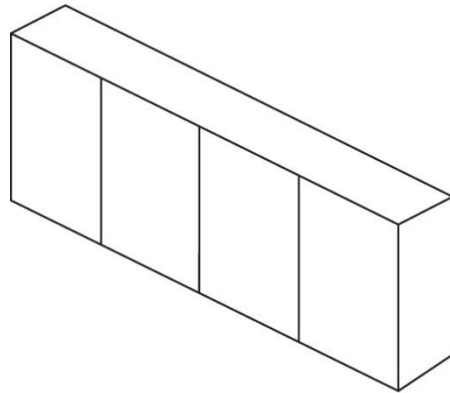
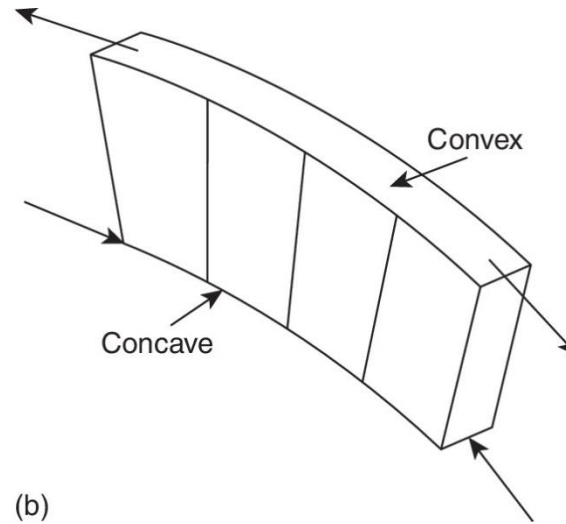


Chapter 16

Bending of open and closed, thin-walled beams



(a)



(b)

FIGURE 16.1 Bending a Rubber Eraser

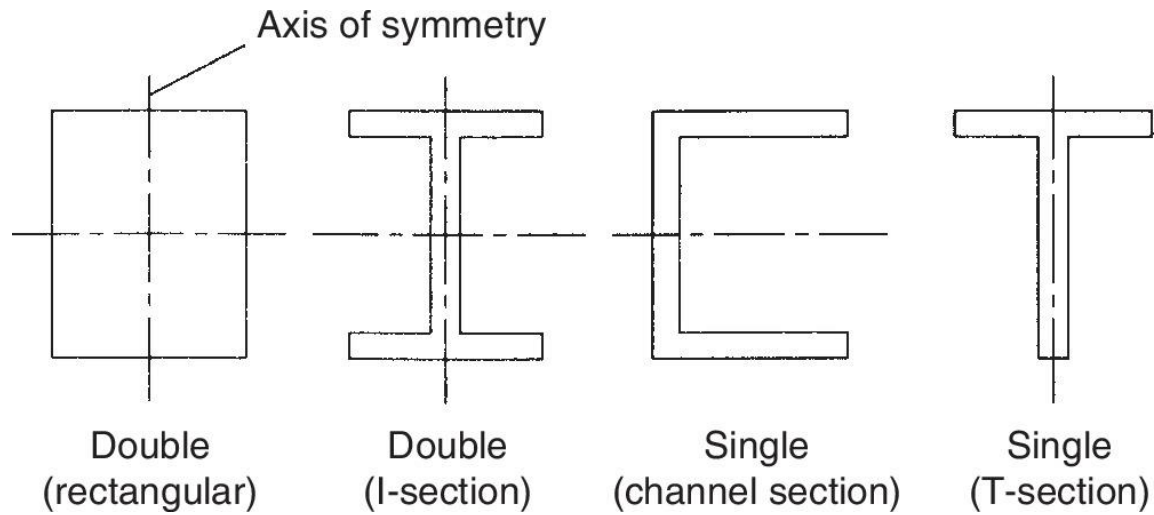


FIGURE 16.2 Symmetrical Section Beams

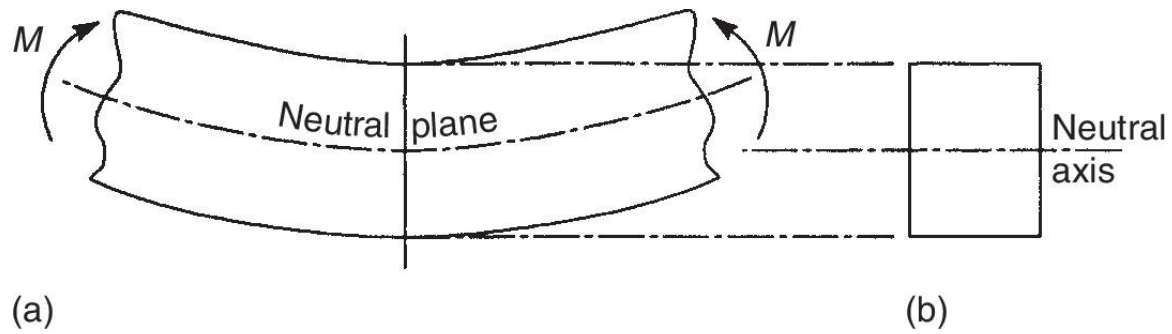


FIGURE 16.3 Beam Subjected to a Pure Sagging Bending Moment

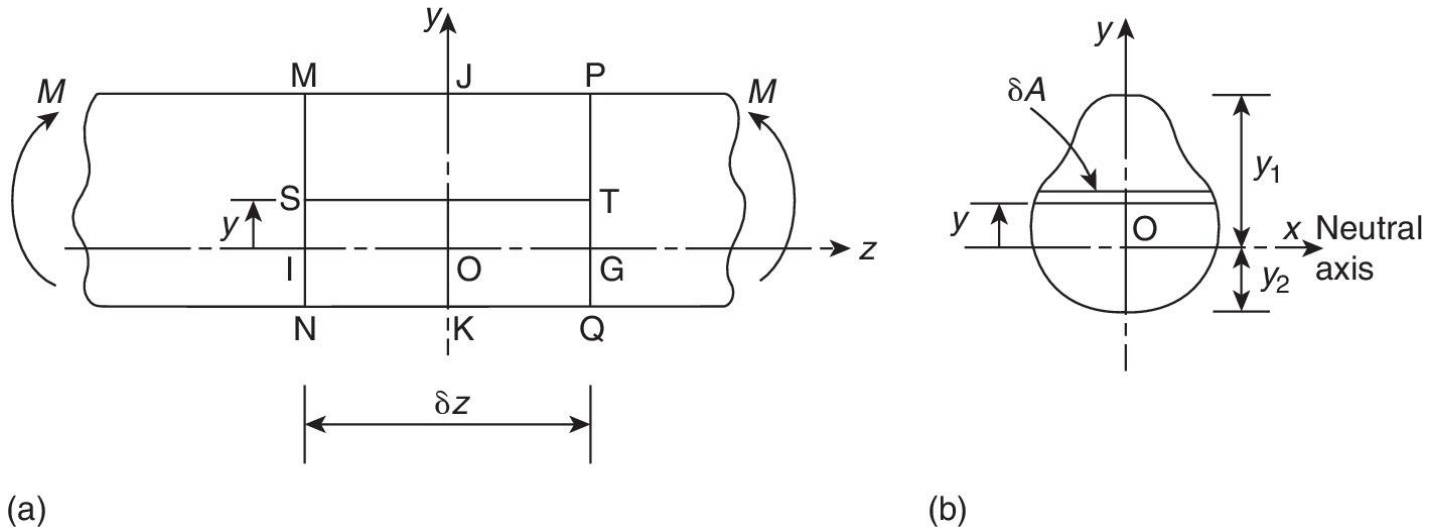


FIGURE 16.4 Bending of a Symmetrical Section Beam

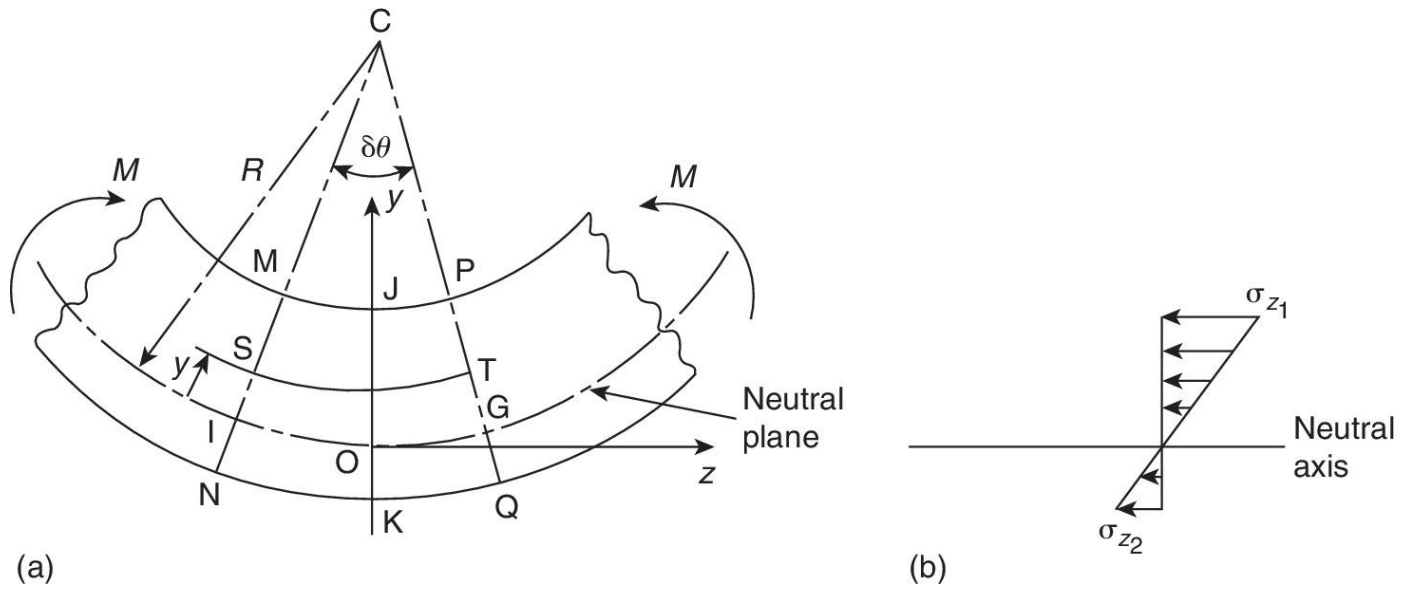


FIGURE 16.5 Length of Beam Subjected to a Pure Bending Moment

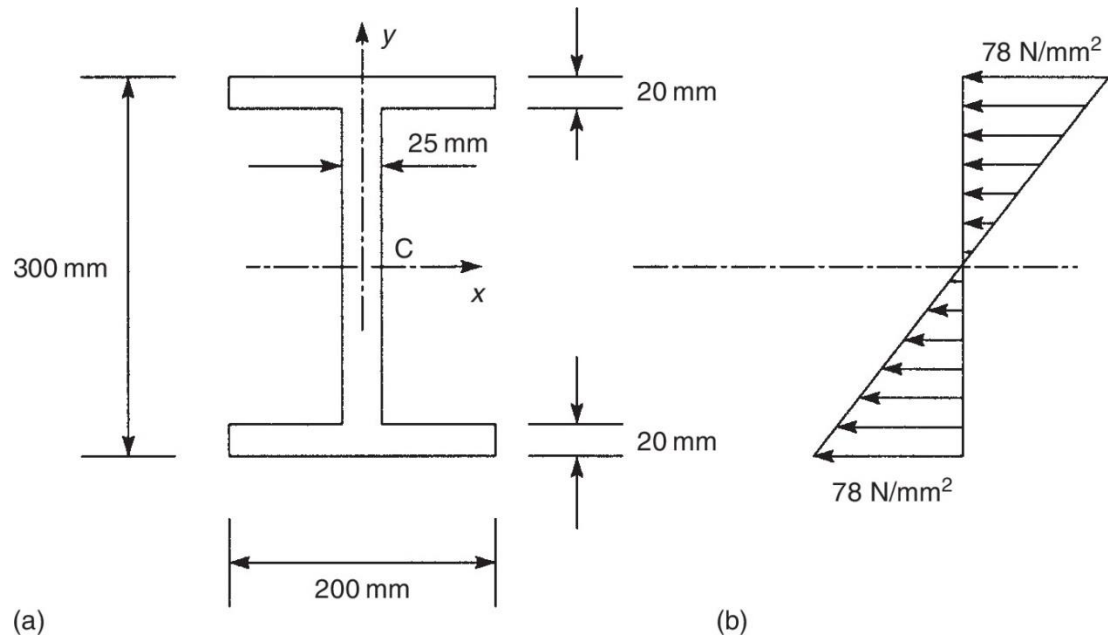


FIGURE 16.6 Direct Stress Distribution in the Beam of Example 16.1

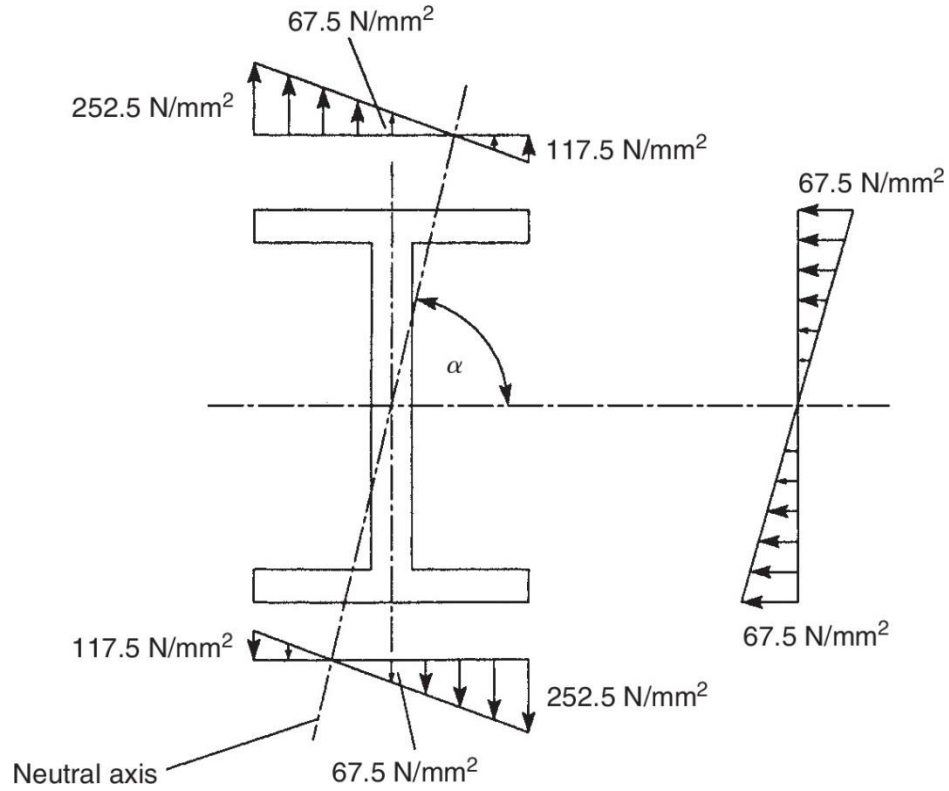


FIGURE 16.7 Direct Stress Distribution in the Beam of Example 16.3

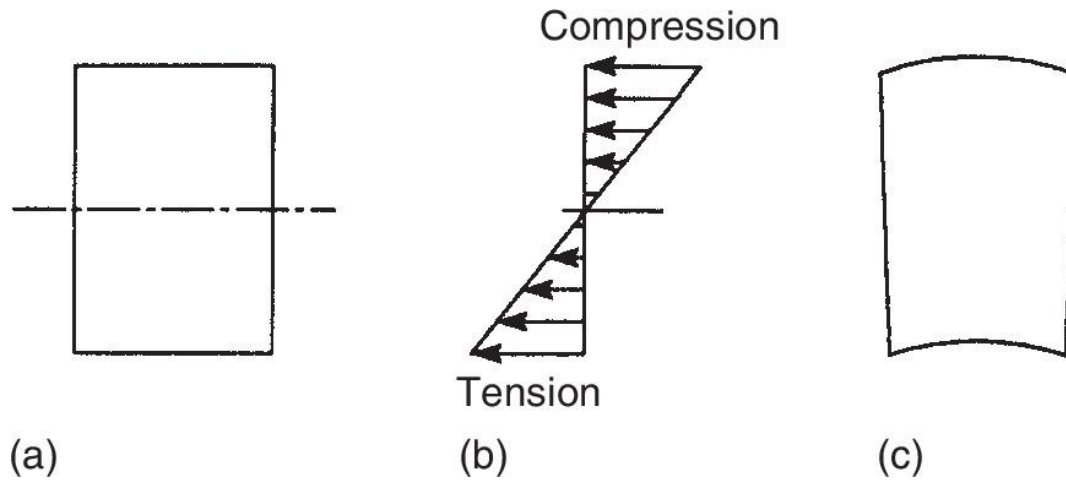


FIGURE 16.8 Anticlastic Bending of a Beam Section

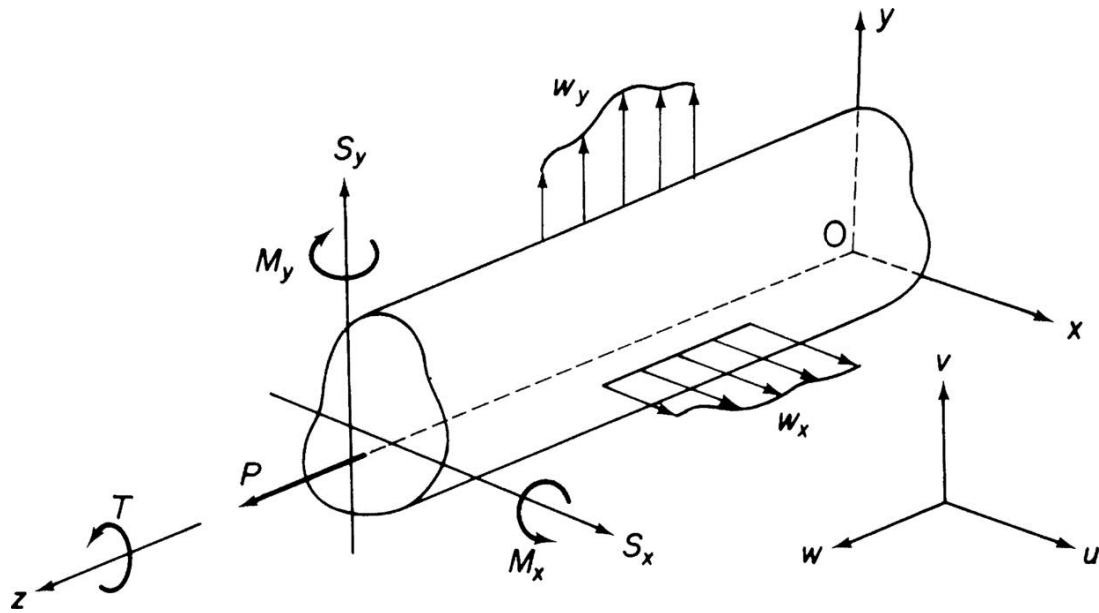


FIGURE 16.9 Notation and Sign Convention for Forces, Moments, and Displacements

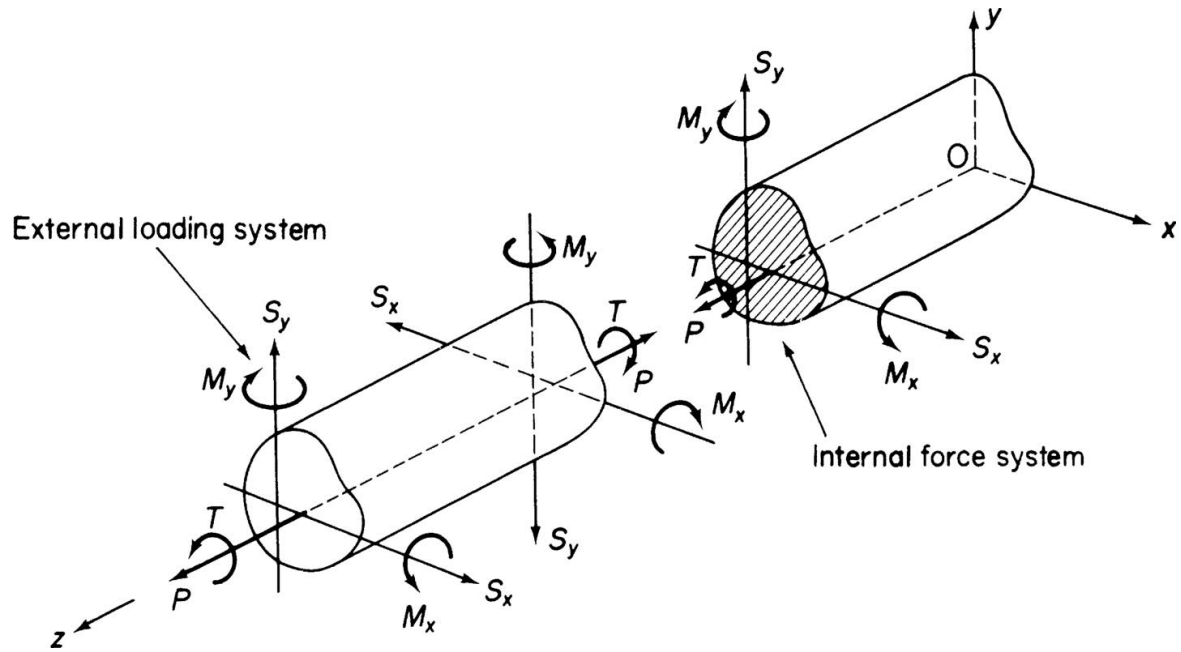


FIGURE 16.10 Internal Force System

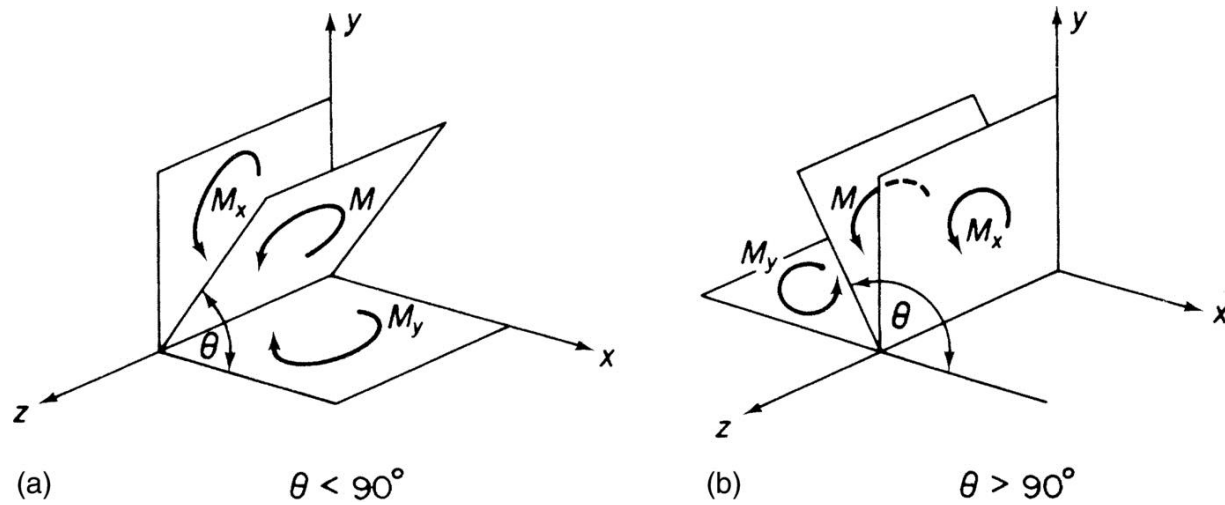


FIGURE 16.11 Resolution of Bending Moments

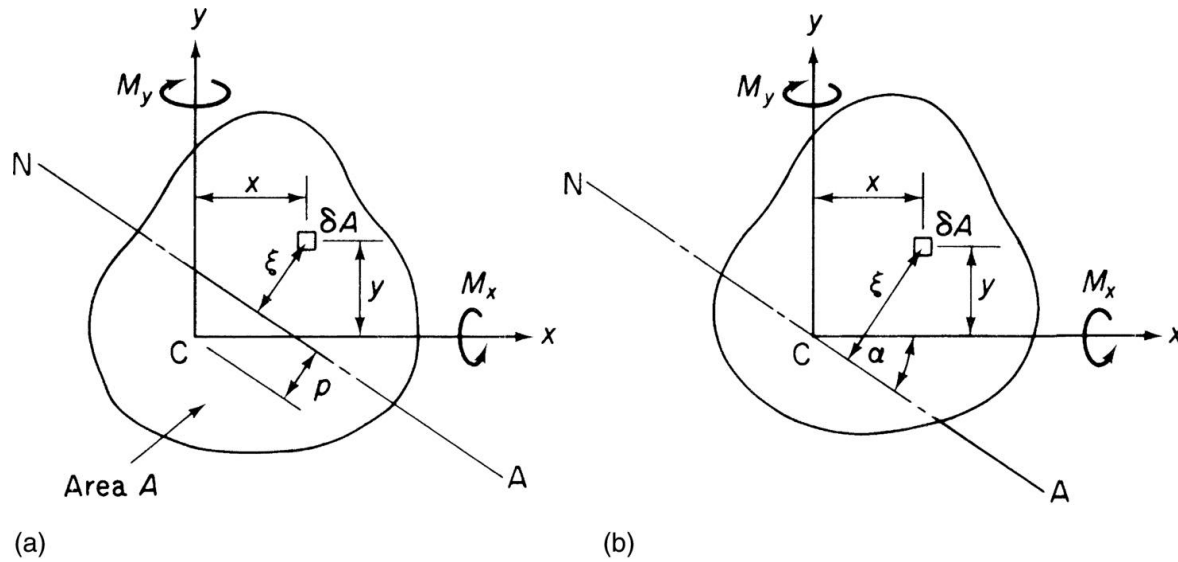


FIGURE 16.12 Determination of Neutral Axis Position and Direct Stress Due to Bending

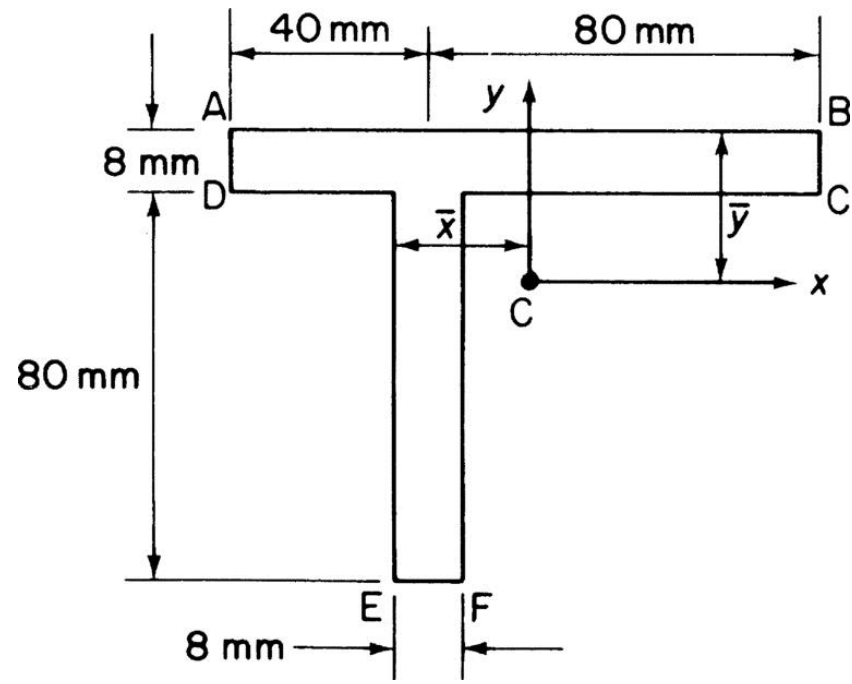


FIGURE 16.13 Cross-Section of Beam in Example 16.4

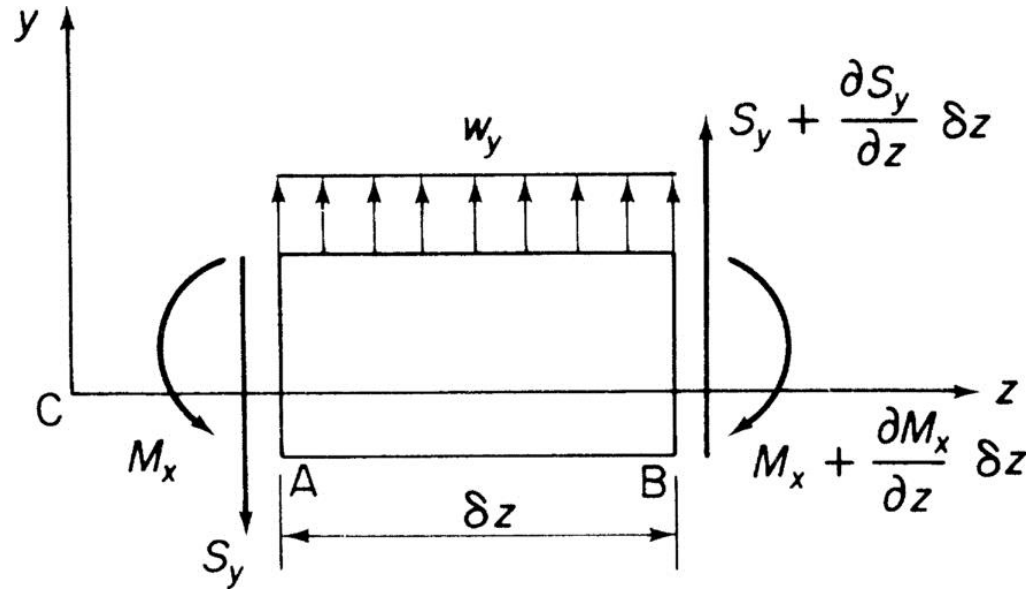


FIGURE 16.14 Equilibrium of a Beam Element Supporting a General Force System in the yz Plane

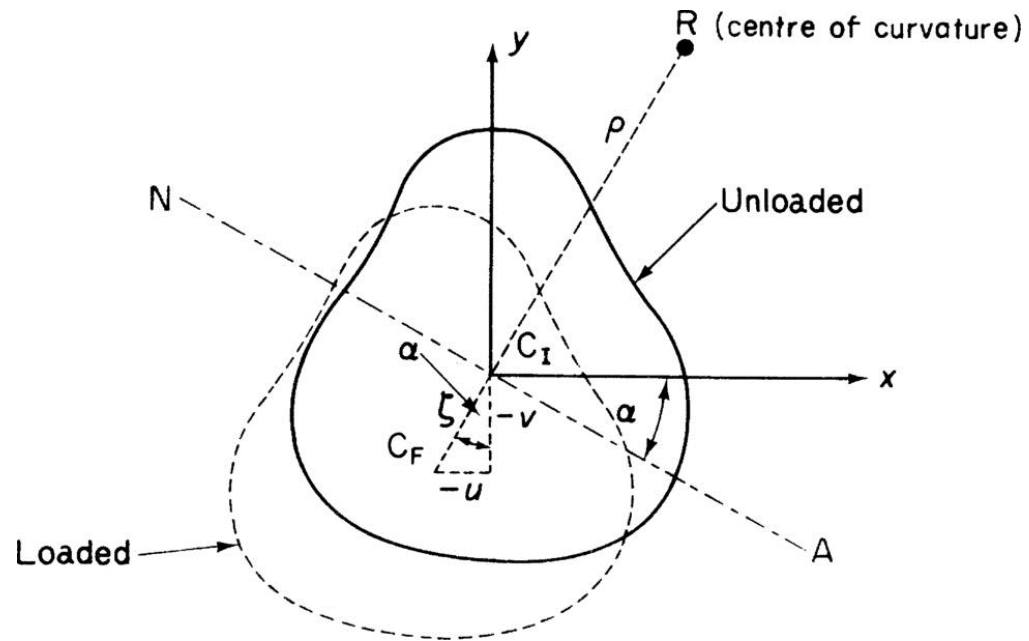


FIGURE 16.15 Determination of Beam Deflection Due to Bending

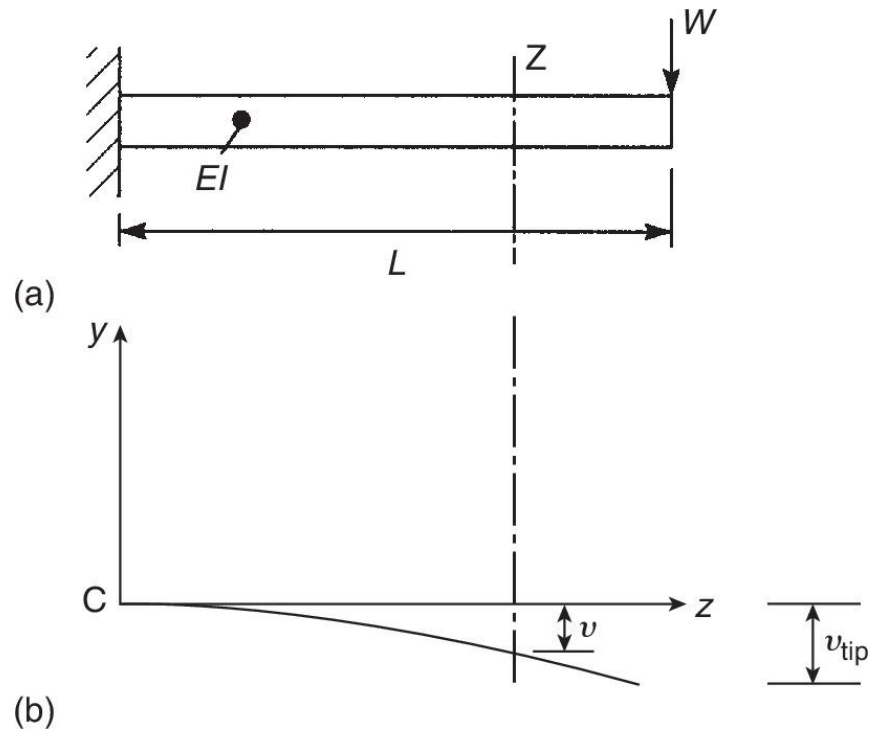


FIGURE 16.16 Deflection of a Cantilever Beam Carrying a Concentrated Load at Its Free End (Example 16.5)

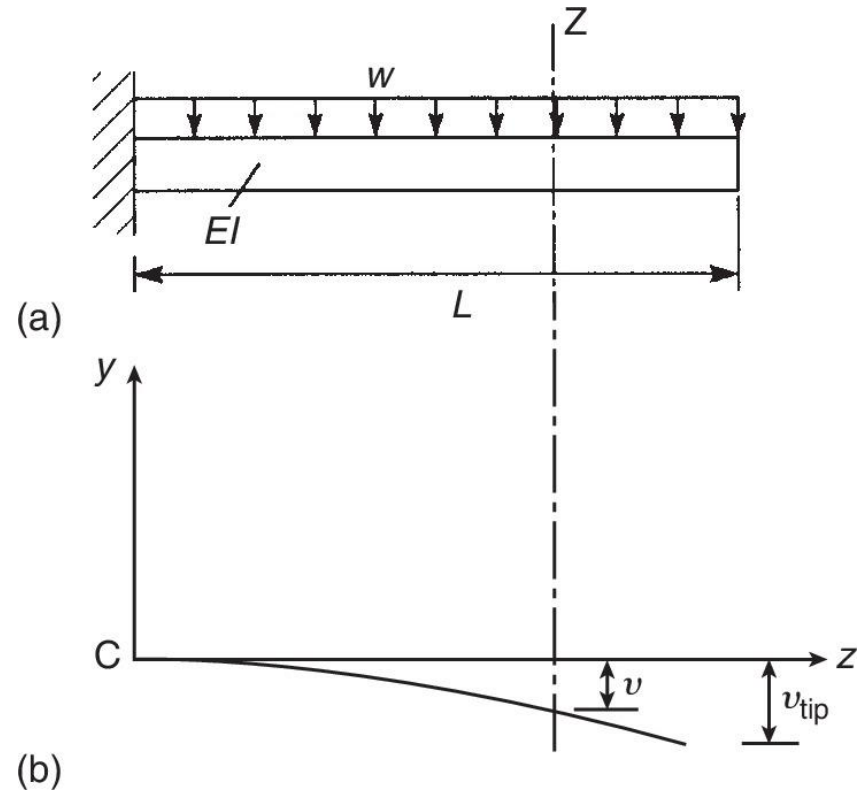


FIGURE 16.17 Deflection of a Cantilever Beam Carrying a Uniformly Distributed Load

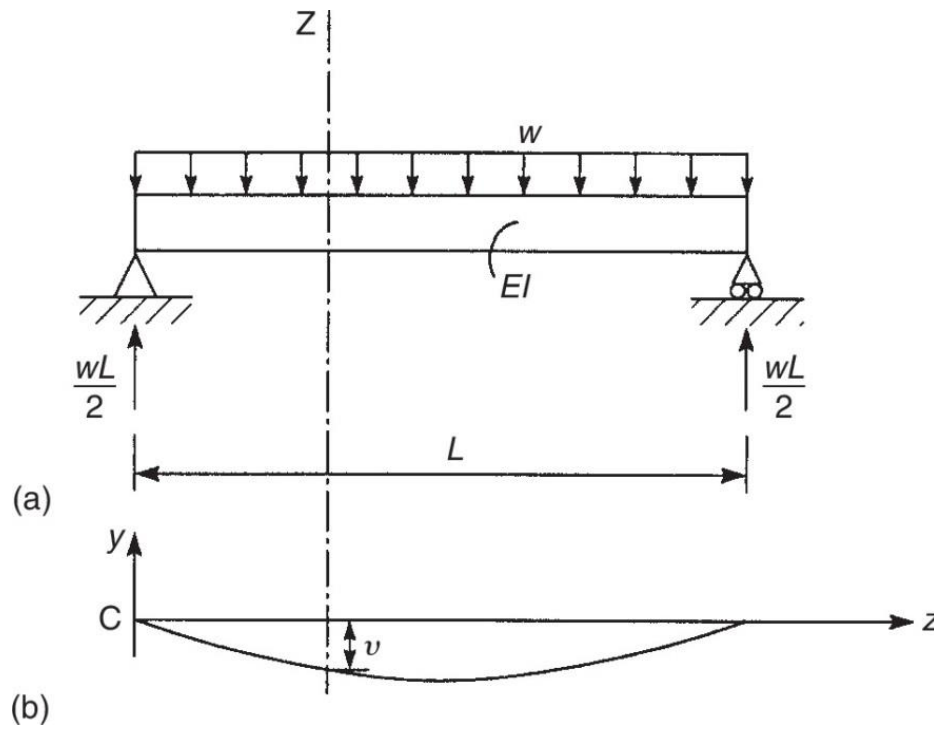


FIGURE 16.18 Deflection of a Simply Supported Beam Carrying a Uniformly Distributed Load (Example 16.7)

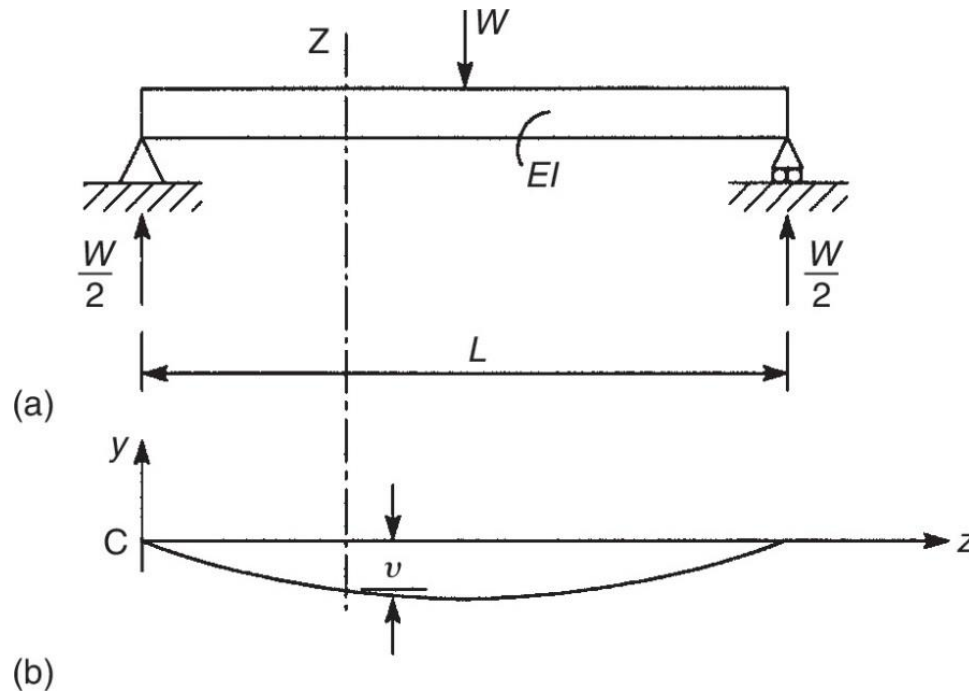


FIGURE 16.19 Deflection of a Simply Supported Beam Carrying a Concentrated Load at Mid-span (Example 16.8)

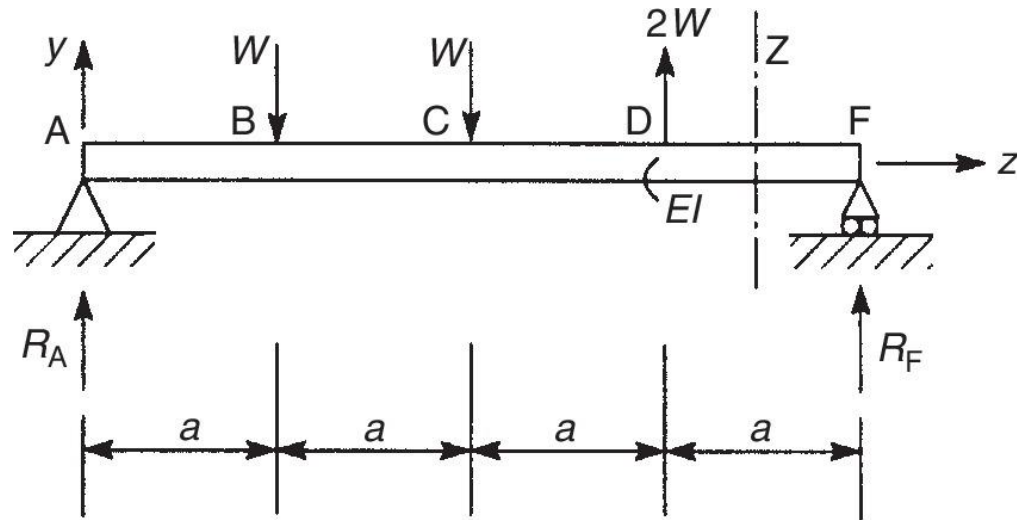


FIGURE 16.20 Macaulay's Method for the Deflection of a Simply Supported Beam (Example 16.9)

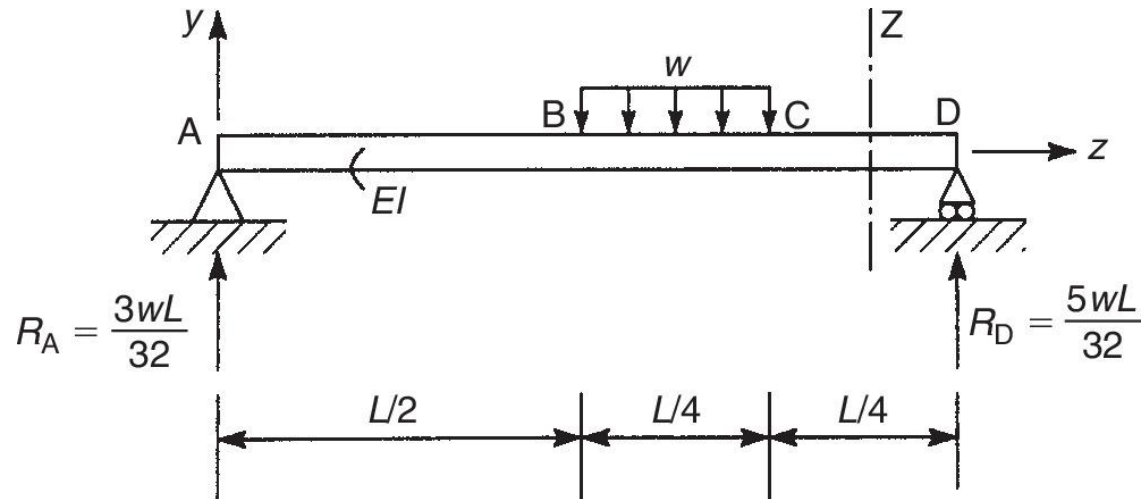


FIGURE 16.21 Deflection of a Beam Carrying a Part Span Uniformly Distributed Load (Example 16.10)

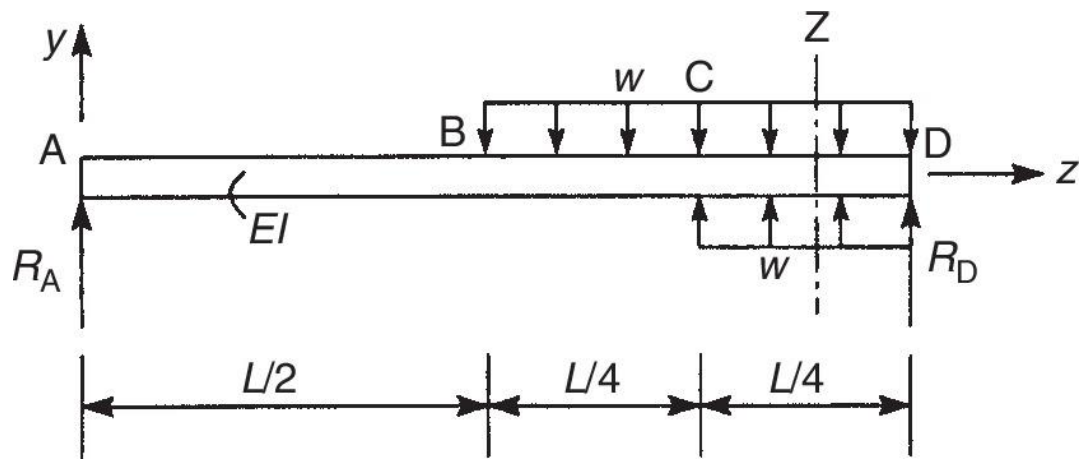


FIGURE 16.22 Method of Solution for a Part Span Uniformly Distributed Load

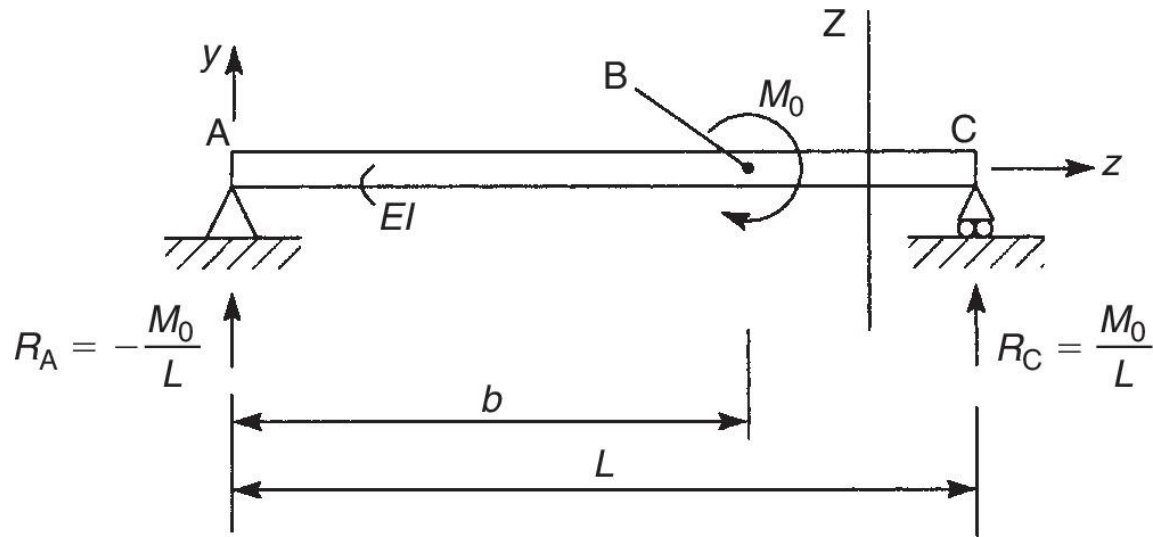


FIGURE 16.23 Deflection of a Simply Supported Beam Carrying a Point Moment (Example 16.11)

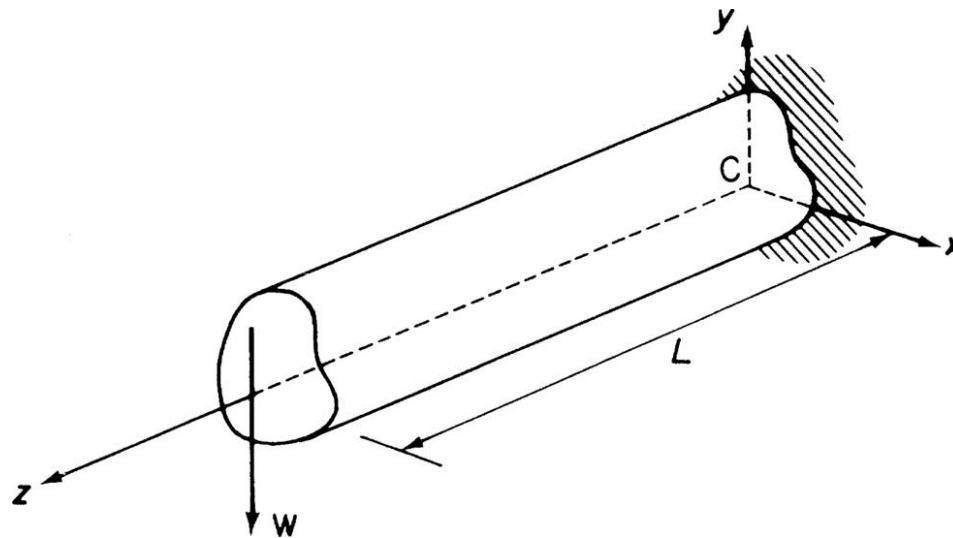


FIGURE 16.24 Determination of the Deflection of a Cantilever

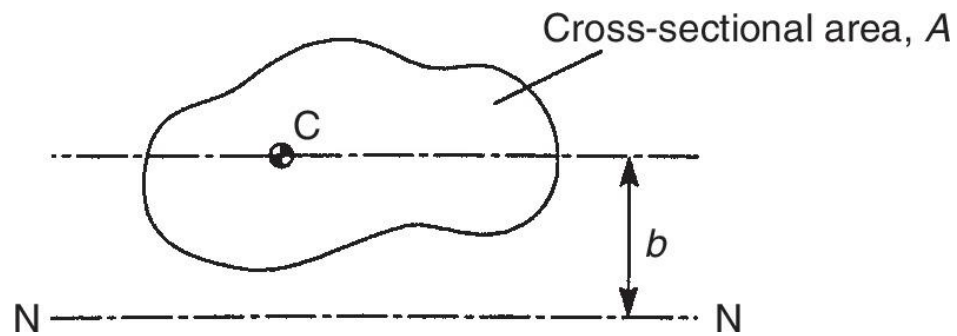


FIGURE 16.25 Parallel Axes Theorem

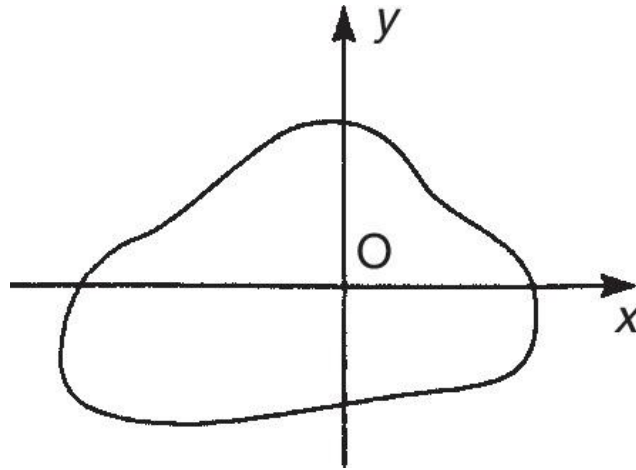


FIGURE 16.26 Theorem of Perpendicular Axes

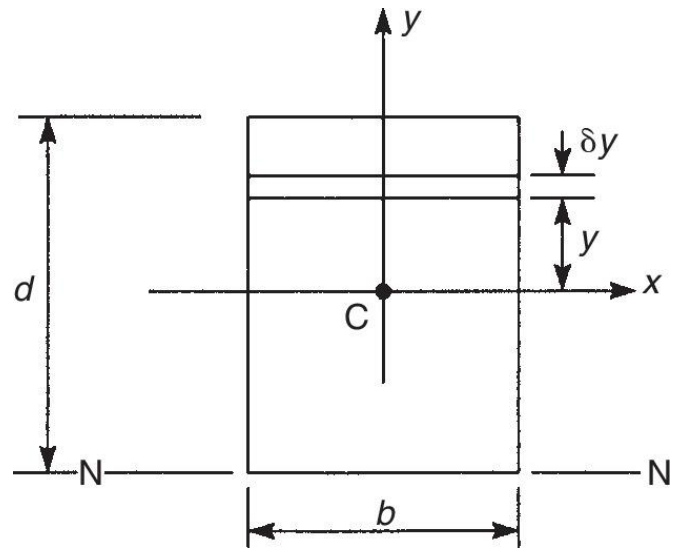


FIGURE 16.27 Second Moments of Area of a Rectangular Section

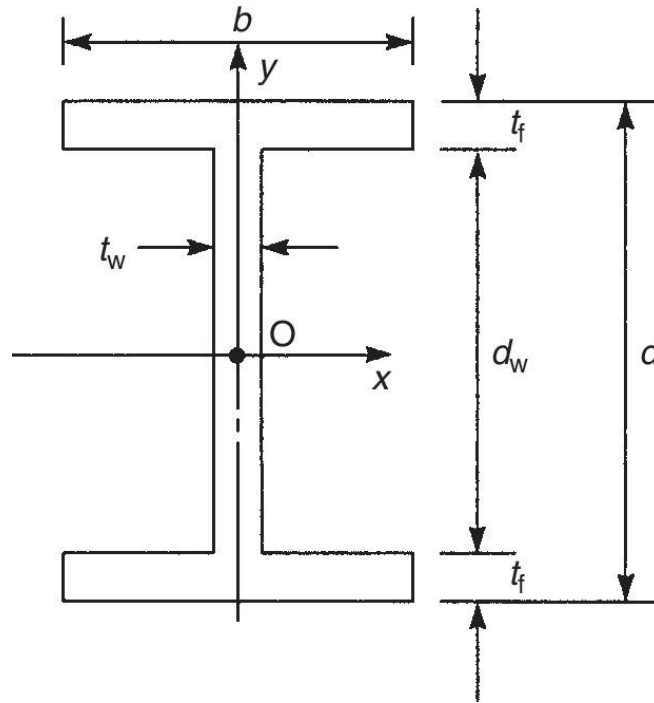


FIGURE 16.28 Second Moments of Area of an I-Section

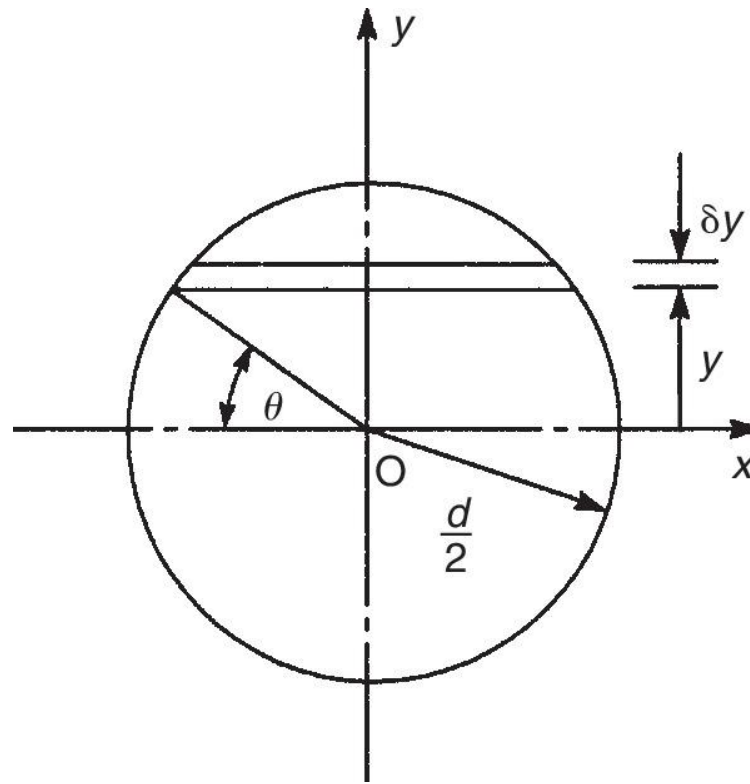


FIGURE 16.29 Second Moments of Area of a Circular Section

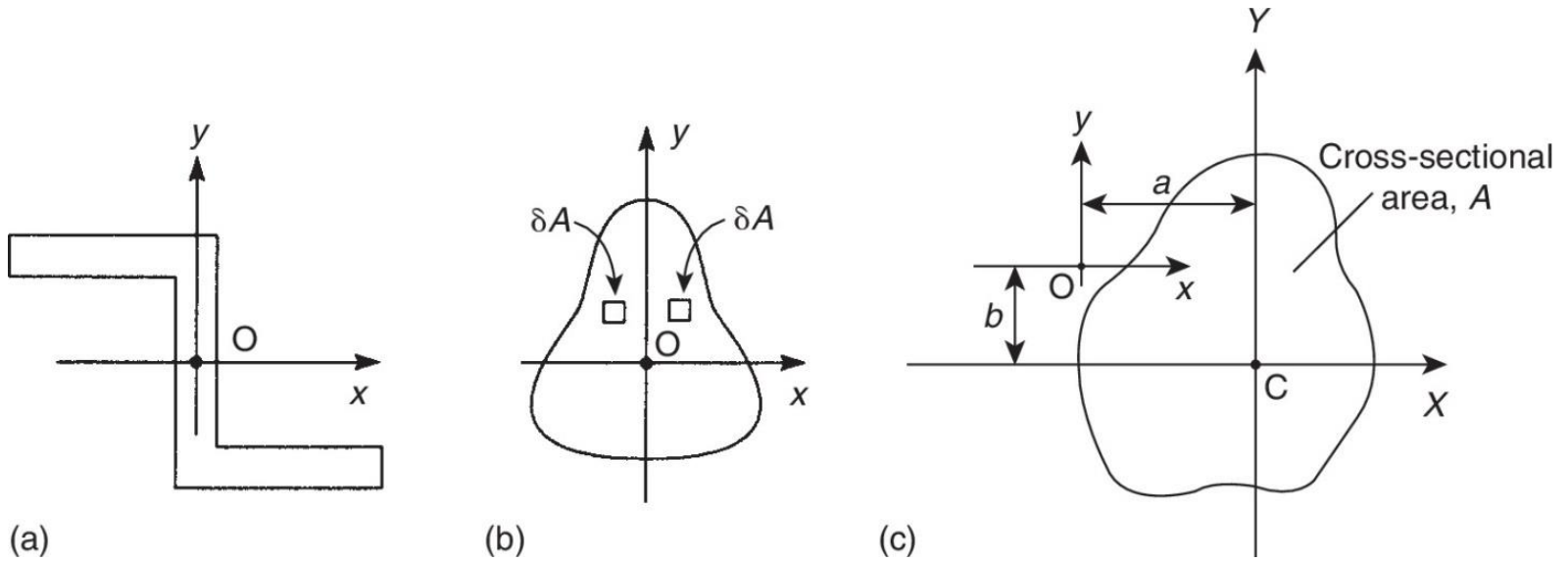


FIGURE 16.30 Product Second Moment of Area

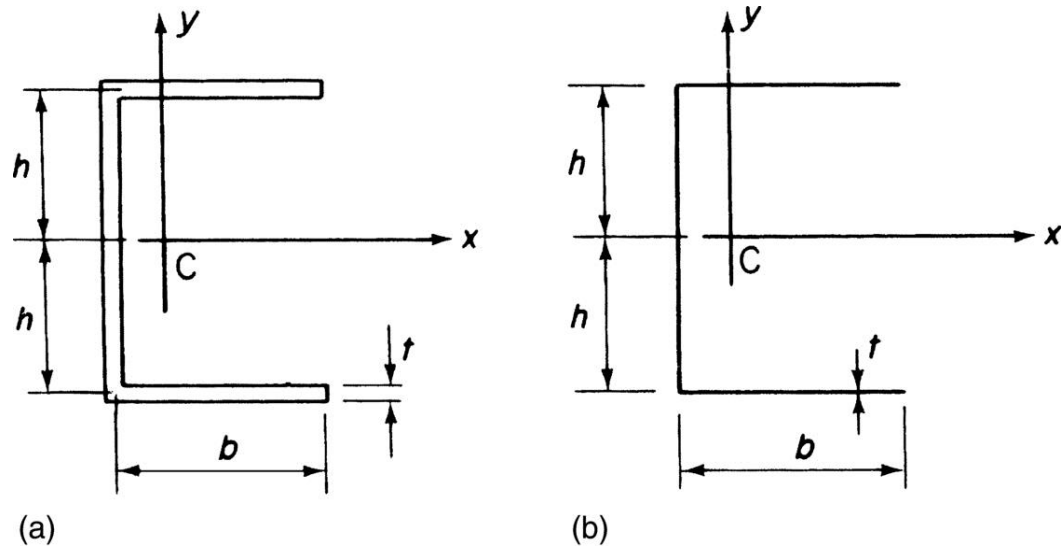


FIGURE 16.31 (a) Actual Thin-Walled Channel Section; (b) Approximate Representation of Section

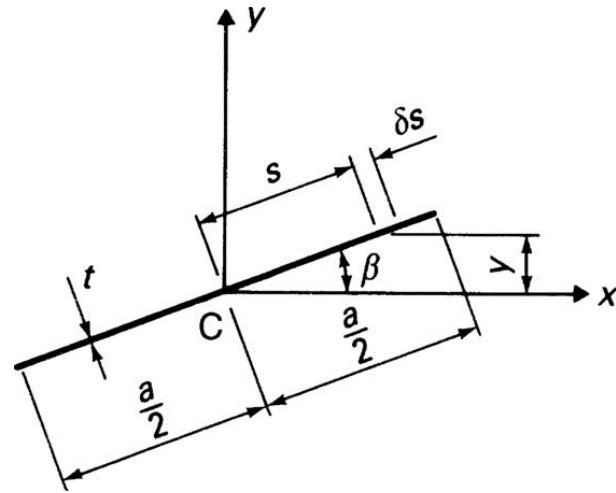


FIGURE 16.32 Second Moments of Area of an Inclined Thin Section

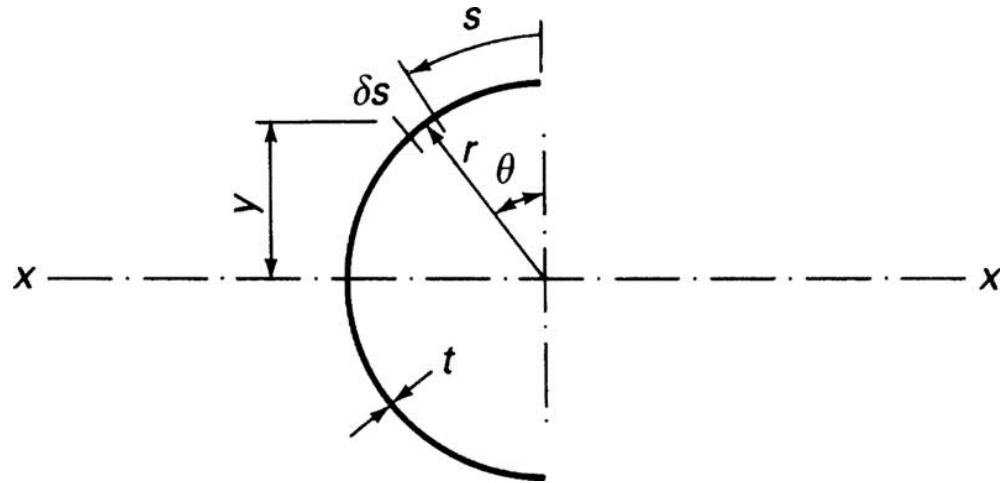


FIGURE 16.33 Second Moment of Area of a Semicircular Section

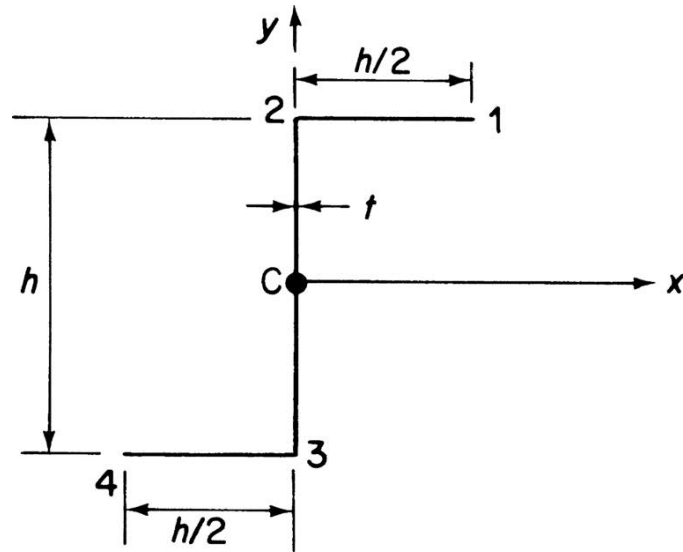


FIGURE 16.34 Z Section Beam of Example 16.14

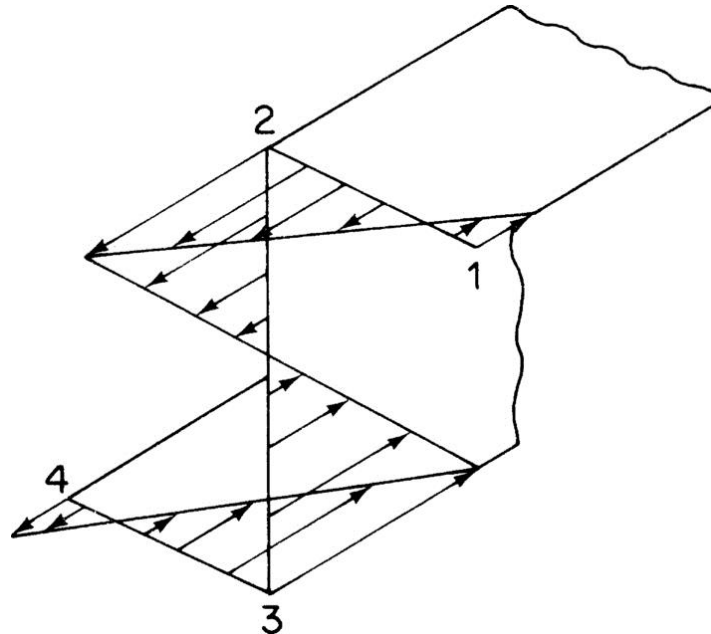


FIGURE 16.35 Distribution of Direct Stress in Z Section Beam of Example 16.14

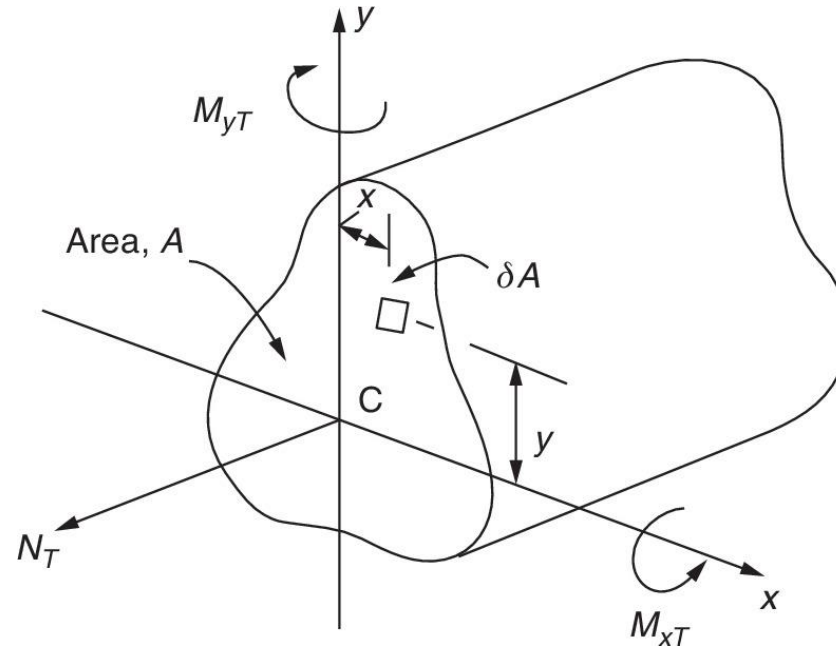


FIGURE 16.36 Beam Section Subjected to a Temperature Rise

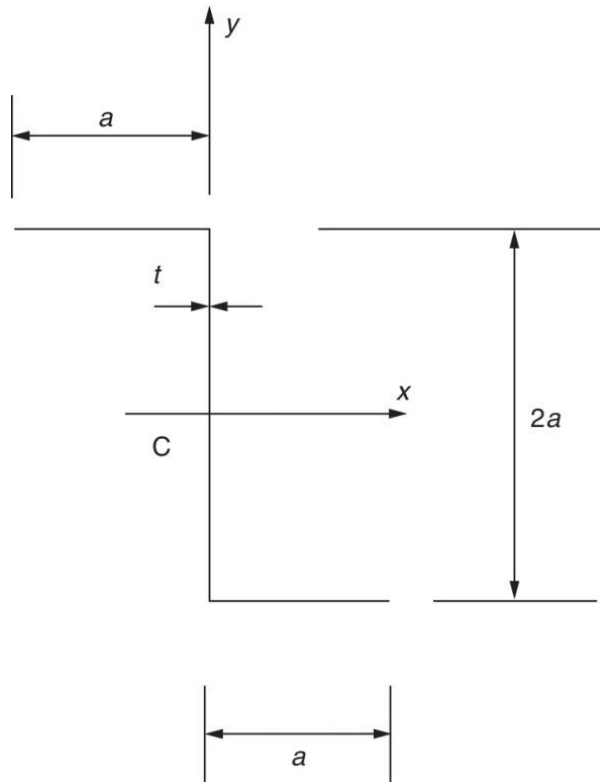


FIGURE 16.37 Beam Section of Example 16.15

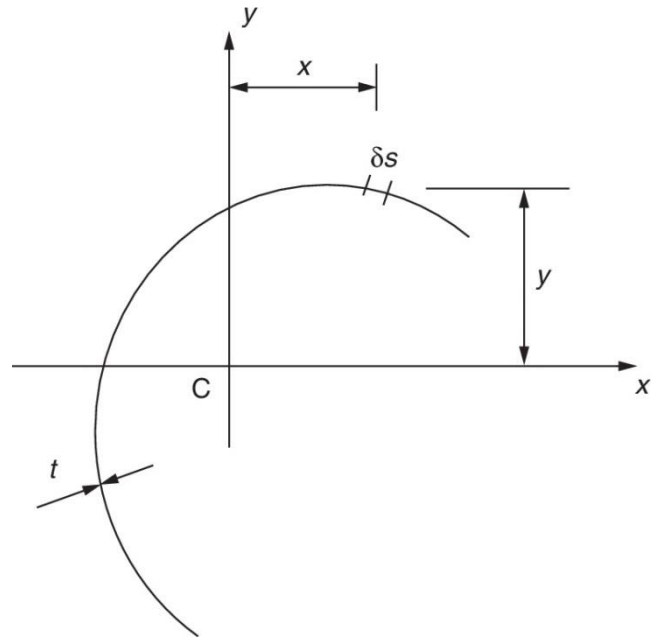


FIGURE 16.38 Thin-walled Beam Section Subjected to a Varying Temperature Change

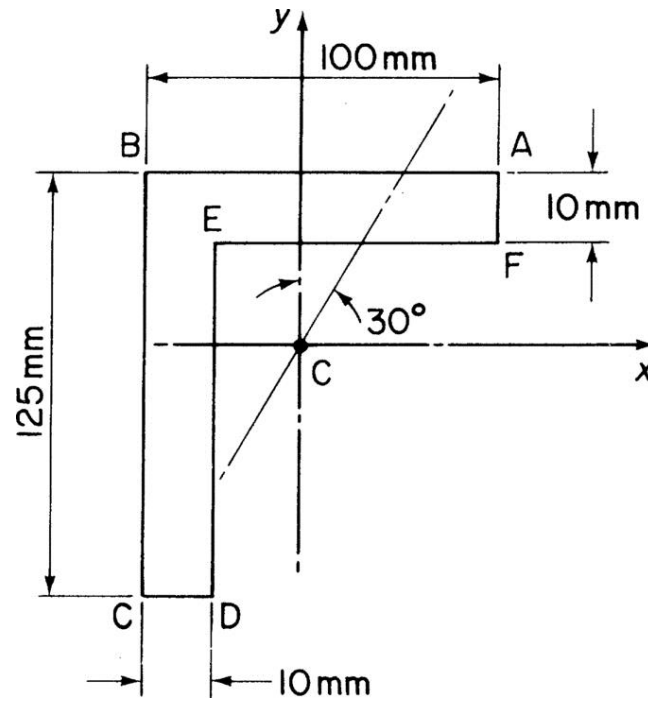


FIGURE P.16.1

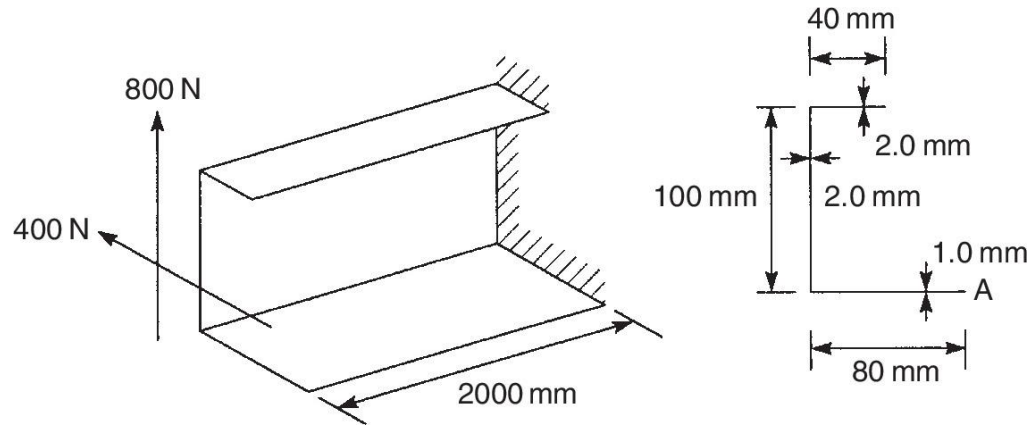


FIGURE P.16.2

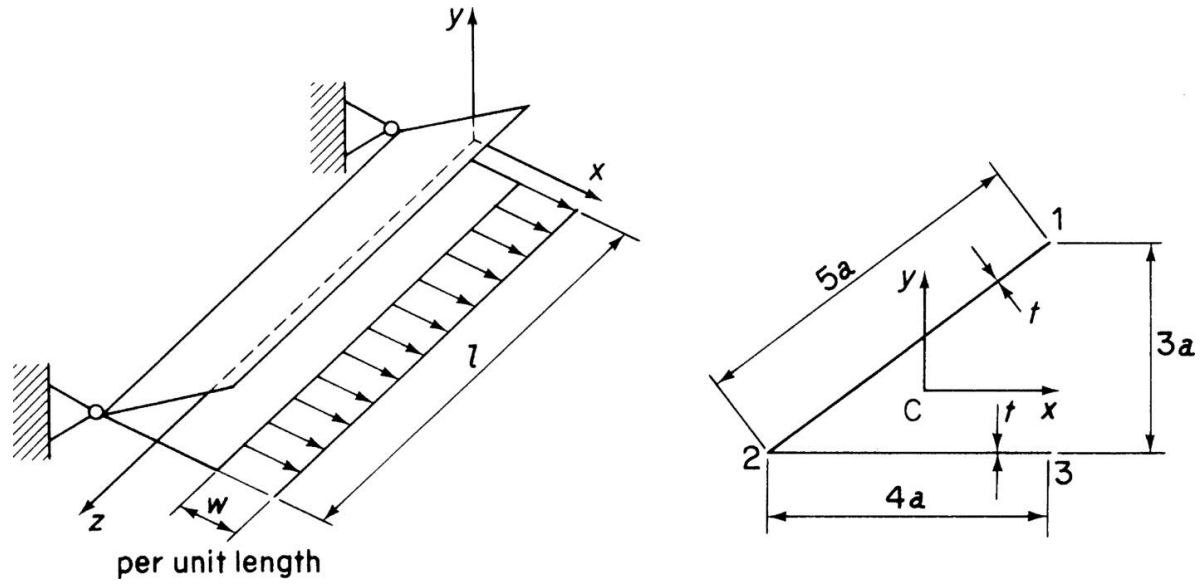


FIGURE P.16.3

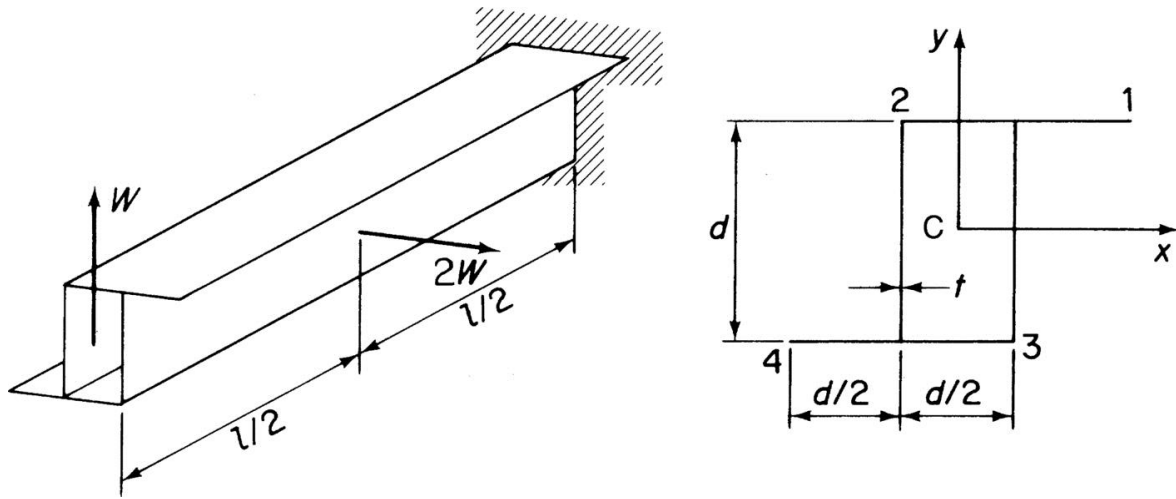


FIGURE P.16.4

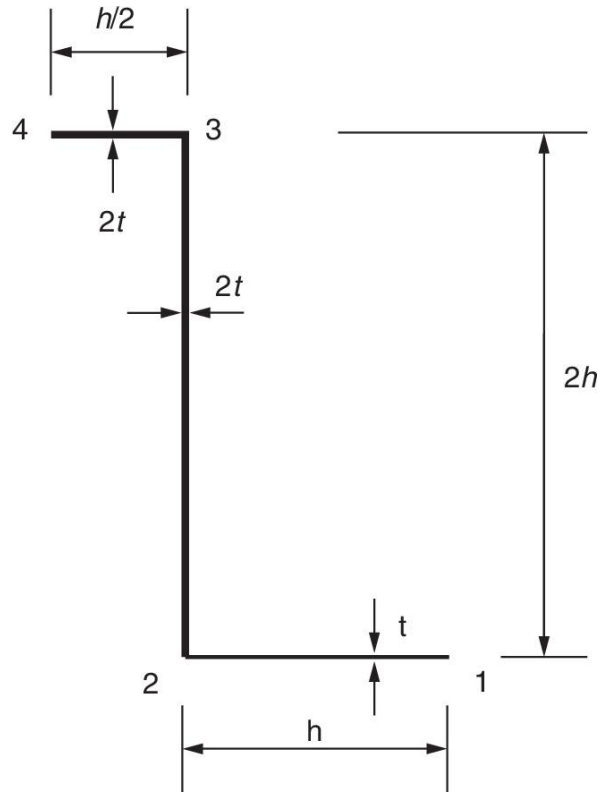


FIGURE P.16.5

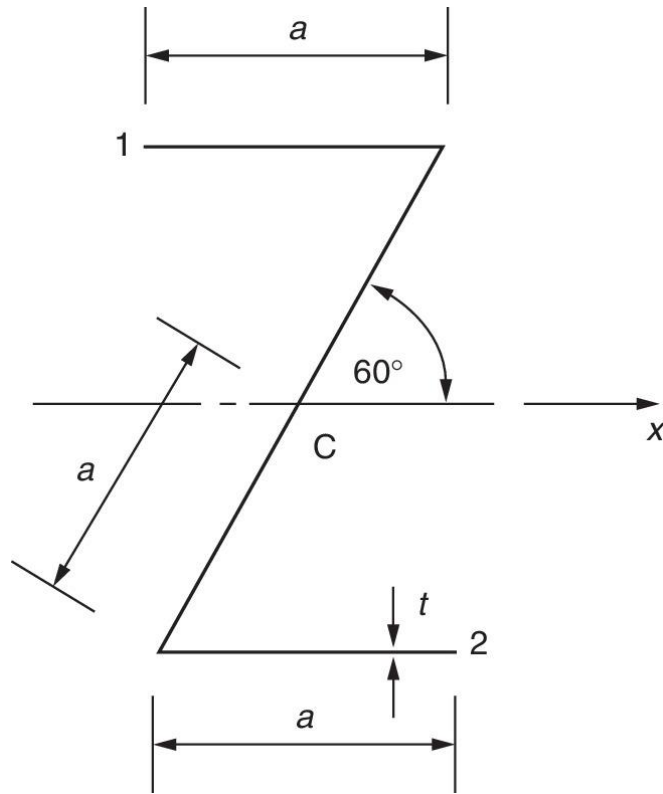


FIGURE P.16.6

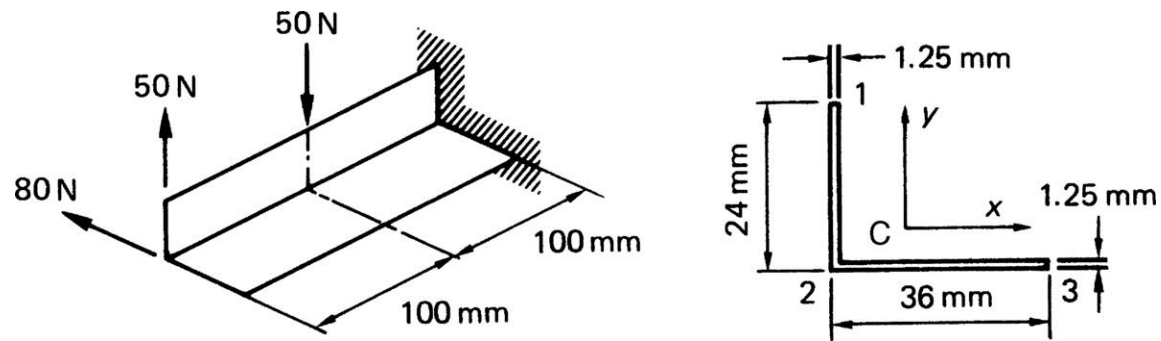


FIGURE P.16.7

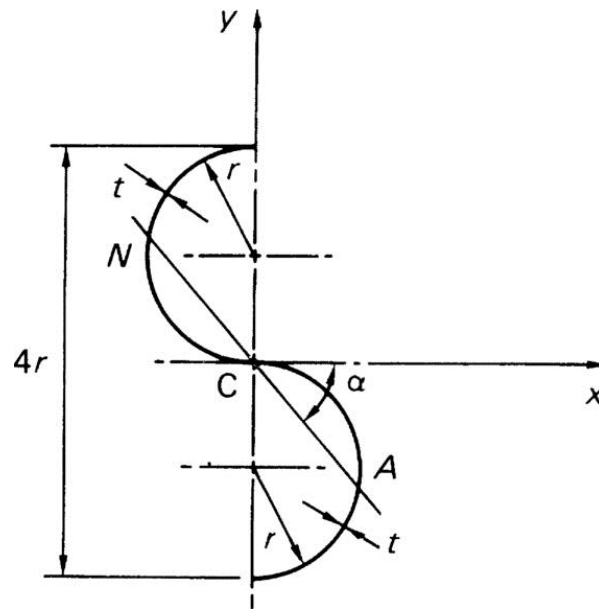


FIGURE P.16.8

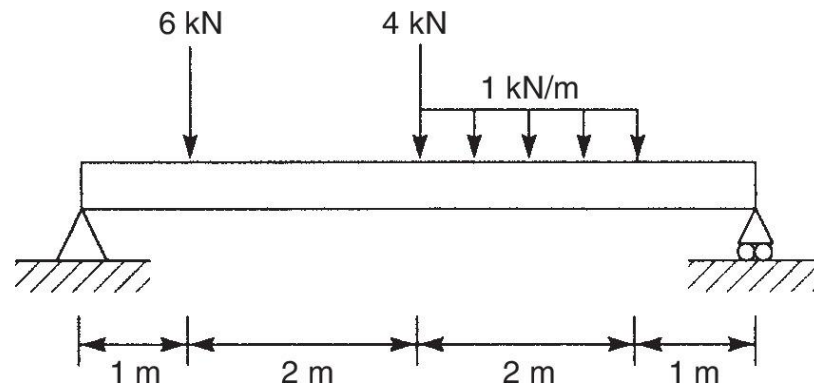


FIGURE P.16.11

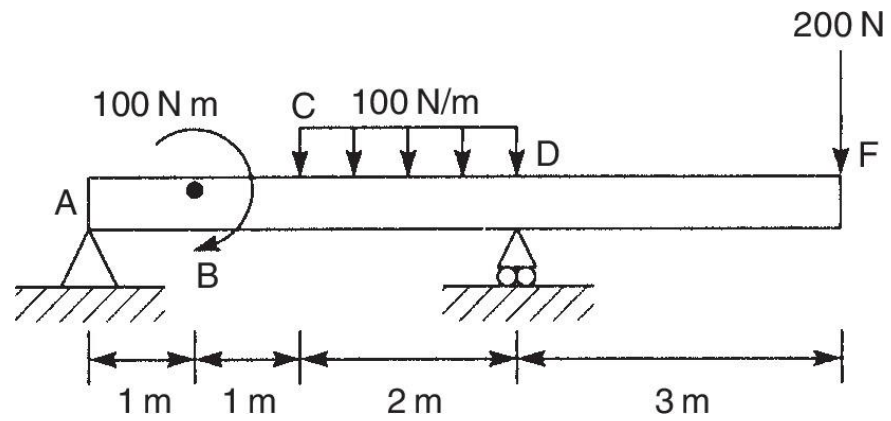


FIGURE P.16.12

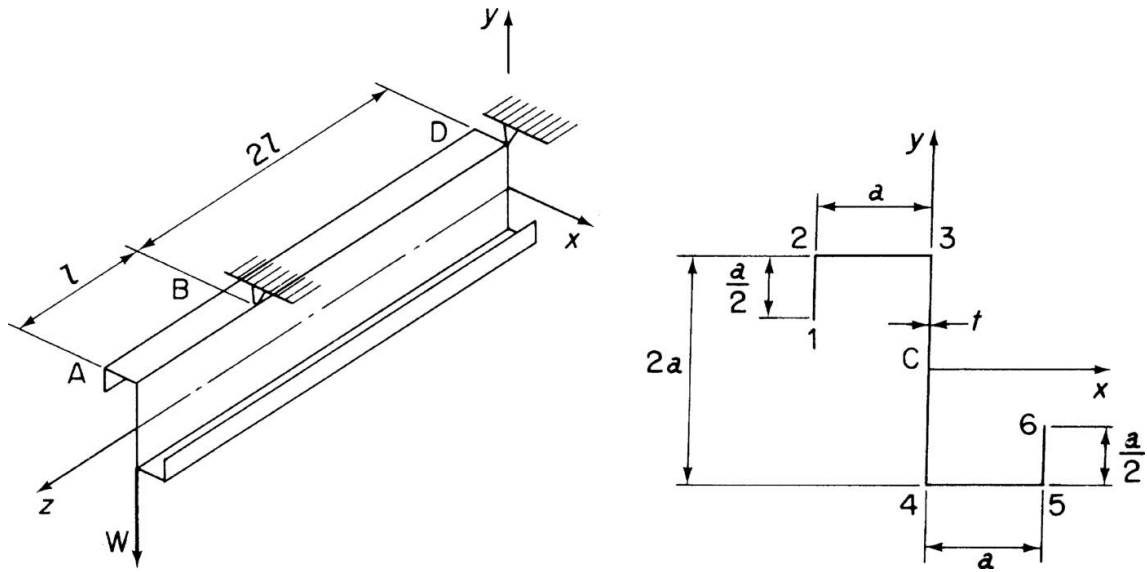


FIGURE P.16.13

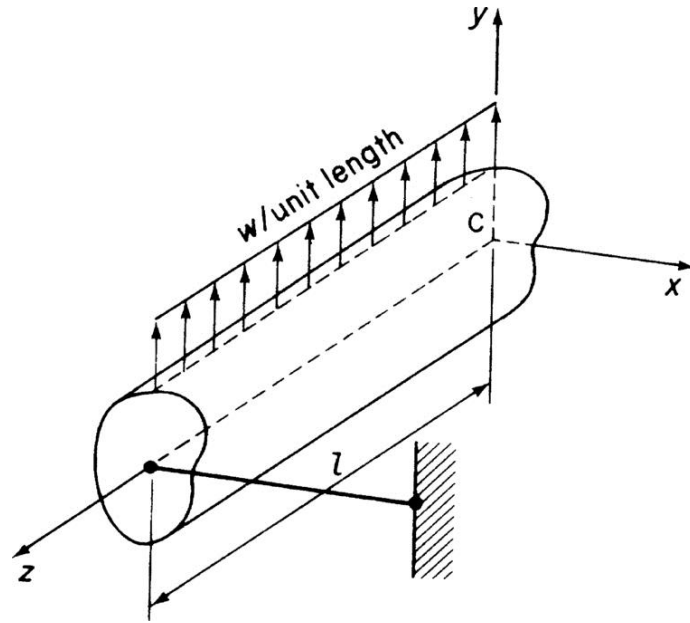


FIGURE P.16.14

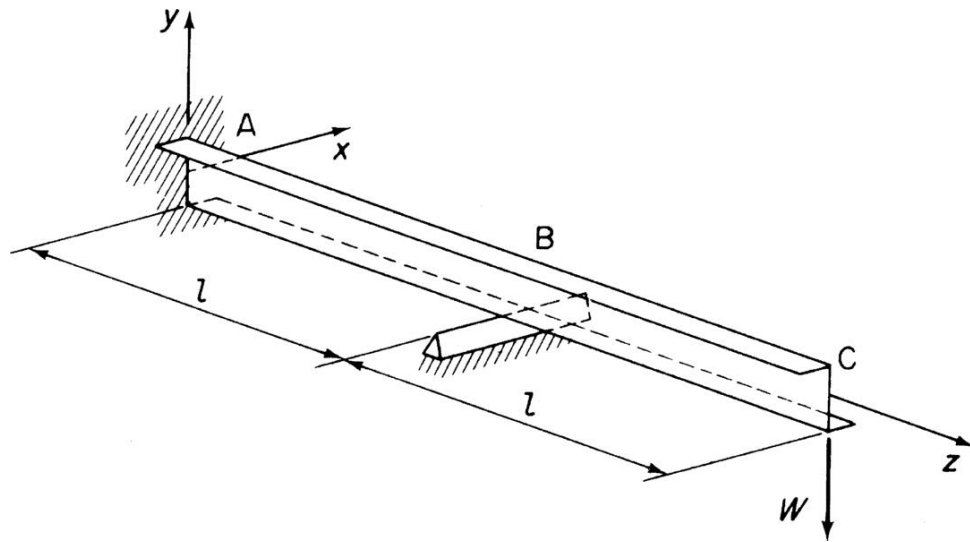


FIGURE P.16.15

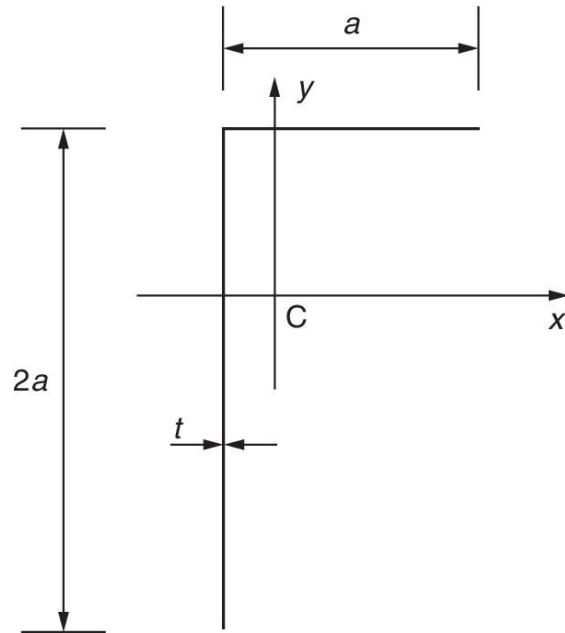


FIGURE P.16.17