0.3) lines.*

Fast container-carrier for short lines is shown by Fig. 10.

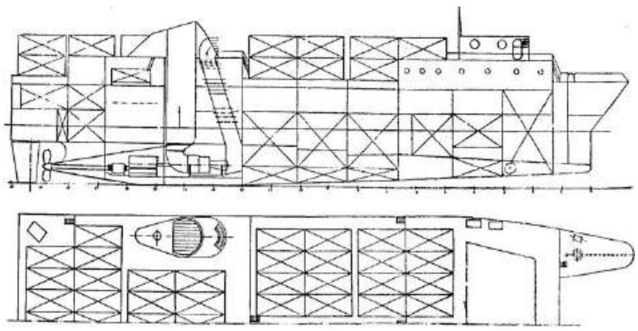


Fig. 10. *Fast container-carrier, deadweight 1200 t, 55 knots, Sea State 6.*

Conclusion, recommendation.

The new shape of hulls with small water-plane area can ensure growth of achievable speeds of ships with small water-plane area, SWA ships.

Such options are recommended for designing, if big speed and good seakeeping are needed.

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References

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