CE 342 - Fall 1999
Exam #2 - Problem #2
RJN 9/23/99

In 1999, I did not discuss the design tandem, so it is not included in this solution. This year, I would include it.

$$kip := 1000 \cdot lbf$$

Distribute loads transversely across deck

AASHTO specifies 12 ft wide lanes; truck or lane load is 10 ft wide.

Place the loads in the extreme right-hand edge of lane and, sum moments around L.H. truss (T_1) to find reaction in R.H. truss (T_2); use unit load (similar to influence line calculation).

$$T_2 \cdot 14 \cdot ft - 1 \cdot kip \cdot (14 \cdot ft - 5 \cdot ft - 1 \cdot ft) = 0 \cdot kip \cdot ft$$

$$T_2 := \frac{4}{7} \cdot kip$$

Tension

Axle loads

First arrangement: place the 32 kip rear axle at L_2, set the rear axle spacing to 14 ft so that the 32 kip middle axle is just to the left of L_3, and place the 8 kip front axle to the right of L_4.

Calculate values of the influence line at the axle locations.

Axle 1 (at L_2)

$$IL_1 := 0.15$$

Axle 2 (left of L_3)

$$\frac{IL_2}{1 \cdot ft} = \frac{0.15}{15 \cdot ft}$$

$$IL_2 := 1.0 \cdot 10^{-2}$$

Axle 3 (Left of L_4)

$$\frac{IL_3}{13 \cdot ft} = \frac{-0.3}{30 \cdot ft}$$

$$IL_3 := -.13$$

Calculate member force

$$U1L2_{axle.tension} := \frac{4}{7}\cdot\left(32\cdot kip\cdot IL_1 + 32\cdot kip\cdot IL_2 + 8\cdot kip\cdot IL_3\right) \qquad U1L2_{axle.tension} = 2.331\,kip$$

Second arrangement: try the 32 kip axle at L_2, the 8 kip axle 1 foot to the left of L_3, and the remaining 32 kip axle spaced 30 ft from L_2, so that it is at the end the bridge.

$$U1L2_{axle.tension2} := \frac{4}{7}\cdot\left(32\cdot kip\cdot IL_1 + 8\cdot kip\cdot IL_2\right) \qquad U1L2_{axle.tension2} = 2.789\,kip$$ Maximum

Lane load

Find where I.L. crosses zero axis between L_1 and L_2

$$\frac{0.15}{x} = \frac{0.15 + 1.04}{15\cdot ft}$$

$$x := 15\cdot ft\cdot\frac{0.15}{0.15 + 1.04} \qquad x = 1.891\,ft$$ to the left of L_2

Load the lane from 1.891 ft to the left of L_2 to L_3

$$U1L2_{lane.tension} := \frac{4}{7}\cdot\left[\frac{1}{2}\cdot(15\cdot ft + x)\cdot 640\cdot\frac{lbf}{ft}\cdot 0.15\right] \qquad U1L2_{lane.tension} = 0.463\,kip$$

Total

$$U1L2_{tension} := U1L2_{axle.tension2} + U1L2_{lane.tension} \qquad U1L2_{tension} = 3.252\,kip$$

Compression

Axle load

First arrangement: place rear axle at L_1, rear axle spacing at 30 ft, middle axle at L_3, and front axle 1 ft to the left of L_4.

Influence line 1 ft to the left of L_4

$$\frac{IL_3}{14\cdot ft} = \frac{-0.3}{30\cdot ft}$$

$$IL_3 := -.14$$

$U1L2_{axle.comp} := \frac{4}{7}\cdot\left(-1.04\cdot 32\cdot kip + IL_3\cdot 8\cdot kip\right)$ $U1L2_{axle.comp} = -19.657\,kip$

Second arrangement: place 32 kip axle at L_1, 32 kip axle one ft to the right of L_0, and 8 kip axle off the bridge

$$\frac{IL_4}{1\cdot ft} = \frac{-1.04}{14\cdot ft}$$

$$IL_4 := \frac{-1.04}{14}$$

$U1L2_{axle.comp2} := \frac{4}{7}\cdot\left(-1.04\cdot 32\cdot kip + IL_4\cdot 32\cdot kip\right)$ $U1L2_{axle.comp2} = -20.376\,kip$ Maximum

Lane load

$U1L2_{lane.comp} := \frac{4}{7}\cdot\left[\frac{1}{2}\cdot(30\cdot ft - x)\cdot(-1.04) + \frac{1}{2}\cdot 30\cdot ft\cdot(-0.30)\right]\cdot 640\cdot\frac{lbf}{ft}$ $U1L2_{lane.comp} = -6.991\,kip$

1.04

Total

$U1L2_{comp} := U1L2_{axle.comp2} + U1L2_{lane.comp}$ $U1L2_{comp} = -27.367\,kip$