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A protection type of flow-guided extrusion die for semi-hollow Al-Profiles

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Abstract. A new die structure for the semi-hollow Al-profiles was presented. Through a practical example, the die structure named protection type of flow-guided die was introduced. The composition of the structure and the selection of structure parameters were analyzed in detail. And the method of checking the die strength was introduced. The characteristics of the new structure were simple and easy to process. The practical application shows that the die structure can enhance the strength and prolong the life of the die. It is worth promoting. The purpose is to extend the experience and the new die structure, Provide reliable and valid reference data to the designers.

1. Introduction

With the continuous progress of modern manufacturing technology, the knowledge and understanding in-depth in Al-alloy from people, the Al-alloy has been widely used. Its applications scope covers various field, more and more varieties and specifications, in various kind of Al-profiles products, the semi-hollow profiles are quite common. The degree of complexity in die design for the semi-hollow profiles is relatively high, the key problem is to solve the die strength because it has a large tongue in its cantilever, the tradition method is to rely on the die material or heat treatment process, but the way is rather limited. This method of changing the structure of the die to improve the force state of the cantilever in the semi-hollow profiles so as to improve the die strength has been highly recognized by the peers. In order to solve the die structure of the semi hollow profiles, a wide range of scholars, experts and engineers have been explored and studied. Some effective structures are obtained. For example, the integral type solid, the mosaic type porthole die, a cover type porthole die, the porthole die with a suspended cantilever and the cutting type porthole die. Through a practical example, in the paper, a new die structure named protection type of flow-guided die was introduced. The new structure has the advantages of simple structure, easy processing, wide application range, and can be used for reference.

2. Die structure analysis

Figure 1 shows a typical semi hollow section.

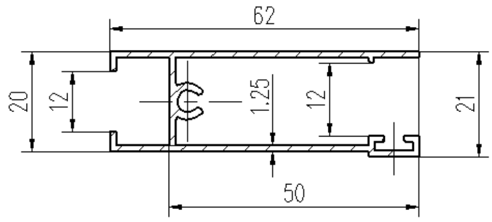

Fig.1 the signal of profile section

The section area is 213 mm^2, the tongue ratio is 6.12, and the length and width ratio of the section is 3.1. For this profile, its die can be used in a variety of structures, and it is obviously effective for the these structures to improve the die strength, but there are still shortcomings. Using the integral solid die structure, the die thickness will be very big, the material consumption is big, the difficulty and the cycle of process will increase. When the cutting type die structure is adopted, which is prone to wire drawing or reinforcement. The mosaic type porthole die structure and covering type porthole die structure have virtual die core and a welding chamber, the adjustment of the flow rate of metal will be complex and have a long processing cycle. And a protection type of flow-guided structure can avoid these defects, this structure is mainly aimed at the narrow and long section its length width ratio is greater than 3, and the cantilever is protected by the cantilever bridge, so that the cantilever can not bear the impact of the metal during the extrusion process, so as to make the force state of the cantilever best, improve the strength of the cantilever, and aiming at the long and narrow characteristics of the profile, only a porthole bridge and different bridge structures in different parts of the according to the part of the corresponding profiles will solve problem, especially in the cantilever end department, a guiding groove will be used to supply metal. Its structure is shown in figure 2.

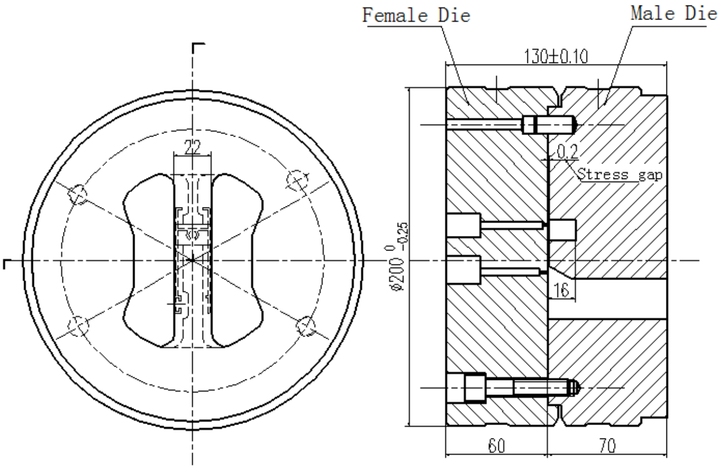

Fig.2 the signal of die structure

3. Determination of structural parameters

3.1 Theoretical basis

For the die for semi-hollow profiles, if the normal structure of the solid die is used, the force state of the cantilever in the die is equivalent to a cantilever beam. As shown in figure 3.

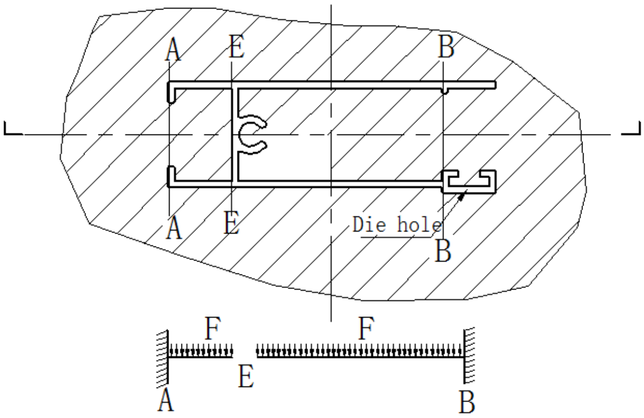

Fig3.the diagram of cantilever force

There may be more than one cantilever in the die, but as a dangerous section to be considered as the die strength is mainly the A-A and B-B section, especially the B-B section, is the most dangerous section, it is regarded a dangerous section as die strength check.Similarly, the force form the end of the cantilever (E-E) on the root (B-B) is also the largest. Therefore,in the die structure, If the load in the structure is reduced, especially the load on the end of the cantilever is reduced, the bending moment at the root of the cantilever is greatly reduced, thereby increasing the strength of the cantilever. In addition, metal supply to form at the end of the cantilever can come from different direction and the process is complex. Metal flow will also produce forces on the ends, thus the root from bending, and end forming of metal quantity enters from the side of supply, especially at the center will be subjected to the minimum force, this will greatly enhance the cantilever's strength. The metal supply of the end of the cantilever is shown in figure 4.

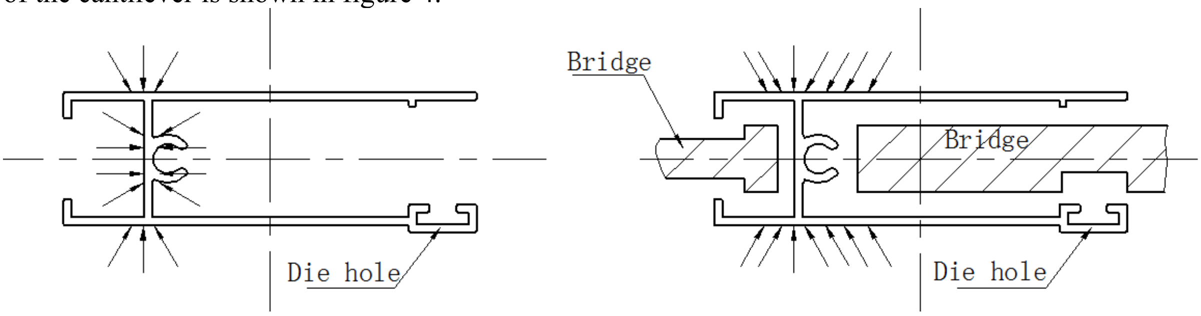

Fig.4 the diagram of metal supply at the end of the cantilever

Based on this principle, a bridge is used in the design to protect the cantilever, which can reduce or not make the cantilever bear the impact of the positive pressure. In order to realize the supply of the metal of the end of the cantilever, the flow guiding groove can be arranged on the end part corresponding to the bridge.

3.2 Determination of parameters

The structure parameters mainly include the design of the portholes and the structure of the bridge.According to the experience, using CAD to design the portholes and the bridge, and then in the UG software environment to build a three-dimensional model. The model is introduced into the simulation software, the simulation operation and observation are carried out by using the software, and the results are analyzed, compared and combined with the experience to make the correction. Finally, the relevant parameters are obtained.

3.2.1 The design of portholes and its ratio. The portholes hole number is two, the maximum hole diameter of porthole is 110mm, the shape from the center outward gradually expanded in the form of, found from the simulation, so throughout the metal flow easily tend to be consistent, shunt ratio is extrusion ratio of about 35 percent. This is a result of balance of considering the extrusion pressure and the bridge width among portholes. The portholes arrangement is shown in figure 5.

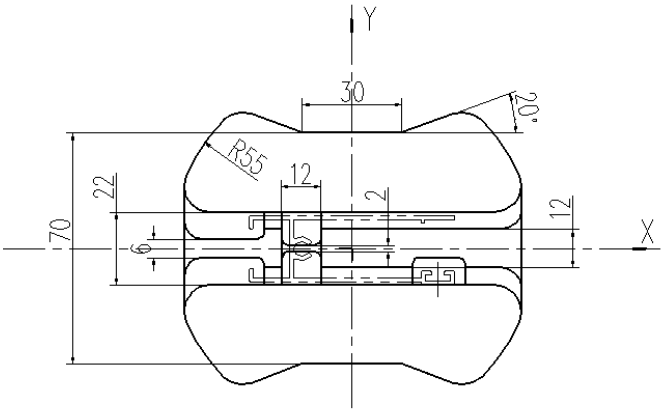

Fig5. The diagram of portholes arrangement

3.2.2 The choice of extrusion machine and die size. To determine the extruding machine is to select the appropriate extrusion ratio and pressure on the cross section of the container. Through calculation and taking into account the die strength and cost needs, the selection of 8MN machine was took, its container diameter is 125mm. So we can conclude that the pressure on the cross section of the container the is 653MPa, extrusion coefficient is 62.3, die size selection of outside diameter 200mm and thickness 130 mm is determined.

3.2.3 Split bridge structure

The bridge structure is the key to the Protection type of flow-guided extrusion die with twin cavities. Its width should not be too large, the width becomes bigger, it will increase the compression area of the bridge, reduce the intensity of the bridge, while the diversion ratio will be reduced, resulting in high extrusion pressure.From the simulation, the split bridge is slightly larger than the width 2mm to 4mm, which is suitable for the flow and deformation of the metal. Therefore adjust the width of the bridge is 24mm. And the contact area of the bottom of the bridge and the cantilever the greatest impact on deformation and flow of metal and forming. Through software simulation and correction combining with the experience, the distance from the bottom edge of the bridge to the die hole is 3mm to 5mm. The transition angle of flow from the bridge to the bottom is 30 degrees, the guide groove dimensions is width of 12mm and height of 16mm. The welding angle of porthole into the guide groove is 60 degrees. The structure of the bridge is shown in figure 6.

3.2.4 Stress gap. In order to avoid the bridge touching cantilever, when it bend downward under positive pressure, so as not to transfer and apply force to the cantilever, according to the experience, a stress space must be made among the porthole bridge and cantilever, For ease to process, the gap should be taken in the bridge. The gap value should not be too large, if it is too large, the metal will enter the gap, the metal will exert force on the role of the cantilever, and the gap is too small, the bridge will exert force on the role of the cantilever. According to experience, the gap is 0.25mm to 0.15 mm.

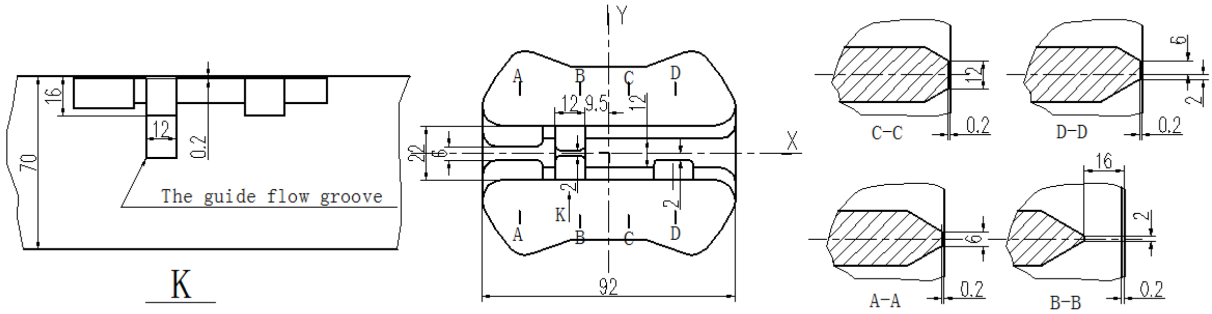

Fig.6 the diagram of the bridge

3.2.5 The choice of the bearing. Because the end of cantilever is under the complete protection of the center of bridge, it is also the most difficult part of the metal flow, so the choice of the bearing of the end part should be chosen as the starting point of the selection. The bearing size is shown in figure 7.

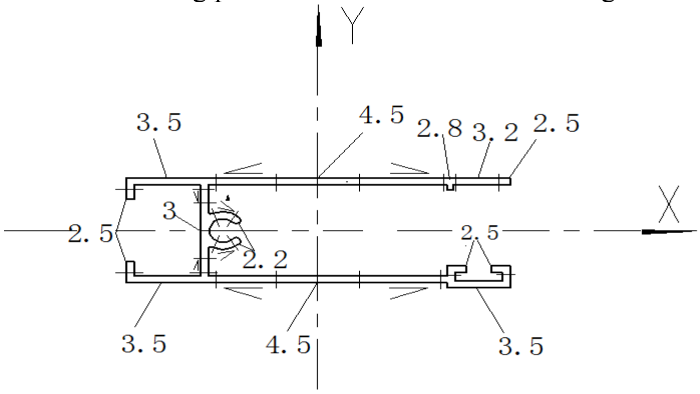

Fig.7 the diagram of the bearing

4. Check the strength of the die

Although the cantilever of semi-hollow profile extrusion die is equivalent to a cantilever beam, but because of the protection of the bridge, the bridge bear directly positive pressure instead of the cantilever during the extrusion, so checking the bridge strength instead of the cantilever is allowed. In the process of extrusion, the bridge is subjected to a cyclic stress, so it is more effective to use empirical formula to check the strength of the bridge in the actual process.As shown in Eq.1.

$$n = \frac{h \times b \times 2 \times \lfloor \sigma \rfloor}{s \times p} \qquad (1)$$

Introduction as follows:

(1) n- safety factor (the porthole die is greater than 3, the solid die is greater than 2).

(2) b-Thickness of the bridge, mm.

(3) s-the total area of the pressure on the bridge, mm^2.

(4) p- extrusion press, MPa.

(5) $[\sigma]$-The bending stress of the die material in the working , the value is 1150MPa.

The strength was calculated according to the above structure:

$$n = \frac{70 \times 22 \times 2 \times 1150}{22 \times 76 \times 653} = 3.24$$

From the results, we can know that the safety factor of the die is enough, the strength is enough to guarantee. However, the personal experience shows that the protection of flow-guided extrusion die structure will be used, you must use a special die support, otherwise, the service life of the die will be greatly reduced. The thickness of the special die support should not be less than 60mm.

5. Conclusions

When the new structure named protection type of flow-guided extrusion die special for semi hollow profile is used, the key points of the structure are to use the bridge to protect the cantilever, and the bridge has a channel to supply the metal, thus it can change the state of force of cantilever and improve the state of the metal flow, in order to improve the strength of die. The structural parameters are determined by the use of computer software to simulate, operation and analysis, and combined with personal experience to correct, it can greatly improve the design accuracy and efficiency. Through the use of the die, the results shown that the new structure is worth promoting the structure.

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