DESIGN AND MATERIAL OF LARGE COMPLICATED CASTINGS OF STAMPING DIES FOR AUTOMOTIVE INDUSTRY

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This research report deals with analysis of large shape-difficulty casting of stamping die for automotive industry – made from materials steel, grey iron and ductile iron. The main goal of this research is to choose a material for any type of stamping die. Second goal is to find problematic areas in the casting design and to change the stamping die design and to recommend optimal technology for casting. The results of this research confirm trend of using ductile iron as better and more suitable material than steel. There are comparing next material – grey iron, ductile iron and steel.

Keywords
ductile iron, stamping die casting, steel, grey iron, casting design

1. Introduction

It should be borne in mind that the shape of our stamping die is not the most technologically appropriate for a process of casting, as no changes can be made in that shape, we must optimize the process of casting using existing technologies and the most suitable materials.

In this section, we will try to decide which of the three materials, mentioned in the beginning of the project, is the most appropriate way to cast the stamping die. It also verifies which of the different casting technology is the most appropriate for the correct manufacturing.

To decide between different materials and technologies we will use a casting simulation program, one of the main reasons why we can highlight the benefits of simulation of the casting is that the technical evidence-error is increasingly dismissed by wasteful. Through simulation, it is possible to improve and even prevent defects that appear in pieces. The main advantages of the simulation are, the detection of potential defects virtually casting (ferrous and non-ferrous), among others, micro and macro shrinkage, gas porosity and evil filling of the pieces. And other advantage is that we can obtain test solutions in interactive fast form before casting. And finally, obtaining information from physical variables (pressure, speed, temperature) in areas that usually it is almost impossible to measure in a real process.

2. Description of the Die

The elements involved in the simulation, are the same ones that must be used in reality, to get, as a result, a piece of the highest possible quality. In our case for improving the quality of the piece we will use risers, breakers and chills. But first let's describe the stamping die.

2.1 Stamping die

Our product is a stamping die used in a large press to get pieces made by the stamped sheet metal and used in the manufacture of automobiles.

As shown in the drawing below, both the size and weight are quite high, it hampers the process of casting. The mass of that stamping die is around 11,5 tons.

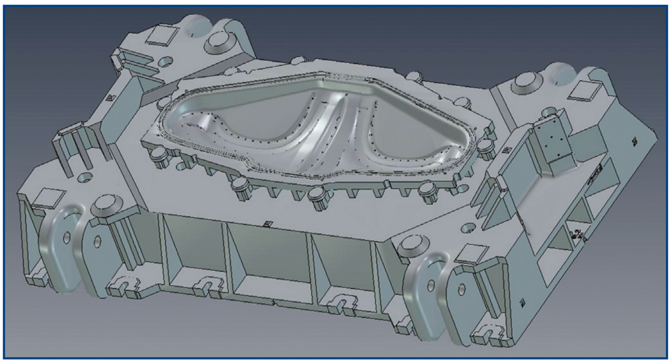

Figure 1. *Solving stamping die*

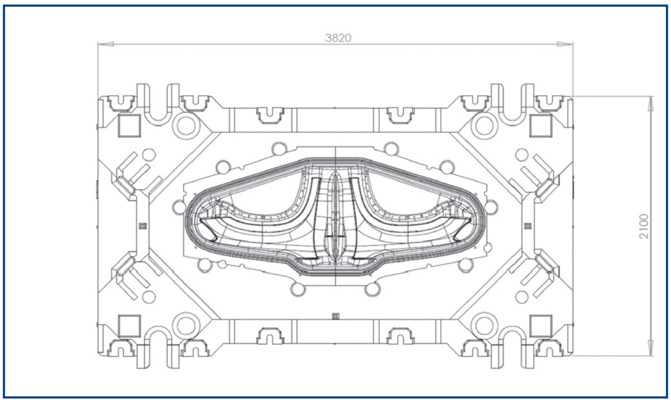

Figure 2. *Drawing of the stamping die (Top view)*

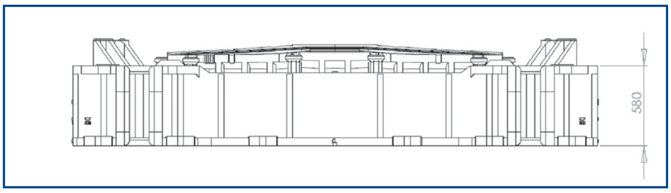

Figure 3. *Drawing of the stamping die (Lateral view)*

Another aspect of our element that hinders the process of casting is its shape, such com or discussed above, the shape of the casting die is not the most appropriate in a process of casting, due to presenting walls with different thickness, small holes and walls crossing to hot spots where is possible remove only with using of chilling.

This element is used to prevent the shrinkage caused by the contraction of the metal, is a reservoir of molten metal from which casting feeds as it shrinks during solidification.

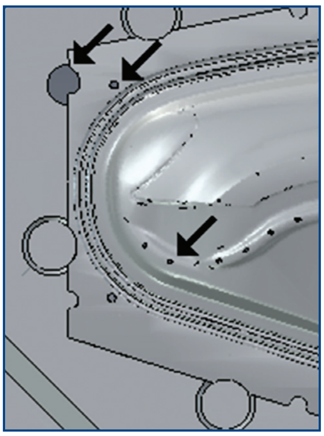

Figure 4. *Example of problems in the shape*

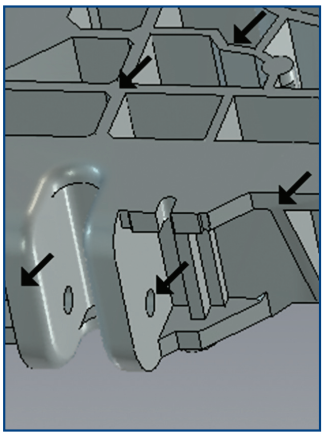

Figure 5. *Example of problems in the shape*

By the differences between the materials to be used to cast that stamping die, have designed two types of risers, both have the same shape and width but differ in length. For the cast pieces of steel casting is a more appropriate a longer riser while for cast with grey and ductile irons is more appropriate use a shorter ones.

Anyway we are going to make variants in the different simulations, so that we can test both types in the different materials to determine, in each case, which is most appropriate.

Breakers element is placed in the neck of the riser to control the shape of the same and thus that riser can be separated from the piece once the casting process finish.

Chills element is a metal, graphite or carbon blocks that is incorporated into the mold or core to locally increase the rate of heat removal during solidification and reduce defects controlling the hot spots.

In our simulations we used two different measures of chills, some normal and others that measure the half. The reason is that when you try to put many, to evacuate the maximum heat in one area, you should put the smallers among biggers to fill best the surface.

3. Description of the solving

In this section will describe different technologies and materials that will change in each simulation and, thus, make a comparison to decide that variation between materials and technology is what gives us a better result minimizing defects.

The three materials involved in our study (grey iron, ductile iron and steel – [1] have already been described in the first chapter, therefore in this section we will talk about the different technologies that have been developed to reduce the defects of the stamping die. Variations in different technology are sets of risers and chills.

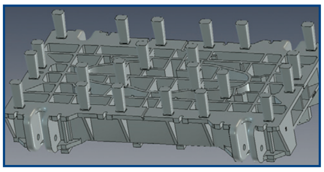

Figure 6. *Distribution of steel risers*

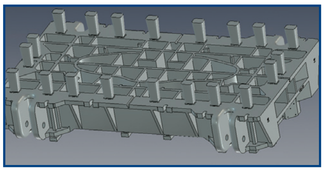

Figure 7. *Distribution of iron risers*

In the case of the risers variation, have developed two options, one is using risers best suited to grey and ductile iron and in the other case will be used best suited to steel casting. The way how the risers are distributed in the mould changes and the number of them also, as in the case of iron risers are placed only on the edge of the piece while in the case of steel risers, they are placed on the edge and the centre, as can be seen in the following images:

In case of the distribution of chills, there are three alternatives. What the difference is the number of items that exists in each one. In the three variants the chills have placed in such a way that its role in the most critical and where they need the best characteristics for the operation of stamping die, this area of the die is the one that has wavy shape and will enter into contact with the sheet when the stamping die is working.

The part of the piece in which we put chills, determines the position of casting in the mould, because the area in which we wish to obtain a higher quality metal should be placed in the bottom of the mould.

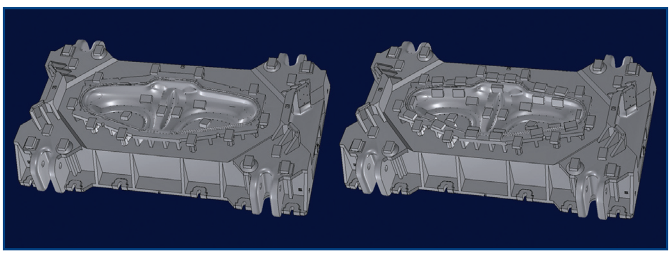

Figure 8. *Distribution of chills*

In the first variant of chills, it has putted 28 chills, of the big ones, in the principle areas where we can get good metal characteristics without defects, and in the areas where there may be a bad heat extraction, as shown in the following image.

In the second variant of chills, it has putted 53 chills, of the big ones. In the third variant, it has putted the same 53 chills of the second variant, and 30 new ones of the small ones.

Once described the variants of technologies, we can enumerate the different simulations.

First we are going to make two simulations without chills, one with a steel casting and the other with ductile iron, in order to identify the most critical areas. Then we are going to make six trials with the option of steel risers, three of them with steel casting and each one with a different distribution of chills, and the other three with ductile iron and each one with a different variant of chills to.

And finally, we are going to make nine simulations with the option of iron risers, tree with steel casting, tree with ductile iron and tree with grey iron, each one of them with a different variant of chills.

Taken all combinations, we get 17 different tests. And in each test, we show the results by observing five sections:

4. Results and discussion

So that we can make an orderly discussion to cover all aspects and take into account all the causes and defects, we going to do an analysis and comparison of the three points which vary among the various simulations, first will be compared different technologies, starting to analyse the different variations of chills and then the two alternative of risers to finish analyzing the differences between the three materials used in this investigation. Thus it will be possible to determine which materials along with technology that provides the bests results.

4.1 Comparison between variants chills

We now turn to comment on the differences between the results for all simulations in order to make a comparison between the different options that we have in terms of the number of chills and their distribution.

4.2 Comparison between the two types of risers

In this section we would try to discuss between the two types of risers that have been used in conjunction with its various distributions on the die casting.

It should be borne in mind that the risers of different variants are not placed in the same places, thus cutting by a section can be that in one distribution is cutting in the midst of the risers, and we can see the effects of those risers, but in the other distribution of risers, the risers can be not cut, and in this case can not be properly compare the effects.

In an initial analysis we can determine that does not affect the variant of chills that we are using to compare the risers, the only important think is compare the effects of different risers by the same variant of chills. So as there is no simulation with grey iron and steel risers, we going to compare on the one hand, as affects different types of risers in the steel casting and on the other hand as affecting in ductile iron.

In the case of ductile iron, we can see that the percentage of shrinkage, remains unchanged between one option of risers or the other, but we go to observe if the distribution of these shrinkages suffers some variation.

4.3 Comparison of materials

Although the comparison of the materials was made in chapter one describing the characteristics of each one, in this section we will see how what has been said previously agreed with what can be seen in the simulations.

For the steel casting has been observed that presents many more defects than the other two materials.

In the case of ductile iron and grey iron, we will make a comparison based first in the liquid phase diagrams. If we compare the liquid phase diagram of the same simulation but only changing the material, such as observing the section E between the simulations fifteen and twelve, although it can be seen between other simulations and sections, we can see how the area that is not dry is the same in both materials but in the case of grey iron this liquid region presents a more reddish colour, it means that the percentage of liquid phase in this area is minor.

In the case of shrinkage, comparing the same sections of the same simulations, we can see how there is a greater amount of this defect in the piece created with grey iron.

In the case of the porosity, there are no major differences between the two materials because any of them presents this defect in a meaningful way.

Acknowledgement

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References

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