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Research of Car Body Component Welding Simulation Technology

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Abstract: Welding deformation is a key problem in the manufacturing of car body parts. The accurate detection and effective control of welding deformation are crucial to ensure the quality of car body. Unreliable welding positioning tooling and immature process may lead to welding deformation due to uneven component heating, and uneven technical level of workers. Welding simulation technology with the help of computer simulation, in-depth analysis of the temperature field and stress field changes in the welding process, can accurately predict the welding deformation and defects, and then optimize the welding process, and reduce the production cost. In this study, we construct an accurate 3 D model, use the numerical calculation method to solve the physical field changes, and improve the model combined with experimental verification. The research results are expected to obtain optimized welding process parameters, significantly reduce welding defects, improve the quality and reliability of car body parts, and lay a solid foundation for promoting the high efficiency and intelligent development of car body manufacturing.

Keywords: Welding deformation; car body parts; welding process; simulation technology.

1. Introduction

In modern industrial manufacturing, welding technology is widely used in many fields and is the key process to realize metal connection. However, the welding deformation problem is always an important factor affecting the welding quality. In the current research on welding process parameters, although the significant influence of welding voltage, current, speed and other [1] on residual stress and welding deformation has been clarified, and the optimal parameter combination [2] has been continuously explored through experiments and simulation, but the traditional research methods have obvious limitations. On the one hand, traditional methods often focus on the analysis of a single factor, and it is difficult to comprehensively consider the complex thermodynamically coupled [3] action and the interaction between multiple parameters in the welding process. In the model building, on the other hand, part of the study on the actual welding process details, such as when considering the heat loss is not accurate, the dynamic simulation of welding sequence is not perfect, the simulation results and the actual situation deviation, cannot meet the modern car body manufacturing demand for high precision, high quality welding process. Based on this, this study aims to break through the limitations of existing research, deeply explore the welding process of car body parts, and realize the optimization and innovation of welding process through multi-dimensional analysis and verification.

2. Simulation and Analysis of Car Body Parts Welding

2.1. Welding heat transfer and stress field analysis

The welding process is a thermodynamic coupled process. Through the basic theoretical analysis, we can deeply understand the influence of [4] and other transfer on the welding temperature field, and how these factors affect the performance of the welding structure.

2.2. Establishment and discretization of car body model

2.2.1. Establishment of 3 D model of the bearing wheel flange of car body parts

As one of the main parts connecting the load wheel and the body, the load wheel flange is very important to the body. In this experiment, the three-dimensional model of the load wheel flange is established by using Solidworks software.

2.2.2. Welding process parameters

During welding, welding process parameters (such as welding voltage, current, speed) have a significant impact on residual stress and welding deformation [6]. TIG welding, welding efficiency is 0.8 (its range is between 0.75-0.9), simulation setting welding voltage 20V, welding current 220A, and welding speed 8mm / s.

The bearing wheel flange is made of 6060 aluminum alloy and TIG welding. In the simplified model, gas exchange is not considered, and the heat source movement is simulated by activating the weld filler.

The actual welding heat loss is caused by light, heat radiation and heat loss from the splashing of welding materials, which introduces the welding thermal efficiency (this finite element simulation is set to 0.8).

Due to the thickness of the plate, multi-layer multi-channel welding is adopted to ensure the quality. The angular joint deformation and factory process are used. The slope is set with 40° and the welding layer is 4 layers. The joint model is shown in Figure 1.

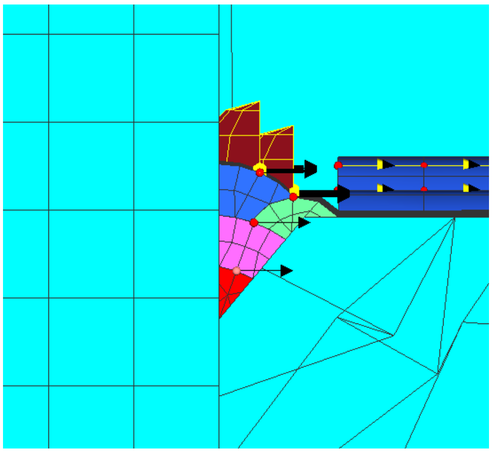


Figure 1. Model diagram of multi-layer and multi-channel welding path

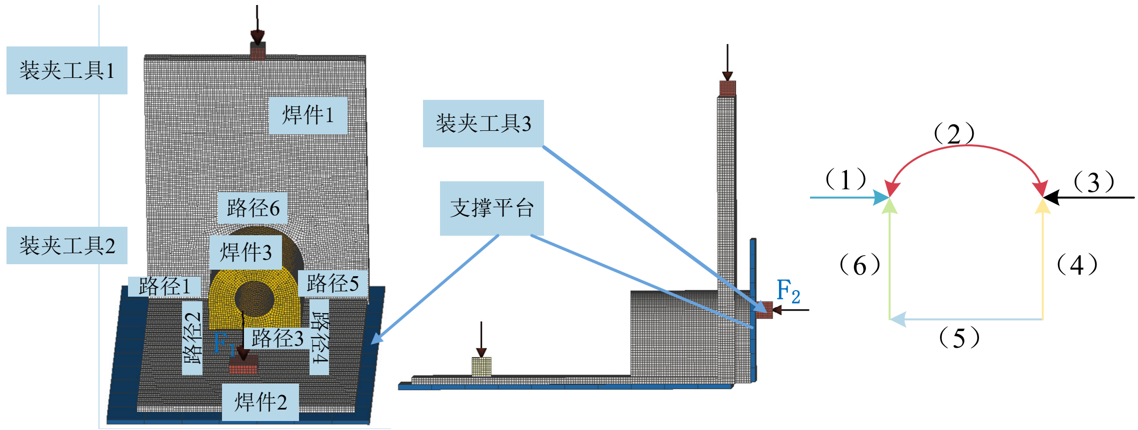
Referring to the actual welding process in the field, the welding voltage range is 18-24V, the welding current is 180A-240A, and the welding speed is 8 mm/s-12 mm/s. As shown in Table 1.

Table 1. Field welding process parameters

Welding voltage U (V)	welding current I(A)	Thermal input power range (W)	Welding speed v (mm/s)
20~24	180~240	3600~5760	8~12

2.3. Setting of the welding simulation environment

3 D modeling of the bearing wheel flange was performed using Solidworks software as shown in Figure 2 (a) (b).weld 1 is 504mm 605mm 35mm and weld 2644mm 498mm 15mm. All welded specimens, the total number of units is 96,000, where the maximum grid size is 10mm and the minimum grid size is 1.5 mm. The mesh is properly encrypted between the weld and the weld to ensure that the mesh size at the weld is 1.5 mm, and that the mesh size in the areas affected by heat is not too sparse. After dividing the grid, import it into the special welding finite element analysis software Simufact. Welding to set up the welding simulation environment. This welding simulation uses two support platforms for placing welding parts 1 and the bearing wheel flange 2 are allowed to produce a deformation along the applied force direction of clamping tool 2 and tool 3, as shown in F1 and F2 in Figure 2 (a) (b), so two clamping tools are used to fix the welding parts 1 and 2 respectively with the definition of stiffness and force of 0.1 kN; The welding order between welding parts is path 1-path 2-path 3-path 4-path 5-path 6, as shown in Figure 2 (c).



(A) Finite element simulation environment front view (b) Finite element simulation environment side view (c) welding sequence

Figure 2. Welding simulation environment

2.4. Analysis of Welding Deformation Distribution

The welding process of high temperature and heat concentration involve the interaction of material yield stress and stress strain, which is extremely complex. The weld will deform from heating expansion to cooling shrinkage, and the deformation cannot be recovered at the yield limit. The deformation of welding parts will reduce the material processing accuracy and affect the welding quality of assembly and car body, so it is very important to study the distribution of welding deformation to control its deformation.

(1) Overall deformation distribution of the weight-bearing wheel flange plate

Figure 3 shows the distribution of welding deformation of the bearing wheel flange after one hour of welding cooling. As can be seen from Figure 3, the welding deformation is mainly distributed near the weld and the heat-affected zone. The maximum welding deformation is at the intersection of weld 1 and weld 6, where the heat source accumulates, resulting in excessive deformation.

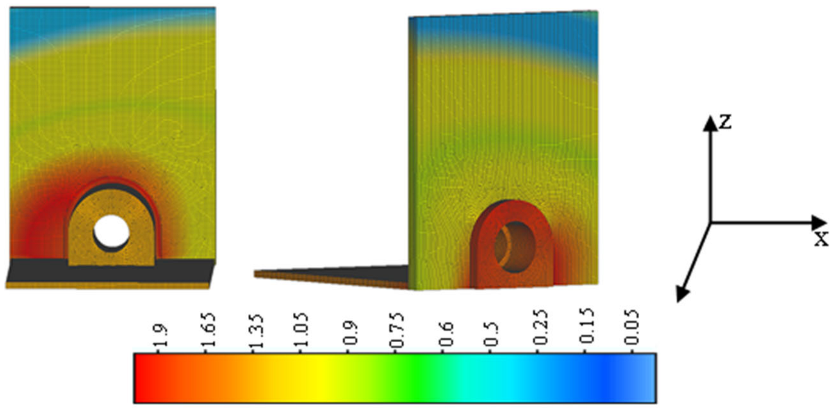


Figure 3. Welding deformation distribution of the weight-bearing wheel flange plate

(2) Rectropic deformation distribution of the bearing wheel flange

Preliminary analysis The welding deformation is mainly distributed near the weld and the thermal influence area. The large deformation weld 1 and weld 6 are selected as the research objects to further analyze the distribution of welding deformation.

As can be seen from FIG. 4, the welding deformation of path 1 is mainly concentrated in the Y direction i. e. the plate thickness direction, the maximum deformation is 1.96mm, and the deformation of the weld in the X and Z directions is small.

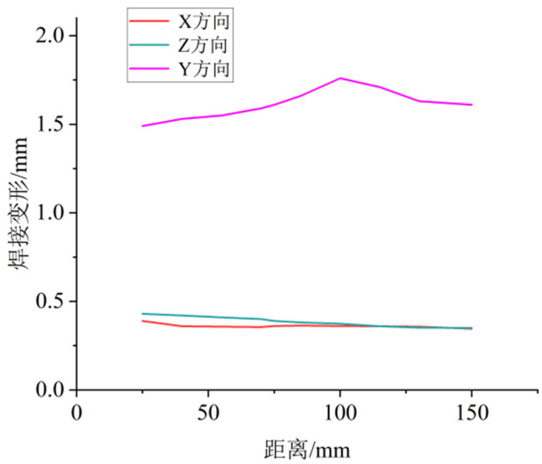


Figure 4. Size curve of path 1

FIG. 5 is a graph of the upward deformation of path 6. It can be seen from FIG. 5 that the closer the flange is to the right angle, the greater the deformation of the node is in the Y direction, while the deformation is relatively stable in the X and Z directions.

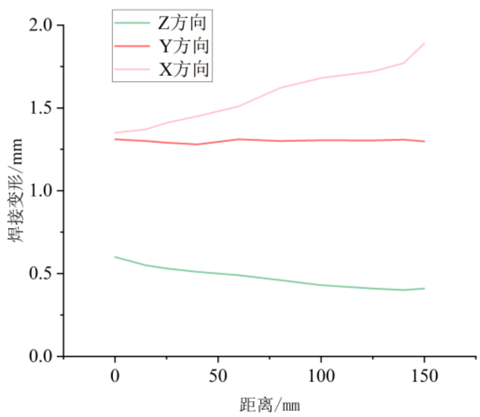


Figure 5. Curve of the size of anisotropic deformation of path 6

3. Conclusion

With the help of welding simulation technology, this study deeply explores the optimization of welding process of car body parts. Through comprehensive analysis of welding heat transfer and stress field, accurate 3 D model of weight wheel flange is constructed, welding process parameters and simulation environment are reasonably set, and it is clear that welding deformation is mainly concentrated in weld and heat influence area. Overall, the deformation of weld 1 and weld 6 is the largest; in the path 1, the deformation in the Y direction near the right angle of the flange disc. Through experiment, the simulation technology can effectively predict the welding deformation and provide reliable basis for the optimization process. The research results are expected to greatly reduce welding defects, improve the quality and reliability of car body parts, and help the car body manufacturing to become more efficient and intelligent. In the future, the research can be further expanded to continuously improve the application of this technology in car body manufacturing.

reference documentation.

Acknowledgement

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