Comparison of Hydrodynamic Performance between the Existing and Esthetic Form for the Fishing Boat

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ABSTRACT

Despite various forms have been developed and applied to ship hull forms, the superiority of hard chine type over other forms of fishing boat has been recognized so far. As one of the ways of forms for new concept fishing boat, this paper presents the result of a performance evaluation for newly developed forms of hull, appendage and deck house, which features that have esthetic forms.

Keywords: Fishing Boat hull Form, Planing Hull, Semi-Twin Hull, Streamlined Trim Control Device, Stream lined Deckhouse, Streamlined Structural Form.

1. INTRODUCTION

For the comfortability and operational economy, the improvement of ship performance and comfortability has been an important topic in ship design and research field due to the increase of personal income and fuel prices with in the 20 years. The problem has been generally tackled by the routine ways of ship hydrodynamics, i.e., optimization of hull form and adoption of improved propulsive system. Despite the continuous efforts of designers in finding the better hull forms, the performance improvement by hull form itself based upon the conventional hull form has its limitations in many cases [1][2][3].

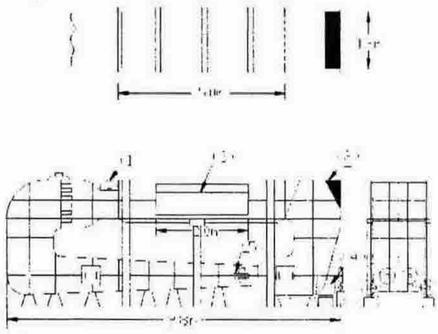
2.MODEL TESTS FOR AFTERBODY VARIATION

2.1 MODEL TEST AT CWC

A circulating water channel (CWC) is a useful facility for several types of experiments that may be required in the development of new hull forms. The advantages are that the running period, unlike a towing tank, is virtually unlimited, permitting measurements to be made over lengthy periods.

It also permits observation of the water surface wave pattern and with suitable equipment measurement of water surface elevation, from which assessment of wave pattern resistance can be deduced. The under water flow directions can also be observed using suitable flow indicators such as tufts, paints and dyes injected in to the water. Compared with large towing tank in which models of about 7.0 m may be used, the main disadvantage of a CWC is the size of the facility and for this reason; the model size that can be tested is limited to 2.0 m. the size limitation brings with it some problems associated with the measurement of small forces and torques to which must be added the scaling problem when attempting to predict ship quantities. A future complication is the slope of the water surface, blockage effect due to limited section and the possibility that the water velocity may vary slightly across the working section.

A schematic diagram of the CWC, which was used in these tests, is shown in Fig. 1. This vertical type CWC with two impellers is 14.8 m long and has a working section dimension of 2.0 m wide and 1.0 m deep and a length of 5.5 m. A rotor type free surface flow accelerator, degassing equipment and a water filter is also installed.



(1) Surface flow accelerator
(2) Measuring section
(3) Motor A.C. 22kW
(4) Impeller

Fig. 1 Schematic Diagram of CWC

As two impellers increase uniformity, the variation of velocity distribution in the working section at 1.0 m/s is within $\pm$ 1.5%.

2.2 PROCEDURES OF MODEL TEST RESULTS ANALYSIS AT CWC

The results of model tests at CWC are analyzed by the procedures as presented as follows:

MODEL TEST

BLOCKAGE EFFECT CORRECTION

STUD DRAG COEFFICIENT (C_{SD}) CALCULATION

MEAN GRADIENT EFFECT CORRECTION (R_{TM}, C_{TM})

$$C_{TM} = \frac{R_{TM}}{\frac{1}{2} \cdot \rho \cdot S \cdot V_M^2}$$

CALCULATION OF FORM FACTOR OF MODEL SHIP

WAVE RESISTANCE COEFFICIENT $C_W = C_{TM} - (1+k).C_{FM}$

C_{TS} CALCULATED BY ITTC 1978 METHOD $C_{TS} = (1+k).C_{FS} + C_W + \Delta C_F + C_{AA} + C_{ASL}$

Total Resistance of actual ship

$$R_S = C_{TS} \cdot \frac{1}{2} \cdot \rho \cdot S \cdot V^2$$

$$P_E(kW) = R_S \cdot \frac{V}{1000}$$

Fig. 2 Procedures of model result analysis at CWC

Resistance correction by blockage effect is carried out with equation(1)

$$\frac{\Delta V}{V} = 0.85 \cdot m \cdot \left[\frac{L_{PP}}{B_T}\right]^{\frac{3}{4}} \cdot \frac{1}{1-(FnH)} \qquad (1)$$

Where,

V_Z : The velocity of water

ΔV : The velocity increment

m : A_X / A_T

A_X : The maximum transverse section area of model ship

A_T : $B_T \cdot H_T$

B_T : The breadth of tank

H_T : The depth of water

L_{PP} : The length of model ship

FnH : $V_M / \sqrt{gH_T}$

The effect of water gradient on the resistance is taken into consideration by equation(2)

$$R_{TM} = \frac{R_{T1}}{Cos\theta} - \Delta Sin\theta$$

Where,

R_{T1} : Measured resistance (N)

Δ : Displacement weight of model (N)

θ : Inclination of surface (rad)

2.3 MODEL TEST AT TOWING TANK(TT)

For the quantitative analysis of resistance test, towing tank asb shown in Table 1 is used.

TABLE 1 Main Characteristics of the Towing Tank

L * B * Draft	79m * 5m * 3m
Max. Towing speed(m/sec)	3.0

2.4 MODELS

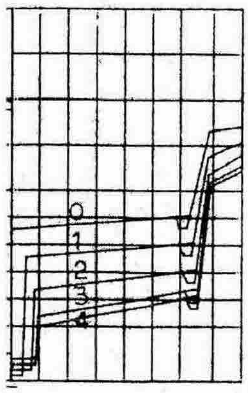


Fig.3 Stern form of Conventional Type Fishing Boat

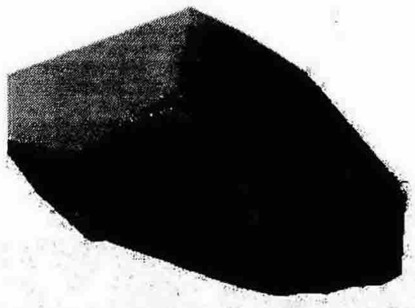


Fig.4 Esthetically Designed Stern Form

To obtain the information for the evaluation of esthetically designed form, tuft test, paint test wave profile observation test and wave survey for both models were performed in the CWC, and the results of wake survey is illustrated in Fig.5 and 6.

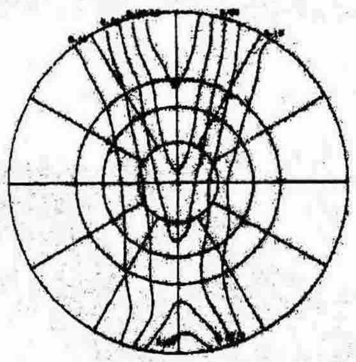


Fig.5 Axial Wake of Conventional Afterbody

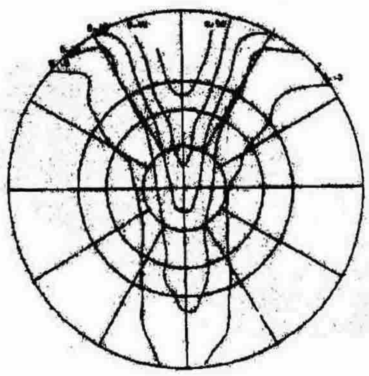


Fig.6 Axial Wake of Esthetically Designed Afterbody

For the comparison of performance between two hull forms C_R at full load trial conditions are compared in Fig.7.

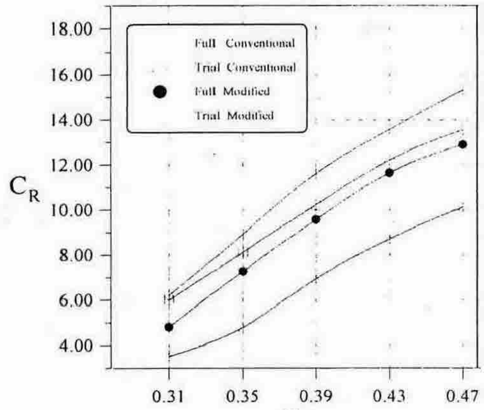


Fig.7 comparison of C_R

Models were manufactured of polyurethane foam to a scale of 14.7. In order to generate turbulent flow during the tests, the models were provided with two rows of studs at station 19 and F.P. The studs were measured 1.6 mm in diameter and 2 mm in height and they were fitted at 10 mm spacing in side and 5 mm spacing in the bottom.

The principal particulars of the ship are listed in Table 2, and the body plans of prototype and configuration of developed hull form are shown in Fig. 3 and 4.

TABLE 2 Particulars of Fishing Boat and Model

	Ship	
	Boat	Model
L_{WL}(m)	17.64	1.2
B(m)	4.30	0.29
T_F	1.35	0.092
T_A	1.45	0.099
C_B	0.64	0.64

3. COMPARISION OF FORMS AND PERFORMANCE

3.1 QUANTITATIVE ANALYSIS

The comparative model tests for the prototype hull form were carried out in the Towing Tank and in the Circulating Water Channel for the purpose of correlation study between the two facilities, and the results are summation in table 3[1].

TABLE 3 Comparison of C_R

Facility \ Fn		0.43	0.47	0.51	0.55
TT	Full	12.7	14.2	16.3	17.5
	Trial	11.9	13.1	14.8	16.3
CWC	Full	13.0	15.6	17.5	19.2
	Trial	12.3	14.2	16.2	17.5

3.2 ESTHETIC DESIGN OF STERN FORM

MAYA, used in the study for 3-D modeling, is a character animation and visual effects system designed for the professional animator.

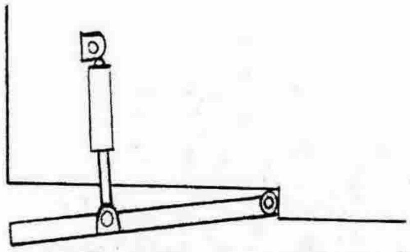
MAYA's system architecture uses a procedural paradigm that integrate traditional key frame animation, inverse kinematics, dynamics and scripting on the top of a node-based architecture that is called the Dependency graph.

This software is for creating professional 3-D character animation and visual effects. It includes dazzling visual effects for film, video, games and the web.

MAYA use major NURBS stands for non-uniform rational b-splines, which is a technical term for a spline curve.

4. ESTHETIC DESIGN OF TRIM CONTROL DEVICE AND DESKHOUSE

Esthetic design of trim control device and deckhouse were also carried to apply for planning hull type high speed fishing boat. The prototype and esthetic design of trim tab and deckhouse are shown in Fig.8 and Fig.9 respectively.



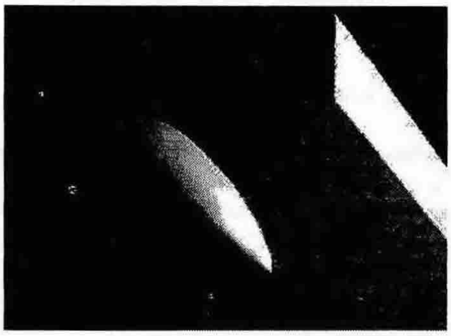
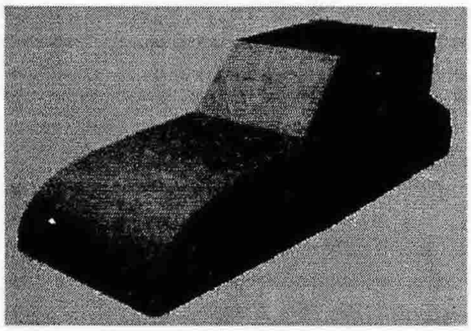


Fig.8 Conventional Trim Tab and Esthetically Designed Trim Control Device



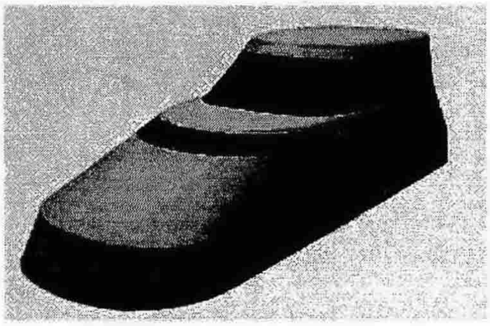


Fig.9 Comparison of Conventional and Design Deckhouse Form

C_R from the result of model tests are presented in Fig.10, and the results of trim measurements are compared in Fig.11 respectively.

Further model tests for the measurement of air resistance of deckhouse models are planned to be carried out in this year. In case of esthetic design, in addition to the advantage of esthetic point of view, no less air resistance reduction is expected in high speed range by the effect of streamlined form.

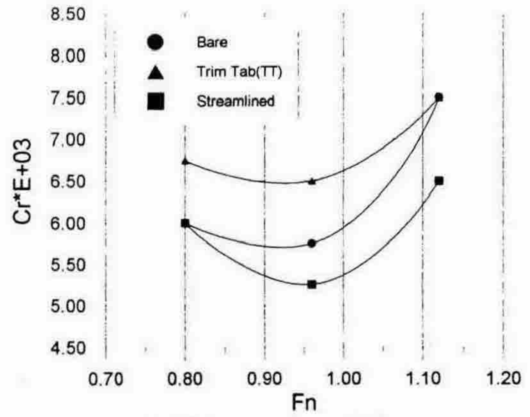


Fig.10 Comparison of C_R

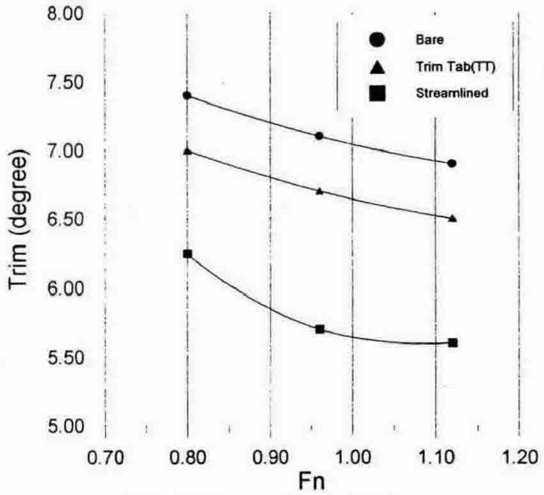


Fig.11 Comparison of Trim

5. CONCLUSIONS

1) The esthetically designed afterbody can be a favorable solution giving fishing vessel lower fuel consumption than a exiting hard chine type design.
2) Further special care for the interaction between hull and propeller would make this design success.
3) Esthetically designed trim control device shows favorable results for both of resistance and trim control performances.

NOMENCLATURE

B, b Beam or breath, moulded (m)

C_{ASL} Coefficient of scale effect between small and large model

C_B Block coefficient

C_{SD} Stud drag coefficient

V Ship speed(Kts)

Δ Displacement weight(ton)

L_{WL} Length of waterline(m)

R_{SD} Resistance due to the stud

$$\left(\frac{1}{2}\cdot\rho\cdot C_{SD}\cdot S\cdot V^2\right)$$

R_T Total resistance(Newton)

T Draft moulded(m)

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