



ISSN (ONLINE): 2321-3051

INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL
ENGINEERING

Ansys-CFX Analysis on a Hatch-Back Car with Wheels and without Wheels

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Abstract

The main aim and scope of this paper is investigation of aerodynamics of Hatch-Back car, measuring drag coefficient and air flow over the car body. The body was modeled in Catia V5R19 and Computational Analysis carried out in Ansys CFX -15.0. The Analysis was done to the Hatch-Back Car with wheels and without wheels at a speed of 16.67 m/s. The main aspect of aerodynamic drag coefficient is the effect on fuel consumption, handling performance, aesthetic design and stability of vehicle. All Researchers focuses to reduce aerodynamic drag coefficient by improving design of vehicle. This paper helps in understanding the contours, vector plots, turbulence, velocity streamlines and drag coefficient of a hatch-back car with wheels and without wheels.

Keywords: Hatch-Back Car, Computational Analysis, Drag Coefficient, Catia Modeling, Ansys-CFX.

1. Introduction

The main target that researchers focus on aerodynamic styling of the vehicle which reduces the drag coefficient that leads to increase in top speed of the vehicle and increase in fuel efficiency. Various computational studies were carried out to this hatch-back car with wheels and without wheels. The study on this model is regarded as independent study to get the aerodynamics characteristics of the car. To achieve high vehicle performance, much of the attention focuses on lowering the vehicle drag coefficient which accounted to about 40 to 60% of total motion resistance at 60 km/h.

Modeling: The 3D modeling was carried out in CATIA V5R19. The relative figures are as follows:

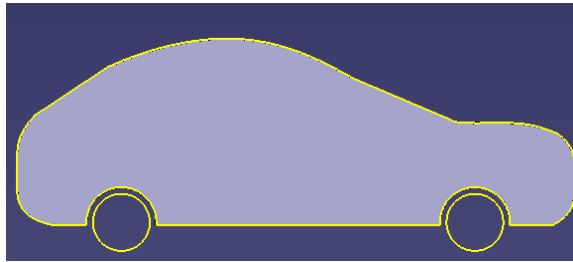


Fig-1: Hatch-Back Car with wheels.

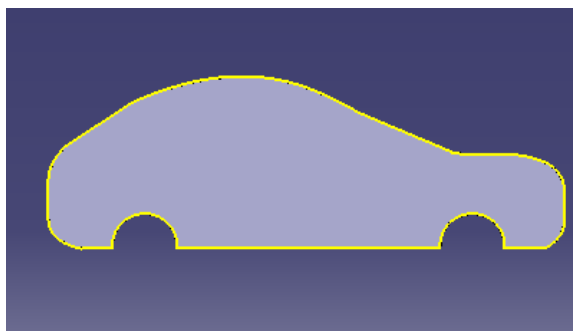


Fig-2: Hatch-Back Car without wheels.

Geometrical Dimensions:

Length	3987.71 mm
Width	1500.00 mm
Height	1328.29 mm
Wheel Base	2529.84 mm
Ground Clearance	183.62 mm
Slant Angle	65 degrees

Table-1.

Analysis: The analysis to this Hatch-Back Car was carried out in Ansys-CFX analysis. The boundary condition for the flow is also an important factor. Boundary conditions used for this analysis are given as follows:

Velocity Inlet	16.67 m/s
Sides and Top	Symmetric Walls
Road	Wall

Table-2.

The image following show the flow of air around the model and further gives the detailed analysis of the regions strengthening the drag coefficient.

The pressure and velocity contours are as follows:

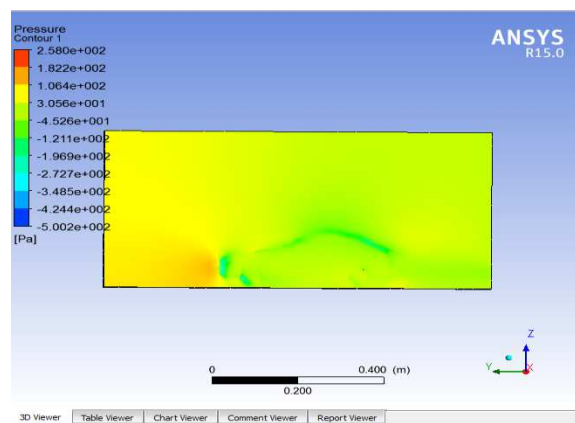


Fig-3: Pressure Contour of Hatch-Back Car with wheels.

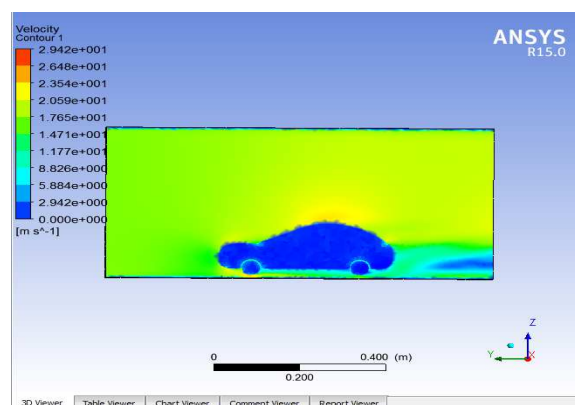


Fig-4: Velocity Contour of Hatch-Back Car with wheels.

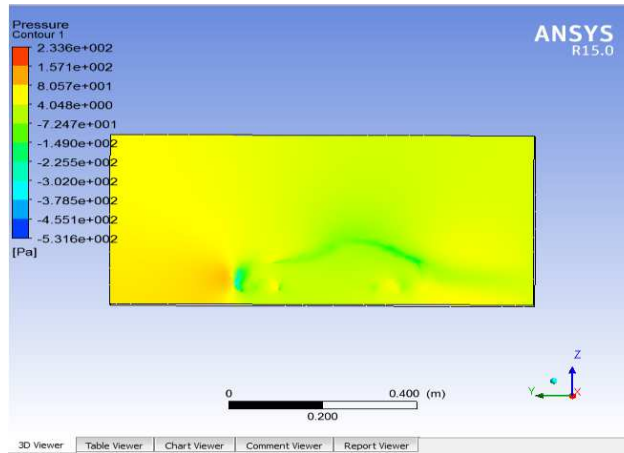


Fig-5: Pressure Contour of Hatch-Back Car without wheels.

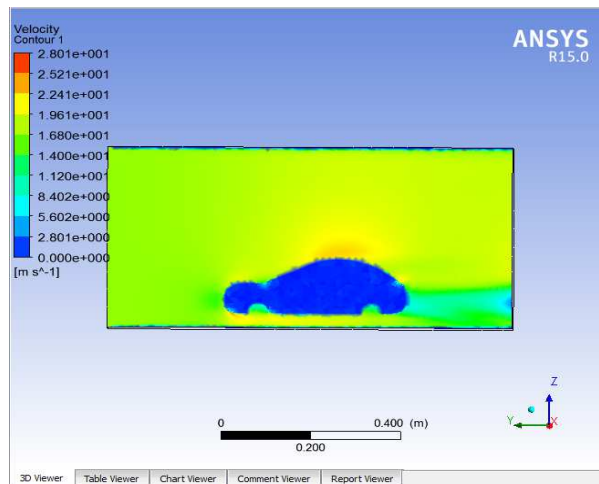


Fig-6: Velocity Contours of Hatch-Back Car without wheels.

The pressure and velocity vector plots are as follows:

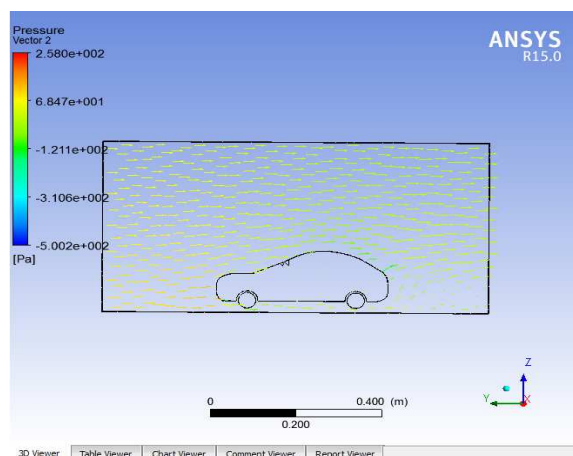


Fig-7: Pressure Vector Plots of Hatch-Back Car with wheels.

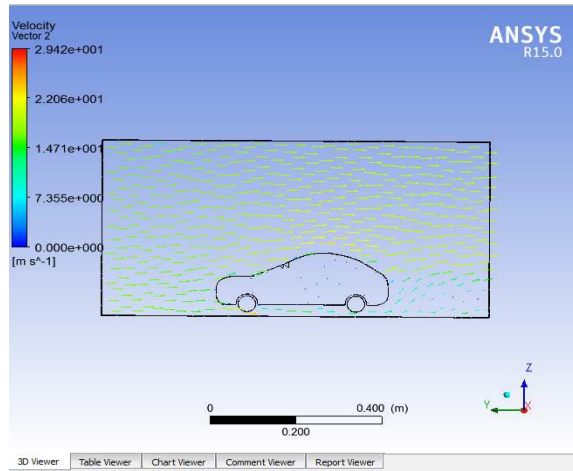


Fig-8: Velocity Vector Plot of Hatch-Back Car with wheels.

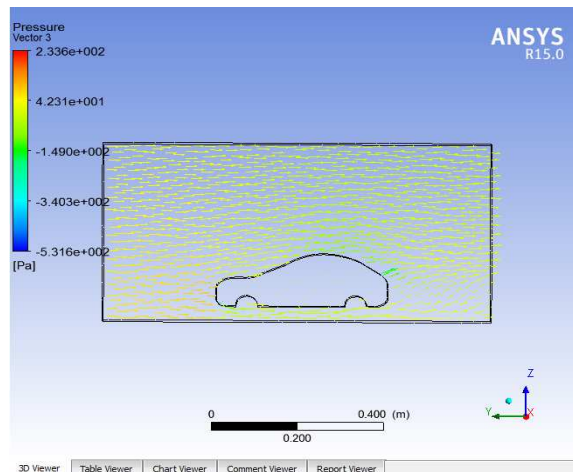


Fig-9: Pressure Vector Plot of Hatch-Back Car without wheels.

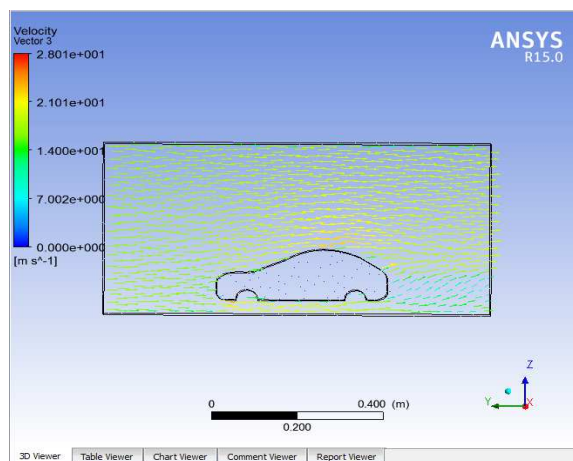


Fig-10: Velocity Vector Plot of Hatch-Back Car without wheels.

The images of Turbulent Kinetic Energy are given below:

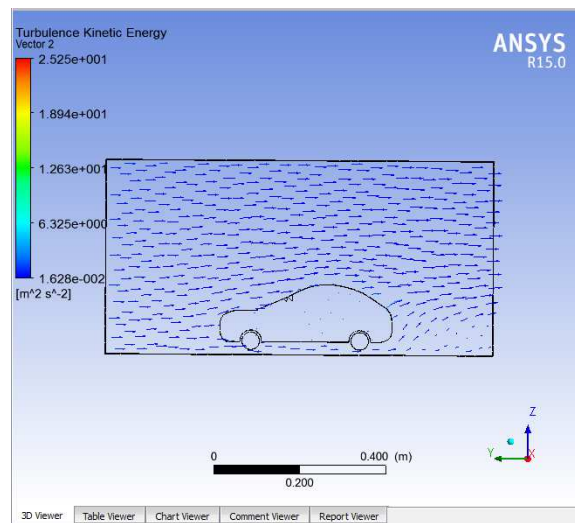


Fig-11: Turbulent (KE) of Hatch-Back Cars with wheels.

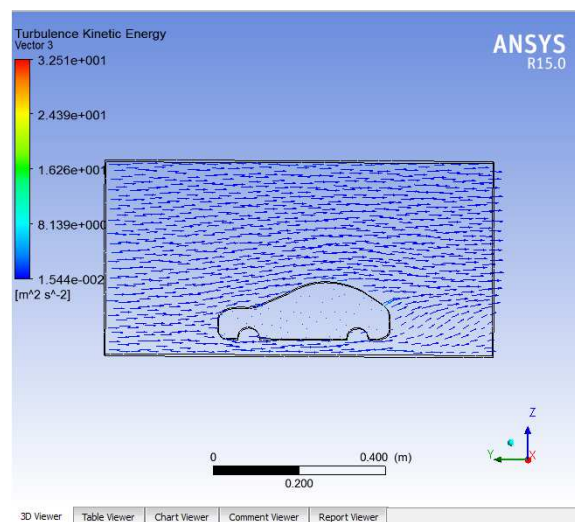
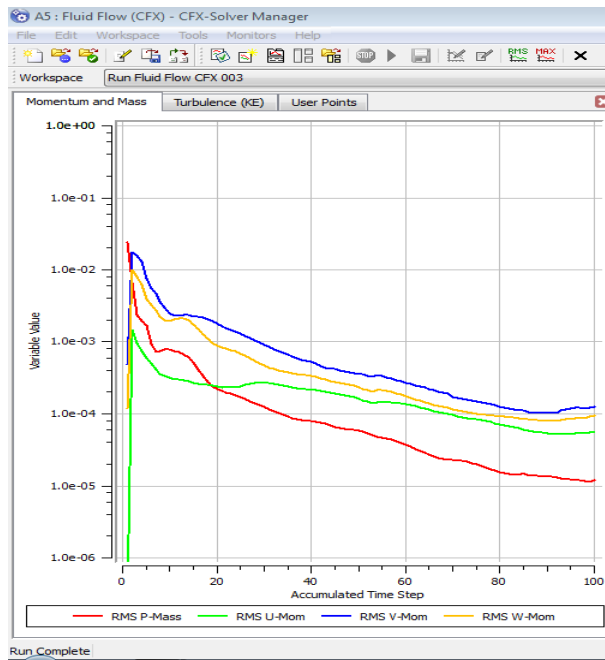
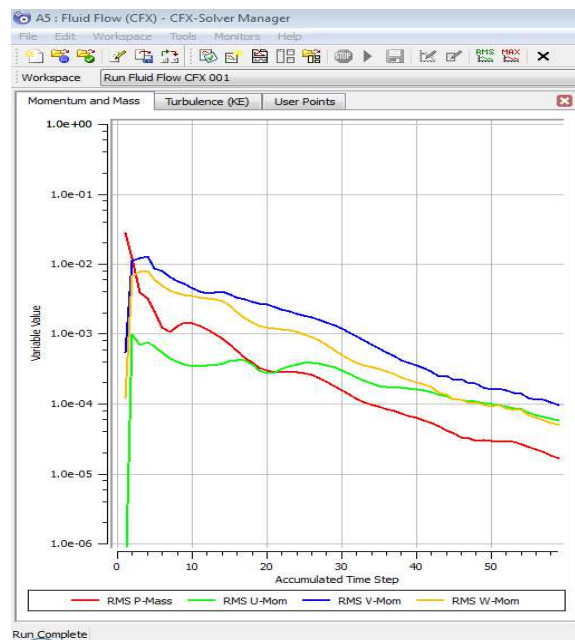


Fig-12: Turbulent (KE) of Hatch-Back Cars without wheels.

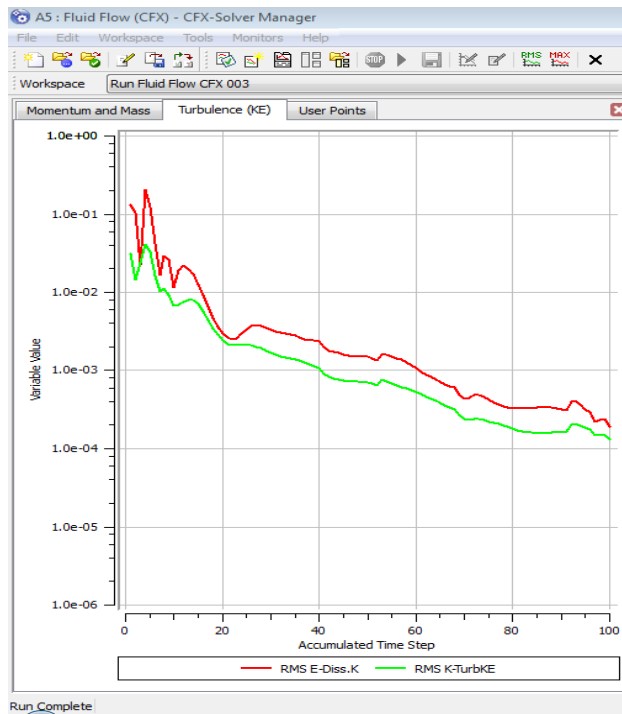
The relevant graphs of Momentum and Mass, Turbulent (KE) and Drag Coefficient are from the Ansys-CFX Analysis of Hatch-Back Car with wheels and without wheels.



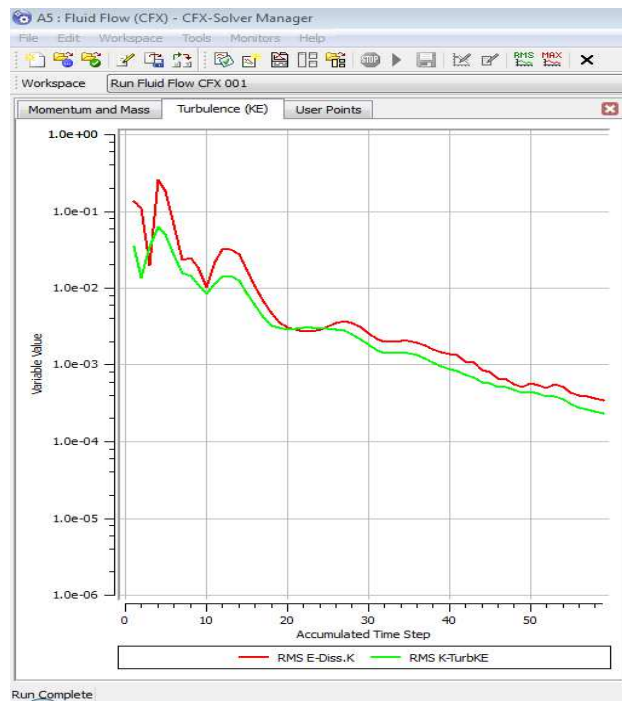
Graph-1: Momentum and Mass of Hatch-Back Cars with wheels.



Graph-2: Momentum and Mass of Hatch-Back Cars without wheels.



Graph-3: Turbulent (KE) of Hatch-Back Cars with wheels.



Graph-4: Turbulent (KE) of Hatch-Back Cars without wheels.

Velocity Streamlines of Hatch-Back Cars with wheels and without wheels are as follows:

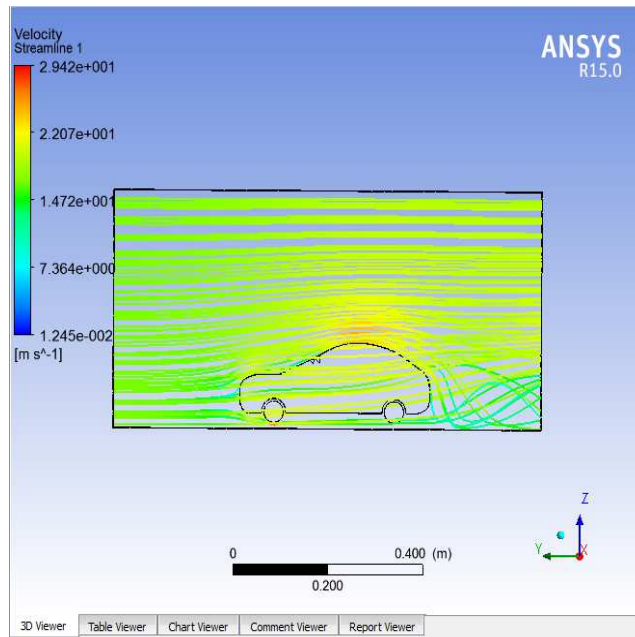


Fig-13: Velocity Streamlines of Hatch-Back Car with wheels.

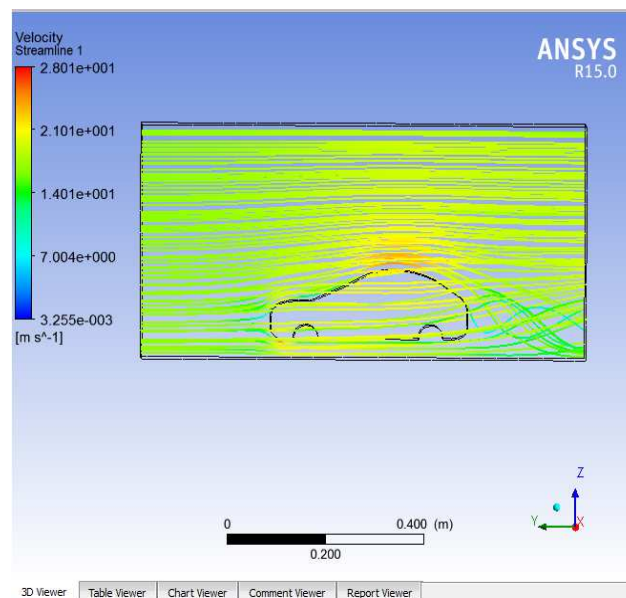
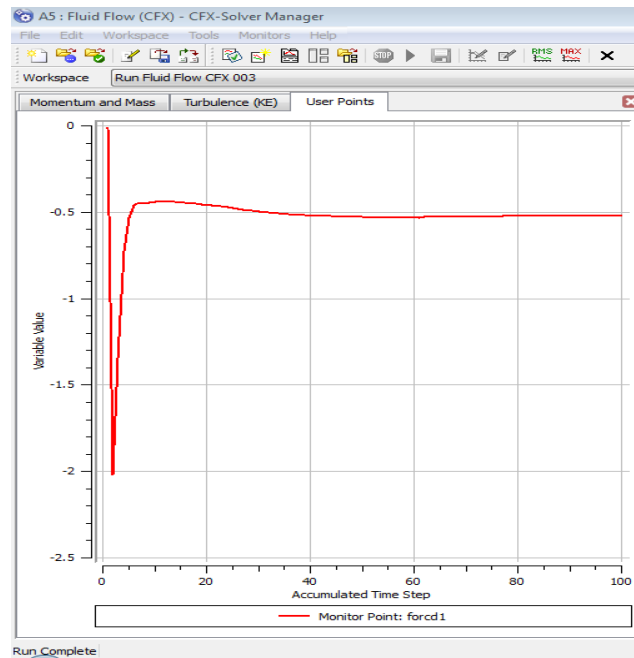
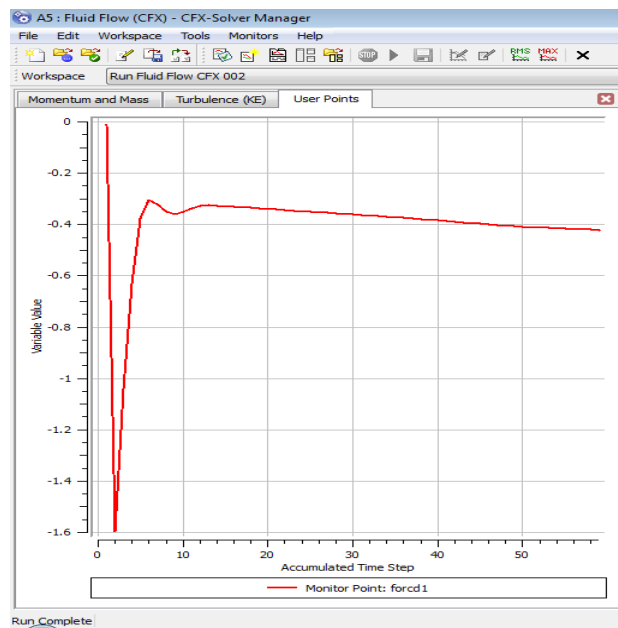


Fig-14: Velocity Streamlines of Hatch-Back Cars without wheels.

Drag Coefficient helps in fuel efficiency and better handling and accelerating performance. The relevant graphs and tables are as follows:



Graph-5: Drag Coefficient of Hatch-Back Car with wheels.



Graph-6: Drag Coefficient of Hatch-Back Cars without wheels.

Note: The variable values in drag coefficient graphs are in negative as the front end of model and the domain are in opposite facing. so, values are negative, neglecting the facing and the values obtained are in positive

which the drag coefficient for these simple model are 0.520376 and 0.421066 of Hatch-Back Car with wheels and without wheels.

Model	Drag Coefficient
Hatch-Back Cars with wheels.	0.520376
Hatch-Back Cars without wheels.	0.421066

Table-3.

Conclusion:

The Drag Coefficient (Cd) evaluated for exterior profile of Hatch-Back, to be of the order of 0.520376 and 0.421066, which are acceptable from standard results provided by various journals, websites and other validated data. The study demonstrated to design more aesthetically and aerodynamically as the car without wheels has lowest drag when compared to car with wheels. And wake formations are more in both cases which it must be rectified by concentrating the car rear end design.

Further Work: To modify the shape and to be concentrate on rear end shape of the car which would impact on drag coefficient and might help in better results that leads to various changes supports in achieving a perfect Hatch-Back Car.

References:

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