

INSTRUCTOR'S SOLUTIONS

MANUAL TO ACCOMPANY

# STEEL DESIGN

6TH EDITION

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## CHAPTER 1 - INTRODUCTION

### 1.5-1

(a)  $P = 20 \cdot 67 = 1340 \text{ lb}$

$$f = \frac{P}{A} = \frac{1340}{19.7} = 68.02 \text{ psi} \qquad \underline{f = 68.0 \text{ psi}}$$

(b) Since  $E = \frac{f}{\epsilon}$ ,

$$\epsilon = \frac{f}{E} = \frac{68.02}{29,000,000} = 2.35 \cdot 10^{-6} \qquad \underline{\epsilon = 2.35 \cdot 10^{-6}}$$

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### 1.5-2

(a)  $L = 9 / \sin 45^\circ = 12.73 \text{ ft}$

$$\Delta L = \epsilon L = 8.9 \cdot 10^{-4} \cdot 12.73 \cdot 12 = 0.136 \text{ in.} \qquad \underline{\Delta L = 0.136 \text{ in.}}$$

(b)  $f = \epsilon E = 8.9 \cdot 10^{-4} \cdot 29,000 = 25.81 \text{ ksi}$

$$P = fA = 25.81 \cdot 1.31 = 33.8 \text{ kips} \qquad \underline{P = 33.8 \text{ kips}}$$

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### 1.5-3

(a)  $A = \frac{\pi d^2}{4} = \frac{\pi (0.5)^2}{4} = 0.1963 \text{ in.}^2$

$$f = \frac{P}{A} = \frac{5000}{0.1963} = 25,470 \text{ psi}$$

$$\epsilon = \frac{\Delta L}{L} = \frac{6.792 \cdot 10^{-3}}{8} = 8.49 \cdot 10^{-4}$$

$$E = \frac{f}{\epsilon} = \frac{25,470}{8.49 \cdot 10^{-4}} = 3.0 \cdot 10^7 \text{ psi} \qquad \underline{E = 30,000 \text{ ksi}}$$

(b)  $F_u = \frac{P_u}{A} = \frac{14,700}{0.1963} = 74,900 \text{ psi} \qquad \underline{F_u = 74.9 \text{ ksi}}$

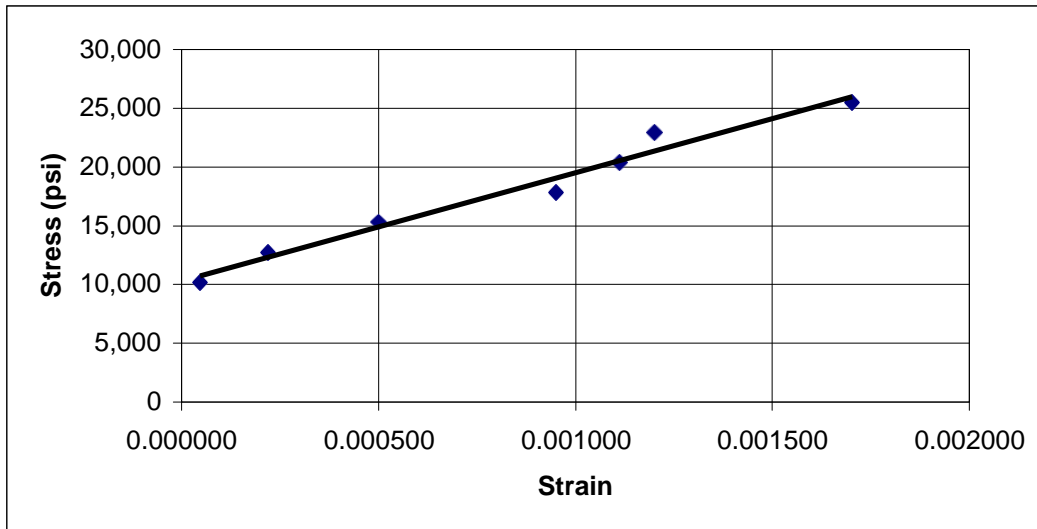
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### 1.5-4

Spreadsheet results:

(a) (b)

Load (lb)	Stress (psi)	microstrain
2,000	10,186	47
2,500	12,732	220
3,000	15,279	500
3,500	17,825	950
4,000	20,372	1,111
4,500	22,918	1,200
5,000	25,465	1,702



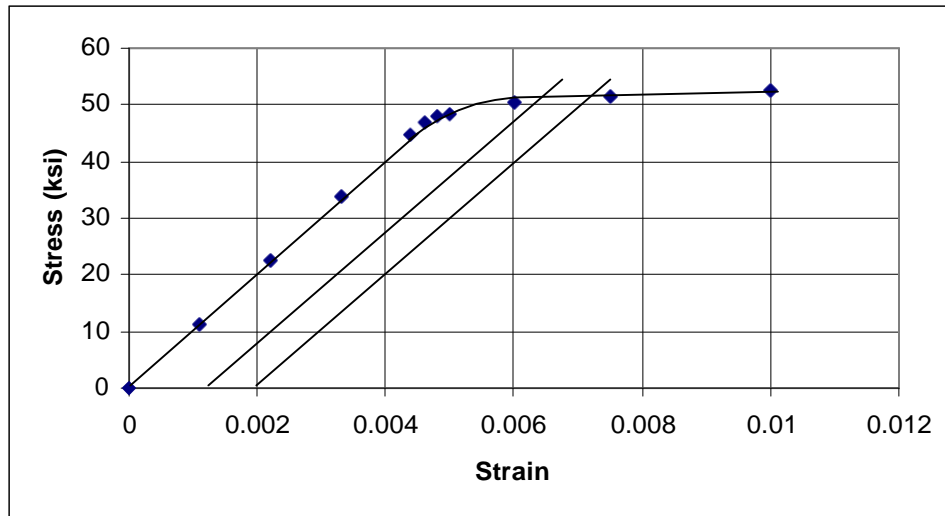
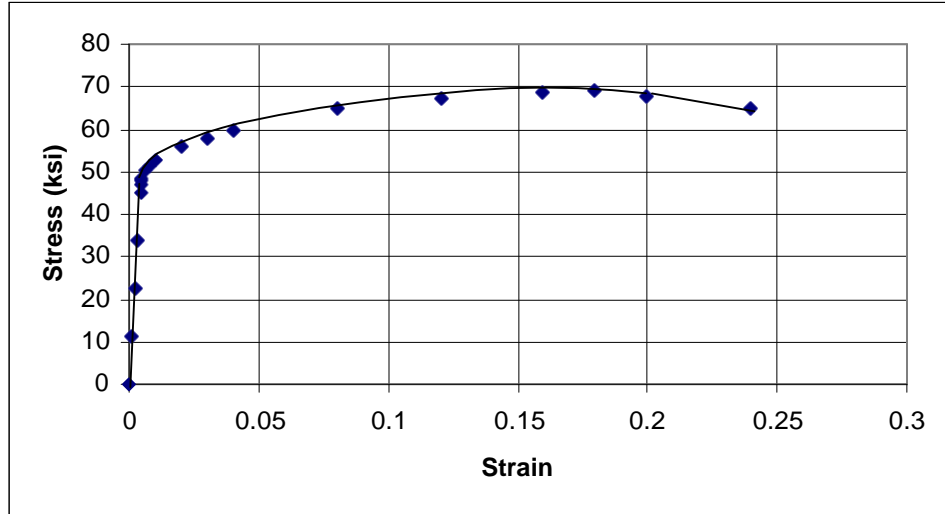
(c)

Slope = 9,210,000 psi = modulus of elasticity

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**1.5-5** (Note: These results are very approximate and depend on how the curves are drawn.)

(a)



(b)  $F_{prop} \approx 47$  ksi

(c)  $E \approx 40/0.004 = 10,000$  ksi

(d)  $F_y \approx 52$  ksi

(e)  $F_u \approx 70$  ksi

$$(f) \quad A = \frac{\pi d^2}{4} = \frac{\pi (0.5)^2}{4} = 0.1963 \text{ in.}^2$$

$$f = \frac{P}{A} = \frac{10}{0.1963} = 50.94 \text{ ksi}$$

$$\epsilon_r \approx 0.0015, \quad \delta_r = \epsilon_r L = 0.0015(8) = 0.012 \text{ in.} \quad \underline{\delta_r = 0.012 \text{ in.}}$$

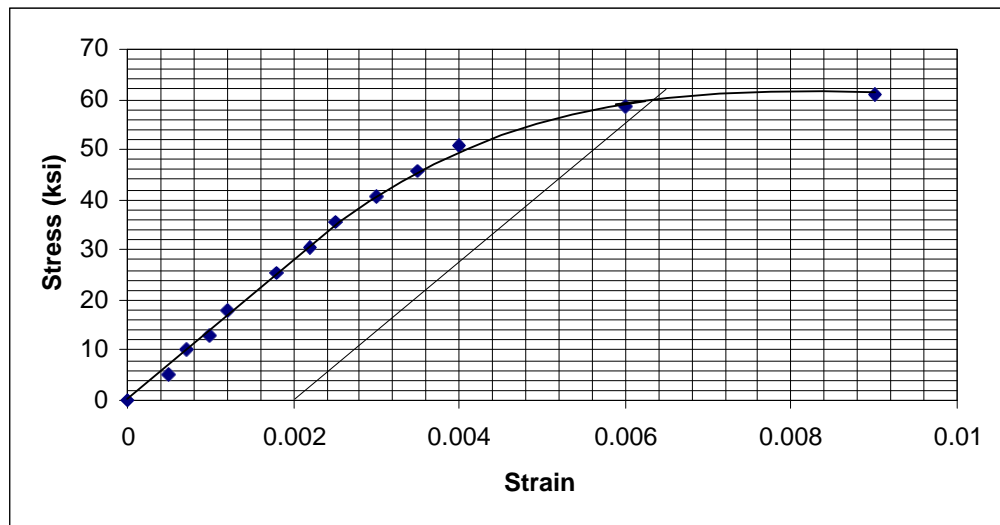
### 1.5-6

Spreadsheet results:

(a)

Load (kips)	Elongation (in.)	Stress (ksi)	Strain
0	0	0	0
1.0	0.0010	5.094	0.0005
2.0	0.0014	10.19	0.0007
2.5	0.0020	12.74	0.0010
3.5	0.0024	17.83	0.0012
5.0	0.0036	25.47	0.0018
6.0	0.0044	30.57	0.0022
7.0	0.0050	35.66	0.0025
8.0	0.0060	40.75	0.0030
9.0	0.0070	45.85	0.0035
10.0	0.0080	50.94	0.0040
11.5	0.0120	58.58	0.0060
12.0	0.0180	61.13	0.0090

(b)



(c)  $E \approx \frac{38}{0.0028} = 13,600 \text{ ksi}$

$E \approx 13,600 \text{ ksi}$

(d)

$F_{pl} \approx 38 \text{ ksi}$

(e)

$F_y \approx 60 \text{ ksi}$

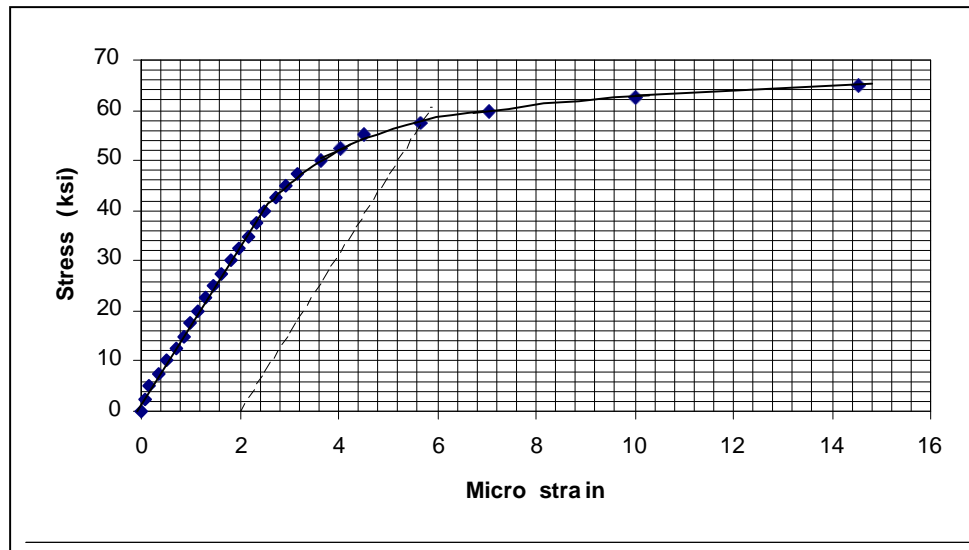
**1.5-7**

Spreadsheet results:

(a)

Load (kips)	Elongation x 10 <sup>3</sup> (in.)	Stress (ksi)	Strain x 10 <sup>3</sup> (in./in.)
0	0	0	0
0.5	0.16	2.5	0.080
1	0.352	5	0.176
1.5	0.706	7.5	0.353
2	1.012	10	0.506
2.5	1.434	12.5	0.717
3	1.712	15	0.856
3.5	1.986	17.5	0.993
4	2.286	20	1.143
4.5	2.612	22.5	1.306
5	2.938	25	1.469
5.5	3.274	27.5	1.637
6	3.632	30	1.816
6.5	3.976	32.5	1.988
7	4.386	35	2.193
7.5	4.64	37.5	2.320
8	4.988	40	2.494
8.5	5.432	42.5	2.716
9	5.862	45	2.931
9.5	6.362	47.5	3.181
10	7.304	50	3.652
10.5	8.072	52.5	4.036
11	9.044	55	4.522
11.5	11.31	57.5	5.655
12	14.12	60	7.060
12.5	20.044	62.5	10.02
13	29.106	65	14.55

(b)



(c) Using the dashed line,  $E \approx \frac{56}{5.6 - 20 \cdot 10^{-3}} = 15,600 \text{ ksi}$

$$E \approx 16,000 \text{ ksi}$$

(d)

$$F_{pl} \approx 42 \text{ ksi}$$

(e)

$$F_y \approx 58 \text{ ksi}$$