Computational Aerodynamic Characteristics of Wing with End-plate for WIG

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ABSTRACT

WIG(Wing-in-ground effect) is the new generation of ship which takes advantage of ground effect near the ground or water surface. The concepts of ground effect have been known since the beginning of human flight and also found from the nature. The first WIG was developed for military use by Alexeiev, a ship designer, in the former USSR and at the same time it was also done by Lippisch, an aeronautical engineer, in Germany. However, developing big WIG was stopped because of the collapse of the Soviet Union. Instead, smaller WIG has been under consideration[1].

Aerodynamic concepts which are related with WIG are divided into two phenomena. At first, lift coefficient generally increases near the ground due to ram effect but sometimes decrease also occurs depending on the shape of airfoil. It is so called venturi effect. These two cases are referred as chord dominated ground effect. As well, wing tip vortex in free flight gets weaker near the ground because of restriction of the ground. In fact, it causes effective aspect ratio to increase. As a result of the facts mentioned above, the L/D ratio generally increases and the efficiency of WIG is definitely superior to conventional aircraft. On the other hand, WIG has pitch up tendency once it gets away from ground effect, which causes WIG unstable. In order to make it stable S-foil design was known as the most efficient way among others. Furthermore Irodov criteria[2] are suggested to evaluate its stability[3].

In the present study the Clark-Y[4] wing designed with DHMTU[5][6] concept was generated, and then End-plate[7] was mounted at the wing tip. To figure out efficiency of End-plate Navier-Stokes solver[8] was used for aerodynamic analysis. First of all, the difference between moving boundary condition and fixed boundary condition had been confirmed in order to obtain rationally better solution. As well, in case of mounting End-plate on wing of WIG moving boundary condition was implemented as bottom wall. Aerodynamic characteristics were evaluated by means of examining changing location of stagnation point, induced drag due to down wash, vortex strength and alteration of vortex cores location. Finally longitudinal stability characteristic with End-plate was evaluated by applying Irodov's criteria.

(a) Fixed viscous wall (b) Moving viscous wall

Fig. 1 Boundary condition test in ground effect

(a) H/c=0.3 (b) H/c=0.2

Fig. 2 Performance test of End-plate in ground effect

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