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DESIGN AND DEVELOPMENT OF STAMPING DIES FOR ONLINE MAINTENANCE

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ABSTRACT

This paper assists the die designer to design press tool dies for the online maintenance in the press itself and to reduce the tool failure due to the dynamic actions of the press tool in the press. In the proposed die design the parts such as punch, punch holder, stripper, die and the die inserts can be removed in the press itself without disturbing the die set. The route chart of the die (tool) maintenance can be decreased by implementing the methodology. The proposed approach increases the productivity by adopting more feasibility to attend online maintenance, and reduce the overall productivity hours.

Keywords: stamping die, maintenance, productivity, failure rate, tool life.

INTRODUCTION

Nowadays, sheet metal parts are directly used for semi finished products. Commonly used applications such as automotive (interior parts, exterior parts), aerospace (components, sub systems), mining, etc. Customization of different types of stamping dies in press for production phase was very difficult. Designing of stamping dies was quite complicated and involves a major activity like analyzing in terms of manufacturing feasibility, availability of resources, selection of presses, life span of dies, and accuracy of the component. Day-by-day the complexity of component was goes on increasing and lead time for manufacturing was reduced. In limited batch production, major problem with the frequent setup changes of stamping dies that increase the overall production time. [1] The current scenario requirement of industry was less production run with maximum productivity. The critical issue for the production was a breakdown of stamping dies during production which will affect the productivity. It is necessary to increase the productivity with the less production time. [2] Maintenance of the stamping dies was due to the breakage or worn out of the tool elements. Worn-out maintenance will occur occasionally due to the tribological properties of the die materials, and sheet metal. This effect will lead to increase the wear co-efficient, as results the element of punch/die are worned out. [3] Breakage maintenances are occurred due to the interruption or failure of the systematic function of the stamping dies/press. (Eg: misleading of the sheet metal, scrap stuck in-between the die and punch etc.) As a result where the online maintenance of stamping die facility was required, the basic idea of the online maintenance is to replace the worn out parts or breakdown parts in the production phase itself without/partially disturbance of set up in the press. Design of stamping dies should be simple and robust that can be useful in view point of manufacturing and maintenance feasibility. [4] The different types of expert systems are used to design the stamping dies, mostly the expert system are focused on the selection of machines, cutting tool selection, selection of presses, design for assembly (DFM), and design for manufacturing (DFM). However they are not focused on the design for maintenance feasibility to do in online. [5] Environment was highly competitive that makes necessary to reduce production time and investment amount on designing,

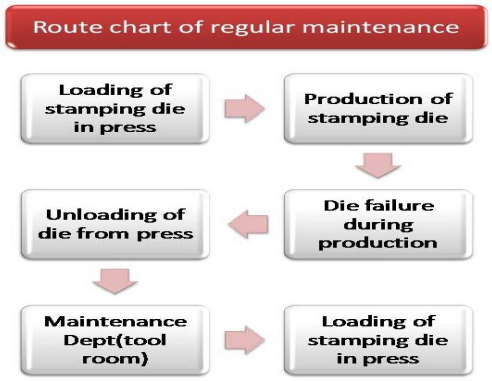

Figure-1. Route chart of regular maintenance.

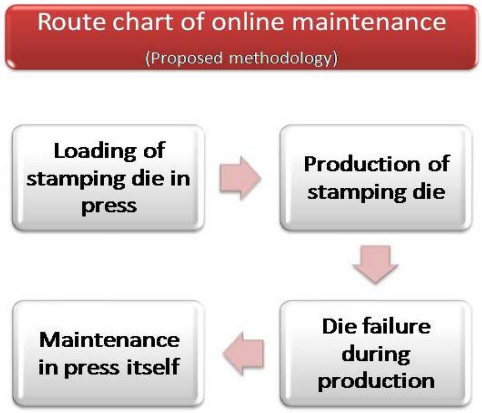

Figure-2. Route chart of proposed maintenance.

manufacturing of stamping dies with high standard of die quality. Moreover, it's quite difficult to modify a design after the dies are manufactured. So, issues are addressed in

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the stages of design itself. [6] The comparison of a routine process of the maintenance works for the present maintenance and proposed methodology. Flow charts are explained above (Figures-1, 2).

LITERATURE REVIEW

The study carried out in this paper is mainly concerned with the press tool how to improve the productivity of the components. Kailash Kumar Lahadotiya1 [1] carried out in the study on the selection of suitable material, applying the practical knowledge of the experienced die designers and the tooling engineers for the better performance of press tool to improve the life of the tool. H. Crauwels [7] investigated about the generation of the production planning with the minimum number of the sheets to reduce the waste and optimization of the total flow of production in the press tool. T. Z. Quazi [8] deals about the proposal of the initial propagation of the crack in the punch and die and calculation of the optimum clearance by using the fem analysis to the different sheet metal. S. Kumar, [9] proposal for a system which consists of twelve modules for the user interactive loaded in auto cad for the expert advices to check the manufacturability of part, selection of a press machine, selection of die components and mainly for the automatic modeling of the blanking die. Verlinden, Bart [10] deals about the using OR techniques for the integrated production plans for the sheet metal operations, minimizing the time consuming set ups of the 3d bending operation of the press brake.

TREND ISSUES

In Stamping industries, they are particularly focused on the reduction at the production time with maximum productivity. Number of set up times for a particular dies due to the maintenance increase the overall production time. To avoid the frequent set up of particular die incorporated the online maintenance feasibility of the die maintenance. To make that feasibility in stamping die analysis are made to incorporate on it. Die failures are happening due to several issues. The collections of the issues for failure of the stamping die during the production times are:

a. Strip feeding is so tight or in the free condition.
b. Run stops not engaging.
c. Trigger stop not functioning.
d. Slug Jamming.
e. Box stripper loosening frequently.
f. Floating stripper malfunctioning.
g. Breakage of punch.
h. Breakage of die.
i. Component loading tight.
j. Component unloading tight.
k. Stripper function is not working properly.
l. Breakage of locating pin.
m. Raw material getting welded with punches or dies.
n. Component struck with draw die.
o. Bottom tool mounting to get disturbed.
p. In consistency in location.
q. Component getting disturbed while bending.
r. Component ejection not working properly.
s. Component sticking.
t. Knock out rod function not good.
u. Breakage of pilot.

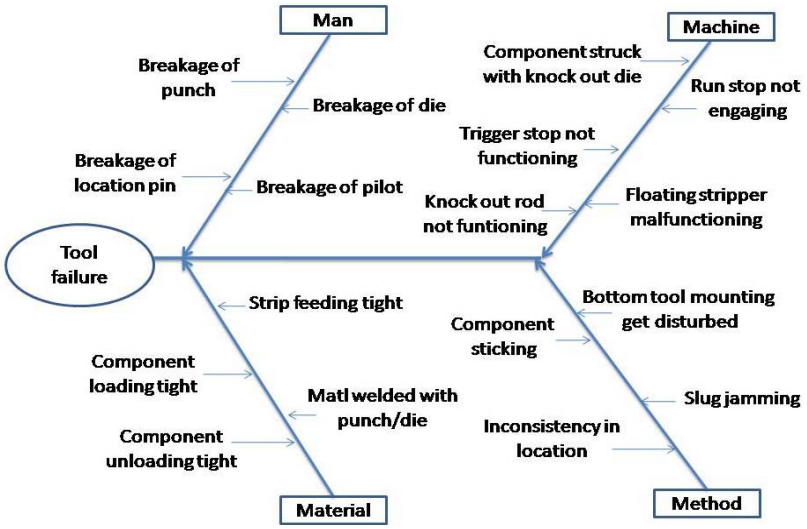

Figure-3. Cause and effect diagram of die failure.

TREND ANALYSIS

The investigation has done in the regular stamping dies wherever the online maintenance feasibility is required to address the issues of the failure reasons happening in the stamping dies. First the investigations were carried out in the causes of failure in dies. The sequence procedure followed is mentioned below

Collection of the failure issue records of the stamping dies

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Table-1. Record for the causes of failures.

Half year maintenance record status all production tools								
Category	**Mon 1**	**Mon 2**	**Mon 3**	**Mon 4**	**Mon 5**	**Mon 5**	**Mon 6**	**Total**
Slug Jamming	II	III		II	III	II	I	13
Floating stripper malfunctioning	I		II	I	II		I	7
Frequent breakage of punch	III	IIII	II	III	III	IIII	III	22
Frequent breakage of die	IIII	III	III	IIII	II	III	IIIII	24
Stripper function is not working properly	II	III	II	IIIII	III	I	II	18
Breakage of locating pin	IIII	IIII	I	III	II	III	I	18
Raw material getting welded with punches or dies	II	I	III	I	III	II	III	15
Component getting disturbed while bending	III	I	I	II	II	III	I	13
Component ejection not working properly		I	II		II	I		6
Component sticking	II	III	I	III	III	I	IIII	17
Knock out rod function not good			I	I			I	3
Pilot breaking	IIII	III	III	I	II	III	II	18
Total	27	26	21	26	27	23	24	174

Checking the availability of online feasibility in failure

Table-2. List of causes.

Causes	**OF AVA**
Strip feeding is so tight or free condition	YES
Run stop not engaging	YES
Trigger stop not functioning	YES
Slug Jamming	-
Box stripper loosening frequently	YES
Floating stripper malfunctioning	-
Frequent breakage of punch	-
Frequent breakage of die	-
Component loading tight	YES
Component unloading tight	YES
Stripper function is not working properly	-
Breakage of locating pin	-
Raw material getting welded with punches or dies	-
Component struck with draw die	YES
Bottom tool mounting get disturbed	YES
In consistency in location	YES
Component getting disturbed while bending	-
Component ejection not working properly	-
Component sticking	-
Knock out rod function not good	-
Pilot breaking	-
OF AVA - Online feasibility available	

Filtering the issues required the online maintenance feasibility

Table-3. List of frequent failures.

Online Maintenance Feasibility Required Areas	
Causes	**FF**
Slug Jamming	YES
Floating stripper malfunctioning	YES
Frequent breakage of punch	YES
Frequent breakage of die	YES
Stripper function is not working properly	YES
Breakage of locating pin	YES
Raw material getting welded with punches or dies	YES
Component getting disturbed while bending	YES
Component ejection not working properly	YES
Component sticking	YES
Knock out rod function not good	NO
Pilot breaking	YES
FF-Frequent Failures	

Area to be modified for online feasibility

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Table-4. List of online maintenance required.

Online Maintenance Feasibility Required Areas		
Causes	**Tool**	
	TH	**BH**
Slug Jamming	-	YES
Floating stripper malfunctioning	YES	-
Frequent breakage of punch	YES	-
Frequent breakage of die	-	YES
Stripper function is not working properly	YES	-
Breakage of locating pin	-	YES
Raw material getting welded with punches or dies	YES	YES
Component getting disturbed while bending	YES	YES
Component ejection not working properly	YES	YES
Component sticking	YES	-
Knock out rod function not good	-	YES
Pilot breaking	YES	-
TH-Top Half BH-Bottom Half		

PROPOSED MODEL AND DESCRIPTION

The proposed design to do online maintenance in dies to solve the issues in the above Table-4 contained. It describes the proposed

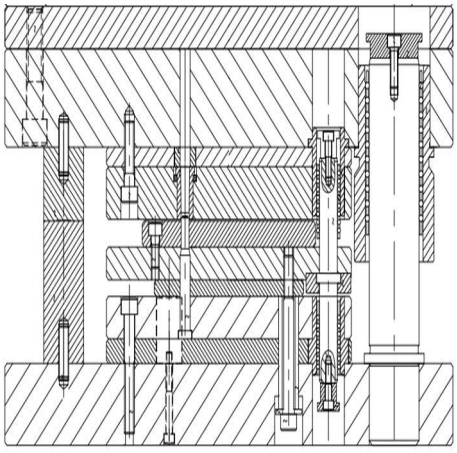

Figure-2. Front view of tool assembly.

design methodology sequence steps to dismantle the die. The general concept of the stamping die is showed in Figure-2.

Design to interchange the punch

The design (Figure-3) explains the sequence steps to interchange the punch. Fastners have to be removed as per the sequence.

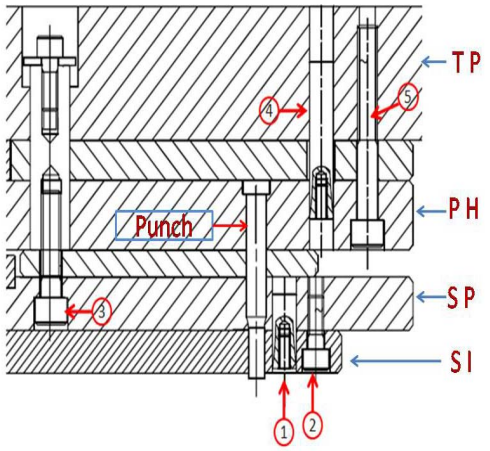

Figure-3. Sectional view of punch assembly (Tophalf).

Step-1. Dowel in-between the stripper inserts (SI) and stripper plate (SP), **Step-2.** SHCS screw in-between the stripper insert (SI) and stripper plate (SP), **Step-3.** distance screw has to be dismantled from the stripper plate (SP), **Step-4.** dowel in-between the punch polder (PH) and top plate (TP), **Step-5.** SHCS screw in-between the punch polder (PH) and the top plate (TP). Then the punch can be easily interchanged. One important thing to consider is the dowel pulling screw will be always in downward direction for the top half of the tool.

Design to check the ejector function

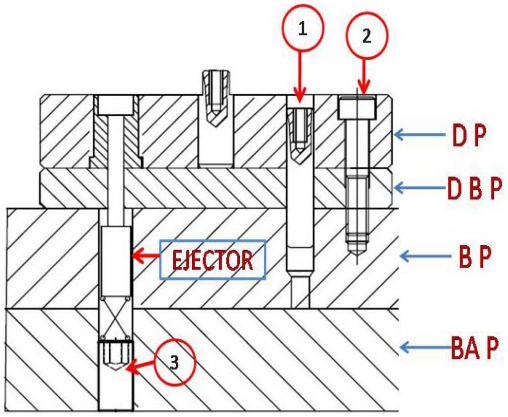

Figure-4. Sectional view of ejection assembly (bottom half).

The design (Figure-4) explains the sequence steps check the ejector function. Fasteners have to be removed as per the sequence.

Step-1. Dowel in-between the die plate (DP) and the bottom plate (BP), **Step-2.** SHCS screw in-between the die plate (DP) and the bottom plate (BP). **Step-3.** Ejector, springs can be take out we can adjust the by means of grub screw. One important thing to consider is the dowel pulling screw and the grub screw hexagonal slot will be always in upward direction for the bottom half of the tool

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Design to interchange the die insert

The design (Figure-5) explains the sequence steps to interchange the die insert. Fasteners have to be removed as per the sequence. **Step-1.** Dowel in-between the die plate (DP) and the bottom plate (BP), **Step-2.** SHCS screw in-between the die plate (DP) and the bottom plate (BP). One important thing to consider is the dowel pulling screw and the grub screw hexagonal slot will be always in upward direction for the bottom half of the tool.

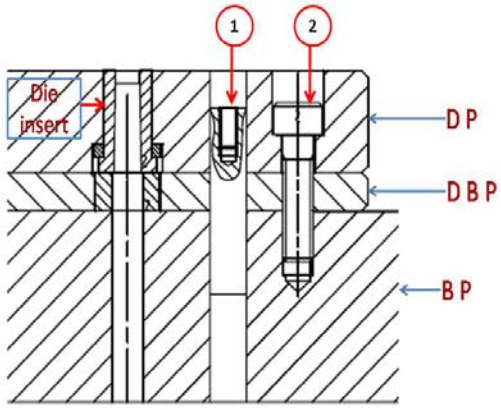

Figure-5. Sectional view of die inserts assembly (bottom half).

Design to check floating stripper

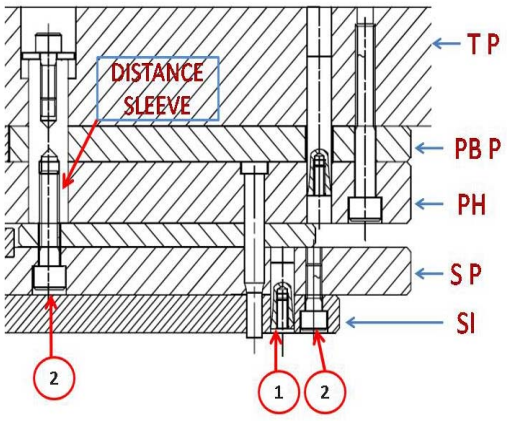

Figure-6. Sectional view of stripper clamping assembly (top half).

The design (Figure-6) explains the sequence steps to floating stripper function. Fasteners have to be removed as per the sequence. **Step-1.** Dowel in-between the stripper inserts (SI) and stripper plate (SP), **Step-2.** SHCS screw in-between the stripper insert (SI) and stripper plate (SP), **Step-3.** Distance screw has to be dismantled from the stripper plate (SP), Then we can check the functions of the springs in between the stripper plate easily.

Design to remove the slug jammed in die house

The design (Figure-7) explains the sequence steps to remove the slug jammed in die house. Fasteners have to be removed as per the sequence.

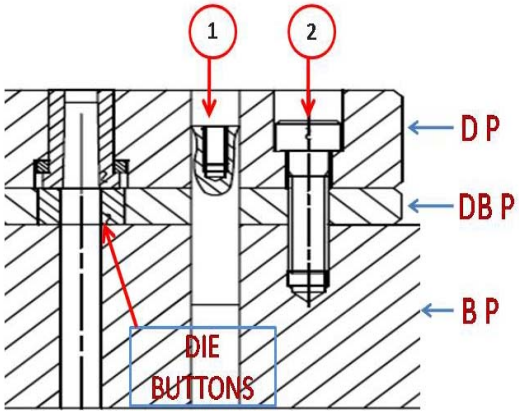

Figure-7. Sectional view of die button (bottom half).

Sequence steps are same as the design to interchange the die insert.

Design to interchange the locatar

The design (Figure-5) explains the sequence steps to interchange the die insert. Fasteners have to be removed as per the sequence.

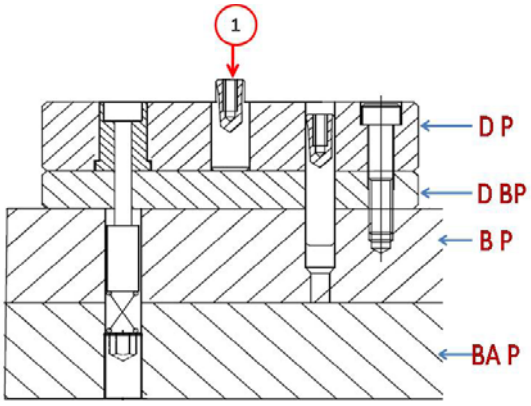

Figure-8. Sectional view of die button (bottom half).

Step-1. Dismantle the locator directly from the die plate. Always confirm that the screw hole depth of the locator should be below to the top surface of the die plate. If not the maximum probability of the locator breakage will be in top surface of the locator. So, removal of the locator is quite difficult.

Design for remova l of raw material welded with punch/die

Proposed design of the interchange of die and design to interchange punch will address this issue.

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Design to check the component disturbed while operation takes place

Proposed design to check the Floating stripper and design to interchange die will address this issue.

Design to interchange the pilot

Design to interchange punch will address this issue.

PROPOSED MODEL ANALYSIS

The design required for online feasibility was 12 issues (causes) out of that 11 issues are addressed with the new proposed design. Proposed to do the online solving the 98% of the causes for the die (tool) failure. According to the Pareto diagram 80% of problems will create remaining 20% of problems.

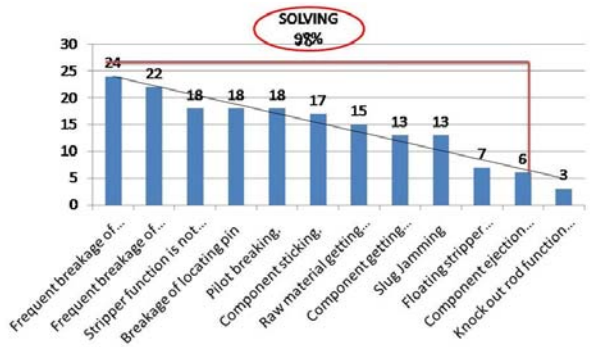

Figure-9. Pareto diagram.

Table-5. Pareto cumulative calculation.

Problems	FREQ	%	CUM %
Frequent breakage of die	24	13.8	13.79
Frequent breakage of punch	22	12.6	26.39
Stripper function is not working properly	18	10.2	36.59
Breakage of locating pin	18	10.2	46.83
Pilot breaking	18	10.2	57.07
Component sticking	17	9.7	66.77
Raw material getting welded with punches or dies	15	8.6	75.37
Component getting disturbed while bending	13	7.4	82.77
Slug Jamming	13	7.4	90.17
Floating stripper malfunctioning	7	4	94.3
Component ejection not working properly	6	3.4	98.3

CONCLUSIONS

The proposed model in the present work regards the modification of design from the existing design of the stamping die. Online maintenance in the die, both top half and the bottom half should increase the productivity and decrease the setting time of the tool. Normal average tool loading time (LT) is 30min and unloading time (UT) is 20 min. If the tool failure happens means Total Loss of the Time (TLT) is (Unloading time of the failure tool + loading time of new tool + unloading time of a new tool + loading time of failure tool after maintenance) = 100 min. Reason for the loading time of the new tool time was added because due to the maintenance work the failure tool, new tool is loaded and taken the production it was unloaded before the batch production completion due to the readiness of failure tool. Due to the online maintenance the Total Saving of Time (TST) = (Total loss of Time (TLT) - Online Maintenance Time (OMT) maximum) = (100 min - 30 min (average)) = 70 min.

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