MACE 61058: Plasticity – Lab report: tensile

Lecturer: Dr. Henry Tan; Operator: Mr Peter Hassall

Deadline: Thursday 14/5/2009, 4pm
Submission: George Begg Coursework Box: Plasticity (Lab report – bulge test)

Objective: Use bi-axial tension test (bulge test) to construct the equivalent yield stress versus equivalent plastic strain curve of a metal.

Experiment:
When pressure is applied to one side of a clamped circular sheet of a ductile material such as a metal, the specimen bulges out as shown in Figure 1.

Figure 1. Specimen bulged out after sufficient pressure (by Alireza Rahmani).

During the bulge test the pressure p, crown-point sheet thickness t and radius of curvature ρ are measured. As shown in Figure 2, the thickness is measured using the extensometers, and curvature is measured using the spherometer.

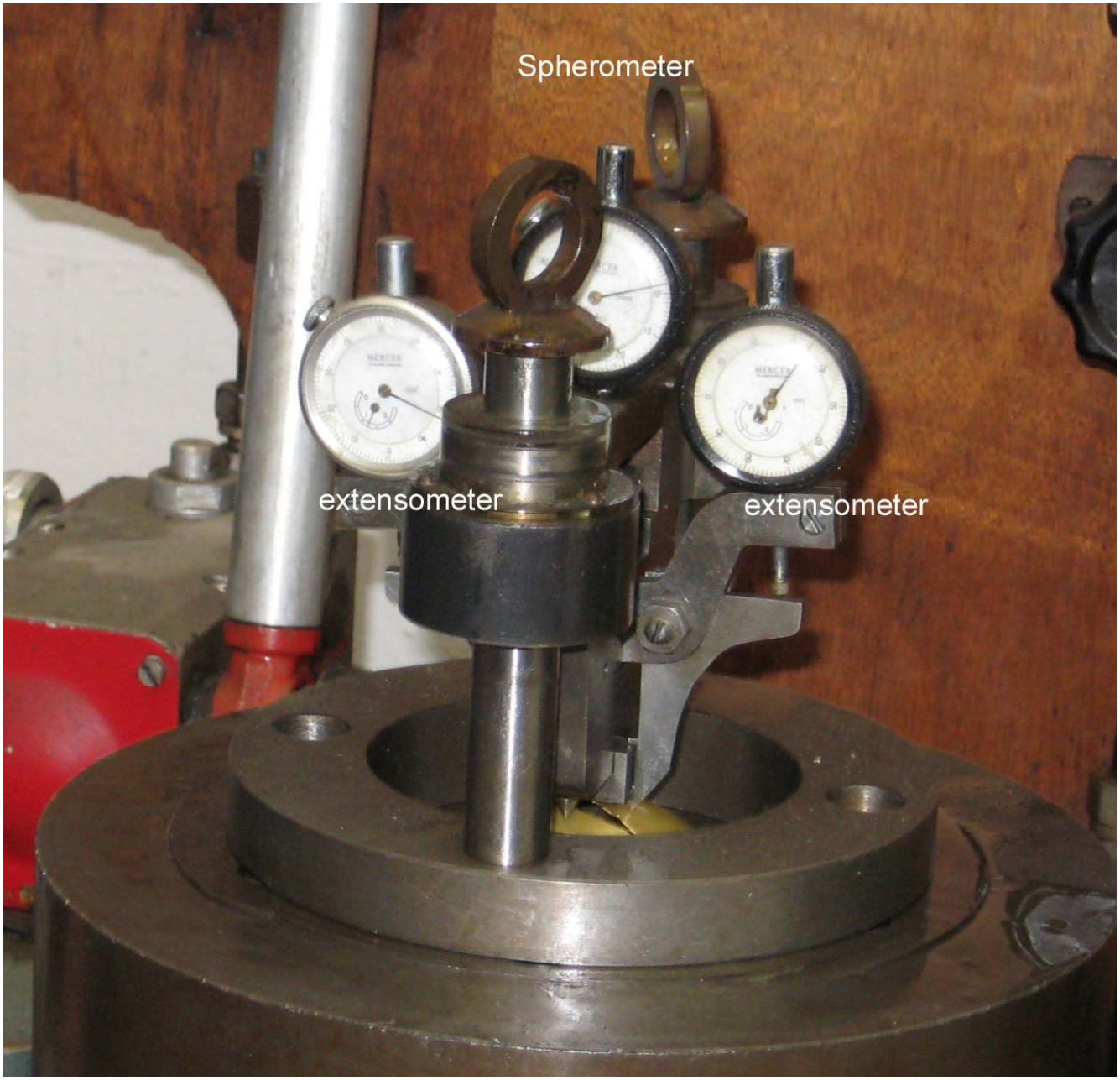

Figure 2. Material element of deforming sheet (by Alireza Rahmani).

Report requirement:

(1) From the calibration data in Table A1 of the lab handout, establish the relation between the lab spherometer reading d and the radius of curvature ρ at the crown point of the specimen.

[1 mark]

(2) From the calibration data in Table A2 of the lab handout, establish the relation between the lab extensometer readings ($\alpha_1 + \alpha_2$) and the sheet thickness ratio t_0 / t, where t is the instantaneous thickness and t_0 is the initial thickness.

[1 mark]

(3) Experimental data for a unknown metal:

Initial sheet thickness is $t_0 = 0.048\text{in}$.

Pressure (lbf/in^2)	Spherometer reading d (10^{-3}in)	Extensometer read α_1 (10^{-3}in)	Extensometer read α_2 (10^{-3}in)
100	15	2.5	4
200	20	5.7	7
250	25	8.0	11
300	30	11.0	17
330	35	15.0	22
375	40	20.0	31
400	45	27.0	41
425	50	38.0	50
430	55	51.0	69
440	60	65.0	87

Draw the curve of equivalent yield stress versus equivalent plastic strain curves for the material.

[2 mark]

(4) The density of the material is $\rho = 2700\text{kg/m}^3$, the heat capacity is $c = 0.888 \times 10^3 \, J/\text{kg} \cdot \text{K}$.

Assume that at the crown-point of the specimen, the plastic energy is completely transferred to heat. The heat causes the temperature rising ΔT which can be calculated from $\Delta T = \frac{W}{\rho c}$, where W is the plastic energy density.

Discuss the relation between the temperature rising and the pressurizing during the bulge test.

[4 mark]

Marking:
This report weights 8% of the overall final.