

Basic Mechanical Engineering, Unit 03

Manufacturing Processes

Forging



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Learning Objectives

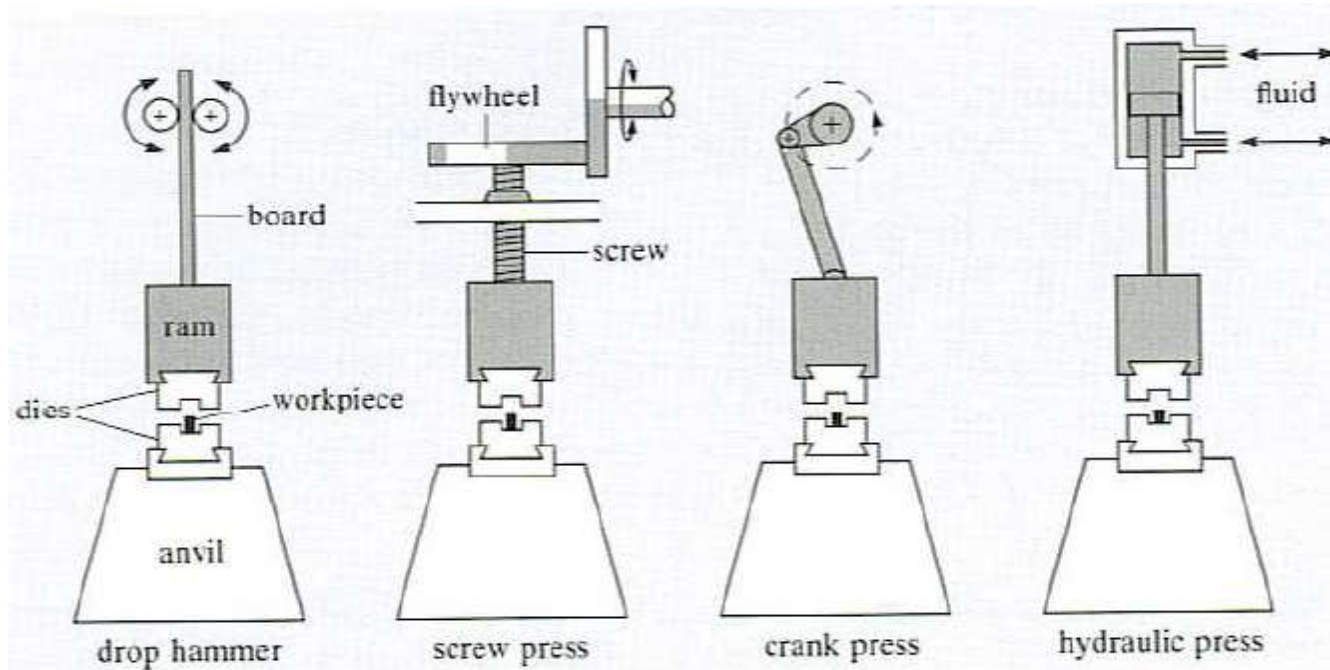
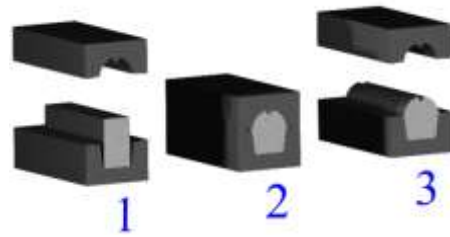
- At the end of this session, student must have sound knowledge of;
 - Need of forging & its applications
 - Forging press
 - Types of forging : Hot & Cold
 - Forging operations

Forging



- The metal is heated & is shaped by plastic deformation, by applying compressive force.
- Compressive force is in the form of hammer blows using a power hammer or a press.
- Forging refines the grain structure & improves Mechanical properties of the metals [Strength, ductility, toughness etc.]
- Forgings are consistent from piece to piece, without any of the porosity, voids, inclusions and other defects
- High strength to weight ratio & good surface finish

Forging Press



Classification of forging

- Based on the heat treatment applied;
 - **Hot forging** (Temp above recrystallization point)
 - **Cold forging** (Temp below recrystallization point)
- By the degree to which the flow of the material is constrained during the process
 - **Open die forging** (work is compressed between two die that do not constrain the work during the process)
 - **Impression die forging** (cavities within the die restrict metal flow during compression of the part, causing the material to deform into a desired geometric shape. Flash is required)
 - **Flashless forging** (the entire work piece is contained within the die in such a way that no material can flow out of the die cavity)

Hot Forging

- **Hot Forging:**
 - The temperature reaches above the recrystallization point of the metal
 - Plastic stage (**Red Hot**)
- **Advantages:**
 - Production of discrete parts
 - Low to medium accuracy
 - Low stresses & Homogeneous grain structure
- **Disadvantages:**
 - Less precise tolerances
 - Possible warping of the material during the cooling process
 - Possible reactions between the surrounding atmosphere and the metal
- **Products:**
 - Connecting rods, gears for motorcycles, fan hubs, fuel injection pump parts,
 - critical aircraft parts such as landing gear, shafts for jet engines and turbines ,
 - structural components for transportation equipment such as automobiles and railroads, crankshafts, levers, gears, connecting rods etc



Cold Forging

- **Cold forging:**
 - Deforms metal while it is below its recrystallization point (**Room temp**)
 - Preferred for soft metal: Aluminum, Copper, Steel & their alloys
 - Less expensive than hot forging
 - The end product requires little finishing work
- **Advantages:**
 - Possible for use of less costly material
 - Increased dimensional control
 - Handles high stress and high die loads
 - Produces near-net shape parts
- **Disadvantages:**
 - The metal surfaces must be clean and free of scale before forging occurs
 - Residual stress may occur
 - Heavier and more powerful equipment is needed
 - Stronger tooling is required
- **Products:** Nut & bolt, fasteners, sleeves, coining etc



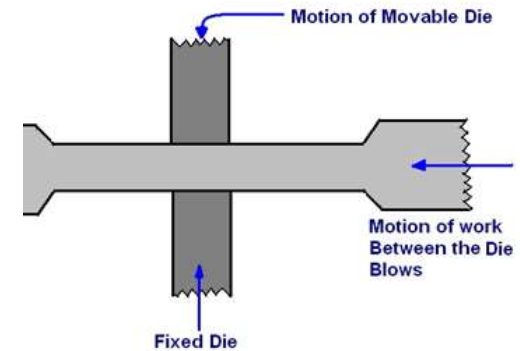
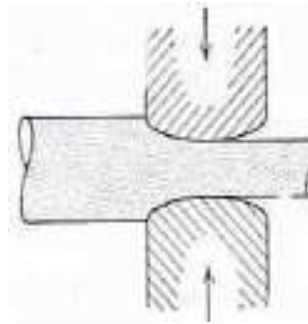
Forging Operations

- **Drawing out:** Increase length, decrease cross-section
- **Upsetting:** Decrease length, increase cross-section
- **Squeezing:** Change length, change cross-section, by squeezing in closed impression dies

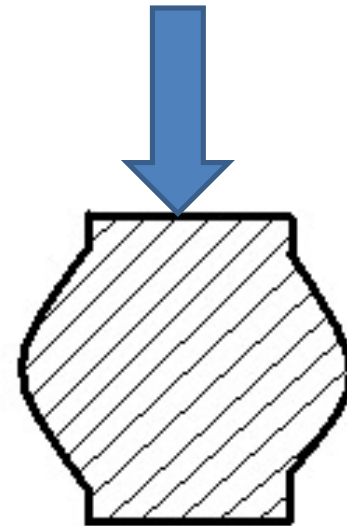
- **Welding:** A process of joining two metal pieces to increase the length by hammering the hot metal ends
- **Cutting:** A process in which a hot metal rod or plate cut out into two pieces, with the help of chisel & hammer

Forging Operations

Drawing: Metal gets elongated with a reduction in the cross section area. Force is applied in a direction perpendicular to the length of job

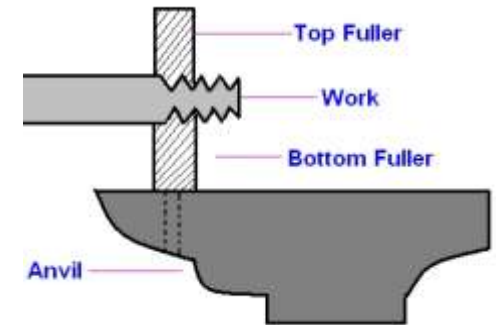


Up setting: Increase the cross sectional area of the stock at the expanse of the length. To achieve the length of upsetting force is applied in a direction parallel to the length of job (forming of a bolt head)

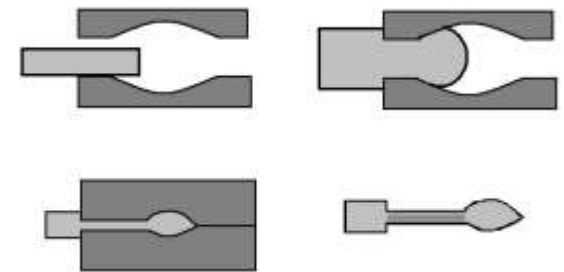


Forging Operations

Fullering: Varying cross sections of job. The bottom fuller is kept in angle hole with the heated stock over the fuller & the top fuller is then kept above the stock. Then with the sledge hammer, force is applied on the top fuller e.g. Grills, Construction steel rods

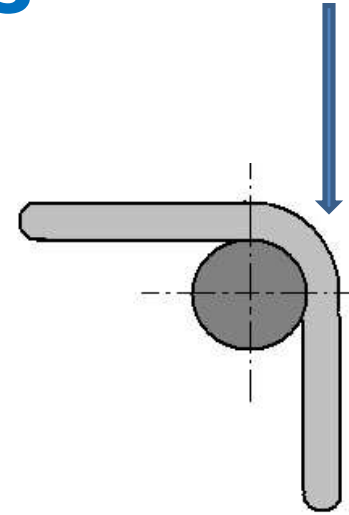


Edging: The metal piece is displaced to the desired shape by striking between two dies. Edging is frequently as primary drop forging operation

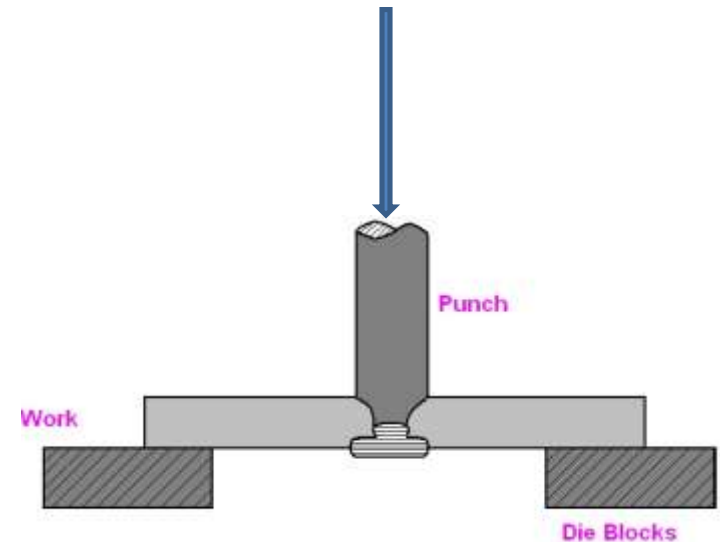


Forging Operations

Bending: To give a turn to metal rod or plate. This is required for those which have bends shapes

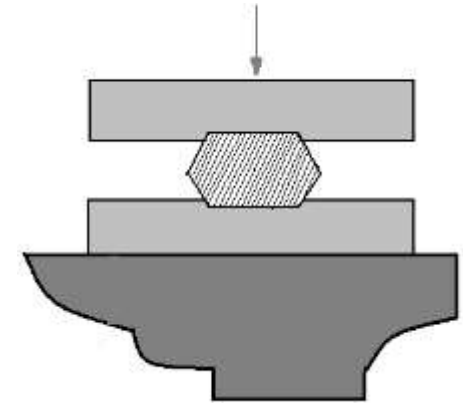


Punching: A process of producing holes in metal plate, which is placed over the hollow cylindrical die. By pressing the punch over the plate the hole is made

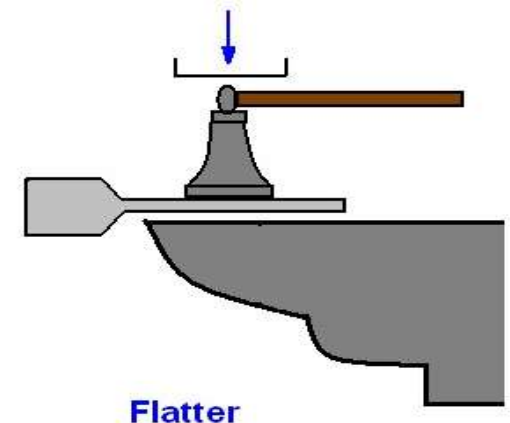


Forging Operations

Swaging : It is done to reduce and finish work for desire size and shape, usually either round or hexagonal. For small jobs top and bottom swage pair is employed, where as for large work swage block can be used



Flating and setting down: Fullering leaves a corrugated surface on the job. Even after a job is forged into shape with a hammer, the marks of the hammer remains on the upper surface of the job. To remove hammer marks and corrugation and in order to obtain a smooth surface on the job, a flatter or set hammer is used



Comparison: Hot & Cold Forgings

Sr.	Hot Forging	Cold forging
01	Deforms the metal when its temperature reaches above the recrystallization point (Red Hot).	Deforms metal while it is below its recrystallization point (Room temp).
02	Preferred for steel & steel alloys.	Preferred for aluminum & its alloys.
03	Production of discrete parts.	Produces net shape or near-net shape parts.
04	Low to medium accuracy.	High accuracy.
05	Highly grained structure increases the strength of metal.	Residual stresses are developed in the cold forged products.

Comparison: Hot & Cold Forgings

Sr.	Hot Forging	Cold forging
06	Finished product is produced.	The end product requires end finishing.
07	Possible reactions between the surrounding atmosphere and the metal.	As worked at room temperatures, no reactions between the surrounding atmosphere and the metal.
08	Less precise tolerances on end product.	Increased dimensional control on end product.
09	Possible warping of the material during the cooling process.	As there is no cooling of product, no warping of the material .
10	Cost of end product is high.	Cost of end product is less.
11	Products: Connecting rods, gears , fan hubs, fuel injection pump parts.	Products: Nut & bolt, fasteners, sleeves, coining etc.

References

1. **Chaudhari, Hajra “ Elements of Workshop Technology”, Fourteenth Edition, Volume I, Media Promoters and Publishers, Mumbai.**
2. **P.C. Sharma, “Production Engineering”, First Edition, S. Chand and Company Limited, Ramnagar, New Delhi.**

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