

Vehicle Structure & Aero

8th April 2022

Andrew Evans

Contents

Q1 - Choose two of the following body/chassis structure types & discuss the pros and cons..	3
Bonded Aluminium	3
Steel Monocoque	4
Q2- An understanding of aerodynamics as it relates to automobiles is important in order to improve which major areas of performance? Also explain the criteria that effects drag or wind resistance of a vehicle	6
What is aerodynamics	6
Why is aerodynamics important in order to improve performance?.....	6
What effects drag or wind resistance of a vehicle.....	7
Reference page	9

Q1 - Choose two of the following body/chassis structure types & discuss the pros and cons

Bonded Aluminium

Bonded aluminium chassis tub with fibre glass body (Lotus Elise)
The bonded aluminium chassis tub is most well known for being used in by Lotus and their car the Lotus Elise. Elise's revolutionary chassis is made of extruded aluminium sections joined by glue and rivets. New technology can make the extruded parts curvy, as seen in the side members.

The main pros are:

- 1. Weight – using aluminium in the design instead of steel gives a lighter car resulting in increased speed and manoeuvrability.*
- 2. Strength – the extrusion aluminium is held together by epoxy resin essentially glue. Thus, making it extremely strong and reliable leading to a much safer around vehicle for the public to drive. Also, the aluminium chassis tub has three times the axle load strength to other chassis types*
- 3. Production – using aluminium can reduce the costs associated with production when compared to using a carbon-fibre chassis and it is easier and quicker to adapt the design for new for different models.*

The main cons are:

- 1. Water – water leaking through the joints in the chassis which can be damaging to the car and can lead to a bad customer experience. However, this can easily be fixed with silicone sealant which should stop the leakage.*
- 2. Design error - On some very early cars there were problems with internal rivets rubbing on the coolant pipes that run internally through the length of the chassis side rails. These would cause the pipe to fail resulting in loss of coolant.*
- 3. Damage – If there is damage to a car made of steel then it can usually be welded and reshaped and painted, however this cannot be done using aluminium.*

https://moodle.uwtsd.ac.uk/pluginfile.php/574604/mod_folder/content/o/2-Chassis%20Types.pdf?forcedownload=1

Steel Monocoque

In the automotive industry the most common chassis type for all cars to adopt is the steel monocoque chassis it is estimated that 90% of production cars in the current market are operating under the steel monocoque chassis.

Steel monocoque is when the frame is integrated into the body construction making it a single structure. The framework of a unibody is designed and built to support the weight of the vehicle. Manufacturers accomplish this by reinforcing the floor of the vehicle, reinforcing the B and C pillars, and using bracing along with various parts of the body for overall strength and rigidity. The weight of the uni-body design is a lot lighter than the ladder frame because it cuts out bulky steel rails as used in the ladder frame, and this results in improved safety and fuel economy.

https://moodle.uwtsd.ac.uk/pluginfile.php/574604/mod_folder/content/o/2-Chassis%20Types.pdf?forcedownload=1

The main pros are:

- 1. Improved safety – through research and development manufactures' have improved safety and monocoque allows for certain areas of the body to bend and crumble on the impact resulting in greater protection for occupants. The vast framework also allows impacts to be absorbed better from various angles since vehicle accidents do not just occur from the front. This also vastly improves the safety aspect of the monocoque chassis.*
- 2. Lower production costs - one ladder frame can be used on a variety of different body types. For example, manufacturers will release a ladder frame UTE like the [Toyota Hilux](#) then use the same ladder frame and put an SUV on top like the Fortuner. You can also have the same ladder frame but with different suspension setups such as leaf spring and dampers in the rear of the UTE truck and Spring and a damper setup in the rear of the SUV. Both are on the same one ladder-frame chassis with different suspensions for different applications, thereby*

reducing overall production costs because of the ability to reuse.

3. *Economical - The amount of material required to build a steel monocoque chassis is far less. So, from a manufacturing perspective it's much more economical to build as the manufacturing process demands less.*

[Jade,C\(2019\) Ladder Frame vs Monocoque SUV Chassis Pros And Cons \(Ladder Frame vs Monocoque SUV Chassis Pros And Cons – 4WheelDriveGuide\)](#)

The main cons are:

1. *Cost of repair - More expensive to repair in the event of an accident due to advanced chassis technology, expensive components and the complete structure makes repairs more complex*
2. *Undercarriage damage – due to design as the undercarriage is lower to the ground, e.g. suspension components these can get damaged and also be prone to rust if exposed to water.*

[Jade,C\(2019\) Ladder Frame vs Monocoque SUV Chassis Pros And Cons \(Ladder Frame vs Monocoque SUV Chassis Pros And Cons – 4WheelDriveGuide\)](#)

Q2- An understanding of aerodynamics as it relates to automobiles is important in order to improve which major areas of performance? Also explain the criteria that effects drag or wind resistance of a vehicle

What is aerodynamics

Aerodynamics is the study of dynamic gasses or the interaction between moving objects. Relating this to cars there is one main important factor when looking at aerodynamics and cars and that is down force. The downward lift force created by the car. By creating downforce, the car can travel faster, as it creates a vertical force on the tires that can increase the tires grip – the more grip the more speed and acceleration

Wall, J (2015) What is aerodynamics,

(<https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-aerodynamics-58.html#:~:text=Aerodynamics%20is%20the%20way%20objects%20move%20through%20air.,a%20rocket%20blasting%20off%2C%20to%20a%20kite%20flying.>)

Why is aerodynamics important in order to improve performance?

- Keeps balance – without getting too technical, the aerodynamic downforce on the axles affects the balance of the car. As the car goes faster, this aerodynamic force affects its ability to take high-speed corners. The downforce should be equal throughout the cars body meaning at the front and rear of the vehicle to keep everything balanced. If the ratio is even the force will be even. If the force throughout the car isn't even it will result in it being much harder to control the car at high speed*
- Avoids stalling - just like with flying a plane, a stall can cause a loss of lift. A stall in the air brings a gut-wrenching drop. It occurs when the boundary level on the wing surface is not attached through the local flow field and with rapid*

deceleration. Translating this image of planes into cars mean we have got to delve into the car's wings. Car wings are all art designed at an angle to generate airflow. Aerodynamics demands declaration in a controlled manner. If a car decelerates too much, I will stall out just like the plane

- *Pressure drags - One type of drag is pressure drag. This occurs when airflow does not fully attach to a surface completely in this case does not attach fully to the car. For example, a full-bodied car has pressure drag on the back end. It also occurs with steps and gaps between windshields, windows, and body panels. Air also squeezes out of various gaps on the top, bottom, and sides of the vehicle. Therefore, it is important to seal those gaps and improve performance. This sealant can be in the form of an aerodynamic windshield and intentional modifications*

Zero2turbo, (August 27 2019) , how aerodynamics improves car performances ([How Aerodynamics Improve Car Performance \(zero2turbo.com\)](http://zero2turbo.com))

What effects drag or wind resistance of a vehicle

- *Driving at higher speeds increased the overall aerodynamic drag which in turn will slow your vehicle down as more drag and wind resistance will be hitting the car resulting in lower performance*
- *The shape of your vehicle can also really affect the drag if the vehicle is shaped without taking into consideration aerodynamics and drag. It's more likely the vehicle will be affected by drag and wind resistance more reducing its overall performance*
- *The overall size of your vehicle can also play and huge part of what effects drag or wind resistance of your vehicle. Bigger bulker shaped vehicles are much more likely to be affected by wind resistance rather than lower small more aerodynamic cars. For example, a Range Rover Velar is much larger than a McLaren 720s so is much more likely to be negatively affected by wind resistance.*

Glenn Research Centre, Hall N (13/05/2021) “Factors that affect drag” (<https://www.grc.nasa.gov/WWW/k-12/airplane/factord.html>)

Reference page

Glenn Research Centre, Hall N (13/05/2021) “Factors that affect drag” (<https://www.grc.nasa.gov/WWW/k-12/airplane/factord.html>)

Zero2turbo, (August 27 2019) , how aerodynamics improves car performances ([How Aerodynamics Improve Car Performance](https://zero2turbo.com/How-Aerodynamics-Improve-Car-Performance) (zero2turbo.com))

Wall, J (2015) What is aerodynamics, (<https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-aerodynamics-58.html#:~:text=Aerodynamics%20is%20the%20way%20objects%20move%20through%20air.,a%20rocket%20blasting%20off%2C%20to%20a%20kite%20flying.>)

Jade,C(2019) Ladder Frame vs Monocoque SUV Chassis Pros And Cons ([Ladder Frame vs Monocoque SUV Chassis Pros And Cons – 4WheelDriveGuide](#))

https://moodle.uwtsd.ac.uk/pluginfile.php/574604/mod_folder/content/o/2-Chassis%20Types.pdf?forcedownload=1