

Steel Monocoque Chassis



A steel monocoque chassis is a structure which integrates body and chassis together to form a composite structure which as a result provides better stiffness as well as a weight advantage. The steel monocoque is the most popular form of chassis to be used and is in more than 95% of all production cars on the market. This type of chassis enables manufactures to create the overall body of the car without the needing or building additional material for the body panels the same as a body on frame chassis which is an advantage. All body panels can be directly attached to the frame providing a more appealing advantage to mass production lines. The overall design is made up of several different steels and metals depending on the overall stiffness, torsion or stress point of the design. All metals are there to act for different purposes and level of stress or level of torsion. All areas highlighted in the Volvo V40 in Red are Ultra high strength steel. This metal is used to increase the safety of the occupants during a collision these are seen as the key impact zones or highest priority to ensure the driver and occupants' safety upon collision. By using this steel ensures the main structure where the occupants are is sound during impact. Using this metal throughout the design would make the overall design very strong however provide a lot of unnecessary weight. This allows manufactures like Volvo to be a little more flexible with materials within their design to save weight but not eliminate any safety. Another advantage to this design is the crumple zone can be used within the structure and the energy and forces can be reduced during a collision. The whole design uses pressed steel and spot welded together by robots which makes the whole frame and can be manufactured 24/7 to keep up with demand. This makes it also incredibly appealing providing a sustainable and fairly quick process to manufacture. The monocoque chassis is a lighter design compared to a ladder chassis which is a plus for fuel efficiency. The monocoque chassis is also a much better chassis for performance oriented vehicles.

There are several disadvantages to a monocoque chassis such as the design is difficult to design and modify (platform sharing) compared to a body on frame design. However the use of computer aided design (CAD) allows this process become a little easier and allows platform sharing little easier. The overall design does use a lot of metal which makes it very heavy. The monocoque chassis is also not as strong as a Tubular Space Frame which is made up of metal tubing this design is stronger in all angles. Monocoque chassis has a high set up costs and does need large production lines. The process is therefore very costly and is not manageable for small production car companies. The tools and robots required are very expensive however will benefit in the long run to keep up with demand.

Bonded Aluminium Chassis tub

This type of chassis lotus is well known for creating an extruded aluminium sectioned chassis bonded together by glue and rivets. The extrusion of these aluminium sheets means that the parts for the chassis can be formed into complex shapes for several purposes which is a huge advantage. This also allows the parts for the chassis to be kept to a minimum with the whole chassis for the Elise consisting for 27 extruded parts. The use of aluminium for the chassis ensures the design is lightweight and strong. The over design also allows good torsional rigidity all these factors make it suitable for providing a good handling car hence why lotus use the design these are all advantages of this type of chassis. Another advantage to this design is its incredibly lightweight in comparison to a steel chassis equivalent but just as strong and weights approximately 68kg. This design also has a very similar weight to carbon fibre however is much simpler to manufacture and easier to adapt to required models.

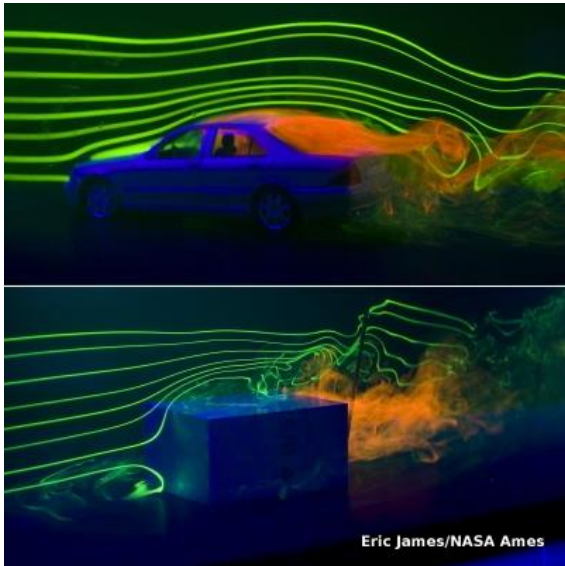
There are several disadvantages to this type of design ,the biggest disadvantage to this frame is the use of the bonding and curing process which is very costly. The overall curing time is 50 minutes and the chassis is required to enter multiple ovens. This would make things very costly for mass production where time isn't an option. As lotus is a small company this isn't really a major factor however is costly to run the ovens. Lotus however have developed a solution which now means that their new epoxy adhesive used on their sports cars can be cured at a lower temperature of 180°C which is the lowest setting in the paint ovens. This as a result has saved the company a fair amount of money as now the cars can be cured in the paint ovens as the cars are being finished. The overall chassis is only suitable for sports cars and would be unsuitable for larger cars. The process is costly and isn't suitable for mass production. The overall design is also made by hand so there is room for human error which may cause defects in the design. The use of aluminium is also prone to oxidising causing weakness in the chassis over long periods of time as shown in the diagram.



In summary both chassis suit their applications and have very different uses and both serve their purpose. The bonded aluminium chassis tub is a great chassis however compared to the monocoque chassis is a lot more costly and time consuming with the monocoque chassis more suitable for mass production. The bonded aluminium chassis tub is cheaper to set up which makes it suitable to smaller production lines. The monocoque chassis is also built by robots so therefore can keep up with demand. The bonded aluminium chassis tub is a lot more difficult and is a lot more time generous process. The monocoque chassis however is incredibly heavy and is very difficult to make lighter with such large volume of steel used with the design. In comparison to the bonded aluminium chassis tub which weights 68kg its incredibly light and definitely suited for its application. The large volume of steel used in the monocoque chassis does result in the design being most suitable for daily use where safety is the key priority. In comparison to the bonded aluminium chassis tub this system is very compact and in comparison does not provide all the built in buffer and crumble zones like the monocoque chassis. The monocoque chassis is also a complex design although the bonded aluminium chassis tub is made up of very limited number of parts making the overall design simpler. Both designs suit their applications very well however both have very different designs depending on the companies use and application.

Aerodynamics

Aerodynamics is the study of forces and the resulting motion of objects through the air ([NASA](#)). All objects such as birds, planes and even vehicles are all effected by aerodynamics.



As shown in the image the airflow flowing over the car is more aerodynamic than the block. We can clearly see this with the air flowing over the vehicle highlighted in green is very equally spaced out in comparison to the block which causes a lot of interference to the air. We can clearly see this by the picture that the car has much less air resistance than the block. This air interference or air resistance is referred to as drag.

Drag is a force that tries to slow an object down which as a result makes it harder for an object to move for example its harder to walk or run through water than it is through air. This is due to water having a much larger level of drag in comparison to air. As seen and explained the more rounded the surface the less drag an object has the most aerodynamic shape is a tear drop as it has very little air resistance. The larger the surface area the more drag an object has. This is why in the automotive industry and in the aeronautical

industry look at the vehicles drag and air resistant very closely. Its important to ensure the car in this instance has very good aerodynamic shapes to ensure the car or vehicle has the best way of accelerating through the air. The drag has a huge effect on the way the car handles and achieves the best fuel economy possible. If a car for example can pass through the air with less difficulty the car can accelerate better resulting in better fuel economy numbers as the engine won't have to work as hard to push the car through the air. If a cars aerodynamics are not looked at in a wind tunnel it is possible that the existing shape could use more than double the power needed to reach the same speed as a car with half the power however has a better Aerodynamics. This car as a result of this will have a smaller engine saving weight on the vehicle. The aerodynamic efficiency of a cars shape is measured by its co-efficient of drag (also described as its Cd figure). Coefficient of drag simply influence the aerodynamic drag by the shape of object. The most aerodynamic shape is a water drop which has a Cd value of 0.05. This shape would be perfect to produce a car from however we cant instead a modern car has a Cd value of around 0.30. Drag is proportional to the drag coefficient including the frontal area and the square of vehicle speed. You can see a car travelling at 120 mph has to fight with 4 times the drag of a car travelling at 60 mph.



Cars have become a lot more rounded on the exterior and air is used to channel all over the car either to cool the engine or around the vehicle in a way the car has very little air resistance and the air channels around the car. Cars such as the new Aston Martin Valkyrie has air channels that move in all sorts of angles even under the car to ensure the car has the least air resistance

possible as shown by the arrow.

If a car is too powerful and is extremely aerodynamic it can cause the car or vehicle to lift similar to an aircraft. Designers and engineers therefore designed a spoilers to prevent the car lifting. This creates downforce which reduces the lifting force pinning the car to the ground. If a vehicle such as a car has too much lift then its hard to get traction which will have a huge effect on the vehicles performance. Rounding features such as lights on the exterior of the vehicle are designed to channel air in a way so that air flows around the car with the least resistance possible even down to to the smallest feature.

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