

ACHA4004 VEHICLE TECH - 2

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Q1- CHOOSE TWO OF THE FOLLOWING BODY/CHASSIS STRUCTURE TYPES AND DISCUSS THE PROS AND CONS: BONDED ALUMINIUM CHASSIS TUB WITH FIBRE GLASS BODY.

Bonded Aluminium

Bonded aluminium tubs and fibreglass bodies are commonly used with higher end sports cars. The chassis of the car is what all the components and body panels are attached to, the most common materials that chassis are made of are steel and aluminium. Aluminium chassis are typically used to bring down the weight of the car. Aluminium is typically used in higher end sports cars over other materials such as steel, the most common metal in car chassis, as it is a much less dense material compared to steel. Steel is around 250% denser than aluminium, this means that it will be around 1/3 heavier, however it also comes with the benefit of being much stronger. Steel is less likely to bend and contort from heat and forces, meaning it is a viable option for many average road cars. Pound for pound, steel is also usually cheaper than aluminium, meaning it will be most likely used in average cars too. Sports cars will typically go for aluminium chassis, due to the much lighter material, it also has a much better strength to weight ratio than steel. This allows for sports cars to keep a lighter weight and remain strong and agile. Another big benefit to using aluminium to steel is that aluminium components won't be susceptible to rust, as when aluminium is exposed to air it creates a layer of aluminium oxide on the surface, protecting the metal from exposure to the elements.

Aluminium chassis are made by using casting and presses to create the intricate shapes and structures that the cars chassis is made up from. This process is the same for steel chassis, however steel is joined together using welding, as steel is an easy material to weld together unlike aluminium, as the layer of oxide on the surface makes it hard to weld as the oxide layer traps gasses in the surface, making the welds weak. Instead, aluminium is joined together using a mixture of rivets and an industrial strength adhesive. Choosing to make a chassis comes with its performance advantages to the car, however companies may need to purchase lots of expensive equipment to allow for the chassis to be made efficiently on a production line such as robots that punch in the rivets, apply the adhesive and move the chassis. Moving the chassis also must be done with vacuum pumps as aluminium is not magnetic. These changes can actually be beneficial to the factories themselves as Ford found that when they began production of their aluminium chassis F-150, it cut down noise from the spot welders, and also reduced space between the welders and their safety cages. This is beneficial as it allows workers to gain easier access to machinery and the chassis for maintenance and all-round ease of work.

On top of the aluminium chassis, sports cars will typically go for aluminium body panels, with higher end cars choosing to go for fibreglass or carbon fibre. Fibreglass panels are used on cars such as the Lotus Elise. Fibreglass is used in cars such as the Lotus Elise for tensile strength, meaning that the panels won't deform like aluminium will, they can absorb the impact much better, however once they crack, they are not likely to be easy to repair. Fibreglass is also used for factors like heat resistance, as it can withstand over 500°C making it more viable to use on a more track-oriented car as aluminium panels will start to experience the effects of heat at around 200-250°C, with a melting point of 660°C meaning that panels around the engine bay can experience deformities due to the heat if the car is pushed hard around a track day. Fibreglass panels won't experience these heat issues as they can withstand much more heat. Another type of panel that is also used on car bodies is carbon fibre, which is extremely light and strong, being five times stronger than steel and significantly lighter. The problem with fibreglass and carbon fibre is that they are much more labour intensive than aluminium panels to produce, with workers needing to apply layers of the composites, with resin glues holding them together, they then need to be vacuum packed and cured. This makes the use of fibreglass panels and carbon fibre panels more expensive to make due to the time, machinery and materials used. Cars that use aluminium and composite body panels are typically lower production runs that cost more, unlike mass produced steel chassis cars with sheet metal and plastic body panels.

Generative design

Generative design is a method of designing where the designers input the set amount of strength and force the part is required to withstand is entered into the programme, they also set the parameters that the part needs to be made into, the type of material, manufacturing methods, cost and more into a software programme. The software then runs simulations and creates the strongest ways of joining the points and sections in a part with the least amount of material used. This method of designing is extremely useful as you know that the parts being created are as well optimised as they can be. The parts used in generative design are made by using methods such as a milling machine, taking away mass from a block of material, casting, which uses molten metal poured into a cast, or seemingly the most appropriate use, 3d printing. 3d printing and generative design are almost made for each other, as both technologies used together allow for more intricate shapes to be created using generative design. Meaning that the most efficient and strongest designs are able to be created using 3d printing. The use of 3d printing and generative design is also massively beneficial to companies not only from the performance benefits, but from the amount of material saved by the manufacturing methods.

Generative design can be a massive factor in gaining a lot of performance in a car, the use of the design method will allow for a massive decrease in the cars weight while remaining just as strong as before, this means that the car will have an extreme boost in all round performance. It will be more agile around the corners and allow for much better acceleration and braking. With the added bonus of being more fuel efficient due to the weight loss.

Generative design can also create very interesting shapes, these can be used to the cars advantage in terms of aesthetics, having some parts exposed can create an intricate and interesting look that hasn't been seen before with many cars. Combining the use of generative design and electric motors could create a whole new design language that hasn't yet been seen before.

Companies that have started to experiment with using generative design include BAC, Hyundai, Volkswagen, General Motors and more. There is however a company called Czinger vehicles that have created a hybrid sports car called the 21C. the car was created using artificial intelligence. The car has a weight of 1250kg and has a maximum hp of 1250hp. It achieves these numbers due to the parts being created using generative design, with the strongest and lightest methods of manufacture being used. The 21c achieves its hp number by using a 950hp V8 and three electric motors. The 21C is set to be released in 2023. Another company that has used generative design have been BAC, they are constantly looking for ways to reduce weight on their BAC mono, one way they have reduced weight using generative design is in the wheels, they have used the new technology to reduce each wheel by 2.2kg this may not seem like a lot but the wheels are now 35% lighter, and that makes a large difference on rotational mass. BAC wanted to make sure the wheels are still aesthetically pleasing and had to set parameters, so the software didn't create a wheel that didn't meet their design criteria.

Although generative design comes with a lot of benefits, it also has its downsides. The equipment needed to produce the designs are extremely expensive. The parts also take time to produce the parts if they are made using milling machines and 3d printers, compared to sheet metal where most of the parts can be quickly created in a press.



Q2- AN UNDERSTANDING OF AERODYNAMICS AS IT RELATES TO AUTOMOBILES IS CONSIDERED TO BE IMPORTANT IN ORDER TO IMPROVE WHICH MAJOR AREAS OF PERFORMANCE? ALSO EXPLAIN THE CRITERIA THAT EFFECTS DRAG OR WIND RESISTANCE OF A VEHICLE?

Aerodynamics are an essential part of a car, not only do they define how the car looks, but they define the performance and handling characteristics of the car. Aerodynamics play a massive part in lateral grip, longitudinal grip, top speed and more. Aerodynamics can be approached in multiple different ways, depending on the desired outcome of the car. If the car is designed in order to reach a top speed, then the main focus of the aerodynamics will be to reduce as much drag as possible whilst keeping the car stable enough to reach the speed. On the opposite end of the spectrum if the car is made for the sole purpose of cornering fast then the aerodynamics will be created to make as much downforce as possible with as little drag as they can achieve. Aerodynamics are also very important in everyday cars, as they play a big part in fuel consumption and efficiency. By being able to reduce the amount of drag a car creates, you are able to create a much more economically friendly car, as it allows the car to go far further on the same amount of fuel, whilst also increasing the performance characteristics as you are able to increase the top speed of the car.

Ways to reduce drag include removing or reshaping any protrusions on the surface of the car, this allows for a smoother airflow over the surface of the car. The underside of the car also plays a huge factor in the aerodynamics, the flatter and smoother the underside of the car, the better the drag coefficient will be. This is why sports cars and race cars have almost completely flat and sealed off undercarriages. This also allows the cars to generate more downforce from ground effect. Diffusers and spoilers can also improve drag coefficient massively, as diffusers encourage airflow to come from underneath the car and direct the air upwards, creating an area of lower pressure. This allows for the airflow to re-join with the flow from the top and sides of the car, reducing drag and having the benefit of increased downforce. Spoilers also allow the airflow to be separated from the rear of the car, allowing for the drag to be reduced and for downforce to be increased, this has added benefits of an increased top speed and more grip through corners from the additional aero.

Drag is created by the difference in velocity between the air traveling around the car and the air stationary in the air. The difference in velocity essentially creates friction, as the stationary particles in the air are coming into contact with faster moving particles close to the body of the car. At the front of the car there will be a higher pressure as the front of the car has to push through the air, towards the rear of the car it is a lower pressure, this is due to the air having been pushed by the front of the car and struggling to flow over the body and separating from the flow. To reduce drag you want the air behind the car to be able to connect behind, without having a difference in speed. This allows for an increase in performance.



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