

Optimized Electrode Design Strategies for Automobile Die Casting Insert By Combined Electrode Concept

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ABSTRACT: The electrode design has a significant impact on the on deciding the manufacturing rope length of the die casting inserts. The rope length of the system completely depends upon the amount of material left by CNC machining. In present work different possible optimized strategies of electrode design are explained which are economical as well as easily feasible to adopt the current manufacturing setup. Proposed methods are performed on inserts that produce Honda Activa Mission case assembly components. The present optimized design are derived for the minimizing the rope length of the die. The implementation of the design aims in reducing the number of electrodes as well as the material cost associated with it. The combined electrode design and the re-born concept are the strategies are implemented on the Honda Activa die.

KEYWORDS: Combined electrode; multi-place electrode; finishing electrode; roughing electrode; re-born electrode.

I. INTRODUCTION

Manufacturing of the automobile insert in tooling industry basically prefers aluminium as the best choice for the production of actual components. The insert material through which these components are extracted makes the prime importance when the insert manufacturing is to be taken into account. Actual material properties such as the hardness as well as the tooling that is used for cutting, decides the actual real-time material that is left in CNC machining.¹ The amount of the solid stock left as well as number of such patches where this kind of solid stock is left decides the actual process length of the job. Electrodes are designed for removal of the solid stock that is left in CNC machining. Electrode design, electrode programming and the electrode sparking are the main activities relate to the electrodes. Number of electrodes is directly proportional to number of patches left on the actual insert.²⁻³

This paper mainly focuses on different techniques that will reduce all activities related to the electrodes. Optimization of the electrode design is carries under two main processes viz: Combined electrode concept and the re-born concept. The actual trail of these concepts is done on the Honda Activa mission case assembly insert.

II. COMPONENT UNDER STUDY

The component under study is the central part of the mission case assembly of the Honda Activa bike. These components are different in shape and size. Due to increase in aesthetic demands these components goes on frequent changes in its shape and size. Change in the shape of the component leads to increase of the complexity of the component. The central part highlighted in light brown color shown in figure 1 is main component in the mission case assembly of the Honda Activa consist of most complex geometry. Manufacturing the most complex geometry will allow and explore new manufacturing techniques that may be applied so that productivity as well as profit can be

improved. Hence selecting this component will make us revisit our strategies and lead us to plot some new optimized techniques of manufacturing which are not yet discovered.

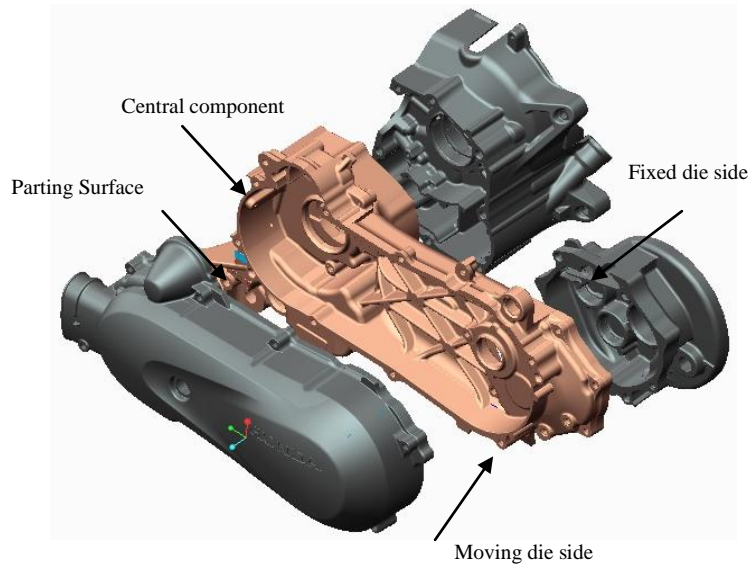


Fig.1 Honda Activa – Mission Case assembly.

III. FIXED AND MOVING INSERT OF THE CENTRAL COMPONENT

The position of the parting surface plays an important role in dividing the complexity of model into two equal halves. The red color surface indicated in figure 2a and b is the parting surface. This surface is mainly responsible for extracting core and cavity for any solid model. Figure 2 shows the constructional details of the fixed and the moving die. In the case of the fixed die usually a cavity is observed in the insert. The position of the cavity is always below the level of the parting surface whereas in the case of moving insert projected material is observed above the level of the parting surface.

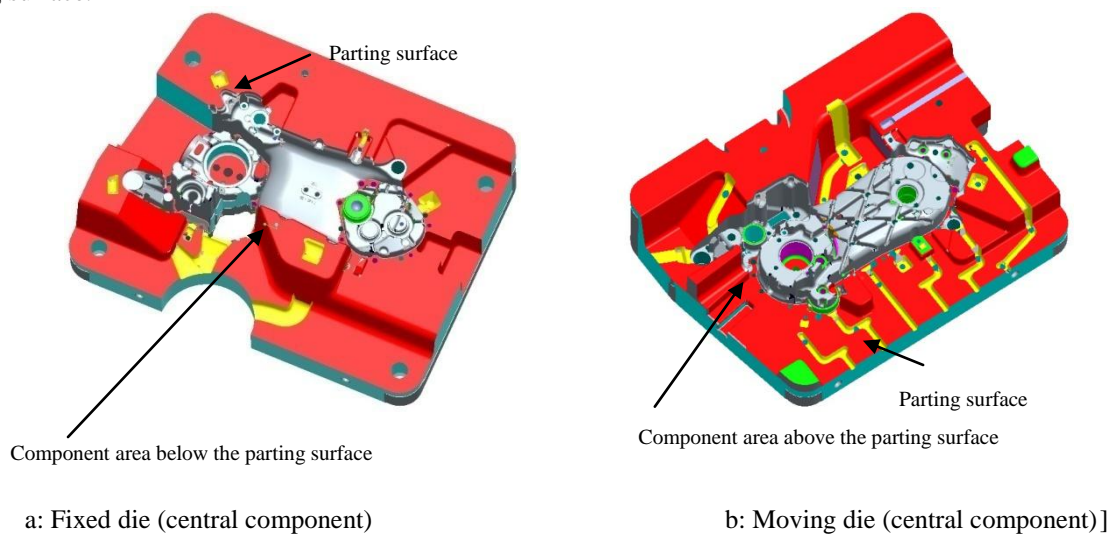


Fig.2 Constructional details of the main insert of central component of the Honda Activa scooter

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IV. STOCK MODEL

CNC tool path programming for the solid model shown in figure 2 is done in DELCAM machining software. Physical execution of all the programs from the first largest cutter to the last smallest cutter will generate an insert from a metal block. The maximum possible material swept by the last cutter will generate the final level stock model. Un-machined areas on the insert will not generate the required features as per the 3D solid model. The extra material left on the insert is called as the “stock”. This stock is to be removed with the help of electrodes in EDM.

Figure 3 shows the stock model generated for the moving die of the central component of the mission case assembly. The areas that are marked in the pink color are those areas that are un-machined in CNC machining. Electrodes are made for the respective areas where the stock is left. Majorly there two areas which come under the electrode design. “A” and “B” areas indicated in figure 3 are the areas where the stock is left. This stock model will have areas such as ribs having high depth around 60-100mm, small ribs having depth around 20-60mm, round bosses and etc.⁴

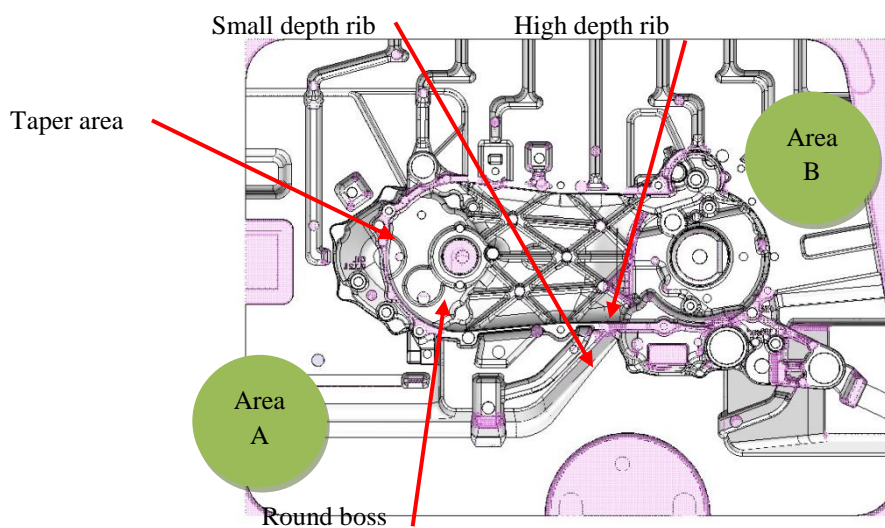


Fig.3 Stock model generated for moving die for central component of Mission case assembly

V. ELECTRODE DESIGN

Electrode design is the spillover activity of CNC machining. All activities related to the electrodes are time consuming as well as independent activities, which involve activities such as electrode design, electrode machining and electrode sparking. Areas marked in pink color in figure 3 are those areas which are left in CNC machining. When any electrode is to be designed for an un-machined area the electrode manufacturing process is as follows:

- a. Study of the stock model left.⁵⁻⁶
- b. Designing of the electrode in Pro Engineer.
- c. Preparing of the manufacturing drawing of the designed electrode.
- d. Exporting of the IGES file for tool path programming of designed electrode.
- e. Actual tool path programming of the electrode in DELCAM software.
- f. Generation of the tool list from the generated tool path.

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- g. Generation of the CL file (Cutter location) for post processing.
- h. Actual post processed file for CNC machine.
- i. Loading of the file on the DNC server.
- j. Generation of process sheet of the electrode.
- k. Cutting of the raw material block as per the process sheet.
- l. Milling of the rough block as per the final size mentioned in the process sheet.
- m. Drilling of holes and inserting the helicoils.
- n. Aligning of the rough block on the CNC machine.
- o. Actual running of the tool path on the CNC machine.
- p. Polishing and de-burring of the electrode.
- q. Dialing and aligning of the electrode in X, Y and Z direction as per the drawing.
- r. Electrode centering process on the EDM machine.
- s. Generation of the electrode program as per the final co-ordinates mentioned in the drawing.
- t. Actual sparking of the electrode.

Activities mentioned from a-t are the mandatory activities which are to be performed for any electrode which is to be sparked. The number of electrodes that are to be sparked for any area depends upon the solid stock left out in CNC machining. Higher the amount of stock that left in CNC machining (greater than 15mm in Z direction) then there will be electrode wear that will be observed on the electrode. Electrode wear kill the dimensional accuracy required on the actual insert. Hence to avoid such dimensional errors two separate electrodes viz: roughing and finishing electrodes with separate spark gaps are manufactured. Designing the roughing and the finishing electrode will directly double the manufacturing cost.

Selection of proper sparking surface area in electrode design is a very critical parameter when designing any electrode. Even any addition of one single electrode will directly add to the manufacturing cost and also increase the actual manufacturing rope length of the job.⁷⁻⁸

VI. OPTIMIZED COMBINED ELECTRODE DESIGN CONCEPT

Optimization of the electrode process is implemented by two parameters, one is to reduce the physical number of electrodes, and the second is to reduce the material cost of the electrodes. Reduction in any one of the above said parameter or both parameters will have a drastic cut down of the manufacturing rope length. Implementation of both the parameters in electrode design is done in the combined electrode concept⁹⁻¹⁴.

6.1 Reduction in the number of electrodes

Reduction in the number of electrodes means physically chopping of the actual head count of the electrodes that are to be sparked in the EDM. The idea behind reducing the numbers electrodes is to reduce the total number of activities. The total scope of work done by the electrodes in the EDM section will be same when compared to implementation of the optimized combined electrode design technique. The speed rate at which this operation is completed keeping the same scope of work is more focused on. This time span in which the operation is completed is tried to cut down achieved by combing the physical number of electrodes. Reduction in the number of electrodes will reduce all the activities mentioned in section 5. The physical number of the electrodes that will be floating in the manufacturing cycle will be less. Figure 4 shows the electrode design without combined electrode concept where as figure 5 shows the combined electrode concept.

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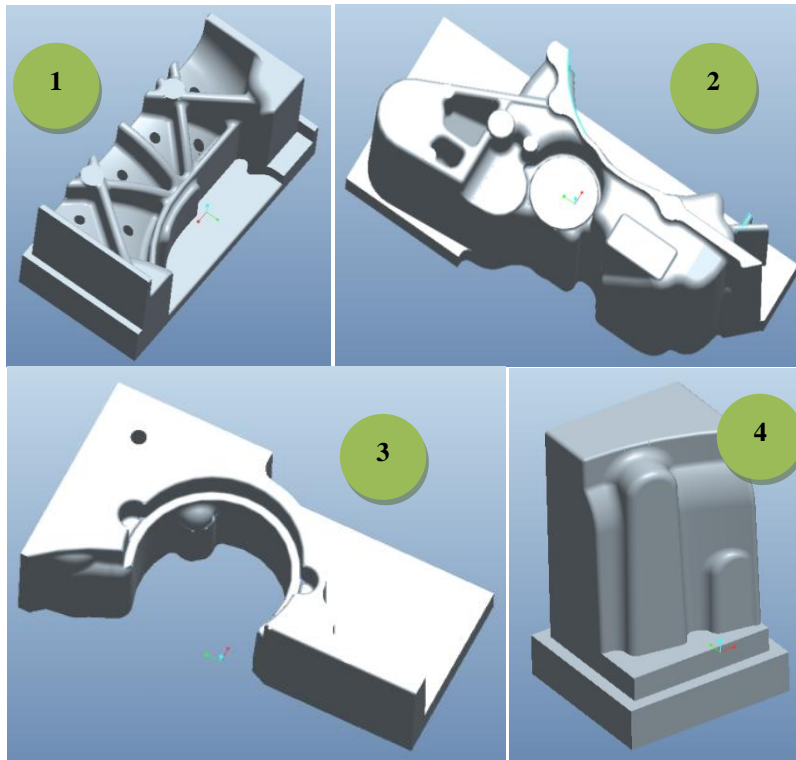


Fig.4 Individual electrode design

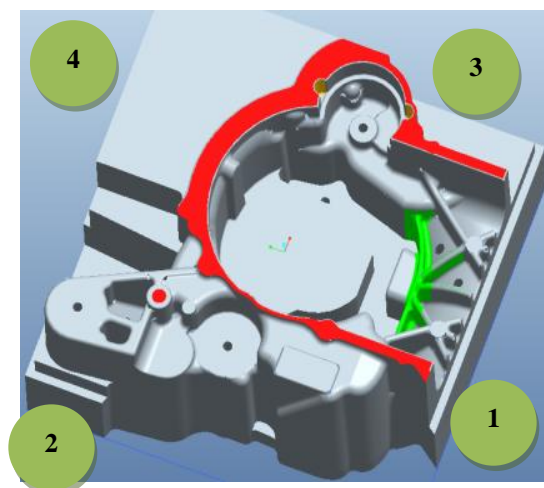


Fig.5 Combine electrode concept

6.2 Reduction in the material cost - Re-born concept

Section 6.1 focuses more on combining the electrodes and cutting down the activities related to it. Optimization of the combined electrode concept can be further be carried by reborn concept where direct killing of all the pre manufacturing activities is focused on. In re-born concept material of previously machined electrode is used for manufacturing a new electrode. A new electrode is generated at the cost of running finishing programs on the old electrode.

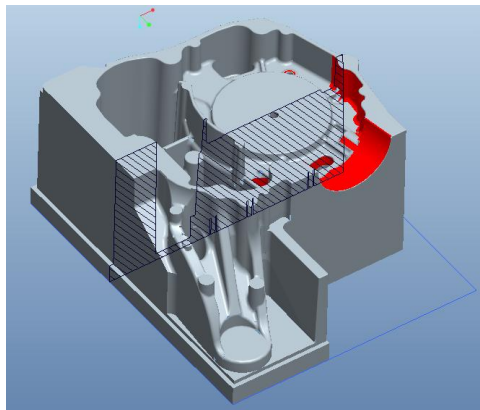


Fig.6 Electrode under Re-born electrode concept

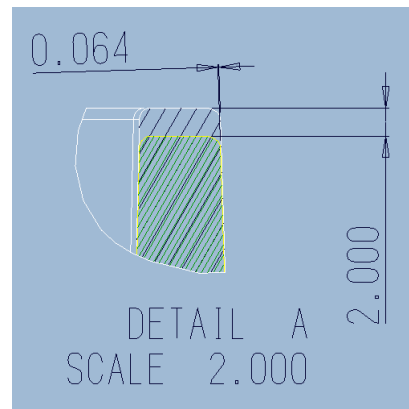


Fig.7 Detail at section A

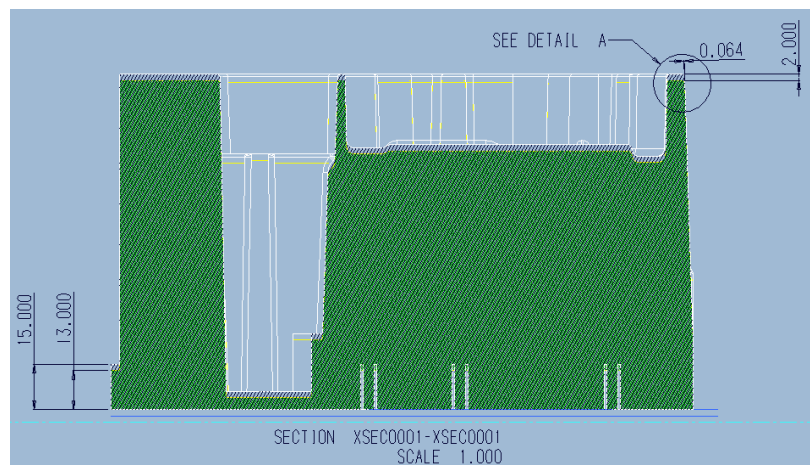


Fig.8 Cross sectional view of graphite electrode

All activities from a - m discussed in section 5 are directly excluded from the system there by reducing the manufacturing rope length of the job. Figure 6 shows the electrode under implementation; Figure 8 shows the cross section of the electrode which is cut by plane X-X. The detail view at section “a” is represented in figure 7. In reborn concept only the finishing programs are made to run on the existing used electrode whose geometrical dimension are disturbed due to wearing of electrode in sparking operations. Usually the electrode is re-machined by 2mm. In re-machining operation a flat finishing program is made to run on the toppest surface. This will allow setting the new Z reference on the electrode. All the other programs will run with the reference of newly generated flat surface. The amount by which the electrode is re-machined will be the stock that is to be removed in the finishing tool path. The amount by which the electrode is re-machined will be the stock that will be obtained in Z direction only. This amount is fairly good enough to take care of the maximum amount of wear on the electrode. There is a very less material about 0.064 that is obtained on the component profile of the electrode area. While designing electrode care must be taken that extra material in the order of 15mm must be left on the collar which will allow re-machining the electrode at least 5 times before it is scraped off. Machining the electrode every time decreases the size of the collar. Figure 7 also shows the section in yellow color is the new electrode that will be born after re-machining. Actual reborn concept implemented in DELCAM interface is shown in figure 9.

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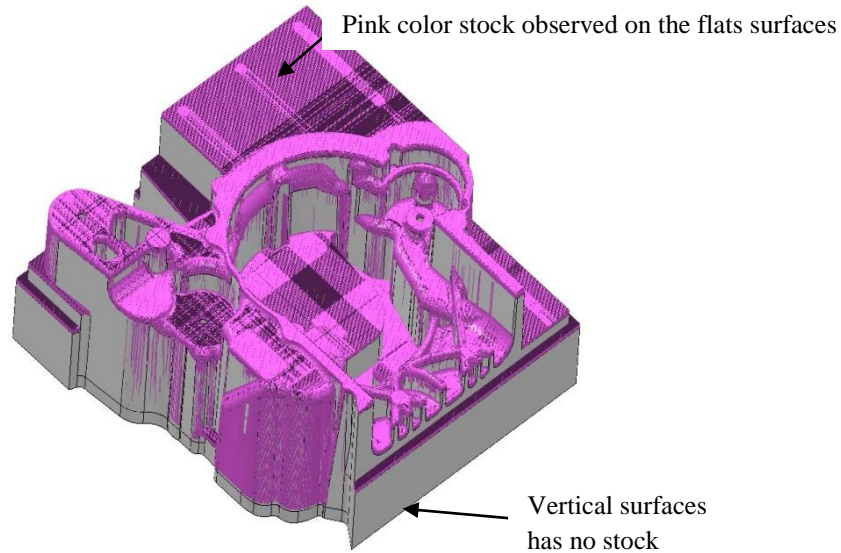


Fig.9 Re-born concept in Delcam interface

VII. CONCLUSION

The generation of the proposed two optimized techniques helps in reducing the rope length of the die.

1. In combined electrode concept major contribution of saving are of sparking time and electrode design time.
2. The total number of electrodes floating in the system will be less.
3. Bottle neck will not be created in the CNC electrode manufacturing section
4. Inherent characteristics of re-born concept allow to skip/ by-pass some of the manufacturing steps. This directly cuts down the rope length and the manufacturing cost associated with it.
5. Direct saving of the material cost is observed in the re-born concept.
6. Total inventory cost is reduced.
7. Overall productivity is increased.

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