재료공학개론 과제4

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1 Problem 1

1.1 a

$$F = \frac{dE}{dr} \tag{1}$$

$$= \frac{A}{r^2} - \frac{nB}{r^{n+1}} \tag{2}$$

1.2 b

$$\frac{dF}{dr} = -\frac{2A}{r^3} + \frac{n(n+1)B}{r^{n+2}} \tag{3}$$

1.3 c

$$\frac{A}{r^2} - \frac{nB}{r^{n+1}} = 0 \tag{4}$$

따라서

$$r_0 = \left(\frac{nB}{A}\right)^{\frac{1}{n-1}} \tag{5}$$

1.4 d

$$\frac{dF}{dr} = -\frac{2A}{r_0^3} + \frac{n(n+1)B}{r_0^{n+2}} \tag{6}$$

$$= \frac{n(n-1)B}{r_0^{n+2}} \tag{7}$$

$$= n(n-1)B\left(\frac{A}{nB}\right)^{\frac{n+2}{n-1}} \tag{8}$$

2 Problem 2

2.1 a

$$\sigma = E\epsilon \tag{9}$$

$$= E\frac{\Delta l}{l} \tag{10}$$

따라서

$$\Delta l = \frac{Fl}{AE} \tag{11}$$

$$= \frac{48900 \times 4 \times 250 \times 10^{-3}}{\pi(15.2 \times 10^{-3})^2 \times 207 \times 10^9} m \tag{12}$$

$$= 3.25 \times 10^{-4} m \tag{13}$$

2.2 b

$$\gamma = -\frac{\Delta d/d}{\Delta l/l} \tag{14}$$

따라서

$$\Delta d = -\gamma \frac{d\Delta l}{l} \tag{15}$$

$$= -0.30 \frac{15.2 \times 10^{-3} \times 3.25 \times 10^{-4}}{250 \times 10^{-3}} m \tag{16}$$

$$= -5.93 \times 10^{-6} m \tag{17}$$

3 Problem 3

3.1 a

$$E = \frac{d\sigma}{d\epsilon} \tag{18}$$

$$= \frac{1000 \times 10^6}{0.005} Pa \tag{19}$$

$$= 200 GPa \tag{20}$$

3.2 b

Proportional limit은 $\sigma = E\epsilon$의 linearity가 만족하지 않는 stress이다. 따라서 $1400 MPa$

3.3 c

Fig.1에서 알 수 있듯 yield strength at a strain offset of 0.002는 약 $1600 MPa$이다.

3.4 d

Fig.2에서 알 수 있듯 tensile strength는 약 $1950 MPa$이다.

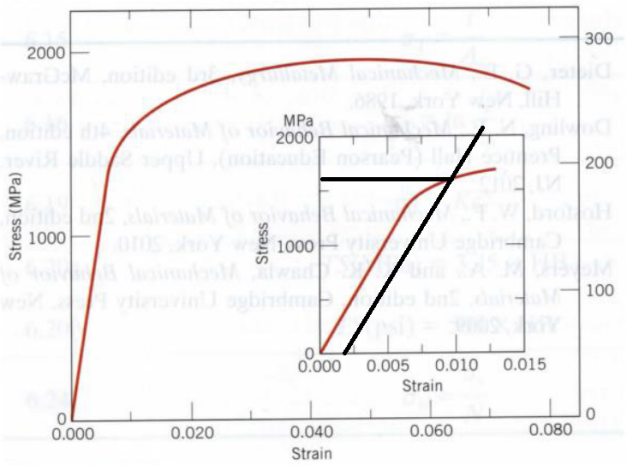

Figure 6.22 Tensile stress–strain behavior for an alloy steel.

Figure 1: yield strength 그래프

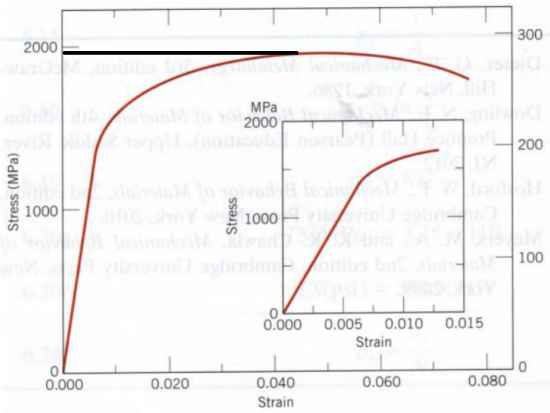

Figure 6.22 Tensile stress–strain behavior for an alloy steel.

Figure 2: tensile strength 그래프

4 Problem 4

4.1 a

Engineering stress와 true stress는 각각 아래와 같이 나타난다.

$$\sigma = \frac{F}{A_0} \tag{21}$$

$$\sigma_T = \frac{F}{A_i} \tag{22}$$

$$= \frac{F}{A_0}\frac{l_i}{l_0} \tag{23}$$

$$= \sigma(1+\epsilon) \tag{24}$$

Engineering strain과 true strain은 각각 아래의 관계를 만족한다.

$$\epsilon = \frac{l_i}{l_0} - 1 \tag{25}$$

$$\epsilon_T = \int_{l_0}^{l_i} \frac{dl}{l} \tag{26}$$

$$= \ln \frac{l_i}{l_0} \tag{27}$$

$$= \ln (1 + \epsilon) \tag{28}$$