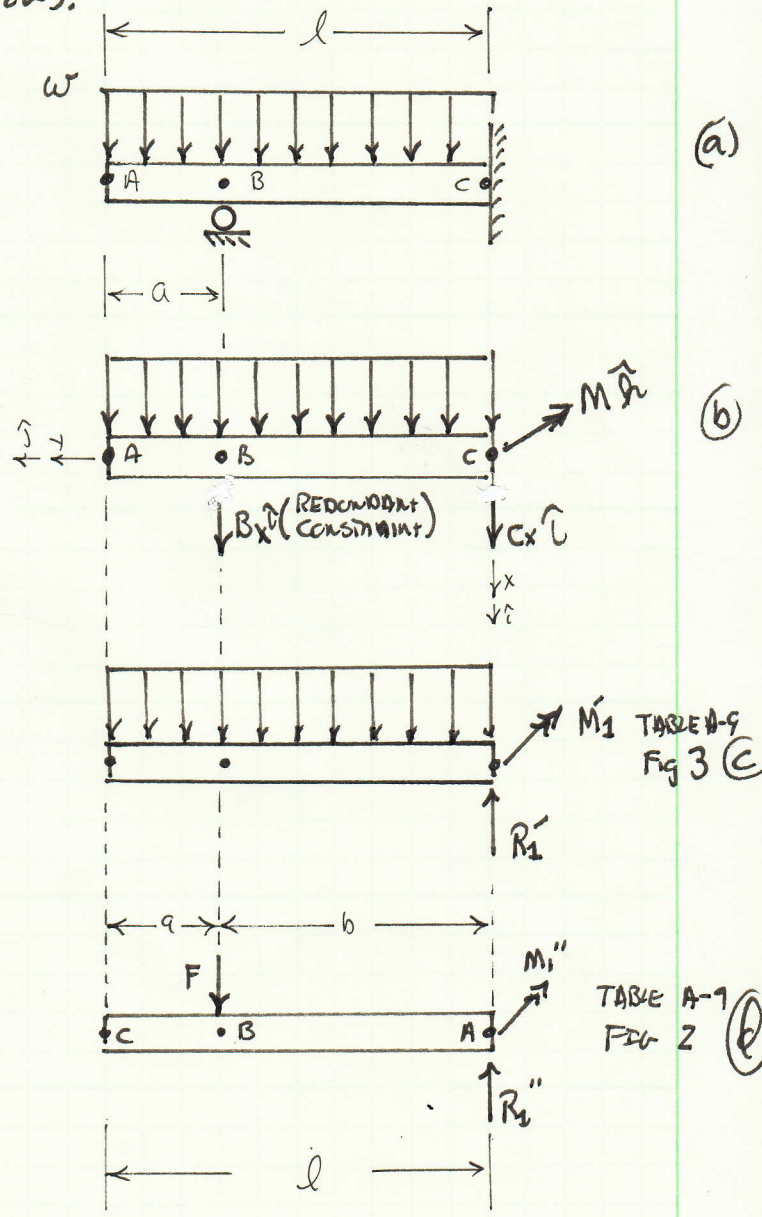
PROBLEM 4-98 | FOR THE BEAM SHOWN, DETERMINE THE SUPPORT REACTIONS USING SUPERPOSITION AND PROCEDURE 1 FROM SECTION 4-10.

GIVEN:
1. A BEAM OF LENGTH l THAT IS FIXED TO A WALL ON THE RIGHT SIDE
2. A ROLLER SUPPORT UNDER THE BEAM A DISTANCE a FROM THE LEFT SIDE.
3. A DISTRIBUTED LOAD ALONG THE LENGTH OF THE BEAM

ASSUMPTIONS:
1. THE BEAM IS INITIALLY STRAIGHT
2. THE BEAM IS ISOTROPIC AND LINEAR-ELASTIC
3. SMALL DEFLECTIONS RESULT FROM THE APPLIED LOADS
4. DEFORMATION IN THE HORIZONTAL DIRECTION IS NOT RESTRICTED

FIND:
1. DETERMINE THE SUPPORT REACTIONS.

FIGURES



$$R_1' = wl$$
$$M_1' = wl^2/2$$

$$u' = \frac{W \cdot y}{24EI}\left[6l^2 + y^2 - 4l \cdot y\right]$$

$$R_1'' = F$$
$$M_1'' = F \cdot b$$

$$y''_{AB} = \frac{F \cdot y^2}{6EI}(3b - x)$$

$$y''_{BC} = \frac{Fb^2}{6EI}(3l - b)$$

Solution:

Because there are two equations of equilibrium and three unknowns, this is an indeterminate problem. The first step will be to choose B_x as the redundant constraint and seperate the beam as shown in (b)-(c)-(d). The third equation is the kinematic condition

$$u(b) = 0 = u'(b) + u''(b)$$

$$R = R_1' + R_1'' = \omega \cdot l + F$$

$$M = \frac{\omega \cdot l^2}{2} + \frac{F}{b}$$

F is the unknown pseudo load that needs to be solved for. Applying the kinematic constraint

$$0 = \frac{F \cdot (l-a)^3}{3EI} + \frac{\omega \cdot (l-a)^2}{24EI}\left[4 \cdot l \cdot (l-a) - (l-a)^2 - 6l^2\right]$$

$$\Rightarrow F = \frac{\omega}{8(l-a)} \cdot (3l^2 + 2al + a^2)$$

$$R = \frac{\omega}{8(l-a)}(5l^2 - 10al - a^2)$$

$$M = \frac{\omega}{8}(l^2 - 2al - a^2)$$

Summary

The superposition technique applied to redundant constraints requires the creation of a kinematic constraint.