3.3.11. Live Load for Decks in Beam Bridges

Decks in beam bridges behave as continues spans without consideration to live load distribution factors ($DFs = 1.0$). However, maximum live load moments values are as tabulated:

Table 3.7: Maximum Live Load Moments Per Unit Width [AASHTO LRFD Tables A4-1]

($\boldsymbol{S}$) m	Positive Moment ($\boldsymbol{M_{LL+IM}}$) kN.m/m	Negative Moment ($\boldsymbol{M^{-}_{LL+IM}}$) kN.m/m						
		Distance from CL of Girder to Design Section for Negative Moment						
		0	75 mm	150 mm	225 mm	300 mm	450 mm	600 mm
1.3	21.13	11.72	10.27	8.94	7.95	7.15	6.06	5.47
1.4	21.01	14.14	12.21	10.34	8.94	7.67	5.96	5.12
1.5	21.05	16.32	14.03	11.72	9.98	8.24	5.82	5.25
1.6	21.19	18.40	15.78	13.16	11.03	8.97	5.91	4.29
1.7	21.44	20.14	17.29	14.45	12.01	9.71	6.06	4.51
1.8	21.79	21.69	18.66	15.63	12.93	10.44	6.27	4.79
1.9	22.24	23.05	19.88	16.71	13.78	11.13	6.65	5.13
2.0	22.78	24.26	20.96	17.67	14.55	11.77	7.03	5.57
2.1	23.38	26.78	23.19	19.58	16.06	12.87	7.41	6.08
2.2	24.04	27.67	24.02	20.37	16.74	13.49	7.36	6.73
2.3	24.75	28.45	24.76	21.07	17.38	14.57	9.08	8.05
2.4	25.50	29.14	25.42	21.70	17.98	15.41	10.87	9.34
2.5	26.31	29.72	25.99	22.25	18.51	16.05	12.40	10.63
2.6	27.22	30.22	26.47	22.73	18.98	16.48	13.66	11.88
2.7	28.12	30.68	26.92	23.17	19.42	16.76	14.71	13.11
2.8	29.02	31.05	27.30	23.55	19.99	17.41	15.54	14.31
2.9	29.91	32.49	28.72	24.94	21.26	18.41	16.80	15.48
3.0	30.80	34.63	30.79	26.96	23.12	19.46	18.03	16.62
3.1	31.66	36.63	32.77	28.89	23.97	21.15	19.23	17.78
3.2	32.50	38.57	34.67	30.77	26.88	22.98	20.38	18.91
3.3	33.36	40.44	36.52	32.60	28.68	24.77	21.50	20.01
3.4	34.21	42.25	38.34	34.43	30.52	26.61	22.60	21.09
3.5	35.05	43.97	40.03	36.09	32.15	28.21	23.67	22.13
3.6	35.87	45.65	41.70	37.76	33.81	29.87	24.70	23.15
3.7	36.67	47.25	43.31	39.37	35.43	31.49	25.79	24.14
3.8	37.45	48.82	44.88	40.94	37.01	33.07	27.08	25.10
3.9	38.23	50.32	46.39	42.46	38.54	34.60	28.33	25.55
4.0	38.97	51.79	47.87	43.95	40.03	36.11	29.57	26.41
4.1	39.71	53.19	49.28	45.37	41.47	37.57	30.77	27.85
4.2	40.42	54.56	50.67	46.77	42.88	38.99	31.96	28.73
4.3	41.12	55.88	52.00	48.13	44.25	40.38	33.13	29.57
4.4	41.80	57.15	53.29	49.44	45.58	41.72	34.25	30.40
4.5	42.46	58.42	54.58	50.74	46.90	43.06	35.38	31.29
4.6	43.11	59.62	55.80	51.98	48.16	44.34	36.70	32.36

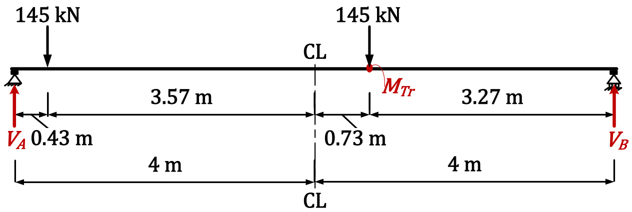
Example 3.1

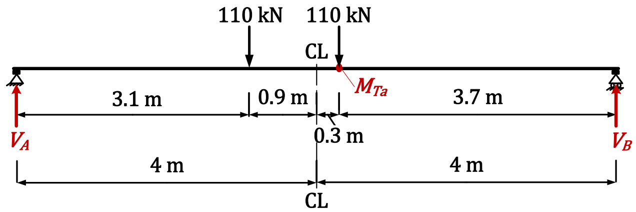
Determine the unfactored bending moment and shear force induced by vehicular live load to act on a simply supported highway bridge. Take the span length is 8 m.

Solution 3.1

Determine unfactored bending moment:

$$w_{Ln} = 9.3 \text{ kN/m}$$
$$M_{Ln} = w_{Ln}L^2/8 = (9.3)(8)^2/8 = 74.4 \text{ kN.m}$$





Moment induced by design truck:

$\Sigma M_B = 0$ ↷+

$V_A\,(8) - (145)(3.27 + 7.57) = 0$

$\therefore V_A = 196.48$ kN

$M_{Tr} = (196.48)(4.73) - (145)(4.3)$

$= 305.85$ kN.m

Moment induced by design tandem:

$\Sigma M_B = 0$ ↷+

$V_A\,(8) - (110)(3.7 + 4.9) = 0$

$\therefore V_A = 118.25$ kN

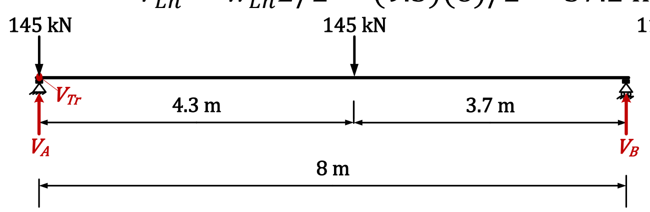
$M_{Ta} = (118.25)(4.3) - (110)(1.2)$

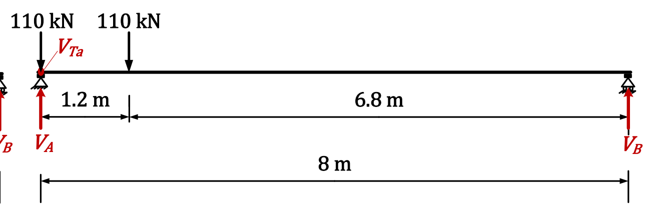
$= 376.48$ kN.m

$$\rightarrow M_{Mo} = M_{Ta} = 376.48 \text{ kN.m}$$
$$IM = 0.33$$
$$M_{LL+IM} = M_{Ta}(1 + IM) + M_{Ln}$$
$$= (376.48)(1.33) + 74.4 = 575.12 \text{ kN.m}$$

Determine unfactored shear force:

$$w_{Ln} = 9.3 \text{ kN/m}$$
$$V_{Ln} = w_{Ln}L/2 = (9.3)(8)/2 = 37.2 \text{ kN}$$





Shear induced by design truck:

$\Sigma M_B = 0$ ↷+

$V_A\,(8) - (145)(3.7 + 8) = 0$

$\therefore V_A = 212.06$ kN

$V_{Tr} = V_A = 212.06$ kN

Shear induced by design tandem:

$\Sigma M_B = 0$ ↷+

$V_A\,(8) - (110)(6.8 + 8) = 0$

$\therefore V_A = 203.5$ kN

$V_{Ta} = V_A = 203.5$ kN

$$\rightarrow V_{Mo} = V_{Tr} = 212.06 \text{ kN}$$
$$IM = 0.33$$
$$V_{LL+IM} = V_{Tr}(1 + IM) + V_{Ln}$$
$$= (212.06)(1.33) + 37.2 = 319.24 \text{ kN}$$

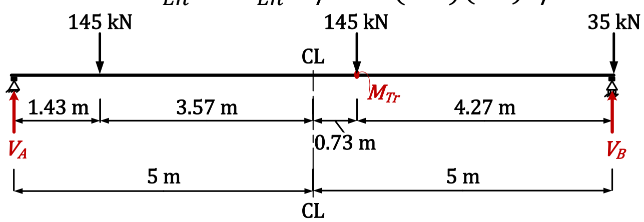
Example 3.2

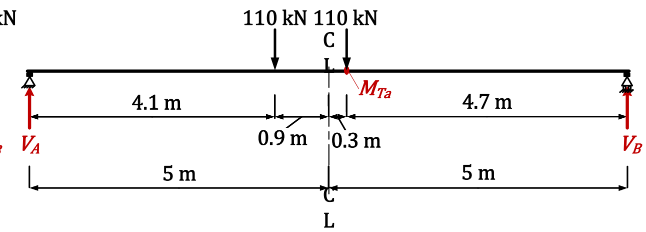
Determine the unfactored bending moment and shear force induced by vehicular live load to act on a simply supported highway bridge. Take the span length is 10 m.

Solution 3.2

Determine unfactored bending moment:

$$w_{Ln} = 9.3 \text{ kN/m}$$
$$M_{Ln} = w_{Ln}L^2/8 = (9.3)(10)^2/8 = 116.25 \text{ kN.m}$$





Moment induced by design truck:

$\Sigma M_B = 0 \curvearrowright^{+}$

$V_A\,(10) - (145)(4.27 + 8.57) = 0$

$\therefore V_A = 186.18 \text{ kN}$

$M_{Tr} = (186.18)(5.73) - (145)(4.3)$

$= 443.31 \text{ kN.m}$

Moment induced by design tandem:

$\Sigma M_B = 0 \curvearrowright^{+}$

$V_A\,(10) - (110)(4.7 + 5.9) = 0$

$\therefore V_A = 116.6 \text{ kN}$

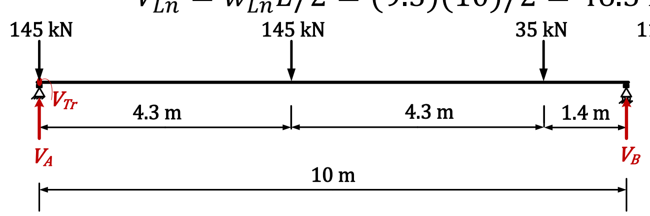
$M_{Ta} = (116.6)(5.3) - (110)(1.2)$

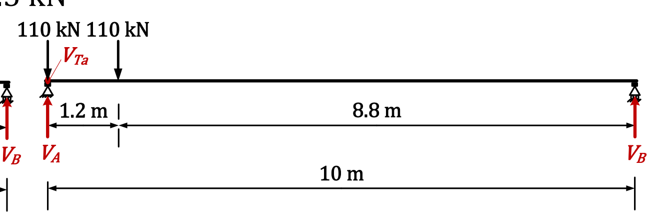
$= 485.98 \text{ kN.m}$

$$\rightarrow M_{Mo} = M_{Ta} = 485.98 \text{ kN.m}$$
$$IM = 0.33$$
$$M_{LL+IM} = M_{Ta}(1 + IM) + M_{Ln}$$
$$= (485.98)(1.33) + 116.25 = 762.6 \text{ kN.m}$$

Determine unfactored shear force:

$$w_{Ln} = 9.3 \text{ kN/m}$$
$$V_{Ln} = w_{Ln}L/2 = (9.3)(10)/2 = 46.5 \text{ kN}$$





Shear induced by design truck:

$\Sigma M_B = 0 \curvearrowright^{+}$

$V_A\,(10) - (35)(1.4) - (145)(5.7 + 10) = 0$

$\therefore V_A = 232.55 \text{ kN}$

$V_{Tr} = V_A = 232.55 \text{ kN}$

Shear induced by design tandem:

$\Sigma M_B = 0 \curvearrowright^{+}$

$V_A\,(10) - (110)(8.8 + 10) = 0$

$\therefore V_A = 206.8 \text{ kN}$

$V_{Ta} = V_A = 206.8 \text{ kN}$

$$\rightarrow V_{Mo} = V_{Tr} = 232.55 \text{ kN}$$
$$IM = 0.33$$
$$V_{LL+IM} = V_{Tr}(1 + IM) + V_{Ln}$$
$$= (232.55)(1.33) + 46.5 = 355.79 \text{ kN}$$

Example 3.3

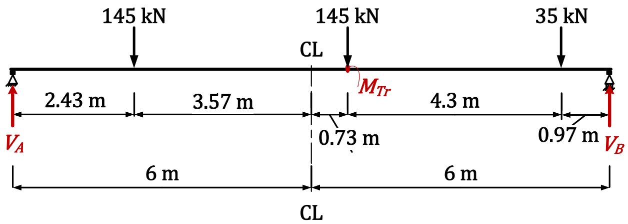
Determine the unfactored bending moment and shear force induced by vehicular live load to act on a simply supported highway bridge. Take the span length is 12 m.

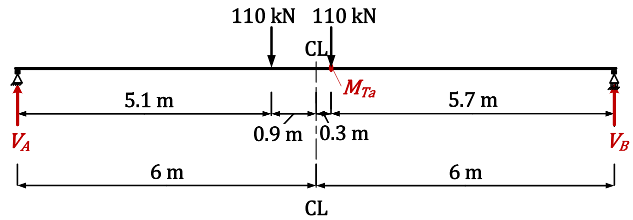
Solution 3.3

Determine unfactored bending moment:

$$w_{Ln} = 9.3 \text{ kN/m}$$

$$M_{Ln} = w_{Ln}L^2/8 = (9.3)(12)^2/8 = 167.4 \text{ kN.m}$$





Moment induced by design truck:

$\Sigma M_B = 0 \curvearrowright^{+}$

$V_A\,(12) = (35)(0.97) - (145)(5.27 + 9.57)$

$\therefore V_A = 182.15 \text{ kN}$

$M_{Tr} = (182.15)(6.73) - (145)(4.3)$

$= 602.34 \text{ kN.m}$

Moment induced by design tandem:

$\Sigma M_B = 0 \curvearrowright^{+}$

$V_A\,(12) = (110)(5.7 + 6.9)$

$\therefore V_A = 115.5 \text{ kN}$

$M_{Ta} = (115.5)(6.3) - (110)(1.2)$

$= 595.65 \text{ kN.m}$

$\rightarrow M_{Mo} = M_{Tr} = 602.34 \text{ kN.m}$

$IM = 0.33$

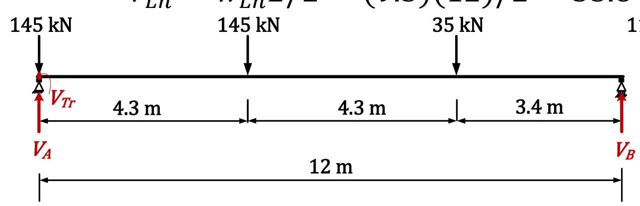
$M_{LL+IM} = M_{Tr}(1 + IM) + M_{Ln}$

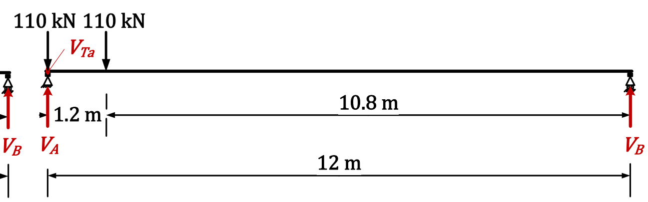
$= (602.34)(1.33) + 167.4 = 968.26 \text{ kN.m}$

Determine unfactored shear force:

$$w_{Ln} = 9.3 \text{ kN/m}$$

$$V_{Ln} = w_{Ln}L/2 = (9.3)(12)/2 = 55.8 \text{ kN}$$





Shear induced by design truck:

$\Sigma M_B = 0 \curvearrowright^{+}$

$V_A\,(12) = (35)(3.4) - (145)(7.7 + 12)$

$\therefore V_A = 247.96 \text{ kN}$

$V_{Tr} = V_A = 247.96 \text{ kN}$

Shear induced by design tandem:

$\Sigma M_B = 0 \curvearrowright^{+}$

$V_A\,(12) = (110)(10.8 + 12)$

$\therefore V_A = 209 \text{ kN}$

$V_{Ta} = V_A = 209 \text{ kN}$

$\rightarrow V_{Mo} = V_{Tr} = 247.96 \text{ kN}$

$IM = 0.33$

$V_{LL+IM} = V_{Tr}(1 + IM) + V_{Ln}$

$= (247.96)(1.33) + 55.8 = 385.59 \text{ kN}$