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Analysis of Press Tool Dies for Alternate Material by Hardening

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Abstract- In sheet metal working industries, design and development of press dies is the most time and cost consuming process. The cost of material and machining of dies involves most of the money in whole manufacturing. In this Work, an industrial press tool die for sheet metal bending was analyzed using finite element analysis. The purpose was to identify the areas where stress concentration is more. The present scenario of industries is towards using material with same mechanical properties for the entire die. The said material properties are decided considering the zones of maximum stresses and there is majority of portion in the die which is not severely stressed. This work aims to make use of this concept. The base material selection was carried out considering the stresses in majority of the die body. For the same low cost material was used. The areas or zones with higher stresses was hardened upto few millimeters to enhance their material properties. The software results obtained previously was used for proper identification of such zones. Finally the comparison was made for the cases as existing material used by the industry and selected material with induction hardening.

Index Terms- Keywords- Induction Hardening; Press Dies; Stress concentrated area; FEA; etc.

1. INTRODUCTION

Metal forming is one of the chip less manufacturing processes. These operations are performed by the press and press tools. Press tools are classified on the basis of their operation like shearing tool, bending tool, blanking tool, combined press tool, combination press tool die, etc.

Induction hardening involves passing a high-frequency alternating current through a suitably-shaped coil to induce rapid heating of the component surface situated appropriately within its electro-magnetic field. Depth of hardening is controlled by the parameters of the induction heating equipment, time of application and the harden ability of the material. A variety of manipulation procedures can be employed to suit the geometry of the component including ‘single-shot hardening’ in which the entire area to be hardened is heated in one operation then quenched, and ‘progressive hardening’ which involves relative movement between the heating coil, quench head and the work piece. Selective area hardening can thus be achieved by the combination of suitable coil design and manipulation.

Finite element analysis is done on the bending press die for identification of areas where stress concentration is more. This identification of stress concentrated areas is needed for hardening process on those areas.

2. OBJECTIVES OF STUDY

The present research work was undertaken with the following objectives:-

(1) To find out better option of material for bending press tool dies with low cost.

(2) To determine best process of hardening for above mentioned material.

3. METHODOLOGY

In this work a press tool die was selected for doing the analysis with hardening process. Hardening process was selected by comparing the propeties of all existing hardening processes and also selected on the basis of material that have been used for this analysis.

3.1. Selection of Die

It was the first step of this study, in this which type of press tool die we were going to use for this study was selected. There are different types of press tool dies are there like piercing dies, forming dies, compound dies, combination dies, bending dies, etc. Amongst all of them Bending tool die was selected because of its simple structure & operation. Its simple structure has given us ease in work with it.

3.2. Selection of Hardening process

Induction hardening was the process selected for hardening the die material amongst all the different heat treatment processes like case hardening, nitriding, etc. Induction hardening is used to selectively harden areas of a part or assembly without affecting the properties of the part as a whole and this was the reason behind selecting this process. The components are heated by means of an alternating magnetic field to a temperature within or above the transformation range followed by immediate quenching. The core of the component remains unaffected by the treatment and its physical properties are those of the bar from which it was machined, whilst the hardness of the case can be within the range 37/58 HRC.

Induction hardening is one of the most widely employed to improve component durability. It determines in the work-piece a tough core with tensile residual stresses and a hard surface layer with compressive stress, which have proved to be very effective in extending the component fatigue life and wear resistance.

3.3. Selection of Material

We analyze the whole bending press die in static structural system of ANSYS. In that analysis we came to know that two parts of press tool, punch and die came under more and continuous strokes of force. And for making the same parts, material named D2 is generally used because of only one property of it that is its hardness which is available in range of 52-60 HRC. D2 is also an expensive material and available in market in price range of about 200-220 Rs. per kg.
So we decided to do our experimentation work with D2 material and to find alternate cheap material for D2 analysis on different combination of material and hardening were carried out.

4. ANALYSIS

For analysis purpose we decided to analyze punch and use the results of punch to derive our conclusion. The analysis was done on different combinations of hardening the material and with different depth of hardenings on material.

The D2 material was taken of 55 HRC hardness. The other combinations of hardening and depth are taken considering 55 HRC and materials with capacity to be maximum hardened. So we take first combination as 30-55HRC with depth of harden varies from 1 mm to 4mm. 30-55 means taking material having 30 HRC and harden it up to 55 HRC with depth of hardening 1mm, 2mm, 3mm, and 4mm. Other combinations were 40-55 HRC, 50-55 HRC.

The best results were obtained with the combination of 30-55 HRC up to 4mm depth.

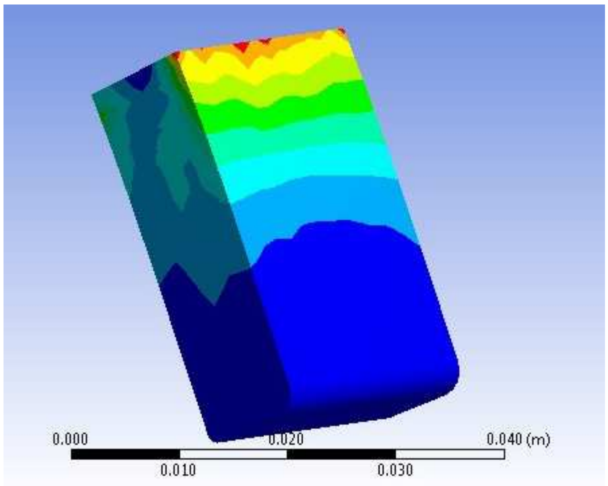

Fig. 1. Maximum Principal Elastic Strain on Punch having 55 Hrc (D2)

In analysis of punch stresses seems to be lowered which was good but strains seems increasing which was not good. Increased strains were in allowable range for material as those were cross checked from Material Handbook, ASM.

This analysis was done in two parts first by software as above and second by actual experimentation. In second part the actual bending press die was manufactured and the punch were used to analyzed on the basis of their wear after 500 bending operations.

Fig. 2. Punch made by D2 material having hardness of about 55 HRC initially

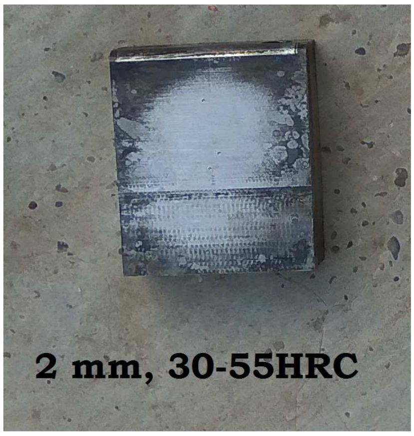

Fig. 3. Punch made by EN19 material having hardness of about 30 HRC initially and then induction hardened up to 55 HRC and 2mm depth

Fig. 4. Punch made by EN19 material having hardness of about 30 HRC initially and then induction hardened up to 55 HRC and 3mm depth

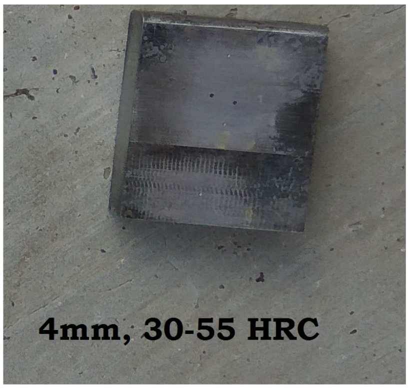

Fig. 5. Punch made by EN19 material having hardness of about 30 HRC initially and then induction hardened up to 55 HRC and 4mm depth

After actual experimentation it seems that the hardened punches also performed well. The bending edge of D2 punch wear more after 500 bending operations than that of hardened punches.

5. RESULT AND CONCLUSION

Any tool grade material having hardness of 30 HRC could be used for above process. The material processed as above could be used in light duty press tool dies and also for those dies which has to produce limited products. It can reduce the tooling cost behind producing those tools.

In Indian industrial market the price of D2 material is about 200-220 Rs. Per kg. the price of EN19 or other material having hardness of 30 HRC is of 95-110 Rs. Per kg. Induction Hardening charges are about 65-75 Rs. Behind per kg. So the charges behind one kg material as above are 110+75=185 Rs. Per kg. This processed material could be used alternately for D2 and saves 35Rs. Behind a kg. material. It saves tooling cost up to 15-16% which is essential in industrial business.

Induction hardening is the processes selected for above process because of its selective hardening property and also it increases materials wear resistance after hardening.

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