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KARALIT CFD VALIDATION: AHMED 35

AHMED 35 DEGREES
A validation study of KARALIT CFD has been carried out on the Ahmed simplified car body for the configuration with 35-degrees slant. It is a well known and publicly available test case for CFD codes validation in the automotive sector that can be found in the ERCOFTAC classical database. Available data for comparison [1] are wind tunnel velocity profiles alongside the car's slant and in the wake region at its mid-span section. The model's geometry is shown in Figure 1.

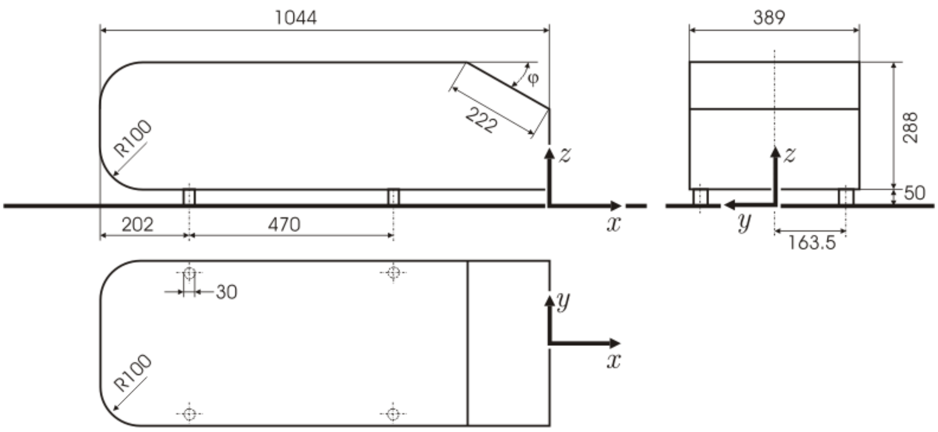

Figure 1: Ahmed model geometry (dimensions are in mm)

SIMULATION PARAMETERS:
- Steady state 3D simulation
- Viscous turbulent flow
- Wind Tunnel App
- Number of cells in the computational domain: about 8 milions
- Spalart-Allmaras turbulence model, wall function
- Velocity inlet: 40 m/s
- Re = 7.68 x 10^5 based on the model height (0.288 m)
- Kinematic viscosity of air: 15 x 10^6 m^2/s
- Grid resolution: min y+ = 78
- Numerics: implicit scheme, 2nd order symmetric TVD discretization scheme, CFL = 5
- Boundary conditions:
  - Slip boundary conditions on domain's side and top walls
  - Symmetry boundary conditions on symmetry plane
  - No slip conditions on the ground

Figures 2 and 3 show the computational mesh at the symmetry plane and a magnified detail of the grid at the back of the car. Exam of the x-momentum convergence plot, that is shown in Figure 4, suggests that the phenomenon is in fact steady in nature.

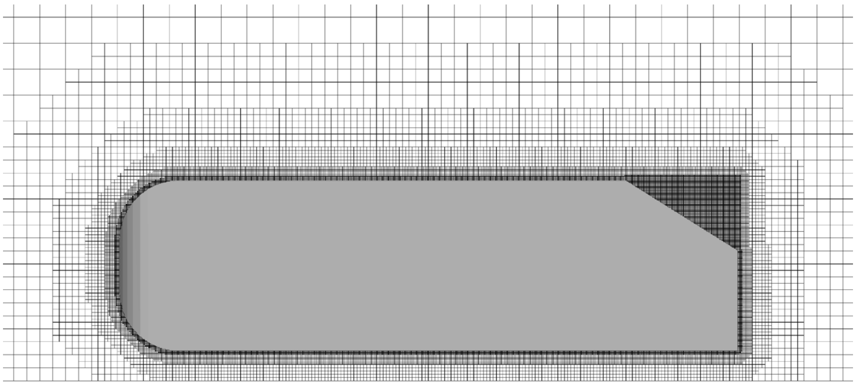

Figure 2: the ASMO computational grid at the symmetry plane

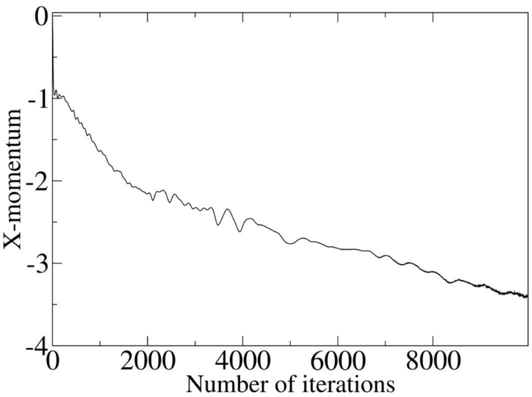

Figure 4: normalized x-momentum residual's convergence history

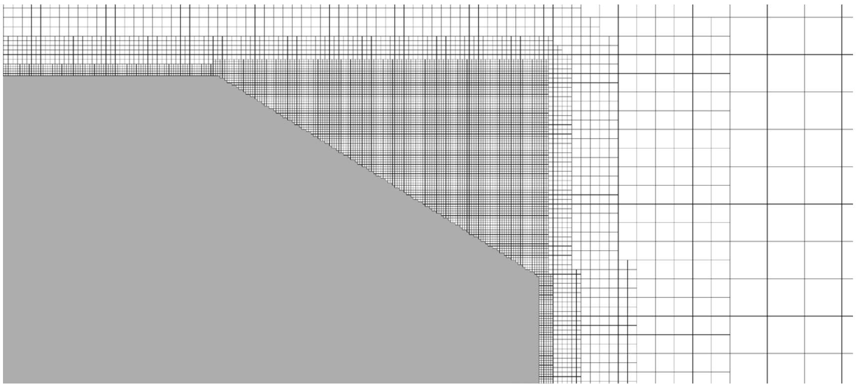

Figure 3: grid magnification at the symmetry plane close to the car's back

Figure 5 shows the computed U-velocity profiles above the car slant and at three different positions along the x axis at the back of the car, all on the symmetry plane. It is evident the generally good agreement with the experimental data. It can be seen that in the 35-degree case the flow separates over the slant. The U-velocity profiles over the slant and in the wake of the body compare favorably to experiments [1].

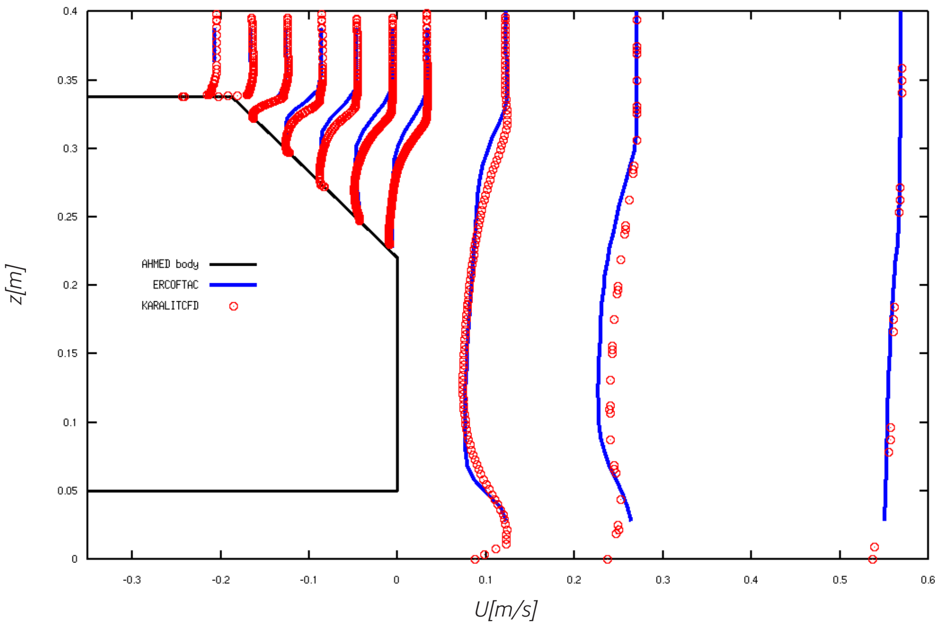

Figure 5: comparison of U-velocity distribution with experimental data [1]

Figures 6 and 7 show velocity magnitude contour plot together with some streamlines at the symmetry plane and on a plane parallel to the main flow direction 0.14m above the ground. It is evident the presence of two counter-rotating vortexes in the car's wake.

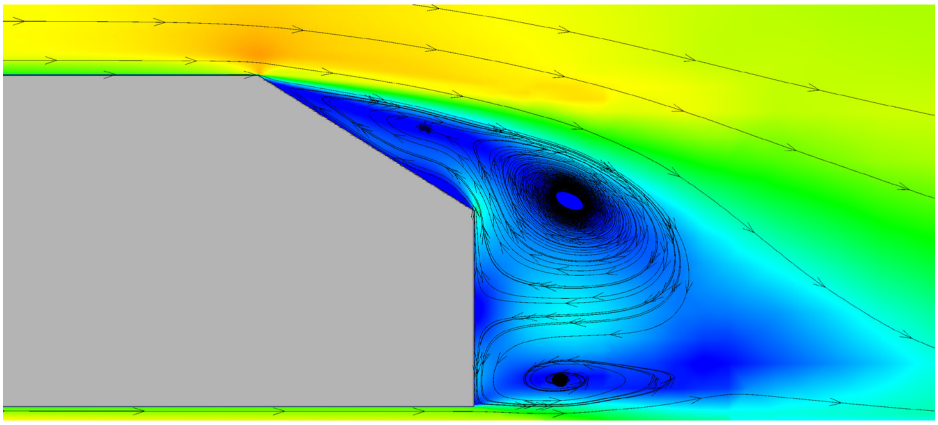

Figure 6: x-velocity component contour plot and streamlines at the symmetry plane; the presence of two counter-rotating vortexes can be observed in the wake region; the flow does separate over the slant

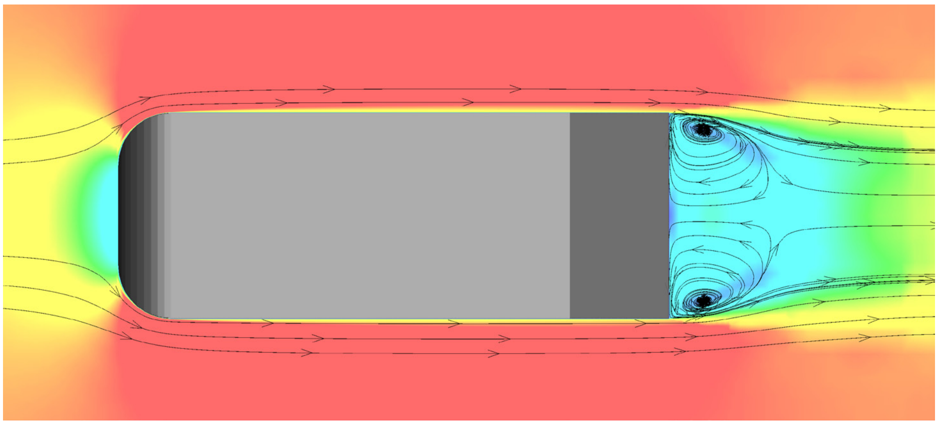

Figure 7: velocity magnitude contour plot over a plane parallel to the main flow direction 0.14m above the ground

Figure 8 shows the velocity vectors and the velocity magnitude contour at two computational domain's cross sections located at 0.2m and 0.5m behind the car in the wake region.

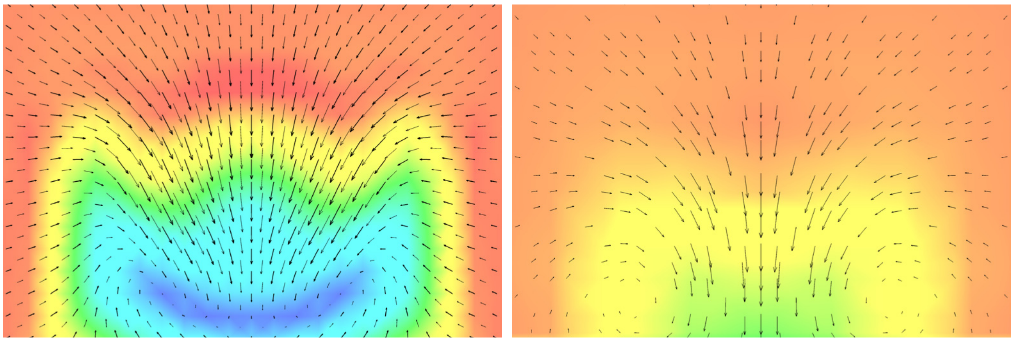

Figure 8: velocity vectors and velocity magnitude contour plot over 2 planes normal to the main flow direction in the wake region at 0.2m and 0.5m behind the car

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CONCLUSIONS

The calculations undertaken with the KARALIT CFD code using the Immersed Mesh technique predict the correct trends of the flow- field streamlines and velocity profiles on the Ahmed simplified car body. Considering the high y+ used for the simulations and therefore the dissipation introduced by the coarseness of the grid, the following results can be considered in fairly good agreement with the experimental results.

The predictions undertaken with the KARALIT CFD code demonstrate the degree of understanding that can be made available to the user with minimum setup for quite challenging flow-field scenarios.

The calculations can be extended invoking different turbulence models in future efforts toward this validation.

REFERENCES

1. Ercoftac classical database - http://cfd.mace.manchester.ac.uk/cgi-bin/cfddb/prpage.cgi?82&EXP&database/cases/case82/Case_data&database/cases/case82&cas82_head.html&cas82_desc.html&cas82_meth.html&cas82_data.html&cas82_refs.html&cas82_rsol.html&1&0&1&0&0&unknown

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