Application of computer-aided engineering optimum design method in aluminum profile extrusion mould

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Abstract: The finite element analysis and the optimum design of aluminum profile extrusion mould were investigated using the ANSYS software and its parameterized modeling method. The optimum dimensions of the mould were obtained. It is found that the stress distribution is very uneven, and the stress convergence is rather severe in the bridge of the aluminum profile extrusion mould. The optimum height of the mould is 70.527 mm, and the optimum radius of dividing holes are 70.182 mm and 80.663 mm. Increasing the height of the mould in the range of 61.282 mm to 70.422 mm can prolong its longevity, but when the height is over 70.422 mm, its longevity reduces.

Key words: extrusion mould; computer-aided engineering; optimum design; ANSYS

1 INTRODUCTION

With the broad application of aluminum profile in the field of the modern decoration, industry, architecture and so on, the structure design of aluminum profile becomes more and more complex and there are more and more kinds. The computer-aided engineering (CAE) technology, used as a tool to shorten the exploitation periods of products, has been more and more broadly introduced into design and manufacture. However, in order to enhance the product competition ability, it is necessary to improve the capability and quality and to decrease the cost. So the most reasonable and economic design method must be found. An analyst can improve the design parameters by trial and error to find the ideal design, but the optimum technology applied into CAE can be free of the heavy work by using the optimum module in ANSYS.

ANSYS is a CAE software which can analyze structure, heat, electromagnetism, fluid. It has mighty ability to handle, such as its preprocessing and post-processing, especially its brainpower mesh generator. It also has a parametric design language (APDL), which has parameter, math function, macro, judgment branch and loop. It is an ideal program flow control language.

2 OPTIMUM DESIGN FLOW IN ANSYS

In ANSYS, the optimum process requires the following steps (see Fig. 1).

2.1 Parameterized modeling

By using the parameterized modeling in ANSYS, the optimum data (design variable (DV)) are defined as model parameters, which provides the possibility of modifying model.
2.2 Solving

The structural parameterized model is loaded and solved.

2.3 Post-processing

The state variable (restrictive condition) and the objective function (optimum goal) were picked up to evaluate in the optimum transaction processor.

2.4 Evaluating the optimum parameters

The optimum parameters in this iteration are compared with those in the last time, if they are the least, or optimum, the iteration is completed and there exists the iteration loop, otherwise, it continues the next step. Design variables are modified according to the completed optimum and the state of the current optimum variable.

3 AN EXAMPLE OF THE OPTIMUM DESIGN IN EXTRUSION MOULD

Take the plane mould which extrudes the aluminum alloy (6063 Al-Mg-Si), for example. The liquidoid of Al is 657 °C, and the melt temperature of Al + Mg_2Si is 556 °C[4]. Taking the extrusion pressure and the quality of products for account, the working temperature is determined to be 450 °C.

3.1 Plotting the mould initial contour

The optimum module can only optimize parameters defined in ANSYS. ANSYS can use solid models plotted by the other 3D plotting software (such as UG, ProE, AutoCAD, etc.), but those models can only be used to verify the rationality and can not be used to optimize design. In this paper, a parameterized model by the APDL[7] of ANSYS is realized (see Fig. 2).

3.2 Extrusion moulding

The sketch map of a hot extrusion mould is shown in Fig. 3.

(a) whole solid model, (b) 1/4 solid model division

Fig. 2 Solid model of the mould

Fig. 3 Sketch map of a hot extrusion mould