Single span moment & shear envelopes for HL-93 loading using influence lines

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Span length, axle weights & lane load (units:Kips, feet)

Span length : $L := 100$

HS-20: $W_1 := 8$ $W_2 := 32$ $W_3 := 32$

Tandem: $P := 25$

Lane load: $q := 0.64$

HS-20 bending moments (both direction)

$$M_1(a, b) := \frac{a \cdot b}{L} \cdot \begin{pmatrix} W_3 + W_2 \cdot \text{if } b > 14 \\ \frac{b-14}{b} \\ \text{else} \\ 0 \end{pmatrix} + W_1 \cdot \text{if } b > 28 \begin{pmatrix} \frac{b-28}{b} \\ \text{else} \\ 0 \end{pmatrix}$$

$$M_2(a, b) := \frac{a \cdot b}{L} \cdot \begin{pmatrix} W_2 + W_1 \cdot \text{if } a > 14 \\ \frac{a-14}{a} \\ \text{else} \\ 0 \end{pmatrix} + W_3 \cdot \text{if } b > 14 \begin{pmatrix} \frac{b-14}{b} \\ \text{else} \\ 0 \end{pmatrix}$$

Tandem bending moments (one direction OK)

$$M_3(a, b) := \frac{a \cdot b}{L} \cdot \begin{pmatrix} P + P \cdot \text{if } b > 4 \\ \frac{b-4}{b} \\ \text{else} \\ 0 \end{pmatrix}$$

Lane load bending moments

$$M_4(a) := \frac{q \cdot a}{2} \cdot (L - a)$$

HS-20 shears (one direction OK)

$$V_1(a, b) := \left(1 - \frac{a}{L}\right) \cdot \begin{pmatrix} W_3 + W_2 \cdot \text{if } b > 14 \\ \frac{b-14}{b} \\ \text{else} \\ 0 \end{pmatrix} + W_1 \cdot \text{if } b > 28 \begin{pmatrix} \frac{b-28}{b} \\ \text{else} \\ 0 \end{pmatrix}$$

Tandem shears (one direction OK)

$$V_2(a, b) := \left(1 - \frac{a}{L}\right) \cdot \begin{pmatrix} P + P \cdot \text{if } b > 4 \\ \frac{b-4}{b} \\ \text{else} \\ 0 \end{pmatrix}$$

Lane load shears

$$V_3(a) := q \cdot \left(\frac{L}{2} - a\right)$$

ENVELOPES :

$$M_{max}(a) := \text{Max}\left(M_1(a, L-a), M_2(a, L-a), M_3(a, L-a)\right) + M_4(a)$$

$$V_{max}(a) := \text{Max}\left(V_1(a, L-a), V_2(a, L-a)\right) + V_3(a)$$

Half span moment & shear envelopes

$k := 20$

$x := 0 , \frac{L}{k} .. \frac{L}{2}$ $n := \text{length}(x)$

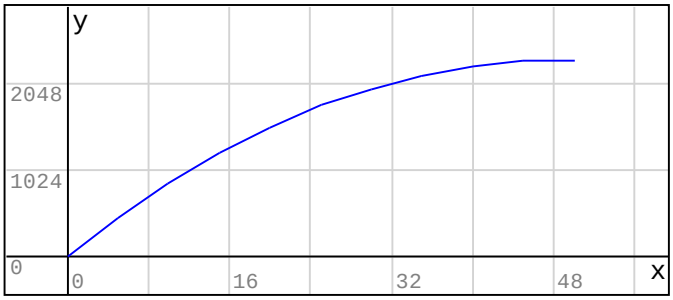
for $k \in 1 .. n$

$m_k := M_{max}(x_k)$

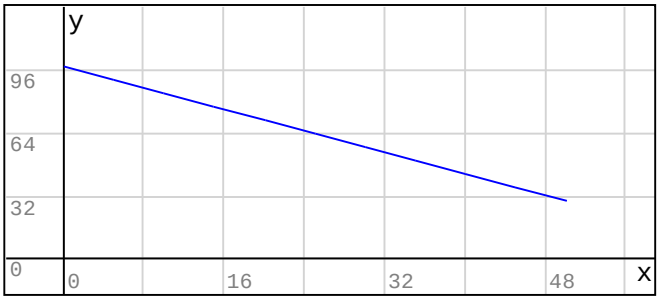
$v_k := V_{max}(x_k)$

$M := \text{augment}(x , m)$

$V := \text{augment}(x , v)$



M



V

$$M = \begin{pmatrix} 0 & 0 \\ 5 & 460.4 \\ 10 & 868.8 \\ 15 & 1225.2 \\ 20 & 1529.6 \\ 25 & 1782 \\ 30 & 1982.4 \\ 35 & 2136.4 \\ 40 & 2249.6 \\ 45 & 2310.8 \\ 50 & 2320 \end{pmatrix} \qquad V = \begin{pmatrix} 0 & 97.28 \\ 5 & 90.48 \\ 10 & 83.68 \\ 15 & 76.88 \\ 20 & 70.08 \\ 25 & 63.28 \\ 30 & 56.48 \\ 35 & 49.68 \\ 40 & 42.88 \\ 45 & 36.08 \\ 50 & 29.28 \end{pmatrix}$$