

Company

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Ver 2013.09.21

STEEL BEAM FLOOR VIBRATION ANALYSIS

www.struware.com

Input Parameters

Description:	Example 4.4	Ex 4.6 Revised	Example 4.8	Example 4.10
Floor Width (perp to beams) ft	90	60	30	90
Floor Length (perp to girders) ft	105	84	105	35
Deck Properties:				
Concrete Density pcf	110	110	110	110
Concrete Strength psi	4000	3000	4000	4000
Concrete thickness above ribs in	3.25	1.5	3.25	3.25
Deck thickness in	2	1	2	2
Beam Properties:				
	W18X35	User1	W18X35	W18X35
Section area in ²	10.30	1.63	10.30	10.30
Section depth in	17.70	26.78	17.70	17.70
Moment of Inertia in ⁴	510	339	510	510
Beam weight plf	35	13.2	35	35
Beam span ft	35	28	35	35
Beam spacing ft	10	2.5	10	10
Girder Properties:				
	W21X50	W30X90	W21X50	W21X50
Section area in ²	14.70	26.40	14.70	14.70
Section depth in	20.80	29.50	20.80	20.80
Moment of Inertia in ⁴	984	3610	984	984
Girder weight plf	50.0	90.0	50.0	50.0
Girder span ft	30	20	30	30
Adjacent Bm span-enter zero if interior edge girder ft	35	28	35	0
Loading Information:				
Non slab, deck & beam dead load psf	5.0	3.0	5.0	5.0
Total floor system dead load psf	49.5	28.6	49.5	49.5
Live load for dynamic analysis psf	11	11	11	11

Vibration Analysis Parameters:

Office, Residential or Church - B=0.03

Damping ratio, β	0.03	0.03	0.03	0.03
Drop load, Po lbs	65	65	65	65
Peak Acceleration (% of gravity):	0.50%	0.50%	0.50%	0.50%

Beam Effective Panel Wt Factor: Cj
Girder Effective Panel Wt Factor: Cg

2	2	1	2
1.8	1.8	1.8	1.8

Coef. for Continuity of Beams:
Coef. for Continuity of Girders:

1.5	1	1.5	1
1	1	1	1

Output Parameters - Results

Peak Acceleration (% of gravity):	0.48%	0.24%	0.63%	0.74%
First Natural Frequency: Hz	4.03	#11.14	3.96	4.54
Floor stiffness kips/in	N/A	61.4	N/A	N/A

denotes peak acceleration exceeds max recommended
 # denotes > 9Hz - Therefore, floor stiffness needs to be >= 5.7 k/in
 Okay - Floor stiffness is greater than 5.7 k/in

Calculations

Beam mode properties

	Effective slab width	ft	10.0	2.5	10.0	10.0
1.35 Ec	dynamic concrete modulus	ksi	3115	2698	3115	3115
n	modular ratio		9.31	10.75	9.31	9.31
/y	centroid of section	in	0.837	3.499	0.837	0.837
Ij	transformed moment of inertia	in ⁴	1833.5	609.1	1833.5	1833.5
wj	uniform distributed beam load	plf	604.6	99.0	604.6	604.6
Δj	beam deflection	in	0.384	0.078	0.384	0.384
fj	beam fundamental frequency	Hz	5.71	12.70	5.71	5.71
de	average concrete thickness	in	4.25	2.00	4.25	4.25
Ds	I per unit width in slab direction	in ⁴ /ft	8.25	0.74	8.25	8.25
Dj	I per unit width in beam direction	in ⁴ /ft	183.3	243.6	183.3	183.3
	2/3 Floor Width	ft	60.0	40.0	20.0	60.0
Bj	effective beam panel width	ft	32.24	13.17	16.12	32.24
Wj	weight of beam panel	kips	102.3	14.6	51.2	68.2

Girder Mode Properties

	Lj average Lj	ft	35.00	28.00	35.00	17.50
	effective slab width	ft	12.0	8.0	12.0	6.0
1.35 Ec	dynamic concrete modulus	ksi	3115	2698	3115	3115
n	modular ratio		9.31	10.75	9.31	9.31
de	average concrete thickness	in	4.25	2.00	4.25	4.25
/y	centroid of section	in	0.347	8.693	0.347	2.055
Ig	transformed moment of inertia	in ⁴	3280.5	6429.0	3280.5	2891.5
wg	uniformly distributed girder loadin	plf	2166.0	1199.2	2166.0	1108.0
Lg / Bj			0.93	1.52	1.86	0.93
Δg	Girder deflection	in	0.415	0.023	0.415	0.241
Δg'	Adjusted girder deflection	in	0.386	0.023	0.415	0.224
f g	girder fundamental frequency	Hz	5.49	23.24	5.49	7.21
Dj	I per unit width in beam direction	in ⁴ /ft	183.3	243.6	183.3	183.3
Dg	I per unit width in girder direction	in ⁴ /ft	93.7	229.6	93.7	330.5
	2/3 Floor Width	ft	70.0	56.0	70.0	23.3
Bg	effective girder panel width	ft	63.9	36.5	63.9	23.3
Wg	girder panel weight	kips	118.6	31.3	118.6	44.3

Combined Mode Properties

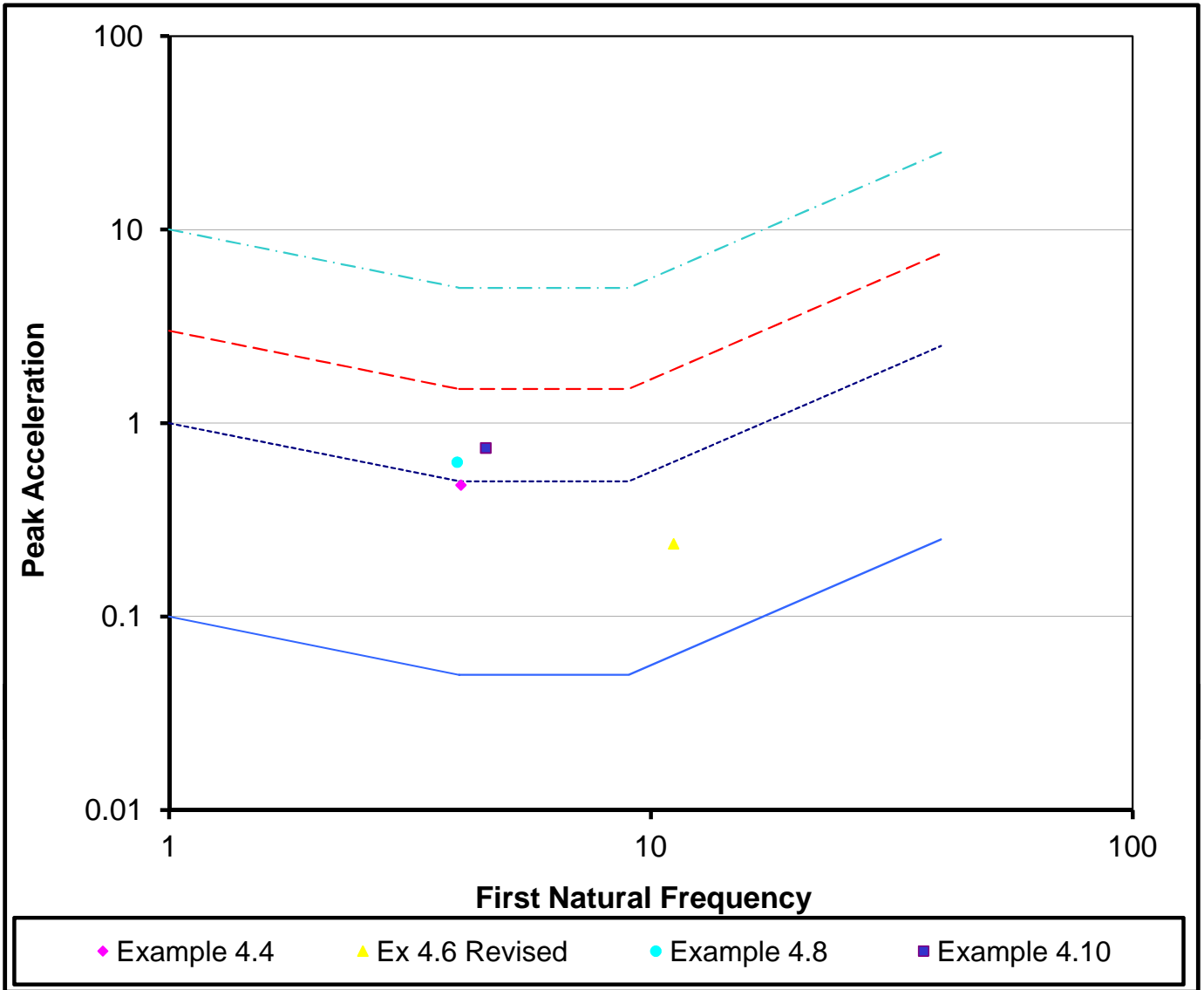
fn	Floor fundamental frequency	Hz	4.03	11.14	3.96	4.54
W	equivalent floor panel weight	kips	110.5	18.4	86.2	59.4
βW	units of lbs.	lbs	3314.0	553.2	2585.2	1782.2
a _p / g	acceleration % of gravity		0.0048	0.0024	0.0063	0.0074

Stiffness Criterion

de / S			0.035	0.067	0.035	0.035
Lj ⁴ / It			16971607	20926687	16971607	16971607
Lj / S			3.50	11.20	3.50	3.50
Neff	Number of effective beams		1.85	2.88	1.85	1.85
Δoj	Single beam static deflection	in	0.0065	0.0101	0.0065	0.0065
Δjp	Beam static deflection	in	0.0035	0.0035	0.0035	0.0035
Δgp	Girder static deflection (.225k)	in	0.0023	0.0003	0.0023	0.0026
Δp	Total static deflection	in	0.0047	0.0037	0.0047	0.0048
Kfloor	Floor stiffness (>5.7 k/in)	kips/in	48.0	61.4	48.0	46.5

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STEEL BEAM GRAPH

- · — · — · — · — Outdoor footbridges, rhythmic activities
- - - - - Indoor footbridges, malls, dining & dancing
- Offices, churches & residences
- ISO Baseline

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STEEL JOIST FLOOR VIBRATION ANALYSIS**Input Parameters**

Description:		Example 4.6	Ex 4.6 Revised	Ex 4.6 Rev2	Ex 4.6 Rev3
Floor Width (perp to joists)	ft	60	60	60	60
Floor Length (perp to girders)	ft	84	84	84	84
Deck Properties:					
Concrete density	pcf	110	110	110	110
Concrete strength	psi	3000	3000	3000	3000
Concrete thickness above ribs	in	1.5	1.5	1.5	1.5
Deck thickness	in	1	1	1	1
Joist Properties:					
Joist designation		30k8	18k6	26k6	28k6
Joist depth	in	30	18	26	28
Joist span	ft	28	28	28	28
Total load capacity	plf	550	346	508	548
Joist spacing	ft	2.5	2.5	2.5	2.5
Joist seat depth	in	2.5	2.5	2.5	2.5
Girder Properties:					
		W30X90	▼ W21X44	▼ W30X90	▼ W27X84
Section area	in ²	26.40	13.00	26.40	24.80
Section depth	in	29.50	20.70	29.50	26.70
Moment of Inertia	in ⁴	3610	843	3610	2850
Girder weight	plf	90.0	44.0	90.0	84.0
Girder span	ft	20	20	20	30
Adjacent joist span-enter zero if interior edge girder	ft	28	28	28	28
Loading Information:					
Non slab,deck & joist dead load	psf	5.2	4.9	4.9	5.0
Total floor system dead load	psf	28.6	28.6	28.6	28.7
Live load for dynamic analysis	psf	11	11	11	11
Vibration Analysis Parameters:					
Office, Residential or Church - B=0.03					
Damping ratio, β		0.03	0.03	0.03	0.03
Drop load, Po	lbs	65	65	65	65
Peak Acceleration (% of gravity):		0.50%	0.50%	0.50%	0.50%
Joist Effective Panel Wt Factor: Cj		2	2	2	2
Girder Effective Panel Wt Factor: Cg		1.6	1.6	1.6	1.6
Coef. for Continuity of Joists:		1	1	1	1
Coef. for Continuity of Girders:		1	1	1	1

Output Parameters - Results

Peak Acceleration (% of gravity):		0.44%	1.16%	0.52%	0.50%
First Natural Frequency:	Hz	9.37#	5.98	8.86	6.35
Floor stiffness	kips/in	44.5	N/A	N/A	N/A

 denotes peak acceleration exceeds max recommended
 # denotes > 9Hz - Therefore, floor stiffness needs to be >= 5.7 k/in
 Okay - Floor stiffness is greater than 5.7 k/in

Calculations

Joist mode properties

	Effective slab width	ft	2.5	2.5	2.5	2.5
1.35 Ec	Dynamic concrete modulus	ksi	2698	2698	2698	2698
n	Modular ratio		10.75	10.75	10.75	10.75
	Joist allowable tensile strength	psi	30000	30000	30000	30000
Ab	Area bottom chord	in	0.726	0.779	0.778	0.777
At	Area top chord	in	0.908	0.974	0.972	0.971
Yc	Joist centroid from top	in	13.39	8.06	11.61	12.50
Ic	Moment of inertia - chords	in ⁴	356.18	131.35	283.60	330.41
	Approx joist weight	plf	7.8	8.4	8.3	8.3
/y	Centroid of section	in	3.500	2.144	3.189	3.448
Icomp	Transformed moment of inertia	in ⁴	626.3	250.9	504.7	581.6
Lj/d	Joist span to depth ratio		11.2	18.7	12.9	12.0
Cr			0.79	0.89	0.83	0.82
γ			0.26	0.13	0.20	0.23
Ieff	Effective moment of inertia	in ⁴	430.7	201.6	372.7	415.7
wj	Uniform distributed joist load	plf	99.1	98.9	98.9	99.2
Δj	Joist deflection	in	0.110	0.234	0.127	0.114
fj	Joist fundamental frequency	Hz	10.67	7.31	9.94	10.49
de	Average concrete thickness	in	2.00	2.00	2.00	2.00
Ds	I per unit width in slab direction	in ⁴ /ft	0.74	0.74	0.74	0.74
Dj	I per unit width in joist direction	in ⁴ /ft	172.3	80.7	149.1	166.3
	2/3 Floor Width	ft	40.0	40.0	40.0	40.0
Bj	Effective joist panel width	ft	14.36	17.36	14.88	14.48
Wj	Weight of joist panel	kips	15.9	19.2	16.5	16.1

Girder Mode Properties

Lj	Average Lj	ft	28.00	28.00	28.00	28.00
	Effective slab width	ft	8.0	8.0	8.0	12.0
1.35 Ec	Dynamic concrete modulus	ksi	2698	2698	2698	2698
n	Modular ratio		10.75	10.75	10.75	10.75
de	Average concrete thickness	in	2.00	2.00	2.00	2.00
/y	Centroid of section	in	10.184	5.045	10.184	7.340
Ig	Transformed moment of inertia	in ⁴	7361	2398	7361	6736
Ig	Adjusted moment of inertia	in ⁴	4548	1232	4548	3821
wg	Uniformly distrib girder loading	plf	1200	1152.1	1197.9	1194.6
Lg / Bj			1.39	1.15	1.34	2.07
Δg	Girder deflection	in	0.033	0.116	0.033	0.196
Δg'	Adjusted girder deflection	in	0.033	0.116	0.033	0.196
f g	Girder fundamental frequency	Hz	19.54	10.38	19.56	7.98
Dj	I per unit width in joist direction	in ⁴ /ft	172.3	80.7	149.1	166.3
Dg	I per unit width in girder direction	in ⁴ /ft	162.4	44.0	162.4	136.5
	2/3 Floor Width	ft	56.0	56.0	56.0	56.0
Bg	Effective girder panel width	ft	32.5	37.2	31.3	50.4
Wg	Girder panel weight	kips	27.8	30.6	26.8	64.5

Combined Mode Properties

fn	Floor fundamental frequency	Hz	9.37	5.98	8.86	6.35
W	Equivalent floor panel weight	kips	18.7	23.0	18.6	46.8
βW	Units of lbs.	lbs	560.2	690.5	558.2	1403.3
a _p / g	Acceleration % of gravity		0.0044	0.0116	0.0052	0.0050

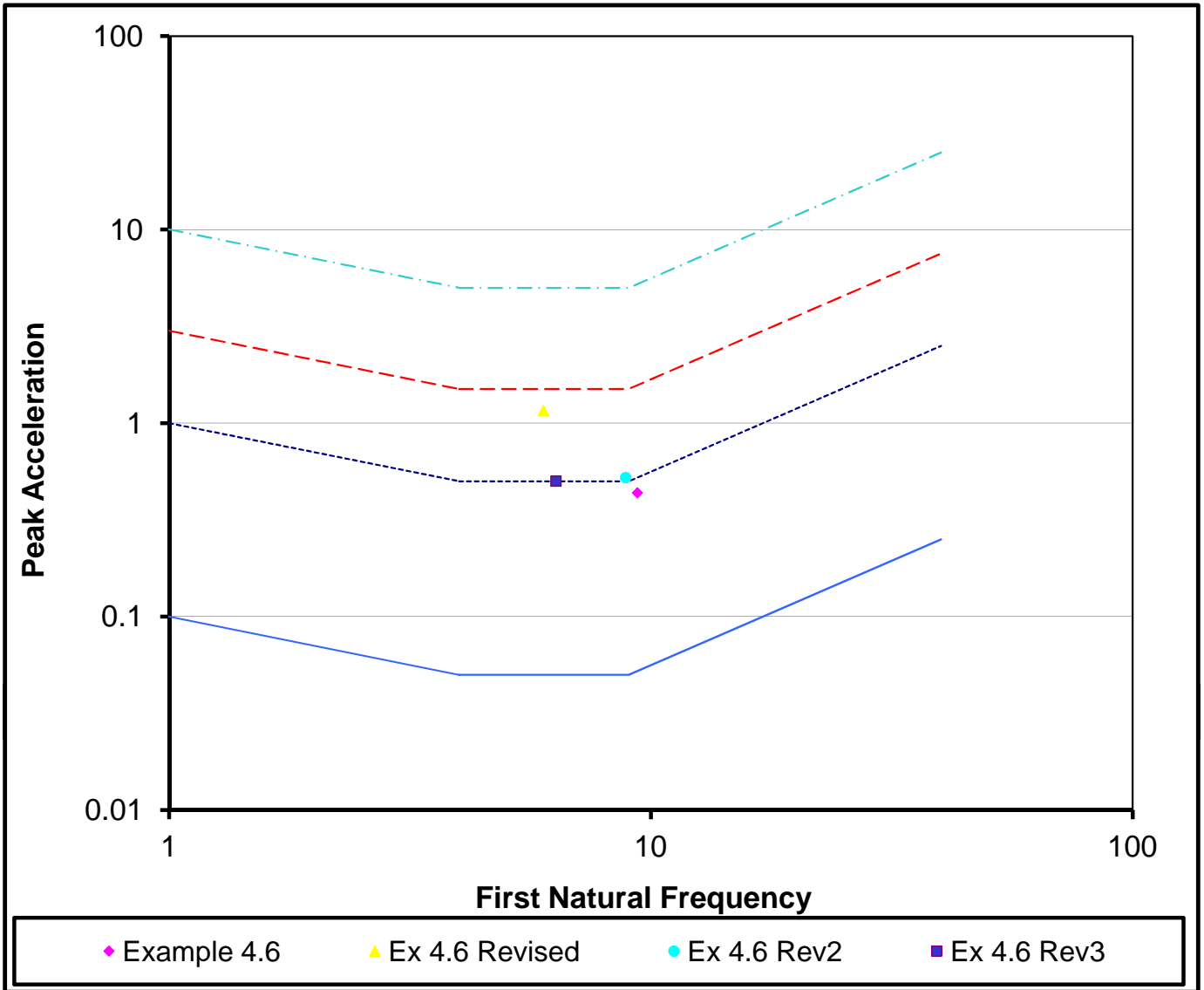
Stiffness Criterion

de / S			0.067	0.067	0.067	0.067
Lj ⁴ / It			29594844	63211585	34196602	30660385
Lj / S			11.20	11.20	11.20	11.20
Neff	Number of effective joists		2.96	3.26	3.00	2.97
Δoj	Single joist static deflection	in	0.0142	0.0304	0.0165	0.0147
Δjp	Joist static deflection	in	0.0048	0.0093	0.0055	0.0050

Δ_{gp}	Girder static deflection (.225k)	in	0.0005	0.0018	0.0005	0.0020
Δ_p	Total static deflection	in	0.0051	0.0102	0.0057	0.0059
K _{floor}	Floor stiffness (>5.7 k/in)	kips/in	44.5	22.0	39.3	37.8

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STEEL JOIST GRAPH

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- Indoor footbridges, malls, dining & dancing
- Offices, churches & residences
- ISO Baseline