

B.Tech 6th Sem, MID Term Examination 2022

Name of subject: Manufacturing Process II

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Name: Pravash Pankayastha

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2. Cold and hot metal working Process

- Hot working :- Hot working is defined as the process which is done above the recrystallization temperature but below the melting temp. of the metal. The recrystallization temperature for lead in metal is always the normal temperature. Hence working of the metals at room temperature is always considered as hot working. Hot rolling, hot forging and hot spinning are hot working process.

- Cold working :- Cold working is defined as the process which is done below the recrystallization temperature. Generally recrystallization temperature of metal varies between 30% to 50% of melting temperature.

• Advantages & disadvantages of Hot working :-

Advantages : Homogeneity of material is improved.

- (ii) Porosity of material is highly eliminated
- (iii) Physical properties of material are improved.

Disadvantages :

- (i) Large parts are difficult to be worked
- (ii) Residual stresses can be harmful
- (iii) High energy required for plastic deformation

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Difference between hot working and cold working :-

Hot working

Cold working

- | | |
|--|---|
| (i) Working temp. is above the recrystallization temperature | (i) Working temperature below the recrystallization temperature |
| (ii) Poor surface finish due to the oxidation | (ii) Better surface finish is obtained |
| (iii) Liquid equipment is used in hot working | (iii) Potentrol and heavy are used for deformation |
| (iv) Force required for deformation is less | (iv) Force is required for deformation is high. |
| (v) Refinement of grains takes place | (v) grains are enlarged |

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Steps for performing Operation in forging are as follows:

- (i) Fullering : In Fullering decreasing cross section and increasing length takes place
- (ii) Edging :- In edging Increase in cross section and decrease in length occurs
- (iii) Rolling :- In rolling straightening of the die takes place
- (iv) Blocking : It ensures complete filling of die cavity
- (v) Bending :- It is done to give a turn a shape to metal rod or plate
- (vi) Trimming :- It is used as a finishing operation for forged parts for removing flash

• Von Mises' maximum distortion energy criterion:-

According to this theory yielding would occur when total distortion energy absorbed per unit volume due to applied loads exceeds the distortion energy absorbed per-unit volume at the tensile yield point. Total strain energy E_s and strain energy for volume change E_v can be given as.

$$E_y = \frac{1}{2} (\sigma_1 \epsilon_1 + \sigma_2 \epsilon_2 + \sigma_3 \epsilon_3) \text{ and}$$

$$E_v = \frac{3}{2} \sigma_m \epsilon_v$$

Substituting strains in terms of stresses the distortion energy can be given as.

$$E_d = E_y - E_v = \frac{2(1+\nu)}{6E} (\sigma_1^2 + \sigma_2^2 + \sigma_3^2 - \sigma_1 \sigma_2 - \sigma_2 \sigma_3 - \sigma_3 \sigma_1)$$

at the tensile yield point $\sigma_1 = \sigma_y$, $\sigma_2 = \sigma_3 = 0$

which gives,

$$E_{dy} = \frac{2(1+\nu)}{6E} \sigma_y^2$$

The failure criterion is thus obtained by equating E_d and E_{dy} , which gives

$$(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2 = 2\sigma_y^2$$

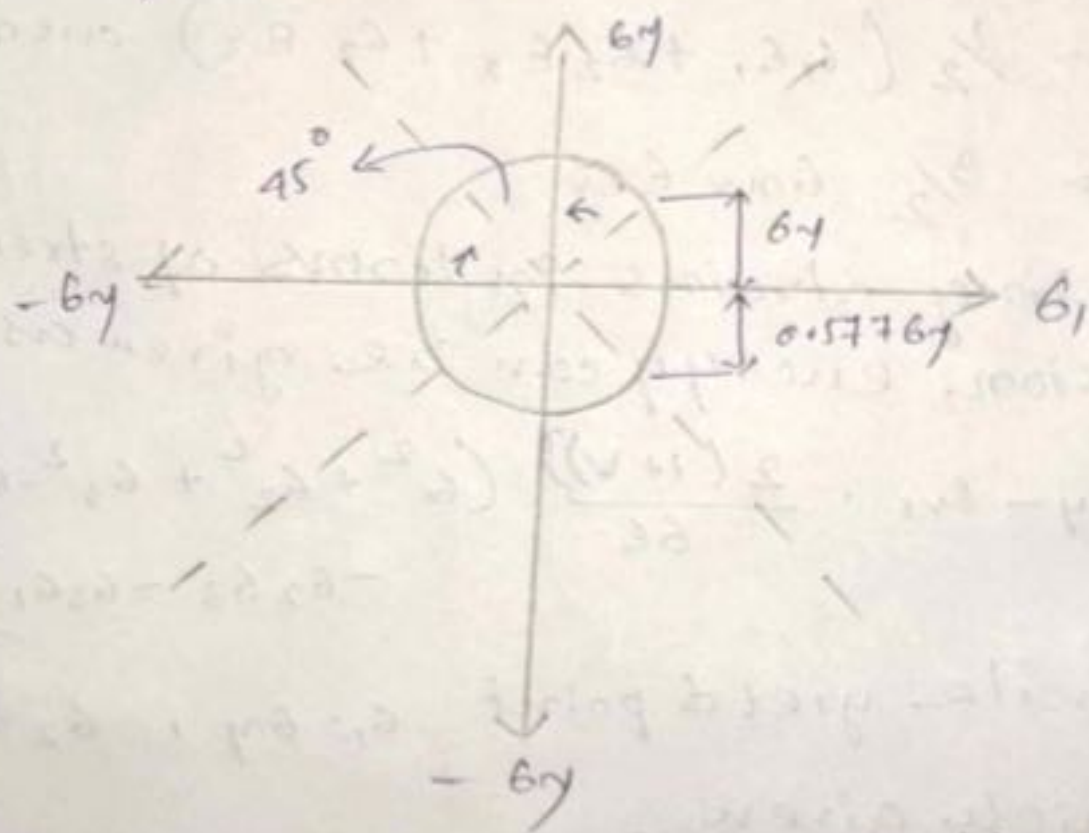
In a 2-D situation if $\sigma_3 = 0$ the criterion reduces to -

$$\sigma_1^2 + \sigma_2^2 - \sigma_1 \sigma_2 = \sigma_y^2$$

$$\text{i.e. } \left(\frac{\sigma_1}{\sigma_y}\right)^2 + \left(\frac{\sigma_2}{\sigma_y}\right)^2 - \left(\frac{\sigma_1}{\sigma_y}\right)\left(\frac{\sigma_2}{\sigma_y}\right) = 1$$

this is an equation of ellipse and the yield surface is shown in the following figure.

this theory agrees very well with experimental results and is widely used for ductile materials



yield surface corresponding to von mises yield criterion

5) Given,

24 x 24 x 150 (Initial dimension)

8 x 72 x 150 (Final dimension)

$$\sigma_s = 7 \text{ N/mm}^2, \mu = 0.15, 2L = 72 \Rightarrow l = 36 \text{ mm}$$
$$h = 8 \text{ mm}$$

→

$$K = \frac{84}{\sqrt{3}} \times \frac{7}{\sqrt{3}} = 4.041$$

$$\alpha_s = \frac{h}{2\mu} \ln\left(\frac{1}{2\mu}\right) = \frac{8}{2 \times 0.15} \ln\left(\frac{1}{2 \times 0.15}\right) = 32.105$$

$$\therefore P_s = 2K e^{\left(\frac{2\mu}{h}\right)\alpha} = 2 \times 4.041 e^{\frac{2 \times 0.15}{8} \alpha} = 8.082 e^{0.0375 \alpha}$$
$$= 8.082 e^{0.0375 \alpha}$$

$$= 2K \left[\frac{1}{2\mu} \left\{ 1 - \ln\left(\frac{1}{2\mu}\right) \right\} + \frac{\alpha}{h} \right]$$

$$= 2 \times 4.041 \left[\frac{1}{2 \times 0.15} \left(1 - \ln\left(\frac{1}{2 \times 0.15}\right) \right) + \frac{\alpha}{8} \right]$$

$$= -5.495 + 1.01025 \alpha$$

$$\therefore F = 2 \left[\int_0^{32.105} 8.082 e^{0.0375 \alpha} d\alpha + \int_{32.105}^{36} (1.01025 \alpha - 5.495) d\alpha \right]$$

$$= 431.04 \left[e^{0.0375 \alpha} \right]_{32.105}^{36} + 1.01025 \left[\alpha^2 \right]_{32.105}^{36} - 2 \times 5495 \left[\alpha \right]_{32.105}^{36}$$

$$\therefore F = 1230.891 \text{ N} \quad [\text{Force per unit length}]$$

So, total force would be $F_{\text{Total}} = F \times 150$

$$= 1230.891 \times 150$$

$$= 184633.681 \text{ N}$$

$$= 0.184 \times 10^3 \text{ KN}$$