



RAM Structural System



RAM Steel 17.00.01.09

DataBase: 2019.12.03_B38_removal of point loads curb loads

Building Code: IBC

Gravity Beam Design

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Steel Code: AISC 360-10 LRFD

Floor Type: L6

Beam Number = 171

SPAN INFORMATION (ft): I-End (42.50,7.78) J-End (72.50,7.78)

Beam Size (User Selected) = W16X40 Fy = 50.0 ksi
 Total Beam Length (ft) = 30.00

COMPOSITE PROPERTIES (Not Shored):

	Left	Right
Deck Label	2.5" Fill o/ 3" Deck	2.5" Fill o/ 3" Deck
Concrete thickness (in)	2.50	2.50
Unit weight concrete (pcf)	150.00	150.00
fc (ksi)	3.00	3.00
Decking Orientation	perpendicular	perpendicular
Decking type	VERCO W3 Formlok	VERCO W3 Formlok
beff (in) =	90.00	Y bar(in) = 16.40
Mnf (kip-ft) =	596.52	Mn (kip-ft) = 493.26
C (kips) =	258.45	PNA (in) = 15.53
Ieff (in4) =	1342.11	Itr (in4) = 1745.90
Stud length (in) =	4.50	Stud diam (in) = 0.75
Stud Capacity (kips) Qn = 17.2	Rg = 1.00	Rp = 0.60
# of studs: Max = 60	Partial = 18	Actual = 30
Number of Stud Rows = 1	Percent of Full Composite Action = 45.04	

LINE LOADS (k/ft):

Load	Dist	DL	CDL	LL	Red%	Type	PartL	CLL
1	0.000	0.412	0.412	0.000	---	NonR	0.000	0.000
	30.000	0.412	0.412	0.000			0.000	0.000
2	0.000	0.322	0.000	0.644	---	NonR	0.000	0.000
	30.000	0.322	0.000	0.644			0.000	0.000
3	0.000	0.320	0.000	0.033	0.0%	Roof	0.000	0.000
	30.000	0.320	0.000	0.033			0.000	0.000
4	0.000	0.040	0.040	0.000	---	NonR	0.000	0.000
	30.000	0.040	0.040	0.000			0.000	0.000

SHEAR (Ultimate): Max Vu (1.2DL+1.6LL) = 35.96 kips 1.00Vn = 146.40 kips

MOMENTS (Ultimate):

Span	Cond	LoadCombo	Mu	@	Lb	Cb	Phi	Phi*Mn
			kip-ft	ft	ft			kip-ft
Center	PreCmp+	1.4DL	71.2	15.0	0.0	1.00	0.90	273.75
	Init DL	1.4DL	71.2	15.0	---	---		
	Max +	1.2DL+1.6LL	269.7	15.0	---	---	0.90	443.93
Controlling		1.2DL+1.6LL	269.7	15.0	---	---	0.90	443.93

REACTIONS (kips):

	Left	Right
Initial reaction	6.78	6.78
DL reaction	16.42	16.42
Max +LL reaction	10.17	10.17
Max +total reaction (factored)	35.96	35.96



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DEFLECTIONS:

Ratio

Multipliers for effects of Web Openings:

Span	Precomp/Noncomp	Composite		
Center Span	1.000	1.000		
Initial load (in)	at 15.00 ft = -0.549		L/D = 656	
Live load (in)	at 15.00 ft = -0.317		L/D = 1134 > 360	0.32
Post Comp load (in)	at 15.00 ft = -0.618		L/D = 583 > 240	0.41
Net Total load (in)	at 15.00 ft = -1.167		L/D = 309 > 240	0.78

WEB OPENINGS:

#	Opening			B	Position to	Stiffener				Weld
	Dist* ft	Shp	H/Dia in			Width in	Thick in	Length in	Sides	
1	7.50	Circ	6.00	---	Centered Center	---	---	---		---
2	12.50	Rect	8.00	18.00	Centered Center	---	---	---		---
3	22.50	Rect	8.00	22.00	Centered Center	---	---	---		Fail

*Dist is the distance along the beam from the left end.

Opening #1 at 7.500 ft

Min. Slab Reinforcement: 0.0025 Transv. and Longit. within a distance of 1.33 ft of opening.

Min. Shear Connectors: 2 studs/ft for a dist. 1.33 ft from opening towards max moment point.

Capacity - Noncomposite / Precomposite

Top Tee

Prt = 0.00 kips mut = 0.00 nut = 0.51 alphavt = 1.00

Vpt = 46.66 kips Vmt = 46.66 kips

Bottom Tee

Prb = 0.00 kips mub = 0.00 nub = 0.51 alphavb = 1.00

Vpb = 46.66 kips Vmb = 46.66 kips

Capacity: Vpbar = 140.87 kips

Upper Limit Vm = 0.67 Vpbar = 93.92 kips

Vm = 46.66 + 46.66 = 93.33 kips

Mm = 288.18 kip-ft

Capacity - Composite

Top Tee

Pch = 120.61 kips dh = 5.24 in Pcl = 120.61 kips dl = 3.26 in

Prt = 0.00 kips mut = 0.96 nut = 0.51 alphavt = 1.89

Vpt = 46.66 kips Vmt(sh) = 54.52 kips Vmt = 54.52 kips

Bottom Tee

Prb = 0.00 kips mub = 0.00 nub = 0.51 alphavb = 1.00

Vpb = 46.66 kips Vmb = 46.66 kips

Capacity: Vpbar = 140.87 kips Vcbar = 7.86 kips

Upper Limit Vm = 0.67 Vpbar + Vcbar = 101.77 kips

Vm = 54.52 + 46.66 = 101.19 kips

Mm = 371.20 kip-ft

Precomposite

Vu = 4.75 kips Mu = 53.43 kip-ft at 7.50 ft (1.4DL)



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$$\begin{aligned} \text{Interaction: } Vu / 0.90 Vm &= 0.057 \\ Mu / 0.90 Mm &= 0.206 \\ \text{M - V Interaction} &= 0.207 \end{aligned}$$

Composite

$$\begin{aligned} Vu &= 17.98 \text{ kips} & Mu &= 202.30 \text{ kip-ft} & \text{at } 7.50 \text{ ft} & (1.2DL+1.6LL) \\ \text{Interaction: } Vu / 0.90 Vm &= 0.197 \\ Mu / 0.90 Mm &= 0.606 \\ \text{M - V Interaction} &= 0.612 \end{aligned}$$

Compression Tee Buckling

Top Tee Aspect Ratio = 1.20 < 4.0 Check not required.

Opening #2 at 12.500 ft

Minimum corner radii (in): 0.6250 or greater

Min. Slab Reinforcement: 0.0025 Transv. and Longit. within a distance of 1.50 ft of opening.

Min. Shear Connectors: 2 studs/ft for a dist. 1.50 ft from opening towards max moment point.

Capacity - Noncomposite / Precomposite

Top Tee

$$\begin{aligned} Prt &= 0.00 \text{ kips} & mut &= 0.00 & nut &= 4.50 & alphavt &= 0.39 \\ Vpt &= 35.22 \text{ kips} & Vmt &= 13.84 \text{ kips} \end{aligned}$$

Bottom Tee

$$\begin{aligned} Prb &= 0.00 \text{ kips} & mub &= 0.00 & nub &= 4.50 & alphavb &= 0.39 \\ Vpb &= 35.22 \text{ kips} & Vmb &= 13.84 \text{ kips} \end{aligned}$$

Capacity: $Vpbar = 140.87 \text{ kips}$

Upper Limit $Vm = 0.67 Vpbar = 93.92 \text{ kips}$

$Vm = 13.84 + 13.84 = 27.68 \text{ kips}$

$Mm = 279.28 \text{ kip-ft}$

Capacity - Composite

Top Tee

$$\begin{aligned} Pch &= 223.99 \text{ kips} & dh &= 5.01 \text{ in} & Pcl &= 189.53 \text{ kips} & dl &= 3.41 \text{ in} \\ Prt &= 0.00 \text{ kips} & mut &= 3.38 & nut &= 4.50 & alphavt &= 0.93 \\ Vpt &= 35.22 \text{ kips} & Vmt(sh) &= 43.08 \text{ kips} & Vmt &= 32.93 \text{ kips} \end{aligned}$$

Bottom Tee

$$\begin{aligned} Prb &= 0.00 \text{ kips} & mub &= 0.00 & nub &= 4.50 & alphavb &= 0.39 \\ Vpb &= 35.22 \text{ kips} & Vmb &= 13.84 \text{ kips} \end{aligned}$$

Capacity: $Vpbar = 140.87 \text{ kips}$ $Vcbar = 0.00 \text{ kips}$

Upper Limit $Vm = 0.67 Vpbar + Vcbar = 93.92 \text{ kips}$

$Vm = 32.93 + 13.84 = 46.77 \text{ kips}$

$Mm = 389.91 \text{ kip-ft}$

Precomposite

$$\begin{aligned} Vu &= 1.58 \text{ kips} & Mu &= 69.26 \text{ kip-ft} & \text{at } 12.50 \text{ ft} & (1.4DL) \\ \text{Interaction: } Vu / 0.90 Vm &= 0.064 \\ Mu / 0.90 Mm &= 0.276 \\ \text{M - V Interaction} &= 0.277 \end{aligned}$$

Composite

$$Vu = 6.00 \text{ kips} \quad Mu = 262.24 \text{ kip-ft} \quad \text{at } 12.50 \text{ ft} \quad (1.2DL+1.6LL)$$



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Interaction: $V_u / 0.90 V_m = 0.142$
 $M_u / 0.90 M_m = 0.747$
M - V Interaction = 0.749

Compression Tee Buckling

Couple arm distance (in) = 14.57 $\phi = 0.90$

K = 1.0 L (in) = 18.00

Top: area (in²) = 4.60 rx (in) = 0.98 ry (in) = 1.77

Cond	Mu kip-ft	LoadCombo	Pu kips	phi*Pn kips	Ratio
Precomp M	69.26	1.4DL	57.05	202.02	0.282

Opening #3 at 22.500 ft
Web Buckling, $p_o > 5.6$ **Fail**

If this is a composite section shouldn't the criteria be $p_o > 6$ according to AISC design guide #2?