Motion and Maneuvering Analysis of ACV in Shallow Water

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ABSTRACT

Air Cushion Vehicle (ACV) could hover by high pressure cushion over operating surface, which forms full amphibious capacity, so it can directly fly over tide water line onto natural beach of islands. ACV needs to trans over shallow water region, which surrounds the islands. Shallow water effects ACV hump location, resistance value of head-on forward and beam-on sideslip, also yawing moment under sideslip. Based on cushion-making wave by Doctors and Zilman at shallow water, American JEFF B ACV was selected as an example to analysis. The resistance curve agrees well with test of full-scale ship. The JEFF B safe boundary of sideslip βmin~Fn, turn rate γ~Fn was theoretical estimated based on cushion-making wave, which agrees well with those of LCAC. The sideslip prone stable curve βcritic~Fn was first presented and could direct maneuver with more efficiency. Shallow water has great effect on resistance and safe boundary of sideslip and turn rate, the method presented could be used to direct design of ACV operating and maneuvering at shallow water.

KEY WORDS: air cushion vehicle; cushion-making wave; sideslip; safe boundary; resistance hump; shallow water effect; motion and maneuvering

INTRODUCTION

Air Cushion Vehicle (ACV) is hovered on operating surface by high pressure cushion formed in the inflated flexible skirt, which forms full amphibious capacity, so it can directly fly over tide water line onto natural beach of islands in sea, and fits to transport human and logistic (Yun and Bliault, 2000). While small islands are often surrounded by shallow water, sometimes the shallow water region is wide. During procedure of ACV landing, it needs to transfer from deep water to shallow water, and last to beach, as shown in Fig.1.

When ACV underway in shallow water region, the cushion-making wave is restricted by water depth, and could not develop freely. This results in variation of head-on forward resistance, especially enlarged hump resistance would affect hump transit ability. During ACV sideslip, the interaction of longitudinal cushion wave and transversal cushion wave would largely affect maneuvering characteristics, as shown in Fig.2 (Zhang and Xu, 2019a).