Indian Institute of Technology, Bombay / Department of Mechanical Engineering / ME 206

Time : 45 mins QUIZ - II Max. Marks : 34

Note: Answer briefly and precisely. You must provide one (or two) reason (in point form) to support your answer. Give a rough, schematic sketch wherever necessary. No credits will be given for answers w/o a reason.

1. Which of the following combination of properties of alloys is / are favorable for forming operations? 2

(i) high yield strength and high ductility (ii) low yield strength and high ductility

(iii) high ductility and high ultimate strength (iv) high ductility and low ultimate strength

Reasons –

- The materials with low yield strength and ductility have greater ability to undergo plastic deformation, and greater formability. Additionally, lower forming load is required for the forming operations of lower yield strength material.

2. The power required during rolling process is 2

(i) directly proportional to roll gap (ii) inversely proportional to roll gap

(iii) directly proportional to roll force (iv) directly proportional to roll speed

Reasons-

- The driving torque is required to overcome the torque exerted on the roll by the interfacial friction force. T = F x R, Power = T x ω, where ω is the angular speed of the roll.
- Power = $2\pi FLN/60000$, where F is the roll force

3. The roll force in rolling is 2

(i) directly proportional to roll gap (ii) inversely proportional to roll gap

(iii) directly proportional to width of work material (iv) inversely proportional to width of work material

Reason –

- The roll force in flat rolling can be estimated from the expression; $F = LwY_{avg}$, where L, w and Y_{avg} are roll-strip contact length, width of the strip, and average true stress, respectively.

4. Which of the following processes is most suitable for forging of bolt heads of hexagonal shape? 2

(i) closed die drop forging (ii) open die upset forging

(iii) open die press forging (iv) impression die forging

Reason –

- Upset forging or heading process is usually used for the production of bolt heads in which the end of a round rod or wire is forged to increase the cross-section. Typical products made by upset forging are nails, bolt heads, screws, rivets, and various other fasteners. This process can be cold, warm, or hot.

5. Rolling of very thin strips of mild steel requires 2

(i) large diameter rolls (ii) small diameter rolls

(iii) rolling at a very high speed (iv) rolling without a lubricant

Reason –

- The draft during flat rolling is given by $\Delta h = h_o - h_f = \mu^2 R$. For very thin strip, the draft should be minimum to avoid any defects. From the above expression, The roll radius should small.

6. The power required during rolling process is 2

(i) directly proportional to roll gap (ii) inversely proportional to roll gap

(iii) directly proportional to roll force (iv) directly proportional to roll speed

Reasons-

- The driving torque is required to overcome the torque exerted on the roll by the interfacial friction force. T = F x R, Power = T x ω, where ω is the angular speed of the roll.
- Power = $2\pi FLN/60000$, where F is the roll force

7. What are the two key differences between rotary swaging and seamless tubing processes? 2

- Rotary swaging is a forging process whereas seamless tubing is an extrusion or rolling process.
- Radial impact forces and radial compressive force are acting in the rotary swaging and seamless tubing process, respectively.

8. During solidification of a metal casting, the compensation for contraction is 2

(i) obtained by designing oversized pattern (ii) obtained by designing undersized pattern
(iii) obtained by promoting directional solidification (iv) ensured by providing sand with high permeability

Reasons-

- All cast metals shrink or contract volumetrically on cooling. In the solidification of metal during casting, compensation for solid contraction (shrinkage allowance) is provided by the oversize pattern

9. Cold shut is a casting defect that occurs due to 2

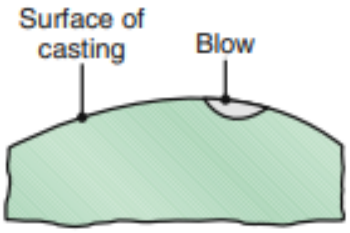
(i) shearing of sand particles from the mold wall (ii) entrapment of atmospheric gases in liquid metal
(iii) discontinuity during shrinkage of solidifying metal (iv) premature cooling of molten metal streams in gating system

Reasons-

- Cold shut is an interface in a casting that lacks complete fusion because of the meeting of two streams of liquid metal from different gates.

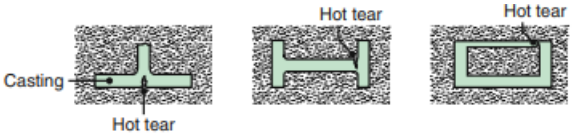
10. **Blow hole** and **hot tear** are two common defects in sand casting. WIth one schematic picture for each, provide two reasons that lead to each of these two defects. 4

Blow hole



- Blow hole is a large smooth cavity below the top surface of casting caused by air or gases from combustion of core binders entrapped by solidifying metal.
- As gases are more soluble in liquid metals than solid metals, the dissolved gases are expelled from the solution, when a metal begins to solidify and form a blow hole.

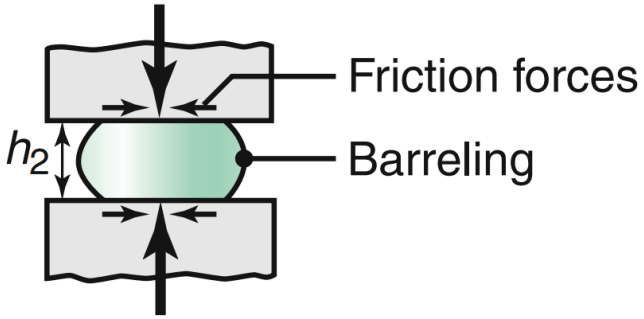
Hot tear



- If casting cannot shrink freely during cooling due to constraints in various portions of the molds and cores
- Coarse grain size and the presence of low-melting-point segregates along the grain boundaries (intergranular) increase the tendency for hot tear.

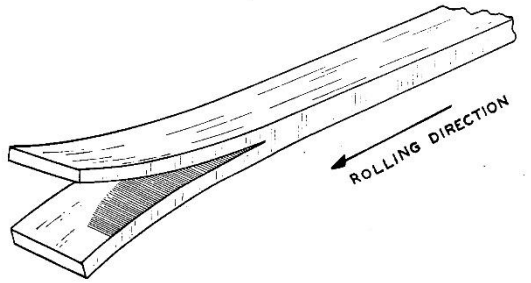
11. **Barreling** is a common problem in forging of metallic materials. With one schematic picture, explain with TWO to THREE bullet points what is barreling, why does it occur, and how it can be avoided. 4

- Barreling refers to the undesired barrel like shape formation when specimen of uniform thickness (cylinder, discs) are open die forged.
- Cause: the metal flows outward in lateral direction during forging. The friction between the dies and the specimen will oppose the flow in the surface but not at the center of specimen which results in barrel like formation as shown in figure.
- It can be avoided by reducing the friction between the dies and the specimen by lubrication.



12. **Alligatoring** is a common problem in rolling of metallic strips. With one schematic picture, explain with TWO to THREE bullet points what is barreling, why does it occur, and how it can be avoided. 4

- Alligatoring is the splitting of metallic strip into two across a horizontal plane parallel to the rolling plane, as shown in the figure.
- Cause: alligatoring is caused by the non uniform bulk deformation of the metallic strip due to the presence of defects or due to the composition of the specimen.
- It can be avoided by choosing metal with less defects and desired composition of elements.



13. What do you think are the TWO most important contrasting properties between a hot rolled mild steel strip and a cold rolled mild steel strip and why? 4

- In hot rolling, the strips are rolled at a temperature above recrystallization temperature and hence have finer grains and isotropic properties whereas in cold rolled steels, the microstructure is elongated along the rolling plane and hence is anisotropic.
- During hot rolling, no strain hardening occurs. But during cold rolling, strain hardening happens and the mechanical properties are enhanced.