Subject: Metal Forming Technology
Code: ME 134/2nd Semester
Class: first Year

Theoretical: 2 hrs./wk.
Units: 2

Unit One: Cold and Hot working

Unit Two: Principles Rolling Processes

Unit Three: Extrusion

Unit Four: Drawing Processes

Unit Five: Welding Technology

Unit Six: Casting Sandy

Unit Seven: Powder Metallurgy

Unit 1: Cold and Hot Working

1. METAL FORMING

Metal forming is also known as mechanical working of metals. Metal forming operations are frequently desirable either to produce a new shape or to improve the properties of the metal. The main objectives of metal working processes are to provide the desired shape and size, under the action of externally applied forces in metals.

Shaping in the solid state may be divided into

1. non-cutting shaping such as forging, rolling, pressing, etc.,
2. cutting shaping such as the machining operations performed on various machine tools.

Metals are commonly worked by plastic deformation because of the beneficial effect that is imparted to the mechanical properties by it. The necessary deformation in a metal can be achieved by application of mechanical force only or by heating the metal and then applying a small force. This plastic deformation of a metal takes place when the stress caused in the metal, due to the applied forces reaches the yield point.

2. RECRYSTALISATION

During the process of plastic deformation in metal forming, the plastic flow of the metal takes place, and the shapes of the grains are changed. If the plastic deformation is carried out at higher temperatures, new grains start growing at the location of internal stresses caused in the metal. If the temperature is sufficiently high, the growth of new grains is accelerated and continuous till the metal comprises fully of only the new grains. This process of formation of new grains is known as recrystallisation. *The temperature at which recrystalisation is completed is known*

as the recrystallisation temperature of the metal. It is this point, which draws the line of difference between cold working and hot working processes. *Mechanical working of a metal below its recrystalisation temperature is called as cold working and that accomplished above this temperature but below the melting or burning point is known as hot working*.

3. Cold Working

Cold working of a metal is carried out below its recrystallisation temperature. Although normal room temperatures are ordinarily used for cold working of various types of steel, temperatures up to the recrystallisation range are sometimes used. In cold working, recovery processes are not effective.

Cold working process increases:

- Ultimate tensile strength
- Yield strength
- Hardness
- Fatigue strength
- Residual stresses

Cold working processes decreases:

- Percentage elongation
- Reduction of area
- Impact strength
- Resistance to corrosion
- Ductility

3.1.Purpose of Cold Working

The common purpose of cold working is given as under

1. Cold working is employed to obtain better surface finish on parts.
2. It is commonly applied to obtain increased mechanical properties.
3. It is widely applied as a forming process of making steel products using pressing and spinning.
4. It is used to obtain thinner material.

3.2. Advantages of Cold Working

1. In cold working processes, smooth surface finish can be easily produced.
2. Accurate dimensions of parts can be maintained.
3. Strength and hardness of the metal are increased but ductility decreased.
4. Since the working is done in cold state, no oxide would form on the surface.
5. It is far easier to handle cold parts and it is also economical for smaller sizes.

3.3.Disadvantages of Cold Working

1. Some materials, which are brittle, cannot be cold worked easily.
2. Since the material has higher yield strength at lower temperatures, the amount of deformation that can be given to is limited.
3. Since the material gets strain hardened, the maximum amount of deformation that can be given is limited.
4. Internal stresses are set up which remain in the metal unless they are removed by proper heat-treatment.

4. Hot Working

Mechanical working processes which are done above recrystallisation temperature of the metal are known as hot working processes. Some metals, such as lead and tin, have a low recrystallisation temperature and can be hot worked even at room temperature, but most commercial metals require some heating.

In hot working, the temperature of completion of metal working is important since any extra heat left after working aid in grain growth. This increase in size of the grains occurs by a process of coalescence of adjoining grains and is a function of time and temperature. *Grain growth results in poor mechanical properties*. *If the hot working is completed just above the recrystallisation temperature, then the resultant grain size would be fine*.

4.1. Advantages of Hot Working

1. At a high temperature, the material would have higher amount of ductility and therefore there is no limit on the amount of hot working that can be done on a material. Even brittle materials can be hot worked.
2. In hot working process, the grain structure of the metal is refined, and thus mechanical properties improved.
3. Porosity of the metal is considerably minimized.
4. If process is properly carried out, hot work does not affect tensile strength, hardness, corrosion resistance, etc.
5. Larger deformation can be accomplished more rapidly as the metal is in plastic state.
6. No residual stresses are introduced in the metal due to hot working.
7. Mechanical properties, especially elongation, reduction of area is improved.

4.2.3.2. Disadvantages of Hot Working

1. Due to high temperature in hot working, rapid oxidation or scale formation take place on the metal surface leading to poor surface finish and loss of metal.
2. The weakening of the surface layer may give rise to a fatigue crack which may ultimately result in fatigue failure of the component.
3. Some metals cannot be hot worked because of their brittleness at high temperatures.
4. Because of the thermal expansion of metals, the dimensional accuracy in hot working is difficult to achieve.
5. Handling and maintaining of hot working setups are difficult and troublesome.

5. CLASSIFICATION OF HOT WORKING PROCESSES

The classification of hot working processes is given as under.

1. Hot rolling
2. Hot extrusion
3. Hot drawing

Comparison of Hot Working with Cold Working		
	Hot Working	**Cold Working**
1	Hot working is carried out above the recrystallisation temperature and below the melting point. Hence the deformation of metal and recovery take place simultaneously.	Cold working is carried out below the recrystallisation temperature. As such, there is no appreciable recovery.
2	No internal or residual stresses are setup in the metal in hot working.	In this process internal or residual stresses are set-up in the metal.
3	It helps in irradiating irregularities in metal composition breaking up the nonmetallic impurities into tiny fragments and dispersing them through composition in the metal	It results in loss of uniformity of metal composition and thus affects the metal properties.
4	Close tolerance cannot be maintained	Close tolerance is accepted
5	Surface finish of this process is comparatively not good.	Surface finish of this process is better.
6	Due to higher deformation temperatures, the stress required for deformation is much less.	The stress required to cause deformation is much higher

YouTube: https://youtu.be/3J1lzJq1rPc