COMPUTATIONAL FLUID DYNAMICS

PROJECT

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FLOW ANALYSIS OVER AN AHMED BODY
MODELING
CAD

CAD Model after being imported into ANSYS
Enclosure for the analysis to take place.

Dimensions:
12500mmX3000mmX3000mm
MESHING

This is the automatically generated mesh in ANSYS
Refined mesh, with the region for wake studies also defined.
Boundary layers defined mesh.

Smooth transition between surfaces defined
The mesh imported in FLUENT.

- Mesh details:
- Blue area: Velocity inlet
- Red area: Pressure outlet
- Yellow area: No shear wall i.e. symmetrical wall
- No. of elements: 1.69 million
- No. of nodes: 369284
BOUNDARY CONDITIONS

- Turbulent intensity at inlet: 1% (recommended by ANSYS)
- Back flow turbulent intensity: 5% (at outlet, the turbulence would be more than at inlet)
- Back flow viscosity ratio: 10
- Velocity: 40 m/s
- Frontal area: 0.057516 m/s$^2$
- Recommended courant No.: 50
- Now, after these conditions were applied, we chose COUPLE scheme to solve over problem instead of SIMPLE method because COUPLE (uses velocity and momentum equation) arrives at convergence faster than SIMPLE method (uses pressure and velocity coupling).
RESULTS

The following results were generated:

- $C_l$, $C_d$, $C_m$ Plots
- Scaled residual plots
- Velocity contours
- Pathlines
- Velocity vectors
- Static pressure contour
- Turbulent kinetic energy contour
$C_m$ Plot

As per expectations, the curve follows a downwards trend.
$C_1$ Plot
$C_d$ Plot
Residual Plot

Scaled Residuals

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ANSYS FLUENT 13.0 (3d, pbns, rke)
As we can see, the flow in most of the area is green, indicating no change in velocity.

But, at front face of the body, there is a stagnation zone indicated by blue colour. Then there is a low velocity zone just behind the body. Where as, at curves, the flow seems to be accelerating.
Here we can see the wake region more clearly. As we can see, the separation starts at the slant part of the body, hence starring the wake region from there itself.
Pathlines

Here we can see the pathlines of the flow over the body. The flow from the side seems to be moving around into the wake region.

We can also see some recirculation at the wake indicating generation of vortices at the back. This results in a low pressure region creating more drag.
Here we can see pathline over the entire body.
The colour of the pathlines indicate the velocity of the flow there.
As we can see, the flow seems to be accelerating at the curves and slowing down at wake.
We can also observe a few red lines in the recirculation region, meaning high velocity at the center of vortices.
Velocity vectors

Here we can see, the velocity vectors of the flow over the body.

The vectors are small arrow heads moving in backward direction.

The colour of the arrows indicate the magnitude of the velocity.
Here we can see the wake region more clearly.

All the arrow heads seem to be moving in the backward direction except the ones that are coloured blue. The are moving inwards, indicating recirculation.
Static Pressure on the body

Here we can see the static pressure acting on the body due to the flow.

As we can see, the curves, where the velocity was higher, pressure is lower there, compared to the rest of the body.

This corresponds to the fact that higher velocity results in lower pressure (Bernoulli's principle)
Turbulent Kinetic Energy

As we can see here, the rest of the flow field has very low turbulent KE.

But, this kinetic energy seems to increase at the wake and at the stagnation zone in the front.
CONCLUSION

The results are backed by popular theories and proved laws and are found consistent with the data available.
THANK YOU