AN INVESTIGATION OF FUEL EFFICIENCY IN HIGH SPEED VESSELS BY USING INTERCEPTORS

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Contents

- Introduction
- Trim Interceptors
- *Interceptors vs. Traditional Trim Tabs*
- Application of Trim Interceptors
- Experimental Study
- Preliminary Results
- Conclusion

Introduction

- *Marine vehicles advancing steadily at especially at High Froude numbers experience sinkage and trim motions because of the hydrodynamic forces acting on the hull.*
- *After a while from beginning to move, a well-designed high speed boat passes to the planning regime*
- *It is also of practical importance to include sinkage and trim effects in calculation of the wetted surface and so calculation of the ship resistance for high speed marine vessels.*
- *To deal with these unexpected motions, nowadays, generally trim interceptors are used for ride and trim control, and also for steering*
- *A sub-work of a PhD study entitled as “Numerical and Experimental Investigation of Trim Interceptors on Stepped and Unstepped High Speed Hulls.” which a number of parameters to deploy interceptors with different positions, depth and also effect with stepped and un-stepped hulls, to create an innovative literature reference.*

Trim interceptors

Trim Tabs

Experimental investigation of dynamic trim control devices in fast speed vessel

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Application of Trim Interceptors

Application of Trim Interceptors

Experimental Study

(Where: Ata Nutku Ship Model Testing Laboratory, Istanbul Technical University, Istanbul, Turkey)

		Scale (8.5)
Test condition		Model
Length between perpendiculars	L_{BP} (m)	2.031
Length on waterline	L_{WL} (m)	1.934
Wetted length	L_{WS} (m)	1.934
Breadth	B (m)	0.588
Draught (amidships)	T (m)	0.108
Draught (AP)	T_A (m)	0.108
Draught (FP)	T_F (m)	0.108
Displacement volume	∇ (m ³)	0.053
Displacement	Δ (ton)	0.053
Nominal wetted surface area	S_0 (m ²)	0.989
Transom area	A_T (m ²)	0.0256
Centre of transom area	H_T (m)	0.0741
Block coefficient	C_B	0.436
Prismatic coefficient	C_P	0.715
Midship area coefficient	C_M	0.611
Waterplane area coefficient	C_{WP}	0.755
Longitudinal centre of buoyancy	LCB (m) (+ fwd)	-0.128
Longitudinal centre of floatation	LCF (m) (+ fwd)	-0.130
Service speed	V_s	4.411 m/s

Trim measurements using high speed camera system (HSCS)

THE EXPERIMENT MATRIX

Interceptor position	Chine	Middle	Bottom
Interceptor height			
1 mm	+	+	+
2 mm	+	+	+
4 mm	+	+	+
6 mm	+	+	+
8 mm	+	+	+
10 mm	+	+	+

203 experiments carried out
 (52 experiments for close to chine placed interceptor +
 59 experiments for middle placed interceptor +
 63 experiment for near keel placed interceptors +
 29 experiments for bare hull)

Interceptors Mounted Near The Chine of The Transom Edge

Interceptors Mounted in The Mid of The Transom Edge

**Interceptors Mounted
Near The Keel of The
Transom Edge**

The Regression Model

$$C \downarrow T = a \downarrow 0 + a \downarrow 1 F n + a \downarrow 2 A + a \downarrow 3 T$$

$$E = \sum_{i=1}^n [C \downarrow T - a \downarrow 0 - a \downarrow 1 F n - a \downarrow 2 A - a \downarrow 3 T]^2$$

$$\partial E / \partial a \downarrow i = 0$$

$$C \downarrow T \downarrow Bottom = 21.512 - 11.787 F n - 1.053 A - 0.314 T$$

$$C \downarrow T \downarrow Middle = 20.103 - 11.910 F n - 0.113 A - 0.028 T$$

$$C \downarrow T \downarrow Chine = 24.748 - 13.554 F n - 2.046 A - 0.353 T$$

The Regression Model

The total resistance coefficient C_T vs Froude number measured for middle interceptor position compared with estimation. Triangle is model estimation, circle is experiment.

The average error compared to the model experiments is 6.9% in chine location of the interceptor, 5.2% in bottom location of the interceptor and 4.2% in the middle location of the interceptor

BOW DOWN MOTION

Conclusion

- ✓ Resistance and running trim results showed characteristics common to planning craft.
- ✓ The most important result is that interceptor blade depth have to be adjusted related to the operation speed.
- ✓ Correspondingly, the study clearly states that, the interceptor systems decrease the unwanted trim angles in high speeds and increase the forward speed up to 4 to 5 knots in full scale, and gain approximately 14% fuel savings.
- ✓ The system also decrease the wetted surface area and supplies a clear angle of sight for the boat operators.
- ✓ For all three type of interceptor locations the interceptors increases the total resistance in slow speeds up to $F_n=0.70$. After the boat starting its planning motion, the interceptor works in advance of reducing the total resistance coefficient C_T . Therefore, the authors advice to use dynamic interceptors in high speed boats. The interceptor blade depth have to be adjusted related to the operation speed.
- ✓ According to the study, interceptor deployment is very important regarding to the advance speed of the hull. At high speeds, at high depth of interceptor deployment lets the hull making bow down motion and extreme spray so increasing the resistance. So, interceptor deployment should be arranged regarding to the speed and it has the be a dynamic blade deployment system with clever motions up to the speed.

Further Work

Further Work

Thanks for your patience

Any Questions ?

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