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The Rapid Design of Stabilizer Bar Checking Fixture

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Abstract. In order to design automobile stabilizer bar checking fixture, the rapid design of stabilizer bar checking fixture is proposed. Aiming at the two difficulties in the design procedure of the stabilizer bar checking fixture, we innovate the method getting the center line of the bar body. In addition, the piece model is used to replace the solid model, a novel method is designed to realize the sweeping forming of checking fixture block. The above two methods are applied to the development of the rapid design technology of the checking fixture. Finally, the feasibility experiment of the program is carried out, and the experimental results show that the program can realize the design of the stabilizer bar checking fixture and the speed is much better than the manual design.

Keywords: Unigraphics NX, secondary development, skeleton extraction, Checking fixture design
DOI: https://doi.org/10.14733/cadaps.2024.625-634

1 INTRODUCTION

Automobile stabilizer bar is installed on car front and rear axle, which is for the stability of the body attitude components, in the process of automobile design, stabilizer bar design in the last, so the design changes produced in the process of automobile design will affect the shape of the stabilizer bar to a certain extent, the corresponding change in the shape of the stabilizer bar reflected to the manufacturer will cause the change of the stabilizer bar checking fixture design scheme. Figure 1 shows the three-dimensional model of a certain type of stabilizer bar checking fixture. The design of traditional stabilizer bar checking fixture mainly depends on the design experience of designers, which is time-consuming and inefficient. At the same time, the change of stabilizer bar design scheme will further increase the working pressure of designers. In view of the above problems, the article proposed for Unigraphics NX (UG) secondary development, to achieve the rapid design of the stabilizer bar checking fixture, in order to achieve the improvement of design efficiency.

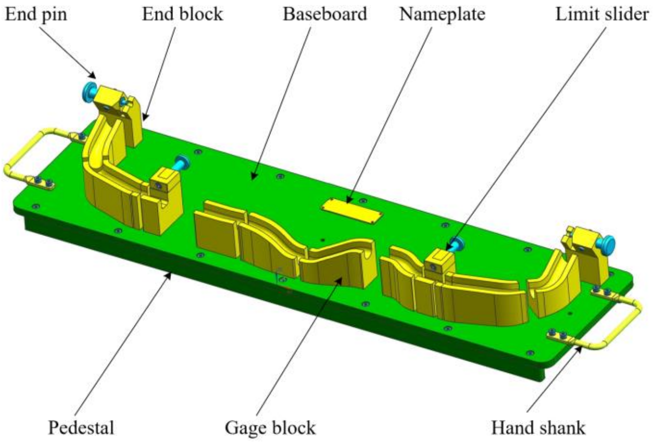

Figure 1: Three-dimensional model of stabilizer bar checking fixture.

With UG as a platform, many researchers have carried out corresponding research for specific purposes. Feng et al. [3] developed a CAD system for rapidly creating 3D screw models on UG, the system can solve the trajectory of milling process when drawing the model. Zhou et al. [11] created dynamic link library DLL plug-in based on UG secondary development, and developed parametric assembly modeling technology and automatic virtual assembly process for mold standard parts fixed seat, realizing rapid model generation, automatic assembly and other functions of standard parts fixed seat. After strength verification, the system has excellent applicability. Liu et al. [7] proposed a porous structure modeling method based on Grasshopper visual programming language and UG secondary development platform, which provided a new research method for sole shock absorption design and had important reference value for footwear design. Zheng et al. [10] combined UG and ASP technology and established the digital design system of the main reducer based on B/S and C/S hybrid modes, realizing the optimization design of structural parameters, three-dimensional parameter design of parts, virtual assembly and other functions of the main reducer. Based on UG, Cao et al. [1] developed a CAD system for the stamping process of automatic production line for robot operation, which can quickly analyze the stamping process and clamping position of robots and generate 3D models, effectively shortening the development cycle of production line products. Dong et al. [2] conducted a secondary development of UG based on the idea of variable parameter modeling to realize the complete expression of gate, gate and overflow system, aiming at the problems such as discrete design parameters, complicated modification of details, and changes of design information caused by different description and organization methods in the modeling process of die casting mold.

There are two main difficulties in the development of the rapid design of the stabilizer bar checking fixture technology. First, the design of the stabilizer bar checking fixture depends on the shape of the stabilizer bar body. The process requires the extraction of the center line skeleton of the stabilizer bar body, and the sweeping molding of the checking fixture block is needed after the extraction of the center line. The above two operations cannot be implemented autonomously, so they need to be developed accordingly.

The center line skeleton is one of the main characteristics of the stabilizer bar, which determines the spatial structure of the stabilizer bar body. The point cloud provides us with the idea of analyzing the model. Through the point cloud, 3D entities can be scanned into editable CAD models, thus providing convenience for accurate description [6]. And so on, Song et al. [8] proposed a range field-guided median method to extract one-dimensional curve skeleton from the point cloud model. After the point cloud voxelization, the initial skeleton of the model is extracted by multi-scale parameter thinning method from the range field of the point cloud. Yu et al. [9] proposed an improved grid skeleton extraction algorithm based on shrinkage. First, the model was virtual closed, and a single ring area sequence weighting scheme was proposed to calculate the displacement of skeleton node displacement to obtain a model skeleton with high accuracy. Feng et al. [4] proposed a skeleton extraction method based on Poisson equation, and defined three-dimensional model skeleton by extracting key points. He et al. [5] studied the skeleton extraction algorithm of point cloud contraction, constructed the transformation matrix by using the neighborhood, extracted the discrete point set approximate to the real skeleton by Laplace Contraction, and constructed the one-dimensional curve skeleton by using the weighted undirected graph and edge folding algorithm.

In the above studies, the model skeleton can be extracted effectively, and the extraction results are approximate solutions. However, in view of the requirement of rapid design of the stabilizer bar checking fixture, the accurate skeleton of the model needs to be obtained. According to the results of the above researchers, in this paper, after the stabilizer bar model is equivalent to the point cloud model, through the spatial relationship between each point in the point cloud model and the original model, the center coordinates of the rod section corresponding to the point in the point cloud are calculated according to the coordinates of each point, and then the precise skeleton of the stabilizer bar is obtained.

2 KEY TECHNOLOGY OF FAST DESIGN OF CHECKING FIXTURE

The checking fixture block is important part of checking fixture which is used to check the stabilizer bar. As shown in Figure 2, the checking fixture block is obtained by sweeping 2 sketches along 2 guide lines.

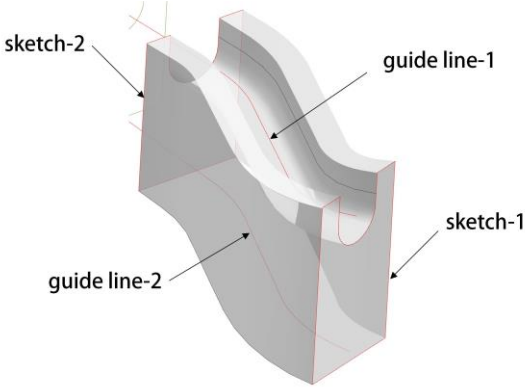

Figure 2: Drawing method of checking fixture block.

In this section, we do research on how to get the center line of rod body, which is one of the guide lines. And then, we do secondary development on sweeping function for realizing checking fixture block sweeping automatically.

2.1 Stabilizer Bar Model Center Line Extraction

The main features of the rod body model include the rod diameter and the center line. The rod diameter defines the radial dimension of the model, and the center line defines the axis dimension and spatial structure of the model. However, as shown in Figure 3(a) and (b), many 3D modeling software including UG can only extract the center line of cylinder and the rotational axis of non-cylinder, and cannot effectively extract the center line of non-cylinder. Some rod bodies are hollow structures. In this study, it is considered that the rod body models of hollow structures are also circular section structures.

Figure 3: (a) Center line of a cylinder segment and (b) Axis of rotation of a non-cylindrical segment.

When extracting the centerline of the stabilizer bar model, it is necessary to divide the stabilizer bar model into the cylindrical end shown in Figure 3(a) and the non-cylindrical segment shown in Figure 3(b), and extract the corresponding centerline of the above segment respectively. But the center line extracted by this method is independent curve segment, which is not conducive to the subsequent use of the call.

The design of stabilizer bar checking fixture depends on the shape of stabilizer bar body. In 3D modeling software, the more complex center line of the rod body cannot be extracted effectively. Therefore, the stabilizer bar model was equivalent to a point cloud with similar shape is proposed, and the rod body corresponding to each point in the point cloud is calculated into the center point through the position relationship between the point coordinates and the rod body model.

Figure 4 shows a non-cylindrical model with a circular cross-section. And Figure 5 is the equivalent point cloud model of this model. In this research, to ensure high accuracy, the point interval is set to 3mm.

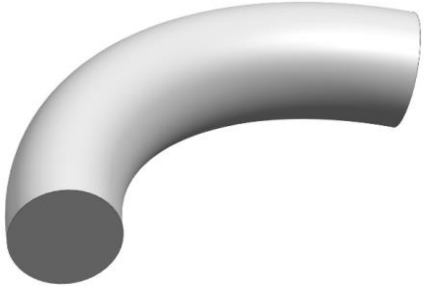

Figure 4: Non-cylindrical model with a circular cross-section.

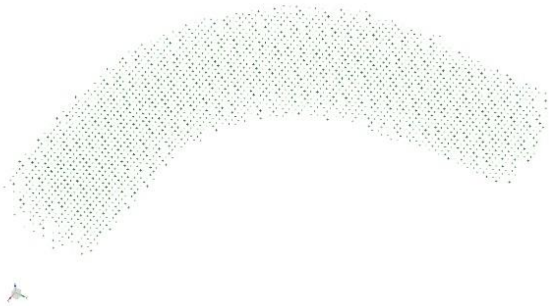

Figure 5: The equivalent point cloud model.

In this paper, the method of extracting the center line is to name the point **A** for each point in the point cloud, obtain the nearest distance and the nearest point from point **A** to the surface of the model surface, the nearest distance is **S**, the nearest point is **B**, and read the spatial coordinates of point **A** and point **B** as $A(x_1,y_1,z_1)$, $B(x_2,y_2,z_2)$. Suppose that the central point of the rod body model corresponding to point **A** is point $O(x_0,y_0,z_0)$, then the positions of **A**, **B** and **O** satisfy the following relation:

$$x_0 = x_2 - k(x_2 - x_1)$$
$$y_0 = y_2 - k(y_2 - y_1)$$
$$z_0 = z_2 - k(z_2 - z_1)$$

k is the ratio of the inner diameter of the model to the distance between **A** and **B**.

Traverse all point **A** in the point cloud model, calculate the coordinates of the corresponding point **O**, and create the corresponding point features according to the coordinates of point **O**. Figure 6 is A schematic diagram of traversing point **A** to create a series of points **O**s, which is the point skeleton of the model. By curve fitting for all points **O**s obtained in Figure 6 by using curve fitting function in UG, the fitting curve shown in Figure 7 can be obtained, which is the center line desired.

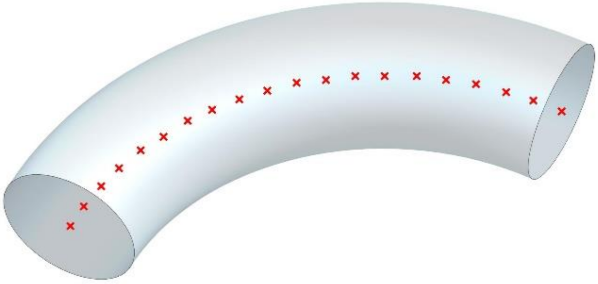

Figure 6: Red dots in the figure is the calculated point Os.

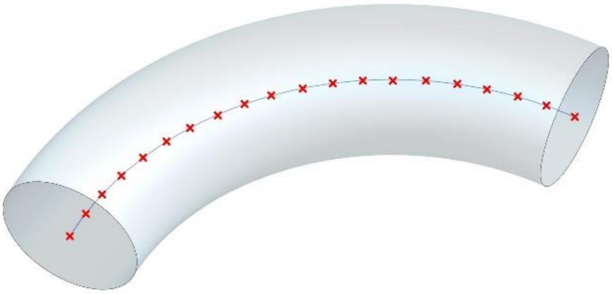

Figure 7: Fitted curve.

2.2 Drawing of Checking Fixture Block

The main detection component of the stabilizer bar checking fixture is the checking fixture block, as shown in Figure 8(a). The checking fixture block is a sweep structure with similar cross-section shape. When drawing the model of the checking fixture block in the mode of sweep, it is necessary to determine the initial cross section of the checking fixture block and the track line of the sweep as shown in Figure 8(b), where the initial cross section determines the boundary of the sweep structure, and the guide line determines the direction of the checking fixture block.

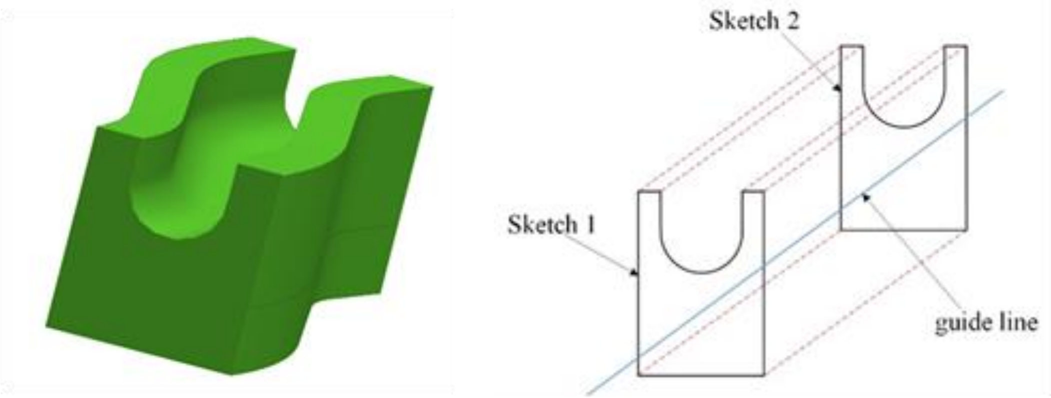

Figure 8: (a) Checking fixture block and (b) Sweep scheme.

However, when sweep, it is necessary to make the curves of the two sketches as the boundary of the sweep correspond to each other, as shown in Figure 9(a); otherwise, the result of the sweep will be the distorted figure shown in Figure 9(b). After the selection of two sectional sketches, the software cannot effectively match the lines of the sketch. In order to solve this problem, the paper proposes to first matching lines of each pair and realize the basic forming of the checking fixture block after traversing all the lines of a group of sketches.

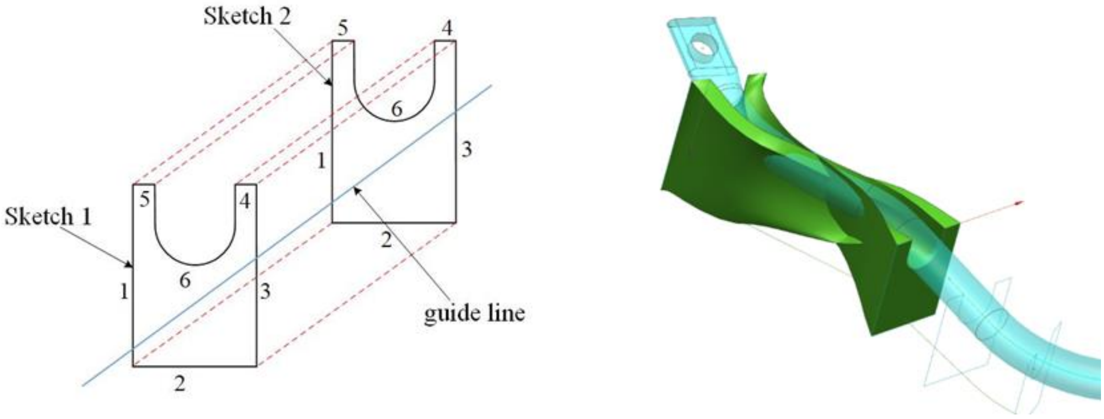

Figure 9: (a) Matching line and (b) Distorted model.

As shown in Figure 10, the three-dimensional model of the checking fixture block achieved by the above method is a chip model, that is, the model is hollow, but its model contour is consistent with that of the corresponding solid model. By the way, the difference between the sheet model and the solid model is that the sheet model is a surface structure and has no thickness, so its volume and mass cannot be obtained.

Figure 10: The slice model of the checking fixture block.

3 IMPLEMENTATION METHOD

The main difficulties are the design of the bar center line extraction program and the checking fixture block. This paper designs the two programs according to the above methods.

3.1 Stabilizer Bar Model Center Line Extraction Development

Figure 11 shows the flow of stabilizer bar centerline extraction program.

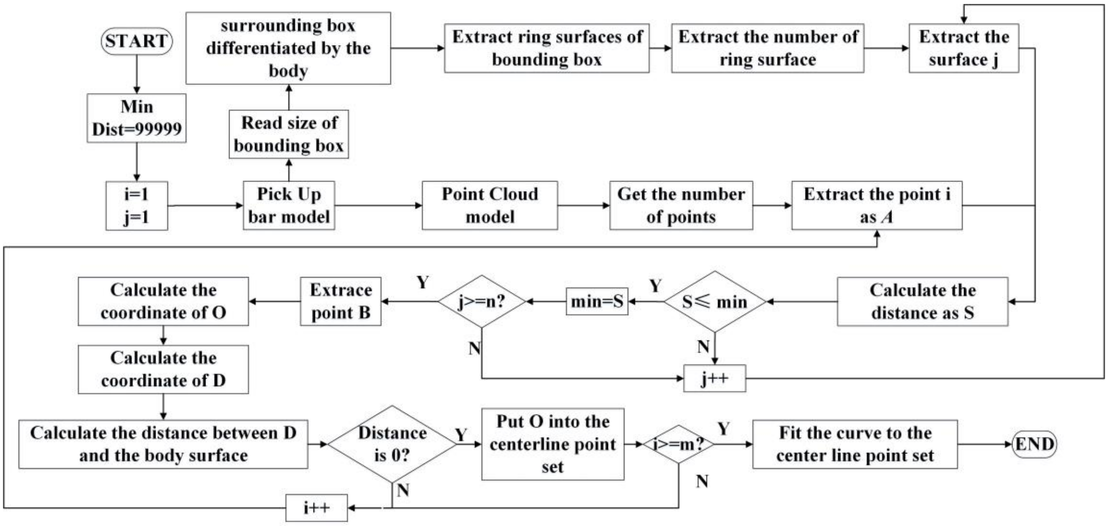

Figure 11: Center line extraction process.

Relevant procedures in UG development, after selecting the target stabilizer bar body model, it needs to be equivalent to a point cloud model, the article proposed first through **UF_MODL_ask_bounding_box** on the stabilizer bar body read the box information, in the box evenly create point features, **UF_MODL_ask_minimum_dist_3** is used to calculate the distance between the created point features and the stabilizer bar body model, and the points whose direct descent distance from the stabilizer bar body was 0 retained, which was the equivalent point cloud model of the bar body. Figure 5 shows the equivalent point cloud model of the model in Figure 4.

Traverse the point features in the point cloud model, set **a** point feature in the point cloud as point **A**, calculate the closest distance between point **A** and the outer surface of the stabilizer rod body model as **S**, and extract the closest distance point **B** of the rod body model surface and point **A**. Through the above calculation method, the center point **O** of the bar section corresponding to point **A** is obtained and corresponding point features are created through **UF_CURVE_create_point**. The process is repeated until all points in the point cloud are traversed, and the set of points **O** of the stabilizer bar as shown in Figure 6 can be obtained. The combination of points **O** are curved-fitted, and its center line is obtained by the set.

3.2 Checking Fixture Block Sweep Development

There are scanning procedures in UG. Generally, the paper will select one or a pair of closed sketches for scanning, and the solid model obtained by scanning. However, the starting position and direction of a pair of closed sketches cannot be determined in the process of the development of the tool block sweeping program. This paper proposes to sweep the corresponding curves in a pair of closed sketches and finish the sweeping of all curves in the closed sketch in turn.

The UG development platform has the **UF_MODL_create_sweep** command, where the input function is the line or sketch to be swept and the guide line to determine the direction of the sweeping, and the output function is the sweeping graph. The paper matched the curves in a pair of closed sketches respectively, as shown in Figure 12, and sweep each pair of curves in a certain sequence to obtain the corresponding piece body features, and finally got the piece body model of the required checking fixture block.

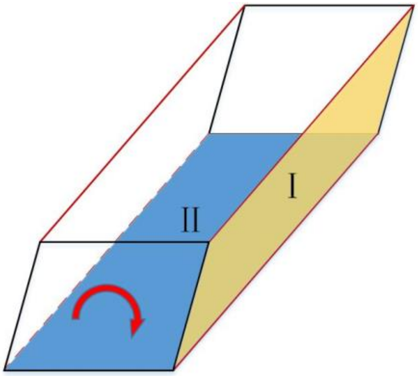

Figure 12: The slice body is obtained by sweeping.

4 EXAMPLE VERIFICATION

Based on the above method, the rapid design of the stabilizer bar checking fixture tool was developed, and the feasibility of the program was verified based on the stabilizer bar body model shown in Figure 13(a) and 13(b).

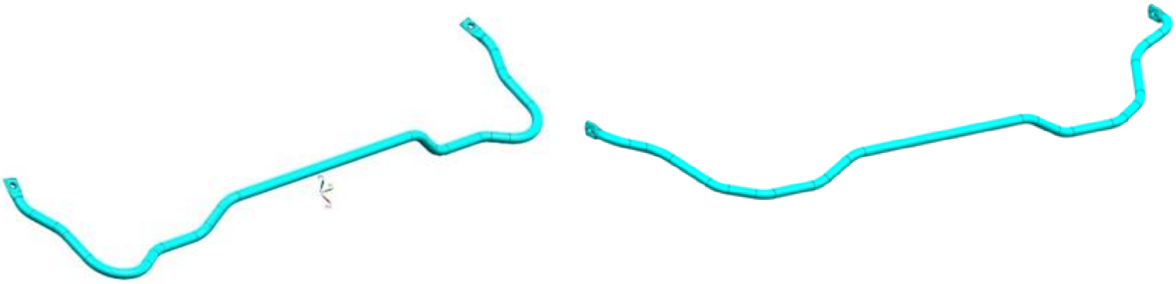

Figure 13: (a) Bar body model 1 and (b) Bar body model 2.

Figure 14(a) and 14(b) show the centerline results extracted from the two models.

Figure 14: (a) Center line extraction of Model 1 and (b) Center line extraction of Model 2.

The information of the center lines of the two models is read, by using the curve fitting function in UG, the error of the fitted center lines are 0.0004877823 and 0.0093708955, less than the default tolerance of the modeling software 0.01. Therefore, the center lines extracted by this method meet the requirements of actual use.

Figure 15(a) and 15(b) are the results of drawing the two models by checking fixture blocks.

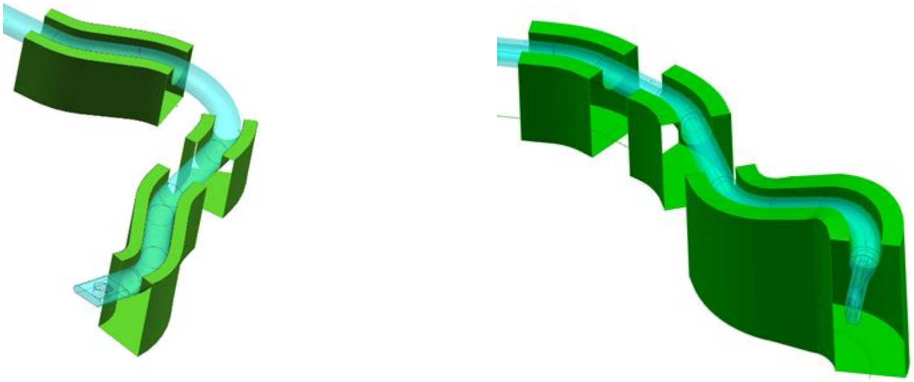

Figure 15: (a) The checking fixture block of Model 1 and (b) The checking fixture block of Model 2.

By comparison, the design result model framework of the program is the same as that of the traditional design method. In addition, the verification time is about 1min to 2min, much less than the traditional design time, about 1h to 2h.

5 CONCLUSIONS

Aiming at the design of stabilizer bar checking fixture, the paper realizes the rapid design of checking fixture through the development. The method of extracting the center line of stabilizer bar and the difficulties in the sweep molding of checking fixture block are innovated. By equivalent the rod body model to the point cloud model, the center point of the rod body is obtained by calculating the corresponding cross section center of each point in the point cloud. The center line of the rod body is extracted by fitting the center point. In the design of the sweeping, the line is used to sweep instead of the sketch to realize the drawing of the checking fixture block, so as to get the checking fixture block model whose model framework is consistent with the traditional design results. The quick design of stabilizer bar checking fixture is verified. The verification results show that the program can realize the design of stabilizer bar checking fixture quickly, and the time is greatly reduced. In the feature, based on the above two procedures, we will complete the rapid design of the stabilizer bar checking fixture, and constantly improve the procedure to meet the design needs of different products checking fixture.

ACKNOWLEDGEMENTS

This research is supported by the Independent Innovation Fund of China Agricultural University.

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