

ANALISIS *PORTABLE TOWING CARRIAGE* SEBAGAI ALTERNATIF *TOWING TANK* KONVENSIONAL

Muhammad Faiz Syakir

ABSTRAK

Fasilitas *towing tank* konvensional untuk validasi hidrodinamika kapal masih terbatas dan mahal di Indonesia, termasuk di Program Studi S1 Teknik Perkapalan UPN Veteran Jakarta yang belum memilikinya. Penelitian ini merancang, menganalisis, dan memfabrikasi purwarupa *portable towing carriage* bersistem teleskopik sebagai alternatif pengujian model kapal di perairan terbuka. Rancangan terdiri atas *towing cart*, *towing arm*, dan *towing rod* dengan jangkauan operasional 6 m (*extended*) dan dapat diringkas hingga 1.75 m (*folded*) untuk mobilitas kendaraan roda dua. Analisis *Finite Element Analysis* (FEA) terhadap empat material—*galvanized steel*, *stainless steel* 304, aluminium 6061, dan CFRP—menunjukkan *galvanized steel* memiliki lendutan terendah (38.67 mm) sehingga dipilih sebagai material purwarupa. Validasi eksperimental mencatat lendutan aktual 41.3 mm (deviasi +6.8% dari FEA). Pengujian dinamis di Waduk Brigif membuktikan purwarupa mampu memfasilitasi pengamatan gerak *pitch* yang natural dan *tracking* arah yang stabil, meski ditemukan keterbatasan gerak *heave* akibat toleransi sambungan *towing rod* dan *drift* akibat *misalignment* roda. Pengukuran kuantitatif 6 *Degree of Freedom* (6-DOF) menggunakan *Inertial Measurement Unit* mengonfirmasi temuan tersebut secara kuantitatif (RMS *pitch* 3.83°; *roll* 3.36°), sekaligus mengungkap deviasi *yaw* yang signifikan (RMS 7.65°) akibat interferensi magnetometer dari struktur logam *carriage*. Purwarupa ini terbukti fungsional sebagai alternatif *towing tank* konvensional bagi praktikum dan penelitian hidrodinamika kapal.

Kata kunci: *portable towing carriage*, *towing tank*, *finite element analysis*, material, purwarupa

ANALYSIS OF A PORTABLE TOWING CARRIAGE AS AN ALTERNATIVE TO A CONVENTIONAL TOWING TANK

Muhammad Faiz Syakir

ABSTRACT

Conventional towing tank facilities for ship hydrodynamic validation remain limited and costly in Indonesia, including at the Naval Architecture Study Program of UPN Veteran Jakarta. This study designs, analyzes, and fabricates a telescopic portable towing carriage prototype as an alternative for ship model testing in open water. The design comprises a towing cart, towing arm, and towing rod, reaching 6 m when extended and compacting to 1.750 when folded for two-wheeled vehicle mobility. Finite Element Analysis (FEA) on four materials—galvanized steel, stainless steel 304, aluminium 6061, and CFRP—showed galvanized steel had the lowest deflection (38.67 mm), leading to its selection. Experimental validation recorded an actual deflection of 41.3 mm (+6.8% deviation from FEA). Dynamic testing at Brigif Reservoir confirmed the prototype's ability to capture natural pitch motion and stable directional tracking, though limited heave motion (rod joint tolerance) and drift (wheel misalignment) were noted. Quantitative 6 Degree of Freedom (6-DOF) measurement using an Inertial Measurement Unit (IMU) confirmed these findings numerically (RMS pitch 3.83°; roll 3.36°), while also revealing a significant yaw deviation (RMS 7.65°) attributed to magnetometer interference from the carriage's metallic frame. The prototype proved functional as an alternative to conventional towing tanks for hydrodynamics coursework and research.

Keywords: *portable towing carriage, towing tank, finite element analysis, material, prototype*