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The Planning and Digital Design for Welding Production Line of the Car Rear Floor

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Abstract

The last two sub-assembly welding production line of the car rear floor is designed in this paper. Firstly, the welding production line of the car rear floor is complete planned and designed from global aspect by analysis the structure of body-in-white and the car rear floor; Secondly, each working position fixture are designed and the location of all fixture are arranged according to location and spot welding requirements with the CATIA software. Finally, the conveying appliance of welding production line for the car rear floor are detailed planed, according to the production program, the economic requirements to complete a three-dimensional design of delivery devices, ergonomic simulation and dynamic interference checking in the process of material transportation are realized in virtual simulation platform DELMIA software, to ensure the production line design is reasonable and feasible from theory.

Keywords: *car rear floor, welding line, planning, DELMIA, CATIA*

1. Introduction

The four main process of produce car body is stamping, welding, painting and assembling, it is usually been welded in working station up to 55-75 by 300 to 500 complex shapes sheet metal parts with high-volume and fast-paced. The clamping anchor point up to 1700-2500, and solder up to 4000-5000. The quality of welding plays a decisive role to the quality of the vehicle, the production line form is mostly used in modern car body welding, advanced welding production lines, directly determines the quality and efficiency of body welding production. There are a large number of applications of high degree of automation, flexible, multi-model mixed production line design of the robot [1-2]. There are still more things we can do to increasing the welding production lines standards of design and manufacturing. The last two major sub-assembly welding production lines of car floor is designed in this study, which is last and most important part of the design of rear floor welding production line, some ergonomics are simulated and calculated in this paper.

2. The Overall Planning of Welding Production Line for Car Floor

Floor component is very important lower part of the car body. The carrying body floor without independent frame have dual task of bearing and bearing suspension. It is vital to maintain sufficient stiffness and strength of floor structure. In this paper, Based on the design theory of jig welding and installing chassis wiring, The welding fixture and the weld install main line of the various locations of the passenger vehicle after floor are planed and designed, using CATIA V5R17 to modelling and assembling the jig, Conforms to the request jig chart is designed and produces the engineering plat. Then, using the DELMIA software carry welding path planning and welding process simulation.

2.1. Analysis of Car Floor

The designed production line is welding together of the rear floor skeleton beam assembly and rear floor sub-assembly, as shown in Figure 1, the work piece are thin pieces, shown in Figure 2.

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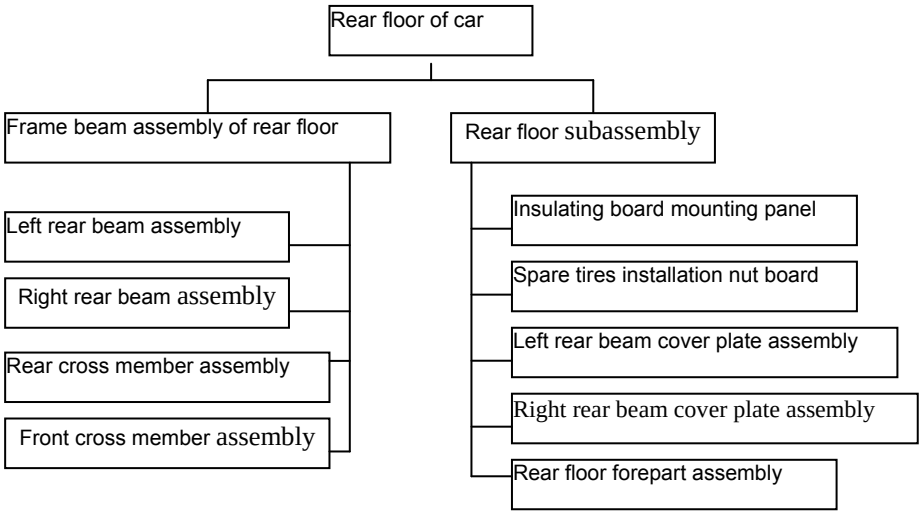

Figure 1. Rear Floor Composition of Car

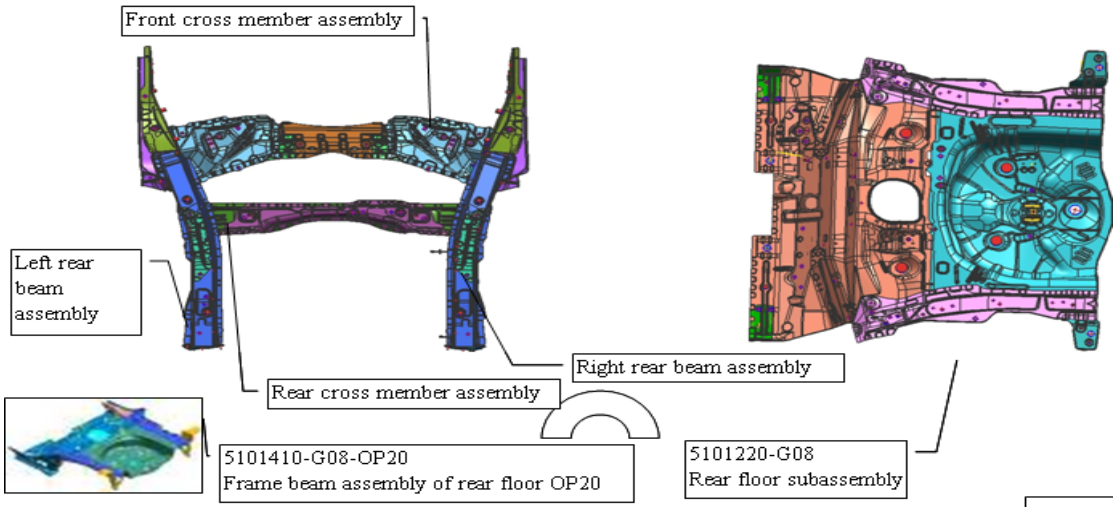

Figure 2. The Two Sub-assembly Floor

2.2. The Planning of Car Floor Welding Production Line

The design for the small batch production, there are 65 solder joints in the last two parts assembly welding totally. in order to make the workpiece deformation minimum during the welding process. Three stations of spot position for fixture points welding production lines are designed considering the rational allocation and production program [3-5], the total length of fixed support frame is 8000mm, and the height is 600mm. There are the pit digging in the factory floor to make the height of production line adjustable, the length of pit is 9547mm, the width is 2300mm, and the height is 450mm, the specific requirements are shown in Figure 3.

3. The Designing of Car Floor Welding Production Line

3.1. Fixture Design

The work piece will be affected by the deformation if the work piece far away from the welding clamp, the fixture and the torch will be interference when the work piece is too close to welding clamp. So the reasonable layout of fixture clamping position and the spot position is very important to distortions deformation during welding, the designed and assembled car rear floor welding production line with three station fixtures shown in Figure 4.

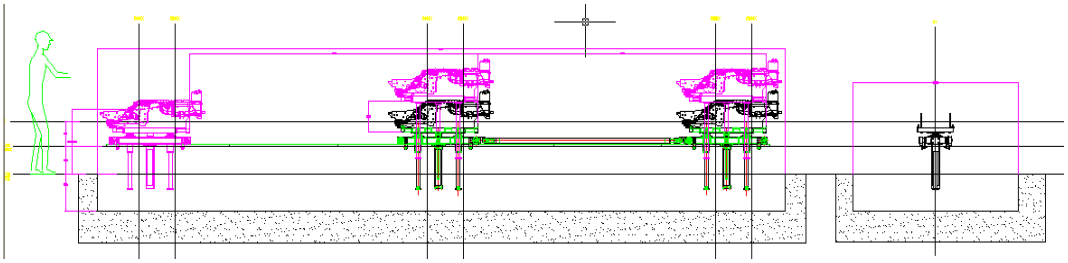

Figure 3. Structure Design of Floor Assembly Welding Production Line

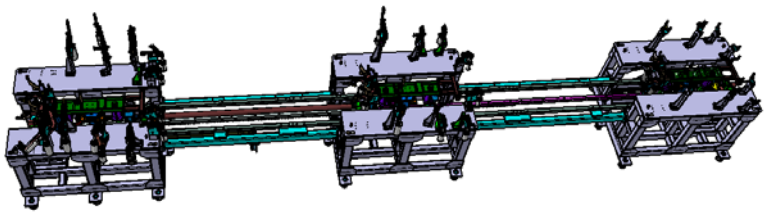

Figure 4. The Overall Three-dimensional Production Line

The interference between the fixture parts, fixture units, fixture and work piece be excluded by a combination method of theoretical analysis and CATIA analysis, to ensure the rationality of the fixture design in theory.

3.2. Delivery Device Design

3.2.1. The Design of Delivery Device Program

Two type of conveyor devices options of reciprocating conveyors and circular conveyor device According to the model output and the flexible production line [6-7]. This design is for the small and medium volume production.

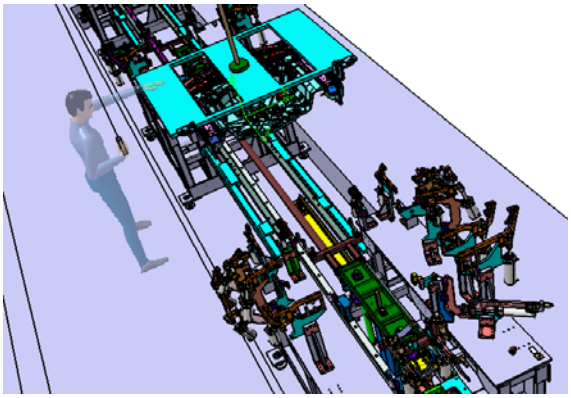

Figure 5. Ergonomic Simulation of the Working Process of Delivery Devices in CATIA

The delivery device designed in this paper is reciprocating semi-automatic transportation device with operated manually from the economy and the simplistic point of view (or hanging plate reciprocating transportation device), its working principle is as follows: the hanging plates fitted with electromagnets, hanging board declined while the solenoid is energized, suck the workpiece and lifted the workpiece off the welding fixture to hanging panels run along a straight line, then the work piece is conveyed to the next station, the Boatswain dropped and the workpiece be placed on the welding jig, electromagnet power outages and rising with hanging

plates. after the third station delivery, the hanging board return to the original station. The entire operation is done by manual remote operation, the transmission line body can meet 7-14 production station based the process requirements, the spacing between two stations is 3.5m-6m, the height is 800mm, the maximum conveying work piece mass is 500kg, can meet the delivery of heavy-duty truck cab assembly. The Boatswain's run beat is about 50s generally according to the workers' proficiency, the "down - suck tight - up - forward - down - place - up" action cycle is done within 50s. The boatswain is made with light weight and small footprint profiles production of special aluminum, its small footprint can avoid the welding fixture interference as much as possible. The mode of transmission drive is motor drive usually. SEW helical gear reducer motor are used in the drive unit of the transmission lines with hoist drives and horizontal reciprocating drive. The SEW helical gear reducer motor has large carrying capacity, reliable operation and low noise. The transport process shown in Figure 5.

3.2.2. The Buffer Design of Transmission Device

It can be found that there are a slight vibration during the material transport after analysis the simulation results, so the safety buffer equipment must be designed, the buffer device set in the hanging board terminal of rear floor assembly welding production lines, the required buffer stroke and the buffering capacity is calculated by the known device quality and speed. The specific selection process are as follows:

Acceleration $[a_{\max}]$. usually$[a_{\max}]$≤ 4m/s2. For elastic buffer, $E_1 \le E_2$, that is, $E_1 = E_p + E_m - E_f \approx E_m = \frac{1}{2}mv^2 \le E_2 = \frac{ma_{\max}}{2} \cdot s$, so: $s \ge \frac{v^2}{a_{\max}}$, Then, select the appropriate buffer according to the buffer stroke and buffer capacity, multiple buffers can be installed when one buffer capacity is limited. Assume the movement speed of car floor horizontal is 0.5m / s, and the quality is m = 100kg, the maximum allowable acceleration is 2.5m/s^2 , selection of the elastic buffer, then the buffer distance is: $s \ge \frac{v^2}{a_{\max}} = \frac{0.5^2}{2.5} \times 1000 = 100(mm)$ Moving parts with the energy of: $E_1 = E_m = \frac{1}{2}mv^2 = \frac{1}{2} \times 100 \times 0.5^2 = 12.5(J)$.So the buffer's capacity is 12.5J, the model of Bhc1-g is selected in accordance with buffer samples.

4. The Design and Simulation of Rear Car Floor Welding Production Line for Material Transport

Combination of ergonomics, DELMIA [8] software is used for materials transport simulation, the specific process shown as follows:

(1) Set new document assembly module to make the total production line equipped with the ground.
(2) Enter the body building blocks, the human body style is set after modeling and edited.
(3) Enter the Process Simulation table of DPM Assembly, inserting the simulation components.
(4) Using the command of "walk tool" and "movement to posture" to do the preparatory work of action of people walking to the front of plat in the body action simulation environment.
(5) Enter into the simulation table of DPM assembly process, the command of [to generate action] is used to completing the hanging plate, work piece movement, back to task simulation table, locate the parts of the action of the workers body. The command of [tracking trajectory] is used to completing action simulation of the work piece from one station to the other.
(6) Finishing the other station action simulation combining the comment of [to open the PERT chart] to adjust the order of the action.
(7) Click [Process Simulation] icon on the run simulation of the entire transportation process, recording motion simulation for interference checking. Next, A contact model of the conductor and the clamp can be established by using finite element method.

The effects of sag angle of the conductor, holding force and tension force can be analyzed. In this way, we can find the contact area in the middle of the clamp look like, and the relation between the suspension angle and the contact stress, and then the clamp force. The tension force in section played a most important role in these affecting factors, to improve the design [9-10].

5. Conclusion

The planning and designing of the car rear floor the last two sub-assembly welding production line is done in this paper, A necessary calculation and analysis are done to make sure feasibility and rationality of design in theory. Including: the planning and design of the welding bus and the reference height, positioning, clamping scheme are determined; the overall three-dimensional model of the car floor assembly welding production line is set in CATIA software, and the static, dynamic interference detection of production line assembly are done as a whole or each fixture unit; DELMIA software is used to simulating of the material transfer process, to ensure the feasibility and rationality of material handling and the shortest path of transport in theory.

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