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Aeroelastic Workshop: The Validation of Aeroelastic Simulations using STAR-CCM+ coupled to Abaqus



The purpose of this study is to validate STAR-CCM+ accuracy in aeroelastic applications. The benchmark examined here is from the Aeroelastic Prediction Workshop. The High Reynolds Number Aerostructural Dynamics (HIRENASD) wing is chosen for this verification study as a good distribution of unsteady pressure measurements, deflection measurements and balance loads measurements at transonic conditions with realistic flight Reynolds numbers.

The CFD geometry has been combined from IGES files and the CGNS mesh obtained from HIRENASD website. Based on this geometry, a polyhedral mesh has been constructed using STAR-CCM+. The structural mesh is converted to Abaqus from the Nastran OML grid, obtained from the NASA website.

Several different types of analyses were conducted and compared to experiments and other reported analysis techniques including:

- ? Coupled aeroelastic equilibrium at different angles of attack,
- ? Stand-alone structural modal analysis in quiescent air,
- ? Coupled transient analysis of the frequency and damping response to impulsive loading,
- ? Stand-alone fluid transient response to forced 2nd bending mode excitation using the measure prescribed wing-tip isplacement amplitude,
- ? Coupled transient response to forced 1st bending mode excitation using a prescribed moment amplitude. Here both the aerodynamic response and the dynamic wing structural deformations are predicted from the applied loading.

The coupled simulations employed the STAR-CCM+/Abaqus co-simulation API for the socket based exchange of data, synchronization and mapping to/from non-conformal surface meshes. The stand-alone fluid transient response analysis imported the eigenmodes from Abaqus using the import and mapping procedures available in STAR-CCM+. The imported eigenmode was used to dynamically morph the fluid mesh according to the prescribed frequency and amplitude. All these different studies gave excellent comparisons to experiments in lift, drag, moments, pressure coefficient and displacement. The results presented will be shown to be comparable to other NASA and academic aeroelastic codes.

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