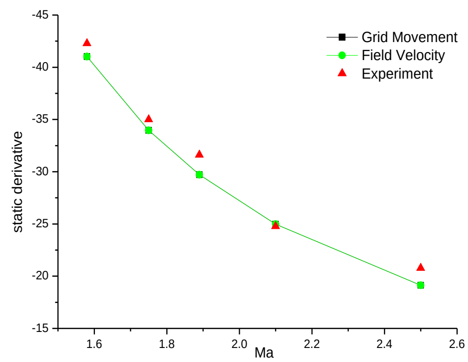
The sign of the acceleration derivative is plus for the $Ma = 1.58$, it means that the plunging motion is unstable under this Mach number, and also indicates that the sign between damping derivative and acceleration derivative maybe different.

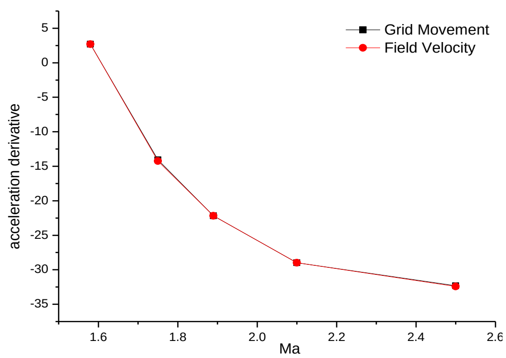
TABLE I Results of Derivatives

Ma		1.58	1.75	1.89	2.10	2.50
Static derivative	Grid movement	-41.0236	-33.9610	-29.7153	-24.9780	-19.1331
	Field velocity	-41.0254	-33.9620	-29.7162	-24.9784	-19.1333
	experiment	-42.2853	-35.0014	-31.6217	-24.7692	-20.7738
Acceleration derivative	Grid movement	2.6848	-14.0742	-22.1835	-28.9742	-32.3266
	Field velocity	2.6963	-14.2431	-22.1916	-28.9805	-32.4077
Damping derivative	Grid movement	-462.7634	-427.3870	-403.8817	-374.9710	-330.5489
	Fieldvelocity	-475.0016	-437.1490	-411.8878	-380.8316	-334.9547

A comparison of derivatives with mach numbers is displayed in Fig.5. The computed static derivatives are in reasonable agreement with the experiment throughout all selected Mach numbers.



A



B

Fig. 5 Variation to derivatives at various Mach numbers

VI . Conclusion

A novel method of calculating static derivatives and acceleration derivatives using CFD methods has been presented. This method uses field velocity approach to simulate the unsteady flow without updating the field grids during each time step. The results using the presented approach were in good agreement with the experimental data for the basic finner. Another interesting conclusion is that the effect of acceleration derivative may be negative damping, which means the plunging motion is unstable.

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