工科大学生用书

材料力学习题集

（英汉对照）

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广东科技出版社

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内 容 简 介

本书共有462道英文习题，选自美国近年大学工科材料力学教材，并且配合我国目前流行的材料力学教材的内容和体系，分成十章。每一章内的习题分成三个类型：①典型例题，用于演示材料力学典型的解题方法；②基本题，用于加深对基本概念和基本理论的理解；③复杂题，用于进一步发展学生的智力与能力。本书的习题同时使用两种单位制：英制与国际单位制。

为了方便读者查阅，本书后面附有参考译文和习题答案，以及几种单位的换算表格。

本书适合于工科的大专院校作材料力学习题集使用，也可供各类工科大专（包括电视大学、业余大学、高级中专）的学生以及工程技术人员作为学习英语和材料力学的参考读物使用。

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习　题

PROBLEMS

Chapter 1

TENSION AND COMPRESSION

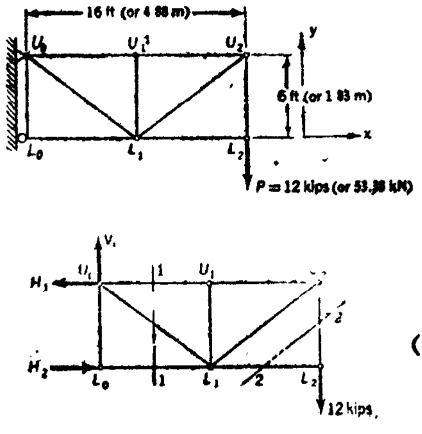
I Internal Force, Stress and Strain

1—1 〔Example〕

Given: The cantilever truss shown in Figure *a*.

Find: The external reactions and internal forces in members U_0L_1, U_2L_2.

Procedure: The roller support provides only a horizontal support; the other provides a vertical and a horizontal support, as shown below in the free-body diagram b.



(a)

(b)

Figure 1-1

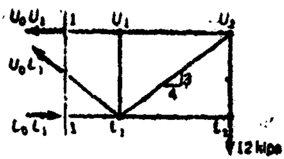
$\Sigma M_{U0} = 0$; therefore, $12 \times 16 - H_2 \times 6 = 0$;

$H_2 = 32$kips(or142.34kN)

$\Sigma F_x = 0$; $|H_1| = |H_2| = 32$kips (or142.34kN)

$\Sigma F_y = 0$; $V_1 = 12$kips (or53.38kN)

To determine the internal forces, we may proceed by isolating (by an imaginary cut) a complete part of the truss, as shown in Figure b by the cuts 1—1 and 2—2. This is generally called the method of sections. Of course, the member for which the load is to be found is one of those separated by this imaginary cut. Caution: If the cut has more than three unknowns, the forces cannot be determined by statics equations alone. Also remember that a truss member is assumed to carry only axial load, tension, or compression. The following procedure illustrates this. The direction of the forces are assumed and corrected later if the result is a negative sign.



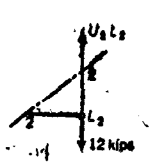


Fig. 1—1 (c) (d)

$\Sigma F_y = 0$; $^3/_5 U_0L_1 = 12$; $U_0L_1 = 20$kips (or 88.96kN)

$\Sigma F_y = 0; U_2 L_2 = 12$ kips (or 53.38kN)

1—2 In Figure 1—2, assume pin connections for A, B, C, and D. Neglecting the weight of the members, determine (a) the magnitude and directions of the reactions at points A and B, (b) the force in cable between CD, and (c) the force in member BC.

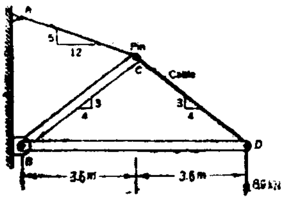


Figure 1—2

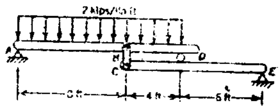


Figure 1—3

1—3 In Figure 1—3, assume that the weight of the members is negligible. For the given uniform load, determine (a) the reaction at A, (b) the tension in linkage tie BC, and (c) the reaction at D.

1—4 What is the force in the turnbuckle tie of Figure 1—4 when P = 40kN?

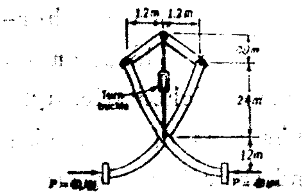


Figure 1—4

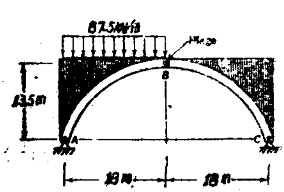


Figure 1—5

1—5 In Figure 1—5 the arch is hinged at points A, B, and C. Draw a free-body diagram of portions AB and BC and show all the forces (magnitudes and directions) acting on these members. Neglect the weight of the members.

1—6 For the truss shown in Figure 1—6, determine (a) the reaction at points L_0 and U_4, and (b) the forces in members L_1L_2 and U_2L_2.

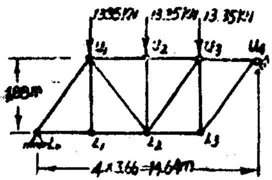


Figure 1 — 6

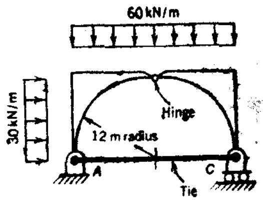


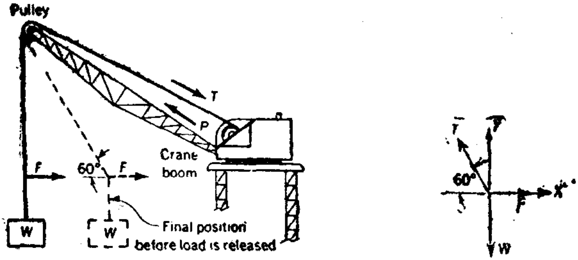
Figure 1 — 7

1—7 For the load shown in Figure 1—7, determine (a) the axial force in the tie, and (b) the reactions at points A and C.

1—8 〔Example〕

Given: A cargo ship loads cargo from the dock by lifting it with a boom crane and then, with a horizontal cable, guiding the weight to a location on the ship (shown in dotted lines). Schematically, this is shown in Figure *a*. The area of each cable is 0.90 in.^{2} (or 5.81 cm^2) and the allowable stress is 15,000 psi (or 35.47 MN/m^2).

Find: The maximum weight the crane can lift at any one time.



(a) Figure 1—8 (b)

Procedure:

$$T = \sigma \cdot A = (15{,}000\ \text{lb/in.}^2)(0.90\ \text{in.}^2)$$

$$T = 13{,}500\ \text{lb}$$

From $\Sigma F_y = 0$ $\quad T \sin 60° = W$

Therefore $W = (13{,}500)(0.866) = 11{,}700$ lb(or 52kN)

From $\Sigma F_x = 0$

$$F = T.\cos 60° = (13{,}500)(0.5) = 6750\ \text{lb}$$

Therefore, the stress in the horizontal cable is

$$\sigma = \frac{F}{A} = \frac{6750}{0.9} = 7500\ \text{psi (or 51.71 MN/m}^2\text{)}$$

1—9 Consider the loads of Figure 1—9 to be axially applied at sections A, B, and C to the steel bar which has a cross-sectional area of 3 in.² Determine the axial stress in the bar on (a) a section 10 in. to the right of A, (b) a section 60 in. to the right of A.

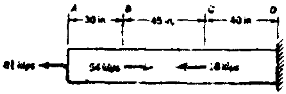


Figure 1—9

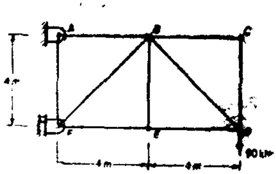


Figure 1—10

1—10 Refer to Figure 1—10. Determine the stress in the truss bar AB ($A=6\times10^{-4}m^2$).

1—11 In Figure 1—11 a man lifts a 667 N weight, as shown. Determine the stress in each rod, if they are of a 1.27cm. diameter.

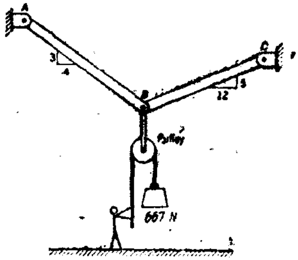


Figure 1—11

1—12 Determine the minimum cross section the cable in Figure 1—2 must have if the allowable stress in the cable is $69MN/m^2$. Check both lengths AC and CD and let the most critical portion control the size for the whole length ACD.

1—13 A steel wire is suspended vertically from one end, supporting only its own weight. It has a cross-sectional area A, a length L, and a specific weight γ. Determine (a) the maximum axial stress in the wire in terms of A, L, and γ and (b) the maximum length that the wire may have if the maximum permissible stress in the wire is 27,000 psi. Take the specific weight of 490 lb/cu ft.

1—14 A short, hollow steel cylinder is to carry an axial compressive load of 50 tons, at a stress of 18,000 psi. Determine the wall thickness necessary for a ratio of outside diameter to wall thickness of 3π to 1.

1—15 A 7000-lb weight is supported by means of a pulley as shown in Figure 1—15. The pulley is supported by the frame ABC. Find the required cross-sectional areas for AC and BC if the allowable stress in tension is 20,000 psi and in compression is 14,000 psi.

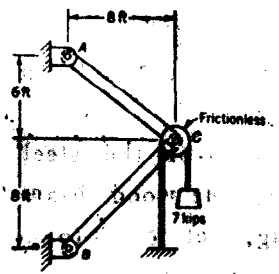


Figure 1—15

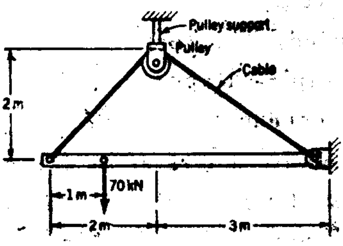


Figure 1—16

1—16 In Figure 1—16 determine the cross-sectional area of the cable and of the pulley support if the allowable stress in each is 140 MN/m^2.

1—17 Refer to Figure 1—17 If the stress in the steel"tie"is not to exceed 138 MN/m^2 determine the cross-section of area needed for tie.

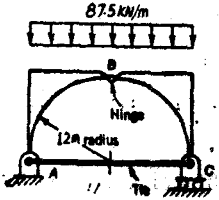


Figure 1—17

1—18 [Example]

Given: The strains in the steel rod and wood beam are 1×10^{-3} in./in. and 3.33×10^{-4} in./in., respectively.

Find: The vertical deflection of point B. Use a graphical approach.

procedure: In Figure *a*, the length of the steel rod is (5 ft)(12 in./ft) = 60 in. The wood beam is (4 ft)(12 in./ft) = 48 in. long. Let δ_{st} = total elongation of the steel rod, and δ_{wd} = total elongation of the wood beam.

$\delta_{st} = 1 \times 10^{-3} \times 60 = 6 \times 10^{-2}$ in. (or 1.52 mm)

$\delta_{wd} = 3.33 \times 10^{-4} \times 48 = 1.6 \times 10^{-2}$ in. (or 0.41mm)

The final length of the steel rod is thus $(60 + 6 \times 10^{-2})$ in. The wood beam has a final langth of $(48 - 1.6 \times 10^{-2})$ in.

Because the rod has point A as its center of rotation and the beam has point C as its center of rotation, plotting the new dimensions on a large enough scale would give the deflected location of point B. However, this is not practical, because the magnitude of the chosen scale necessary to reflect the effect of the strains would be too large. Therefore, graphically, only the changes of lengths are plotted instead of the lengths themselves. Starting with point B, the rod is assumed to deform downward along the slope of the rod an amount δ_{st}. The wood is assumed to contract to the left, relative to point B, by an amount δ_{wd}. The two ends of the rod and beam must meet at the intersection of the arcs that would be formed by the lengths. (This point may be approximated with perpendicular lines as shown in Figure b). The arbitrarily chosen scale for sketching the deformations is 1 in. $= 10 \times 10^{-2}$ in. Therefore,

$$\delta_Y = 12.13 \times 10^{-2} \text{ in. (measured)}$$

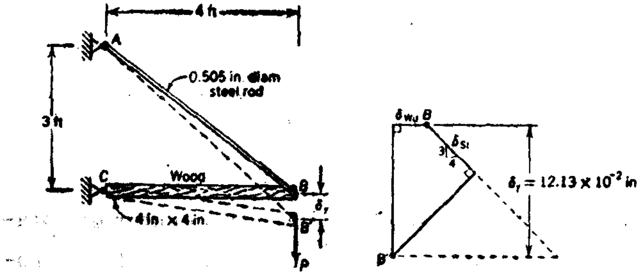


Figure 1—18 (a) (b)

1—19 Given: The three wires shown in Figure 1-19 are of the same material and have the same cross section. Assume the bar to be rigid, that is, no bending.

Find: The ratio of the strains of the three wires, using the short wire as the basis of comparison.

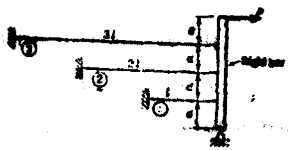


Figure 1—19

1—20 A standard tensile steel specimen, 0.505 in. in diameter, shown in Figure 1—20 is marked in 1/2-in. increments, as shown in Figure a before the test. After the test, these increments are a little longer than 1/2-in., as shown in Figure b.

Determine the strain for each 1/2-in. length and the average strain for the 2-in. gage length.

Figure 1—20 (a) (b)

1—21 The horizontal bar of Figure 1—21 is assumed to be rigid. The two wires supporting the bar are tightened so that when the strain in wire DE is 1000×10^{-6}, the strain in BC is 100×10^{-6} and the bar is horizontal. Then the load P is added and the strain in DE becomes 2000×10^{-6}. Determine the new strain in BC.

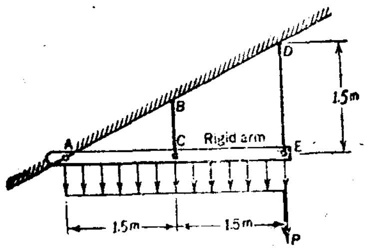


Figure 1—21

1—22 The force P in Figure 1—22 lowers the rigid arm, which is hinged at the point A and suspended by a rod BC as shown. Points D and E are frictionless pin hinges. When the rigid beam ACD is horizontal the gap at point F is 0.1 in. Determine the strain in rod BC when the gap is 0.2 in.

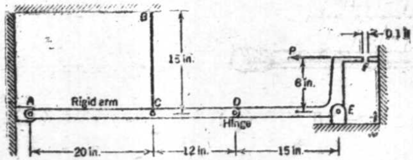
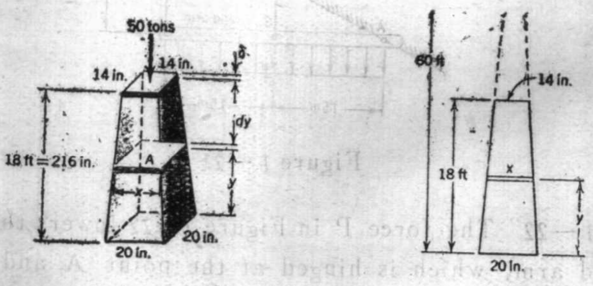


Figure 1—22

1—23 [Example]

Given: A concrete column 18-ft (or 5.49-m) high supports a 50-ton (or 444.82kN) load. Its square dimension at the top is 14 in. ×14 in. and at the bottom 20 in. ×20 in. as shown in Figure *a*.

Find: The total compressive deformation in the column, neglecting the weight of the column. Assume that $E_c = 3\times10^6$ psi (or 20×10^6 kN/m^2).



a) Figure 1—23 b)

Solution: For an element of length dy,