

KARALIT CFD VALIDATION: AHMED 25

AHMED 25 DEGREES

A validation study of KARALIT CFD has been carried out on the Ahmed simplified car body for the configuration with 25-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.

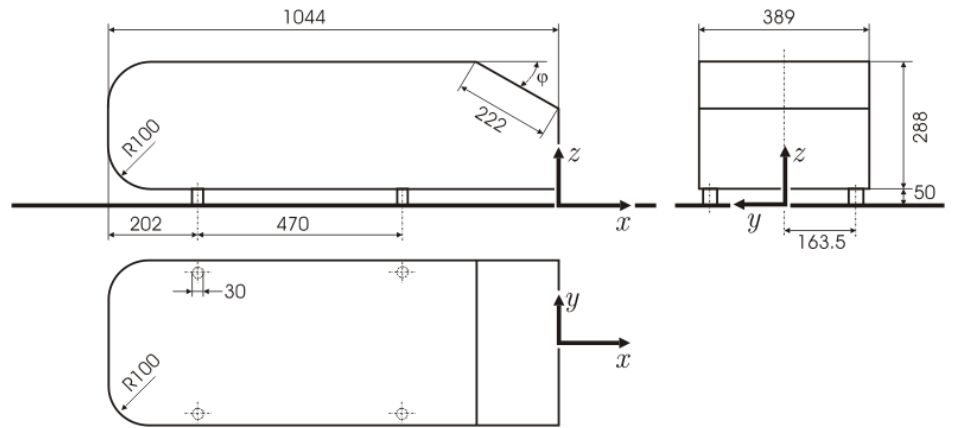


Figure 1: Ahmed model geometry (dimensions are in mm)

SIMULATION PARAMETERS:

- Steady state 3D simulation
- Viscous turbulent flow
- Wind Tunnel App
- Number of cells in the computational domain: about 8 millions
- Spalart-Allmaras turbulence model, wall function

- Velocity inlet: 40 m/s
- $Re = 7.68 \times 10^5$ based on the model height (0.288 m)
- Kinematic viscosity of air: $15 \times 10^{-6} \text{ m}^2/\text{s}$
- 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.

Figure 2: the ASMO computational grid at the symmetry plane

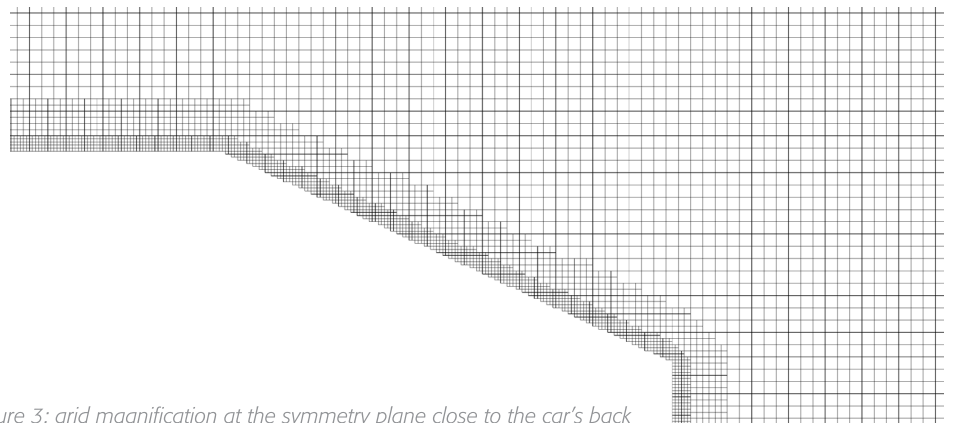
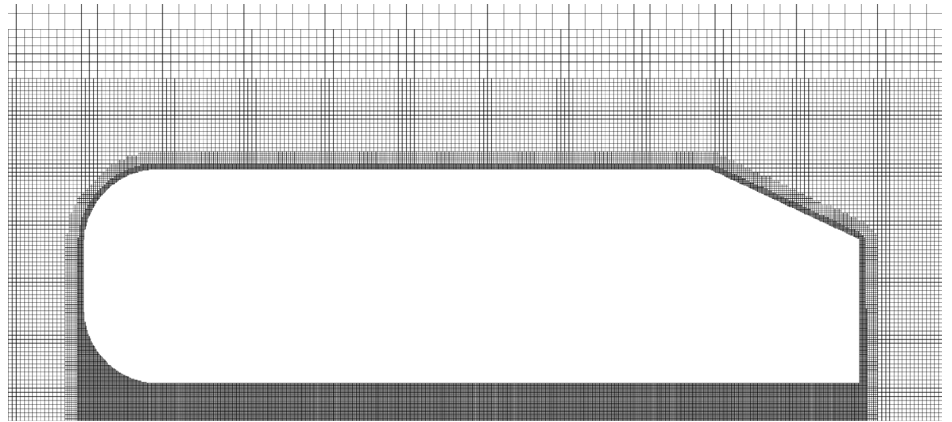


Figure 3: grid magnification at the symmetry plane close to the car's back

Figure 4 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 25-degree case the flow over the slant remains attached. The U-velocity profiles over the slant and in the wake of the body compare favorably to experiments [1].

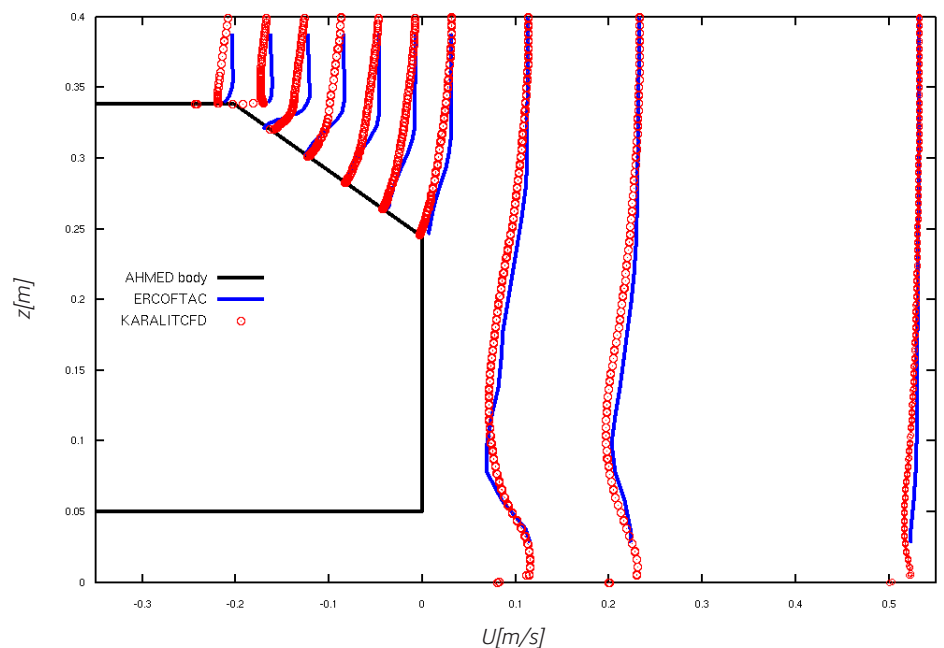


Figure 4: comparison of U-velocity distribution with experimental data [1]



Figure 5 shows the velocity magnitude contour plot at the symmetry plane together with some streamlines. It is evident the presence of two counter-rotating vortices in the car's wake.

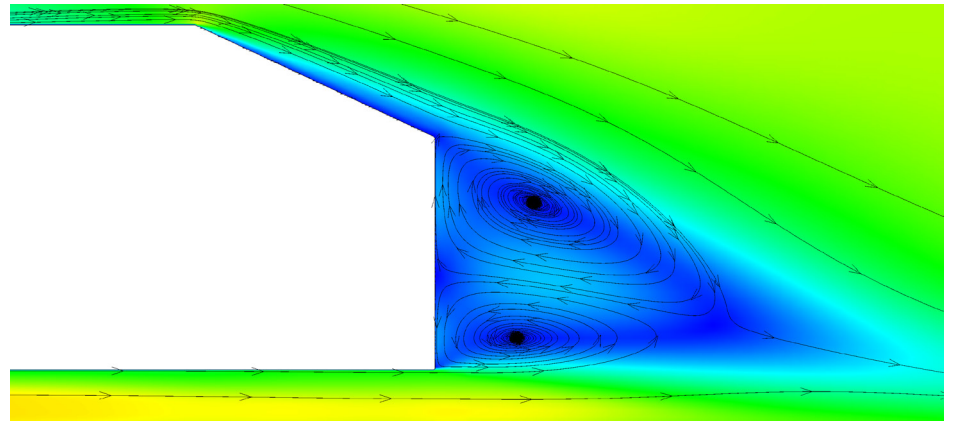


Figure 5: x-velocity component contour plot and streamlines at the symmetry plane; the presence of two counter-rotating vortices can be observed in the wake region; the flow does not separate over the slant

Figure 6 shows the velocity magnitude contour plot over a plane parallel to the main flow direction 0.01m above the ground. This complex vortical pattern is, in fact, unsteady in nature, as it has been shown by numerical computations [2].

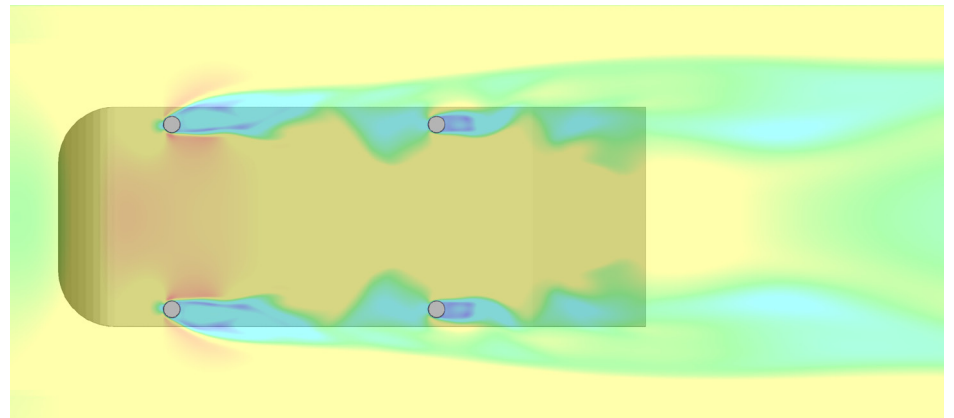


Figure 6: velocity magnitude contour plot over a plane parallel to the main flow direction 0.01m above the ground

Figure 7 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.

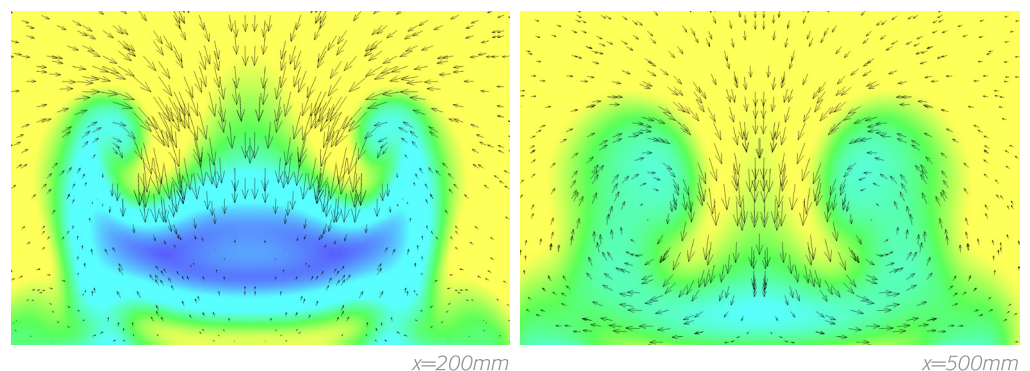


Figure 7: velocity vectors and velocity magnitude contour plot at two computational domain's cross sections located at 0.2m and 0.5m behind the car

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/cfdcdb/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
2. Sebastian MÖLLER, Daniele SUZZI, Walter MEILE, Investigation of the flow around the Ahmed body using RANS and URANS with various turbulence models - https://online.tugraz.at/tug_online/voe_main2.getVollText?pDocumentNr=81599

IMMERSED BOUNDARY (IB) METHOD FOR:

- Saves up to 80% in user time by eliminating the need for pre-meshing
- Faster turnaround time to reach a solution
- Reduces manual preprocessing work
- Increases accuracy by solving on rectangular grids
- Focuses engineering resources on analysis, not preprocessing

CUSTOMIZED APPS:

- Fast case setup
- Minimum effort to set up complex CFD simulations
- Easy setup for parametric analyses
- Ideal simulation tool for moving objects
- Ultimate engineering "what-if" design tool

VALUE-BASED PRICING:

- Pay nothing extra to add hardware
- Unlimited parallel processing
- All inclusive
- Easy budgeting

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