22.314J – Spring 2004

Problem Set I

Due 2/12/04

Problem I.1

A tensile test conducted on an aluminum cable of an initial diameter of 0.505 inch resulted in the data shown in Table 1.

1. Determine the yield stress of this material in *psi* and MPa units.

2. Suppose that a force of 5000lbs was applied to a 0.65 inch diameter cable of the same material with an initial length of 30 inches. What is the final length of the cable?

3. Calculate the minimum diameter of a cable required to support fuel assemblies as they are transferred to the fuel storage pool. Assume each assembly weighs 600 kg.

TABLE 1

The Load-Gage Length Data obtained from a Tensile Test of a 0.505 in. Diameter Aluminum Alloy Test Bar

Load (lb)	Gage Length (in)
0	2.000
1000	2.001
3000	2.003
5000	2.005
7000	2.007
7500	2.030
7900	2.080
8000	2.120
8000 (max)	2.160
7600 (fracture)	2.205

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Problem I.2

Geometry

Consider the structure illustrated in Figure 1.

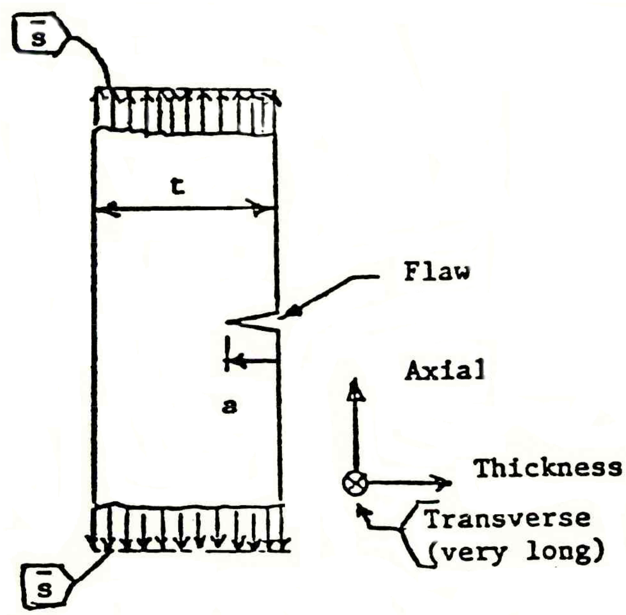

Figure 1.

It is subjected to a uniform axial stress $\bar{s}$ at positions far from the flaw. The flaw is sharp and of uniform depth a. The thickness, t, is 216 mm and the initial flaw depth, a_0, is 54 mm.

Material

A steel is used for construction which has the following properties:

- at the nil-ductility transition temperature, NDT, the fracture toughness, is $K_{IC} = 55 MPa\sqrt{m} = 55 MN/(m)^{3/2}$

- at operating temperatures, the fatigue crack growth rate is defined by $\frac{da}{dN}(\frac{in}{cycle}) = 3.04\ x\ 10^{-9}(\Delta K)^{2.26}$

Questions

1. At what stress will brittle fracture occur at NDT? Denote this stress by $\overline{s}_1$

2. Consider that at the operating temperature the stress is varied from zero to $\overline{s}_1$ and back to zero and that this cycle repeated a number of times. How many cycles will be required for the flaw to grow to a depth of 108 mm?

Table 2 Stress Concentration Factor for various Crack Depths

(a/t)	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	
Y	1.14	1.19	1.29	1.37	1.50	1.66	1.87	2.12	2.44	2.82	