Drag Optimization Due To Aerodynamic Effect Over A Go-Kart

UjjalKalita*, RajkumarKhorwal, ShubhiTiwari
School of Mechanical Engg.,
Lovely Professional University, Phagwara, Punjab, India
*ujjal.19355@lpu.co.in

Abstract: Aerodynamics has always been a major interest of the Automobile Sector.The study here assists the aerodynamic flow over a Go-kart, and the optimization of drag factor. In this study the body works of the vehicle are designed in CATIA V5, and simulation is performed on ANSYS. Using Computational Fluid Dynamics (CFD), the flow over the Go-kart is observed.The study intends to reduce the drag by proposing a design of body works. The Body works of Go-kart also carries an aesthetic aspect as well as aerodynamic. The bodyworks design is inspired by a bird wing structure.This omits the vortex formation over its surface using a reinforced angle of attack to the wind direction. The body works thus observed from the study could be used in Go-kart of 100cc-150cc. A low level and light vehicle like Go-kart, can achieve an average speed of 90kmph, with a 125cc engine installed.The optimization of drag here becomes a crucial factor, so that the fuel energy thus saved will be used for speed generation by engine. The total tractive effort by the engine is also reduced. The Go-kart study is an attempt to study the aerodynamic flows over a Racing Kart.

Keywords: Aerodynamics, Body works, Drag, Go-kart

1. Introduction:

Aerodynamics initially was and is even now the prominent factor for the design of aviation vehicles and rockets. But since 1920s the automobile sector also admitted theimportance of aerodynamics into its vehicles and it came as an inevitable aspect of vehiclebody engineering.

Go kart is a small but fast vehicle which is easy to engineer but requires optimum focus on its design to optimize factors which affect its efficiency and mobilization to the most near idlelevel. And not to mention engineers use aerodynamics at its end limit by directing themovement of air in various directions to decrease the drag force and also to turn lift force into

the most helpful value.

Of course, there are numerous other factors which affect the efficient performance of anyvehicle but the easiest and the one factor with least maintenance after the vehicle is designedis its aerodynamic drag factor. And all the high-end vehicles like Bugatti Chiron andLamborghini utilize this aspect of design to a maximum level. But go-kart which has thehighest manufacturability is famous among young engineers and independent creators andthey can rarely afford time and resources such as software to perform deep analysis in thisaspect of vehicle design [1]. That is why this study aims in delivering answers to such questionsand queries to such fellow mates who can easily mend their results and designs for theoptimum performance of their vehicle.

1.1 About Go-Kart

Go-kart vehicle is made considering the weight, cost and speed effectiveness. The chassisdesign is optimized to be smaller so that there is ease on turns. The DTSI engine, thus usedhas a twin spark ignition leading to complete combustion and lesser weight. The shaft andstub-axels used is of EN-8 material. Different researchers have worked on the increase in performance of the Go-kart. Gianluca and Marco had worked on the optimization of aerodynamic in Go-kart for achieving a world record speed. In their work a standard chassis is modified and the roll cage are included to protect the pilot. For better aerodynamic performance the side pods and the front nose are replaced and the chassis is attached with an external shell. They focused on finding the best effect of pressure load on the aerodynamic of aircraft on varying the speed of kart.

1.2 Aerodynamics of Go-kart

The bodyworks of the go-kart are an essential part of the go-kart manufacturing.The bodyworks help in directing the flow in streamline fashion, that may cause disturbance to the driver as well as increase in drag. It happens because major section/ parts will be in direct contact with the air, thus increasing the air striking area. The design of the bodyworks is inspired by the wings of falcon.The bodywork structured has the same grade to surface area ratio, and the flow is streamlined, without generating any cusp in the flow. The design enables flow to stick to the surface. The triangular section on the front section allows the flow to direct towards the either side, without deflecting much in the middle section, where the driver sits. The go-kart has been modeled in CAD software and further FEM analysis is performed [1]. Tor-Vergata karting research group has analyzed aerodynamic drag forces and down forces on different components of low weight go-kart vehicle, by the help of Computational Fluid Dynamics (CFD) test on ANSYS [2]. They find out the forces on components as like total lift was 30N and total drag was 173N. The contribution of components to global drags was 33% of driver, 20% of wheels, 15% of front spoiler and deflector and 10% radiator. They used parameter like front area is 0.57484 m square, density 1.2 kg per meter cube, speed 90 kph of go-kart to find out coefficient of drag [3,4]. They got coefficient of drag was 0.78(CFD result graph between coefficient of drag and speed).According to Wolf-Heinrich HuchoOstringon road vehicle having the lots of aerodynamics effects exerted due to its large geometrical and mechanical complexity and the surface areas shape and size.All the aerodynamics effects have estimated by the Computational Fluid Dynamics test, in the automobile industries the CFD test had become the first priority to interest in numerical method is to save time during product development [5].Moffat has also worked on the different aerodynamic forces acting on the kart.According to them aerodynamics forces can be controlled by changing the vehicle design and add or remove its parts [6]. Vipul et. Al. in their work discussed the importance of downforce and optimization of engine capacity and aerodynamic drag. The vehicle speed has a cubic relation to the force of drag, states that a small change in the speed of the car can require a large amount of engine power to overcome the drag force[7].

2. Specification of Model used for study

The Go-kart used for study has the following specifications.

Engine DISCOVER, DTSI-125cc, weighing 13.5kg.

- The Kerb weight is 95kg.
- Steering Ackerman Geometry.
- Chassis Material- AISI1020
- The exhaust noise is optimized to 75 dB
- The Wheel Base is 43”, track-width front 34”, track-width rear is 40”
- The caliper used is Bajaj Floating Type caliper.
- The brake disc is of 160mm.
- The bumper material is Aluminum.

2.1 Engine Specifications

1. Engine: DISCOVER 125 DTSI
2. Clutch type: Wet Multi Plate
3. Rolling Resistance: G.V.M * C.R.R*cos15*g
   =150*0.022*0.966*9.81
   =31.272 N
4. Aerodynamic drag: 0.5*density*C_D*A*V^2
   =0.5*1.225*0.22*0.6*$(22)^2$
   =38.5 N
5. Grade resistance: G.V.M*sin15* g
   =150*sin15*9.81
   =380.852 N
6. Total tractive effort (TTE): R.R+A.D+G. R
   =31.272+37.966+380.852
   =450.09 N

2.2 Position of Bodyworks

The placement of the bodywork is according to the chassis and go-kart requirement. The position of body work is shown in figure 1 and figure 2.

Figure 1: Bodyworks position

Figure 2: Bodyworks position on frame

2.3 Chassis dimension: The dimensions of the chassis are

Front track width 34 inches

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

Rear Track width 40 inches
Wheel base 43 inches
Overall length 58 inches

2.4Mounting of bodyworks

The bodyworks are mounted over the bumpers, mounted over the chassis, to cover the peripheral flow around the go-kart are shown in figure 3 and 4.

Figure 3: Bodyworks after surface finishingon chassisFigure 4: Bodyworks after painting

The body work dimensions:

Front Section: Width 46 inches, Length 8 inches, Height 6 inches, Thickness 6cm
Nose Section: Mounted at angle of 20 degree downward from the horizontal place situated at the top of nose.Overall Length is 18 inches, Thickness 5 cm
Side Section: Width 6 inches, Length 16 inches, Thickness 5 cm
Tail Section: Width 46 inches, Length 4 inches, Height 6 inches, Thickness 5cm

2.5 Material used

Glass Fiber is readily available, cheap and easy to mould. Glass Fiber is set using the hardener and resin. The ratio of hardener to resin is 20ml of hardener in 1 litre of resin.

2.6 Mould

The mould was created using G.I sheet of 1mm thickness, and negative moulding was used to create the bodyworks. The mould was brushed using grease or oily substance (Vaseline). Cling wrap was laid on the greased surface, 1st layer of resin + hardener was stuck to the surface and fiber glass was layered on it, the same process was repeated two more times. Along with the hardener colour substance is also mixed i.e. 20-30 ml, as per the depth of colour is required. The mould is allowed to dry for 24 hours, 18 hours not in direct contact with sun and 6 hours in sun rays.

The bodywork is then extracted and is rubbed using sandpapers of 150 grit. Then layers of putty are applied on the bodyworks, allowed to rest and get hardened, different sandpapers of 150,400 and 600 are used to get the smooth surface. Layer of surface is

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

sprayed using paint gun. Desired colour can be sprayed on the bodywork, and the finished product is achieved after 24 hours of colouring.

3. Results and Discussions

The body works used in this model for study is compared with two other models. The drag produced by the body work is determined by ANSYS fluent and due to this, the velocity and pressure distribution across the body work is evaluated.The software used for designing and simulation are CATIA V5 and Ansys Workbench 15. The designing of the body works was done by multiple iterations and by analysing various body works design. The design use for study was inspired from Falcon wings.

The assumptions considered while designing the body works are

1. The speed limit of the go-kart varied from 70-95 kmph.
2. The weight of go-kartranges from 100-130 kgs.
3. The front track width of the go-kart ranged between 30-34 inches.
4. The weight of the body works ranged from 5-10 kgs.

3.1 Velocity Streamline

Model 1

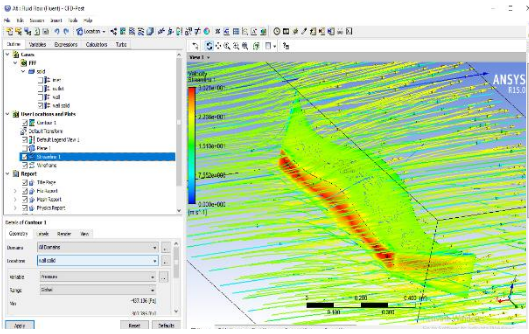


Figure 5: Velocity Streamline for Model 1

Model 2

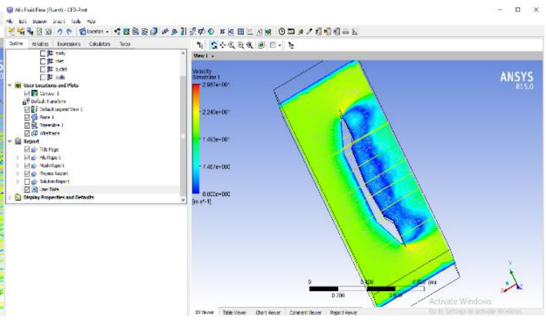


Figure 6: Velocity streamline for Model 2

Model 3

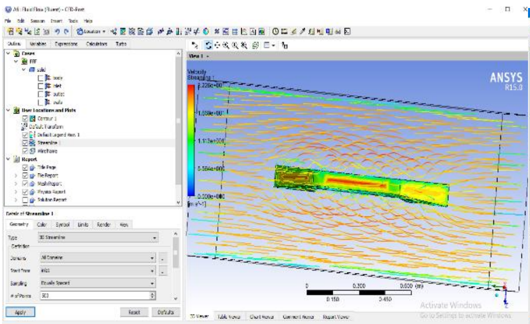


Figure 7: Velocity Streamline for Model 3

Velocity streamline of complete body work

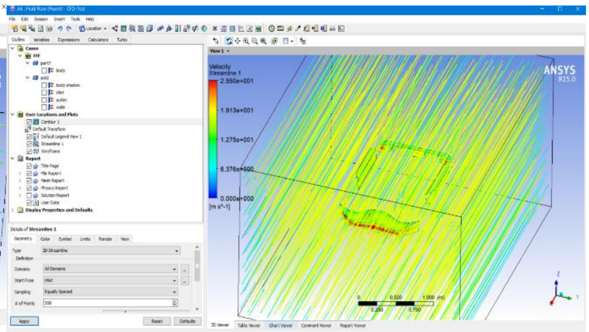
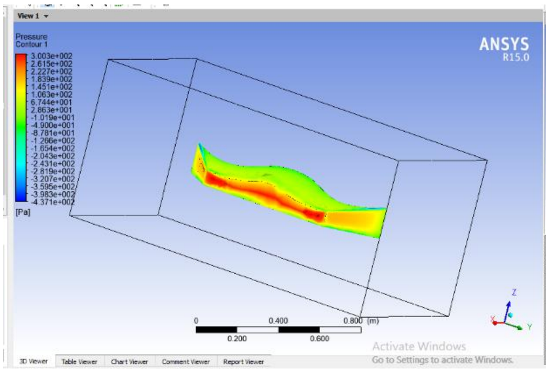


Figure 8: Velocity streamline for complete bodyworks.

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

3.2 Pressure Distribution and Drag force

Model 1:



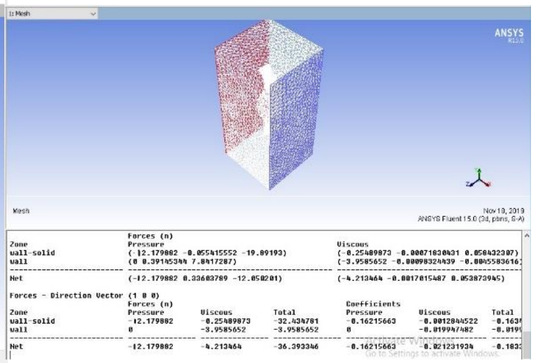
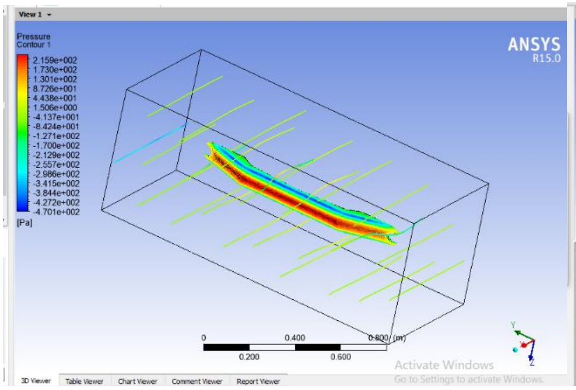


Figure 9: Pressure distribution for model 1

Figure 10: Drag force in x-direction

Model 2



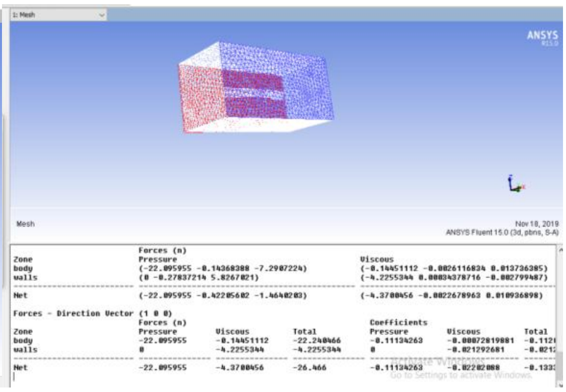
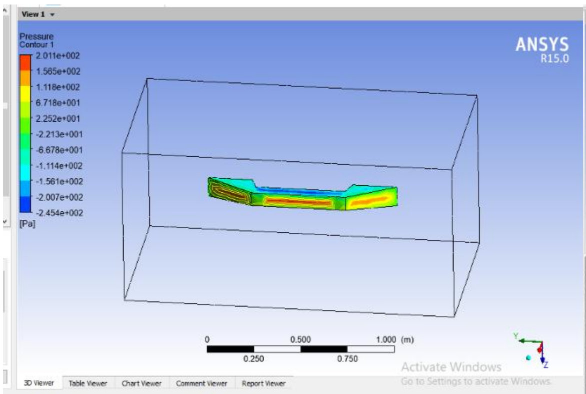


Figure 11: Pressure distribution in model 2

Figure 12: Drag force in x-direction

Model 3



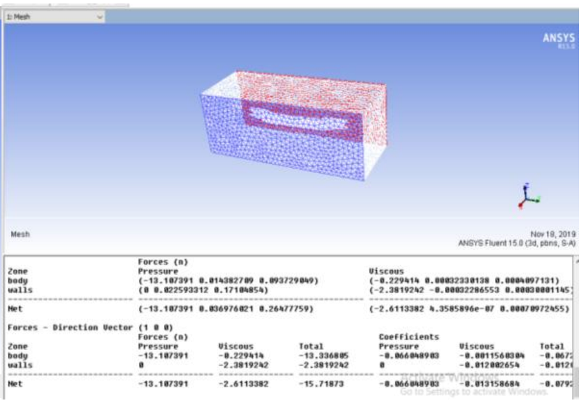


Figure 13: Pressure distribution in model 3

Figure 14: Drag force in x-direction

From the analysis it is found that the maximum velocity achieved over model 1 is 30.209 m/s as shown in figure 5.The surface shows lesser failure, flow bleeding is less in model 1, than model 2 and model 3. The maximum velocity achieved in model 2 is 29.866

ISSN: 0971-1260
Vol-22-Issue-17-September-2019

m/s and in model 3 it is 22.2562 m/s as shown in figure 6 and figure 7. The pressure distribution in model 1 i.e. figure 9 is less than that in model 2 due to less frontal area interaction and hence drag produce is less as shown in figure 10 of about 12.18 N. The model 2 has more frontal area exposed, hence drag experiencedis morei.e. about 22.1 N as shown in figure 11 and figure 12. In the model 3, the frontal area exposed is very less, such designs are for Go-kart very low to ground and drag force is 13.11 N as shown in figure 14. Least flow separation is observed in model 1, the flow is continuous and sticks to the surface. The flow separation observed in model 2 isdistorted and is bleeding throughout the surface. In model 3 bleeding is more, the geometry doesn't support the flow, the bleeding is observed over the sharp edges, that separates the flow and distortion occurs.

4. Conclusions

The Go-kart thus build is an 125cc-DTSI installed, with the exhaust built and tyres for all weather conditions. The top-speed is 90 kmph. The Go-kart is thus optimized to face lesser drag and the better use of fuel energy. The optimization of study will lead to body works that can be installed in a 100cc-150cc kart. Such studies are a step towards sustainable development and better use of fuel energy. The study will open ways for the optimization of drag over small vehicles. The aerodynamics over vehicle has always been a challenge to the manufactures of the Vehicles. The Go-kart is the first step to the F1 racers; thus, such study will allow the better understanding of speed andaerodynamics.

References

[1] ManieriGianluca, Urbinati Marco, "DESIGN OF A LAND SPEED RECORD GO KART" University ofRome "TorVergata", Italy, F2006SC16- F2006SC17

[2] Hitoshi Takagi, "Real-life coefficient of drag- A simple extraction method", Auto Technology, Volume No.4, pp. 52-56, August 2005

[3] M.E.Biancolini, F.Renzi, G. Rizzoni, "Design of a lightweight chassis for land speed record vehicle Buckeye Bullet 2", International Journal of Vehicle Design, Vol. 44, Issue no.3/4,pp. 379-402, Jan 2007.

[4] A.A. Faieza, S.M.Sapuan, M. K. A. Ariffin, B.T.H.T.Baharudin and E.E. Supeni, "Design and fabrication of a student competition based racing car", Scientific Research and Essay, Vol.4, Issue 5, pp.361-366, May 2009.

[5] Wolf-Heinrich Hucho, "Aerodynamics of road vehicle", Annu. Rev. Fluid Mech.25; pp. 485-537, 1993.

[6] Jason Moffat, "Aerodynamic Design & Preparation of a Road Vehicle for Racing application", School of Engineering Blackpool and the Fylde college, Nov 2016.

[7] VipulKshirsagar, Jayashri V. Chopade, "Aerodynamics of High-Performance vehicles", International Research Journal of Engineering and Technology (IRJET), Volume:5, Issue: 03,pp. 2182-2186, Mar 2018