Analysis over the Improvements in Punching or Piercing Process

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Abstract— Now a days the sheet metal operations have the important place in production industries. The required size holes, rectangles etc. are cut directly by using punching machines but as well as the thickness of the sheet is increased it becomes difficult to cut it properly in exact size with required quality. If some important changes are provided in material structure of the metal or alloy of the sheet, in the design of the hole to be cut and in the punching process we can cut the thick sheets also by using normal force applied.

Keywords: Punching or Piercing Process

I. Introduction

The thick metal sheets also may be cut by providing some required changes. By this the production rate will be increased sufficiently because it will be possible to cut the thick sheets within seconds and the requirements of the other heavy cutting machines will be minimized. If we cut the thick sheets by using normal force then it will be easy to maintain the punching process also. Besides it the punching operation will be helpful to cut the metals and alloys fatally in production industries. Sometimes it is seen that the production time is also increased due to more time consumed in cutting of the raw material and the semi-finished products. So it is very necessary that we should involve such type advantageous cutting technique in production process.

II. Methodology or Literature Survey

A. Methodology Related To Obtain the Required Changes in Material Structure during the Casting Process –

To provide required changes in material of the metal the required type chemical reactions should be provided at melting time of the metal which is to be converted into the sheets. These chemical reactions are provided to improve the softness and ductility of the metal or alloy and to reduce the chances to develop the various type defects. Besides it to improve the lubricating property in material structure the various type elements may be mixed with it as lead, graphite, tin etc. according the base metal of the casting. But here it is also important that the combination between the softness and ductility of the metal should be maintained properly because sometimes the ductility is increased more than required quantity when we try to increase the softness. It generally depends on the physical and material properties.

B. Methodology Related To the Forging of Metal Sheets –

Here first the metal should be converted into flat and longitudinal billets by semisolid metal or alloy obtained by casting and then it should be converted into a sheet by using the two forming processes. In first process by using drawing or extrusion the metal should be converted into long flat rods at some above the lower critical temperature of the metal and then in second process all flat rods should be added together by using number of roll passes at above the higher critical temperature. By this the all metal particles of the sheet are connected longitudinally in series and its bending strength may be achieved better. After this the sheet is left sometime in oven for heat treatment process to remove the various type defects produced during this process like internal stress, brittleness, torsion, porosity, non-homogenous strength etc. Here if the cut area of the sheet is also squeezed previously with the forming process then it will help to cut this area of the sheet easily on applying less effort.

C. Methodology Related To the Modification in Design of Required Shape and Size –

The sheet should be designed such that the cut or sheared portion is circular mostly. Besides it if the rectangular or square cut is required strictly then at such condition the corners of the cut shape should be recommended round so that there is no problem in cutting the sheet metal due to stress concentration provided by sharp corners.

D. Methodology Related To Modification in Punching Process –

Sometimes due to defects available in sheet metal or due to more ductility the sheet doesn't punch properly and the size of the hole is not obtained in exact size and shape. To solve such type problem first the perimeter of the hole to be cut should be some squeezed and then it should be cut from the sheet. By this the quality problems produced due to metal defects or due to ductility may be minimized till a sufficient limit. Besides it this technique also will help to cut the thick metal sheets properly by using less effort. To obtain such type drive the cam operated or rack – pinion operated punching machines should be used.

E. Methodology Related To Modification Provided In the Shear of the Punch –

Here the punch is made hollow like fig.(A) and here only the double shear is recommended according the requirement and change in punching process.

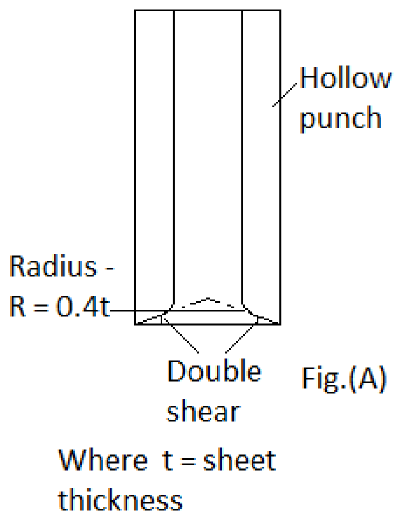

Fig.(A)

Besides it the punch is made hollow to flow the metal to the middle side of the punch when it is squeezed.

III. ANALYSIS

A. Analysis Over the Design of the Punch and Metal Flow during Squeezing –

Here we will have to use the hollow punch which is very hard also. According the new process first the punch will squeeze the particular thick parameter of the hole to be cut but here it is done by a special arrangement as given fig.(B).

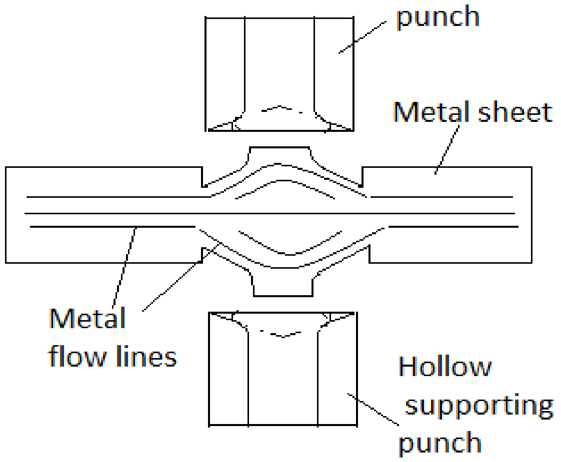

Fig.(B)

Here a supporting hollow die is also fixed downside with the main die. This die also provides the same effort as the punch and squeezes the same thickness of the metal sheet as by the punch.

After squeezing the supporting die pushed downside and metal cutting is done just after it. Here the sheet is heated till below the lower critical temperature to flow the metal towards hollow portions easily during squeezing.

B. Analysis over the Change in Design of Punching Machine –

Here some changes are provided in die design. Here a hollow supporting die is also fixed with below the main die and it is same as the upper punch. But this die is used only to squeeze the sheet metal from downside. Here both the punch and supporting die squeeze the metal sheet simultaneously at same time. Just after squeezing the metal sheet the lower ram returns to its housing and supporting die comes down such that its top point remains below the platform from which the cut piece is to be extracted out. This process is repeated again and again to cut the scrap from the metal sheet.

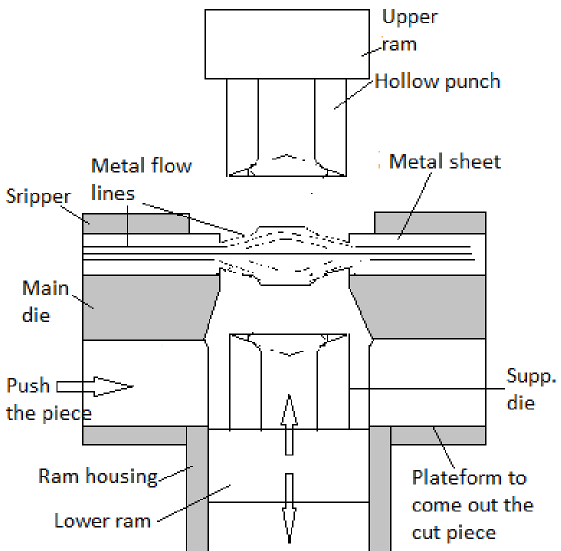

Fig.(C)

C. Analysis Related To the Force Required To Punch the Sheet after Modification in Operation –

It can be understood by using an example. Let a punching machine may punch the 5 mm thick sheet but we want to punch 8mm sheet by using this punching machine. Then here due to squeezing the metal almost 40%, it is possible to do it. Means by using normal range punching machines we can easily punch the require sized hole from the thick sheet. But due to different hardness of the different-2 type metals or alloys the maximum thickness to be cut will be different-2. Let the maximum capacity of the punching machine is 500KN. Means it is clear that the sheet may cut if the cutting force is required below the 500KN.Now to take the few type metals to understand it clearly.

D. For aluminum –

Shear strength (σ_s) = 207 N/mm^2
Compressive strength (σ_c) = 142 N/mm^2
Maximum shear force (F_S) = 500 KN
Maximum compressive force (F_c) = 500 KN
Area of shearing (A_S)= $\pi d_1 t_1$
Area of compression (A_C) = $\pi/4\ (d_1 - d_2)\ t_2$
(Let d_1 = 20mm, d_2 =16mm)
Then from $F_S = \sigma_S A_S$
$500\times10^3 = 207\times\pi\times20\times t_1$
Then t_1 = 38.44 mm
And from $F_C = \sigma_C A_C$
$500\times10^3 = 142\times(\pi/4)\times(20^2 - 16^2)\times t_2$
Then t_2 = 31.13 mm

Means it is that the Alluminium sheet may shear equal to 38.44mm thickness without any squeezing while if the squeezing is done before the shear then the total removal thickness of the sheet = 38.44 + 31.13 = 69.57 mm.

E. For copper –

Shear strength (σ_s) = 150 N/mm^2
Compressive strength (σ_c) = 217 N/mm^2
Maximum shear force (F_S) = 500 KN
Maximum compressive force (F_c) = 500 KN
Area of shearing (A_S)= $\pi d_1 t_1$
Area of compression (A_C) = $\pi/4\ (d_1 - d_2)\ t_2$

(Let d_1 = 20mm, d_2 =16mm)
Then from $F_S = \sigma_S A_S$
$500\times10^3 = 150\times\pi\times20\times t_1$
Then t_1 = 53.051 mm
And from $F_C = \sigma_C A_C$
$500\times10^3 = 217\times(\pi/4)\times(20^2 - 16^2)\times t_2$
Then t_2 = 20.37 mm

Means it is that the copper sheet may shear equal to 53.051mm thickness without any squeezing while if the squeezing is done before the shear then the total removal thickness of the sheet = 53.051 + 20.37 = 73.421 mm.

F. For mild steel –

Shear strength (σ_s) = 240 N/mm^2
Compressive strength (σ_c) = 250 N/mm^2
Maximum shear force (F_S) = 500 KN
Maximum compressive force (F_c) = 500 KN
Area of shearing (A_S)= $\pi d_1 t_1$
Area of compression (A_C) = $\pi/4$ ($d_1 - d_2$) t_2
(Let d_1 = 20mm, d_2 =16mm)
Then from $F_S = \sigma_S A_S$
$500\times10^3 = 240\times\pi\times20\times t_1$
Then t_1 = 33.16 mm
And from $F_C = \sigma_C A_C$
$500\times10^3 = 250\times(\pi/4)\times(20^2 - 16^2)\times t_2$
Then t_2 = 17.68 mm

Means it is that the Alluminium sheet may shear equal to 33.16mm thickness without any squeezing while if the squeezing is done before the shear then the total removal thickness of the sheet = 33.16 + 17.68 = 50.84 mm.

G. For stainless steel

grade – 316 →
Shear strength (σ_s) = 180 N/mm^2
Compressive strength (σ_c) = 170 N/mm^2
Maximum shear force (F_S) = 500 KN
Maximum compressive force (F_c) = 500 KN
Area of shearing (A_S)= $\pi d_1 t_1$
Area of compression (A_C) = $\pi/4$ ($d_1 - d_2$) t_2
(Let d_1 = 20mm, d_2 =16mm)
Then from $F_S = \sigma_S A_S$
$500\times10^3 = 180\times\pi\times20\times t_1$
Then t_1 = 44.21 mm
And from $F_C = \sigma_C A_C$
$500\times10^3 = 170\times(\pi/4)\times(20^2 - 16^2)\times t_2$
Then t_2 = 26 mm

Means it is that the Alluminium sheet may shear equal to 44.21 mm thickness without any squeezing while if the squeezing is done before the shear then the total removal thickness of the sheet = 44.21 + 26 = 70.21 mm.

IV. FINAL RESULT

Hence it is clear that the punching operation may be performed effectively if some improvements are provided in its working process from initial to last steps and in resultant we may punch the thick sheets easily.

V. CONCLUSION

Here it is clear that we can provide the required changes in any machining operation to obtain the better result than previous. But it depends on the type of operation, working environment, availability of the sources, capital investment for its development and practical etc. also.

REFERENCES OF THE BOOKS

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