ME-230
HW#1
Instructor: Prof. Ramesh Singh

Assigned: Jan 28, 2026
Due: Feb 4, 2022

1. Find the expression of the average forging pressure and forging force for plane strain forging of blocks having initial height h to a final height of h/2. There are two cases shown in the Fig.1. Assume all sliding conditions and coefficient of friction as μ. Also check the results with approximate average pressure formula for pure sliding. Which one is higher? Please provide a physical explanation.

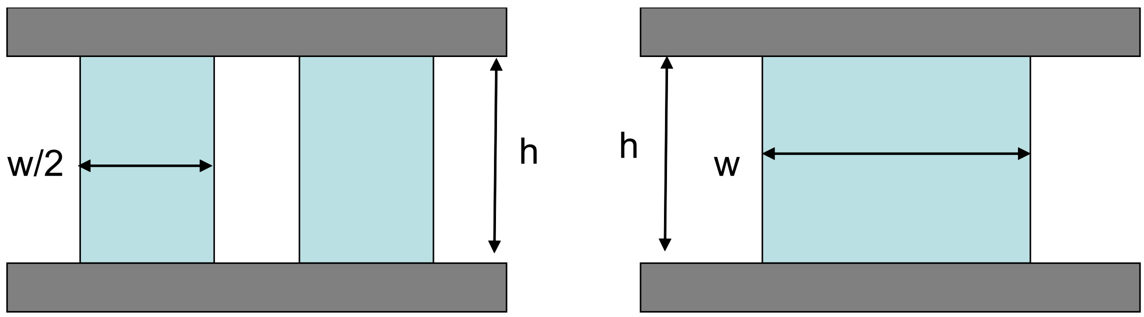

Fig. 1. Dimensions of the blocks for forging

2. Ball bearing balls are formed cold from wire stock in a closed-die (see Fig. 2). Consider a ball of 0.2 in. in diameter made from wire having an initial diameter of 0.15 in. The variation in length of the wire slug sheared from the rod is ± 3%. This gives rise to the variation in flash. The slug length is adjusted so that at its maximum length, the cavity is just filled and maximum flash thickness is 0.005 in.
   a. Find the maximum flash length
   b. If the average flow stress, τ_{flow} = 60,000 psi and a coefficient of friction is 0.1, estimate the maximum forging force.

   State all your assumptions in solving the problem.

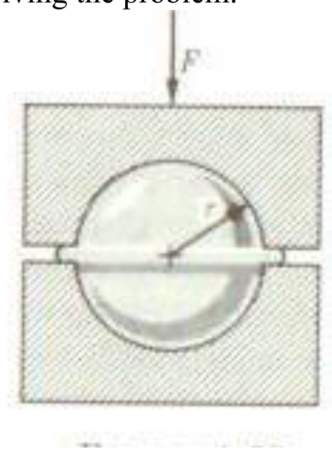

Fig. 2. Ball forging

3. You are cold upset forging a cylinder of steel that has K = 250 MPa and n = 0.13. The initial cylinder is 25 mm in height and 600 mm in diameter. It is being reduced to half its height between flat dies.

a. Derive the expression for the sticking-sliding transition and write the pressure equations in both the zones. Plot the pressure profile on the cylinder.
b. Determine the maximum force required, if the coefficient of friction is 0.4.
c. Determine the extra force required over what would be needed if no friction were present.
d. Compute the average pressure and force required when it is all sticking.
e. If the process takes 3 seconds, and the efficiency is 40 percent, determine the power required for part (a).

4. Given that for hot forging the flow stress relationship is $Y_f = C\left(\dot{\varepsilon}\right)^m$. Use $\dot{\varepsilon}$ = V/h where V is the velocity and h is the final height. You are hot forging a piece of steel (C = 45 MPa, m = 0.1). Its initial size is 1 m (height) by 300 mm (width), by 2 m (long, i.e. into the paper). Its final height is 200 mm. The platens move at 10 m/min. The coefficient of friction is 0.15.
   a. Check for sliding or sticking condition and is there any transition.
   b. Determine the forging force and power.
   c. For a safety factor of 3, determine the yield strength of the die.

5. A sticking/sliding transition can occur in cylindrical forging.

   a. Show the pressure distribution plot in sliding and sticking region.
   b. Explain how you will get the forging loads with the pressure equations in the two regions.
   c. Assuming all sliding, plot the variation of radiation pressure at different coefficient of friction until $\mu = 0.5$.
   d. Can you have sliding friction beyond $\mu = 0.5$? Explain what happens after that and provide a plot of the radial pressure for conditions $\mu > 0.5$.

6. You are hot forging a piece of steel (C = 45 MPa, m = 0.1). Its initial size is 1 m (height) by 300 mm (width), by 2 m (long, i.e. into the board). Its final height is 200 mm. The platens move at 10 m/min. The coefficient of friction is 0.15.
   a. Determine the forging force and power.
   b. Find the peak pressure.
   c. For a safety factor of 3, determine the yield strength of the die.

7. You are cold forging a cylindrical piece of metal (upsetting) (K = 450 MPa, n = 0.12). Its initial size is 50 mm (height) by 25 mm (diameter). Its final height is 30 mm. The coefficient of friction is 0.12.
   a. Determine the press force needed using the full equations.