Analysis of Automobile Body Structure and Monocoque Body Welding Technology

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Abstract. Is the main purpose of the car body by passenger, cargo, safely and reliably protect passengers and cargo from wind, sand, rain, snow, etc., constitute a good air mechanics environment, body should guarantee reasonable structure, beautiful shape, color coordination, and can effectively reduce the car's fuel consumption, air resistance and ensure the car driving stability and cooling condition of the engine, ensure the car ventilation, etc. The body parts mainly include body shell, surface meal gold, freight car and cab, door, window, frame and so on. The automobile body structure can be divided into three types: non-bearing, semi-bearing and bearing. There are many kinds of welding methods commonly used in body maintenance, and it is of great significance to research and formulate the welding repair process for body.

Keywords: The Car Body, Welding Repair, Welding Deformation, the Control Method

1. Introduction
The body of the car is the place where the driver works, as well as the place accommodates passengers and cargos, Its main function is to safely and reliably accommodate passengers and cargos and protect them from wind, sand, rain, snow and other attacks and adverse weather effects, forming a good aerodynamic environment. A good body of the car can not only bring better comprehensive performance, ensure that the car has a reasonable external shape, beautiful shape, color coordination, also can effectively reduce the air resistance and fuel consumption when the car is running, which is helpful to improve the driving stability of the car and improve the cooling condition of the engine and ensure the ventilation inside the car. The structure of automobile body mainly includes body shell, surface sheet metal parts, carriage of truck, cab, door, window, interior and exterior decoration parts, body accessories, seat, heating and ventilation devices, etc. Automobile body structure from the form can be divided into non - bearing type, semi - bearing type and bearing type three types. There are many kinds of welding technology used in body repair, so it is of great significance to research and develop the welding technology scheme for body repair. With the development and research of new technology, new process and new material, automobile body is developing towards safer, environmental protection, energy saving, beautiful, comfortable and durable direction. Corresponding to it, welding method in body repair is also changing with each passing day [1-3].
2. Classification of Car Bodies
According to the bearing mode of the car body, the car body can be divided into three types: non-bearing type, semi-bearing type and bearing type three types.

2.1. The Non-Bearing Body Structure
The traditional non-bearing body is placed on the frame of the car and connected by elastic elements, the vibration of the frame is transmitted to the body by elastic elements and most of the vibration is weakened or eliminated, the frame can absorbs most of the impact in a collision and protects the body when driving on bad roads, therefore, the carriage deformation is small, stability and safety is good, and the noise inside the carriage is low. This kind of body is mainly used for heavy freight cars, medium and large passenger cars and high rigid engineering vehicles, such as freight cars, engineering cars, off-road vehicles, etc. This kind of car body structure has strong bearing capacity, high torsional rigidity, simple structure, easy to develop and manufacture, and low production process requirements. But the weight of the frame is very heavy; the frame accounted for the total weight of the car is large, strong and solid frame through the whole vehicle, affecting the layout of the vehicle and space use. The thickness of the girder makes the height of the car and freight car mounted on it rises from the ground, the center of gravity of the vehicle is on the high side, and the stability of high-speed driving is poor. Non-bearing steel body used by the steel plate material is mainly low alloy structural steel, This material is plastic, easy to process, good weld ability, heating and cooling in the welding, the impact on the strength of the body is small, usually adopt gas shielded welding. The non-bearing body structure as shown in Figure 1.

![Figure 1. The non-bearing body structure](image1)

![Figure 2. The semi-bearing body structure](image2)

2.2. The Semi-Bearing Body Structure
semi bearing type body its body and frame use welding, riveting or bolt connection and other ways to connect, the load is mainly borne by the frame, the body also bears part of the gravity. The advantage of this kind of car body is that it can reduce the noise emitted when the non-bearing type car body is relative to the frame displacement, but it is seldom used at present because of its larger mass. The semi-bearing body structure as shown in Figure 2.
2.3. The Bearing Body Structure

The bearing body structure is needed to meet the needs of energy conservation and environmental protection, a seamless automobile body that appeared around 1940. This kind of structure, directly installed the car's engine, suspension, etc. on the body, make the body bears all the load, act as car's frame. The bearing body is generally formed by high strength low alloy structural steel and welded. The body is a frame structure with cabin, engine compartment and bottom frame, which is widely used in various cars and large and medium-sized buses. Compared with the traditional non-bearing body, the advantages of this body are reflected in several aspects: ① The quality is small. Due to using sheet metal stamping forming components and welding, good rigidity, torsion resistance ability, small quality. ② High productivity. Adopting advanced production methods such as spot welding and multi-station automatic welding, Make the body after welding the overall deformation of small, good product quality, high production efficiency. ③ Good security. The center of gravity is low and can bear the load uniformly and diffuse gradually, which has good absorption performance and safety to the impact energy. As the bearing structure of the whole car body, the car body has a decisive influence on the handling performance, driving performance and comfort performance, and has higher requirements on the selection of materials. More than 70% of the materials used in the load-bearing body components are high strength steel (HSS) and ultra-high strength steel (UHSS). Bearing body structure is shown in Figure 3.

3. The Welding Method of the Load-Bearing Body

Welding is a process by which using heat, pressure methods or both are used to bind two separate parts of metal firmly and permanently by means of the bonding and diffusion of atoms within the metal. There are dozens of welding methods, welding methods used for the welding and repair of automobile bodies, mainly includes fusion welding and pressure welding. Fusion welding is make use of local heating method, make welded metal junction heating to the melting state, adding or without adding filler metal, cooling crystallization after the formation of a firm joint welding method, can be divided into gas shielded arc welding, manual arc welding and submerged arc welding. Pressure welding is a method that uses pressure or simultaneous heating to make the welded metal joint in close contact. It can be divided into resistance welding, friction welding, cold pressure welding, ultrasonic welding and high-frequency welding [4-6].

3.1. CO2 Gas Shielded Welding

As an efficient welding method, CO2 gas shielded welding has been widely used in automobile body welding manufacturing due to its characteristics of small welding deformation and low welding cost. However, there are still some problems in the practical application of CO2 gas shielded welding, Such as arc voltage, welding current or welding circuit inductance mismatch, welding wire length is not
appropriate, all of these may cause instability of welding arc, spatter and lack of penetration, etc., which have great influence on weld forming and mechanical properties. The CO2 gas protection welding device is shown in FIG. 4.

(1) Choice of welding machine. Should choose the body special welding machine, because the thickness of 1.0mm or so bearing car body plate will be easy to welding through without small and stable current. Non-special welding machine for the body, with the change of the grid voltage, the current is not stable when welding, which is not good for the welding of the sheet metal.

(2) Selection of welding materials. Should use AWS- ER70s-6, 0.6mm diameter welding wire for body welding. The welding current should be reduced in order to ensure that the welding seam is formed and not melt through. In order to ensure the stability of the welding process with small current should use fine welding wire. The welding wire with diameter of 0.8mm is suitable for the steel plate with thickness of 1.5-2.5mm, which is not suitable for the plate with thickness of 1.0mm or so of the bearing type body.

(3) Selection of protective gas. Protection of argon gas should be chosen (75%) and the mixture of carbon dioxide (25%), are burning stability, little splash, and oxidation resistance, overcome the argon welding when the surface tension, liquid metal sticky, spot problems such as easy to drift, and depth of molten weld mushroom-shaped improved, car panels welding practical effect is good. And 100% carbon dioxide as a protective gas, when welding will produce a greater depth of fusion, easy lead to welding through the sheet pieces.

(4) Welding method. The welding methods required by each piece of body welding are different. Butt welding, lap welding and plug welding are commonly used. In accordance with the requirements of automobile manufacturing operation, adopt piecewise welding to make each welding seam fully cooled so as to prevent deformation of the pieces.

![Figure 5. Resistance welding diagram](image)

![Figure 6. Laser welding schematic diagram](image)

3.2. Electric Resistances Welding

Resistance welding is a welding process in which electric current flows through two pieces of metal clamped together to generate resistance heat, partially melting and applying pressure to weld them together. Resistance welding is very suitable for the lap welding of sheet steel, it is the most common welding method in the bearing type body manufacturing. For ultra-high strength steel, the welding heat of gas shielded welding will destroy the inner structure of ultra-high strength steel and reduce its strength, so must choose the resistance spot welding method [7-9].

(1) The advantages of resistance spot welding. ① Low welding cost, do not need for wire, electrode, protective gas, no welding metal needs to be polished. ② Clean, do not produce smoke. ③ The welding position is flexible and suitable for the welding of galvanized sheet. ④ The welding quality is high, the speed is fast, in one second may weld the high strength steel, the high strength low alloy steel or the
low carbon steel work piece, the welding heat is only one half of the gas protection welding, the heating range is small, the work piece is not easy to deform.

(2) The operation points of resistance spot welding. ① Surface treatment of welding parts. Since the dust, paint, grease and rust on the welding parts will reduce the welding current and affect the welding strength; these sundries must be removed from the surface of the welding parts before welding. ② Adjust the electrode arm. The length of the electrode arm should be adjusted as short as possible to maximize the welding pressure. The electrode arm and electrode head should be fixed to avoid loosening in the welding process. The electrode head should be perpendicular to the surface of the plate, otherwise the welding current will weaken and the welding strength will not be enough. ③ Welding. Select the relevant parameters and electrodes according to the welding specifications, determine the mutual positions of the welding pieces and clamp them with special tools such as a clamp, then welding can be carried out on the welding spots distributed according to the plan. The number of solder joints should be about 30% higher than that of the manufacturer, and the original solder joints should not be welded. For portable spot welders, should stop after welding 5~6 spots in a row to cool the welder. During normal use, the electrode will burn and scale to increase the resistance, the current passing through the welding will be reduced, and the welding depth will become shallow, leading to insufficient strength of the welding spot. When found the electrode tip turn into red or spray increase during the welding process, the electrode end should be repaired and ground promptly with a special electrode dresser or electrode grinding machine. General resistance spot welder welding current can reach about 6000A, for the body of the general plate welding. But the welding current of galvanized steel plate is increased by about 50% than that of low carbon steel plate without galvanized layer, the thicker the coating, the more uneven, the greater the current required, for some ultra-high strength steel, welding current may reach more than 9000A, otherwise the welding spot cannot guarantee enough strength. ④ Inspection of solder joints. The welding quality is judged by appearance inspection, as shown in Figure 1. Figure 1a: Check the indentation depth shall not be greater than 1/2 of the plate thickness. when the two plate thickness is inconsistency, the size of the thin plate shall prevail; Figure 1b: There shall be no more obvious pinholes on the surface of the welding piece; Figure 1c: There should be no obvious welding spatter on the surface of the welding piece, Such as belong to body skin, outer board and other covering parts, wear gloves to wipe not to hang silk. The destructive test shall check the welding quality of weldment, and the method shown in FIG. 2 can be disassembled. According to the clearness of the fracture, the quality of spot welding is judged intuitively. The flat chisel as shown in Figure 3 can also be used to wedge into the plate along the welding joint and leave the welding spot at 7-10mm until the nugget shape is observed (no more than 30mm). The flat chisel can be pulled out after the welding spot is confirmed to be intact and the inspection place shall be fixed. The resistance welding device is shown in Figure 5.

3.3. Laser Welding
Compared with traditional welding, laser welding has incomparable advantages in welding precision, efficiency, reliability, automation, lightweight and cost reduction. Laser is a kind of light beam with high brightness, strong directivity and good monochromator. The key of laser welding equipment is the high-power laser. At present, there are mainly two kinds of solid laser and gas laser. The laser materials commonly used for solid-state lasers are ruby, neodymium glass or neodymium-doped yttrium aluminum garnet, while gas lasers use CO2 gas. The basic principle is to use the laser beam generated by excitation of the laser, the focusing system can focus to a very small focus (spot), which has a high energy density. When focusing on the welding joint, the light energy is converted into heat energy, which makes the metal melt to form the welded joint. Laser welding technology is mainly used in the car body welding and the welding of parts. For example, welding the roof and welding the tests circumference. However, laser welding requires high precision of welding assembly, and the position of the beam on the workpiece should not deviate significantly, otherwise it is easy to cause welding defects, and it is rarely used in body maintenance. The principle of laser welding is shown in Figure 6.
4. Conclusions
With the continuous development of modern industrial technology and material science, automobile production and manufacturing technology is also constantly improving. New welding techniques, such as plasma arc welding, vacuum electron beam welding, vacuum diffusion welding, variable polarity MIG/MAG welding, laser-arc composite welding, magnetic pulse welding, adhesive bonding and mechanical bonding, have been successfully applied in the manufacturing process of various new models. The scientific development concept of high efficiency and low consumption in the new era is accompanied by the continuous development and strength of China, and the revolution of the automobile industry is also undergoing earth-shaking changes.

Acknowledgments
Fund project: Characteristic Innovation Support Project for universities in Guangdong Province (2019GKTSCX163). Classification No: TG444, Reference code: A

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