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Design and Analysis of Car Rear Spoiler by Using Different Composite Fibres

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ABSTRACT: The ever-rising price of crude oil, in conjunction with growing concerns about the state of the planet, has led to an increase in the amount of pressure that is being put on automakers to produce vehicles that consume less fuel and produce fewer harmful emissions. This is a direct result of the combination of the two factors. As a direct result of this, an increased amount of pressure is now being applied to the individuals and organizations who are accountable for the production of commodities. During the course of the last several years, the automotive industry has placed a significant emphasis on the development of vehicles that use a lower volume of gasoline than their forebears did when they were first produced. It is anticipated that this pattern will go on for the foreseeable future. As part of this initiative, a significant amount of time, energy, and focus is now being devoted to the research and development of novel approaches that may enhance the aerodynamic performance of automobiles. This program's overarching objective is to lessen the amount of resistance to forward motion that moving vehicles produce. It is feasible to increase the fuel economy of a car, which would be beneficial for the protection of the environment. This enhancement might be achieved by reducing the amount of air resistance that the vehicle encounters, which is in part performed by the car's spoiler. Even while travelling at moderate speeds and maintaining a height that is relatively small above the ground, the drag coefficient has a significant influence on the quantity of fuel that is successfully consumed by the vehicle. This is due to the connection that exists between the two contributing components. The primary objective of this study is to make use of a simulation of computational fluid dynamics (CFD) in order to ascertain the impact that a rear spoiler has on the flow of fluid as well as the amount of effective drag that a vehicle is subjected to. This will be accomplished by determining the amount of effective drag that a vehicle is subjected to. To achieve this goal, we will investigate how the presence of a rear spoiler influences the flow of fluid. To be able to achieve our goal, we are going to measure the amount of effective drag that is experienced by a vehicle. This will make it feasible for us to do what we set out to do. SOLIDWORKS is a computer-aided design (CAD) application that was used throughout the whole of the process of generating the model of the automobile. This programme was used during the entire procedure. This programme was utilized throughout the whole process of creation in its many guises. An assessment and optimization of a system based on the Reynolds-Averaged Navier-Stokes (RANS) equations and a Reliable k- turbulence model were carried out with the assistance of the commercial software package. Both of these processes were carried out. ANSYS 18, FLUENT CFD Solver. The effects of aerodynamic drag won't start to become noticeable to the human eye until the vehicle has reached very high speeds. Before then, you won't be able to see them. While the person who was going to be the subject of the study sat in the seat that was furthest towards the back of the vehicle, researchers conducted research and made assessments on a number of different topics. These topics included things like velocities, pressures, streamline profiles, and velocity graphs.

KEYWORDS: Spoiler, Computational Fluid Dynamics, Automobile, drag coefficient

I. INTRODUCTION

Aerodynamics studies gas-body interactions. Aerodynamics studies lift and drag as air travels over and around solid structures. Air is our most common fuel, therefore this makes sense. The car consumes 3% of its petrol in urban areas and 11% on the motorway. Urban vehicle resistance causes this discrepancy. Several design experts are interested in improving vehicle aerodynamics with simple design changes due to highway driving's high fuel consumption.

Engineers may use aerodynamics to create buildings, bridges, soccer balls, and even aircraft and automobiles. Engineers can design skyscrapers, bridges, and soccer balls using aerodynamics. This study examines airflow issues across the whole vehicle. Aerodynamics is linked to all of these components, and most people instinctively associate

higher speeds with worse fuel efficiency. Not so. Automobile aerodynamics includes engine cooling, cabin ventilation, air conditioning, aerodynamic noise reduction, high-speed stability, dirt deposition, and much more.

We'll discuss structure exterior aerodynamics next. A moving vehicle must overcome body resistance, driveline friction, elevation variations, acceleration fluctuations, and aerodynamics. In aerodynamics, a "back spoiler" is a device attached to the roof or boot deck's trailing edge to boost aerodynamic efficiency. This makes the vehicle more aerodynamic overall. Despite increasing drag, the purpose is to improve downforce.

The vehicle's only external forces are aerodynamic drag and tyre friction over a level surface at a constant speed. Vehicle aerodynamics include wheel arches and lighting to minimise air resistance. It will feature a fastback or liftback tail and be streamlined to avoid sharp edges that block windflow above the windscreen. It will also be streamlined to avoid sharp edges that block windflow below the windscreen.

Vehicle aerodynamics research uses wind tunnel and computer modelling. The undulating road is typically introduced within a wind tunnel experiment to ensure accuracy. Aerodynamic drag slows vehicle movement. Aerodynamic drag force. This force is crucial for building the vehicle's exterior. It exerts 65% of the vehicle's overall force, hence it must be considered. The working component has a moveable floor that travels at the same speed as the airflow. Inhibiting a border layer on the working area floor affects outcomes directly.

Auto spoilers reduce drag and turbulence. Its goal is to "spoil" turbulence or drag on a moving vehicle. "Air dams" are another name for front-mounted spoilers. They reduce aerodynamic lift and drag by directing airflow and minimising airflow underneath the vehicle. Spoilers, originally designed for racing and high-performance sports cars, are now being used on passenger automobiles. Notwithstanding their racing and high-performance sports vehicle origins. Spoilers are used on automobiles to help them look better. In certain cases, these spoilers worsen the vehicle's aerodynamic performance. When a vehicle's fascia, which creates drag and down force, is physically removed, its rear spoilers become wings. Wings are aerodynamic, unlike spoilers. Before the oil crisis, cars were intended for high-speed agility, comfort, and safety. Nevertheless, since 2003, rising oil prices have hurt automobile sales worldwide. This impact began this decade. In the instant that followed, many doubts were raised regarding how a shortage of oil would affect this business. This incident prompted these questions. Several solutions have been proposed, and many that were previously dismissed are now being reconsidered. Besides fuel cell and electric vehicles, several research approaches have been proposed. Redesigning the car's chassis and body to save weight and improving its aerodynamics are examples. These tactics improve cruising conditions, navigational stability, and fuel efficiency. Several topics indirectly affect noise pollution and environmental protection. Aspiration and aerodynamics cause automobile noise. Aspiration noise occurs when the negative pressure on the vehicle's surface exceeds the sealing pressure. Only when the aspiration noise exceeds the pressure to seal the car can this happen. Most modern car designs account for the sealing system's pressure, which has improved the sealing mechanism and reduced aspiration noise. Nonetheless, aerodynamic noise outside a high-speed vehicle due to various airflows remains a key concern and requires substantial consideration.

II. LITERATURE SURVEY

When driving in urban areas, the resistance caused by the form of the car requires around 3% of the gasoline that is used by the vehicle, but travelling on the highway requires 11% of the fuel that is consumed. This very high value of fuel use when driving on the highway draws a number of design experts who are motivated to improve the aerodynamics of the vehicle by making just minor design adjustments [1]. In the realm of aerodynamics, a rear spoiler is a term that refers to a device that is often attached to the trailing edge of a vehicle's roof or trunk deck in order to increase the vehicle's overall level of aerodynamic performance. In spite of the inevitable increase in drag, the primary objective is to achieve an increase in down force [2]. The body of the vehicle is subjected to the force of aerodynamic drag, which works to oppose the forward motion of the vehicle. When constructing the outside body of a vehicle, it is essential to take into account this force, since it accounts for about 65 percent of the total force that acts on the whole body [3]. The model of the vehicle has been simulated in the wind tunnel as part of the research that has been carried out. In order to do this, the space surrounding the body is modelled after a section of the actual wind tunnel's dimensions and handled as such [4]. This shift in the direction of technological trends is based on the nature of composite reinforced natural fibres, which are plentiful in nature, can be recycled, are relatively affordable, and are less destructive to the environment than other types of materials [5]. The conclusion that can be drawn from this observation is that natural fibres are capable of producing favorable interfacial interactions with a matrix composed of resin. Because of this study, a new kind of biomaterial has been produced. It is made up of composite fibres made from

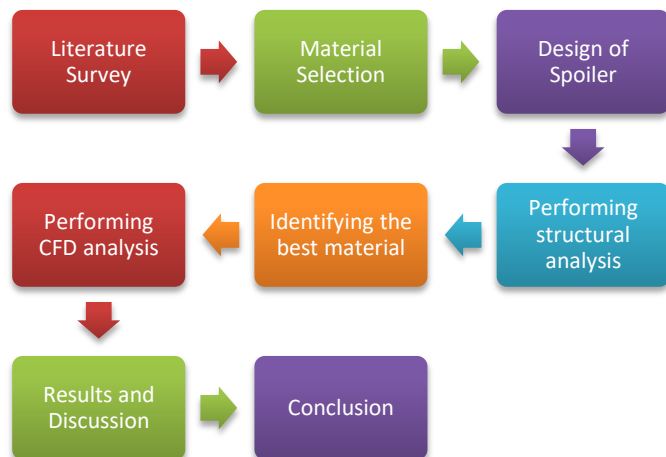


ramie, bamboo, and rattan, and it has a resin matrix [6]. When compared to fibreglass, the mechanical properties of some natural fibres, such as those found in ramie, bamboo, and rattan, are superior. For instance, certain natural fibres have a greater elastic modulus, a lower density, and a lighter weight than fibreglass. The specific strength of these natural fibres, on the other hand, is becoming closer and closer to the specific strength value of fibreglass [7]. A numerical analysis looked at the potential fuel savings offered by drag-reducing devices that may be installed on heavy trucks. The study came to the conclusion that such devices could cut fuel consumption by as much as 9 percent. The amount of money saved on gasoline each year varies from 600 to 2600 litres [8]. The shape optimization process takes into account all of the relevant constraints, such as the geometry, stress, and displacement. It will deliver a new optimum form to components that are either two-dimensional (2D) or three-dimensional (3D), while maintaining the lowest possible mass or weight, under all of these limitations. In this brave new world of faster computers, advanced structural analysis and optimization are now within reach, allowing for the design to be improved in a way that is both effective and efficient. It is strongly recommended to pay attention to form optimization techniques, as they are able to handle mechanical design difficulties in a more appropriate and effective manner [9]. The significant challenge of lowering a vehicle's aerodynamic drag has been a hot subject of discussion over the last ten years, and as a result, the issue of computational cost and its complexity has emerged. The notion of computational fluid dynamics (CFD), which was used to reduce the amount of drag a three-dimensional model of an automobile produced, was put to the test via a series of trials to ensure that it could be used into any future design tweaks [10]. Automobiles and other types of faster-moving vehicles use spoilers, which are aerodynamic devices, to reduce the amount of turbulence that is generated over the body of the vehicle. It is affixed to the body of a vehicle. One of the challenges that vehicles face is maintaining control of their wake. The way that is advised is to adjust the form of the rear body as well as the shape of the spoiler, and the findings of the trials show that this leads to a significant decrease in the value of CD and CL [11]. Attempts are made to cut down on fuel consumption by using more modern materials in place of traditional ones, which are the subject of research. In order to satisfy the stringent requirements of the rising future demand, these changes need to be addressed. Unreinforced thermoplastic is the material that is recommended to use for spoilers in this scenario [12]. The magnitude of drag is found to be dependent on a vehicle's physical appearance, including its shape, the accessories it has attached, any protrusions it may have, and so on. This was determined through comparisons of different aspects, such as form and material, in the design of human-powered vehicles on different types of roads [13]. The effect of applying a spoiler on the rear part of the car is studied by making a basic car model and running a CFD simulation to find CD and CL values first without spoiler and then with spoiler and found percentage reduction in CD and CL values to be 1.7 and 4 respectively. The results of modeling car geometry and analyzing for CFD give results like experiments and behavior that can be predicted in advance [14].

1. 3. Aim & Objective

- To identify the materials
- To design the spoiler
- To perform analysis of the designed spoiler by applying materials
- Identify the best material and perform CFD analysis
- To compare and analyze the results obtained from structural and CFD analysis

2. 4. Methodology



3. Design and Analysis

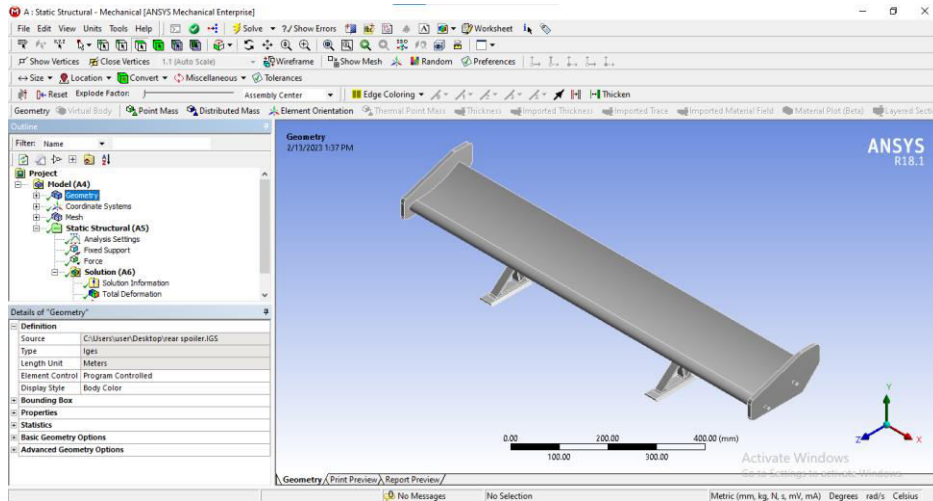


Fig.1 Geometry

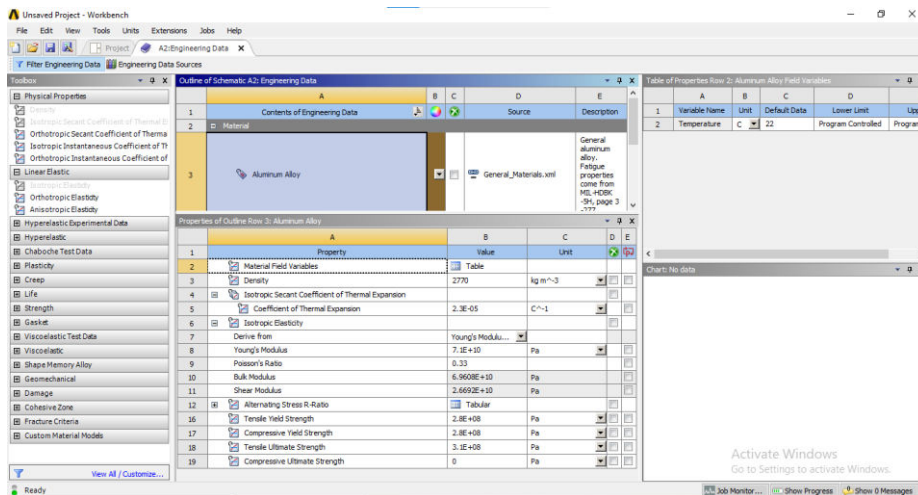


Fig. 2 Material Properties

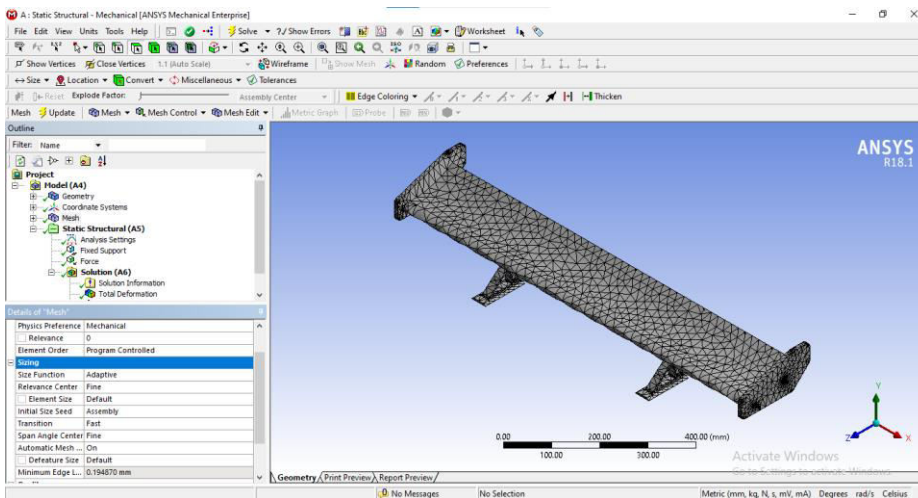


Fig. 3 Meshing Image
Boundary Conditions

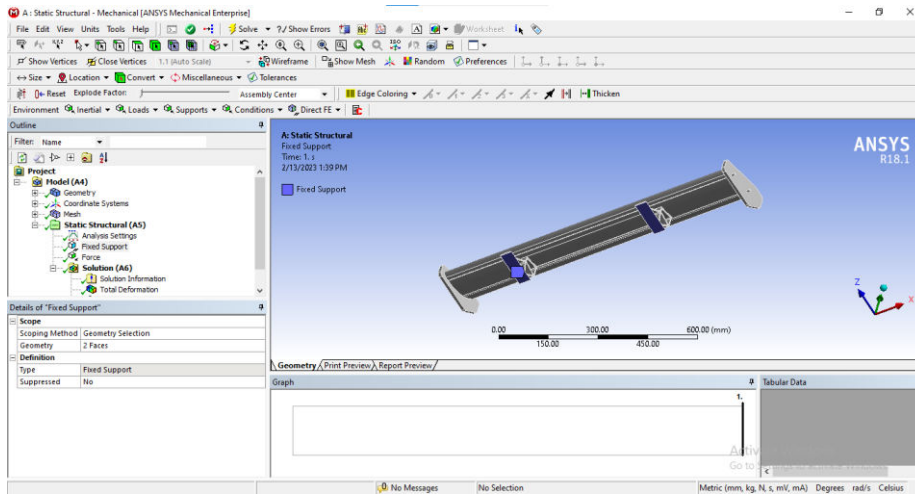


Fig. . 4 Fixed Support

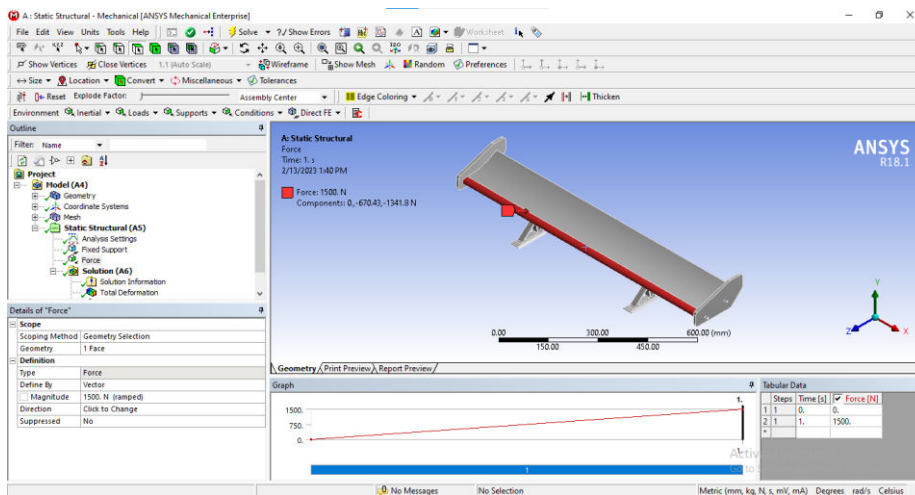


Fig. 5 Force Results

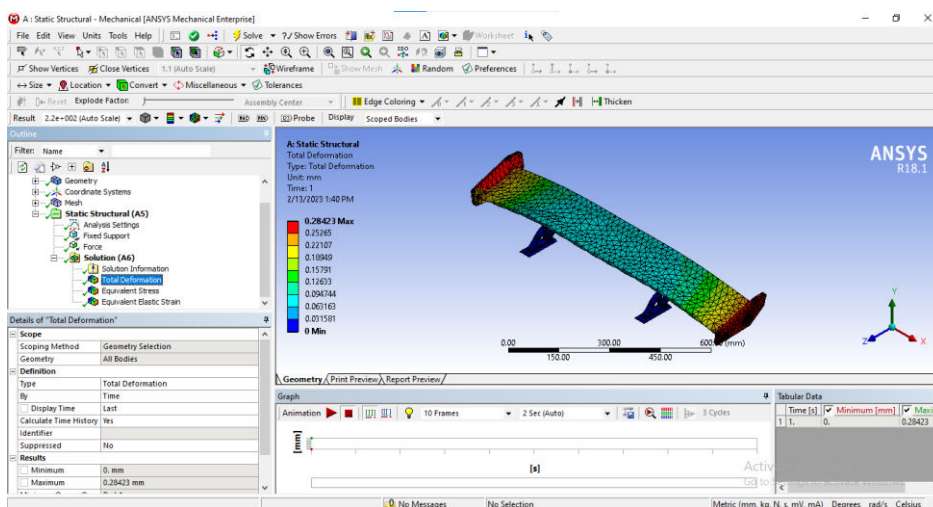
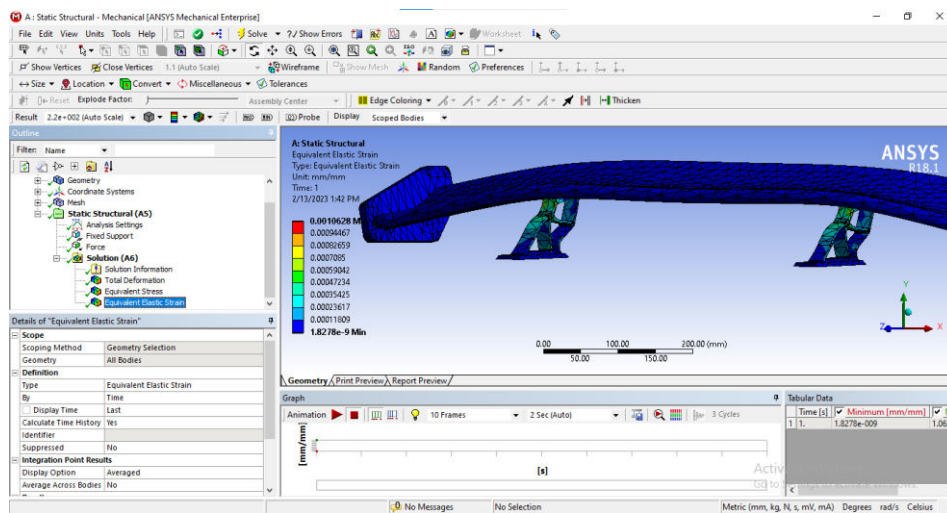
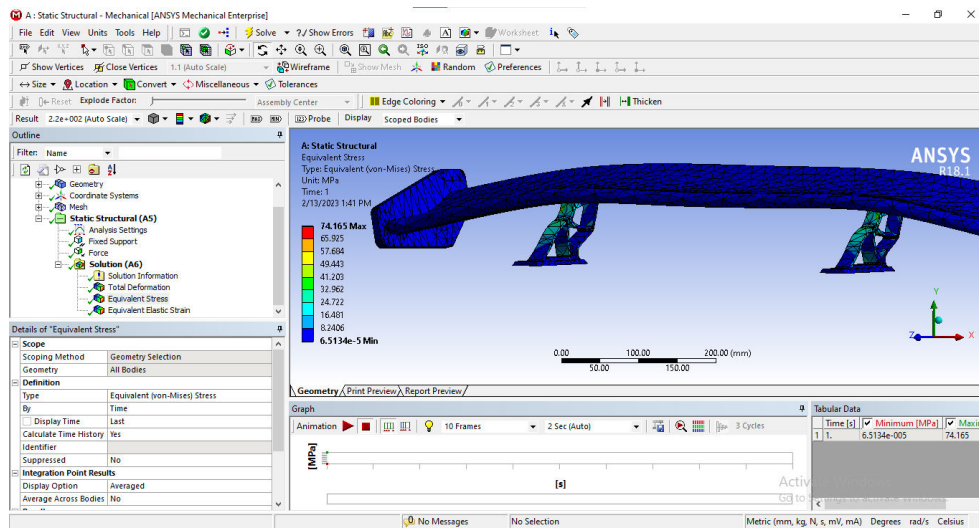
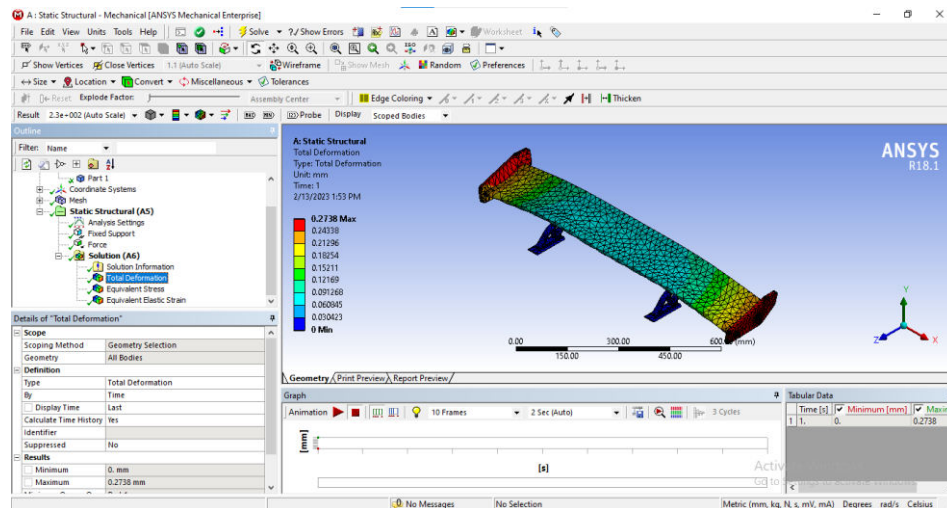


Fig.6 Total deformation



GFRP



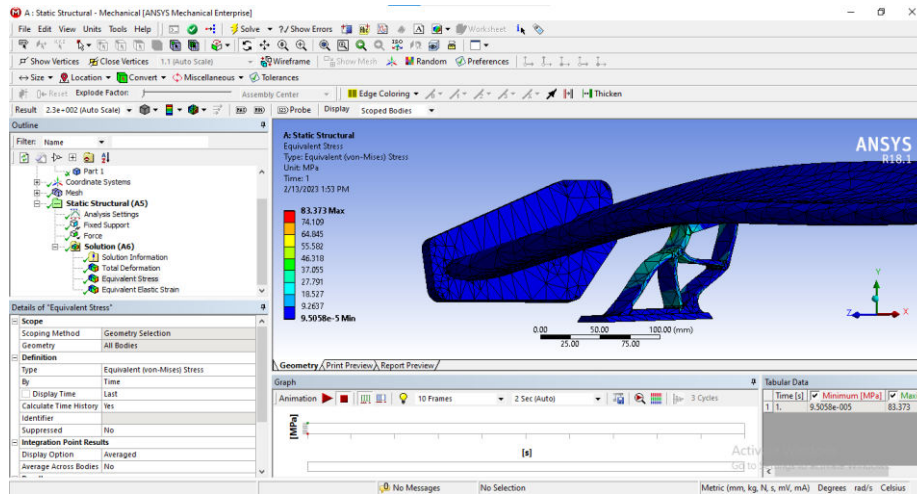


Fig.10 Equivalent stress

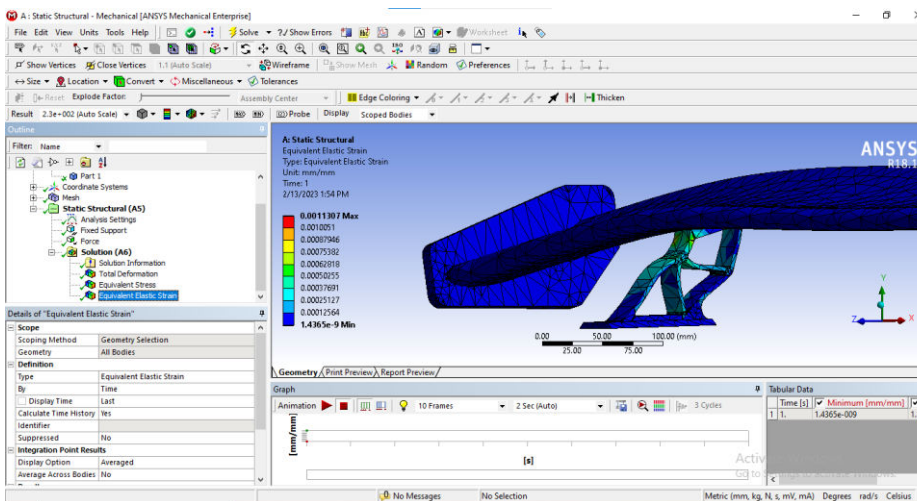


Fig.11 Equivalent elastic strain

GFRP with Sugarcane

Results

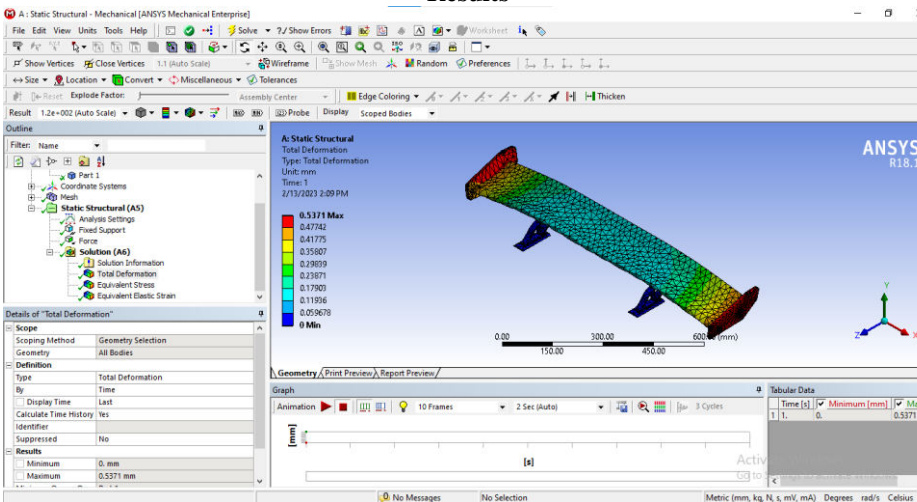
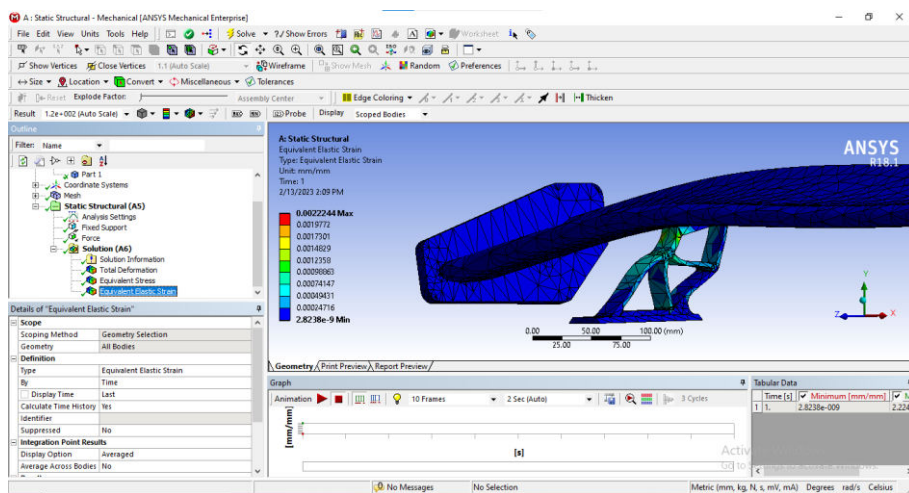
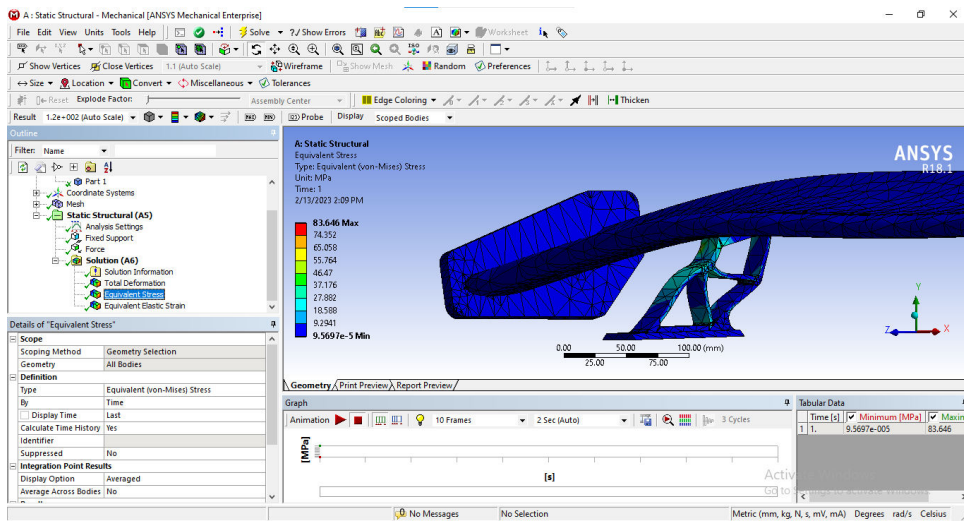
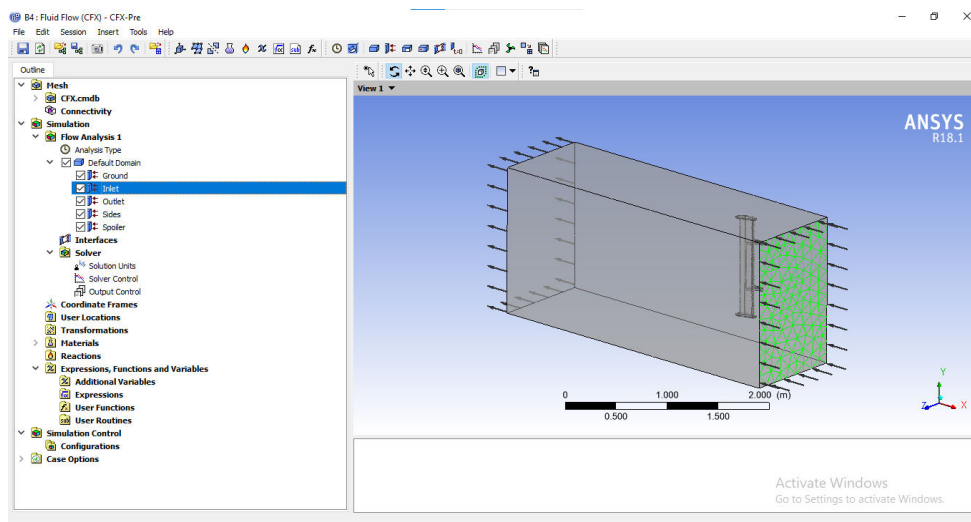


Fig.12 Total deformation



CFD Analysis



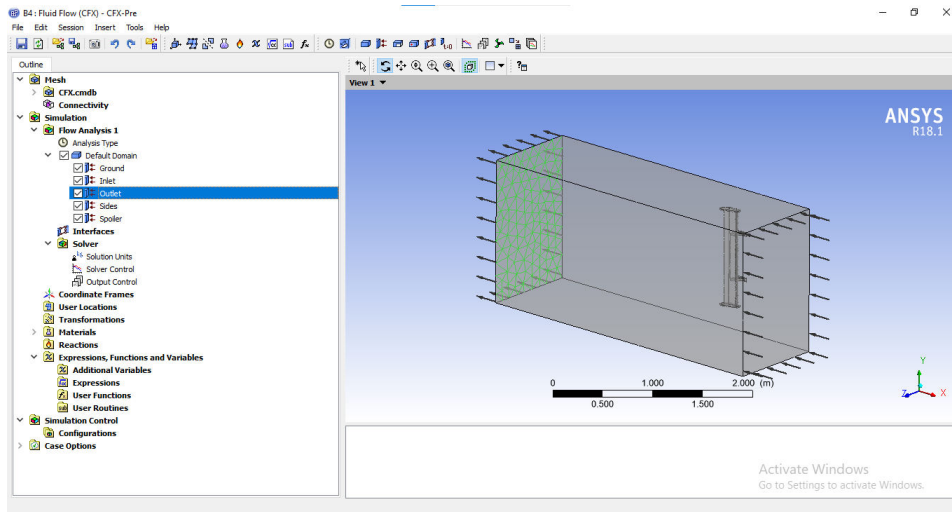


Fig.16 Outlet

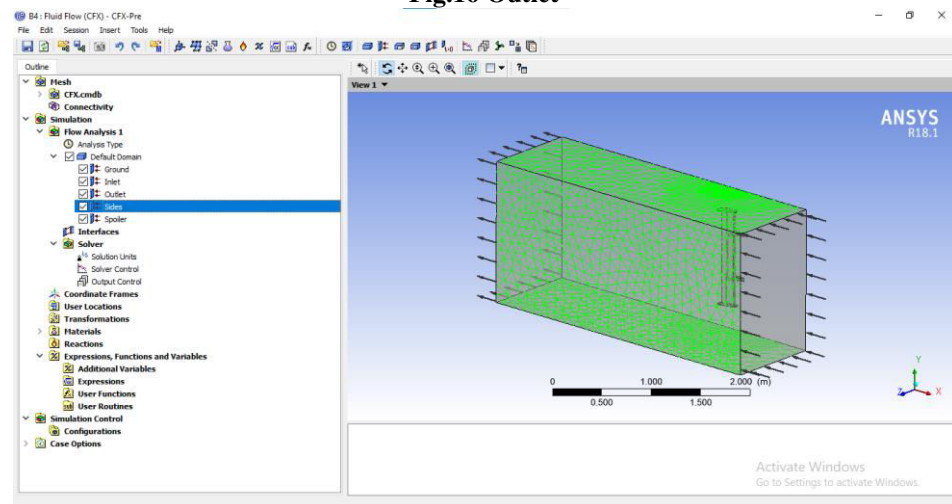


Fig. 17 Wall

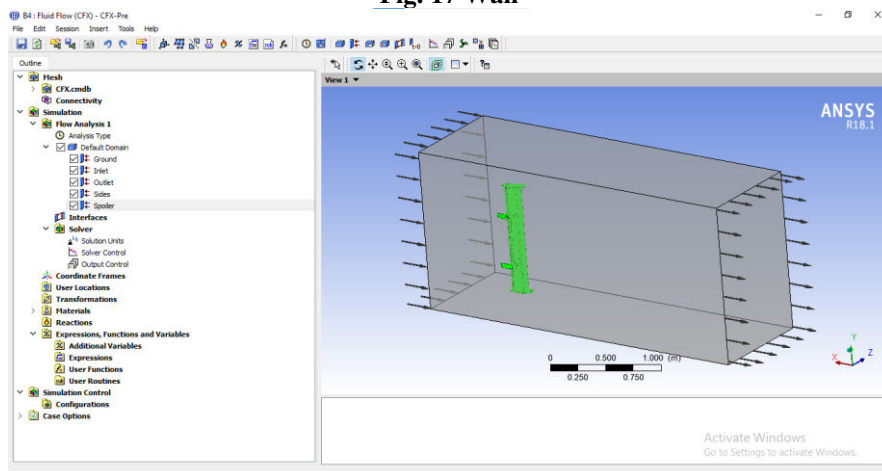


Fig.18 Spoiler

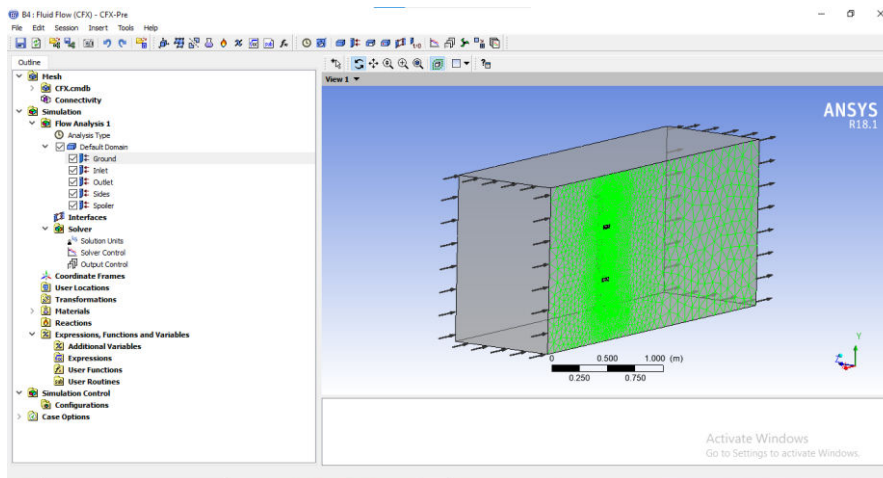


Fig.19 Ground

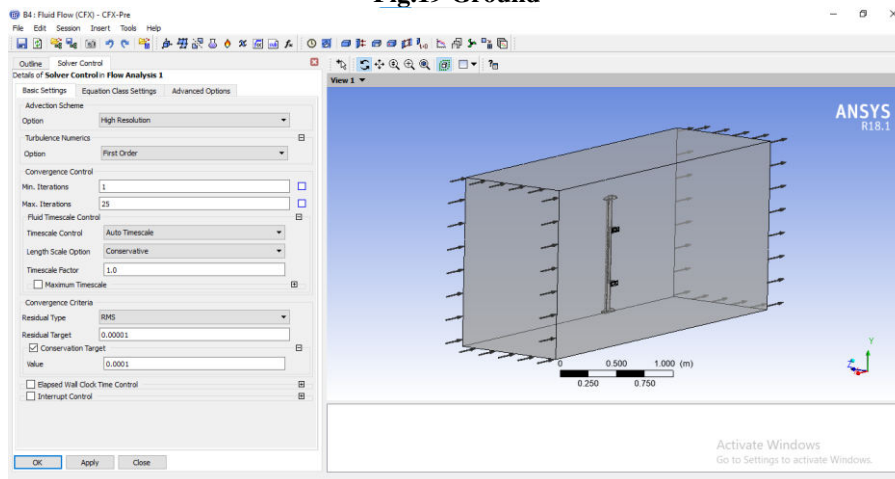


Fig.20 Solver Control

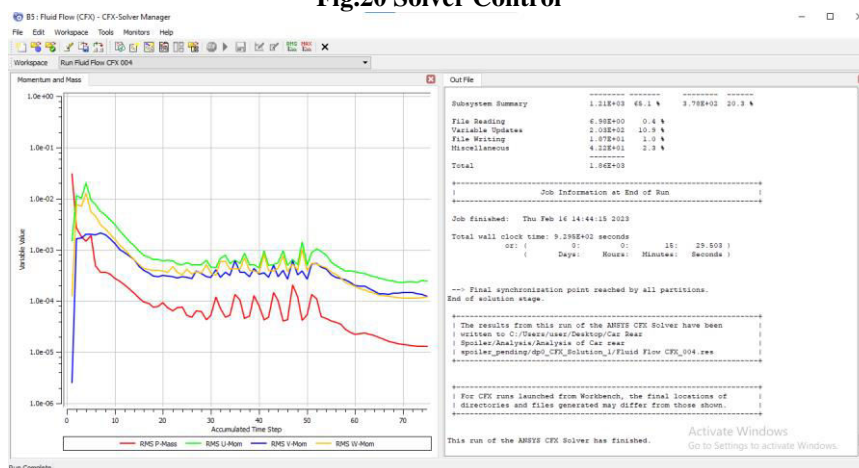


Fig.21 Momentum and Mass Existing Spoiler results

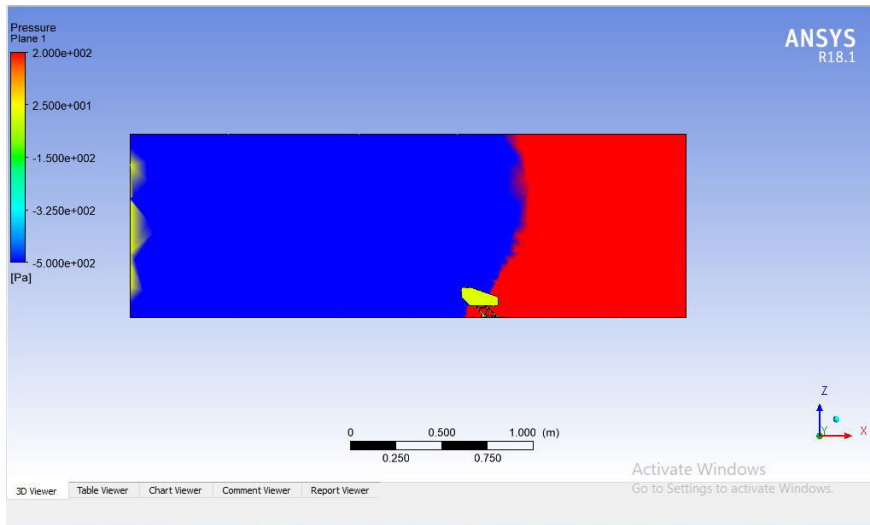


Fig.21 Pressure contour

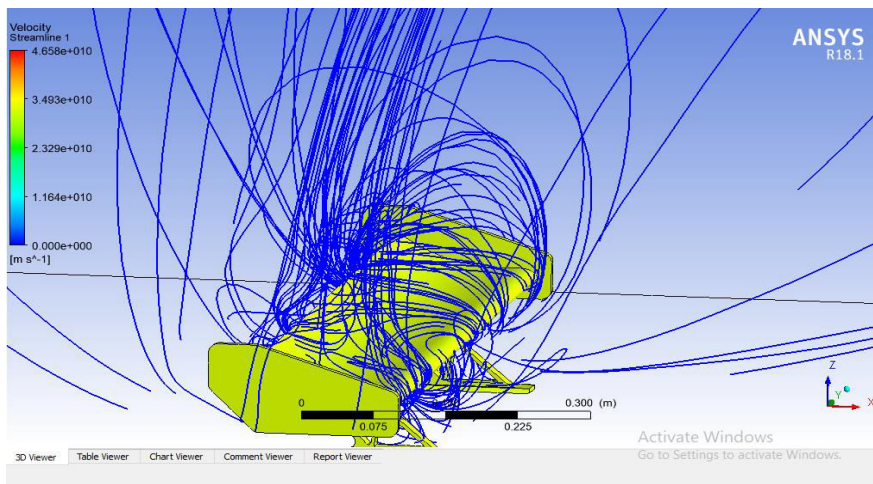


Fig. 22 Velocity Streamline
Modified Spoiler Results

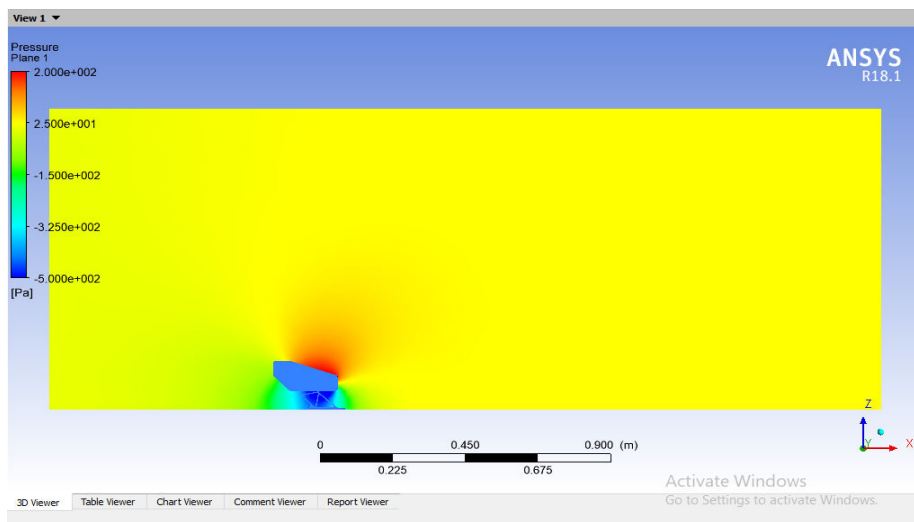


Fig.23 Pressure Plane

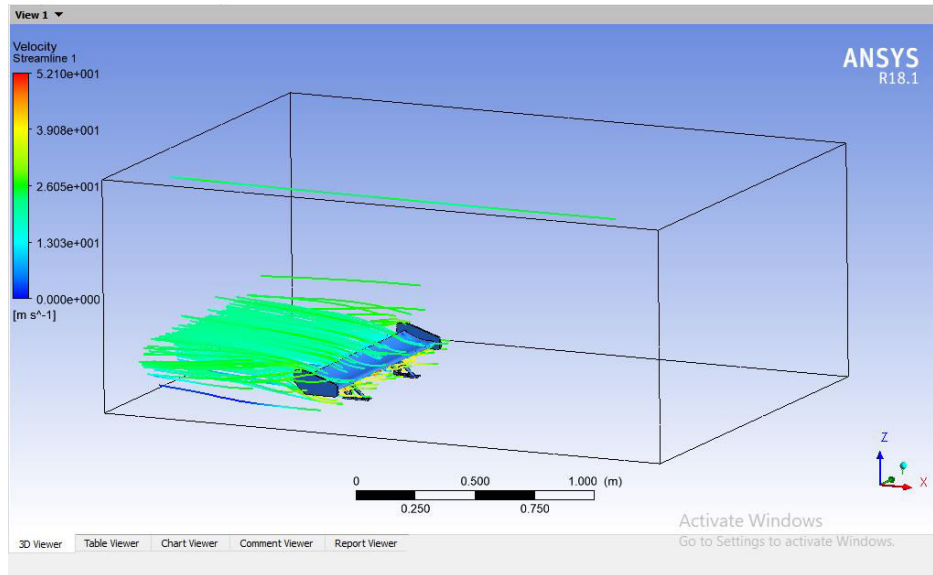
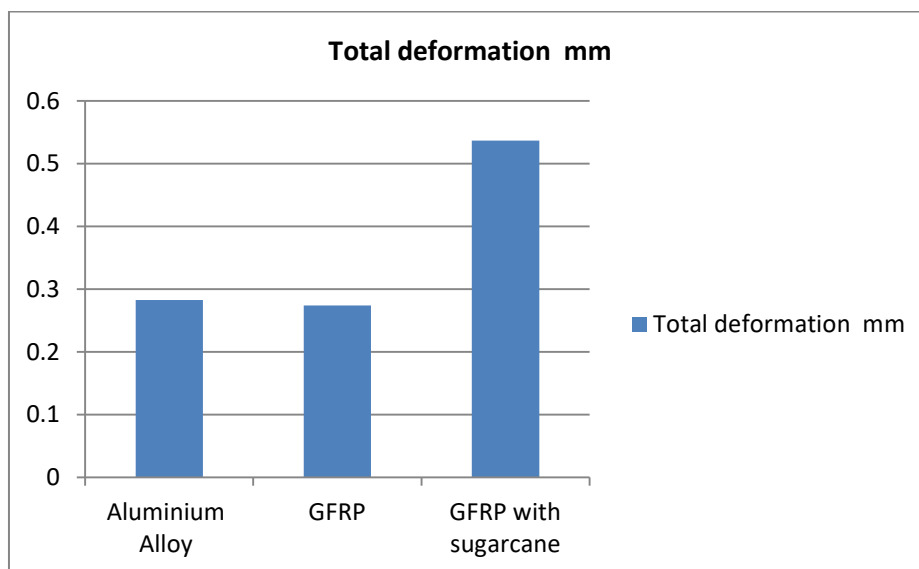


Fig.24 Velocity streamline

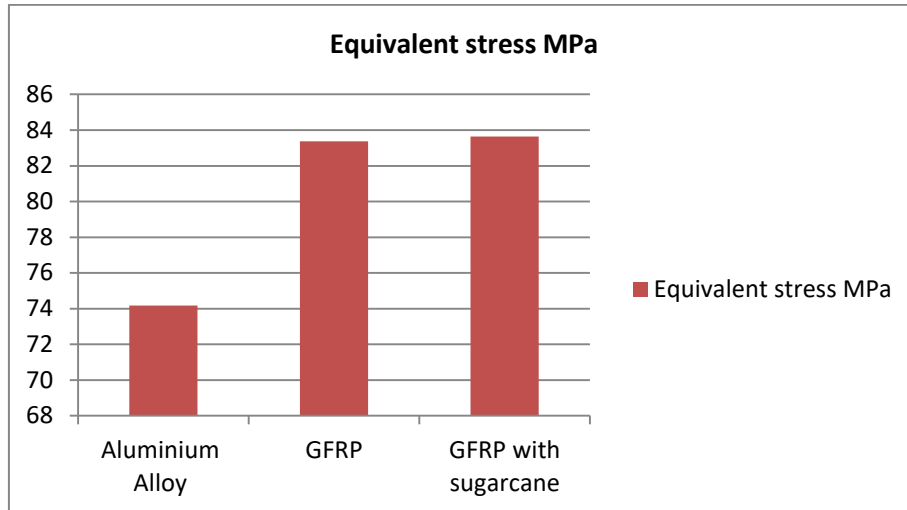
III. RESULTS & DISCUSSION

Comparison of Car rear spoiler analysis results

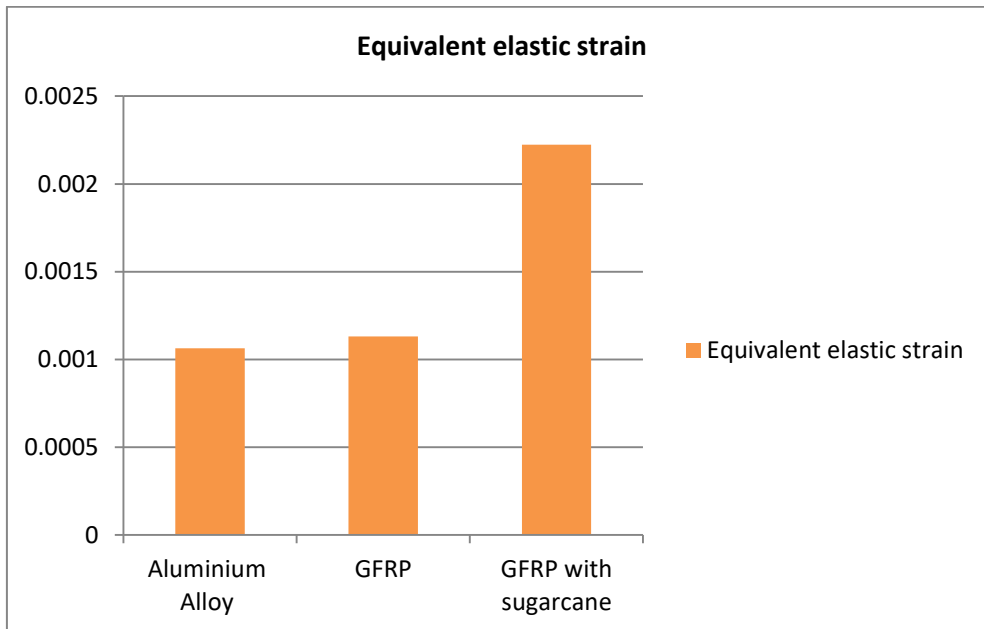
	Total deformation mm
Aluminium Alloy	0.28243
GFRP	0.2738
GFRP with sugarcane	0.5371



	Equivalent stress MPa
Aluminium Alloy	74.165
GFRP	83.373
GFRP with sugarcane	83.646

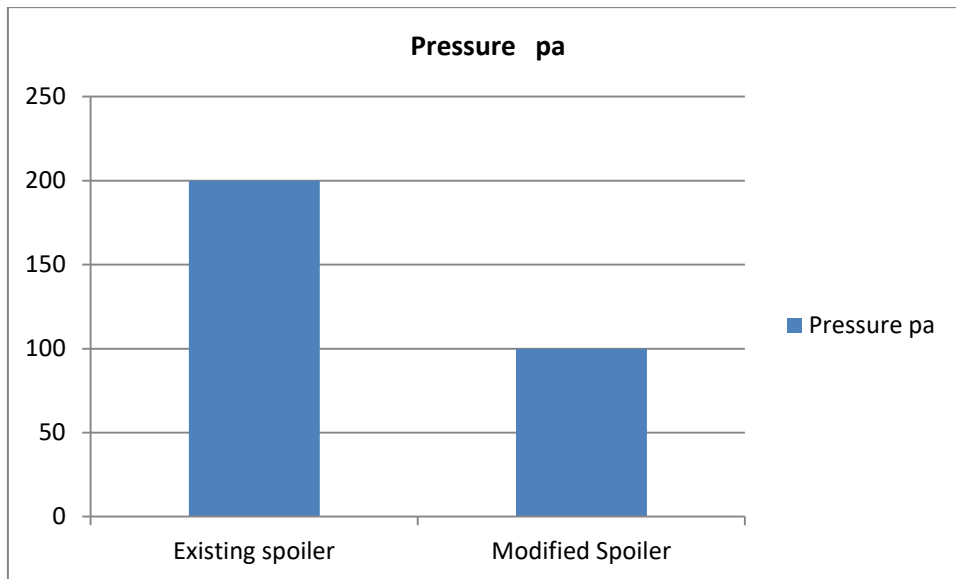


	Equivalent elastic strain
Aluminium Alloy	0.0010628
GFRP	0.0011307
GFRP with sugarcane	0.0022244

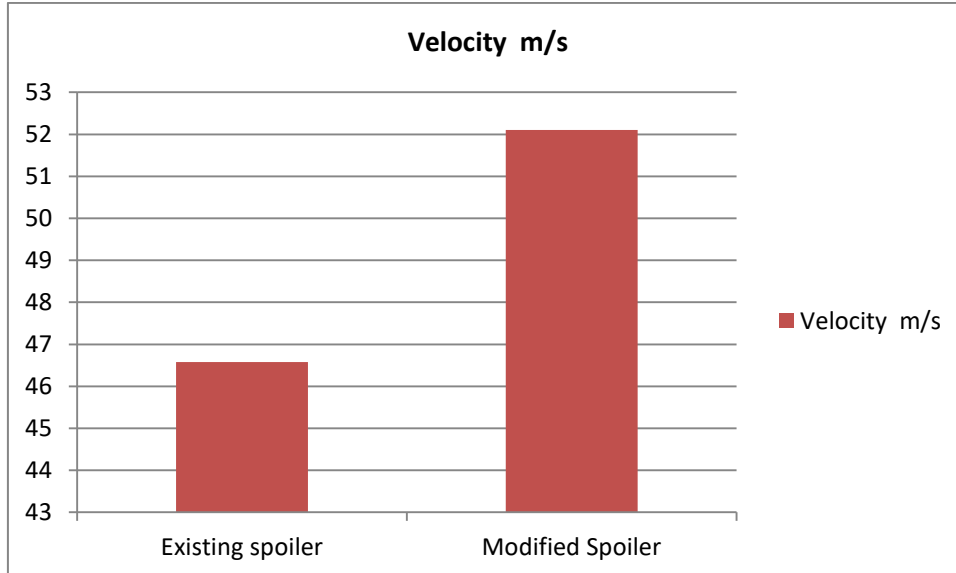


CFD Comparison

	Pressure pa
Existing spoiler	200
Modified Spoiler	100



	Velocity m/s
Existing spoiler	46.58
Modified Spoiler	52.1



IV. CONCLUSION

This project involves the design and modeling of an automobile rear spoiler in the 3D modelling programme Solidworks using many different types of spoilers. ANSYS software was used to do the analysis on the model. After the application of three distinct materials and the completion of a structural study, it was determined that the most effective material was GFRP that was reinforced with sugarcane fibre. Based on the findings of the CFD research, it can be deduced that the pressure drop, velocity, and mass flow rate would all rise when the speeds are raised. The modified model shows a drop in pressure while travelling at a speed of 25 kilometres per hour. The updated model will have a speed boost of fifty kilometres per hour for the velocity. It is possible to draw the conclusion that since the modified model has a speed of 50 kilometres per hour, rather than the current model's speed of 42 kilometres per hour, the modified model of the spoiler is the superior model.



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