Evaluating the accuracy of the computational fluid dynamics solver, FLUENT

Jumpei Nomura[1,2], Andrew Meade[3] and Javier Villarreal[3]

[1] Department of Social and Environmental Engineering, Vehicle and Environmental Systems, Hiroshima University, Higashi-Hiroshima, Japan

[2] Nakatani RIES: Research & International Experiences for Students, Rice University, Houston, Texas, U.S.A.

[3] Department of Mechanical Engineering, Rice University, Houston, Texas, U.S.A.

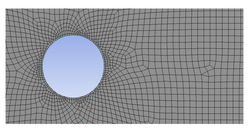
What is Computational Fluid Dynamics (CFD)?

- Branch of fluid mechanics that uses numerical analysis and data structures to solve and analyze problems that involve fluid flow.
- Experimental development can be too costly and time consuming.
- The equations of fluid mechanics are solvable for only a limited number of flows.

Research Project Objectives

- Simulation of viscous and vortex flow of a circular cylinder at various values of the Reynolds number
- Simulation of viscous flow of an NACA 0012 airfoil at various angles of attack

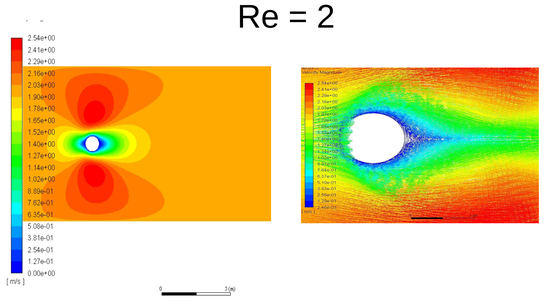
Software Analysis Using FLUENT



- Geometry and Mesh
  - Design geometry to calculate a flow
  - Create mesh on that geometry
  - The finer the mesh, the more accurate the data
- Physical Model
  - Set the model to solve the flow problem
  - Steady, unsteady, incompressible, viscous flow used for a cylinder
  - Incompressible, viscous flow used for an airfoil
- Boundary Condition
  - Set for velocity, pressure and viscosity

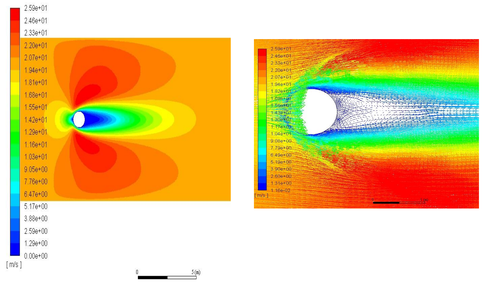
Result 1: – Steady Incompressible Flow Over a Cylinder

Re = 2



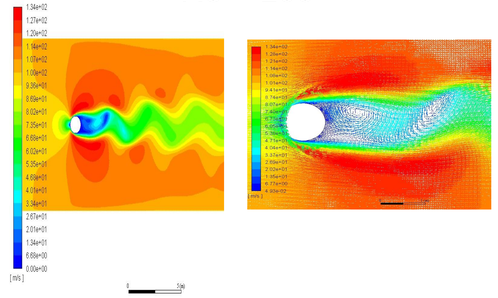
- No vortex

Re = 20



- Vortices form in the wake of the cylinder

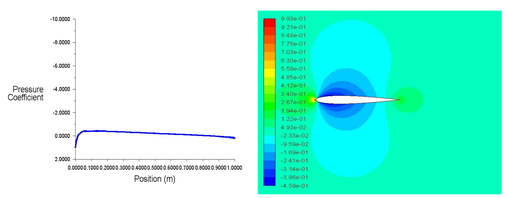
Re = 100



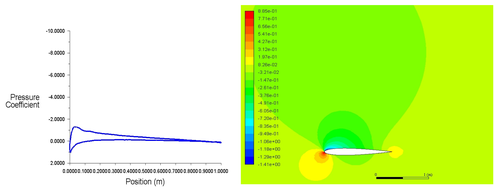
- Oscillation of the solution due to vortex shedding

Result 2: – Incompressible Flow Over an NACA 0012 Airfoil

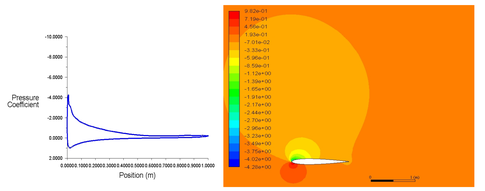
- Simulation of Pressure Coefficient at various angles
- Re = 3E+6, M = 0.3



Angle of attack = 0 deg.



Angle of attack = 3.86 deg.



Angle of attack = 9.86 deg.

Conclusion

- The wake characteristics behind a cylinder depend on Re number.
- Cp distribution around an airfoil is dependent on angle of attack and Mach number.

Future Work

- Run simulations of transonic and supersonic flow
- Observe the formation of shock waves across airfoils
- Model wings and even full aircraft models

Reference

[1] Charles D. Harris, “Two-Dimensional Aerodynamic Characteristics of the NACA0012 Airfoil in the Langley 8-foot Transonic Pressure Tunnel, *NASA Technical Memorandum*, (1981), p. 57-61

[2] Joel H. Ferziger and Milovan Peric, “Computational Methods for Fluid Dynamics”, *Springer*, (1999), p. 1-37

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