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Causes & Preventation of Defects (Burr) In Sheet Metal Component

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Abstract

Burr formation is common sheet metal defect and Burr control / deburring is an important issue for industrialist and engineers. It is produced in all shearing & cutting operations. In sheet metal parts burr is usual but after a specified limit it takes a form of defect. This leads to rework and quality problem of part. So controlling this defect is the issue of quality as well so a study of all relevant factors is done in this paper, individually. This paper describes that what are the possible causes & how can we prevent it. Except die & punch clearances, there are still many factors which affect the burr formation. Now, when CAD/CAM software is in use, it is not a very critical task to maintain a proper clearance accordingly. As all the sheet metal industries are heavily affected by burr problem, indicating the study of all the possible causes and remedies. This paper also clears that what practices can increase the tool life & how long we produce "burr free" parts. It includes the selection of the best materials and methods for 'press tools', 'tool design review', "machine selection" etc.

Keywords: Sheet metal parts, Burr, Press Tools.

I. Introduction:

Sheet metal parts play an important role in automotive industry. Different types of reinforcement, body parts, and door parts are manufactured in sheet metal scope. With every manufacturing process there are some defects associated with the same. In same manner in sheet metal components there are also many types of defects arises in different processes. But out of these defects the most common and prominent defect is 'burr' [5]. This defect has a no. of cost effective impacts as follows.

1. Adding unnecessary processes i.e. rework
2. Production loss
3. Quality issues
4. Risk of defect being passed to "customer"
5. Affecting 5-S

Application of sheet metal components includes Aircraft industry, Automobiles, Construction work and many other applications such as appliances, food and beverage containers, boilers, kitchen equipment, office equipment etc.

II. Process Identification

Different types of processes involved in sheet metal work, which produce burr are given in table 1.

Table 1: Processes and their harmful effects

Processes	Defects	Harmful Effects	Rework able defects
	Cutting processes		
Blanking	Blank out, Burr	Quality issue, rework	BURR
Punching	Oval, Burr	Quality issue, rework	BURR
Shearing	Taper cutting, Burr	Quality issue, rework	BURR
Trimming	Chip off, Burr	Quality issue, rework	BURR
Notching	Burr	Quality issue, rework	
	Non-cutting processes		
Forming	Wrinkles, Thinning, Crack	Quality issues, rejection, production loss	
Draw	Wrinkles, Thinning, Crack	---DO---	
Coining	Thinning	---DO---	
Bending	Spring Back	---DO--	

III. Defect Understanding

Following data was observed in a sheet metal industry with the help of Pareto Diagram which shows how important is to control the burr, a defect, which has a major contribution to increase the defect graph of any organization[5].

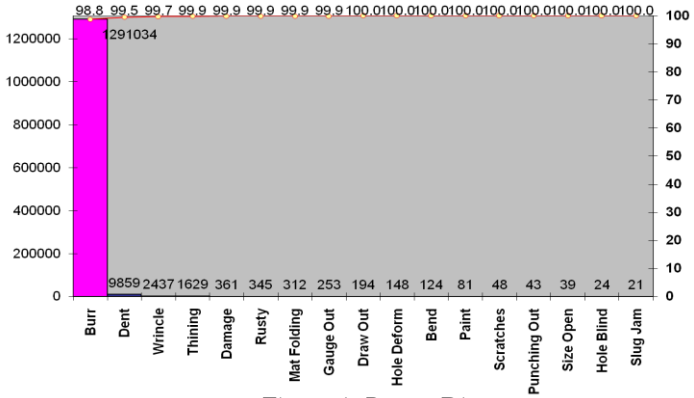

Figure 1: Pareto Diagram

IV. Possible Causes (Cause & Effect Diagram)

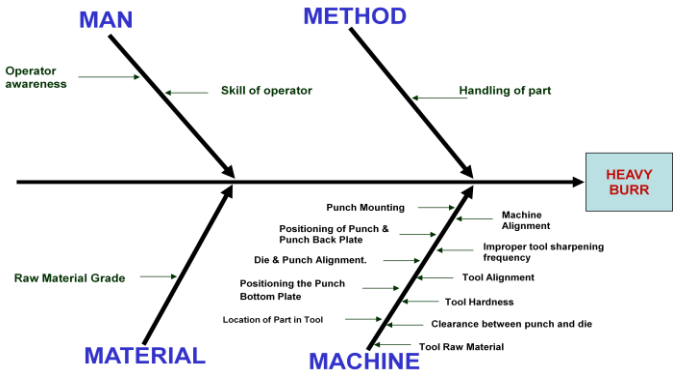

Figure 2: Cause & Effect Diagram [13]

V. Study of all factors causing BURR

5.1 Man

Identify Cause	Reason	Countermeasure
Operator awareness	Operator is not locating the part in specified location gauge. Feeding of double parts / sheets which can damage the sharp edge of die and punch. This leads to burr formation.	Training has to be provided
Skill of Operator	Operator should be capable to grasp the given training. Due to absence of skill he will repeat the mistake thus it increase the chance of accident.	Operator should be according to process criticality.

5.2 Material

Identify Cause	Reason	Countermeasure
Raw material grade & thickness	Due to die & punch clearance is depend on raw material thickness. So it is important to feed actual sheet thickness material. If we select a sheet having less thickness from actual then in this condition clearance between die & punch will be more and at the time of cutting proper shearing & breakage will not be produce. Thus burr will be form. As well if we will use higher sheet thicknesses then less clearance will be maintained or no clearance thus cutting process will be interrupted and heavy accident will go on.	Proper control on raw material should be taken place by the RI department. Also quality & production supervisors should be insuring about the RM before feeding in tool. For proper implementation of the above idea this should be converting into a system.

5.3 Method

Identify Cause	Reason	Countermeasure
Part handling	Method is directly related with Man i.e. operator resource. In absence of proper handling or part loading method into tool may cause of burr. Sometimes part trim / edge get damage due to unsafe part handling or movement.	Operator should be sufficiently trained

5.4 Machine

There are several reasons responsible for burr formation during machining phase. Broadly they can be classified into two groups.

5.4.1 Press Machine Alignment:

As far as burr is concern, press machine alignment is an important factor which is responsible for the burr formation and is clear from figure 3.

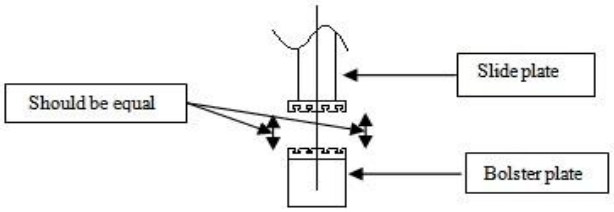

Figure 3: Press machine Alignment

From figure 3 at the time when slide comes down for the intended operation then linear dimensions between slide plate and bolster plate should be equal. This is the press alignment. If it is not, then loaded tool perpendicularity will be hit i.e. die & punch will not meet at 90°. Upper half will hit lower half beyond clearance provided. In this condition uniform shearing & breaking of edge will not be happen and will cause the burr formation and reduces the tool as well life.

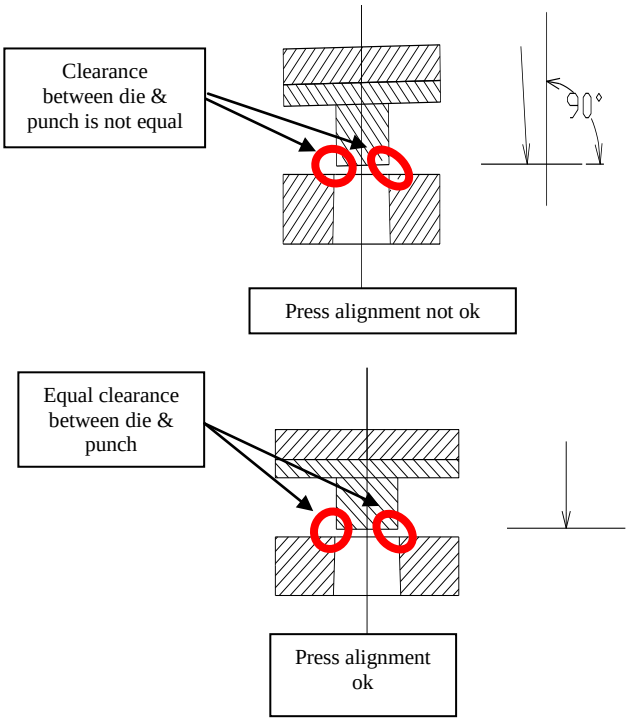

Figure 4: Press Alignment (Die & Punch Assembly)

5.4.2 Press Tool: Clearance between die & punch

The cutting of sheet metal in press work is a shearing process. The punch is of the same as of the die opening except that it is smaller on each side by an amount known as clearance. As the punch touches the material and travels downwards, it pushes the material into the die opening; the material is subjected to both tensile and compressive stresses

a) Stresses will be highest at the edges of punch and die and the material will start cracking there. The various steps in the rupture or fracture of the material can be written as: stressing the material beyond its elastic material, plastic deformation, reduction in area, fracturing starts in the reduced area and becomes complete. If the clearance between punch and die is correct, the cracks starting from the punch and die edges will meet and the rupture is complete, as shown in the figure 5.

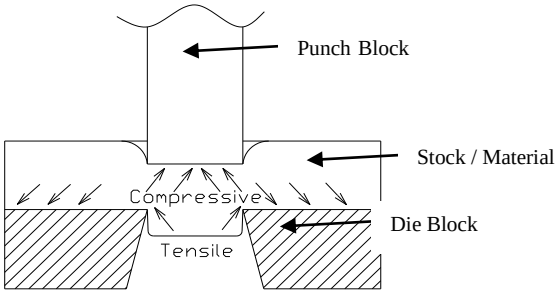

Figure 5: Stresses during cutting

b) If the clearance is too large or too small, the cracks do not meet and a ragged edge results die to the material being dragged and torn through the die. Thus burr formation will occur.

In Blanking operation die is master and clearance / side should subtract from punch. In Punching operation punch is master and clearance / side should add in die. The usual clearances per side of the die, for various metals, are given below in terms of the stock thickness, t:

For brass and soft steels	c = 5% of t
For medium steel,	c= 6% of t
For hard steel,	c= 7% of t
For aluminum,	c= 10% of t

VI. Tool Raw Material

Raw material selection influences three following areas.

1) Tool Life
2) Part Quality
3) Tool sharpening frequency

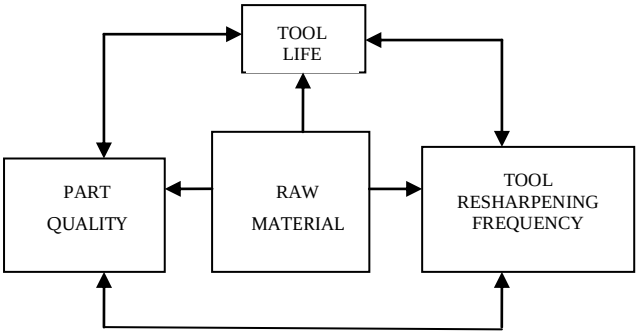

Figure 6: Tool Sharpening Frequency

For burr concern we can study about the following three tools in which burr formation will be occur. Blanking Tool, Punching Tool & Trimming tool. In these tools the raw material selection depicts the following three questions?

1) What will be the tool life?
2) How much burr free part will be produce?
3) What will be sharpening frequency?

Therefore RM selection of tool is an important factor from burr point of view. RM selection of tool is based on

1) Part quantity to be produced by tool.
2) Operation to be performed by tool.
3) Feed material/sheet metal to be used.

On the basis of practical experience & observation collected regarding this, we can go through the following tabulated material list for achieving the best result in an economical way.

Table 2: Operation and material

Operation Name	Feeding Material	Volume / annum	Appropriate Material
Blanking	CRC / HRC	≥ 100000	Die & Punch D3(HCHCR)
Punching	CRC / HRC	≥ 100000	Punch & bush to be made by D3 (HCHCR)
Trimming	CRC / HRC	≥ 100000	Trimming inserts AISI D2

If we choose a lower grade tool material then tool life will be less. Die & punch edge will bunt earlier which leads to the burr formation.

6.1 Raw Material Hardness

Tool hardness refers to the heat treatment process of specific blocks (can say die block & punch block) to achieve the required hardness. This process directly affects the tool life. In the absence of proper hardness following bad results may appear.

1) Blunt the die & punch face resulting burr which reduces the tool life.
2) Smooth cutting will not be performing.
3) Sharpening frequency of die & punch will increase.

We can select the raw material hardness from below table for best performance.

Material Name	Operation	Sheet Metal Thickness	Appropriate Hardness
AISI D2	Trimming	< 3.0 mm	60 – 62 HRC
		3.0 – 6.0 mm	58-60 HRC
D3	Blanking, shearing, punching	-	58- 60 HRC

6.2 Die, Punch& Punch Back Plate Alignment

Die and punch alignment based on manufacturing & final assembly of tool. Proper alignment of die & punch decide the part quality in view of burr. Alignment ultimately affects the clearance between die & punch which is the measure cause of burr formation. So it is important to study the points are belonging to said alignment. We can understand easily from following description.

The following conclusions can be made from figure 7.

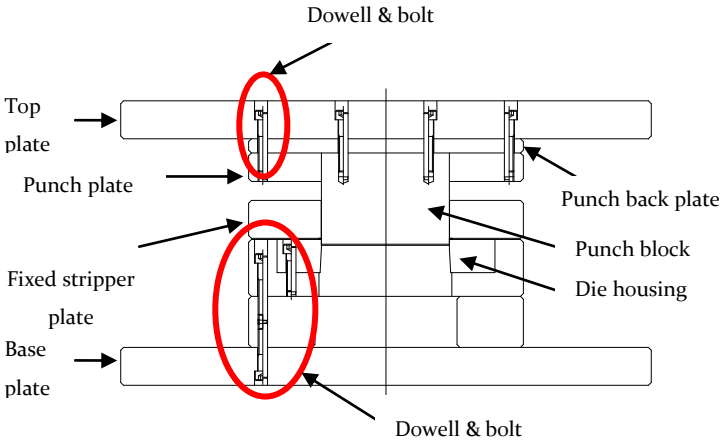

Figure 7: Sectional view of tool in assembly

1. Punch block, punch plate & punch back plate dowelled & bolted to each other & as well top plate also for sound positioning.
2. Same thing in lower half die housing, die insert & riser block dowelled & bolted to each other.
3. Punch is mounted in punch plate.
4. Punch plate & punch back plate dowelled in top plate
5. Punch directly dowelled in top plate with punch back plate.

All above points are said into account of sound tool design for proper alignment of die and punch.

VII. Chances of failure in Manufacturing & Assembly of Tool

There are so many factors in mfg. as well tool assembly which is also responsible for proper alignment of die & punch.

1) Flatness of all the blocks which should be maintain in 0.02 – 0.05 mm. Surface of the block should be grinded.
2) 2D machining i.e. all bolt & dowell holes should be at your right position. (In under 0.05mm)
3) Clearances of die and punch should be proper at the time of EDM wire cut.
4) At the time of assembly, equal tightening force should be given alternately to each bolt.
5) In case of piercing, punch should be guide in stripper plate.
6) Hole & shaft tolerances should be applicable in all sliding, push fit holes.
7) All dowell holes should be reamed.
8) Machine accuracy is important ex – grinding m/c, shaper, milling m/c (2D), Wire cut, CNC Milling (3D). Its accuracy affects the operation being performed.

VIII. Conclusion

Focus & taking care of all above points leads us for a better part quality & better tool stability.

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