Journal of Mechanical Engineering and Vocational Education (JoMEVE)

Jurnal Homepage: https://jurnal.uns.ac.id/jomeve

ANALYSIS OF THE USE OF SPOILER ONE LEVEL AND TWO LEVELS IN CONDITIONS OF STEADY AGAINST THE DRAG AND LIFT COEFFICIENTS ON A SEDAN TYPE CAR BY USING CFD (COMPUTATIONAL FLUID DYNAMIC)

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KEYWORDS

Drag Coefficient,
Lift Coefficient,
Pressure Distribution,
Speed Distribution,
Aerodynamic,
CFD,
Sedan Car.

ABSTRACT

This research was simulation analyzing the condition of steady flow in around of body car made and investigated computed using CFD program (Computational Fluid Dynamic). The model used was a Sedan car designed with different rear end body by adding the spoiler. Analyzing in this research was conducted by using Software 18.2–CFD Student Version. Design of the three models was compared to find out the difference in magnitude of Coefficient of Drag, Coefficient of Lift, pressure distribution, velocity distribution, and behavioral character of flow around the rear end of the car in the condition of a steady stream. The model was made an inappropriate scale with the model of Honda city 2008 sedan car. The observation was made to look at the behavior of fluid flows both in front and back the car in different fluid speed ranges in steady condition. The simulation results obtained from packet CFD on each condition were; model without the spoiler, a model with 1 level spoiler, and model with 2 level spoiler. Where this simulation showed that CD and CL were decreased. One of the examples was at speed 40km/hour obtained the coefficient of drag (CD) of 0.31061, 0.28603, and 0.2054, it proved that 1 level spoiler could reduce the value of drag coefficient about 7.9135% of the sedan car without spoiler, while the car with 2 level spoiler could reduce the amount of drag coefficient approximately 33.8592% without spoiler. For the coefficient of lift (CL) on each model was -0.38487, -0.54624, and -0.62097 proved that spoiler 1 level could reduce the value of lift coefficient about 41.92845% of the sedan car without spoiler, while the car with 2 level spoiler could reduce the amount of lift coefficient about 61.35984% without spoiler. On the result of pressure, distribution and relative velocity give little effect to the upper and lower surface where almost no color difference contours indicated this. Then, if it was suggested from streamline and the formation of a vortex, there was a significant difference so that it was very influential on the size of CD and CL occurred. By changing geometric proved that the spoiler car 1 and 2 level were more aerodynamic than the car without the spoiler.

INTRODUCTION

The phenomenon of fluid flow through a body (geometry of a vehicle which consists of various components) is a phenomenon that often we meet in life. Enclosing fluid flow or hitting an object in full will cause tension in the purpose, either the standard voltage as well as the shear stress. The average voltage is formed due to the pressure of the fluid, while shear stress arises due to the viscosity of the liquid. If the review of two-dimensional flow, flow

e-ISSN : 2615-5699
DOI: http://dx.doi.org/10.20961/jomeve.v1i2.25066

flowing horizontally will pose a drag or a drag because of this style of the direction opposite to the flow direction, while streams that flow vertically lift or raise style lift (Fox et al., 1994).

Research on fluid flow through various forms of car body has a lot to do. Manan Desai (2008) conducts research on the style of German car in numeric, where the result is a critical value's drag (Cd) on numerical experiments of 0.4 and 0.55. Damjanovic (2010) perform simulation characteristics of the aerodynamics of the car, where the results with design changes will result in better airflow when the vehicle crosses so that it will become more stable and increase traction.

Tristan (2011) done on the 3D flow analysis on automobile aerodynamics using CFD (Computation Fluid Dynamic) and test experiments in a wind tunnel. Zaki (2003) doing the testing fluid flow of two-dimensional (2D) and three-dimensional (3D) to make the most optimal design of vehicle Proton Aeroback Isvara using Fluent. Based on the analysis that has been found that's a drag (CD) and the elevator's (CL) for a 2D model for static floor circumstances each is 0.3794 and-0.4797. For the State of the floor moving CD and CL value of each is 0.3776 and-0.6187.

The addition of a spoiler in the rear on the model of Ahmed will led to a reduction in the value of the CD (drag coefficient), CLR (the ratio of lift the backside) and CLF (the coefficient of lift the front part) when the height of the spoiler must be adjusted (Xu-xia, 2011). The addition of a spoiler on the back of the body can reduce downwash (flow) of the upside. And it could minimize the resultant spiral vortex so that the CLR (the coefficient of lift the back) is reduced and will also reduce the rear surface vortex intensity, especially vortex at the upper end of the rear surface of the CD and CLF (the coefficient of lift front section) decreases (Tastan, 2011).

Kumar (2015) in his studies analyzing the influence of the addition of a spoiler on a car against car aerodynamic characteristics of the car. Process simulations conducted by (Kumar, 2015) aims to find out the influence of variation of level 1 spoiler mounted on the vehicle with a coefficient of drag and lift. From the results obtained that the addition of spoiler will affect the coefficient of drag and lift. So the addition of spoilers on cars sedan can serve to reduce the coefficient of drag and boost coefficients.

On the research that has been done before the design used is a type of spoiler spoiler spoiler, while the standards used in this research is a type of spoilers that have been modified on many cross-section shape and cross-section. On this spoiler modification made include the use of a kind of Airfoil NACA 2412 spoiler cross-section and the number of variations of the cross-section, then the angle of slope of a cross-section of spoiler also modified amounting to 250.

Thus the research conducted by the researcher based on the results of earlier studies by performing Simulations Using Spoiler Installation Specifications NACA 2412 Airfoil on a type of Spoiler, Spoiler That Researchers Use A Spoiler is using a single Airfoil and Airfoil 2 And Angle that were applied on the Airfoil is 25 ˚.

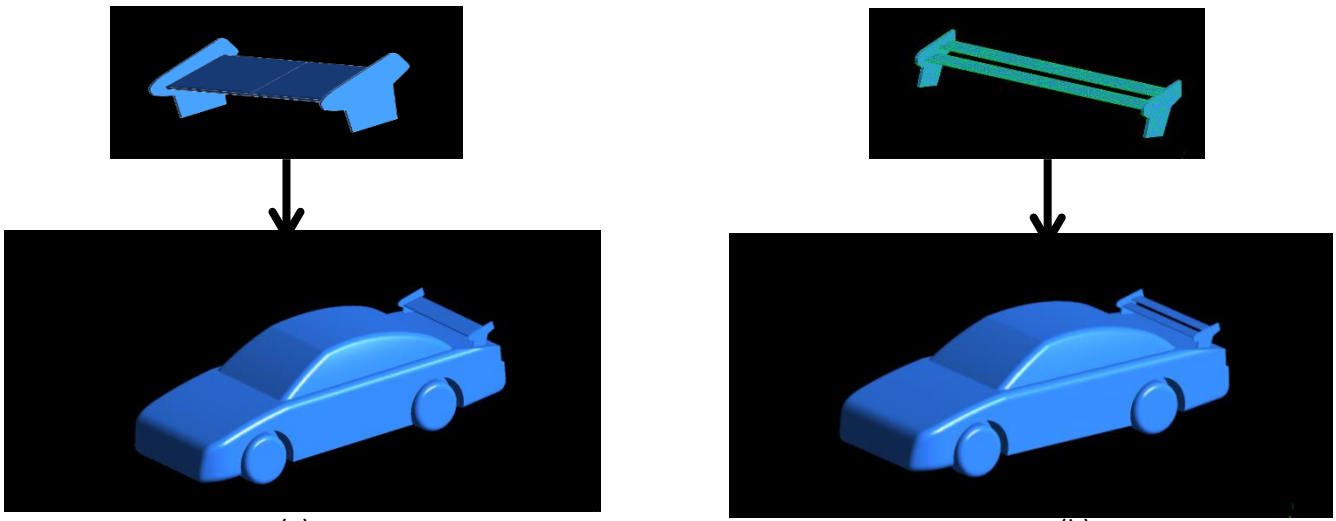
RESEARCH METHODS

Experimental Set-Up

This research was conducted to find out the influence of the use of installation of a Spoiler on the back of the car against the value of the coefficient of drag and lift. Kind of a spoiler that is used is a type of spoiler that uses a NACA 2412 Airfoil cross-section as the air. Then the type of car used car type is a sedan, as the base area in the wake of this kind of small cars, as well as modification of the geometry on a vehicle of this type, is also limited. Full specs about this research are shown in table 1.

Table 1. Specification of Research

Spesification	Value
Car	Type Sedan
Desain Scale the geometry between the original Model design	1 : 1
Spoiler variation	1 level and 2 level
Type of cross-section *spoiler*	Naca 2412
Angle of slope cross-section of spoiler	25^{o}
Wind speed	40 – 100 km/hour



(a) (b)

Figure 1. (A) Sedan Car Design Using Spoiler Level 1 (B) Sedan Design That Uses A Spoiler Level 2

Design Research

Research of the influence of mounting spoilers on cars kind of sedan to the changes the value of the coefficient of drag and lift, with the research-based simulation using software Ansys (R) Student 18.2. Process simulation is designed to find out the influence of mounting spoilers. Several factors are applied to this simulation, where those factors are the wind speed set in ranging from 40 km/h to 100 km/h. The process of meshing the geometry is conducted with methods symmetry (half body). The simulation using tetrahedron with modifications maximum and minimum size cell. The flow simulation using a k-epsilon method, realizable which has high accuracy on turbulent flow type. The setting of the boundary condition done by changing the speed of the wind at the inlet that is of 40-100 km/h with intervals of 20 km/h then the setting on the turbulence level outlet 5% with the change of pressure.

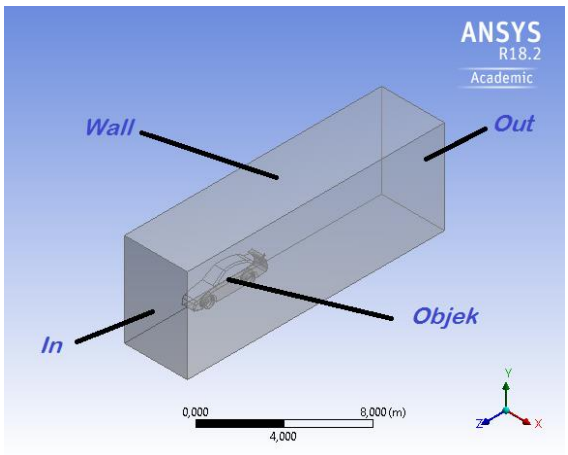
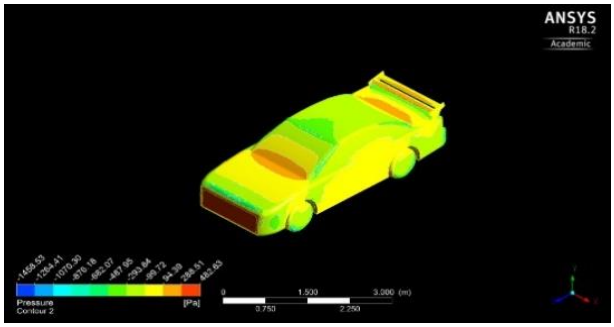


Figure 2. Domain Research Design

RESULTS AND DISCUSSION

The Influence of The Spoiler Against The Aerodynamics

The results showed mounting spoiler level 1 and level 2 could improve the condition of aerodynamics. It is affected by the distribution of pressure, speed distribution, vortex formation, and streamlined flow patterns that occur at the car. It can be concluded that the installation of a spoiler on this car can improve aerodynamics conditions. See figure 3, 4, 5 and 6.



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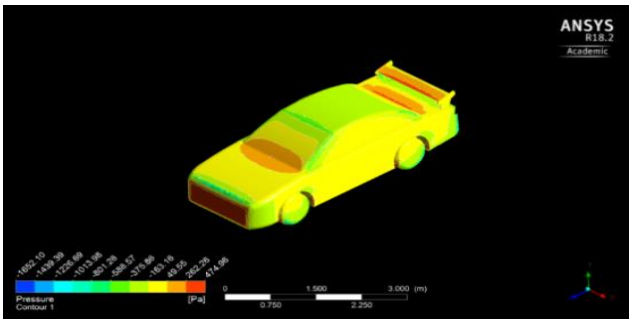
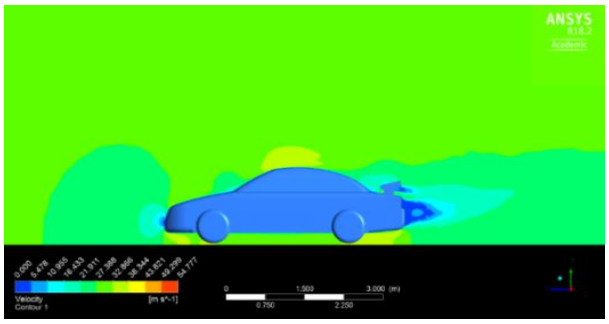


(b)

Figure 3. The Contour Pressure: (A) Cars With Spoilers Level 1(B) Cars With Spoilers Level 2



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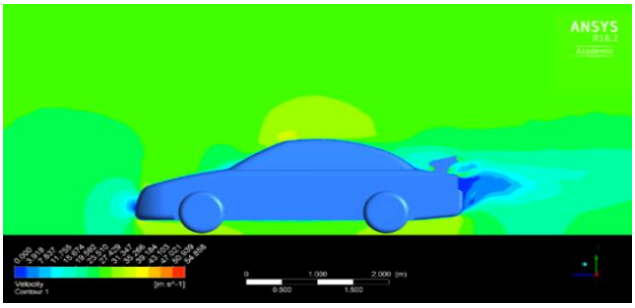
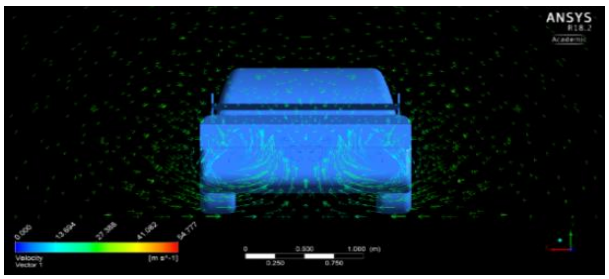


(b)

Figure 4. Contour Speed: (A) Cars With Spoilers Level 1 (B) Cars With Spoilers Level 2



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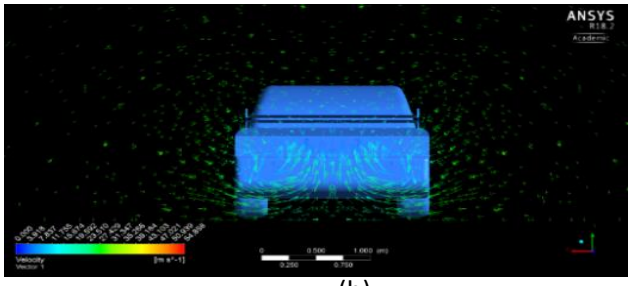
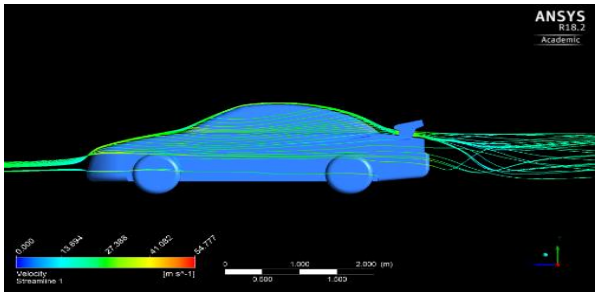


(b)

Figure 5. Pattern Formation of Vortex: (A) Cars With Spoilers Level 1 (B) Cars With Spoilers Level 2



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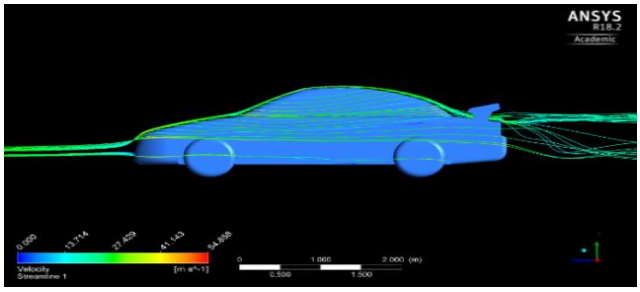

(b)

Figure 6. Streamline Pattern: (a) Cars With Spoilers Level 1 (B) Cars With Spoilers Level 2

From Figure 3, 4, 5 and 6 can be seen the difference in the conditions experienced by the car's aerodynamics on set up factors. The pressure contour on spoiler level 2 has a lower value than spoiler 1 level. Then, if seen from the contour of the speed differences of speed in some parts so that it also affects the magnitude of the pressure on the car. A vortex of spoiler level 2 is smaller than spoilers level 2. The car with a spoiler level 2 produces greater downforce than spoilers level 2. it can be concluded that the addition of a spoiler on the back of the sedan have been quite useful in improving the condition of aerodynamics at the moment the car drove of the factors described above.

Influence of Mounting Spoilers in The Style of Drag and Lift

Installation of the spoiler on the back of the car will affect the form of drag and lift in the car. The influence of drag coefficient and occur on the elevator from the car. The results showed that the use of spoiler could reduce the magnitude of the drag-style as well as increase downforce on the car, style for more details see figure 7 and 8.

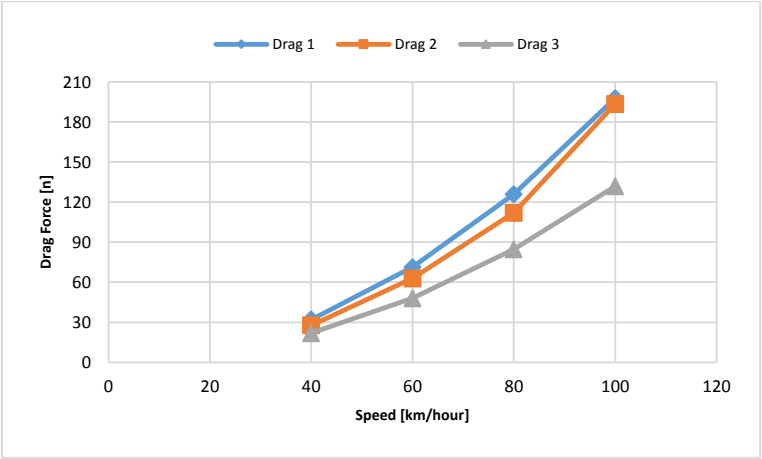

Figure 7. Comparison chart style drag on every model spoilers

Figure 7 is the value of a style of drag on any model of the spoiler. Drag 1 is the model without a spoiler, Drag 2 is Model 2 for spoilers 1 level and Drag 3 is the spoiler models 2 level. At the speed 40 Km/h, the value of the drag that occurs in the design of the car without a spoiler is 31.9624 N. While the spoiler design level 1 and level 2 is 27.75321 N and 21.7594 N. These data concluded that drag the style to work decreased in accordance with the design of the spoiler. The design of a spoiler mounted on the car type sedan is good enough for the reduction of drag that occurs. It may be due to the influence of the geometry on the back of a car.

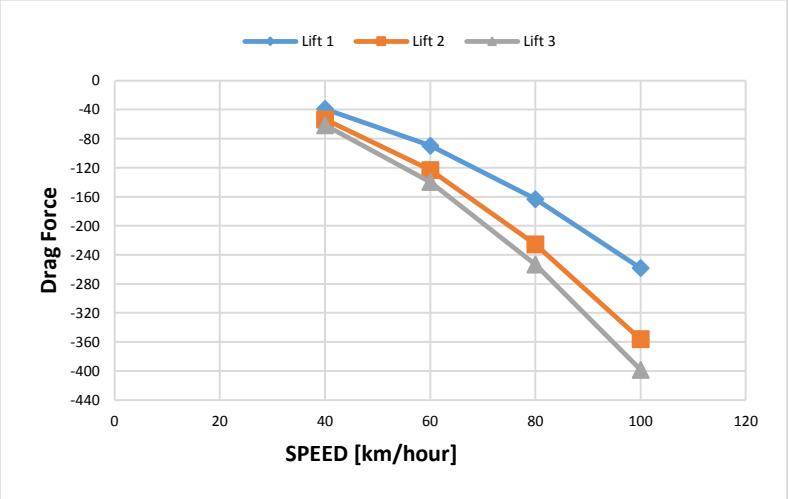

Figure 8. Comparison Chart Style Downforce on Every Model Spoilers

Figure 8 is the value of a style lift on every model of spoilers. Elevator 1 is the model without spoilers, Lift 2 is a Model of a spoiler 1 level, and 3 represents level 2 spoiler models. The graph show that the value of a style lift decreases, it can be seen from the value of the elevator of any speed. The example at a speed of 40 Km/h, the value of the lift that occurs in the design of the car without a spoiler is-39.1396 N, whereas on the design of a car with a spoiler design level 1 and level 2 is-53.5128 and N-61.246 N. Data show that lifts style decreases according to the spoiler design. The design of a spoiler mounted on the car is good enough to reduce elevator happens. Simulation result could influence the geometry on the back of a car.

Influence of Mounting Spoilers on The Value of The Coefficient of Drag and Lift

Installation of the spoiler on the back of the car will affect the magnitude of the style of drag and lift on this car, because of the effect on the coefficient of drag and lift from the car. The results showed that the use of Spoiler could reduce the magnitude of the value of the coefficient of drag and reduce the value of the coefficient of lift on the car, which is shown in Figure 9 and 10.

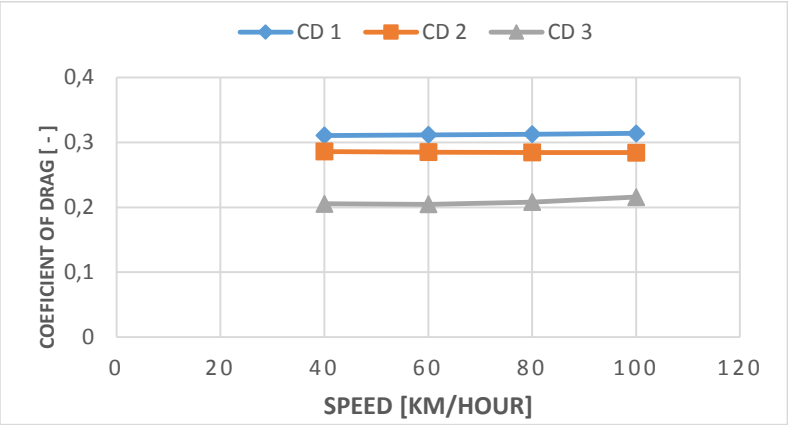

Figure 9. The Drag Coefficient Comparison Chart on Every Model

Figure 9 represents the value of a style lift on each model of the spoiler where CD 1 is the model without a spoiler, CD 2 is a Model of level 1 spoiler, and CD 3 is a model 2 level spoiler. Of the graph can be seen that the coefficient of drag on the design of the car without a spoiler at any speed is high enough, namely 0.31061, 0.31171, 0.31262 and 0.31386. While in the car with design spoiler one level of magnitude of drag coefficient, 0.28603, 0.28495, 028418 and 0.2846. Then the magnitude of the coefficient of drag on the design of a car with a spoiler 2 levels, namely 0.20544, 0.20812, and 0.21567 0.2047. The coefficient value of drag at any speed and design can be seen that the coefficient of drag has decreased in every design, where the design of the car without a spoiler has the most significant drag while the design of the car with a spoiler 2 level has most small drag coefficient value. From the data and graphs can be inferred that the spoiler had considerable influence in the reduction coefficient of drag.

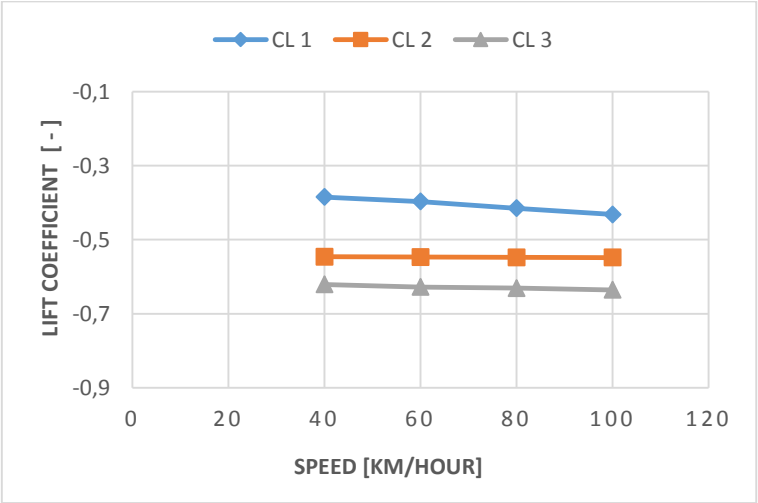

Figure 10. The Lift Coefficient Comparison Chart on Every Model

Figure 10 is the value of a style lift on each model of the spoiler where CD 1 is the model without a spoiler, CD 2 is a Model of level 1 spoiler, and CD 3 is a model 2 level spoiler. The coefficient of lift on the design of the car without a spoiler at any speed is high enough, that is-0.38487, -0.39703, -0.41492 and-0.4321. While in the car with design spoiler 1 level of the magnitude of the coefficient of lift of-0.54624,-0.54708,-0.54768 and-0.5481. Then the magnitude of the coefficient of lift on the design of a car with a spoiler 2 level that is-0.62097,-0.62805,-0.63108 and-0.63557. Of the value of the coefficient lift at any speed and design can be seen that the coefficient of lift has decreased in every design. The design of the car without a spoiler has the highest lift while the design of the car

with a spoiler 2 level has very small lift coefficient value. From the data and graphs can be inferred that the spoiler had considerable influence in the reduction coefficient of lift.

CONCLUSION

Installation of a spoiler on this sedan type car can improve aerodynamics on the car while speeding. It can be seen from the contoured speed, pressure, the formation of a vortex, as well as a streamlined flow pattern formed on the car of the moment, is simulated. Installation of spoilers can reduce the magnitude of the value of the coefficient of drag and reduce the value of the coefficient of lift that occurs on the car kind of sedan. On spoiler 1 level could reduce the value of the coefficient of drag of approximately 7.9135% of car sedan without spoilers, while cars with spoilers 2 levels can reduce the drag coefficient of 33.8592% of the car without spoilers. Spoilers 1 level can reduce the value of the coefficient of lift of approximately 41.92845% of car-sedan without spoilers, while cars with spoilers 2 levels can reduce the value of the coefficient of lift of 61.35984% of the car without spoilers. From these results it can be concluded with spoiler mounting design level 1 or 2 levels can affect the large, small value of the coefficient of lift of the sedan type car.

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