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JOB
SHEET NO. OF
CALCULATED BY DATE
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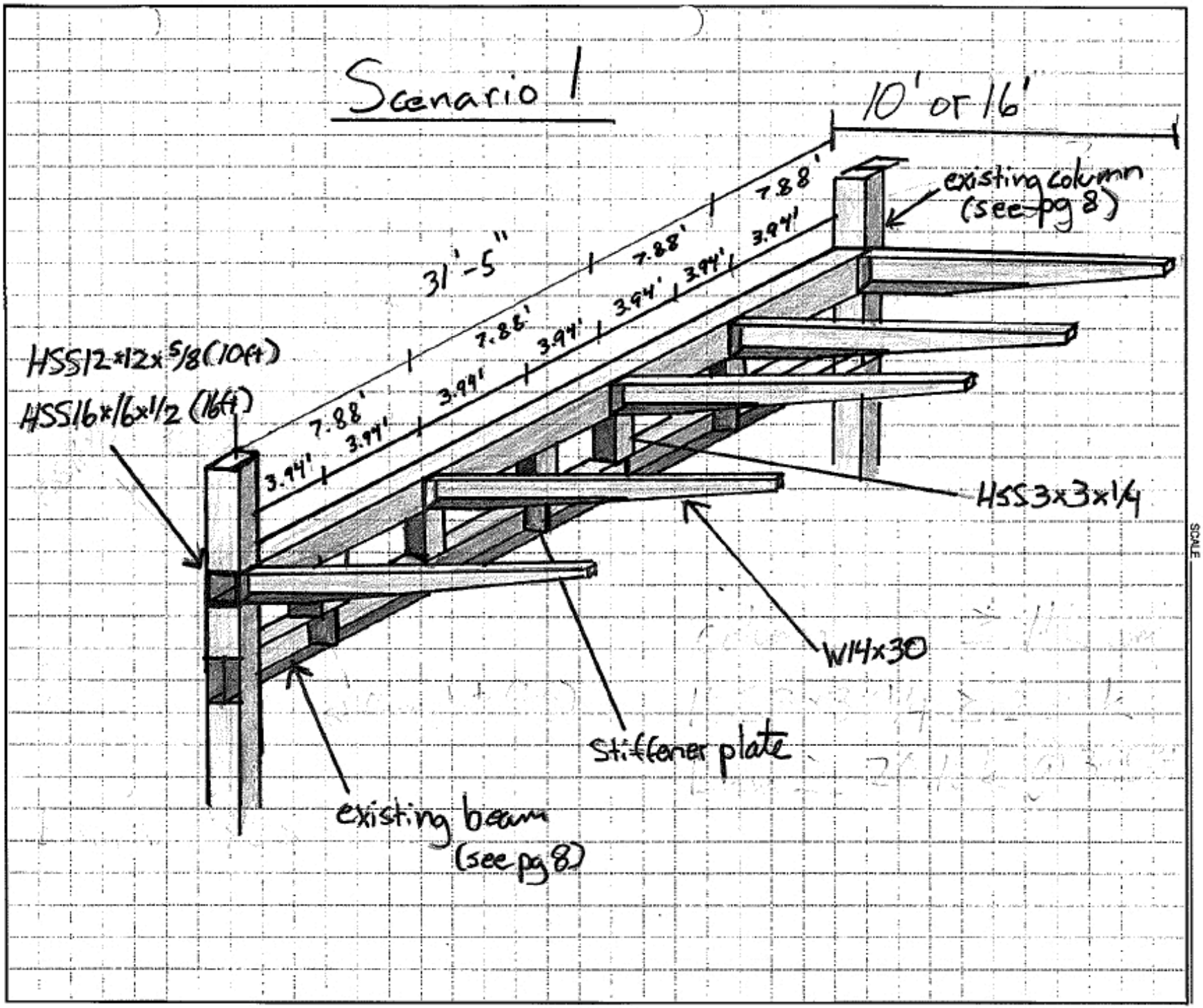
SCALE

Scenario 1



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JOB SUNY Buffalo Canopy
SHEET NO. 1 OF
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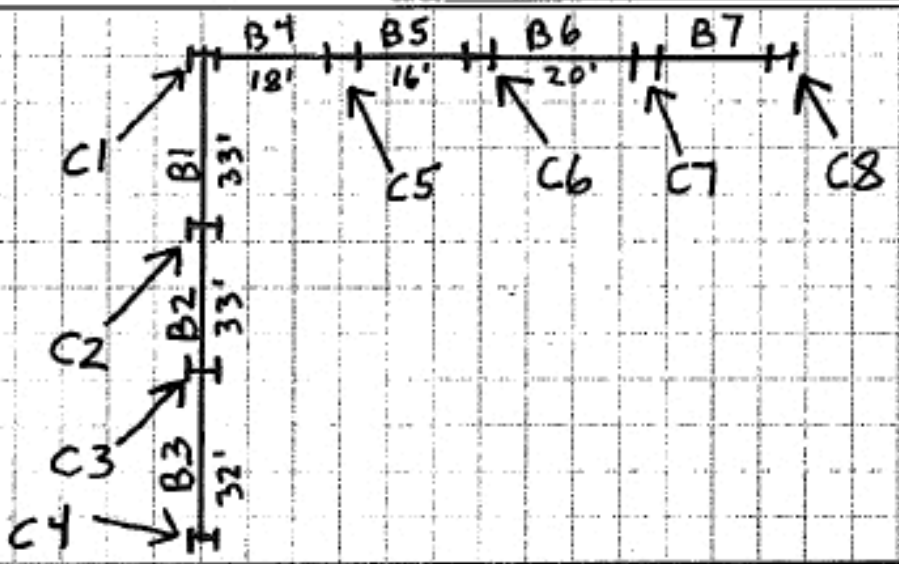
Plan



$P_f = .7 C_e C_t I p_g$ $C_e = 1.0$ $C_t = 1.0$ $I = 1.1$

Buffalo, NY $p_g = 50$ psf

$P_f = .7(1)(1)(1.1)(50)$

$P_f = 38.5$ psf $l_u = 72'$ (length of roof above canopy)

(ASCE 7-9) $h_d = 3$ ft ($l_u = 72$ ft, $p_g = 50$)

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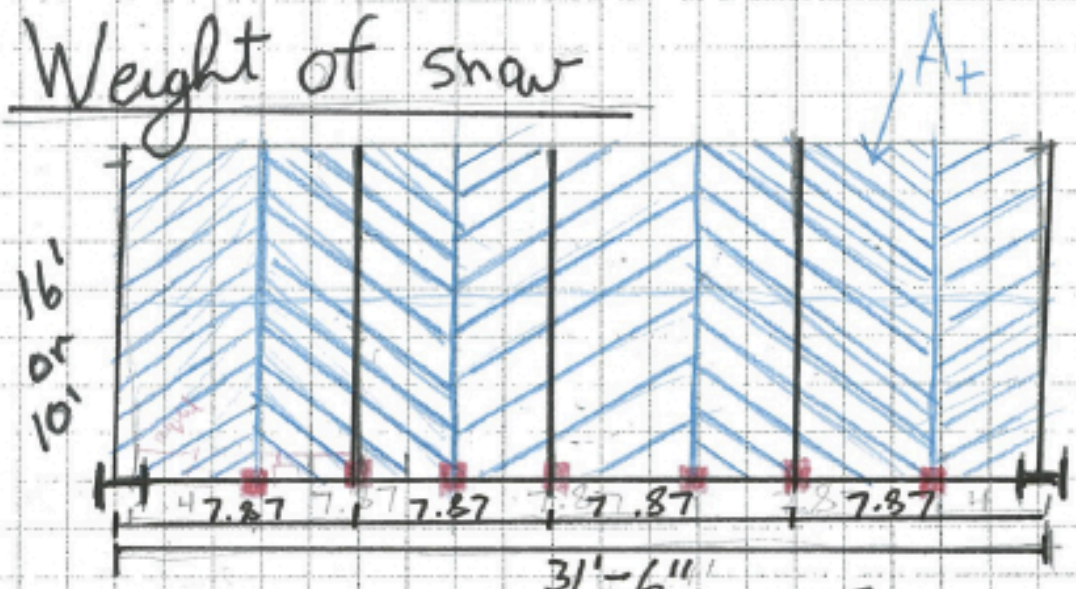
Weight of snow

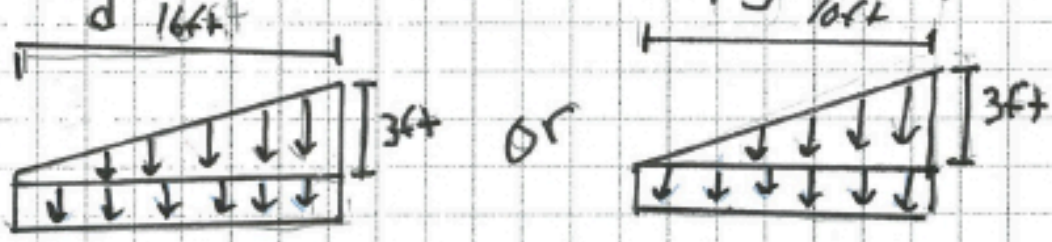


$A_{t_1} = (31.5)(10) = 315 ft^2$

$A_{t_2} = (31.5)(16) = 504 ft^2$

$P_f = 38.5 psf \quad (p_g = 50 psf)$

$h_d = 3ft \quad (l_u = 72 ft \quad p_g = 50 psf)$



$\gamma = .13 p_g + 14 \qquad \gamma = .13(50) + 14 = 20.5$

(1) Volume of $\Delta = \frac{1}{2} bh l = \frac{1}{2}(7.87)(3)(16)$

$= 188.88 ft^3$

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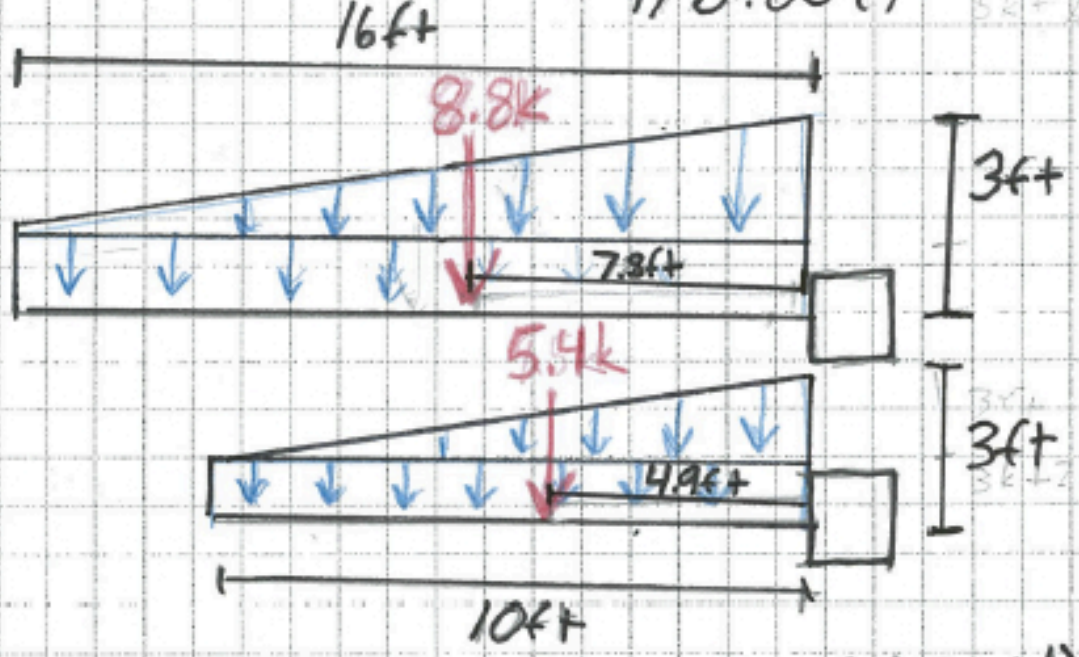
(2) Volume of $\Delta = \frac{1}{2} bh l = \frac{1}{2}(7.87)(3)(10)$
$= 118.05 ft^3$



Case 1

Case 2

Case 1 | $\Sigma W_{+s} = P_f + P_d = (38.5)(504) + (\frac{1}{2})(16)(3)(31.5)(20)$

$35.5k = 19.40 + 15.5$

$35.5 / 31.5 = 1.1 k/ft$

Case 2 | $\Sigma W_{+s} = P_f + P_d = (38.5)(315) + (\frac{1}{2})(10)(3)(31.5)(20)$

$(12.1 + 10) = 22.1 / 31.5 = .7 k/ft$

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JOB SUNY Buffalo Canopy
SHEET NO. 5 OF
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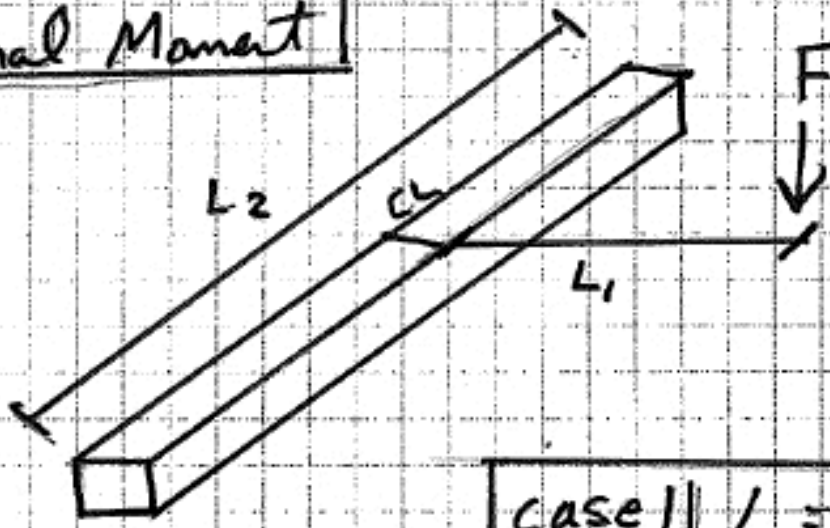
Enercalc Torsion Input

Torsional Moment



Bending Moment

case 1 $L_2 = 31.5$ $L_1 = 7.8$
$F = 34.65K$
$L_3 = 15.75$

Result - HSS16x16x½

Case 2 $L_2 = 31.5$ $L_1 = 4.9$
$F = 22.05K$
$L_3 = 15.75$

Result - HSS12x12x⅝

✓ 10ft

Title :
Dsgnr:
Description :

Job #
Date: 4:53PM, 24 JUL 13

Scope :

Steel Beam w/ Torsional Loads

Description

General Information

Code Ref: AISC 9th ASD, 1997 UBC, 2003 IBC, 2003 NFPA 5000

Steel Section	**HSS12X12X5/8**	Fy	40.00 ksi
		Load Duration Factor	1.00
Beam Span	31.50 ft	Beam Wt. Added to Applied Loads	
Torsional End Fixity	Pin-Pin	Unbraced Length	4.00 ft
Bending End Fixity	Pin-Pin	Elastic Modulus	29,000.00 ksi

Applied Loads

Bending Moments...	Dead Load	Live Load	Short Term	Location
# 1	347.290		k-ft	15.750 ft
Torsional Moments...	**Dead Load**	**Live Load**	**Short Term**	**Location**
# 1	108.050		k-ft	15.750 ft

Summary

Beam OK

Using: HSS12X12X5/8, Span = 31.50ft, Fy = 40.0ksi, End Fixity : Bending= Pinned-Pinned, Torsion= Pinned-Pinned

Max Flange Bending Stress	24.31 ksi		
Allowable	26.40 ksi		
Flange Stress Ratio	0.921 : 1	Max. Deflection	0.425 in
Max Flange Shear Stress	9.50 ksi	Max. Rotation	0.00000 rad
Allowable	16.00 ksi		
Flange Stress Ratio	0.594 : 1		

Summary Analysis

	Dead	Live	DL + LL	DL+LL+Short Term
Flange Bend + Warp	24.31 ksi	ksi	24.31 ksi	24.31 ksi
Allowable...	26.40 ksi	26.40 ksi	26.40 ksi	26.40 ksi
Stress Ratio.....	0.921 : 1	: 1	0.921 : 1	0.921 : **1**
Flange Bend+Warp+Tors	ksi	ksi	26.40 ksi	ksi
Web Bend + Warp	9.50 ksi	ksi	9.50 ksi	9.50 ksi
Allowable...	16.00 ksi	16.00 ksi	16.00 ksi	16.00 ksi
Stress Ratio.....	0.594 : 1	: 1	0.594 : 1	0.594 : **1**

Summary - Service Load Effects

		Dead	Live	DL + LL	DL+LL+Short Term
Moments	Left	k-ft	k-ft	k-ft	k-ft
	Center	185.18 k-ft	k-ft	185.18 k-ft	185.18 k-ft
	Right	k-ft	k-ft	k-ft	k-ft
Reactions	Left	-9.56 k	k	-9.56 k	-9.56 k
	Right	12.49 k	k	12.49 k	12.49 k
Deflections		0.425 in	in	0.425 in	0.425 in
....X-Dist to maximum		21.63 ft	31.50 ft	21.63 ft	21.63 ft
Rotations		rad	rad	rad	rad
....X-Dist to maximum		23.52 ft	31.08 ft	23.52 ft	23.52 ft

Fa calc'd per Eq. E2-1, K*L/r < Cc

16ft

Title :
Dsgnr:
Description :

Job #
Date: 4:49PM, 24 JUL 13

Scope :

Steel Beam w/ Torsional Loads

Description

General Information

Code Ref: AISC 9th ASD, 1997 UBC, 2003 IBC, 2003 NFPA 5000

Steel Section	**HSS16X16X1/2**	Fy	40.00 ksi
		Load Duration Factor	1.00
Beam Span	31.50 ft	Beam Wt. Added to Applied Loads	
Torsional End Fixity	Pin-Pin	Unbraced Length	4.00 ft
Bending End Fixity	Pin-Pin	Elastic Modulus	29,000.00 ksi

Applied Loads

Bending Moments...	Dead Load	Live Load	Short Term	Location
# 1	545.000		k-ft	15.750 ft
Torsional Moments...	Dead Load	Live Load	Short Term	Location
# 1	265.000		k-ft	15.750 ft

Summary

Beam OK

Using: HSS16X16X1/2, Span = 31.50ft, Fy = 40.0ksi, End Fixity : Bending= Pinned-Pinned, Torsion= Pinned-Pinned

Max Flange Bending Stress	22.82 ksi		
Allowable	24.00 ksi		
Flange Stress Ratio	0.951 : 1	Max. Deflection	0.281 in
Max Flange Shear Stress	15.06 ksi	Max. Rotation	0.01420 rad
Allowable	16.00 ksi		
Flange Stress Ratio	0.941 : 1		

Summary Analysis

	Dead	Live	DL + LL	DL+LL+Short Term
Flange Bend + Warp	22.82 ksi	ksi	22.82 ksi	22.82 ksi
Allowable...	24.00 ksi	24.00 ksi	24.00 ksi	24.00 ksi
Stress Ratio.....	0.951 : 1	: 1	0.951 : 1	0.951 : 1
Flange Bend+Warp+Tors	ksi	ksi	24.00 ksi	ksi
Web Bend + Warp	15.06 ksi	ksi	15.06 ksi	15.06 ksi
Allowable...	16.00 ksi	16.00 ksi	16.00 ksi	16.00 ksi
Stress Ratio.....	0.941 : 1	: 1	0.941 : 1	0.941 : 1

Summary - Service Load Effects

		Dead	Live	DL + LL	DL+LL+Short Term
Moments	Left	k-ft	k-ft	k-ft	k-ft
	Center	285.20 k-ft	k-ft	285.20 k-ft	285.20 k-ft
	Right	k-ft	k-ft	k-ft	k-ft
Reactions	Left	-15.69 k	k	-15.69 k	-15.69 k
	Right	18.91 k	k	18.91 k	18.91 k
Deflections		0.281 in	in	0.281 in	0.281 in
....X-Dist to maximum		21.84 ft	31.50 ft	21.84 ft	21.84 ft
Rotations		0.014 rad	rad	0.014 rad	0.014 rad
....X-Dist to maximum		15.54 ft	ft	15.54 ft	15.54 ft

Fa calc'd per Eq. E2-1, K*L/r < Cc

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JOB SUNY Buffalo Canopy
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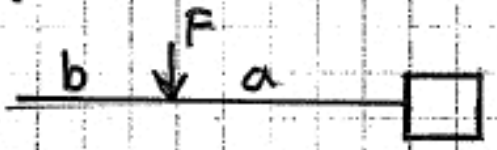
Deflections Limits case 1: L/200 = .08ft = .96in
case 2: L/200 = .05ft = .6in

$$\delta = (Fa^3/(3EI))(1+3b/2a)$$



$$.96 = \delta_1 = ((8.8)(820025)/(87000I))(2.58)$$

$$.96 = \frac{82.95}{I}(2.58)$$

$$I.37 = 82.95 \quad \bar{I}_{avg} = 222.93 in^4$$

$$.6 = \delta_2 = ((5.4)(203297)/87000I)(2.56)$$

$$.6 = \frac{12.62}{I}(2.56)$$

$$I.234 = 12.62 \quad \bar{I}_{avg} = 53.85 in^4$$

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JOB SUNY Buffalo Canopy
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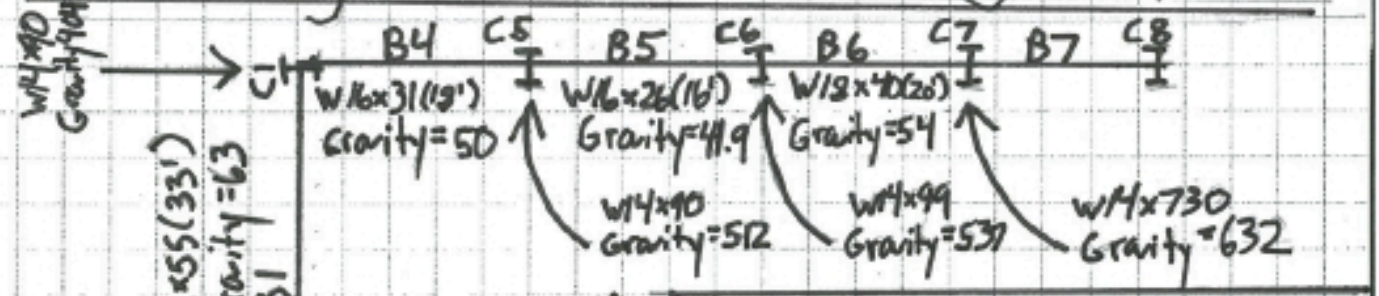
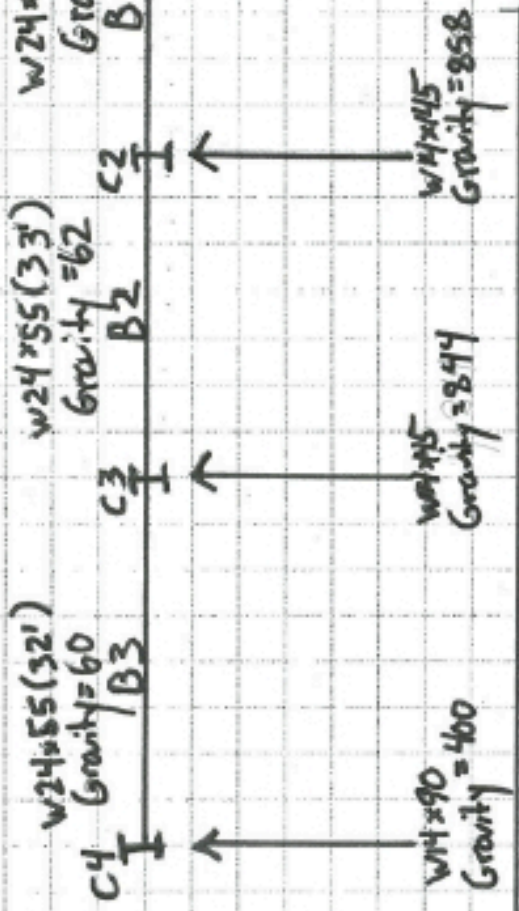
Checking beams + columns for gravity + canopy





B1, B2, B3

W24x55 (33ft) Max=84
(16) gravity + canopy = 97.65
(10) gravity + canopy = 85.05
use W24x68 for 16ft
use W24x62 for 10ft

B4

W16x31 (18ft) Max=60
(16) gravity + canopy = 69.8
(10) gravity + canopy = 62.6
use W16x36

B5

W16x26 (16ft) Max=55
(16) gravity + canopy = 59.5
use W16x31

B6

W18x40 (20ft) Max=78.2
(16) gravity + canopy = 76

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C1, C4 | W14×90 (21ft) Max axial = 547
(16) gravity + canopy = 400 + 19 = 419

C3 | W14×145 (21ft) Max axial = 940
(16) gravity + canopy = 844 + 19 = 863

C2 | W14×145 (21ft) Max axial = 940
(16) gravity + canopy = 858 + 19 = 877

C5 | W14×90 (21ft) Max axial = 560
(16) gravity + canopy = 512 + 10 = 522

C6 | W14×99 (21ft) Max axial = 620
(16) gravity + canopy = 537 + 9 = 546

C7 | W14×730 (21ft) Max capacity = HUGE
(16) gravity + canopy = 632 + 12 = 644

All columns ok

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SHEET NO. 10 OF
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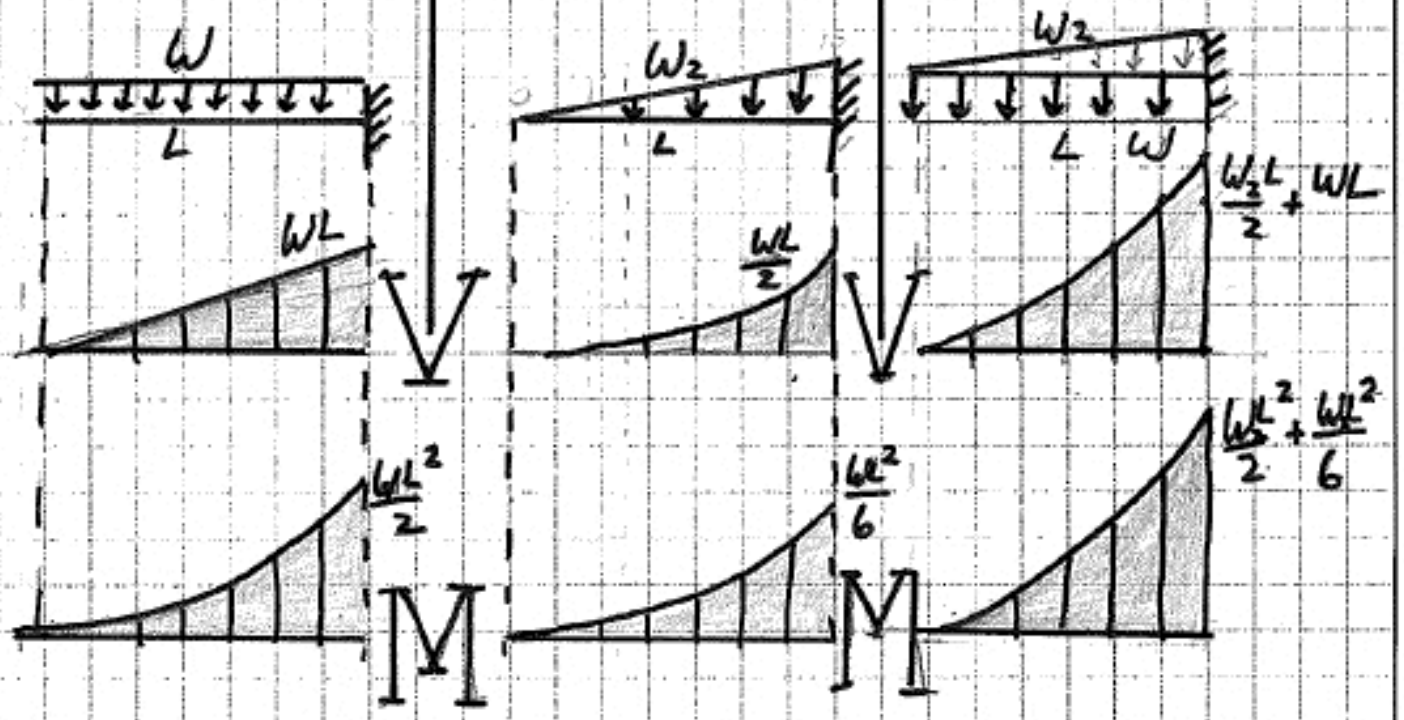
Design of Cantilever



$V_{max} = 8.8k\ (16ft) \;/\; 5.4k\ (10ft)$

$M_{max} = 68.64k\text{-}ft\ (16ft) \;/\; 26.46k\text{-}ft\ (10ft)$

$I_{avg} = 1.54in^4\ (16ft) \;/\; .23in^4\ (10ft)$

(see pg 6)

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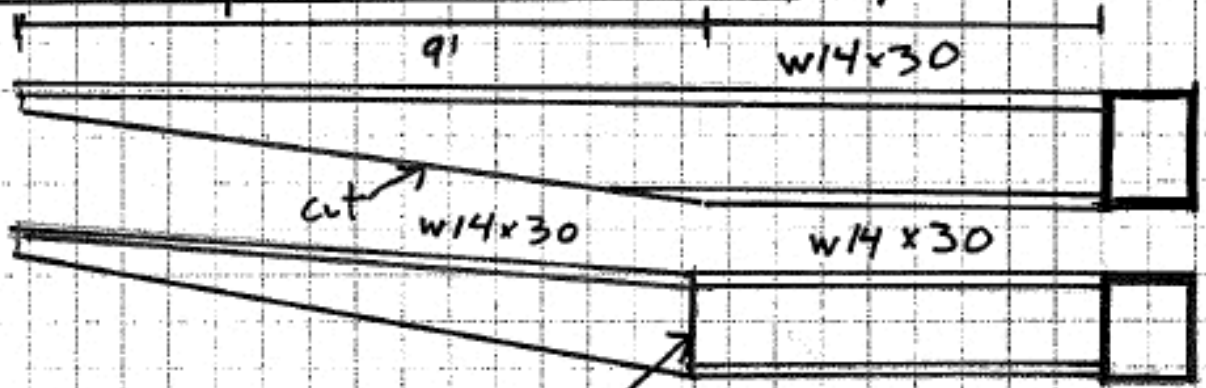
Shape to be designed for

Architect's shape based on Section

Paul's shape base on WT's



two pieces, cut + pen weld

W14x30 $M_r/\Omega_b = 73.4$ k-ft $> 8.8(7.9) = 68.64$ k-ft

ok

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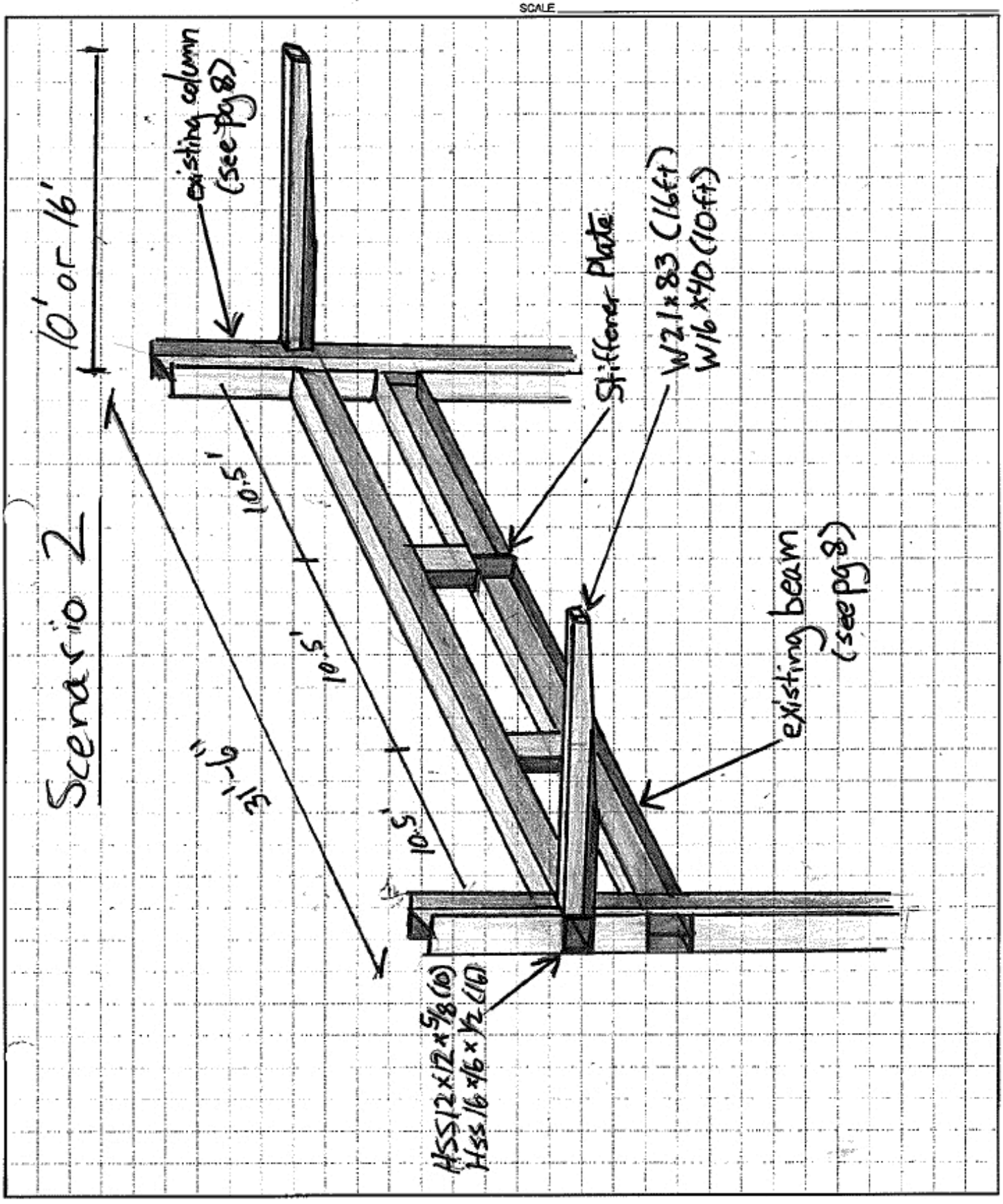

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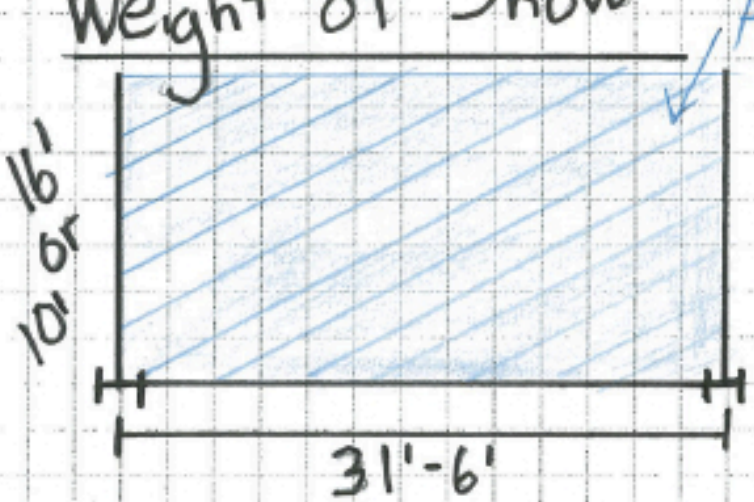
Weight of Snow



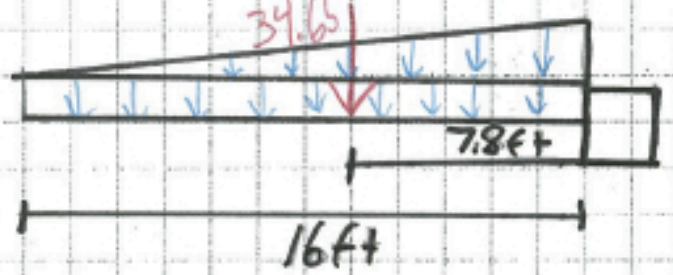
$A_{t_1} = (31.5)(10) = 315 ft^2$

$A_{t_2} = (31.5)(16) = 504 ft^2$

$P_f = 38.5 psf$

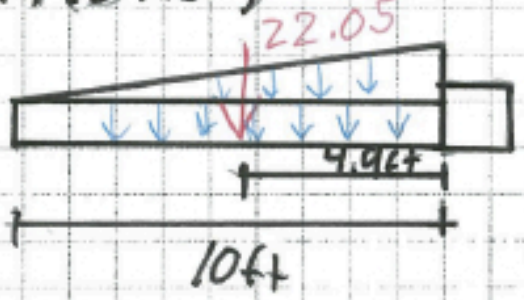
Case 1 $W = 1.1 k/ft$

$F = 1.1(31.5) = 34.65k$



Case 2 $W = .7 k/ft$

$F = .7(31.5) = 22.05k$



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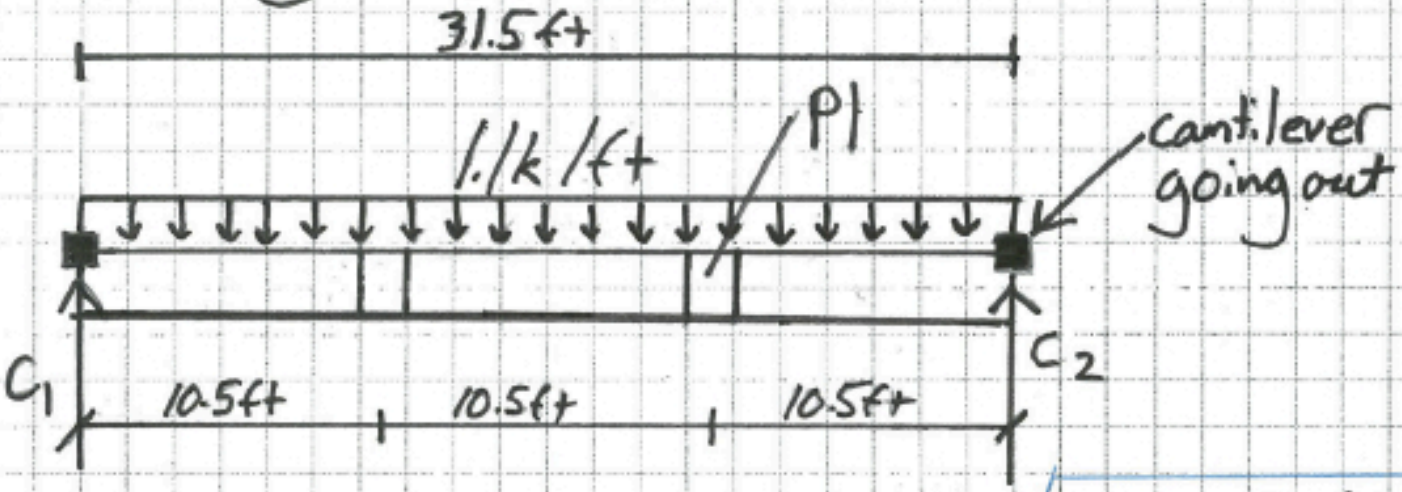
Solving for post location/sizes



ΣF_{yP_1} | $34.7/2 = 17.35k$ use HSS3x3x1/4

Deflections | Limits case 1: L/200 = .96in
case 2: L/200 = .6in

$\delta = (Fa^3/(3EI)) X (1 + 3b/2a)$

$.96 = \delta_1 = ((34.65 X 820025)/(87000I)(2.58)$

$.96 = \frac{326.60}{I}(2.58)$ $\overline{I}_{Avg} = 877.73in^4$

$.6 = \delta_2 = ((22.05 X 203297)/(87000I)(2.56)$

$.6 = \frac{51.53}{I}(2.56)$ $\overline{I}_{Avg} = 219.86in^4$

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JOB SUNY Buffalo Canopy
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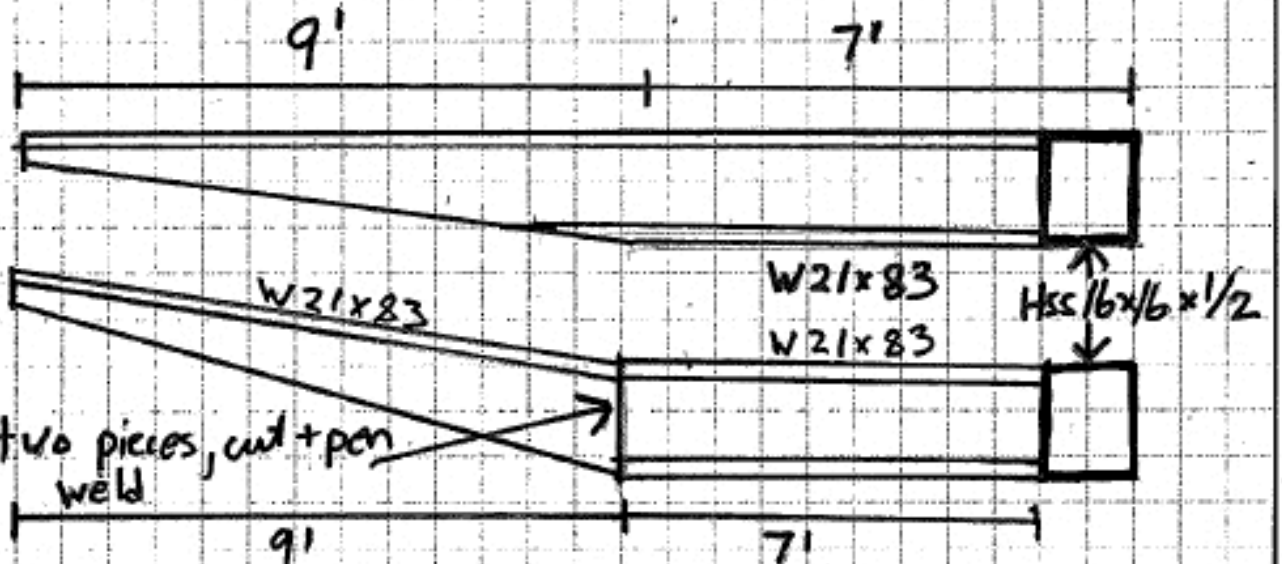
Design of Cantilever

V_{max} = 34.65k (16ft) / 22.05k (10ft)

M_{max} = 270.27kft (16ft) / 108.05kft (10ft)

I_{avg} =



W21x83 M_r/Ω_b = 299 > 270.27 ok

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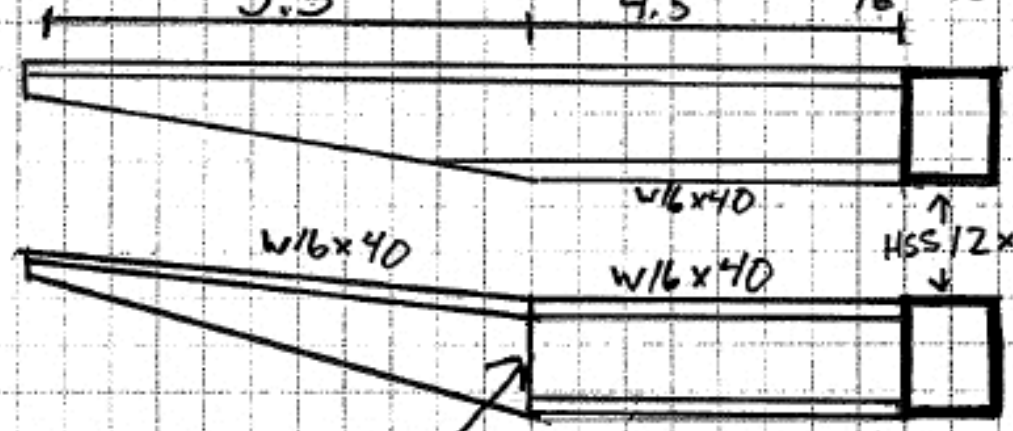
$V_{max} = 22.05k$ (10ft) $M_{max} = 108.05$ (10ft)

$\frac{7}{16} = \frac{x}{10}$ $16x = 70$ $x = 4.5$



two pieces, cut + pen weld

W16x40 $M_r/\Omega_b = 113 > 108$ ok