

Department of Mining and Materials Engineering
Faculty of Engineering, Prince of Songkla University

Final Examination 2nd Semester

Academic Year 2006

Subject: 237 – 302 Materials forming

Time: 13.30pm-16.30pm

Date: 1st March 2007

Room: A401

- Instructions:**
1. Lecture handouts and notes are **not** allowed.
 2. Students are allowed to bring in calculator and dictionary.
 3. Answer all questions in the answering sheets provided.

"ทฤษฎีในการสอบ โทษขั้นต่ำ คือ พักการเรียน 1 ภาคการศึกษาและ ปรับตกใน
รายวิชาที่ทฤษฎี"

Question 1 (20 marks)

- a) It is proposed to reduce a copper rod of 9mm diameter to a diameter of 7mm in one drawing operation. (10 marks)

Using the data below, calculate the stress required to perform the operation.

Data: the coefficient of friction, μ , between the copper and the die is 0.1

True stress/true strain data for the 9mm diameter copper wire is given in table 1 below:-

| True strain | True stress (MPa) |
|-------------|-------------------|
| 0 | 40 |
| 0.1 | 50 |
| 0.2 | 60 |
| 0.3 | 70 |
| 0.4 | 80 |
| 0.5 | 90 |
| 0.6 | 100 |
| 0.7 | 110 |
| 0.8 | 120 |

- b) The capacity of the draw bench that you have available is 4 kN. Using your answer to part (a) comment on whether this one-step reduction process is feasible. Explain your reasoning with relevant calculations. (6 marks)
- c) Discuss possible defects that might occur if an approach angle significantly less or greater than the optimum is used to perform a wire drawing operation. (4 marks)

Data:

The stress required for wire drawing, σ_D , is given by the following equation

$$\sigma_D = \bar{\sigma} \cdot \ln \frac{A_0}{A_1} + \frac{\mu}{\tan \alpha} \cdot \bar{\sigma} \cdot \ln \frac{A_0}{A_1} + \frac{2}{3} \cdot \bar{\sigma} \cdot \alpha$$

Where

| | | |
|----------------|---|--|
| A_0 | = | initial wire cross section |
| A_1 | = | final wire cross section |
| μ | = | coefficient of friction |
| α | = | approach angle in radian |
| $\bar{\sigma}$ | = | average yield strength of the material being drawn |

The optimum approach angle (α_{opt}) in a wire drawing operation is

$$\sin \alpha_{opt} = \sqrt{\frac{3 \cdot \mu}{2} \cdot \ln \frac{A_0}{A_1}}$$

Question 2 (20 marks)

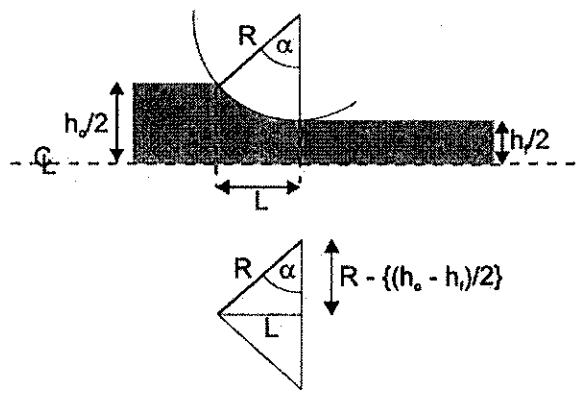
- (a) Show that the rolling torque (T) under plain strain conditions can be given by:-

$$T = \chi \cdot \lambda \cdot w \cdot R \cdot (h_0 - h_f) \cdot \sigma_0$$

Where

| | | |
|-----------|---|--|
| χ | = | factor allowing for friction (~1.2 for cold rolling) |
| λ | = | lever arm (~0.45 for cold rolling) |
| w | = | width of sheet |
| R | = | roll radius |
| h_0 | = | initial sheet thickness |

h_f = final sheet thickness
 σ_o = mean flow stress of material



(b) Aluminum sheet (1m wide) is cold rolled in a 2 high mill from an original thickness of 5mm down to 3.5mm in a single pass. If the roll diameter is 0.5m, and the mean flow stress of the aluminum is 100 MPa. Using the following information:-

- (i) Calculate the roll gap required, in order to achieve a final sheet thickness of 3.5mm
- (ii) Calculate the rolling torque

Mill stiffness = 5MN/mm

$$\text{Mill stiffness } (E_{\text{mill}}) = \frac{F}{h_f - h_{\text{mill}}}$$

where h_f = final thickness
 h_{mill} = roll gap

The rolling force (F) under plain strain conditions can be given by:-

$$F = \chi \cdot w \cdot \sqrt{R(h_o - h_f)} \cdot \sigma_o$$

χ = factor allowing for friction (~1.2 for cold rolling)
 w = width of sheet
 R = roll radius
 h_o = initial sheet thickness
 h_f = final sheet thickness
 σ_o = mean flow stress of material

(c) **Describe** a typical rolling schedule that would be employed to roll as cast ingot of 400mm thick to thin sheet (~0.25mm). **Briefly discuss mill configuration** and **show how the advantages of both hot and cold rolling** are exploited.

Question 3 (20 marks)

- a) Bending is one of the sheet metal forming operation. If a piece of sheet metal is to be bent using a wiping die. Springback normally occurs in the bending operation. What is springback and briefly discuss why it occurs? Also briefly suggest what can be done to compensate the springback. (4 marks)
- b) Compare and contrast including advantages and disadvantages of the stretch forming over stamping processes. (4 marks)
- c) Explain the following terms: (12 marks)
- (i) Reverse redrawing
 - (ii) Earing
 - (iii) Clearance in sheet metal cutting
 - (iv) Hot Isostatic Pressing

Total of 60 marks

Good luck!!!