ANALISIS *MANUEVERING* KAPAL *CONTAINER* MENGGUNAKAN *VIRTUAL CAPTIVE MODEL TEST* TERHADAP *VARIASI SQUAT EFFECT*

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ABSTRAK

Penelitian ini menganalisis pengaruh *squat effect* terhadap karakteristik manuver kapal kontainer menggunakan *Virtual Captive Model Test* (VCMT) berbasis *Computational Fluid Dynamics* (CFD). Model kapal KCS dengan panjang LPP 7,2786 m disimulasikan pada dua kondisi kedalaman (h/T = 1.25 dan h/T = 2.5), dengan variasi sudut drift 2°–10° serta kecepatan 0.915–1.922 m/s. Validasi terhadap data eksperimen menunjukkan *error* <10%, sehingga model dinyatakan akurat dan layak digunakan.Hasil simulasi menunjukkan bahwa *squat effect* secara signifikan meningkatkan gaya lateral (*sway force*) dan momen yaw, terutama pada perairan dangkal. Pada h/T = 1.25, aliran terkompresi di bawah lambung menghasilkan tekanan rendah yang lebih dominan sehingga respons manuver meningkat tajam, khususnya pada sudut drift besar dan kecepatan tinggi. Data gaya dan momen yang diperoleh dari VCMT kemudian dianalisis menggunakan *Least Squares Method* untuk memperoleh turunan hidrodinamika (*hydrodynamic derivatives*). Metode ini berhasil menghasilkan pola regresi yang konsisten, menggambarkan peningkatan sway dan yaw yang sejalan dengan variasi kedalaman, sudut drift, dan kecepatan. Penelitian ini menegaskan bahwa kedangkalan perairan merupakan faktor kritis dalam performa manuver kapal dan bahwa kombinasi VCMT – CFD serta *Least Squares Method* mampu memberikan prediksi hidrodinamika yang reliabel sebagai alternatif uji fisik.

Kata Kunci : *Squat effect, Virtual Captive Model Test*, CFD, Manuver Kapal, *Sway Force*, *Yaw Moment*, *Least Square Method*

MANEUVERING ANALYSIS OF A CONTAINER SHIP USING A VIRTUAL CAPTIVE MODEL TEST UNDER VARIATIONS OF SQUAT EFFECTS

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ABSTRACT

This study analyzes the effect of squat on the maneuvering characteristics of a container ship using a Virtual Captive Model Test (VCMT) based on Computational Fluid Dynamics (CFD). A KCS ship model with a length between perpendiculars (Lpp) of 7.2786 m was simulated under two water depth conditions (h/T = 1.25 and h/T = 2.5), with drift angles ranging from 2° to 10° and ship speeds between 0.915 and 1.922 m/s. Validation against experimental data showed an error of less than 10%, indicating that the numerical model is accurate and suitable for further analysis. The simulation results show that the squat effect significantly increases the lateral force (sway force) and yaw moment, particularly in shallow water conditions. At h/T = 1.25, flow compression beneath the hull produces more dominant low-pressure regions, resulting in a sharp increase in maneuvering response, especially at larger drift angles and higher ship speeds. The hydrodynamic forces and moments obtained from the VCMT simulations were subsequently analyzed using the Least Squares Method to determine the hydrodynamic derivatives. This method successfully generated consistent regression trends, representing increased sway force and yaw moment in accordance with variations in water depth, drift angle, and ship speed. This study confirms that shallow water conditions are a critical factor in ship maneuvering performance and that the combined VCMT–CFD approach with the Least Squares Method is capable of providing reliable hydrodynamic predictions as an alternative to physical model testing.

Keywords *: Squat effect, Virtual Captive Model Test, Computational Fluid Dynamics, Ship Maneuvering, Sway Force, Yaw Moment, Least Squares Method*