May 19, 2023

Stormy Shanks
KCL Engineering
312 NW 10th Ave., Suite 100
Portland, OR 97209

RE: BSD Southridge HS HVAC Upgrades
        EELLC Project No. 22190

Dear Stormy:

Attached please find calculation sheets C1 through C11, dated May 19, 2023, which verify the structural adequacy of the existing roof structure supporting RTUs 1 through 13 to be replaced at Southridge High School at 9625 SW 125th Ave in Beaverton, Oregon, as shown on M0.0 through M5.3 dated May 19, 2023. Design is based on the provisions of the 2022 Oregon Structural Specialty Code. Note anchorage of replacement RTU units, as well as evaluation of other mechanical unit replacements is outside of our scope. Note that potential catwalks matching the length and width of RTUs 1-9, and 11-13 shall be limited to a maximum distributed self-weight allowance of 10 pounds per square foot and shall be designed and anchored to structure by others. RTU 10 shall not have a catwalk adjacent.

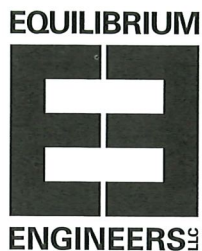Please call if you have any questions.

Sincerely,

Leif Erickson, S.E.
Managing Principal

Enclosures

Project	Sowthridge HS	EQUILIBRIUM	By	E	Sheet #
Location			Date	5/17/23	
Client	KCL	ENGINEERS LLC	Revised		Job #
			Date		22190

(E) Roof Dead Loads:

Roofing & Cover Board	6 psf
Insulation	3 psf
1½" metal Decking	3 psf
MEP	4 psf
MISC	2 psf
Joists	3 psf
	21 psf

Check difference in (N) & (E) RTU weights does not exceed 5%. Note most units will weigh less and the existing structure is ok by inspection. See following pages for further evaluation on select units

	RTU-1	RTU-2	RTU-3	RTU-4	RTU-5	RTU-6
(E) weight	24,195 lb	24,195 lb	24,195 lb	24,195 lb	16,942 lb	22,000 lb
(N) weight	14700 lb (including curb, typ)	14700 lb	15600 lb	15600 lb	16700 lb	14800 lb
Dimensions (Does not change UNO) (HxWxL) inches	73×99×515	73×99×515	73×99×538	73×99×538	97×99×490	73×99×515
	OK by inspection	OK	OK	OK	see following calcs	OK

	RTU-7	RTU-8	RTU-9	RTU-10	RTU-11	RTU-12	RTU-13
	15,673 lb	13,925 lb	13,900 lb	7,500 lb	11,800 lb	10,200 lb	10,340 lb
	14800 lb	10700 lb	11100 lb	7500 lb	10500 lb	5800 lb	10200 lb
	97×99×442	77×96×388	96×77×436	96×77×256	97×99×288	55×94×244	77×96×368
	see following calcs	OK	OK	Note this unit to recieve a special curb adapter and will not have a catwalk adjacent	OK	OK	OK

Project	Southridge HS		By	LE	Sheet #	
Location			Date	5/17/23		
Client	KCL		Revised		Job #	
			Date		22190	

EQUILIBRIUM ENGINEERS LLC
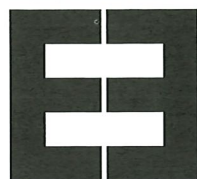
RTU-5

Check worst case (E) joist for change in loading

Existing:

$W = 21$ psf D
$\quad$ 25 psf S
$\quad$ 20 psf L

$W_1 = 16942^{lb}/(99 \times 490/144) = 50.3$ psf

$M_{max} = 103.54$ kft

$V_{max} = 10.3^k$

New:

$W = 21$ psf D $\quad + 10$ psf catwalk D
$\quad$ 25 psf S
$\quad$ 20 psf L

$W_1 = 16700^{lb}/(99 \times 490/144) = 49.6$ psf

$M_{max} = 104.7^{kft} > 103.54^{kft} \quad 101\% < 105\%$ OK

$V_{max} = 10.814 > 10.3^k \quad 104.9\% < 105\%$ OK

∴ No Reinforcement of (E) structure required
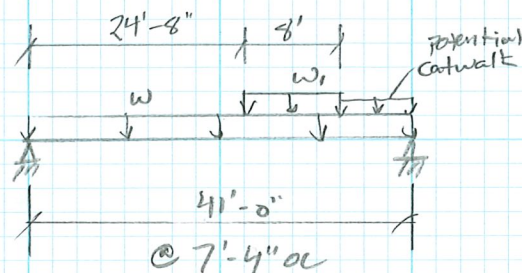
[Sketch: beam diagram with dimensions 24'-8", 8', loads w and w_1, supports A and B, total span 41'-0", @ 7'-4" oc, "Potential Catwalk"]

Project Title:
Engineer:
Project ID:
Project Descr:

General Beam Analysis

Project File: Southridge Calcs.ec6

LIC# : KW-06017318, Build:20.23.04.05   EQUILIBRIUM ENGINEERS LLC   (c) ENERCALC INC 1983-2023

DESCRIPTION: RTU-5 - (E)

General Beam Properties

Elastic Modulus	29,000.0 ksi							
Span #1	Span Length =	41.0 ft	Area =	10.0 in^2	Moment of Inertia =	100.0 in^4	

D(0.153993) L(0.14666) S(0.183325)   D(0.3688499)

Span = 41.0 ft
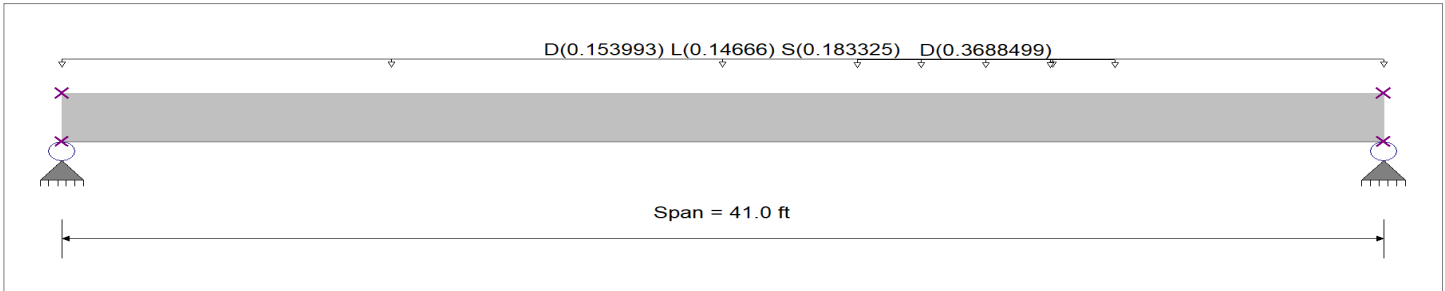
Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Uniform Load : D = 0.0210, L = 0.020, S = 0.0250 ksf, Tributary Width = 7.333 ft

Uniform Load : D = 0.05030 ksf, Extent = 24.670 --> 32.670 ft, Tributary Width = 7.333 ft, (RTU)

DESIGN SUMMARY

Maximum Bending =	103.533 k-ft	Maximum Shear =	10.294 k
Load Combination	+D+0.750L+0.750S	Load Combination	+D+0.750L+0.750S
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Location of maximum on span	22.755 ft	Location of maximum on span	41.000 ft

Maximum Deflection
Max Downward Transient Deflection	4.051 in	121
Max Upward Transient Deflection	0.051 in	9563
Max Downward Total Deflection	10.865 in	45
Max Upward Total Deflection	0.049 in	10079

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios		Summary of Moment Values (k-ft)						Shear Values (k)	
Segment Length	Span #	M	V	Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega Cb	Rm	Va Max	Vnx Vnx/Omega
Overall MAXimum Envelope											
Dsgn. L = 41.00 ft	1			103.53		103.53				10.29	
D Only											
Dsgn. L = 41.00 ft	1			52.97		52.97				5.22	
+D+L											
Dsgn. L = 41.00 ft	1			82.67		82.67				8.23	
+D+S											
Dsgn. L = 41.00 ft	1			90.24		90.24				8.98	
+D+0.750L											
Dsgn. L = 41.00 ft	1			75.15		75.15				7.48	
+D+0.750L+0.750S											
Dsgn. L = 41.00 ft	1			103.53		103.53				10.29	
+0.60D											
Dsgn. L = 41.00 ft	1			31.78		31.78				3.13	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+0.750L+0.750S	1	10.8645	20.910		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1   Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	9.118	10.294
Overall MINimum		
D Only	4.044	5.220
+D+L	7.051	8.227
+D+S	7.802	8.978
+D+0.750L	6.299	7.475
+D+0.750L+0.750S	9.118	10.294
+0.60D	2.427	3.132

General Beam Analysis

Project File: Southridge Calcs.ec6

LIC# : KW-06017318, Build:20.23.04.05   EQUILIBRIUM ENGINEERS LLC   (c) ENERCALC INC 1983-2023

DESCRIPTION: RTU-5 - (E)

Vertical Reactions

Support notation : Far left is #1   Values in KIPS

Load Combination	Support 1	Support 2
L Only	3.007	3.007
S Only	3.758	3.758

General Beam Analysis

DESCRIPTION: RTU-5 - (N)

General Beam Properties

Elastic Modulus	29,000.0 ksi				
Span #1	Span Length =	41.0 ft	Area =	10.0 in^2	Moment of Inertia =	100.0 in^4

D(0.153993) L(0.14666) S(0.183325) D(0.3637168)   D(0.07333)

Span = 41.0 ft
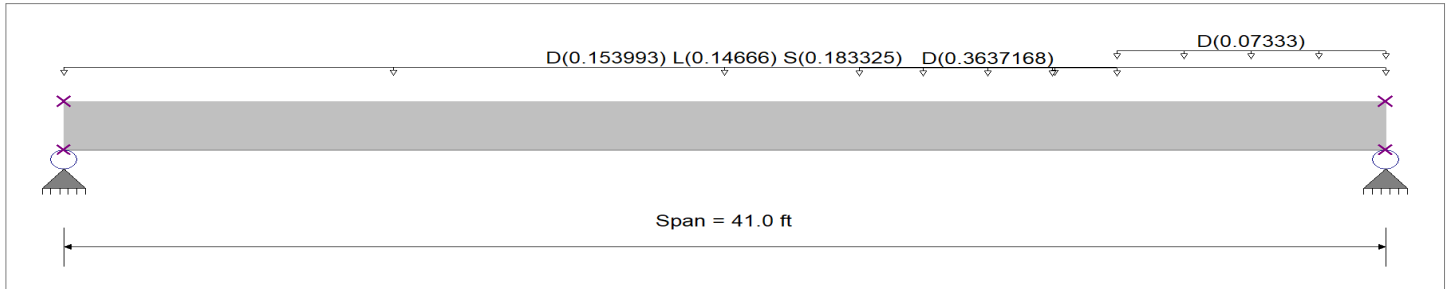
Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Uniform Load : D = 0.0210, L = 0.020, S = 0.0250 ksf, Tributary Width = 7.333 ft

Uniform Load : D = 0.04960 ksf, Extent = 24.670 -->> 32.670 ft, Tributary Width = 7.333 ft, (RTU)

Uniform Load : D = 0.010 ksf, Extent = 32.670 -->> 41.0 ft, Tributary Width = 7.333 ft, (Catwalk)

DESIGN SUMMARY

Maximum Bending =	104.664 k-ft	Maximum Shear =	10.814 k
Load Combination	+D+0.750L+0.750S	Load Combination	+D+0.750L+0.750S
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Location of maximum on span	22.755 ft	Location of maximum on span	41.000 ft

Maximum Deflection		
Max Downward Transient Deflection	4.051 in	121
Max Upward Transient Deflection	0.051 in	9563
Max Downward Total Deflection	10.993 in	44
Max Upward Total Deflection	0.050 in	9873

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios		Summary of Moment Values (k-ft)					Shear Values (k)	
Segment Length	Span #	M	V	Mmax +	Mmax - Ma - Max	Mnx Mnx/Omega Cb	Rm	Va Max	Vnx Vnx/Omega
Overall MAXimum Envelope									
Dsgn. L = 41.00 ft	1			104.66	104.66			10.81	
D Only									
Dsgn. L = 41.00 ft	1			54.22	54.22			5.74	
+D+L									
Dsgn. L = 41.00 ft	1			83.85	83.85			8.75	
+D+S									
Dsgn. L = 41.00 ft	1			91.39	91.39			9.50	
+D+0.750L									
Dsgn. L = 41.00 ft	1			76.34	76.34			8.00	
+D+0.750L+0.750S									
Dsgn. L = 41.00 ft	1			104.66	104.66			10.81	
+0.60D									
Dsgn. L = 41.00 ft	1			32.53	32.53			3.44	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+0.750L+0.750S	1	10.9934	20.910		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1   Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	9.167	10.814
Overall MINimum		
D Only	4.094	5.740
+D+L	7.100	8.747
+D+S	7.852	9.498
+D+0.750L	6.349	7.995

General Beam Analysis

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DESCRIPTION: RTU-5 - (N)

Vertical Reactions

Support notation : Far left is #1   Values in KIPS

Load Combination	Support 1	Support 2
+D+0.750L+0.750S	9.167	10.814
+0.60D	2.456	3.444
L Only	3.007	3.007
S Only	3.758	3.758

Project	Southridge HS		**EQUILIBRIUM**	By	LE	Sheet #	
Location				Date	5/17/23		
Client	KCL		**ENGINEERS** LLC	Revised		Job #	
				Date		22190	

RTU-7

Check worst case (E) joist for change in loading. Note (E) theater ceiling grid not included in Dead/live load comparison to be conservative
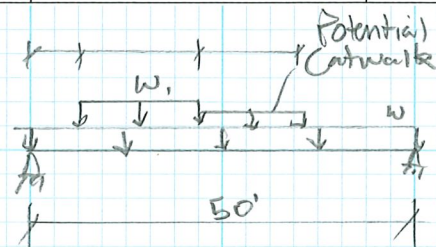
Existing:

$$W = 21 \text{ psf } D$$
$$25 \text{ psf } S$$
$$20 \text{ psf } L$$

$$W_1 = 15673/(99 \times 442)/144 = 51.6 \text{ psf}$$

$$M_{max} = 145.4^{kft}$$
$$V_{max} = 12.36^{k}$$

New:

$$W = 21 \text{ psf } D \quad + 10 \text{ psf Catwalk}$$
$$25 \text{ psf } S$$
$$20 \text{ psf } L$$

$$W_1 = 14800^{lb}/(99 \times 442)/144 = 49.7 \text{ psf}$$

$$M_{max} = 150.9^{kft} > 145.4^{kft} \quad 104\% < 105\% \text{ ok}$$

$$V_{max} = 12.6^{k} > 12.36^{k} \quad 102\% < 105\% \text{ ok}$$

∴ No reinforcement of (E) structure required

Project Title:
Engineer:
Project ID:
Project Descr:

General Beam Analysis

DESCRIPTION: RTU 7 - (E)

General Beam Properties

Elastic Modulus	29,000.0 ksi				
Span #1	Span Length =	50.0 ft	Area =	10.0 in^2	Moment of Inertia = 100.0 in^4

D(0.3783828)   D(0.153993) L(0.14666) S(0.183325)

Span = 50.0 ft
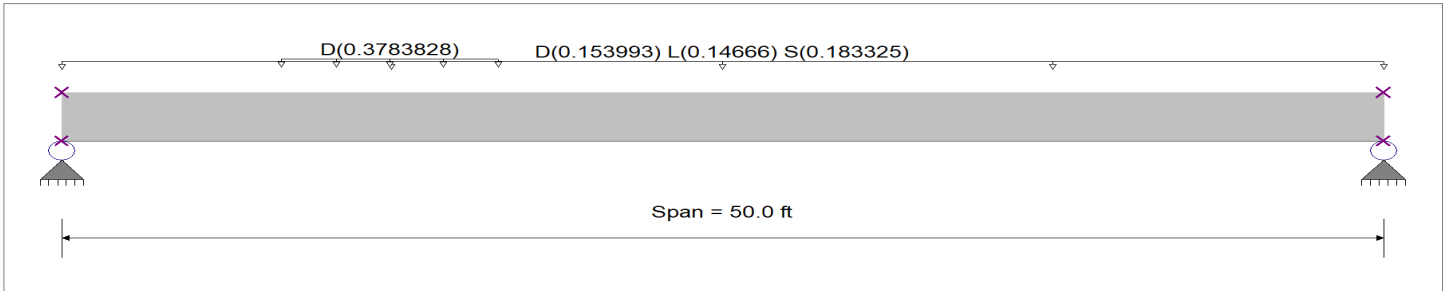
Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Uniform Load : D = 0.0210, L = 0.020, S = 0.0250 ksf, Tributary Width = 7.333 ft

Uniform Load : D = 0.05160 ksf, Extent = 8.333 -->> 16.50 ft, Tributary Width = 7.333 ft, (RTU)

DESIGN SUMMARY

Maximum Bending =	145.380 k-ft	Maximum Shear =	12.360 k
Load Combination	+D+0.750L+0.750S	Load Combination	+D+0.750L+0.750S
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Location of maximum on span	23.000 ft	Location of maximum on span	0.000 ft

Maximum Deflection		
Max Downward Transient Deflection	8.961 in	66
Max Upward Transient Deflection	0.114 in	5272
Max Downward Total Deflection	22.910 in	26
Max Upward Total Deflection	0.104 in	5763

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios		Summary of Moment Values (k-ft)						Shear Values (k)	
Segment Length	Span #	M	V	Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega Cb	Rm	Va Max	Vnx Vnx/Omega
Overall MAXimum Envelope											
Dsgn. L = 50.00 ft	1			145.38		145.38				12.36	
D Only											
Dsgn. L = 50.00 ft	1			69.22		69.22				6.17	
+D+L											
Dsgn. L = 50.00 ft	1			114.12		114.12				9.84	
+D+S											
Dsgn. L = 50.00 ft	1			125.47		125.47				10.76	
+D+0.750L											
Dsgn. L = 50.00 ft	1			102.80		102.80				8.92	
+D+0.750L+0.750S											
Dsgn. L = 50.00 ft	1			145.38		145.38				12.36	
+0.60D											
Dsgn. L = 50.00 ft	1			41.53		41.53				3.70	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+0.750L+0.750S	1	22.9095	24.750		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1   Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	12.360	10.804
Overall MINimum		
D Only	6.173	4.617
+D+L	9.839	8.284
+D+S	10.756	9.200
+D+0.750L	8.923	7.367
+D+0.750L+0.750S	12.360	10.804
+0.60D	3.704	2.770

General Beam Analysis

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DESCRIPTION: RTU 7 - (E)

Vertical Reactions

Support notation : Far left is #1   Values in KIPS

Load Combination	Support 1	Support 2
L Only	3.667	3.667
S Only	4.583	4.583

General Beam Analysis

DESCRIPTION: RTU 7 - (N)

General Beam Properties

Elastic Modulus	29,000.0 ksi				
Span #1	Span Length =	50.0 ft	Area =	10.0 in^2	Moment of Inertia = 100.0 in^4

Span = 50.0 ft
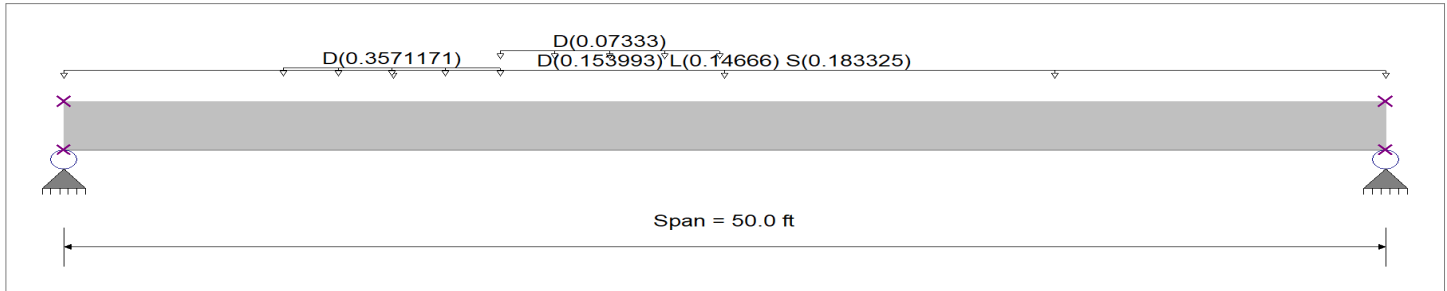
Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Uniform Load : D = 0.0210, L = 0.020, S = 0.0250 ksf, Tributary Width = 7.333 ft

Uniform Load : D = 0.04870 ksf, Extent = 8.333 -->> 16.50 ft, Tributary Width = 7.333 ft, (RTU)

Uniform Load : D = 0.010 ksf, Extent = 16.50 -->> 24.833 ft, Tributary Width = 7.333 ft, (Catwalk)

DESIGN SUMMARY

Maximum Bending =	150.912 k-ft	Maximum Shear =	12.588 k
Load Combination	+D+0.750L+0.750S	Load Combination	+D+0.750L+0.750S
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Location of maximum on span	23.000 ft	Location of maximum on span	0.000 ft

Maximum Deflection		
Max Downward Transient Deflection	8.961 in	66
Max Upward Transient Deflection	0.114 in	5272
Max Downward Total Deflection	23.630 in	25
Max Upward Total Deflection	0.111 in	5428

Maximum Forces & Stresses for Load Combinations

Load Combination		Max Stress Ratios		Summary of Moment Values (k-ft)						Shear Values (k)		
Segment Length	Span #	M	V	Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega Cb	Rm	Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope												
Dsgn. L = 50.00 ft	1			150.91		150.91				12.59		
D Only												
Dsgn. L = 50.00 ft	1			74.69		74.69				6.40		
+D+L												
Dsgn. L = 50.00 ft	1			119.68		119.68				10.07		
+D+S												
Dsgn. L = 50.00 ft	1			131.02		131.02				10.98		
+D+0.750L												
Dsgn. L = 50.00 ft	1			108.37		108.37				9.15		
+D+0.750L+0.750S												
Dsgn. L = 50.00 ft	1			150.91		150.91				12.59		
+0.60D												
Dsgn. L = 50.00 ft	1			44.82		44.82				3.84		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+0.750L+0.750S	1	23.6304	24.750		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1   Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	12.588	11.014
Overall MINimum		
D Only	6.401	4.827
+D+L	10.067	8.493
+D+S	10.984	9.410
+D+0.750L	9.150	7.577

General Beam Analysis

Project File: Southridge Calcs.ec6

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DESCRIPTION: RTU 7 - (N)

Vertical Reactions

Support notation : Far left is #1   Values in KIPS

Load Combination	Support 1	Support 2
+D+0.750L+0.750S	12.588	11.014
+0.60D	3.840	2.896
L Only	3.667	3.667
S Only	4.583	4.583