EXPERIMENTAL RESEARCH ON SHIP MANEUVERABILITY ACCORDING TO LOADING CONDITION

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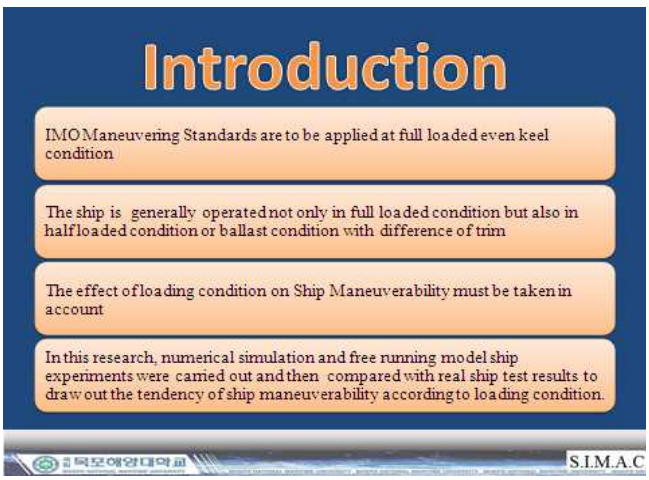
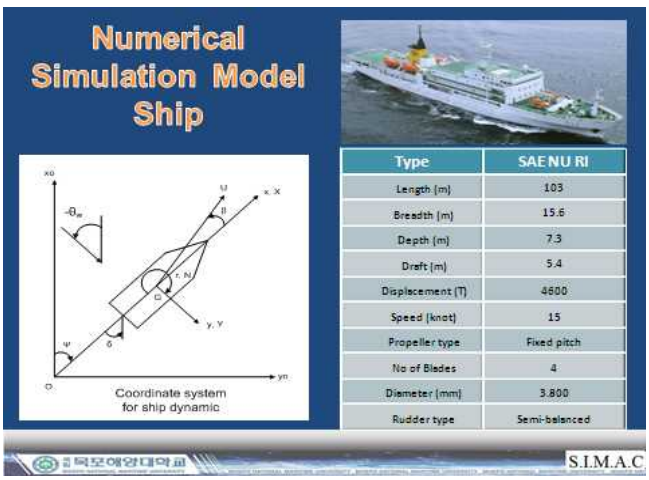
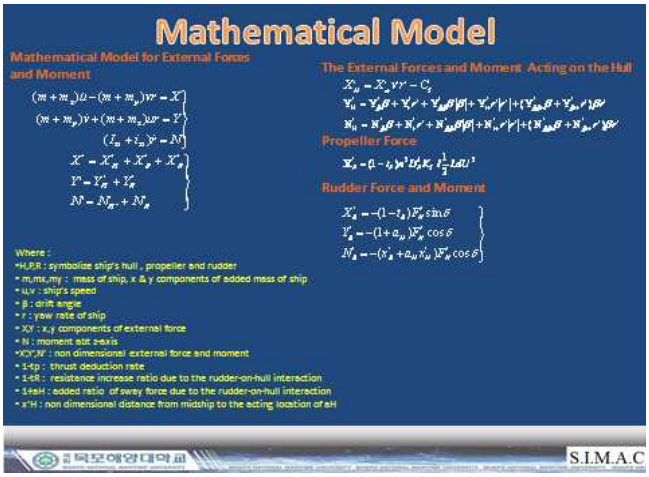
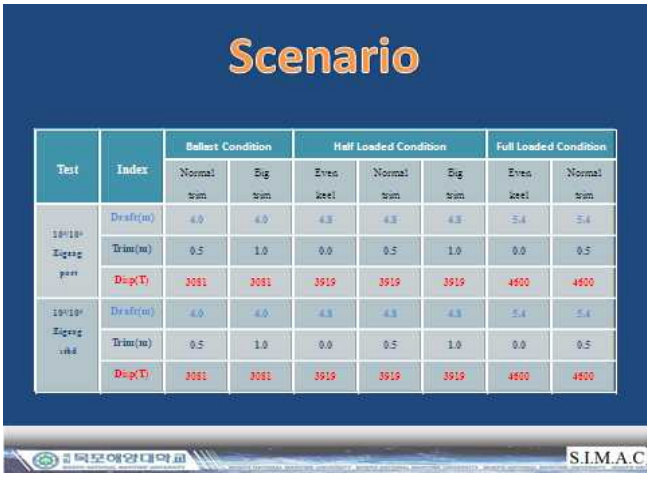
Abstract : *In December 2002, International Maritime Organization (IMO) has adopted the Resolution MSA.137(76) Standards for the Ship Maneuverability. For applying the standards, we have to estimate and evaluate the Maneuverability of a ship at the design stage in difference of trim and displacement as accurate as possible. In this paper, the effect of loading condition on the ship Maneuverability was investigated through 3 methods : numerical simulation, free running model ship and real ship data.. Firstly, We carried out numerical simulation, free running model ship experiments and real ship experiments at ballast condition, half loaded condition and full loaded condition with difference of trim.. Secondly, by comparing these results of 3 methods, we draw out the trend of ship Maneuverability due to the change of trim and displacement of a ship.*

Key words: ship maneuverability, loading condition









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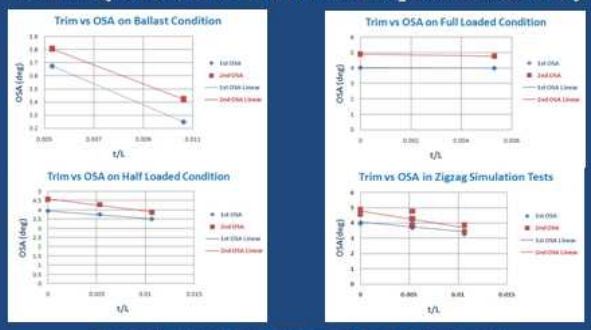
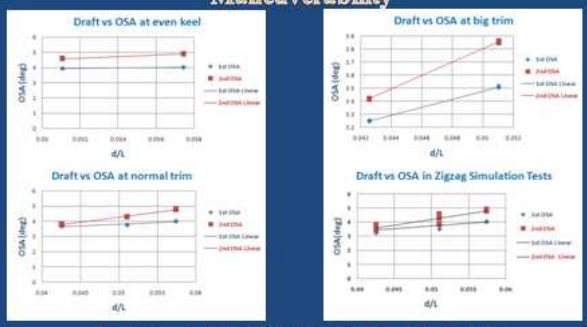
Summary of the Effect of Trim on Ship Maneuverability



•The overshoot angle decreases when the trim of ship increases
•Rate of change of OSA due to Trim effect decreases when draft increases

Summary of the Effect of Displacement on Ship Maneuverability



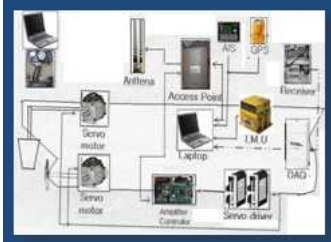
•The overshoot angle increases when the draft of ship increases
•Rate of change of OSA due to Draft effect increases when trim increases

Main Particulars of Free Running Model Ship

	Ship	Model
Scale ratio	1	1/100
Type	Tanker Ship	Tanker Ship
Design speed (m/s)	7.973	O.7973
L.B.P (m)	320	3.2
B (m)	58.0	0.58
Depth (m)	30.0	0.3
Draft (m)	20.8	0.2080
Displacement (m^3)	312737.5	0.3127

Rudder		Propeller	
Type	Horn	Type	FP
S of rudder (m^2)	273.3	No. of blade	4
Lat. area (m^2)	136.7	D(m)	9.86
Turn rate (deg/s)	2.34	P/D (0.7R)	0.721
		Ae/A0	0.431
		Rotation	Right hand
		Hub ratio	0.155

Overview of the System



System flow chart of Free Running Model Ship Main screen of operating program

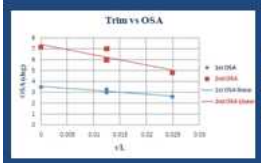
Scenario

	Df (m)	Da (m)	Trim (m)
Ballast	0.08	0.08	0.00
Half Loaded	0.12	0.12	0.00
	0.10	0.14	0.04
	0.08	0.16	0.08
Full Loaded	0.18	0.18	0.00

Environment

Time	Humidity (%)	Wind course	Wind speed (m/s)	Pressure (atm)
3pm	76	WSW	2.8	1007.5
4pm	77	WNW	3.0	1007.3
5pm	81	NW	3.9	1007.7
6pm	91	NW	3.0	1008.4
7pm	97	NW	2.0	1008.8

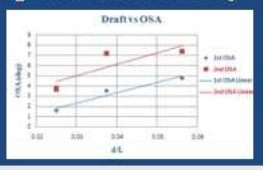
Effect of Trim on Ship Maneuverability



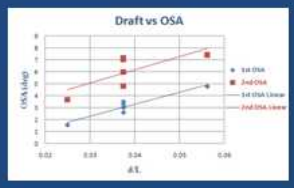
- The overshoot angle decreases when the trim of ship increases
- The course keeping and yaw checking abilities in big trim is better than in small trim

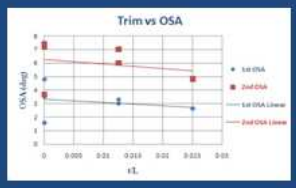
Effect of Displacement on Ship Maneuverability

- The overshoot angle increases when the draft of ship increases
- The course keeping and yaw checking abilities in small draft is better than big draft



Summary of the Effect of Loading Condition on Ship Maneuverability





Effect of draft **Effect of trim**

- The overshoot angle increases when the draft of ship increases
- The overshoot angle decreases when the trim of ship increases

Main Particulars of SAE YU DAL

Type	SAE YU DAL
Length (m)	102.7
Breadth (m)	14.5
Width (m)	9.5
Draft (m)	5.2
Displacement (T)	3644
Speed (knot)	15
Propeller type	Fixed pitch
No of Blades	4
Diameter (mm)	3.060
Are Ratio	0.63
Rudder type	Semi-balanced

Location

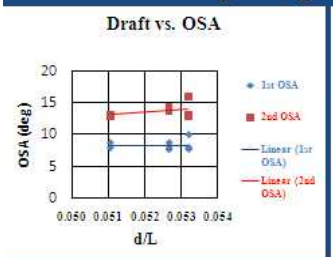
Scenario

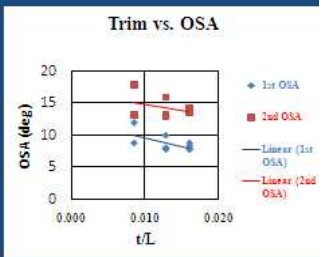
	East China Sea	Luzon West Coast	Luzon west Coast
Experiment cases	4	4	2
Df (m)	4.40	4.20	4.4 0
Da (m)	5.60	5.70	5.20
Draft (m)	5.00	4.95	4.80
Trim (m)	1.20	1.50	0.80

Results

Draft (m)	4.80	4.80	4.95	4.95	4.95	4.95	5.00	5.00	5.00	5.00
Trim(m)	0.80	0.80	1.50	1.50	1.50	1.50	1.20	1.20	1.20	1.20
1st OSA	8.80	8.00	8.30	7.80	7.80	8.80	10.00	7.80	8.00	8.00
2nd OSA	13.30	13.0	13.80	14.20	13.70	14.40	16.00	13.30	13.00	13.00

Real Ship Experiment Results

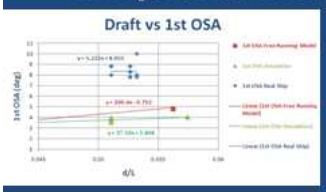


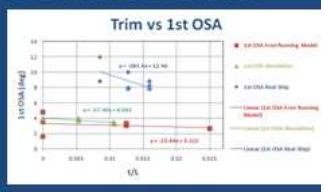


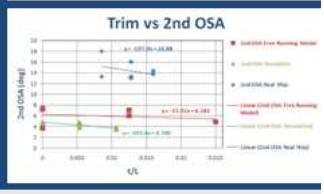
Effect of Displacement on Ship Maneuverability **Effect of Trim on Ship Maneuverability**

- The overshoot angle increases when the draft of ship increases
- The overshoot angle decreases when the trim of ship increases

Comparison of 3 Method's Results







Conclusion

- These experimental results are agreed with previous research.
- The overshoot angle increases when the draft of ship increases
- The course keeping and yaw checking abilities of ship in small draft is better than in big draft
- The rate of change of OSA due to trim effect decreases when displacement increase
- The overshoot angle decreases when the trim of ship increases
- The course keeping and yaw checking abilities of ship in big trim is better than in small trim.
- The rate of change of OSA due to draft effect increases when trim increases