Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfilment of the requirements for the degree of Master of Science

# COMPUTATIONAL FLUID DYNAMICS ANALYSIS ON SYMMETRICAL BRIDLE TOWLINE MODEL OF A SHIP TOWING SYSTEM

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**May 2020**

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Instability of a towed ship presented in the form of her vigorous horizontal motions may be susceptible to a serious towing accident especially in the confined waterways. To prevent such phenomenon occur, a comprehensive investigation on employing proper towline model of a ship towing system is obviously required. This thesis presents Computational Fluid Dynamic (CFD) approach to analyze the symmetrical bridle towline model on a ship towing system performance. Hence, course stability and seakeeping performances have been accordingly analysed in calm (3-DOF) and waves (5-DOF), respectively. In the course stability and seakeeping assessments, the motion of the towed barge has involved three (surge, sway and yaw motions) and five (surge, sway, yaw, heave and pitch motions) Degrees-of-Freedom (DOF), respectively. Several towing parameters such as various towing point location on the symmetrical bridle towline model, towline lengths and towing speed have been taken into account in the simulation. In addition to the seakeeping performance of the ship towing system, effect of various wavelengths and wave directions are appropriately evaluated. The results revealed that the increase of the towing's point location improved the course stability of the towed ship. Besides, the increment of towline length and towing's speed degraded the

course stability of the towed ship indicated by large sway motion. In addition, the seakeeping performance has been improved indicated by the reduction of heave and pitch motion within the range $1.25<\lambda<2.0$ and $0<\theta°<90$, respectively. The magnitude of towline tension is increased as the towline length and towing's speed increased to 3.0 and 0.873 m/s, respectively. The result of the simulation is well agreed with experimental result in case of towing point location of 0.5 and towline length of 1.0 in calm water conditions. Thus, these findings are beneficial and contribute to ship towing system safety navigation.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan untuk Ijazah Sarjana Sains

# ANALISIS PERKOMPUTERAN BENDALIR DINAMIK TERHADAP MODEL TALI PENARIK SIMETRI BAGI SISTEM PENUNDAAN KAPAL

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Ketidakstabilan kapal yang ditunda dalam bentuk pergerakan mendatar yang bertenaga mendedahkan kepada kemalangan yang serius terutama dalam laluan air yang terhad. Bagi mengelakkan fenomena seperti ini terjadi, satu penyiasatan yang menyeluruh mengenai pemasangan model tali penarik yang sesuai pada sistem penundaan kapal amat diperlukan. Tesis ini mempersembahkan pendekatan menggunakan Perkomputeran Bendalir Dinamik (CFD) untuk menganalisis model tali penarik simetri kepada prestasi sistem penundaan kapal. Oleh itu, kestabilan jalan lurus dan prestasi seakeeping telah dianalisis sewajarnya dalam air tenang (3 DOF) dan gelombang (5 DOF). Penilaian bagi kestabilan jalan lurus dan *seakeeping,* pergerakan kapal ditarik melibatkan tiga pergerakan (lonjakan, goyangan dan olengan) dan lima pergerakan (lonjakan, goyangan, olengan, lambungan dan anggukan). Beberapa parameter penundaan seperti pelbagai lokasi titik penundaan pada model tali penarik simetri, panjang tali penarik dan kelajuan penundaan telah diambil kira dalam simulasi. Tambahan kepada prestasi seakeeping, kesan pelbagai panjang gelombang dan arah gelombang dinilai dengan sewajarnya. Hasil dapatan menunjukkan peningkatan lokasi titik tunda memperbaiki kestabilan laluan kapal ditunda. Selain itu, penambahan panjang tali penarik dan kelajuan penundaan telah

merendahkan keupayaan kestabilan jalan lurus yang ditunjukkan oleh pergerakan goyangan yang besar. Tambahan, analisis seakeeping menunjukkan hasil yang lebih baik melalui pengurangan pergerakan lambungan dan olengan pada $1.25<\lambda<2.0$ dan $0<\theta°<90$. Nilai ketegangan tali penarik meningkat apabila panjang tali penarik dan kelajuan penundaan meningkat masing-masing ke 3.0 dan 0.873 m/s. Hasil simulasi dan eksperimen menunjukkan persetujuan dalam kes titik lokasi penundaan 0.5 dan panjang tali, 1.0 dalam keadaan air tenang. Oleh yang demikian, penemuan ini memberi manfaat kepada keselamatan navigasi sistem penundaan kapal.