530.215 MBD, Spring 2009
Solutions for HW#5

Problem 1

Choose 15 mm as basic size, D, d. Table 7-9: fit is designated as 15H7/h6. From Table A-11, the tolerance grades are $\Delta D = 0.018$ mm and $\Delta d = 0.011$ mm.

Hole: Eq. (7-36)

$$D_{\max} = D + \Delta D = 15 + 0.018 = 15.018 \text{ mm} \quad \textit{Ans.}$$
$$D_{\min} = D = 15.000 \text{ mm} \quad \textit{Ans.}$$

Shaft: From Table A-12, fundamental deviation $\delta_F = 0$. From Eq. (2-39)

$$d_{\max} = d + \delta_F = 15.000 + 0 = 15.000 \text{ mm} \quad \textit{Ans.}$$
$$d_{\min} = d + \delta_R - \Delta d = 15.000 + 0 - 0.011 = 14.989 \text{ mm} \quad \textit{Ans.}$$

Problem 2

Choose 45 mm as basic size. Table 7-9 designates fit as 45H7/s6. From Table A-11, the tolerance grades are $\Delta D = 0.025$ mm and $\Delta d = 0.016$ mm

Hole: Eq. (7-36)

$$D_{\max} = D + \Delta D = 45.000 + 0.025 = 45.025 \text{ mm} \quad \textit{Ans.}$$
$$D_{\min} = D = 45.000 \text{ mm} \quad \textit{Ans.}$$

Shaft: From Table A-12, fundamental deviation $\delta_F = +0.043$ mm. From Eq. (7-38)

$$d_{\min} = d + \delta_F = 45.000 + 0.043 = 45.043 \text{ mm} \quad \textit{Ans.}$$
$$d_{\max} = d + \delta_F + \Delta d = 45.000 + 0.043 + 0.016 = 45.059 \text{ mm} \quad \textit{Ans.}$$

Problem 3

Assumption: The deflection is elastic.

Analysis:

1. For linear deflection:

   From Table 5.1 (Case 5), $\delta = \frac{PL^3}{3EI}$

   From Appendix B-1, $I = \frac{\pi d^4}{64} = \frac{\pi 25^4}{64} = 19{,}175\ mm^4$

   From Appendix C-1, $E = 207\ GPa$

   So, $\delta = \frac{(1000)200^3}{3(207)(19175)} = 672\ \mu m = 0.672\ mm$

2. For angular deflection :

   From Table 5.2,

   $\theta = \frac{TL}{JG} = \frac{32TL}{\pi d^4 G}$ [in rad]

   $= \frac{32TL}{\pi d^4 G}(\frac{180}{\pi}) = \frac{584TL}{d^4 G}$ [in degrees]

   where $G = 79\ GPa$ (Appendix C-1)

   $\theta = \frac{584(100)(0.2)}{(0.025)^4(79\times10^9)} = 0.38$ deg.

Problem 4

Assumption: The beam remains in the elastic region.

Analysis:

1. Calculation of EI

For d = 30 mm, where $I = \frac{\pi d^4}{64}$ (Appendix B-1)

E = 207 GPa (Appendix C-1)

$$EI = (207 \times 10^9)[\frac{\pi(30 \times 10^{-3})^4}{64}] = 8230 \text{ N·m}^2$$

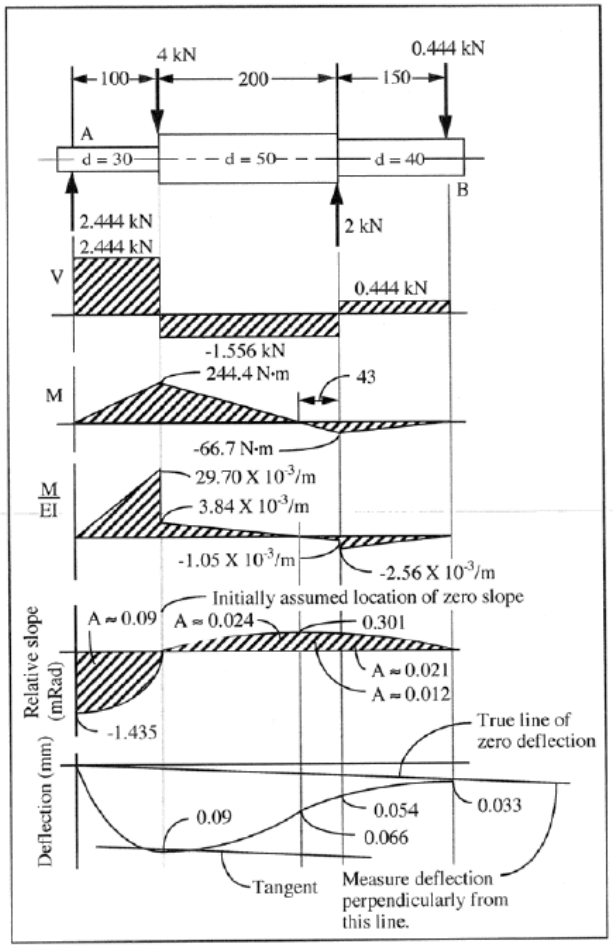
For d = 50 mm,

$$EI = (207 \times 10^9)[\frac{\pi(50 \times 10^{-3})^4}{64}] = 63{,}500 \text{ N·m}^2$$

For d = 40 mm,

$$EI = (207 \times 10^9)[\frac{\pi(40 \times 10^{-3})^4}{64}] = 26{,}010 \text{ N·m}^2$$

2.


4 kN
0.444 kN
100
200
150
A
B
d = 30
d = 50
d = 40
2.444 kN
2 kN
2.444 kN
V
0.444 kN
-1.556 kN
244.4 N·m
43
M
-66.7 N·m
M/EI
29.70 X 10-3/m
3.84 X 10-3/m
-1.05 X 10-3/m
-2.56 X 10-3/m
Initially assumed location of zero slope
A ≈ 0.09
A ≈ 0.024
0.301
A ≈ 0.021
A ≈ 0.012
Relative slope (mRad)
-1.435
True line of zero deflection
Deflection (mm)
0.09
0.054
0.066
0.033
Tangent
Measure deflection perpendicularly from this line.