Forging

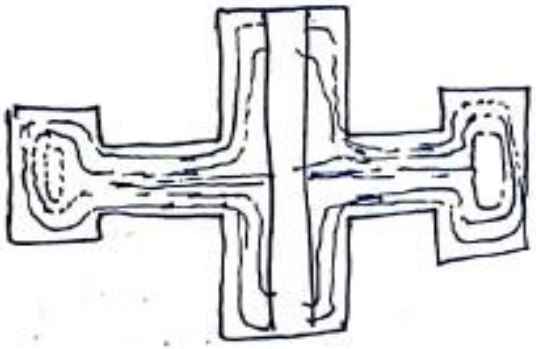
Plastic Deformation : UNIT 4

Plastic deformation is deformation which is permanent and beyond the elastic range of the metal. Most of the metals are worked by plastic deformation because of the beneficial effect that is imparted to the mech. properties by it. The necessary deformation is achieved by application of large amount of mechanical force only or by heating the metal and then applying small force.

Deformation is due to displacement of the atom by the process of slip or twinning. ~~The details~~ When plastic deformation occurs the metal appears to flow in the solid state along specific direction, which are dependant on the type of processing & directions applied force. The crystal or grains of the metal are elongated in the direction of metal flow. This flow of metal can be seen under microscope after polishing and suitable etching of the metal surface. These visible lines are called "fibre flow lines"

Since the grains are elongated in the direction of flow they would be able to offer more resistance to stresses acting across them. As a result the mechanically worked metals called Wrought products would be able to achieve better mech. strength in Sp. orientation that of the flow direction these flow lines can be controlled by the manipulation of the applied force. Metal of course weak along the flow lines

The wastage of material in metal working is either neg. negligible or very small, and the production rate is high with economy



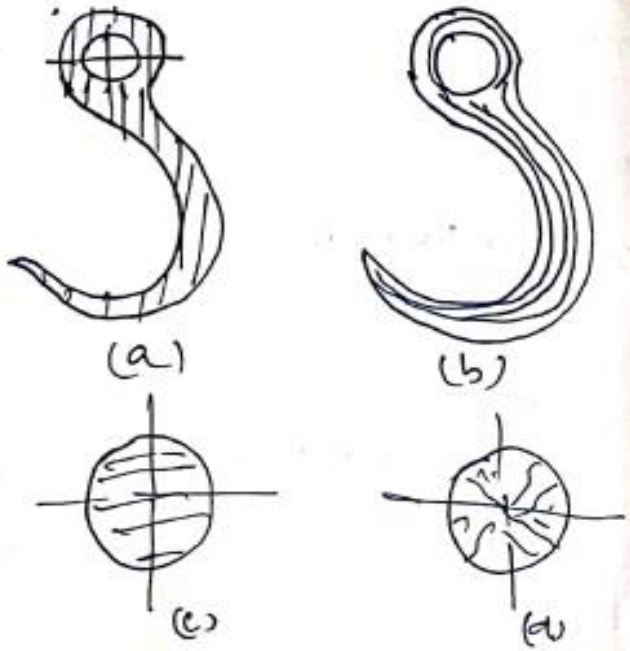
(a) bar stock (b) forged stock

Forging :- Two types - Forging is the operation where the metal is heated and then a force is applied to manupulate the metal in such a way that the required final shape is obtained. This is the oldest of the metal working process known to mankind since copper age. Forging is generally hot working operation though cold forging is used sometimes

.. Forging operation:- Two types of operations are used in forging in order to arrive at the final object configuration. They are

Drawing out:- This is the operation in which the work metal gets elongated & a reduction in the cross-section area. For this purpose, the force is to be applied in a direction ⊥ to the length axis

Upsetting:- This applied to increase the cross-sectional area of the stock at the expense of its length. To achieve the upsetting, force is applied in a direction ∥ to the length axis.



Forging has a manipulative ability. it is possible to closely control the grain flow in the specific directions such that the best mechanical properties can be obtained based on the specific application. grain flow directions are depicted.

It is possible of desirable grain flow. the grain pattern obtained without bending is shown in fig(a) whereas the one in (b) is obtained by bending after drawing out. As a result, the grain also bent along the hook and thus provides the necessary strength for lifting loads. Similarly the gear blanks shown in (d) is obtained by upsetting the blanks and then finishing

For example crane hooks shows grain flow of two types

forging, whereas the one is (c) is obtained without upset ting the blank. The upselling process provides the radial grain flow, which is essential for good strength in the gear tooth for severe applications.

- Forging types: Four types of forging methods which are generally used. (1) Smith forging :- This is traditional traditional forging done openly or in open dies by village blacksmiths or modern shop floor by manual hammering or by power hammers.

(2) Drop forging :- This is the opⁿ done in closed impression dies by means of drop hammers. Here the force for shaping the component is applied in a series of hammers.

Press forging :- Similar to drop forging, Press forging is also done in closed impression dies ~~c~~ the exception that the force is a continuous squeezing type applied by the hydraulic presses

Machine presses: Unlike the drop or press forging where the material is drawn out, in machine forging, the material is only upset to get the desired shape.

Smith forging:

The process involves heating the stock in the blacksmith's hearth and then beating it over the anvil. To get the desired shape. The operator has to manipulate the component in b/w the blows. Type of operations available are fullering, flattering bending, upsetting and swaging.

In fullering operation bottom fuller is fitted on anvil and upon which heated work piece to be set and then top fuller is brought over the place and hammering (Sledge hammer) is blowed the area of the work piece decreased at the centre of the fuller and repeating the operations by moving the up fuller and get the desired shape. After fullering the stock would have the fullering marks left which are then cleared by means of flattering. To obtain specific shapes like round, square, hexagon

etc. open general purpose dies called Swage blocks are used.

Smith forging involves a lot of skill on the part of the operator and also is more time consuming. But no dies are used, Smith forging is more beneficial in the manufacturing of small lots or in Trial production, because heavy cost of closed impression dies can not be justified in these cases.

Drop forging: In drop forging closed impression dies are used to obtain the desired shape of the component. This is obtained by the repeated blow of the hammer given to the material in the die cavity. The equipment used for delivering the blows are called drop hammer.

The die consists of two halves: Lower half is kept on anvil of the machine. while the upper die is fixed with the ram of the hammer

The heated stock is kept on the lower die and the ram delivers hammer blows in two to four quick succession. So that the metal spread and completely fills the die cavity when the two die halves close - complete cavity is formed.

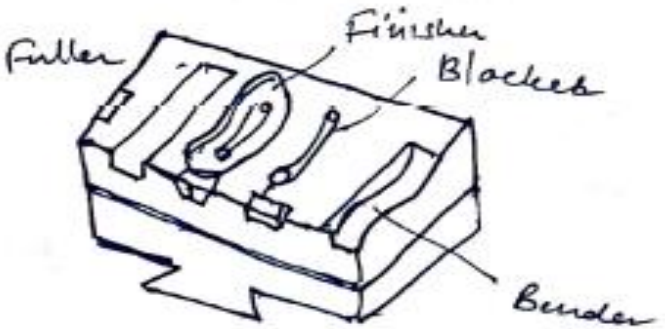
Shape of the impression is machined in the die cavity, because of which more complex shape can be obtained, in drop forging as compared to smith forging. However more complex, intricate shapes deep pockets, & re-entrant shapes etc cannot be obtained due to the limitation of the withdrawal of the finished product from the die. The products obtained are crank, crank shaft, connecting rod, wrench, crane hook. etc.

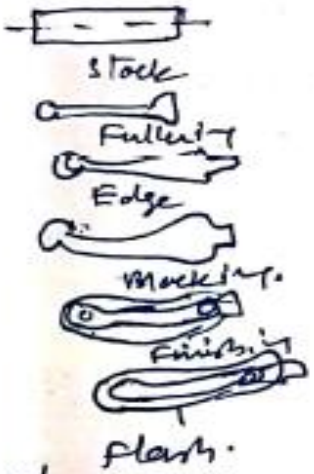
The final shape desired in drop forging in single pass. Depending on the shape of the component, and desired grain flow direction, the material should be manipulated in no. of passes.

→ Fullering impression: Here the reduction of the stock cross-section is obtained with no upsetting. The very first step is to reduce the stock size. The impression machined in the die is called fullering impression.

→ Edging impression: Also called preform, this stage is required to gather the exact amount of material required at each cross-section of the finished component. This most important stage became it ensures preform, defect-free flow of metal, complete die fill and min flash loss.

Bending impression:





This is required for those component which has bent shape. For proper bending and the grain flow to obtained in the component, it is to be followed after edging impression.

Blocking impression: This is also called semi finishing stage. in forging it is very difficult for the material to flow to deep pockets sharp corners etc. Hence before the actual shape is obtained, the mtl is allowed to have one or more blocking impression where it accentries the

very near to the final one. blocking impression are characterised larger corner radii and fillets but no flash. For complex shape than one blocking impression may be used

:shing impression. impression where the

Finishing impression :— This is the final impression where the actual shape required is obtained, in order to ensure the metal is completely fills the die cavity, a little extra metal is added to the stock. This extra metal will flow in the form of flash surrounds the forging in the parting plane.

Trimming :- In this stage, the extra flash present around the forging is trimmed to get the forging in the required form.

Press forging :- Dies and process followed are same as drop forging. The metal is shaped not by means of a series of blows as in drop forging but by means of a single continuous squeezing action. This is obtained through hydraulic presses.

Continuous action of hydraulic presses, the material gets uniformly deformed throughout its entire depth. The force is transferred to stock where as in drop forging to machine frame. The impression on stock is clear & clean as compared to drop forged mill. The draft angles are less than drop forging. but the press capacity is very high. So smaller components only are press forged in closed dies. but there is no limitation for open impression die.

The press capacity may vary from 5MN to 50MN for normal applications. and for heavy duty it may vary from 150MN to provide necessary alignment of the two dies, die posts are attached to the bottom die so that the top die would likely to slide only on the posts and thus register the correct alignment. No tong is required in press forging as in drop forging but the proper arrangement of fuller, bender, blocker finisher is to be done

Machine forging :- Also known as upset forging. Though both the drop and press forging is done by the machine but only upset forging is referred as machine forging. This was developed for making bolt heads in continuous fashion. But there are large no of devices used for this process. Because grains flow obtained, it is used for making gear blanks, shaft, axles, spindles etc.

Horizontal upsetting machines, called upsetters, are generally horizontal acting
tive die set consists of a die and corresponding punch or a head
tool. The die consists of two parts. one called the stationary
gripper die which is fixed to the machine frame, and the other
movable gripper die. which moves along the die slide of the
upsetter. The stock is held b/w these two gripper dies by fri
stationary die to grip the stock. The two dies, when in closed
position, form necessary die cavity. Then the heading tool ad
ces against the stock and upset it to completely fill the die ca
-ty. Having completed the upsetting, the heading tools moves ba
to its back position. movable gripper die releases the stock
by sliding backwards.

Vertical: Similar to drop forging, it is not possible to get the final shape in a single pass in upset forging too. Therefore the operation is carried out in a no. of stages. The die cavities required for the various operations are all arranged in vertically on the gripper dies. The stock is then moved from one stage to the next in a proper sequence. Till the final forging is ready. A heading tool each, for every upsetting stage is arranged on the heading die slide of the upsetting machine