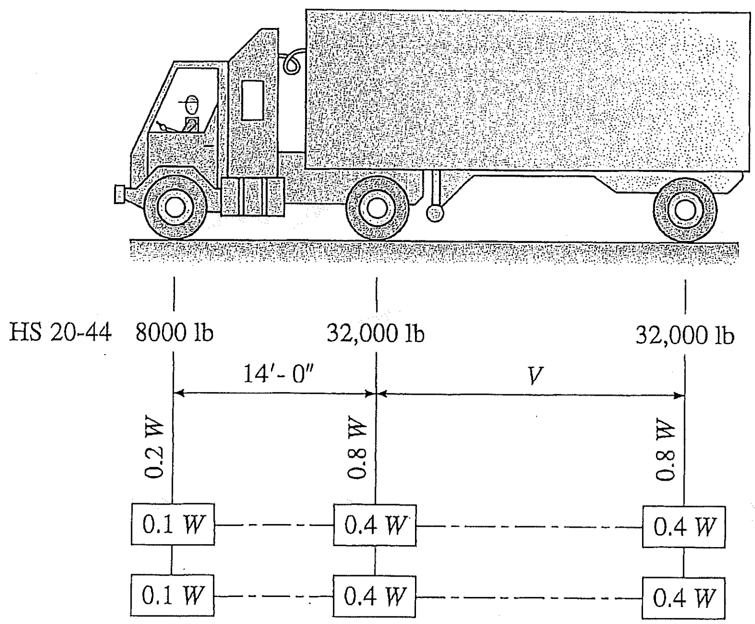
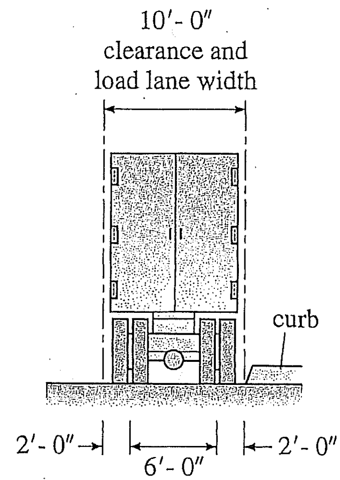
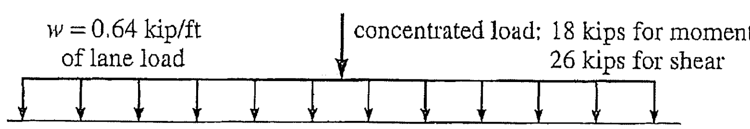




American Association of State Highway and Transportation Officials (ASSHTO) requires major highway bridges must be designed to carry in each lane either the standard 72-kip HS 20-44 truck (Fig 25a), or a lane loading consisting of the uniformly distributed and concentrated loads shown in Fig 25(b).

W = Combined weight on the first two axles, which is the same as for the corresponding H truck
V = Variable spacing – 14 ft to 30 ft inclusive. Spacing to be used is that which produces maximum stresses.

(*a*)



(*b*)

Figure 8.25: Lane loads used to design highway bridges; (*a*) standard 72-kip, HS 20-44 truck; or (*b*) uniform load plus concentrated load which is positioned to maximize force in structure.

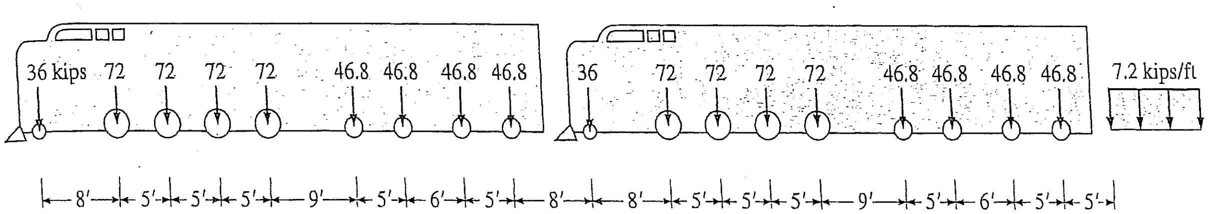


Figure 8.26: Cooper E-72 train for design of railroad bridges (wheel loads in kips).

American Railway Engineering and Maintenance of Way Association (AREMA) specifications require that bridges are designed for a train composed of two engines followed by a line of railroad cars.

Leet & Uang §14.1 – 14.5

Construction using moment distribution

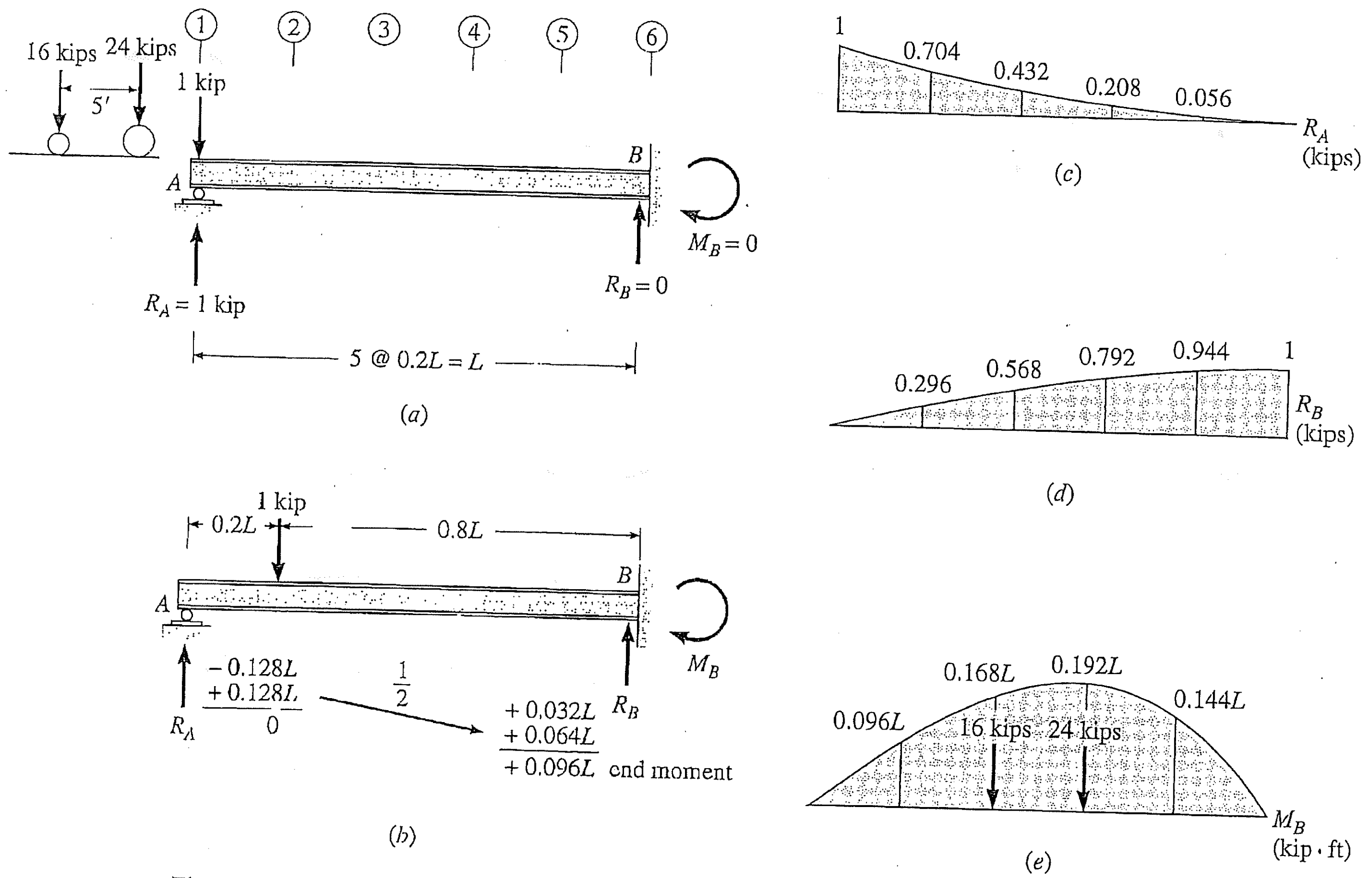
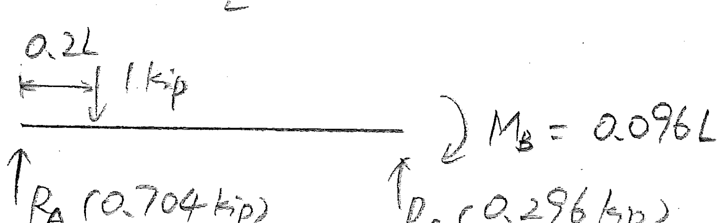


Figure 14.1: (*a*) Unit load at support *A*; (*b*) unit load 0.2*L* to right of support *A*; (*c*) influence line for reaction at *A*; (*d*) influence line for vertical reaction at *B*; (*e*) influence line for moment at support *B*.

(a) At 0.2L, $FEM_{AB} = -\frac{Pab^2}{L^2} = -\frac{1\cdot(0.2L)(0.8L)^2}{L^2} = -0.128L$

$FEM_{BA} = \frac{Pba^2}{L^2} = +0.032L$



(b) $0.168L \times 16\text{ kps} + 0.192L \times 24\text{ kps} = 7.296L = 182.4\text{ kip}\cdot\text{ft}$

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Müller - Breslau Principle

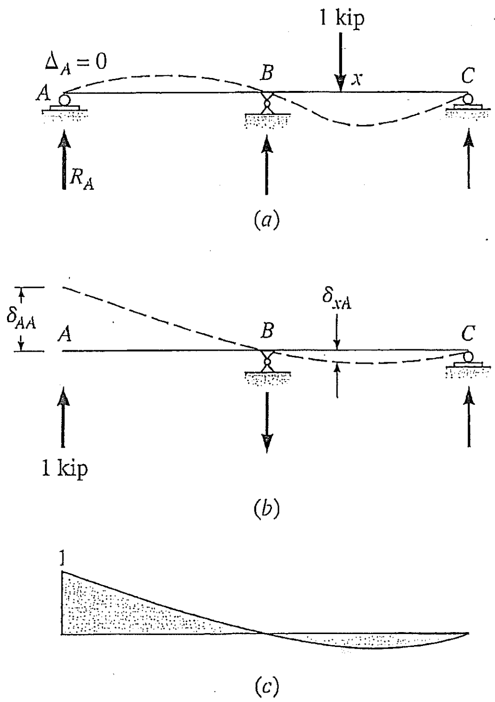


Figure 14.3: (*a*) Unit load used to construct influence line for R_A; (*b*) unit load used to introduce a displacement into the released structure; (*c*) influence line for R_A.

Betti's law applied to the structure with two different support conditions: virtual work done by forces of the first system acting thru the displacements of the second system is equal to the virtual work done by the other way:

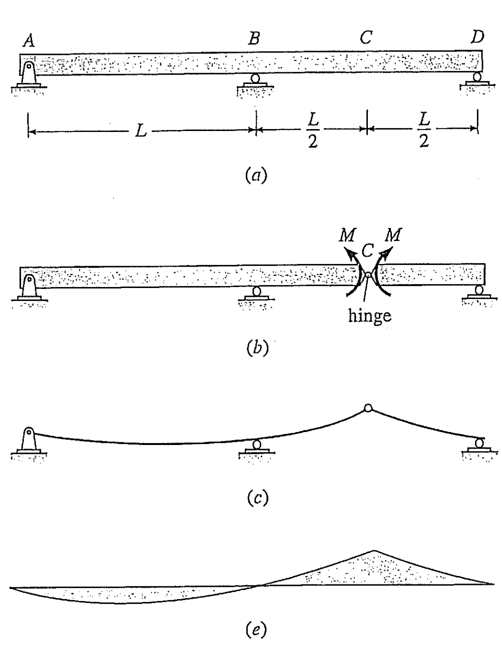
$$\Sigma F_1 \Delta_2 = \Sigma F_2 \Delta_1$$

$$R_A \cdot \delta_{AA} + 1\,\text{kip} \cdot \delta_{XA} = 0$$

$$R_A = -\frac{\delta_{XA}}{\delta_{AA}}$$

If $\delta_{AA} = 1$, i.e. unit deformation, then $R_A = -\delta_{XA}$

⇒ Müller-Breslau principle can be used to generate qualitative influence lines of indeterminate structs



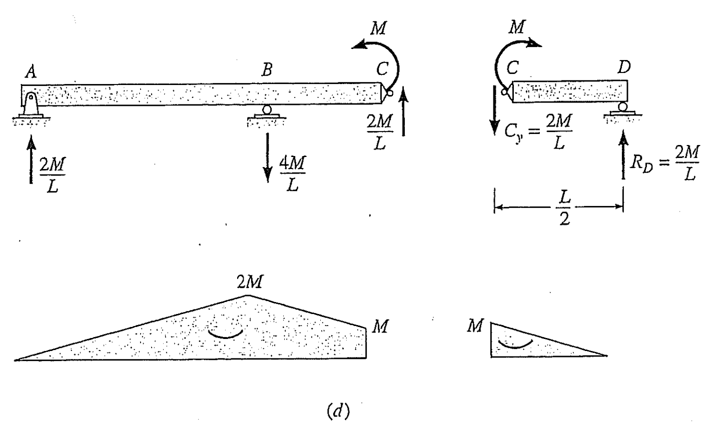


Figure 14.4: Construction of the influence line for moment at *C* by the Müller–Breslau method: (*a*) two-span beam; (*b*) released structure; (*c*) deflected shape produced by a displacement to the restraint removed at *C*; (*d*) moment curves to establish deflected shape of released structure; (*e*) influence line for moment *C*.

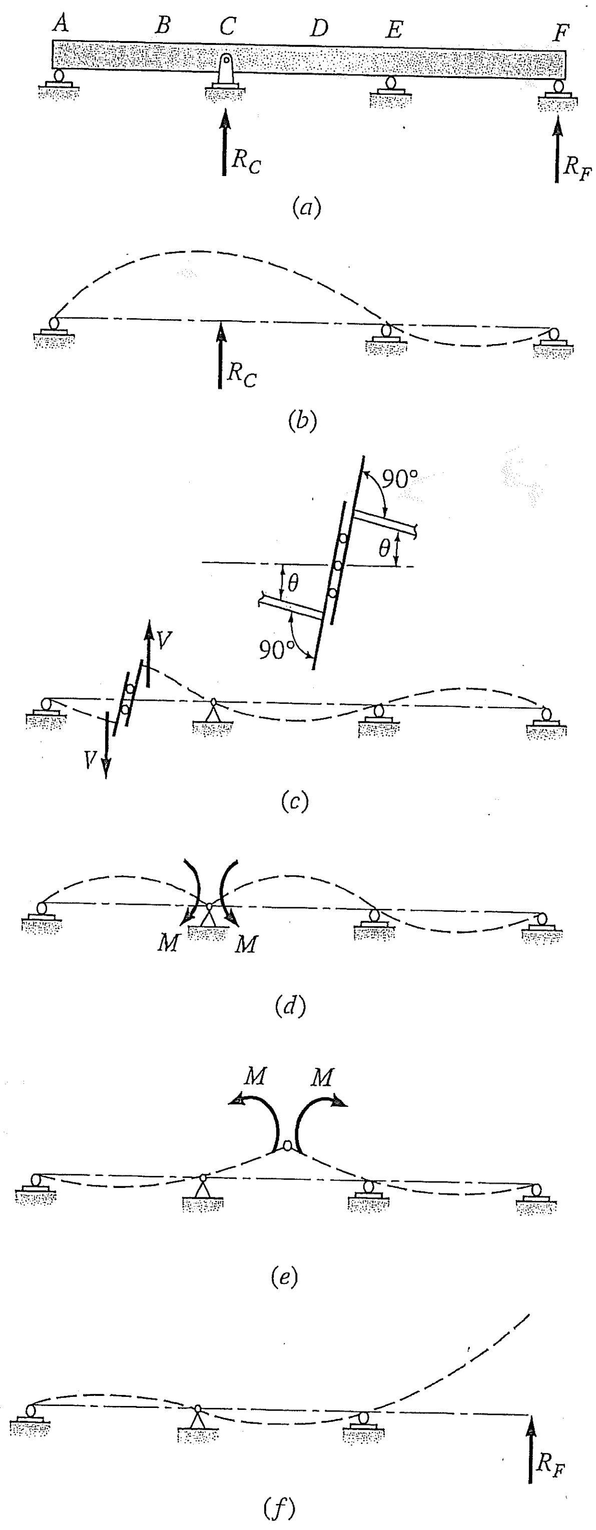


Figure 14.5: Construction of influence lines by the Müller–Breslau method for the three-span continuous beam in (*a*); (*b*) influence line for R_C; (*c*) influence line for shear at *B*; (*d*) influence line for negative moment at *C*; (*e*) influence line for positive moment at *D*; (*f*) influence line for reaction R_F.

The continuous beam in Figure 14.6a carries a uniformly distributed live load of 4 kips/ft. The load can be located over all or a portion of each span. Compute the maximum value of shear at midspan (point B) of member AC. Given: EI is constant.

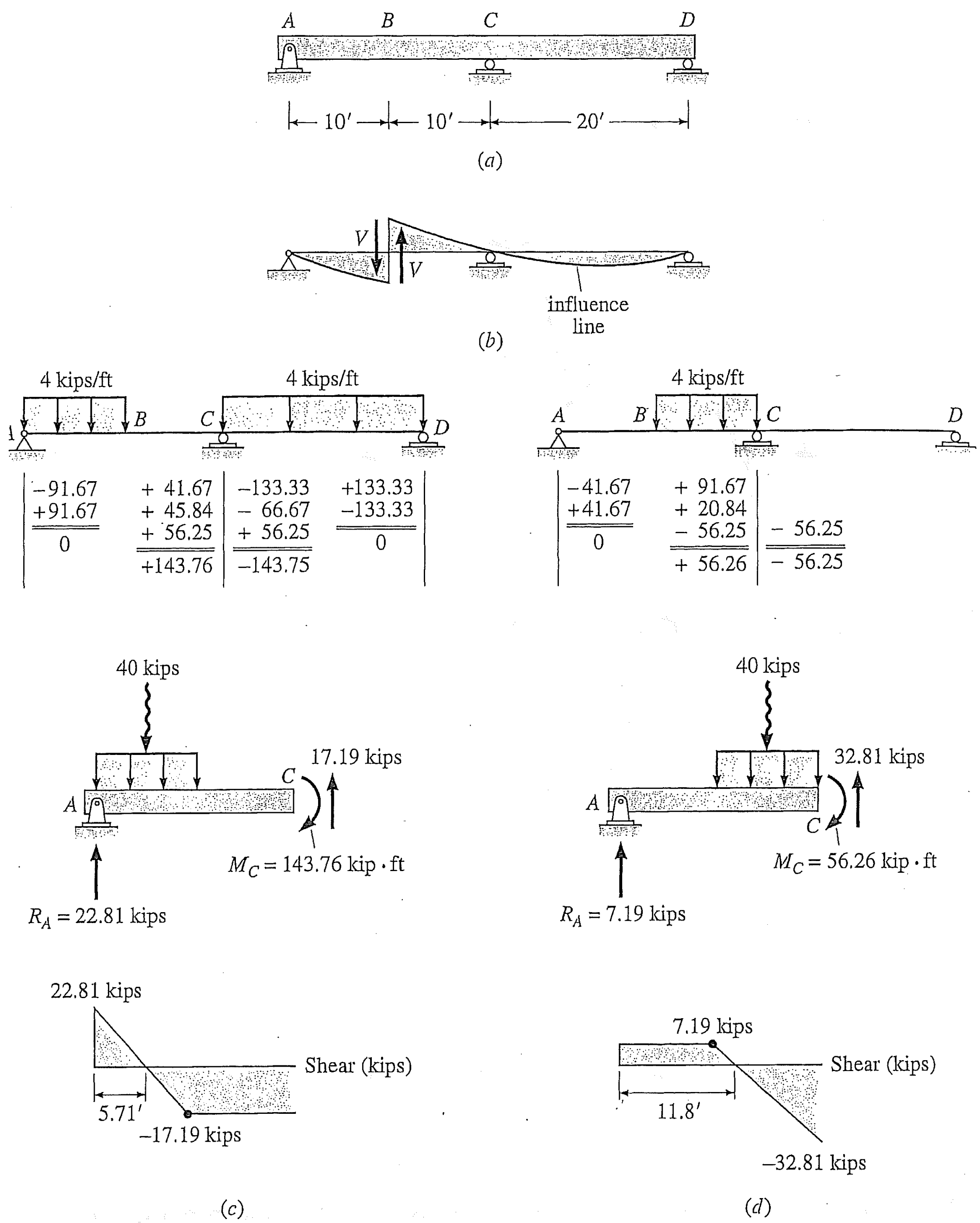


Figure 14.6: Computation of maximum shear at section B: (a) continuous beam (b) influence line for shear at B; (c) analysis of beam with distributed load placed to produce maximum negative shear of 17.19 kips at B; (d) analysis of beam with distributed loac positioned to produce maximum positive shear of 7.19 kips at B.

EXAMPLE 14.4

The continuous beam in Figure 14.7a carries a uniformly distributed live load of 3 kips/ft. Assuming that the load can be located over all or a portion of any span, compute the maximum values of positive and negative moment that can develop at midspan of member BD. Given: EI is constant.

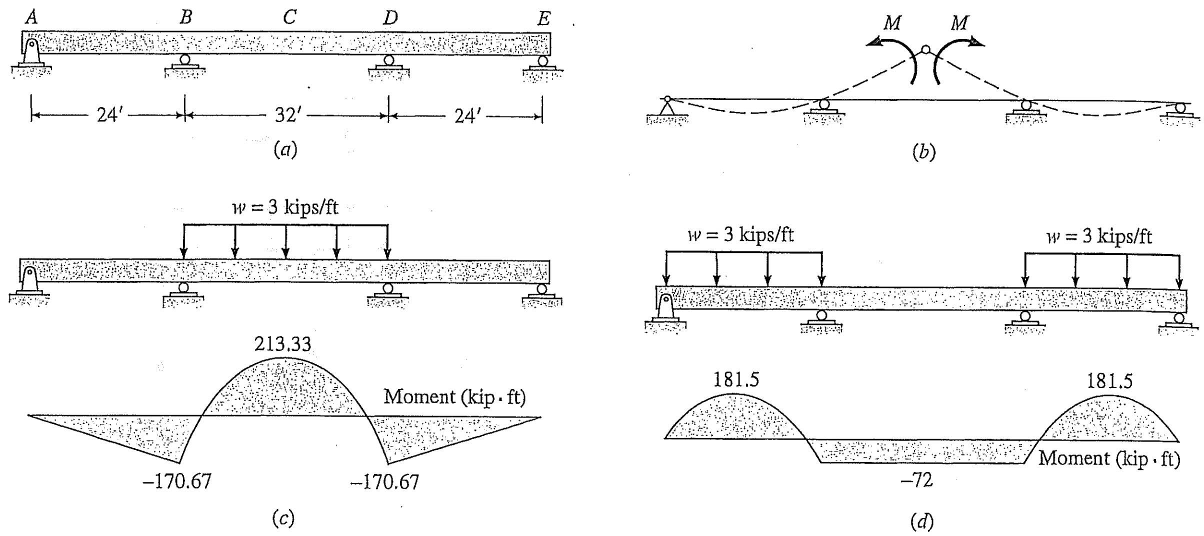


Figure 14.7: (a) Details of beam; (b) construction of qualitative influence line for moment at C; (c) load positioned to maximize positive moment at C; (d) load positioned to maximize negative moment at C.

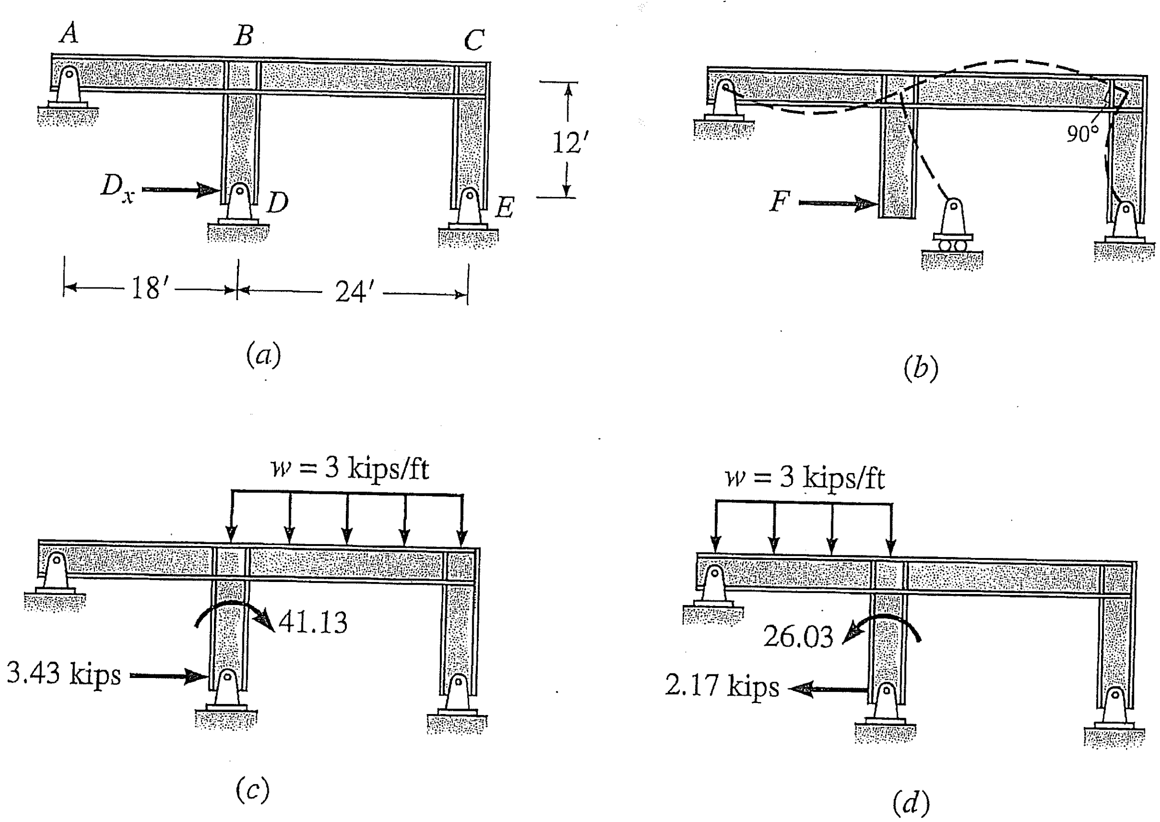


Figure 14.8: (a) Dimensions of frame; (b) establishing the shape of the influence line, horizontal restraint removed by replacing pin with a roller, dashed lines show the influence line; (c) position of load to establish maximum lateral thrust in positive sense (to the right); (d) position of load to produce maximum thrust in negative sense.

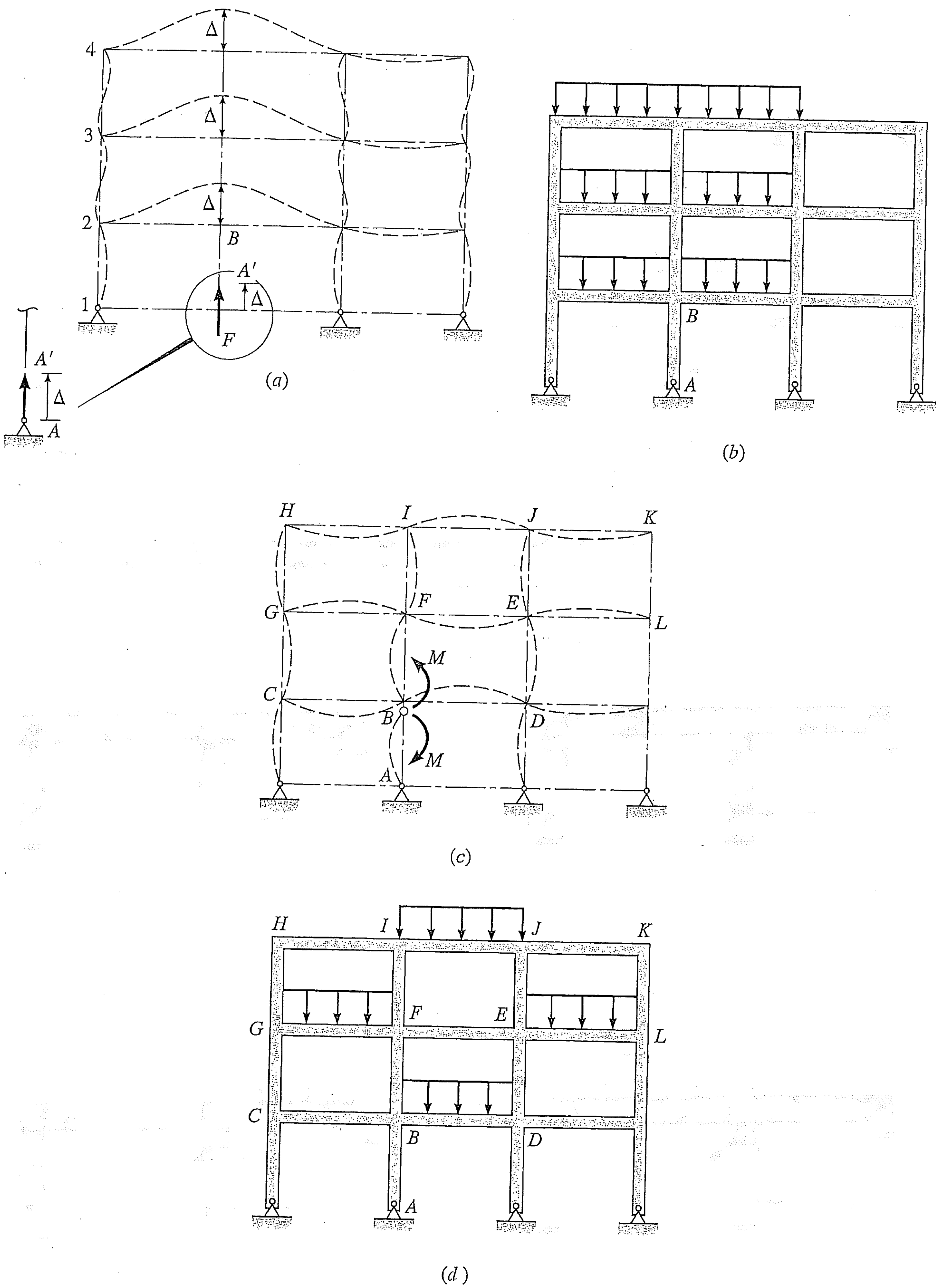


Figure 14.9: Pattern loading to maximize forces in columns: (*a*) influence line for axial load in column *AB*; (*b*) live load pattern to maximize axial force in column *AB*; (*c*) influence line for moment in column *AB*; (*d*) position of live load to maximize moment in column *AB*, and the axial force associated with maximum moment is approximately one-half that shown in (*b*) since a checkerboard pattern of loading is required.

Using the Müller–Breslau principle, construct the influence lines for positive moment at the center of span BC in Figure 14.10a and for negative moment in the girder adjacent to joint B. The frames have rigid joints. Indicate the spans on which a uniformly distributed live load should be positioned to maximize these forces.

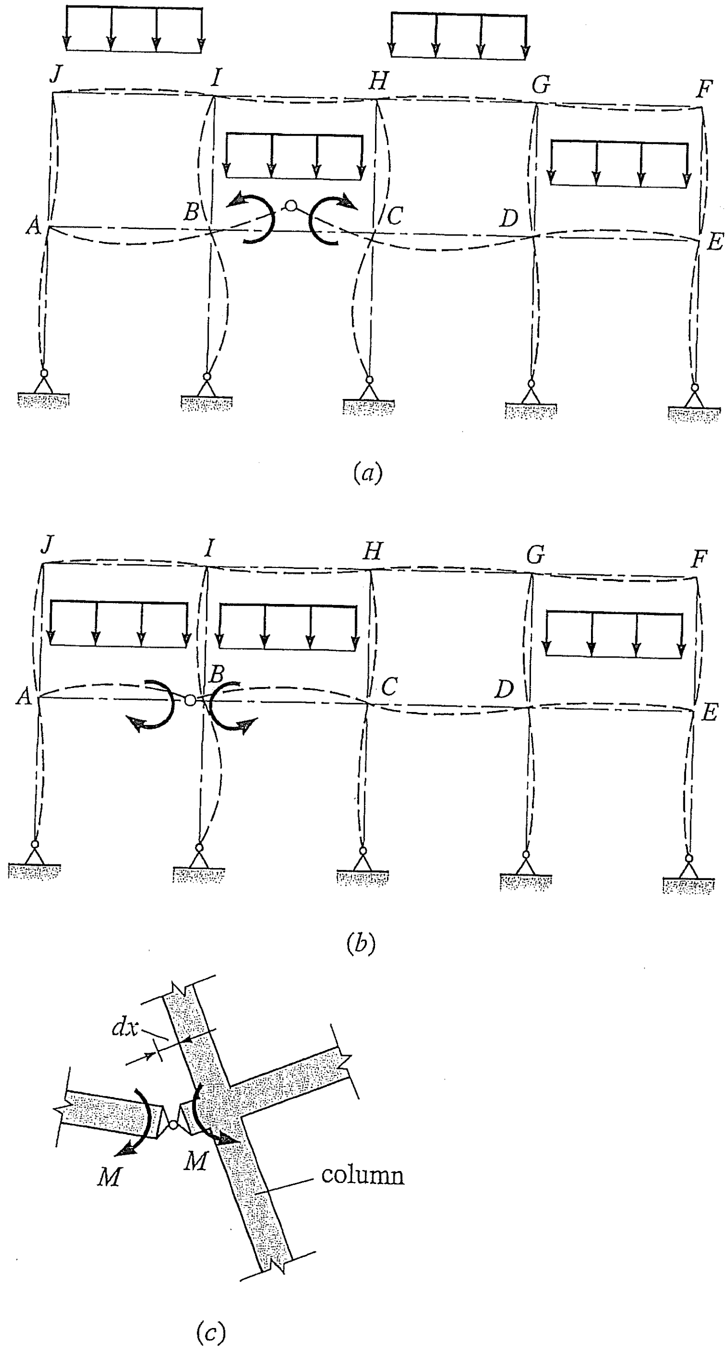


Figure 14.10: Positioning uniformly distributed loads to maximize positive and negative moments in continuous frames; (a) influence line for positive moment at midspan of beam BC; (b) influence line for negative moment in beam adjacent to a column; (c) detail of position of hinge for frame in (b).