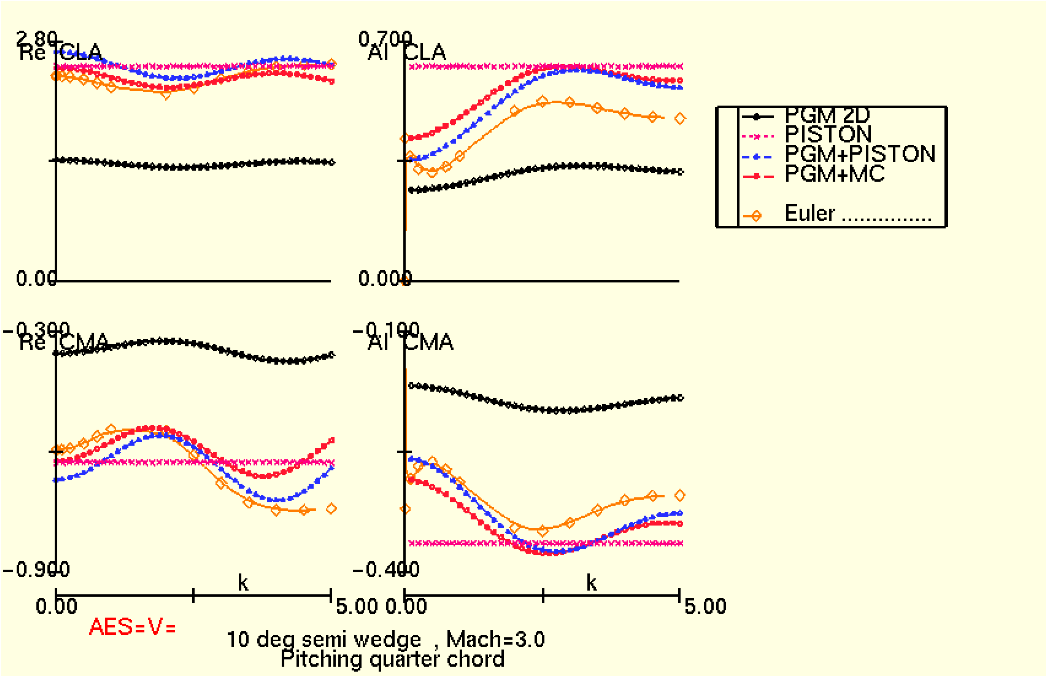
Hypersonic & Supersonic loads

To support the hypersonic & supersonic Mach number range the general 3D lifting surface **aes=3=** (http://www.aes4ac.com/app3/apps3.html) panel method and the 2D lifting surface **aes=2=** (http://www.aes4ac.com/apps2.html) panel method have taken into account wing thickness & wing camber (**D.D. Liu** et al. *From Piston Theory to a Unified Hypersonic – Supersonic Lifting Surface Method. 1997*) to calculate efficiently unsteady loads due to oscillating vibrations/motions compliant with calculated loads from an unsteady Euler CFD method (**B.B. Prananta & M.H.L. Hounjet**. *Computational Unsteady Aerodynamics in Aeroelastic Simulations*. 1998). The updated methods are compared here for a pitching motion about the quarter chord of a wing section with a 10-degree semi-wedge aerofoil (<). The aspect ratio of the wing is chosen such that the flow is two dimensional at the mid chord. The 2D and 3D panel methods produce the same loads at the mid chord.

The figure illustrates the real and imaginary part of the calculated sectional CL_Alpha (CLA) & CM_Alpha(CMA) versus reduced frequency k up to 5.0 at Mach number is 3.0. The imaginary parts (AI) are divided by the reduced frequency. The figure compares calculations of five methods: a) panel method (PGM=Potential Gradient Method); b) explicit third order piston theory (PISTON); c) panel method implicitly fortified with third order piston theory (PGM+PISTON); d) panel method based on the reduced local Mach number aft of the leading edge (PGM+MC) and e) Euler CFD.



Compared to the CFD Euler data the panel method (PGM) has a large deviation. The real part of the Mach number corrected panel method (PGM+MC) is the closest to the CFD Euler data and the imaginary data of the panel method implicitly fortified with third order piston theory (PGM+PISTON) is closest to the Euler data. The fortified methods are an improvement.