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Error Analysis and Optimization of Automatic Feeding Device for Bending Machine

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Abstract

Sheet bending machine is an important processing equipment for power tower manufacturers. Its processing efficiency and machining accuracy have a great impact on the subsequent welding process. This paper briefly introduces the structural composition of the automatic feeding device for bending parts, and analyzes the causes of errors during its operation. It is found that the distance between the edge of the plate and the putter and the placement position of the plate have a great influence on the edge error. And the corresponding improvement suggestions are given.

Keywords

Bending Machine; Error Analysis; Automatic Feeding.

1. Introduction

Large-scale sheet metal bending machines use simple molds to press metal sheets into the required geometric shapes, with high production efficiency and good processing quality. They are important equipment in the field of mechanical manufacturing [1-3]. At present, the feeding devices used in sheet metal bending machines in China generally adopt asynchronous motor + chain drive, feed cylinder drive, electric servo drive, etc.[4,5]. The existing sheet metal bending equipment of a power tower production company is a 14m bending machine. The supporting feeding drive device of this bending machine adopts asynchronous motor + chain drive. The installation position of the feeding drive device is shown in Figure 1.

During the bending operation, the operator controls the movement of the motors on both sides according to experience, and pushes the sheet to the equal bending point. The work efficiency is low, and the error is greatly affected by the operator's proficiency, which affects the subsequent process. The process is carried out, so the feeding device has been digitally transformed, and the structural layout is shown in Figure 2. This scheme adopts the drive mode of servo motor + ball screw, and adopts open loop control mode. In the process of operation, you only need to input the length and width of the bending piece and the number of bending sides to realize automatic pushing and bending operations.

2. Analysis of the operation error of the feeding device

In order to improve the utilization rate of the equipment, taking into account the processing length range of the bending parts, the feeding device is arranged in a center-symmetrical arrangement. The center distance between the two push rods is 6m, which can push the workpiece of 7-14m. Bending parts are mainly trapezoidal and rectangular in shape. During the operation of the feeding device, it is found that the device has an operating error in a single stroke. The single-pass error value measured at the edge of the bent part is related to the length and bending of the bent part. The placement of the parts is related; and as the number of bending parts increases, the cumulative error gradually increases. Therefore, the reasons for the influence of the edge error during the operation of the device are analyzed, because the

operation process of the short side push rod is the same as that of the long side push rod during the operation of the feeding device, so only the long side push rod is used for single push Take Cheng as an example to analyze the causes of board edge errors.

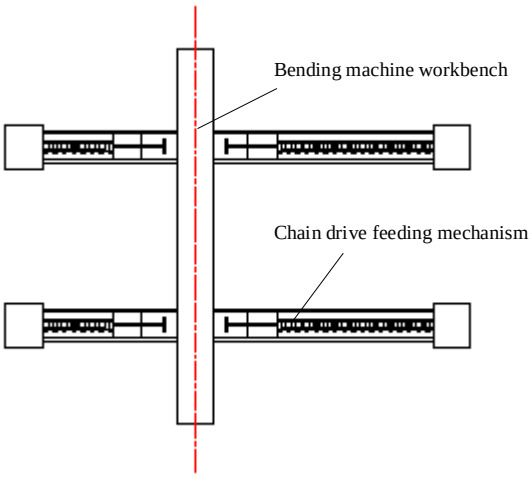

Fig.1 Installation position of the feeding drive device feed drive

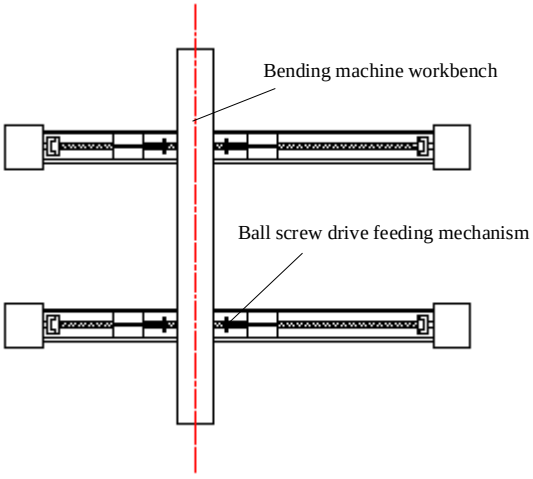

Fig.2 The installation position of the device after the transformation

2.1. The influence of the length of the bending part on the one-way error

Taking one end of the bending piece close to the push rod, the length of the other end changes, and the width does not change as an example, the single stroke error at each measurement point obtained after testing is shown in Table 1. (The shape of the bending piece is rectangular, and the single stroke is 400mm).

Table 1 The error of each measurement point of the bending part under different lengths (unit: mm)

Length of bending parts	7000	10000	13000
Push rod 1 error	0.9	0.9	0.9
Push rod 2 error	1.4	1.4	1.4
Error of the left end of the sheet	0.8	0.8	0.8
Error of the right end of the sheet	1.5	1.7	2.0

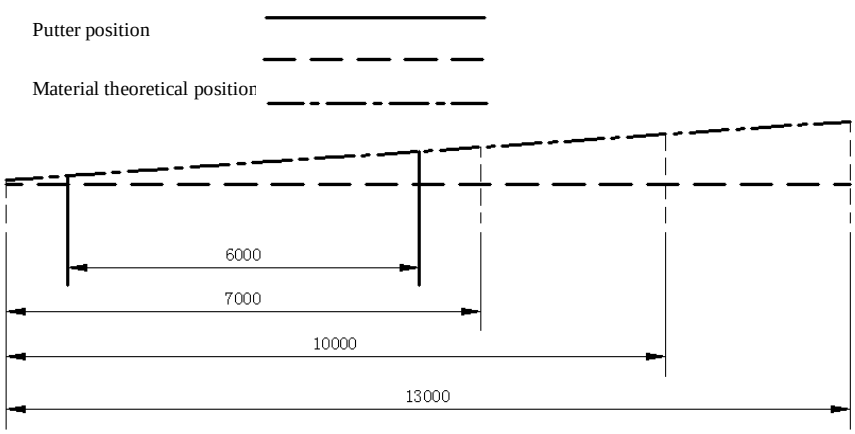

Fig.3 Schematic diagram of the influence of the plate length of the bending part on the error

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The influence of the length of the bending part on the single-pass error is shown in Figure 3. According to the data in Table 1 and Figure 3, it is found that the bending

When the position of the bent part is fixed at one end, the farther the other end is from the push rod, the greater the margin error caused; on the contrary, the smaller the error, and close to the error value at the push rod. In addition, the marginal error value of the two ends of the bending part is also related to the relative error of the two push rods. The relative error of the push rod has an "addition and subtraction" effect on the marginal error value of the two ends of the bending part, which will enlarge the bending part at one end. The edge error value of the plate affects the machining accuracy of the bending parts.

2.2. The influence of the position of the bending parts on the single-pass error

In order to make the comparison obvious, the bending parts of the same specification as in Table 1 are used, and the form of placing symmetrically on both sides of the push rod is adopted. The single stroke error of each point obtained after testing is shown in Table 2. (The shape of the bending piece is rectangular, and the single stroke is 400mm). The schematic diagram of the influence of the placement position of the bending piece on the edge error of the two ends of the bending piece is shown in Figure 4.

Table 2 The error of each measuring point of the symmetrical placement of the bending piece (unit: mm)

Length of bending parts	7000	10000	13000
Push rod 1 error	0.9	0.9	0.9
Push rod 2 error	1.4	1.4	1.4
Error of the left end of the sheet	0.8	0.7	0.6
Error of the right end of the sheet	1.5	1.6	1.7

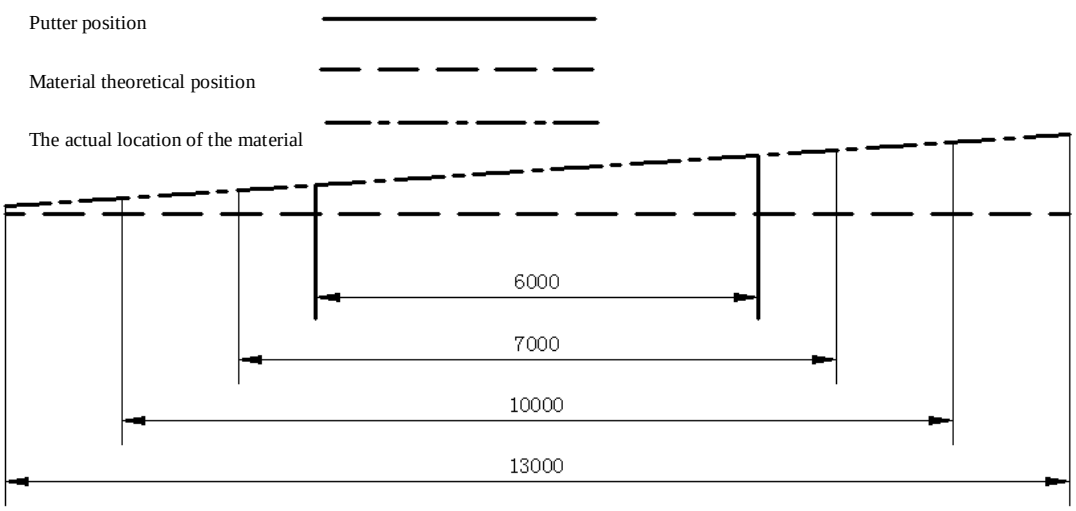

Fig.4 Schematic diagram of the influence of the position of the bending part on the error

According to the analysis of the data in Table 2, it is found that the smaller the distance between the two ends and the push rod when the bending part is placed, the smaller the maximum edge error value. The edge error value of the two ends of the bending part and the inclination direction and placement position of the bending part Related, affect the final distribution of the edge error at both ends of the bent part.

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The comparison of the data in Table 1 and Table 2 is shown in Figure 5, and the following conclusions can be drawn: under the conditions of the same length of the bending part and the same error of the push rod, placing the bending part at different positions will affect the plates at both ends of the bending part. The size of the edge error, the symmetrical placement of the bending piece about the push rod can reduce the edge error of the two ends of the bending piece.

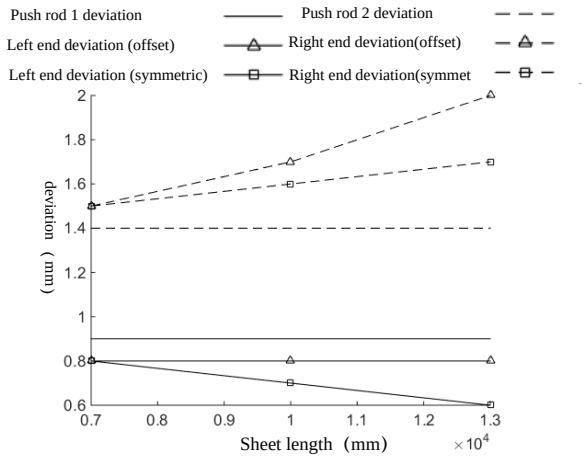

Fig.5 The influence of different placement positions on the board edge error under the condition of equal board length

If the shape of the bent piece is trapezoidal, the length and placement position of the bent piece in a single operation of the push rod have similar effects to the edge error of the two ends of the bent piece, so it will not be repeated here.

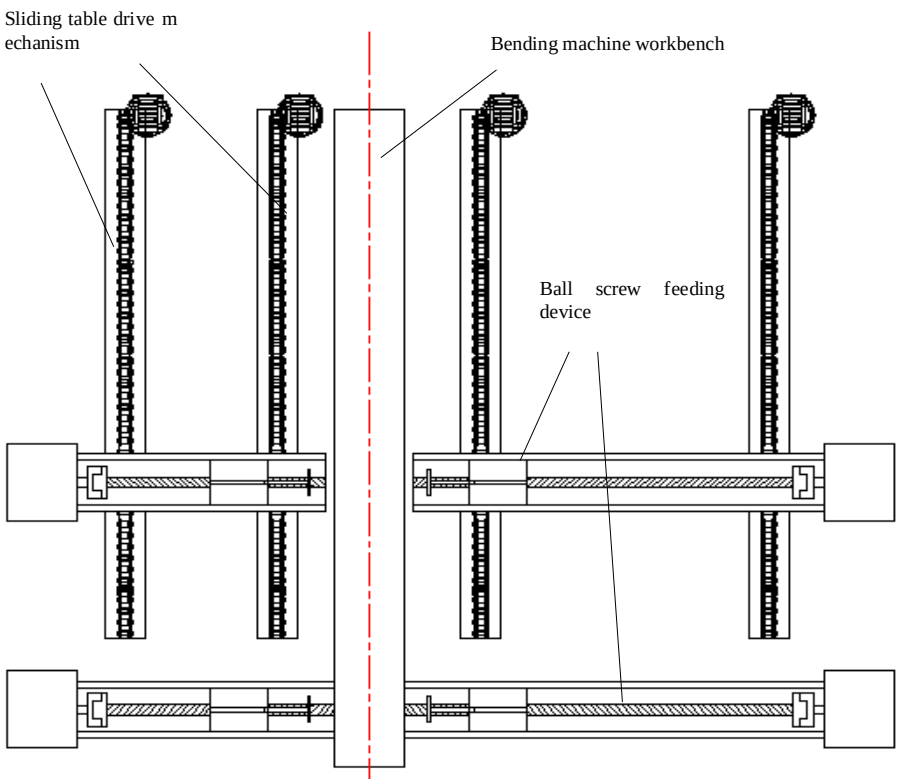

Fig.6 Schematic diagram of improved feeding device design

3. Optimized design of feeding device

During the pushing process of the bending part, the feeding device needs to control the edge error value of the two ends of the bending part. The error at either end cannot exceed the allowable value, so comprehensive control is required. Based on the foregoing error analysis results, the following two aspects of improvement suggestions are proposed.

(1) The position of the push rod is adjustable

According to the analysis of the error caused by the feeding device of the bending machine mentioned above, the "error amplification" is mainly due to the fixed position of the push rod, and the wide range of the length of the bending part, and the distance between the push rod and the two ends of the bending part is too large Or caused by asymmetrical placement of bending parts. Therefore, in the design of the new scheme, one pair of push rods is fixed in position and placed close to one end of the bending machine, and the other pair of push rods adopts a sliding arrangement scheme, as shown in Figure 6. After the position of the push rod is improved, the final error value of the plate edge at both ends of the bending part will be similar to the error value at the push rod.

(2) Improve the precision of push rod transmission

In the analysis of the aforementioned error causes, only the "error amplification" caused by the relative position of the push rod and the bending part after the error measurement at the push rod is determined, and the final error value at both ends of the bending part is still compared with that at the push rod. Therefore, improving the transmission control accuracy of the push rod can reduce the marginal error value at both ends of the bending part. The control system can be changed from open-loop control to closed-loop control, or operating error compensation.

4. Conclusion

(1) The main factors affecting the operating error of the feeding device are: the distance between the push rod and the two ends of the sheet, whether the relative position of the push rod and the sheet is symmetrical, and the transmission accuracy of the push rod during operation.

(2) By improving the transmission accuracy of the push rod and changing the position of the push rod to adapt to the change of the sheet length, the error value of the feeding device can be reduced.

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