1.6 The sign convention (positive direction of resultants) used in the beam theory depends on the coordinate system chosen. Consider the moment-curvature relation

$$M = -EI\frac{d^2w}{dx^2}$$

in reference to the coordinate system shown in Fig. 1.18. If *w* is regarded as a positive displacement (or deflection) in the positive y-direction, find the positive direction of the bending moment. State the reason.

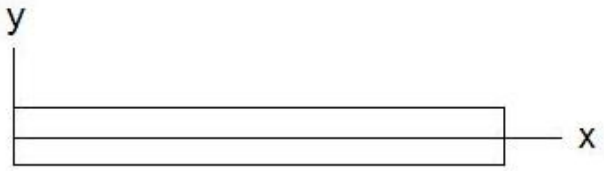
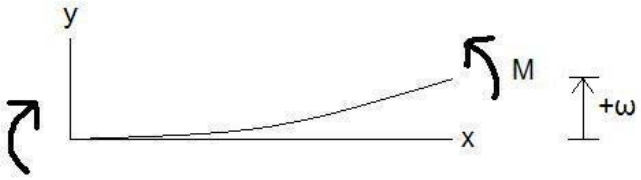


Figure 1.18 Coordinate system for a beam

Solution:

(1) The moment-curvature relation $M = -EI\frac{d^2w}{dx^2}$ gives that $\frac{d^2w}{dx^2}$ is always opposite in sign to *M*. (It is quite obvious that both *E* and *I* are always positive.).

(2) We can assume a moment M applying to the beam as shown below, which makes the beam concave upwards. It is not difficult to observe that the slope $\frac{dw}{dx}$ increases with increasing x and thus a positive $\frac{d^2w}{dx^2}$.



(3) By applying the statement (1), it is concluded that the deformation described in (2) is produced by a negative moment while a positive moment makes the beam concave downward as shown below..