ME 338

Manufacturing Process 2

Autumn 2023 – 24 (Batch S2)

Assignment 1

1. In an orthogonal cutting test, the following condition were noted:

   Width of cut = 2.5 mm
   Undeformed chip thickness = 0.25 mm
   Chip thickness = 1.0 mm
   Chip Tool contact length l_f = 0.75 mm
   Working normal rake angle = 5°
   cutting force Fc = 900 N
   Thrust force Ft = 450 N

   Calculate
   a. The mean shear strength of the work material
   b. The mean frictional stress on the tool face

2. Show that in metal cutting when the working normal rake is zero, the ratio of eth shear strength of the work material, τ_s to the specific cutting energy p_s is given by

$$\frac{\tau_s}{p_s} = \frac{(1-\mu r_c) r_c}{1+ {r_c}^2}$$

   where μ is the co-efficient of chip- tool friction, and r_c is the chip thickness ratio

3. For the orthogonal cutting of a particular work material, it is found that the length of the chip tool contact is always equal to the chip thickness t and that the mean shear stress at the chip tool interface is equal to the mean shear stress on the shear plane. Show that, under the circumstances, the mean coefficient of friction on the tool face μ must be equal to or less than 4/3 and that when it is equal to unity, the shear angle, ϕ, is equal to the working normal rake γ.

4. Mild steel is being machined at a cutting speed of 200 m/min with a tool of rake angle 10°. The width of cut and the uncut thickness are 2 mm and 0.2 mm, respectively. If the average value of the coefficient of the friction between the tool and the chip is 0.5 and the shear stress τ_s of the work material is 400 N/mm^2, determine

   (i) the shear angle ,
   (ii) the cutting and the thrust components of the machining force.

5. The chips from an orthogonal cutting operation with an uncut thickness of 0.2 mm for various rake angles are:

γ	15°	10°	5°	0°
t_c	0.45	0.5	0.63	1.13

Calculate, for each chip, the corresponding shear angle and shear strain and plot them against γ.

6. The cutting and thrust components of the machining force during orthogonal machining of aluminum with a rake angle of 10° are found to be 312 N and 185 N, respectively,
   i. Estimate the coefficient of friction between the tool and the chip
   ii. If the rake angle is reduced to 0°, keeping all the other parameters the same, and if the coefficient of friction also remains unchanged, estimate the new values of F_c and F_t , using Merchant's first solution.

7. Calculate the mean shear plane temperature rise θ_s during orthogonal machining with zero rake. Given
   U_c = 1.5 J/mm^3, μ= 0.8, t = 0.2 mm, rc = 0.2, ρ= 7000 kg/m^3, c = 500 J/kg-$^{\circ}$C, V = 2 m/sec. Assume that 15% of the heat generated goes into the workpiece.

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