Different Designs of a Car Body Structure - A Review

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Abstract

The nucleus part of every car is the body structure. The car body connects each and every one the dissimilar components; it houses the drive train and on the whole essentially carry and protect passengers and cargo. The body structure requirements to be firm to hold up burden and pressure and to steadily bind mutually every one of the components. Additionally, it should defend against and become softer the impact of a stop working to undamaged save from harm the occupants. In adding together, it requirements to be as light as possible to optimize fuel cost-cutting measure and performance. Over the years, a variety of designs have been used and each one of them has its reimbursement and drawbacks. In this paper different types of car body structures and their own benefits and drawbacks were reviewed for different design and materials aspects.

Keywords: car body structure, design, material.

1. Introduction

The main role of car body is decreasing of automobile accidents consequences (passive safety increasing) and increasing of both design attractiveness and car convenience. Consequences of automobile accidents or survive of passengers at car accident depend on amount of human organism overloading and space size needed for survive of car crew. When harder and tougher car body parts contact solid barrier at impact, the overloading of human organism depends on ability of deformation zone components to absorb kinetic energy. Hence, kinetic energy absorption is realized by utilization of pneumatic or hydraulic shock-absorbers as well as deformable thin-walled structures from steel, plastic or composites. Dropping vehicle mass was and is a severe confront amongst automobile makers to trim down their product's ecological pawmarks by falling their energy utilization. Vehicle weight

cutback–that is, building the vehicle additional structurally capable - is one decisive aspect for congregation green recital needs. Furthermore, automakers have the superfluous defy achieving this structurally proficient weight drop at the same time as moreover getting better protection and maintain affordability - requirements that may be in undeviating conflict to each other. In several cases, automakers began to look at choice, low - solidity materials as a replacement for of steel to meet up the challenges they faced [1].

At some stage in the last years, the quantity of steel used in car body manufacturing has decreased endlessly. As an end result, plastics and light metals have replaced numerous parts until that time contrived from steel. Due to its admirable properties, aluminum is one of largely-used light metals in car body manufacturing. Unluckily, laser assisted joining of aluminum and steel tends to the development of fragile intermetallic phase [2]. The contemporary fashion in car body structure pertaining to light mass design and car safety enhancement progressively more requires an adaptation of the narrow material property on the element load. Martensitic hardenable steels, which are characteristically used in car body components, show a considerable hardening outcome, for case in point in laser welded seams. This outcome can be decisively used as a local strengthening method [3]. The basic constructional materials of car body interior multifunctional elements, endowed with improved sound absorption characteristics are one-piece molded air-permeable fibrous and / or foamed open-cell structure of materials [4]. Raw materials have a say in relation to 47% to the cost of a vehicle. On average, an automobile is 47% steel, 8% iron, 8% plastic, 7% aluminum, and 3% glass. Other materials account for the remaining 27%. [5]

2. Car body design with aluminium

Steel automobile bodies are historically fancied from sealed sheet components joined by resistance spot attachment. Newer developments enclosed the introduction of the hydro forming technology and therefore the ray attachment technique. alongside the market introduction of latest high and extremist high strength steel grades, it absolutely was so doable to boost the stiffness and crash goodness and/or scale back the load of the steel automobile bodies at no or very little extra price. optical device welded, continuous joints considerably increase the rigidity of the monocoque body part and structural parts and sub frames factory-made from skinny, hydro shaped steel tubes change additional enhancements of the body strength and stiffness. Similar style Associate in nursing producing principles as used for steel body structures are often applied to comprehend an all-aluminium automobile body. However, easy material substitution leads not forever to price economical

solutions. It's essential to require a holistic approach and to contemplate the overall system consisting of the development material, acceptable style ideas and applicable fabrication strategies. Technically and economically promising metallic element automobile body ideas square measure the results of aluminium-oriented style ideas and properly custom-made fabrication technologies. With its completely different product forms (sheets, extrusions, castings, etc.), metallic element offers a large form of style choices. So associate in nursing acceptable substitution of steel by metallic element within the body part allows not solely a big weight reduction, however influences the value potency too. The choice of the foremost acceptable product kind – looking on the kind of automobile and therefore the planned production volume – also permits the improvement of the technical performance beneath the given economical and ecological boundary conditions. A most significant advantage of metallic element compared to steel is that the extra handiness of extruded, single- or multi-hole profiles with sophisticated cross sections and thin-walled, in an elaborate way formed castings with wonderful mechanical properties. These parts cannot be solely beneficially used for load-carrying and/or stiffening functions, however may additionally function connection parts. The right use of extruded (and formed) or die solid merchandise allows the event of latest, innovative structural style solutions and, consequently, vital weight and price savings by components integration and therefore the incorporation of extra functions. metallic element sheets show similar denting and bending stiffness as steel sheets once their thickness is accrued by forty the troubles, i.e. the load reduction ensuing from a cloth substitution reaches up to fifty the troubles. just in case of the profiles, the substitution of steel by metallic element offers above all potential for weight reduction once the profile pure mathematics (cross section) are often varied, e.g. by dynamic from Associate in Nursing hospitable a closed profile or by the introduction of multi-chamber profiles. What is more, there's a transparent potential for the helpful application of extruded metallic element profiles once the profile diameter are often accrued. The causal factor within the choice of the foremost effective metallic element body style idea is that the envisaged production volume. High volume production appearance for minimum material (part) price and low assembly price, however will afford comparatively high capital investments (both in tools and producing equipment). In distinction, low volume production asks for minimum capital expenditures whereas part and assembly prices play a reduced role **(Figure.1).**

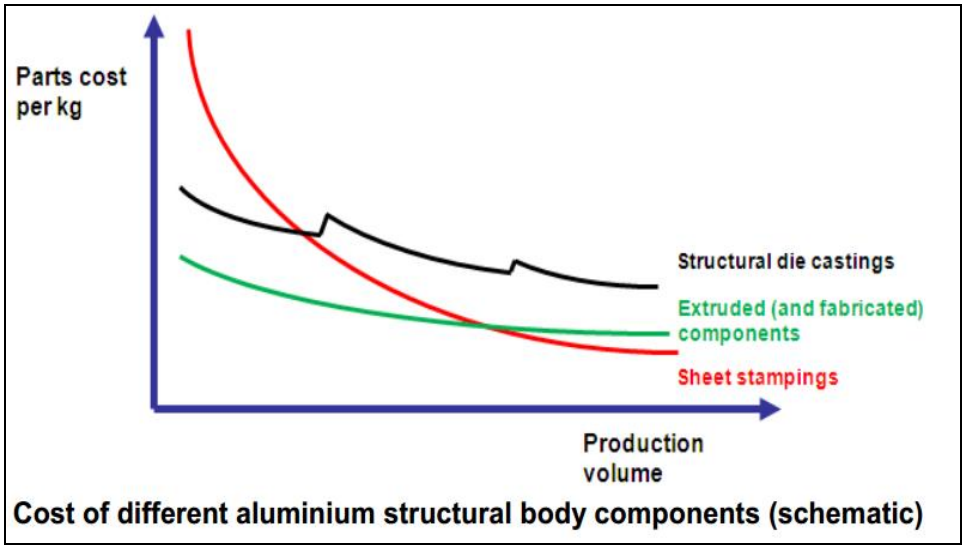

Figure 1 Cost for aluminium body structure components [6]

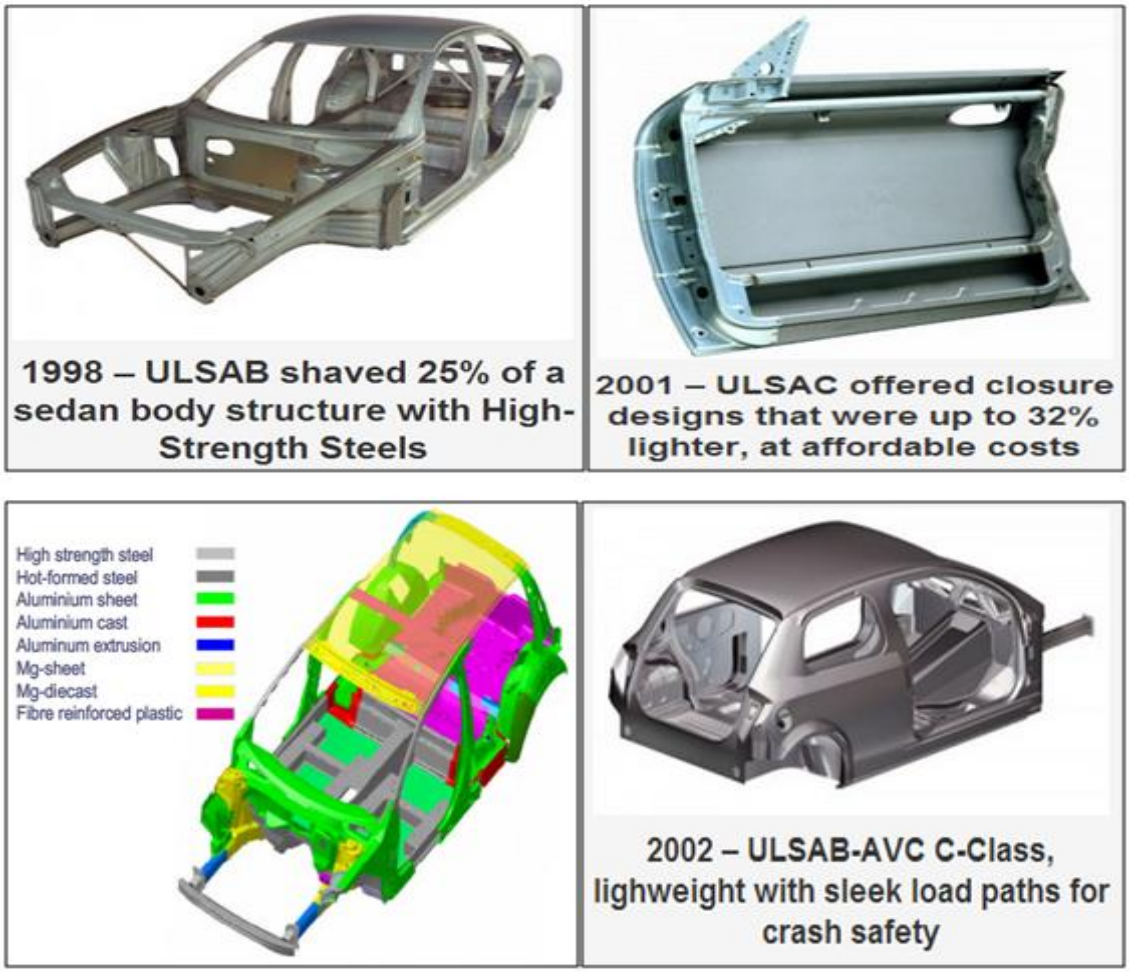

Figure 2 Material contribution for different car body structure [6]

The cost relations shown on top of for ready-to-assemble structural automotive body components offer solely a rough indication. In observe the particular value of metal body parts can vary considerably. The shapes of the parts, the specified geometrical tolerances and mechanical properties, etc., area

unit most relevant parameters. the value of extruded metal parts dissent considerably betting on the required extra forming and machining steps. 3D-bending and hydro forming operations area unit explicit cost-intensive. just in case of structural die castings, a most significant value issue is that the (part-specific) tool time period. What is more, the assembly prices will show giant variations betting on the application-specific needs and therefore the geometrical tolerances of the only parts. However conjointly the value of surface preparation and corrosion protection may be vital. Thus, an in depth analysis of all the assorted factors influencing the general value are going to be typically necessary. Betting on the planned production volume, the assorted product forms – sheets, extrusions and structural die castings – may be utilized in varied proportions for the automotive anatomical structure. Mixed material styles, i.e. the mixture with alternative material parts (steel, magnesium, fibre strengthened composites, etc.) add more potentialities. For aluminium-intensive automotive body structures, however, solely 3 basic automotive body style ideas area unit used today:

- Extrusion-intensive frame structures (straight and 2D-bent extrusions)
- Space frame structures as well as shaped extrusions and huge, thin-walled castings
- Sheet-intensive unibody structures **(Figure. 2 & 3).**

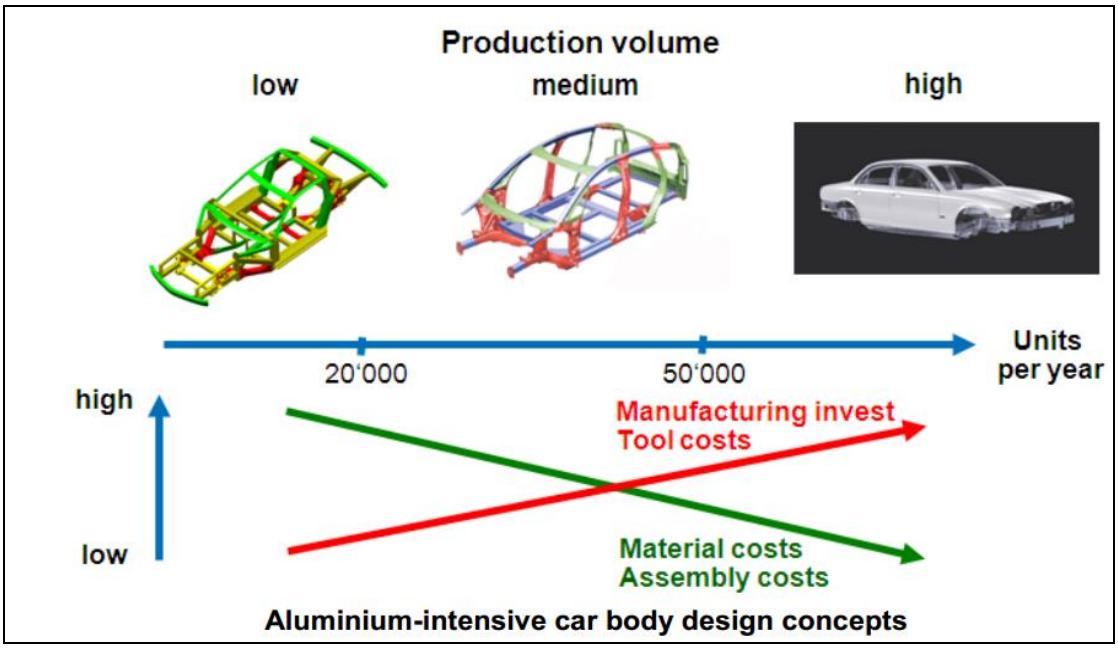

Figure 3 Car body design cost - Aluminium material [6]

3. Different designs of car body structure

3.1 Ladder frame design structure

The oldest structural vehicle style is that the body-on-frame idea. The frame usually consists of 2 parallel, connected rails ("ladder frame") that the

suspension and wheelwork square measure connected to. The remainder of the body, or the shell, sits on the frame. The body-on-frame idea was used till the first Sixties by nearly all cars within the world. The first frames were made from wood (commonly ash), however steel ladder frames became common within the Nineteen Thirties. Today, the frame style is merely utilized for light-weight trucks and life-size SUVs. The frame seems like a ladder, 2 longitudinal rails connected by many lateral and cross braces. The meridian member's square measure the most stress member. They cope with the load and also the longitudinal forces caused by acceleration and braking. The lateral and cross members offer resistance to lateral forces and increase the torsional rigidity. Frames square measure used on trucks as a result of their overall strength and skill to sustain weight. The disadvantage of the frame style is that it's sometimes significant and – since it's a two-dimensional structure – the torsional body stiffness must be improved. Also, the frame tends to require up lots of valuable house and forces the centre of gravity to travel up. Safety is additionally compromised in an exceedingly body-on-frame vehicle as a result of the rails don't deform below impact; i.e. a lot of impact energy is passed into the cabin and to the opposite vehicle **(Figure.4).**

Figure 4 Ladder frame design structure [6]

3.2 Unibody design structure

Consequently most recent automobile bodies don't seem to be true monocoque styles; instead today's cars use a unitary construction that is additionally called unibody design. This uses a system of box sections, bulkheads and tubes to produce most of the strength of the vehicle, to that the stressed skin adds comparatively very little strength or stiffness. The unibody style permits a big weight reduction of the automobile body and allows a additional compact, nonetheless spacious vehicle configuration. Additionally

safety is enhanced as a result of heat-absorbing deformation zones will be designed into the unibody. The rigidity of the automobile body is somewhat compromised as a result of the fundamental monocoque assembly is formed of sheet panels that square measure – a minimum of just in case of steel styles – typically spot welded, i.e. solely domestically connected. However, it's simply doable to extend the stiffness of the unibody by victimization continuous joints (e.g. adhesive bonding or optical maser welding) or by the addition of tubes, closed sections or alternative stiffening parts. On the opposite hand, once a vehicle with a unibody style is concerned in a very serious crash, it's going to be harder to repair than a full frame vehicle **(Figure.5).**

3.3 Tubular space frame design structure

The hollow area frame chassis employs dozens of tubes or alternative rod-shaped elements, positioned in several directions to produce the desired mechanical strength against forces from anyplace. The result's a really complicated welded structure. Since the middle 60s, several high-end sports cars additionally adopted the hollow area frame style to boost the rigidity / weight magnitude relation. However, several of them truly used area frames just for the front and rear structure and used a monocoque cabin for value reasons **(Figure.6).**

Figure *5* Unibody design structure [6]

3.4 Backbone design structure

The backbone chassis is extremely easy. It consists of a powerful annular backbone (usually with an oblong cross section) that connects the front and rear shaft and provides nearly all the mechanical strength. The total drive train, the engine and therefore the suspensions are connected to each ends of

the backbone. The backbone chassis is powerful enough for little sports cars, however not appropriate for prime performance sports cars. Additionally it doesn't offer any protection against aspect impact and off-set crash **(Figure.7).**

3.5 Monocoque design body structure

With the fourth generation vary Rover (L405) that was given in Sep 2012, Jaguar's lightweight Weight Vehicle technology was 1st applied to a machine motorcar vehicle. The all-aluminium monocoque structure is thirty-nine per cent lighter than the steel body within the outgoing model sanctionative total vehicle weight savings of up to 420kg. With a complete body-in-white weight of 379 metric weight unit, the light-weight atomic number 13 platform delivers vital enhancements in performance and gracefulness, at the side of a metamorphosis in fuel economy and greenhouse emission emissions. The optimised atomic number 13 structure is meant for optimum inhabitant protection victimization Associate in nursing unbelievably sturdy and stable atomic number 13 safety cells, and provides a awfully stiff platform for superior NVH and vehicle dynamics **(Figure.8).**

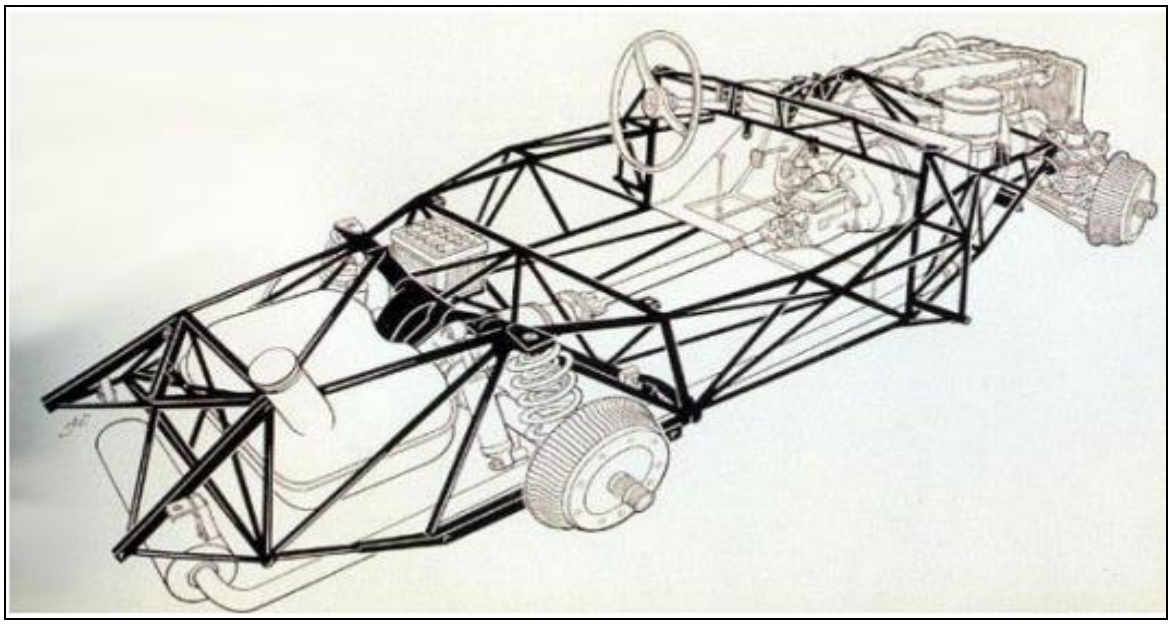

Figure 6 Tubular space frame design structure [6]

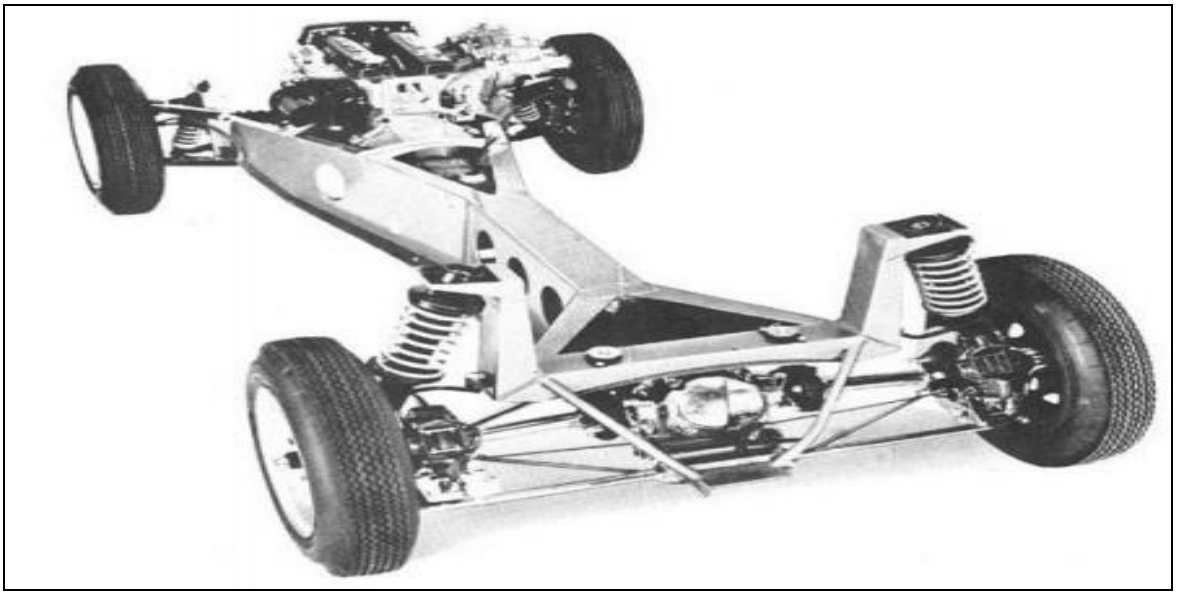

Figure 7 Backbone design structure [6]

3.6 Space frame structure

The house frame body construct exploits the chance of high half integration (i.e. the potential reduction of producing and tooling costs) and permits a weight reduction of over four-hundredth. Though the assembly of top quality structural pressure die castings and shaped and machined extruded sections is comparatively costly, hefty total value savings is achieved for tiny and medium production volumes compared to pure sheet body style ideas. However the house frame construction conjointly exhibits a considerable fraction of formed sheet elements. Especially the sheet elements mounted between the frames components are most significant conditions for the rigidity of the structure **(Figure.9).**

Figure 8 Monocoque design body structure [6]

Figure 9 Space frame design structure [6]

3.7 Crosslane 2+2 coupe design body structure

Most fascinating is additionally the Audi Crosslane idea that was given at the Paris automobile show in 2012 with its multi-material house frame. Extruded aluminium profiles type a stiff, closed structure round the rider compartment. Aluminium sections beneath the bonnet connect the aluminium frame round the grille that has conjointly a structural perform, with the protection cell. The front and rear crash management systems are manufactured from carbon fibre strengthened composites, alternative carbon fibre strengthened composites among the rider compartment like the inside sill beams, firewall, tunnel and floor cross beams also are a part of the construction. Flat optical fibre strengthened plastic panels complete the automobile anatomical structure **(Figure.10).**

Figure 10 Crosslane 2+2 coupe design body structure [6]

3.8 Shell type body design structure

Mercedes-Benz describes the body of the 2013 S category model (W222) as a third-generation metallic element hybrid body shell. The body consists of fifty metallic elements together with high- and ultra-high strength steels. A light-weight style construct by material and geometrical improvement plus an extremely advanced connexion technology (specifically the appliance of further mechanical connexion technologies) permits the new S category model to any raise the bar within the rigorous luxury saloon section – while not adding weight. The light-weight index, the torsional stiffness in reference to weight and vehicle size, has been improved by five hundredth compared to the forerunner model. An extra style goal was a more robust NVH performance than the already superb preceding model **(Figure.11).**

3.9 Tunnel type design structure

In order to attain handling dynamics similar to those of the auto version despite the dearth of a set roof, the roadster has 2 options designed to extend the rigidity of the body shell: the cross-member carrying the dashboard has extra supporting struts at the screen frame and at the centre tunnel, and a strut mounting keep between the soft high and also the fuel tank makes the rear shaft even a lot of rigid. The facet members of the front and rear modules in each SLS AMG models are identical **(Figure.12).**

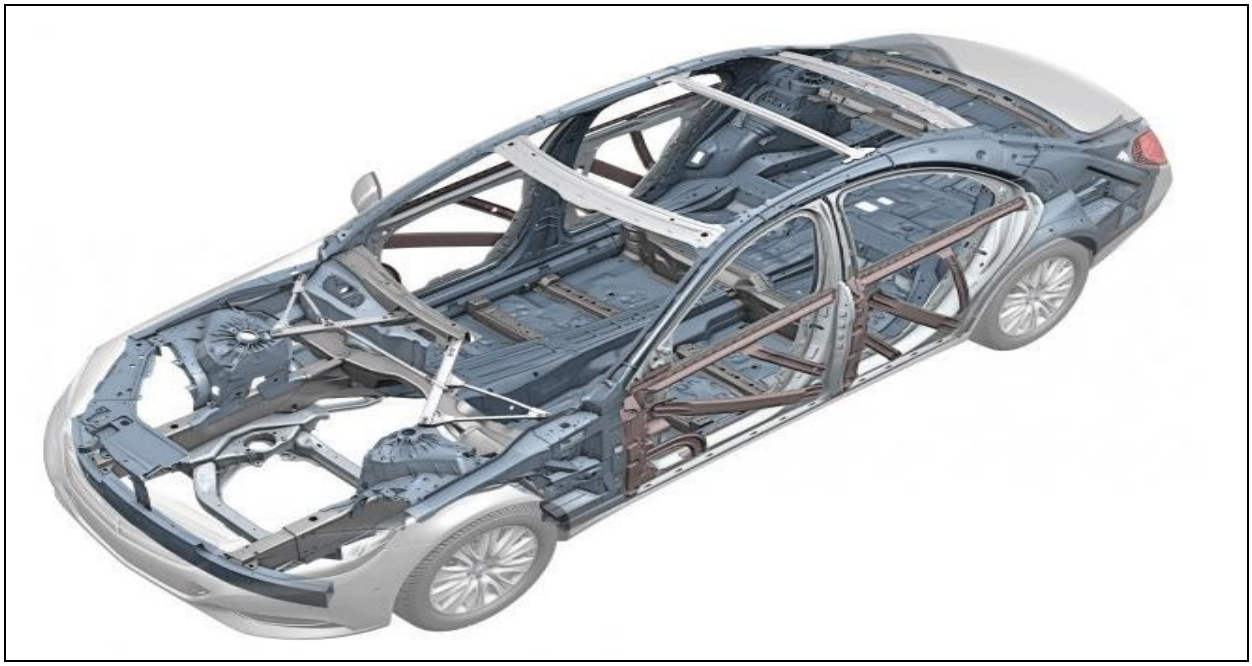

Figure 11 shell type body design structure [6]

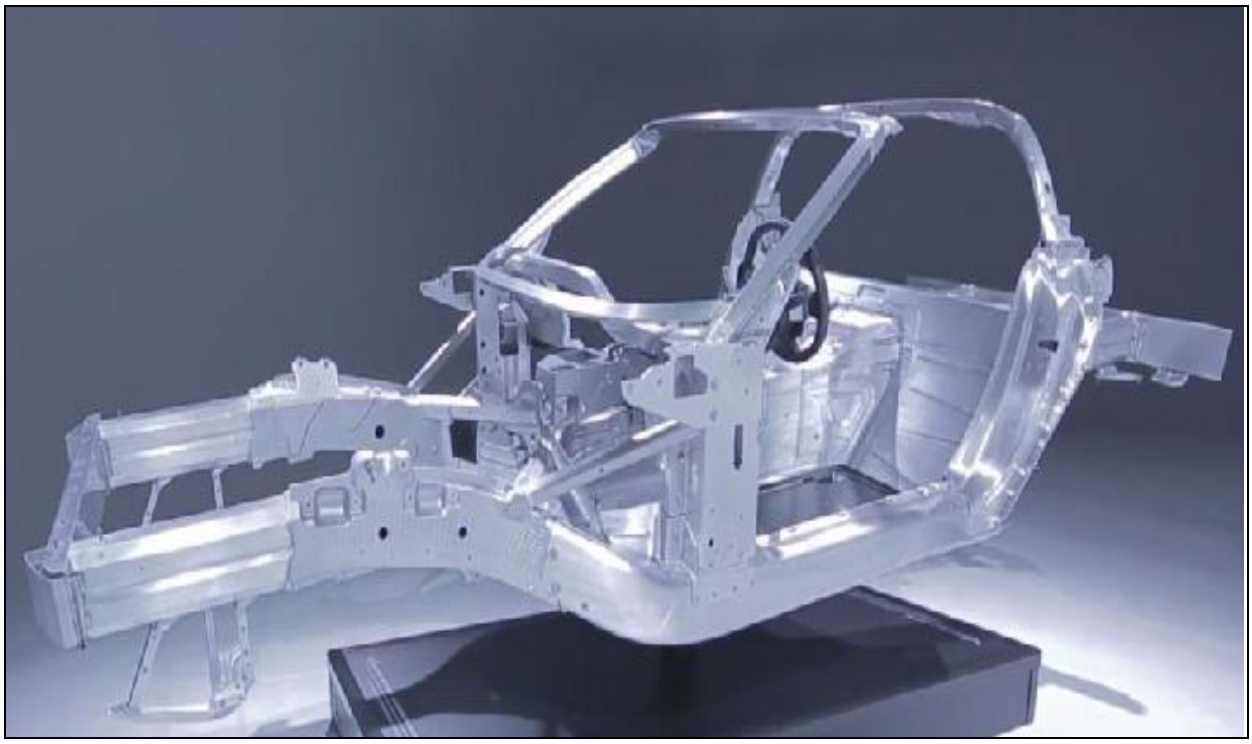

Figure 12 Tunnel type design structure [6]

4. Conclusions

This paper reviews the different types of an automobile car body structure designs, material contribution towards the car body structure manufacturing and the various benefits of all type of car body structures under

the different design, material and dynamic loading aspects. In this paper also shows the uniqueness between the different design structures of typical car body. Each car body structure has its own unique benefits and different limitations according to the usage, design and manufacturing methods.

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Biographies

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