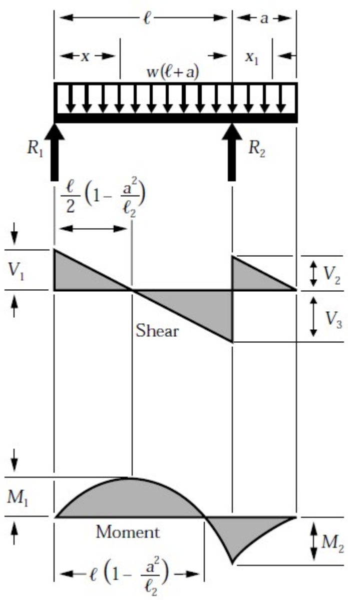
Overhanging Form Deck Deflection

Description

Calculate deflections for outer and middle form deck spans.

Deflection for Outer Form Decks (Uniformly Distributed Load)

Figure 18 Beam Overhanging One Support – Uniformly Distributed Load



$$R_1 = V_1 \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . = \frac{w}{2\ell}(\ell^2 - a^2)$$

$$R_2 = V_2 + V_3 \; . \; . \; . \; . \; . \; . \; . \; . = \frac{w}{2\ell}(\ell + a)^2$$

$$V_2 \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . = wa$$

$$V_3 \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . = \frac{w}{2\ell}(\ell^2 + a^2)$$

$$V_x \text{ (between supports)} \; . \; . \; . \; . = R_1 - wx$$

$$V_{x_1} \text{ (for overhang)} \; . \; . \; . \; . \; . \; . = w(a - x_1)$$

$$M_1 \left(\text{at } x = \frac{\ell}{2}\left[1 - \frac{a^2}{\ell^2}\right]\right) \; . \; . \; . = \frac{w}{8\ell^2}(\ell + a)^2(\ell - a)^2$$

$$M_2 \text{ (at } R_2) \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . = \frac{wa^2}{2}$$

$$M_x \text{ (between supports)} \; . \; . \; . \; . = \frac{wx}{2\ell}(\ell^2 - a^2 - x\ell)$$

$$M_{x_1} \text{ (for overhang)} \; . \; . \; . \; . \; . \; . = \frac{w}{2}(a - x_1)^2$$

$$\Delta_x \text{ (between supports)} \; . \; . \; . \; . = \frac{wx}{24EI\ell}(\ell^4 - 2\ell^2x^2 + \ell x^3 - 2a^2\ell^2 + 2a^2x^2)$$

$$\Delta_{x_1} \text{ (for overhang)} \; . \; . \; . \; . \; . \; . = \frac{wx_1}{24EI}(4a^2\ell - \ell^3 + 6a^2x_1 - 4ax_1^{\,2} + x_1^{\,3})$$

$w := -90\ plf$ | $E := 29000\ ksi$ | $I_{pos} := 0.290\ in^4$ | $I_{neg} := 0.277\ in^4$

$l := 7\ ft$ | $a := 6\ ft$ | $x := 0.5 \cdot l = 3.5\ ft$ | $x_1 := a = 6\ ft$

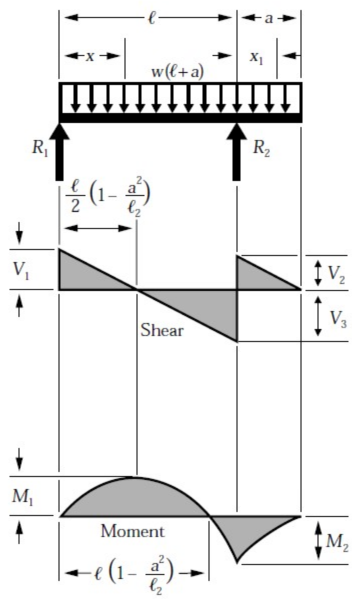
$$d_{a1} := \frac{w \cdot x}{24 \cdot E \cdot I_{neg} \cdot l} \cdot \left(l^4 - 2 \cdot l^2 \cdot x^2 + l \cdot x^3 - 2 \cdot a^2 \cdot l^2 + 2 \cdot a^2 \cdot x^2\right) = 0.462\ in$$ Between Supports

$$d_{a2} := \frac{w \cdot x_1}{24 \cdot E \cdot I_{pos}} \cdot \left(4 \cdot a^2 \cdot l - l^3 + 6 \cdot a^2 \cdot x_1 - 4 \cdot a \cdot x_1^{\,2} + x_1^{\,3}\right) = -6.07\ in$$ Overhang End

(Note: da2 deflection assumes overhang end is completely unsupported. However, the outer form deck ends will be supported by the middle form deck.)

Deflection for Middle Form Deck (Uniformly Distributed Load)
(Note: deflections below may be conservative because actual middle form deck overhangs both supports. However, the way concrete is placed during pour may negate that.
Figure 18 below seems reasonable to use assuming this is a realistic loading condition during construction).

Figure 18 Beam Overhanging One Support – Uniformly Distributed Load



$R_1 = V_1 \ldots\ldots = \frac{w}{2\ell}(\ell^2 - a^2)$

$R_2 = V_2 + V_3 \ldots\ldots = \frac{w}{2\ell}(\ell + a)^2$

$V_2 \ldots\ldots = wa$

$V_3 \ldots\ldots = \frac{w}{2\ell}(\ell^2 + a^2)$

V_x (between supports) $\ldots = R_1 - wx$

V_{x_1} (for overhang) $\ldots = w(a - x_1)$

$M_1 \left(\text{at } x = \frac{\ell}{2}\left[1 - \frac{a^2}{\ell^2}\right]\right) \ldots = \frac{w}{8\ell^2}(\ell + a)^2(\ell - a)^2$

M_2 (at R_2) $\ldots = \frac{wa^2}{2}$

M_x (between supports) $\ldots = \frac{wx}{2\ell}(\ell^2 - a^2 - x\ell)$

M_{x_1} (for overhang) $\ldots = \frac{w}{2}(a - x_1)^2$

Δ_x (between supports) $\ldots = \frac{wx}{24EI\ell}(\ell^4 - 2\ell^2x^2 + \ell x^3 - 2a^2\ell^2 + 2a^2x^2)$

Δ_{x_1} (for overhang) $\ldots = \frac{wx_1}{24EI}(4a^2\ell - \ell^3 + 6a^2x_1 - 4ax_1^2 + x_1^3)$

$w := -90\ plf$ $\quad E := 29000\ ksi$ $\quad I_{pos} := 0.290\ in^4$ $\quad I_{neg} := 0.277\ in^4$

$l := 7\ ft$ $\quad a := 1\ ft$ $\quad x := 0.5 \cdot l = 3.5\ ft$ $\quad x_1 := a = 1\ ft$

$$d_{b1} := \frac{w \cdot x}{24 \cdot E \cdot I_{pos} \cdot l} \cdot \left(l^4 - 2 \cdot l^2 \cdot x^2 + l \cdot x^3 - 2 \cdot a^2 \cdot l^2 + 2 \cdot a^2 \cdot x^2\right) = -0.55\ in$$

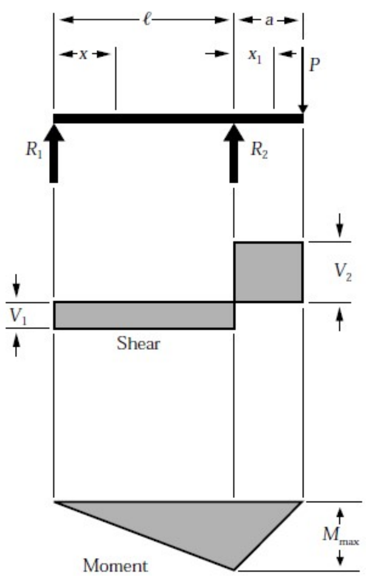
Between Supports

$$d_{b2} := \frac{w \cdot x_1}{24 \cdot E \cdot I_{neg}} \cdot \left(4 \cdot a^2 \cdot l - l^3 + 6 \cdot a^2 \cdot x_1 - 4 \cdot a \cdot x_1^{\,2} + x_1^{\,3}\right) = 0.252\ in$$

Overhang End

Deflection for Middle Form Deck (Overhanging End Concentrated Load)

Figure 20 Beam Overhanging One Support – Concentrated Load at End of Overhang



$R_1 = V_1 \dots = \frac{Pa}{\ell}$

$R_2 = V_1 + V_2 \dots = \frac{P}{\ell}(\ell + a)$

$V_2 \dots = P$

M_{max} (at R_2) $\dots = Pa$

M_x (between supports) $\dots = \frac{Pax}{\ell}$

M_{x_1} (for overhang) $\dots = P(a - x_1)$

Δ_{max} $\left(\text{between supports at } x = \frac{\ell}{\sqrt{3}}\right) = \frac{Pa\ell^2}{9\sqrt{3}EI} = .06415\frac{Pa\ell^2}{EI}$

Δ_{max} (for overhang at $x_1 = a$) $\dots = \frac{Pa^2}{3EI}(\ell + a)$

Δ_x (between supports) $\dots = \frac{Pax}{6EI\ell}(\ell^2 - x^2)$

Δ_{x_1} (for overhang) $\dots = \frac{Px_1}{6EI}(2a\ell + 3ax_1 - x_1^{\,2})$

$P := -203\ lbf$ $\quad E := 29000\ ksi$ $\quad I_{pos} := 0.290\ in^4$ $\quad I_{neg} := 0.277\ in^4$

$l := 7\ ft$ $\quad a := 1\ ft$ $\quad x := 0.5 \cdot l = 3.5\ ft$ $\quad x_1 := a = 1\ ft$

$$d_{c1} := \frac{P \cdot a \cdot x}{6 \cdot E \cdot I_{neg} \cdot l} \cdot \left(l^2 - x^2\right) = -0.134\ in$$

Between Supports

$$d_{c2} := \frac{P \cdot a^2}{3 \cdot E \cdot I_{neg}} \cdot (l + a) = -0.116\ in$$

Overhang End

$t := 84\ in$

Superimposed Deflection for Middle Form Deck

$$\frac{l}{180} = 0.467\ in$$

$$d_{total1} := d_{b1} + d_{c1} = -0.684\ in$$

Between Supports

$$\frac{l}{240} = 0.35\ in$$

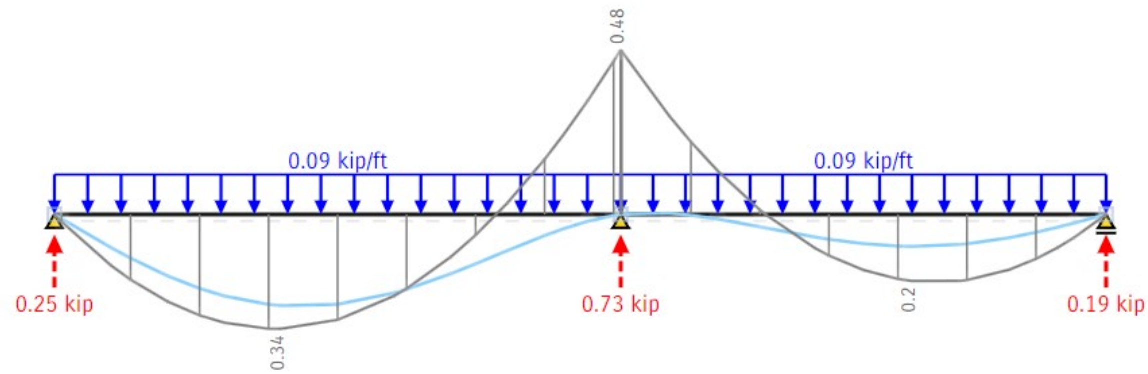
$$d_{total2} := d_{b2} + d_{c2} = 0.135\ in$$

Overhang End

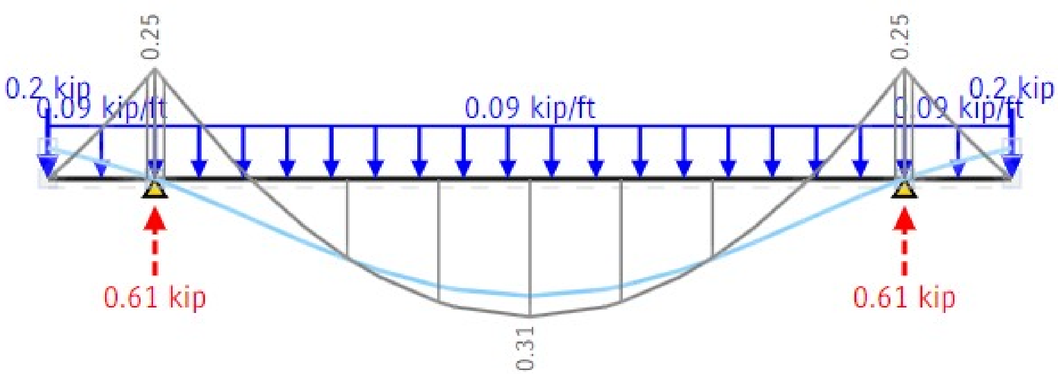
$$\frac{l}{360} = 0.233\ in$$

Free Body Diagrams (Deflected Shape & Moment)
(Bending diagram reversed)

Outer Form Decks



Middle Form Deck
(overhang both supports)



Middle Form Deck
(overhang only one support--deflection calculations above assume this condition)