Alexandria University
Faculty of Engineering
Electrical Engineering Department - Communication
April 2016

جامعة الاسكندرية
كلية الهندسة
قسم الهندسة الكهربية- اتصالات
إبريل 2016

Mechanical Engineering (Design)
Second Year
Time Allowed: 45 Minutes

الهندسة الميكانيكية (تصميم)
السنة الثانية
الزمن: 30 دقيقة

***Answer the following two questions at the same paper*:**

QUESTION ONE (10 points):

A tension test was conducted on a 1.975-inch-wide by 0.375-inch-thick specimen of a Nylon Plastic. A 4-inch gage length was marked on the specimen before load application. In the elastic portion of stress-strain curve at an applied load of P = 6000 Ibf as shown in figure 1, the elongation in the gage length was measured as 0.023 inch. Determine the elastic modulus E.

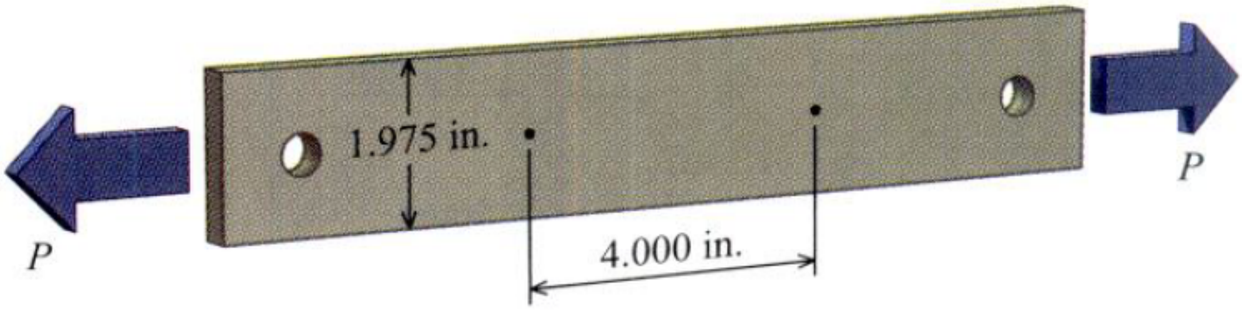

Figure 1.

Plan the Solution

(a) From the load and the initial measured dimensions of the bar, the normal stress can be computed. The normal strain in the longitudinal (i.e., axial) direction ε_{long} can be computed from the elongation in the gage length and the initial gage length. With these two quantities, the elastic modulus E can be calculated from Eq. (3.4). (b) From the contraction in the width and the initial bar width, the strain in the lateral (i.e., transverse) direction ε_{lat} can be computed. Poisson's ratio can then be computed from Eq. (3.6). (c) The shear modulus can be calculated from Eq. (3.7).

SOLUTION

(a) The normal stress in the plastic specimen is

$$\sigma = \frac{6{,}000 \text{ lb}}{(1.975 \text{ in.})(0.375 \text{ in.})} = 8{,}101.27 \text{ psi}$$

The longitudinal strain is

$$\varepsilon_{long} = \frac{(0.023 \text{ in.})}{(4.000 \text{ in.})} = 0.005750 \text{ in./in.}$$

Therefore, the elastic modulus E is

$$E = \frac{\sigma}{\varepsilon} = \frac{(8{,}101.27 \text{ psi})}{(0.005750 \text{ in./in.})} = 1{,}408{,}916 \text{ psi} = 1{,}409{,}000 \text{ psi}$$ **Ans.**

QUESTION TWO (10 points):

The cross-sectional dimensions of a beam are shown in figure 2. If the maximum allowable bending stress is 230 Mpa MPa in either tension or compression. Determine the magnitude of the maximum internal bending moment M that can be supported by the beam. The centroid z of the beam is shown and The moment of inertia about the centroidal axis z is I_z = 126,248.4 mm4.

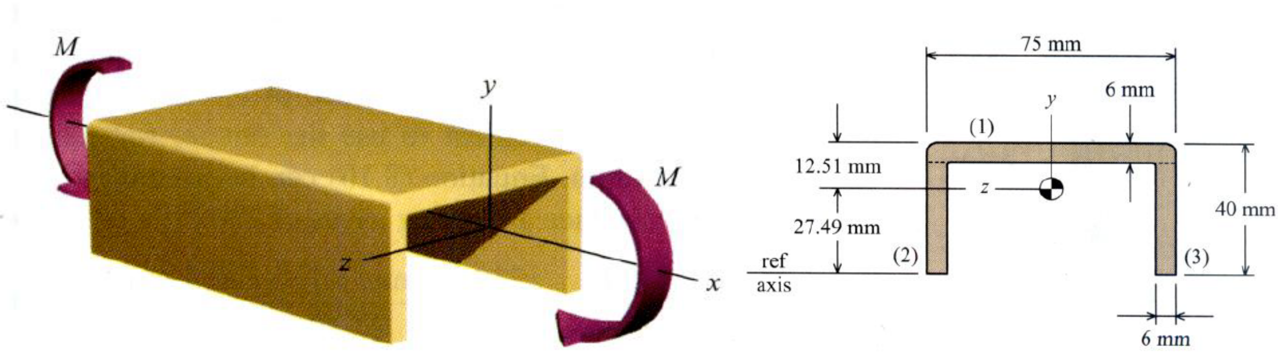

Figure 2.

The largest bending stress in any beam will occur at either the top or the bottom surface of the beam. For this cross section, the distance to the bottom of the beam is greater than the distance to the top of the beam. Therefore, the largest bending stress will occur on the bottom surface of the cross section at $y = -27.49$ mm. In this situation, it is convenient to use the flexure formula in the form of Eq. (8.10), setting $c = 27.49$ mm. Equation (8.10) can be rearranged to solve for the bending moment M that will produce a bending stress of 230 MPa on the bottom surface of the beam:

$$M \le \frac{\sigma_x I_z}{c} = \frac{(230 \text{ N/mm}^2)(126{,}248.4 \text{ mm}^4)}{27.49 \text{ mm}} = 1{,}056{,}280 \text{ N-mm} = 1{,}056 \text{ N-m}$$

Ans.

For the bending moment direction indicated in the sketch on the previous page, a bending moment of $M = 1{,}056$ N-m will produce a compression stress of 230 MPa on the bottom surface of the beam.