International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 07 | July 2021 www.irjet.net p-ISSN: 2395-0072

# Drag Reduction using Rear Wing Spoiler

**Amar Jadhav[1], Harshavardhan Karale[2], Vineet Kundal[3], Kunal Jambhale[4], Tejas Kalel[5]**

*[1]Professor, Automobile Engineering, PHCET RASAYANI, MAHARASHTRA, INDIA*
*[2,3,4,5]B.E. Student, Automobile Engineering, PHCET RASAYANI, MAHARASHTRA, INDIA*

---

**Abstract -** *The goal of this work is to analyze the variation in flow physics and the effect of opposing wind on the rear wing spoiler on different angles applied on a sedan car. For this purpose CFD analysis and fluent with solid works is used for observation. With the recent years, inflation in the fuel prices & the demand to have reduced greenhouse emissions has played a significant role in re-explaining the car aerodynamics. The shape of the vehicle uses about 3% of fuel to overcome the resistance in urban driving, whereas it takes 11% of fuel for the highway driving. This considerable high value of fuel usage in highway driving attracts several design engineers to enhance the aerodynamics of the vehicle using minimal design changes. Besides, automotive vehicles have become so much faster experiencing uplift force which creates unexpected accidents. This brings the idea of using external devices such as spoiler which could be attached on vehicle without doing any changes to body. This paper is based on the design, development and numerical calculations of the effects on spoiler, which will be mounted at the rear side of the sedan car to make the present vehicles more aerodynamically attractive. The influence of rear spoiler on the generated lift, drag, and pressure distributions are investigated and reported using commercially available software.*

***Key Words*: Spoiler, Sedan Car, CFD analysis, Simulation**

## 1.INTRODUCTION

Aerodynamics is the study of how moving objects interact with the air. How the body behaves when it comes in contact with the air which determines the forces induced by the air flowing over and around the body of a car. There is an aerodynamic force created by the pressure and shear stress distribution over the wing surface. Over the past few years, the degrading air quality and the shortage of natural resources primarily oil, have tremendous pressure on automotive manufacturers to come up with some practicable solutions to overcome this crisis. In earlier times, high-speed cars were only dependent on the horsepower of the engine to maintain the performance segment of the vehicle. But in recent upcoming years, design engineers are adapting the concepts of aerodynamics to enhance the efficiency of the vehicle. Driving the car is like swimming through the endless ocean of air. A spoiler is an automotive/manual aerodynamic device whose intention design function is to "spoil" unfavorable air movement across a body of a vehicle in motion, usually it is described as drag. Drag is a force that acts parallel to and in the same direction as the airflow. The drag coefficient of an automobile measures the way the automobile passes through the surrounding air. For better cruise conditions, greater stability of navigation, and for low energy and power consumption, the car body and frame is designed in such a way that it reduces its total weight & improves the vehicle's overall aerodynamic performance so that it can smoothly move o he road. These subjects are also indirectly related to environmental protection and noise pollution. In the process of car design, the aerodynamics must be solemnly considered. A car design is only acceptable if drag is reduced properly without any accidents. Many researchers have made use of CFD techniques (2-5) to perform numerical simulations related to automobile.

Engineers apply the principles of aerodynamics to the designs of many different things, including buildings, bridges and even soccer balls; however, of primary concern is the aerodynamics of aircraft and automobiles. This is a study concerns about the airflow around the vehicle body. It turns out that the science of aerodynamics is directly tied to all of these elements, and most of us intuitively relate higher speeds to reduced fuel economy.

## 2. LITERATURE REVIEW

John G. Aerni et. al, author explained, Design of a hybrid electric vehicle chassis for the 1993 and 1994 HEV Challenge is presented. Computer finite element modelling and solid modelling techniques were used in developing the chassis. The main design parameters are presented and described. Final chassis design was tested, using finite element analysis, to ensure overall structural integrity and occupant safety. The chassis proved to be safe and reliable, under the rigors of competition driving, in the 1993 and 1994 HEV Challenges. Author observed, A high-technology computer-aided approach was utilized in the chassis' structural system development. Computer solid modelling and finite element modelling were used extensively in the chassis design. Solid modelling was especially helpful in packaging the components, deciding mount locations, verifying vision requirements, surfacing the body, and provided an accurate visual aid. Finite element analyses were instrumental in determining structural member locations and cross-sections. Structural integrity finite element analyses were performed to ensure that the chassis would be safe and able to withstand the excessive rigors of competition. I-DEAS proved to be a valuable tool in the development of the chassis.

Dominic J. Bologna, author described, the oldest dropping dumping has been conceived by observing the difficulty in unloading the sand or assets. there is survey in these regards in automobile garages, revealed the facts that mostly difficult methods were adopted in unloading the materials from the trailer or dumper. This paper has mainly on above difficulty. Hence a prototype of flexible arrangement has been designed. Vehicles can be unloaded from the trailer in three axes without application of any other force. There is way of the mechanism are be control with the help of ball and socket joint which connected to ram of the hydraulic cylinder which lifting the dumper cabin in require side. Further modifications and working limitations will put this work in the main league of use. This research paper is help to. and terne coated steel. This study of author has dealt with the materials and painting processes employed by Chrysler to build corrosion resistant cars and trucks to last. Continued engineering and manufacturing plans predict even more use of galvanized product in the coming years. The primary grade for exterior panels in use today is 1-1I2-side galvanized steel. As the application of more corrosion resistant materials continues, together with cathodic electrodeposition primer and durable enamel top coat systems, cars and trucks are expected to achieve outstanding corrosion resistance.

T. G. Chondros et. al, author state, Electric vehicles are once again attracting much attention as an important solution to the problem of improving air quality. Research and development efforts are moving ahead and steady progress is being made. Day by functionality of their mechanical and electrical day, a lot of progress is being made in the fields of range, acceleration, economy, and also energy and power density and recharging time of the batteries, which are the main drawbacks of the electric vehicles. The process of design and manufacturing, beginning with an idea and ending with a final product, is a closed loop one. The computer-aided analysis capability serves as part of the process and is also used as a model simulator for manufactured end product Since FULD in electric cars is in a quick progress and changes and modifications in the arrangement and parts are everyday practice, a simplified tool is necessary for the chassis design. The outlined procedure provides a complete solution to the problem of the design of the chassis for a small electric car. First it provides an initial estimation of the frame elements through a finite element static analysis and, furthermore,

A. D. Deshmukh et. al, author derived, the car industry uses a tremendous number of materials to build cars, including iron, aluminium, steel, glass, rubber, petroleum products, copper, steel and others. Given both domestic and foreign sources of information, it follows that car manufacturers are constantly pushing to create the lightest cars possible to increase speed and power. Research and development into lightweight materials is essential for lowering their cost, increasing their ability to be recycled, enabling their integration into vehicles, and maximizing their fuel economy benefits. Light weighting without loss of strength and speed properties is the present, and the future, of the automotive manufacturing industry. It brings innovative materials to the frontline of design. Thus, we can conclude that the automotive industry is not standing still and developing to the satisfaction of the consumer who wants a fast and safe car. At the expense of innovative development of automobile industry, it is possible to realize competitive products both on the national and international markets, which will ensure the country's entry into the international economic community.

Kristina Berladir, author observed , The solution to this problem is to design and build a lightweight foldable bicycle. Also, incorporating an electrical system further improves its versatility. A foldable electric bicycle is a bicycle designed to fold into a compact form, facilitating transport and easy park with an integrated electric motor. It provides healthy mobility by enabling riders to incorporate moderate exercise into everyday travel routines. The foldable electric bicycle offers a flexible mode of transportation. Author resulted, the current prototype is built using steel frame. Such This leads to the fact that in the production of cars used increasingly new materials that meet modern requirements.

Sachin Johny et. al, author explained, the rising cost of fossil fuels and the increasing level of greenhouse gas emissions have driven the need to find an economic and environmentally friendly means of transport. Usage of electric powered vehicles in such a context is becoming a phenomenon. Today, electric vehicles are both cost-effective and environmentally friendly. Cycling is a preferred mode of transport among people for short distances. But the major obstacle to its use is portability. Most bicycles available on the Indian market have a heavyweight steel frame instead of lightweight frames weigh more than frames constructed from aluminium and carbon fibre. Thus, affecting the portability. The use of a lightweight frame and the incorporation of a foldable handle can improve the portability and compactness of the bicycle. In addition, incorporating new battery charging technologies from renewable resources and tracking the rider's lifestyle in future models will increase its market value and make it exclusive.

Nico A.J. Langerak et. al, author state, Hogeveen's has developed a concept for a car body, based on both steel and aluminium, which can fulfil the future requirements for so called three litre cars. The purpose of this design study was to develop a car body with a maximum weight reduction combined with low production costs in order to make the car suitable for mass production. In the paper, the developments at the new Hogeveen's Product Application Centre are shown on the basis of this design; the hydroforming of steel tubes, the forming of high strength steel, the use of tailored blanks, Steelite® and Hylite® sandwich materials and the application of aluminium body sheet. the developments at the new Hogeveen's Product Application Centre are shown on the basis of several projects aimed at helping our customers to make lighter cars, using both steel and

aluminium. These projects focus on five topics by which this can be reached, the use of hydroformed components. the use of high strength steels. the use of tailor-made blanks. the use of aluminium hang-on parts. the use of sandwich materials. The application of these materials and techniques in a design for a lightweight family car results in an estimated weight saving of about 35% compared to the body of comparable cars produced today.

Petr Noskievič, author described , The paper presents new concept of control of the linear hydraulic actuator. Linear hydraulic actuators are used in the industry mainly for manipulation with heavy products and in the technologies, which requires high forces, dynamic movements and high accuracy. Due to the design of the production equipment's the differential cylinders are used for the realization of the linear hydraulic servo drives controlled by the servo valves. The real properties of the classical concept of the hydraulic servo drive will be summarized and new concept of control based on the full hydraulic resistance bridge will be presented in the paper. Finally, the realization of the integrated actuator will be shown and results from the laboratory testing of the digital closed loop control using the embedded control system will be demonstrated. The presented linear hydraulic actuator controlled by the full hydraulic bridge realized by four proportional control valves allows the position, velocity and force control. The advantage of the described concept is also simple realization of the combined tasks like positioning, high speed back movement and force control. The change of the function of the drive is done at the control level only using the specific control algorithm and the same hydraulic circuit is in operation. The alternative control concept is based on control of both cylinder chambers independently by separate proportional control valves, which are integrated in the manifold directly on the cylinder.

Mathew Holloway et. al, author explained, an innovative design for a folding robotic vehicle is presented that can deploy through small openings into crawl spaces and underfloor voids to survey and carry out operations within them. The mechanism employs a four-bar linkage, enabling the axles to be extended away from the chassis and the axle to be deployed in line with the chassis, thus producing an elongated but small cross-sectional area. In its low cross-sectional area form the device can be fed in through a small opening and once in position, the axles can be rotated into their functional position and locked in place. To remove the robot the mechanism works in reverse, with the axle is unlocked and rotated in line with the chassis This transformation is a key enabler for deployment and practical applications of this type of robot. mechanism has been the commercially developed and used for both survey and applying treatments in a wide range of building applications, although other uses are possible. This paper describes the practical aspects of the mechanism as an enabler for the transformation of a robot chassis for accessing confined spaces. An innovative design for a folding robotic vehicle is presented that can deploy through small openings into crawl spaces and underfloor voids to survey and carry out operations within them. The mechanism employs a four-bar linkage, enabling the axles to be extended away from the chassis and the axle to be deployed in line with the chassis, thus producing an elongated but small cross-sectional area. In its low cross-sectional area form the device can be fed in through a small opening and once in position, the axles can be rotated into their functional position and locked in place. To remove the robot the mechanism works in reverse, with the axle is unlocked and rotated in line with the chassis This transformation is a key enabler for deployment and practical applications of this type of robot. The mechanism has been commercially developed and used for both survey and applying treatments in a wide range of building applications, although other uses are possible. This paper describes the practical aspects of the mechanism as an enabler for the transformation of a robot chassis for accessing confined spaces

ANDRÉ CERVIERI et. al, the aim of author's work is to design and analyse the structure of a chassis of a sports car. The chassis structure is fundamental in design efficiency, for in it are fixed mechanical parts that make up the steering system, suspension, and traction, among others. The chassis geometry was designed in SolidWorks 3D CAD program and the numerical analysis was performed using the Finite Element Method (FEM) with FEMAP program. The chassis was designed using average surfaces in order to use the formulation of shell elements on analysis with finite element method. Using this methodology was possible to realize static and dynamic analysis to check how the structure will behave when subjected to static and dynamic loads during travel the vehicle. The analysis allows to estimate the magnitude and the form that loads acted on the chassis frame used to verify security, and if the structure is suitable for a sports vehicle with tubular chassis. Thus, one can determine the points of least resistance and alter the geometry to eliminate critical points. The results were used to evaluate the project with respect to their suitability the norms the results were a torsional rigidity 1639 Nm / °, meeting the standards of a ladder frame type according to the Standard Fiat, Torino, 2002. The vibration frequency modules obtained in the analysis was 34.4 Hz for the first module and 41.5 Hz for the second module.

M.G. Rajapakse at. Al, author conclude, Stainless Steel Sports car, or sports car, is a small, usually two-seater, Two-door automobile designed for spirited performance and nimble handling which include quick response, easy manoeuvrability, high acceleration for high (Sports car". Merriam-Webster.com, 2017; " Collins Dictionary, 2017). In order to achieve these requirements lightness is a mandatory requirement. Stainless steel used in making frames of car chassis contributes significantly to the overall weight of the motor vehicle. In this review, we discussed materials that are used in manufacturing motor vehicles with particular emphasis on sport cars. Here, we considered the weight reduction of sport cars as of primary importance and hence starting from Stainless Steel that is originally

used, we discussed its replacement by lighter materials. In doing so, Aluminium alloys were the first to be used. We further discussed clay-electronically conducting polymer nanocomposites that we have developed. These materials are excellent catalysts for the oxygen reduction half-reaction of fuel cells. Since they are of very low-cost compared to traditional C-Pt catalysts sport cars powered by fuel cells can be realized in the near future.

Paul Verhoeven's et. al, author explained, design for sustainability (DFS) is a holistic approach that covers all environmental, economic and societal factors. Unfortunately, the integration of sustainability aspects into the design process tends to complicate material selection process. In order to ensure that does not happen there is a need for tools to support designers and help them to achieve their sustainability goals. Rather than attempting to develop local optimisation problems (e.g., minimise energy used, reduce CO2 emissions, minimise the mass, etc.), using current sustainable material selection method may afford best tool to incorporate all sustainability aspects in one design model (i.e., global optimisation problem: sustainable lightweight design). Materials selection indices and material selection charts are good tools for materials selection in early conceptual design stage. In the field of mechanical design, these charts are a simple and quick way of assessing whether a material is suitable for the case in hand. By taking these charts and extending their range to include sustainability concerns, designers may consider them in exactly the same way they consider other material properties.

Paul Verhoeven's et.al, author described, The Deep Orange initiative is an integral part of the automotive graduate program at Clemson University International Centre for Automotive Research. The initiative was developed to provide the graduate students with hands-on experience of the knowledge attained in the various engineering disciplines and related disciplines (such as marketing and human factors psychology). For the 3rd edition of Deep Orange, the goal was to develop a blank sheet hybrid mainstream sports car concept targeted the Generation Y (Gen Y) market segment. The objective of this paper is to explain the unique body-in-white (BiW) concept that offers space for 6-passengers and includes a dual-mode hybrid all-wheel drive powertrain. An additional objective of the project was to develop and showcase a body-in-white concept that will eliminate metal stamping and high capital investments associated with this technology (such as dies and stamping tools'. Once the properties and design targets were met, the complete sheet Folded Metal Technology (FMT) design was realized using aluminium and structural adhesives. In addition to describing the conceptual analyses, the paper will also elaborate on the final realization of the BiW concept.

Li Jie Zhao et. al, author's experiment as the result, one chassis folding type car is introduced. In the meantime, three-dimensional structure model is built and the kinematic and structural analysis are conducted through professional packages. By analyse folding principle of different folding cars, this paper investigates to design a chassis contraction folded and body raised type car. According to the designing result, the prototype of the car is assembled and tested at the same time. With one DOF, interference occurs easily as folding, so the design of front and back body is very important which should be paid more attention in the future research. For the analysis of structure and movement, 3D model is built by the use of UG and kinematics analysis is executed to ensure comfortableness for passenger when the car folds. In succession, the modal analysis embedded in ANSYS package is conducted to find the natural frequencies and mode shapes of chassis. The results are evaluated for the chassis structure. Flaws can be found and modified in the chassis structure, and theoretical conclusions can be utilized to improve chassis structure. In the future, more tasks are needed, Make the modification to eliminate the defect existing in present prototype. Perform static and dynamic analysis under different loads to verify the strength of chassis. A kinematics analysis under more complex conditions should be conducted for further work.

## 3. CONCLUSIONS

To reduce space consumption concept of folding car efficient. By folding mechanism, we can increase volumetric efficiency of parking lot or space. To introduce folding mechanism for car lightweight materials in compulsory. Folding mechanism is more suitable for electric cars instead of IC engine cars. The geometry of the folding car can be design by using cad software in three dimensions. Using finite element method, it is possible to obtain reliable result at lower cost and faster that production of an experimental model for testing.

## REFERENCES

1. T.G. Chondros, S.M. Michalitsis , S.D. Panteliou , A.D. Dimarogonas " Chassis Design For A Small Electric City Car " February 28 – March 3, 1994 SAE TECHNICAL PAPERS SERIES 940294.

2. Antonio Flavio Rodrigues, Andre Luis Rosa Poncio, Andre Cervieri, Luiz Carlos Gertz, Moises Da Silva Pereira, Anderson Bonsanto Oliveira "Static & Dynamic Analysis of a Chassis of a Prototype Car" September 22 to 24 SAE TECHNICAL PAPER SERIES 2015-36-0353 E.

3. Petr Noskievic "Smart Control of the Integrated Hydraulic Actuator" VSB – Technical University of Ostrava.

4. Sachin Johny, Sachin S. Kakkattil, Sachin Sunny , K.S. Sandeep , Vishnu Sankar " Design And Fabrication Of Foldable Electric Bicycle " ELSEVIER.

5. Paul Verhoeven's , Keith Bell , Parathmesh Marathe , Aniket Patkar , Frederick LaMance, Daniel Lind & Chris D' Amico " Application Of A Novel Metal Folding Technology

For Automotive BiW Design" 04/08/2013 SAE International 2013-01-0373.

6. Nico A.J. Langerak, Simon p. Kragtwijk, "The application of steel and aluminium in a new lightweight car body design", SAE technical paper 1998.

7. John G. Aerni, Clark J. Radcliffe and John L. Martin, "Design and analysis of a hybrid electric vehicle chassis", SAE technical paper 1995Hovorun T. P., Berladir K. V., Pererva.

8. V. I., "Modern materials for automotive industry", Journal of engineering science 2017. Ahmad Mayyas, Ala Qattawi, Mohammad A Omar, "Sustainable lightweight vehicle design: A case study of eco-material selection for body –in-white", International Journal of sustainable manufacturing 2012.

9. Dominic J. Bologna, "Corrosion resistant material and body paint system for automotive application", Chysler Motors corp 2018.

10. Review of low cost and light weight novel nanocomposite material for application in sport car component; T. Piumnil gamagedara, W.P.S.L Wijesinghe; University of Peradeniya.

11. Mr Mathew Holloway, dr. maiguel Julia, "3 way hydraulic dumping trolley", IJSRT 2017.

12. W.M. Davis, "Folding mechanisms overview", Agricultural machinery conference 1985.

13. Abhimanyu Deshmukh, Vivek Patil, Vivek Chavan, Mahesh kadam, "Folding mechanism for remotely deployable robotic vehicle", int. journal for scientific research &development 2016.