Computational and analytical investigation of aerodynamic derivatives of similitude delta wing model at hypersonic speeds

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This research paper presents a computational and analytical investigation of aerodynamic derivatives in an oscillating wedge. Unsteady hypersonic similitude has been apprehended for an oscillating wedge with an attached bow shock at a large incidence angle. The problems of instability and shock waves are generally associated with hypersonic flow and, therefore, it is imperative to evaluate aerodynamic models that can solve these problems. Lighthill’s piston theory is an unsteady aerodynamic model that is valid for an oscillating wedge with an attached shock wave. The analytical solution verifies that both the stiffness and the damping derivatives attain high values when the semi-vertex angle of the wedge is increased, while both derivatives assume lower values at increasing Mach numbers. Similarly, the pressure distribution over the wedge is evaluated to determine the details of how the developing flow cause the instabilities. Our study presents the contour plots of pressure, temperature, density, and Mach number that unravels the positions of flow separations in an oscillating wedge model