FUNDAMENTALS OF STRUCTURAL ANALYSIS

3rd Edition

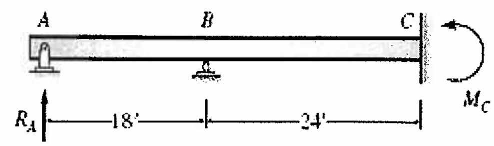
Kenneth M. Leet, Chia-Ming Uang, and Anne M. Gilbert

SOLUTIONS MANUAL

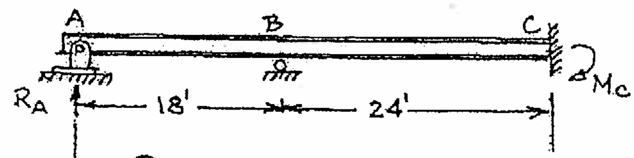
CHAPTER 14:

INDETERMINATE STRUCTURES: INFLUENCE LINES

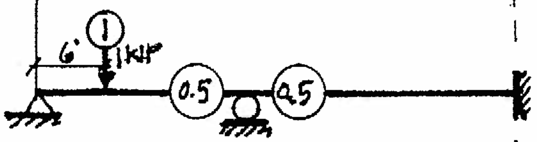
P14.1 Construct the influence lines for the vertical reaction at support *A* and the moment at support *C*. Evaluate the ordinates at 6 ft intervals of the influence line. *EI* is constant.



P14.1



LOAD @ ①:

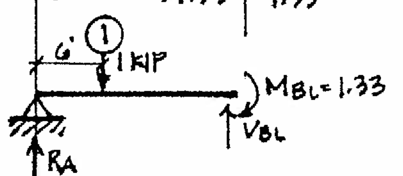


FEM	−2.67	+1.33	0	0
DEM	+2.67	COM → +1.33		
DEM		−1.33	−1.33	COM → −0.67
FINAL	0	+1.33	−1.33	−0.67 = M_C

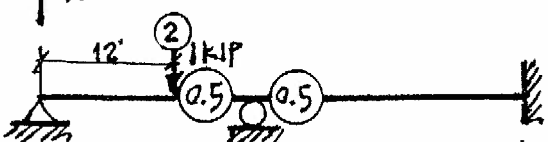
FBD: $\Sigma M_B = 0$

$R_A(18') - 1^K(12') + 1.33 = 0$

$R_A = +0.593$



LOAD @ ②:

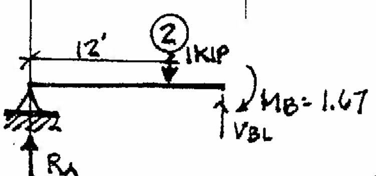


FEM	−1.33	+2.67	0	0
DEM	+1.33	COM → +0.67		
DEM		−1.67	−1.67	COM → −0.833
FINAL	0	+1.67	−1.67	−0.833 M_C

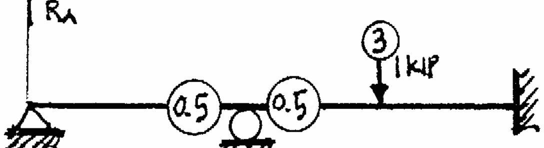
FBD: $\Sigma M_B = 0$

$R_A(18') - 1^K(6') + 1.67 = 0$

$R_A = +0.241$



LOAD @ ③:

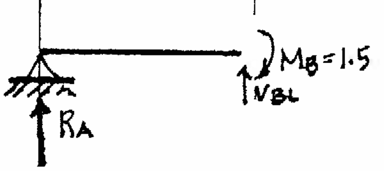


FEM			−3	+3
DEM		+1.5	+1.5	+0.75
	0	+1.5	−1.5	+3.75 = M_C

FBD: $\Sigma M = 0$

$R_A(18') + 1.5 = 0$

$R_A = -0.083$



MOMENT DISTRIBUTION

DISTRIBUTION FACTORS:

$K_{AB} = (I/18)3/4 = I/24$

$K_{BC} = I/24$

$DF_{BA} = 0.5$

$DF_{BC} = 0.5$

LOAD @ ①:

$FEM_{AB} = -\frac{Pab^2}{L^2} = -\frac{1(6)(12)^2}{(18)^2}$

$= -2.67$

$FEM_{BA} = +\frac{Pa^2b}{L^2}$

$= +1.33$

LOAD @ ② MAGNITUDES

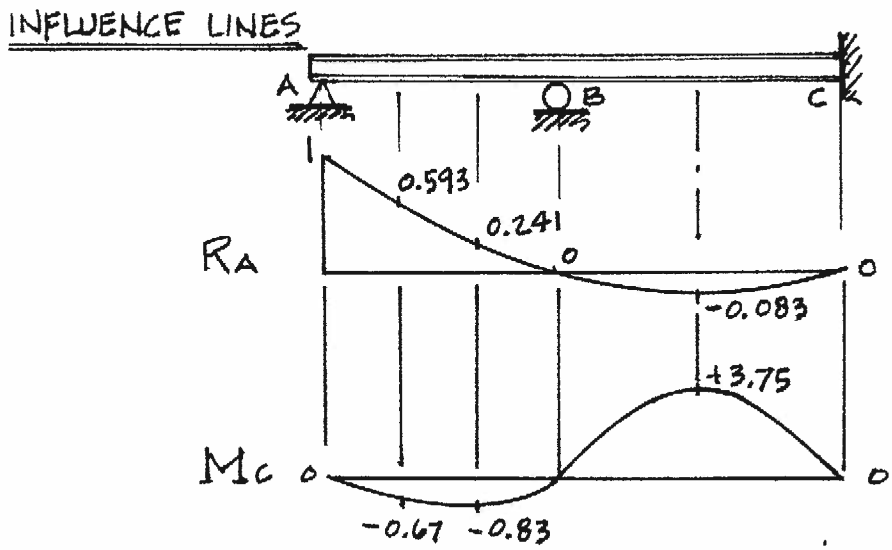
LOAD @ ③

$FEM_{BC} = -\frac{PL}{8} = -3$

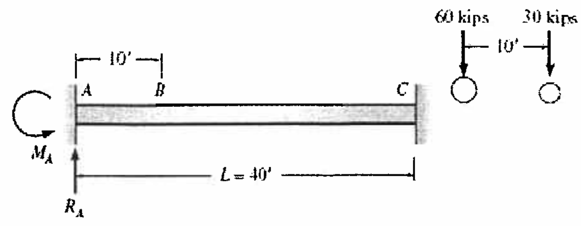
$FEM_{CB} = +\frac{PL}{8} = +3$

P14.1 Continued

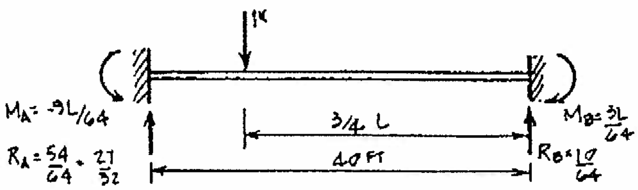
P14.1 Continued



P14.2 (*a*) Using moment distribution, construct the influence lines for the moment and the vertical reaction R_A at support *A* for the beam in Figure P14.2. Evaluate the influence line ordinates at the quarter points of the span. (*b*) Using the influence lines for reactions, construct the influence line for moment at point *B*. Compute the maximum value of R_A produced by the set of wheel loads.



P14.2



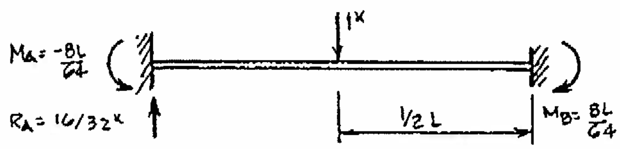
$M_A = FEM_{AB} = -Pab^2/L^2 = -9L/64$

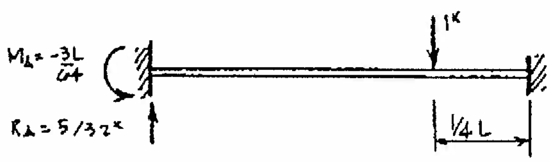
$M_B = FEM_{BA} = Pba^2/L^2 = 3L/64$

$\Sigma M_B = 0$

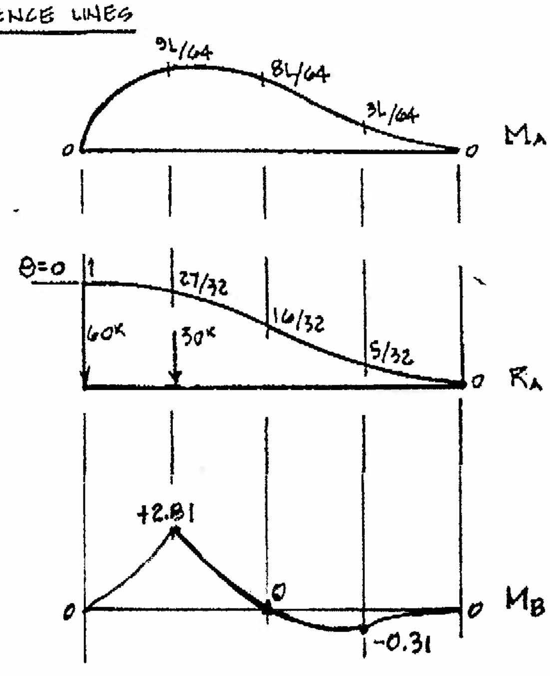
$R_A L - 1(3/4\ L) - 9L/64 + 3L/64 = 0$

$R_A = 54/64$





INFLUENCE LINES



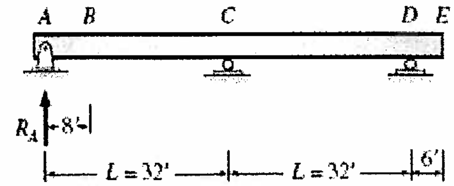
$MAX\ R_A = 60^K(1) + 30^K(27/32) = 85.31^K$

LOAD @ 1/4 L: $\frac{27}{32}(10) - \frac{9(40)}{64} = 2.81$ FT·K

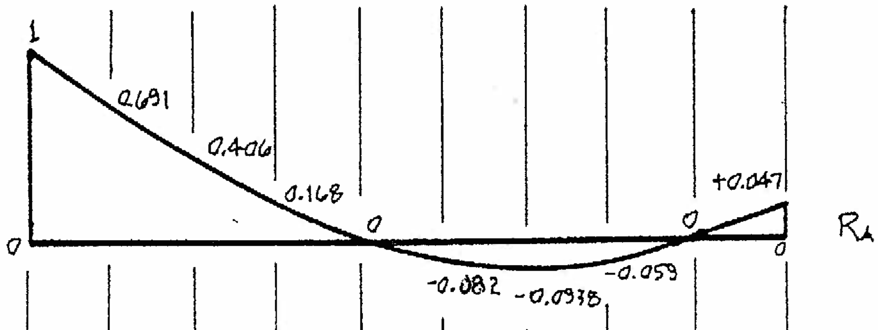
LOAD @ 1/2 L: $\frac{16}{32}(10) - \frac{8(40)}{64} = 0$

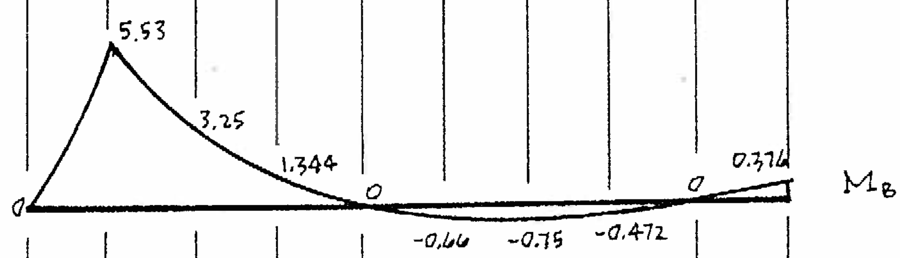
LOAD @ 3/4 L: $\frac{5}{32}(10) - \frac{3(40)}{64} = -0.31$ FT·K

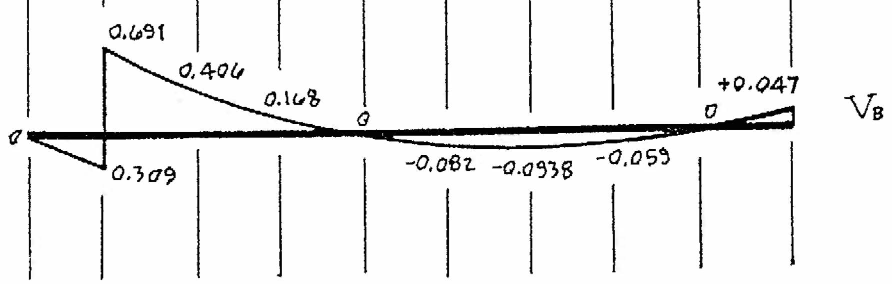
P14.3 Using moment distribution, construct the influence lines for the reaction at *A* and the shear and moment at section *B* (Figure P14.3). Evaluate influence line ordinates at 8-ft intervals in span *AC* and *CD* and at *E*. *EI* is constant.



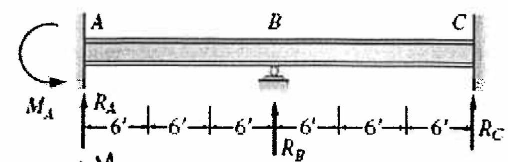
P14.3



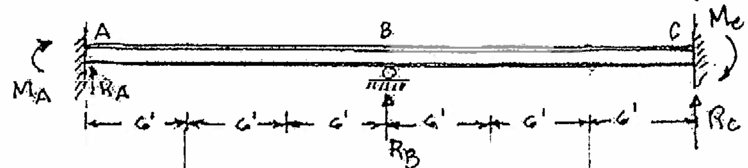




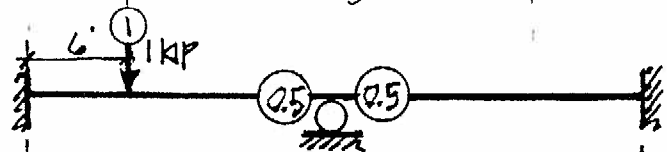
P14.4 Construct the influence lines for R_A, R_B, R_C, and the moments at supports *A* and *B*. Evaluate the ordinates at 6 ft intervals. *EI* is constant.



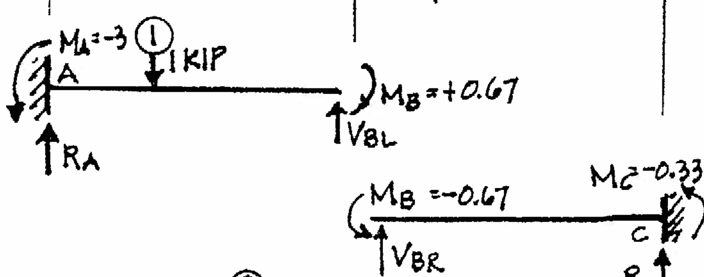
P14.4



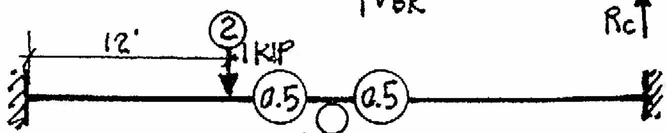
LOAD @ ①:



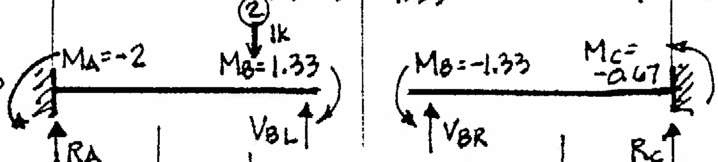
	A	BA	BC	C
FEM	-2.67	+1.33	0	0
DEM	-0.33 ← COM	-0.67	-0.67	COM → -0.33
FINAL	-3.0	+0.67	-0.67	-0.33



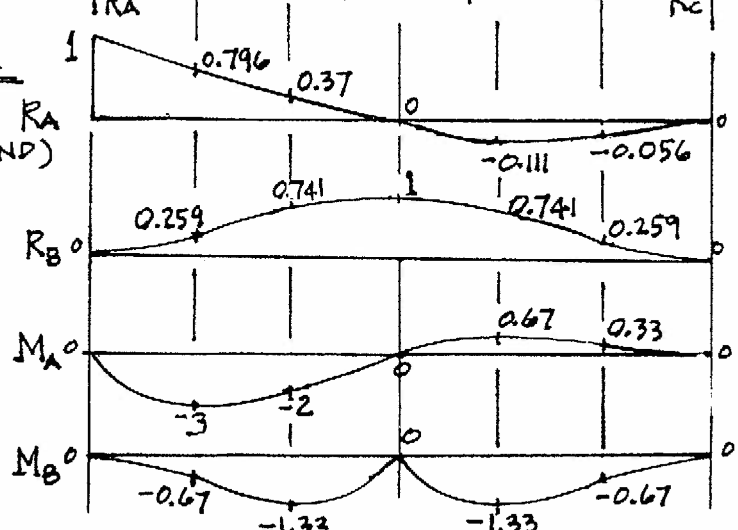
LOAD @ ②:



	A	BA	BC	C
FEM	-1.33	+2.67	0	0
DEM	-0.67	-1.33	-1.33	-0.67
FINAL	-2	+1.33	-1.33	-0.67



INFLUENCE LINES
(R_C OPP. HAND)



MOMENT DISTRIBUTION

LOAD @ ①:

$FEM_{AB} = -Pab^2/L^2 = -2.67$

$FEM_{BA} = +Pa^2b/L^2 = +1.33$

FBD: LEFT OF B : $\Sigma M_B = 0$

$R_A(18') - 1(12') - 3 + 0.67 = 0$

$R_A = 0.796\uparrow$

$+\uparrow \Sigma F_Y = 0;$

$V_{BL} + 0.796 - 1 = 0$

$V_{BL} = 0.204\uparrow$

FBD: RIGHT OF B : $\Sigma M_B = 0$

$-0.67 - 0.33 - R_C(18) = 0$

$R_C = -0.056$

$+\uparrow \Sigma F_Y = 0$

$V_{BR} - 0.056 = 0$

JT. B EQUILIBRIUM:

$R_B = V_{BL} + V_{BR} = 0.26\uparrow$

LOAD @ ②:

FBD: LEFT OF B : $\Sigma M_B = 0$

$R_A(18) - 2 - 1(6') + 1.33 = 0$

$R_A = 0.37\uparrow$

$+\uparrow \Sigma F_Y = 0;$ $V_{BL} + 0.37 - 1 = 0$

$V_{BL} = 0.63\uparrow$

FBD: RIGHT OF B: $\Sigma M_B = 0$

$-R_C(18') - 1.33 - 0.67 = 0$

$R_C = 0.111\downarrow$

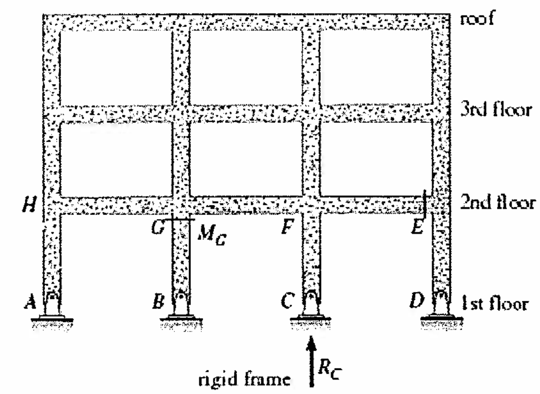
$+\uparrow \Sigma F_Y = 0;$ $V_{BR} - R_C = 0$

$V_{BR} = 0.111\uparrow$

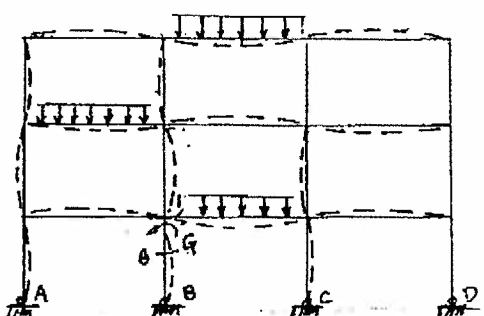
JT. B EQUILIBRIUM

$R_B = V_{BL} + V_{BR} = 0.741\uparrow$

P14.5 (*a*) Draw the qualitative influence lines for (1) the moment at a section located at the top of the first-floor column *BG* and (2) the vertical reaction at support *C*. Columns are equally spaced. (*b*) Indicate the spans on which a uniformly distributed load should be placed to maximize the moment on a section at the top of column *BG*. (*c*) Draw a qualitative influence line for negative moment on a vertical section through the floor beam at *E*.

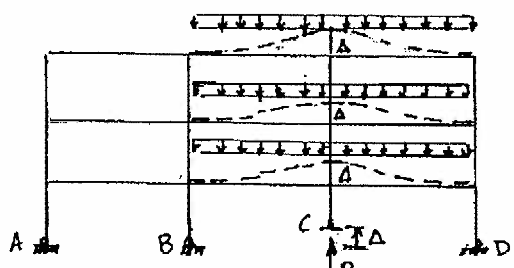


P14.5



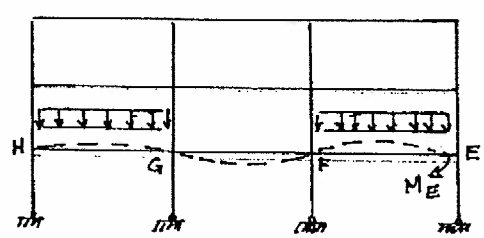
(a)

NOTE: FOR MAX. MOMENT AT "G", LOAD ALTERNATE FLOORS ON EITHER SIDE OF COLUMN.



(b)

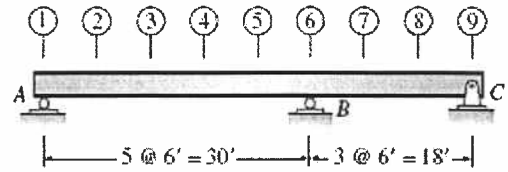
AXIAL LOAD AT SUPPORT "C"



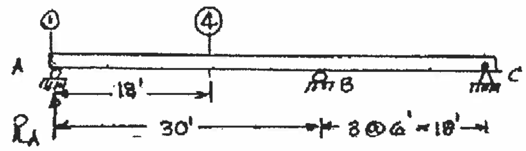
(c)

LOADING TO MAXIMIZE NEG. MOMENT AT E

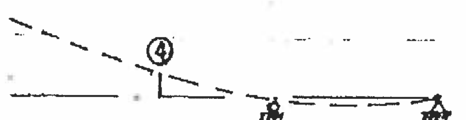
P14.6 (*a*) Draw a qualitative influence line for the reaction at support *A* for the beam in Figure P14.6. Using *moment distribution*, calculate the ordinate of the influence line at section 4. (*b*) Draw the qualitative influence line for the moment at *B*. Using the *conjugate beam or moment distribution method*, calculate the ordinate of the influence line at Section 8. *EI* is constant.

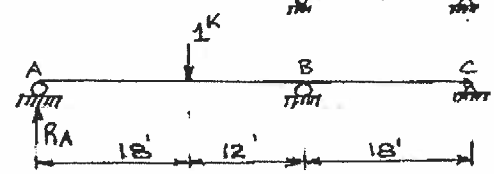


P14.6



(a) INF. LINE FOR R_A





use Moment Distri.

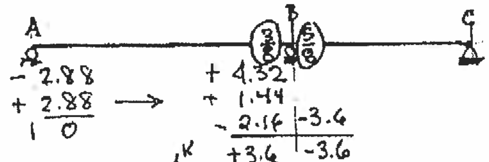
$K_{AB} = \frac{I}{30} \times \frac{3}{4} = \frac{I}{40} = \frac{3I}{120}$ D.F. 3/8

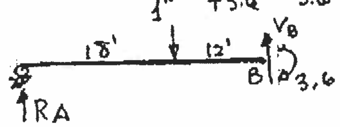
$K_{BC} = \frac{I}{18} \times \frac{3}{4} = \frac{I}{24} = \frac{5I}{120}$ 5/8

$\Sigma K's = 8I/120$

$FEM_{AB} = -\frac{Pab^2}{L^2} = -\frac{1(18)12^2}{30^2} = -2.88$

$FEM_{BA} = \frac{Pba^2}{L^2} = \frac{1(12 \times 18^2)}{30^2} = 4.32$ kip·ft

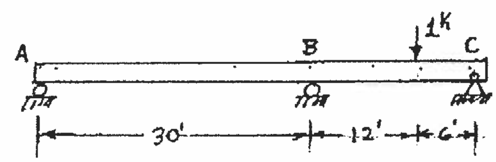




$\Sigma M_B = 0 = R_A 30 - 1 \times 12 + 3.6$

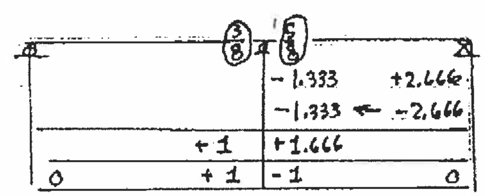
$R_A = 0.28$ kips

(b). QUALITATIVE INFLU. LINE FOR M_B



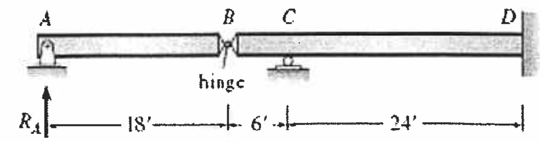
$FEM_B = \frac{Pab^2}{L^2} = -\frac{1(12)6^2}{18^2} = -1.333$ k·ft

$FEM_{CB} = \frac{Pba^2}{18^2} = \frac{1(6)12^2}{324} = 2.666$ k·ft

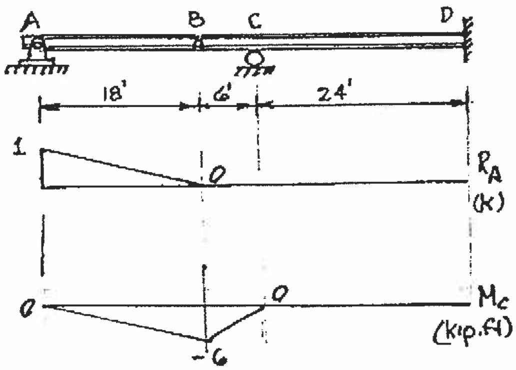


ORDINATE OF I.L. at 8 = -1 kip·ft

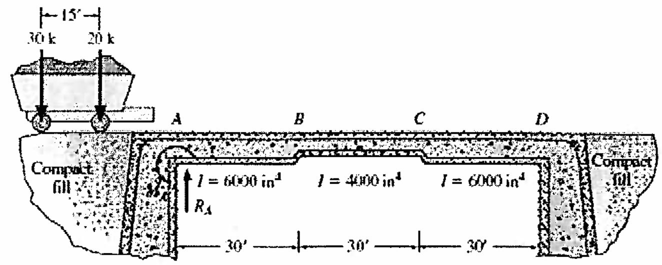
P14.7 Construct the influence lines for R_A and M_C in Figure P14.7, using the Müller–Breslau method. Evaluate the ordinates at points A, B, C, and D. EI is constant.



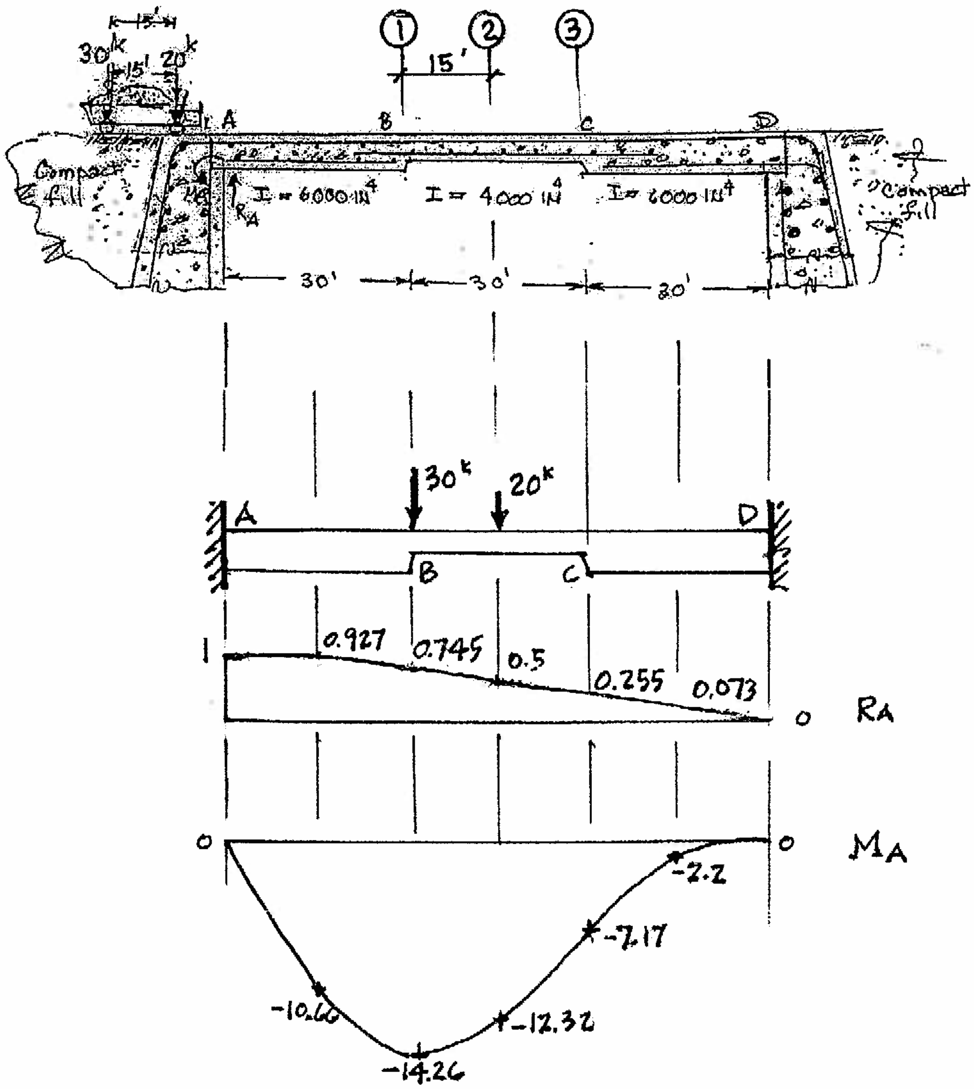
P14.7



P14.8 *Computer analysis of beam of varying depth.* The reinforced concrete bridge girder, attached to the massive end wall as shown in Figure P14.8, may be treated as a fixed-ended beam of varying depth. (a) Construct the influence lines for the reactions R_A and M_A at support A. Evaluate the ordinates at 15-ft intervals. (b) Evaluate the moment M_A and the Vertical reaction R_A at end A produced by the loaded orecarrier when its 30-kip rear wheel is positioned at point B. E = 3000 kips/in^2.



P14.8



$R_A = 30^k(0.745) + 20^k(0.5) = \underline{\underline{32.35^k}}$

$M_A = 30^k(-14.26) + 20^k(-12.32) = \underline{\underline{674.2 \text{ FT}\cdot\text{K}}}$ ↺