Research on machining technology of complex structure parts of high-speed train body

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Abstract. According to the high-speed train body chassis connecting plate and the side wall key piece structure is complex, the processing difficulty is big, the processing is easy to deform, the precision is not easy to control, the processing efficiency is low, carries on the process craft characteristic analysis, produces the process craft analysis report. The dynamic milling forces in X, Y and Z directions during milling process are tested by means of testing and analyzing the dynamic characteristics of the machine tool, and the dynamic performance of the system can be tested by means of modal test, the transfer function of the system is obtained, and the modal parameters such as natural frequency, damping ratio and modal stiffness are obtained by mode fitting on the basis of the transfer function data, complete the dynamic characteristic analysis of the machine tool. Based on the modal analysis of the whole process system and the dynamic model analysis of the milling process, the chatter stability region of the milling process is simulated by using the theory of regenerative chatter, the results of chatter stability region related to milling process parameters are given.

1. Introduction

At present, China has become the world's largest market for rail transportation equipment, of which 25,000 kilometers of high-speed trains will remain in high demand until 2020, with about 350 trains per year.

Figure 1. High speed train.
At present, the development and production of high-speed train parts with 250 km/h, 350 km/h and other multi-speed grades are required. High-speed train body aluminum alloy large key parts chassis connection plate: Large Processing Area, precision is not easy to control, low processing efficiency, single milling processing time up to 15 hours.

Figure 2. Body Chassis Connection Plate.

SIDE WALL STRUCTURAL ELEMENTS: Structure is complex, hollow multi-cavity thin-walled parts, curvature, difficult to clamp, processing easy deformation, high reject rate, single milling processing time up to 40 hours.

Figure 3. Car body side Wall.

The main defects in the machining of key parts of large aluminum alloy are summarized as follows: Poor machining precision; difficult to guarantee the machining precision of key parts of car body aluminum alloy. LOW PRODUCTION EFFICIENCY: Parts Processing Time is too long. Low Reliability: processing thin-walled parts easy to deformation, unstable clamping. POOR QUALITY CONSISTENCY: high reject rate. Lack of database and knowledge base of cutting process: lack of support of large-scale database of key parts of aluminum alloy. Therefore, it is very necessary to research a high-speed and high-efficiency machining technology. On the basis of existing numerical
control equipment, the research of high-speed and high-efficiency numerical control technology for key parts of aluminum alloy is carried out in this paper.

2. Research Status at home and abroad
With the huge demand of high-speed train market, high-speed and efficient processing of high-speed train has become an important measure for the rapid development of China's high-speed rail industry. CNC high-speed and high-efficiency machining technology has been widely used in developed countries abroad, the utilization rate of CNC machine tools can reach more than 70-80%. The efficiency of numerical control is only about 50% in China. Tsinghua University and Shandong University have studied the technology of machining the key parts of the large-scale aluminum alloy of the train body, but mainly the development of the structure of the processing equipment, the optimization of its processing technology and the improvement of its efficiency have not been deeply studied.

3. The technical route to be taken

3.1. Cutting parameter optimization technology for high efficiency NC machining of key parts of aluminum alloy body
The machining characteristics of key parts of aluminum alloy in enterprises are analyzed. The dynamic characteristic parameters of cutting tools are obtained by modal analysis using the technology of testing and analyzing the dynamic characteristics of machine tools and the simulation technology of milling dynamics. On the basis of dynamic simulation calculation, the main and important processing parameters, such as spindle speed, feed, axial cutting depth and radial cutting depth, are taken as design variables, and the minimum machining time is taken as the optimization target, the process parameters which meet the optimization target and condition are obtained, especially the high-speed and high-efficiency NC machining which aims at the optimization of the process parameters and the increase of the metal material removal rate. The cutting parameters are optimized by high efficiency numerical control (CNC) cutting optimization experiment and production site experiment, and the data manual of high efficiency cutting for aluminum alloy and the procedure and process specification of high efficiency CNC machining for typical aluminum alloy parts are formed. The concrete implementation scheme is shown in figure.
3.2. Process optimization technology for key parts of hollow thin-walled aluminum alloy body

Efficient machining of aluminum alloy thin-walled parts of car body is realized by means of tool matching, tool geometry optimization, fixture optimization, processing parameters optimization, heat treatment and so on. By improving the clamping structure of key parts of aluminum alloy body, the deformation caused by clamping force is reduced, and the processing parameters are optimized by cutting force simulation and analysis, and the deformation caused by cutting force is reduced, based on the existing high-efficiency cutting technology of thin-walled parts, the basic process parameters are further revised through the production site verification experiment. The General Implementation Scheme of the process is shown in figure.

**Figure 4.** Specific implementation scenarios.
3.3. The technology of building database and knowledge base of cutting process for key parts of aluminum alloy car body

On the basis of experiments and according to the different machining requirements of the workpiece, the database of tool feature optimization, NC equipment and tooling state is established, through further on-site Verification Experiments, the basic process parameters are revised and the reasonable range of cutting parameters and machining quality data are obtained, the process parameter optimization database including milling and the process knowledge base based on the feature of parts are established. The construction technology of the cutting parameter database, the processing technology of the cutting experiment data, the transfer and management technology of the cutting parameter data are studied. Set up the data module of part material, part, characteristic code, machining method, cutter parameter, cutting parameter and so on. In the knowledge base, there are knowledge table, process data and, the acquisition of knowledge requires standardization and convenience. Database and knowledge base construction framework, Database System Interface, tool information query interface, cutting parameters optimization interface as shown in figure.
4. Conclusions
The research of this topic makes the enterprise improve the production efficiency and the product processing quality in the production of large-scale aluminum alloy key parts. The research results will
be widely used in high-speed train body aluminum alloy parts processing and other products of aluminum alloy processing, the technology can be extended to automobile, rail bus, aviation, aerospace and other fields. Specific calculation method: According to the present annual output of 900 pieces of car body chassis connecting plate, 800 pieces of side wall structure, the processing cost of the former is 3500 yuan per piece, the latter is 4000 yuan per piece, the efficiency is increased by 0.5 times after the research, annual savings of more than 2 million yuan.

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