DANE COUNTY DEPT. OF PUBLIC WORKS, HIGHWAY & TRANSPORTATION

1919 Alliant Energy Center Way
Madison, Wisconsin 53713
Office: 608/266-4018 ◊ Fax: 608/267-1533
Public Works Engineering Division
Public Works Solid Waste Division

ADDENDUM

February 15, 2018

ATTENTION ALL REQUEST FOR BID (RFB) HOLDERS

RFB NO. 317031 - ADDENDUM NO. 1

JOB CENTER SOLAR ARRAY

BIDS DUE: TUESDAY, FEBRUARY 27, 2018, 2:00 PM. DUE DATE AND TIME ARE NOT CHANGED BY THIS ADDENDUM.

This Addendum is issued to modify, explain or clarify the original Request for Bid (RFB) and is hereby made a part of the RFB. Please attach this Addendum to the RFB.

If any additional information about this Addendum is needed, please call Eric Urtes at 608/266-4798, urtes.eric@countyofdane.com or Ryan Shore at 608/266-4475, shore@countyofdane.com.

Sincerely,
Ryan Shore
Project Manager

Enclosures:
- Structural Analysis of Existing Roof
- Bidders Questions w/ Responses
- Pre-Bid Site Tour Attendees List

STRUCTURAL ANALYSIS OF EXISTING ROOF SYSTEM TO SUPPORT NEW PHOTOVOLTAIC CELL ARRAYS

DANE COUNTY
HUMAN SERVICES BUILDING
MADISON, WISCONSIN

PREPARED FOR:
STRANG, INC.

MP-SQUARED PROJECT NO. 1714147WI

December 1, 2017

Designed by:
Justin Rademacher, E.I.T

Supervised by:
Melissa A. Peyton, P.E.

583 D'Onofrio Drive, Suite 201, Madison, WI 53719 Phone: 608-821-4770 Fax: 608-821-4780
www.mpsqrd.com

TABLE OF CONTENTS

EXECUTIVE SUMMARY

MP-Squared Structural Engineers, LLC (MP-Squared) was retained by Strang, Inc. to determine the feasibility of installing photovoltaic (PV) arrays on the roof of the Dane County Human Services Building in Madison, Wisconsin.

The original roof framing plan by Klefstad Engineering Co, provided by Strang, shows the existing roof framing is composed of 22H7 joists spanning 40 ft., at 4 ft. on-center, framing into wide-flange girders at Lines B, C, D, and E. We estimate the building was constructed circa 1967; the allowable total safe load for joists from that era was determined using standard load tables printed in the *75-Year Steel Joist Manual* published by the Steel Joist Institute. The girders are assumed to be rolled with 36 ksi material.

Information regarding the roof type and the uniform dead load of each solar panel array was provided by Strang, Inc. MP-Squared made further assumptions regarding the weight of the roof deck, hanging MEP equipment, and other miscellaneous suspended items to estimate the total uniform dead weight of the roof. Existing RTU weights were also provided by the client for our use.

The uniform roof snow load was determined per the current Wisconsin Commercial Building Code (based on the 2009 International Building Code). The presence of solar panels makes an otherwise partially exposed roof, "sheltered." Sliding snow and snowdrift patterns, primarily north and south, were determined per the recommendations prescribed in *Snow Loads on Solar-Paneled Roofs* by the American Society of Civil Engineers.

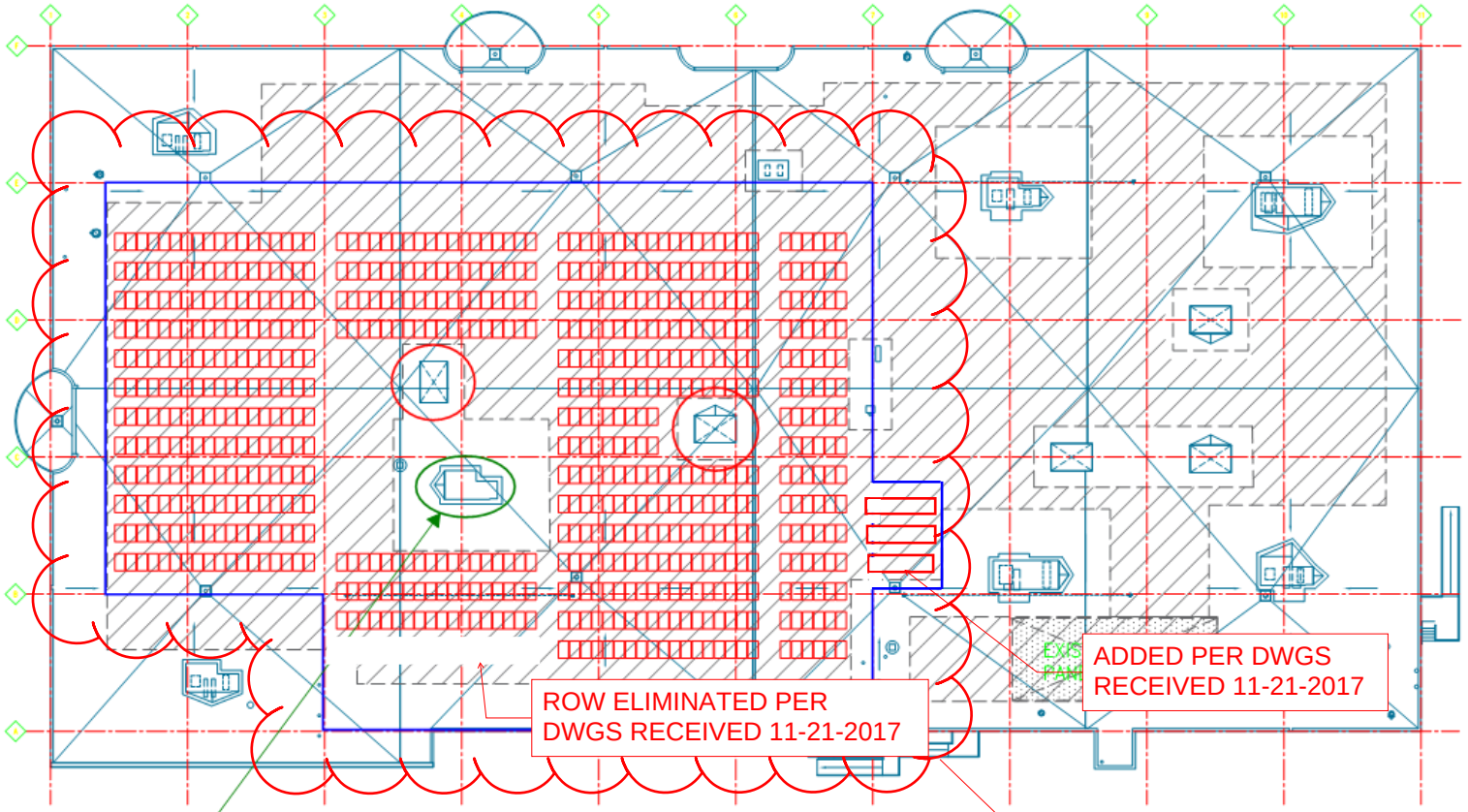
We determined the sliding snow and snowdrift patterns produced by the solar panel configuration depicted on E201 and E401. Detail 1/E401 indicates the lower end of the array is about 21 inches above the existing roof. The snow load pattern created by this configuration will require strengthening of the existing roof joists and girders.

Reducing the gap to 14 inches revises the snow load pattern such that the existing roof joists and girders are adequate as-designed and do not require strengthening.

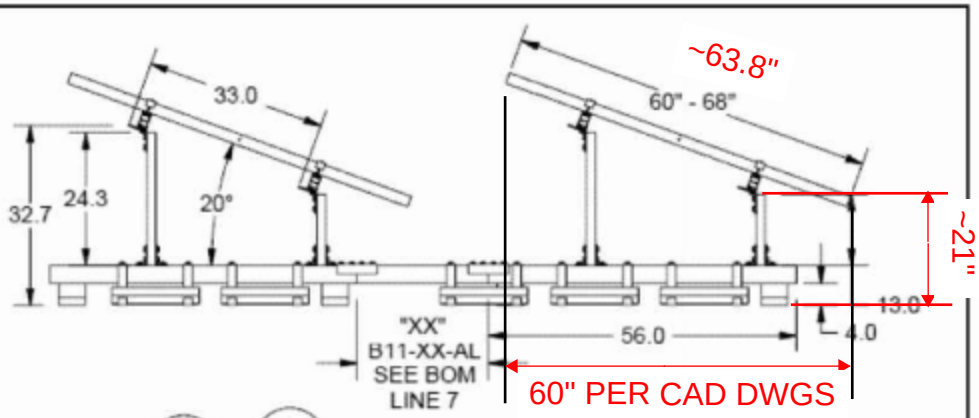
Please refer to the enclosed calculations for more in-depth analysis. If any of the assumptions used in the analysis of the existing roof system are incorrect, please contact MP-Squared to provide additional structural analysis.

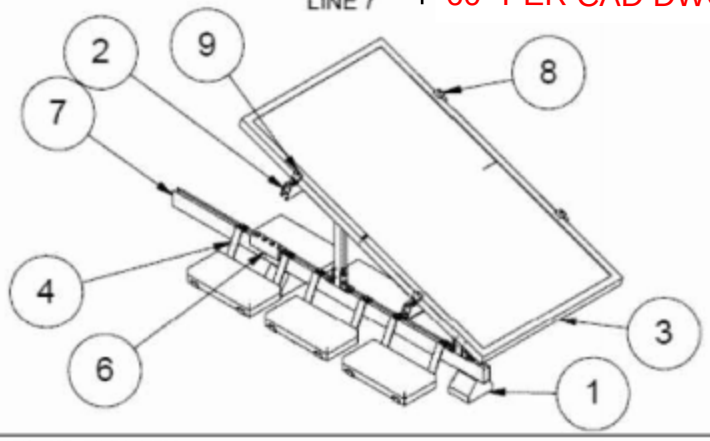
LOADING INFORMATION

EXISTING ROOF PLAN W/ PROPOSED PHOTOVOLATIC CELL ARRAY



P.V. CELL SCHEMATIC





ITEM NO.	DESCRIPTION
9	SHDENDXX PA AL W/SS
8	SHDMIDXX PA AL W SS
7	B11-XX AL - LENGTH TO SET ROW SPACING
6	B172PA FOUR HOLE SPLICE, PREASSEMBLED
4	SRTBS-1PA BALLAST STRIP - PRE ASSEMBLED
3	SOLAR MODULE, CUSTOMER SUPPLIED
2	B22A-AL
1	SRTM20PXXXX, ROOFTOP SOLAR SUPPORT 20 DEGREE MONOLITHIC PORTRAIT

BILL OF MATERIAL

COOPER B-Line
509 W. Monroe Street
Highland, IL 62249
Phone (618) 654-2184
FAX (618) 654-5499
www.cooperbline.com

SUBMITTAL DRAWING

TITLE:
ARISTA MONOLITHIC ROOFTOP
SOLAR RACKING SYSTEM
20 DEGREE PORTRAIT
60"-68" SOLAR MODULES

EQUIPMENT FURNISHED HAS BEEN FABRICATED IN ACCORDANCE WITH THIS DRAWING.

REFERENCE DWG(S): 00018181, 00017106, 00018216, 00003117, 00017240, 00000018

MODEL SOURCE FILE: 00018175 REV: 00

SUBMITTAL NO: S00018182

DRAWN BY: ERN REV: A

DATE: 01/27/2011

SHEET: 1 OF 1

STANDARD LOAD TABLE

OPEN WEB STEEL JOISTS, H-SERIES

Allowable Total Safe Loads in Pounds Per Linear Foot of H-SERIES Steel Joists — *For Joist Depths 8" to 14" inclusive.

The black figures in the following table give the TOTAL safe uniformly-distributed load-carrying capacities, in pounds per linear foot, of H-Series High Strength Steel Joists adopted by the Steel Joist Institute. The weight of DEAD loads, including the joists, must in all cases be deducted to determine the LIVE load-carrying capacities of the joists.

The figures shown in blue in this load table are the LIVE loads per linear foot of joist which will produce an approximate deflection of 1/360 of the span. LIVE loads which will produce a deflection of 1/240 of the span may be obtained by multiplying the figures in blue by 1.5. In no case shall the total load capacity of the joist be exceeded.**

** — Section 5.9 of the "Specifications for Open Web High Strength Steel Joists, H-Series" limits the design LIVE load deflection as follows: **Floors** — 1/360 of span. **Roofs** — 1/360 of span where a plaster ceiling is attached or suspended; 1/240 of span for all other cases

Joist Designation	8H2	10H2	10H3	10H4	12H2	12H3	12H4	12H5	12H6	14H3	14H4	14H5	14H6	14H7
*Depth in Inches	8	10	10	10	12	12	12	12	12	14	14	14	14	14
Resisting Moment In Inch-Pounds	73,000	91,000	116,000	148,000	111,000	140,000	180,000	222,000	260,000	165,000	212,000	259,000	307,000	369,000
Maximum End Reaction In Pounds	2000	2200	2500	2800	2400	2800	3200	3600	3900	3200	3500	3800	4200	4600
†Approximate Weight in Pounds per Foot	4.2	4.2	5.0	6.1	4.5	5.2	6.2	7.1	8.2	5.5	6.5	7.4	8.6	10.0
Span in Feet														
8	500													
9	444													
10	400	440	500	560										
11	364 319	400	455	509										
12	333 246	367	417	467	400	467	533	600	650					
13	288 193	338 300	385 282	431	369	431	492	554	600					
14	248 155	310 240	357 306	400 368	343	400	457	514	557	457	500	543	600	657
15	216 126	270 195	333 249	373 299	320 286	373 365	427	480	520	427	467	507	560	613
16	190 103	237 161	302 205	350 247	289 236	350 300	400 364	450 440	488	400	438	475	525	575
17		210 134	268 171	329 206	256 196	323 250	376 304	424 367	459 437	376 346	412	447	494	541
18		187 113	239 144	305 173	228 165	288 211	356 255	400 309	433 368	340 292	389 354	422	467	511
19		168 96	214 122	273 147	205 141	259 179	332 217	379 263	411 313	305 248	368 301	400 364	442 437	484
20		152 82	193 105	247 126	185 120	233 154	300 186	360 225	390 268	275 212	350 258	380 312	420 374	460 435
21					168 104	212 133	272 161	336 194	371 232	249 183	320 223	362 270	400 323	438 375
22					153 90	193 115	248 140	306 169	355 202	227 159	292 194	345 235	382 281	418 326
23					140 79	176 101	227 122	280 148	328 176	208 140	267 169	326 205	365 246	400 286
24					128 69	162 89	208 108	257 130	301 155	191 123	245 149	300 181	350 217	383 251
25										176 109	226 132	276 160	327 191	368 222
26										163 96	209 117	255 142	303 170	354 198
27										151 86	194 104	237 127	281 152	337 176
28										140 77	180 94	220 114	261 136	314 158

*Indicates Nominal Depth of Steel Joists only.
†Approximate Weights per Linear Foot of Steel Joists only. Accessories and nailer strip not included.
*†See Manufacturers' Catalog for detailed information on specific joist types.

LOADS ABOVE COLORED LINES ARE GOVERNED BY SHEAR.

Tests on steel joists designed in accordance with the Steel Joist Institute Standard Specifications have demonstrated that the Steel Joist Institute Load Tables are applicable for concentrated top chord loadings (such as are developed in bulb-tee roof construction) when the sum of the equal concentrated top chord loadings does not exceed the allowable uniform loading for the joist type and span and the loads are placed at spacings not exceeding 33" along the top chord.

Adopted by the Steel Joist Institute May 31, 1961.

This Table in accordance with Simplified Practice Recommendation filed with the Commodity Standards Division, Office of Technical Services, U. S. Department of Commerce.

STEEL JOIST INSTITUTE

LT-15

Allowable Total Safe Loads in Pounds Per Linear Foot of H-SERIES Steel Joists — *For Joist Depths 16″ to 24″ inclusive.

Joist Designation	16H4	16H5	16H6	16H7	16H8	18H5	18H6	18H7	18H8	20H5	20H6	20H7	20H8	22H6	22H7	22H8	24H6	24H7	24H8
*Depth in Inches	16	16	16	16	16	18	18	18	18	20	20	20	20	22	22	22	24	24	24
Resisting Moment In Inch-Pounds	221,000	289,000	344,000	413,000	478,000	325,000	383,000	466,000	540,000	365,000	406,000	499,000	602,000	422,000	526,000	653,000	462,000	576,000	716,000
Maximum End Reaction In Pounds	3800	4300	4600	4900	5200	4500	4800	5200	5400	4800	5100	5400	5600	5400	5600	5800	5600	5800	6000
†Approximate Weight in Pounds per Foot	6.6	7.8	8.6	10.3	11.4	8.0	9.2	10.4	11.6	8.4	9.6	10.7	12.2	9.7	10.7	12.0	10.3	11.5	12.7
Span in Feet																			
16	475	538	575	613	650														
17	447	506	541	576	612														
18	422	478	511	544	578	500	533	578	600										
19	400 399	453	484	516	547	474	505	547	568										
20	368 342	430 413	460	490	520	450	480	520	540	480	510	540	560						
21	334 295	410 357	438 429	467	495	429	457	495	514	457	486	514	533						
22	304 257	391 310	418 373	445 434	473	409 398	436	473	491	436	464	491	509	491	509	527			
23	279 225	364 272	400 326	426 379	452 434	391 348	417	452	470	417	443	470	487	470	487	504			
24	256 198	334 239	383 287	408 334	433 382	375 306	400 367	433 427	450	400 380	425	450	467	450	467	483	467	483	500
25	236 175	308 211	367 254	392 295	416 338	347 271	384 325	416 378	432	384 336	408 405	432	448	432	448	464	448	464	480
26	218 155	285 188	339 226	377 262	400 300	321 241	369 289	400 336	415 385	360 299	392 360	415	431	415	431	446	431	446	462
27	202 139	264 168	315 201	363 234	385 268	297 215	350 258	385 300	400 344	334 267	371 321	400 375	415	386	415	430	415	430	444
28	188 124	246 150	293 181	350 210	371 240	276 193	326 231	371 269	386 308	310 239	345 288	386 336	400 385	359 351	400	414	393	414	429
29	175 112	229 135	273 162	327 189	359 216	258 173	304 208	359 242	372 278	289 216	322 259	372 302	386 346	335 316	386 368	400	366	400	414
30	164 101	214 122	255 147	306 171	347 195	241 157	284 188	345 219	360 251	270 194	301 244	360 274	373 313	313 286	373 417	387 382	342 342	387	400
31	153 91	200 111	239 133	287 155	332 177	225 142	266 170	323 198	348 227	253 176	282 212	346 247	361 284	293 259	361 301	374 346	320 310	374 361	387
32	144 83	188 101	224 121	269 141	311 161	212 129	249 155	303 180	338 206	238 160	264 193	325 225	350 258	275 235	342 274	363 315	301 282	363 329	375
33						199 117	234 141	285 164	327 188	223 146	249 176	305 205	339 235	258 214	322 250	352 287	283 257	352 300	364 344
34						187 107	221 129	269 150	311 172	210 133	234 161	288 187	329 215	243 196	303 228	341 263	266 235	332 274	353 315
35						177 98	208 118	254 137	294 158	199 122	221 147	272 177	320 197	230 180	286 209	331 241	251 215	313 251	343 288
36						167 90	197 108	240 126	278 145	188 112	209 135	257 158	310 181	217 165	271 192	322 221	238 198	296 231	333 265
37										178 103	198 125	243 145	293 167	206 152	256 177	314 204	225 182	280 212	324 244
38										169 95	187 115	230 134	278 154	195 140	243 163	301 188	213 168	266 196	316 225
39										160 88	178 106	219 124	264 142	185 130	231 151	286 174	202 155	252 181	308 208
40										152 82	169 98	208 115	251 132	176 120	219 140	272 161	193 144	240 168	298 193
41														167 112	209 130	259 149	183 134	228 156	284 179
42														159 104	199 121	247 139	175 124	218 145	271 167
43														152 97	190 113	235 130	167 116	208 135	258 155
44														145 90	181 105	225 121	159 108	198 126	247 145
45																	152 101	190 118	236 135
46																	146 94	181 110	226 127
47																	139 89	174 103	216 119
48																	134 83	167 97	207 111

SAFE LOAD CARRYING CAPACITY OF EXISTING 22H7 JOIST(S)

*Indicates Nominal Depth of Steel Joists only.
†Approximate Weights per Linear Foot of Steel Joists only. Accessories and nailer strip not included.
*†See Manufacturers' Catalog for detailed information on specific joist types.

LOADS ABOVE COLORED LINES ARE GOVERNED BY SHEAR.

Tests on steel joists designed in accordance with the Steel Joist Institute Standard Specifications have demonstrated that the Steel Joist Institute Load Tables are applicable for concentrated top chord loadings (such as are developed in bulb-tee roof construction) when the sum of the equal concentrated top chord loadings does not exceed the allowable uniform loading for the joist type and span and the loads are placed at spacings not exceeding 33″ along the top chord.

Adopted by the Steel Joist Institute May 31, 1961.

This Table in accordance with Simplified Practice Recommendation filed with the Commodity Standards Division, Office of Technical Services, U. S. Department of Commerce.

OPEN WEB STEEL JOISTS, H-SERIES

LT-16

Welcome Michel Robert! New Search (Logout)

AAON Inc. Unit Documents Viewer

DSO #: 476262 **Site:** Tulsa **Ordered On:** 07/20/2009 **Shipped On:** 09/24/2009
JobName: DANE CO.JOB CTR
Cutomer: MASTERS BUILDING SOLUTIONS
Shipped To: DANE CO. PARKS STORAGE
C/O TOWER MECHANICAL, 4318 ROBERTSON RD., MADISON, WI USA 53714
Rep: 766 **PO#:** B96-0033-A

Please select the Serial # to View

DSO Lines for 476262

TAG

Serial #	DSO Line #	Part #	Description	WEIGHTS
RTU-1 ANGT07112	001	99842	RN-030-8-0-EA09-344:CFGDK0ADELB00R0ACG0H0000000000B	3,255
RTU-2 BNGU07127	002	99843	RN-031-8-0-EA09-3C4:CEHQK0AGDFB00K0ACG0H0000000000B	6,073
RTU-3 ANGT07113	003	99842	RN-030-8-0-EA09-344:CFGDK0ADELB00R0ACG0H0000000000B	3,255
RTU-4 BNGW07128	004	99844	RN-050-8-0-EA09-3C4:CEHEK0AGDGB00K0ADG0H0000000000B	6,695
RTU-5 ANGT07114	005	99842	RN-030-8-0-EA09-344:CFGDK0ADELB00R0ACG0H0000000000B	3,255
RTU-6 ANGP07115	006	99846	RN-020-8-0-EA09-344:CEGDK0ADESB00R0ABG0H0000000000B	3,157
RTU-7 ANGR07116	007	99848	RN-025-8-0-EA09-344:CEGEK0ADESB00R0ACG0H0000000000B	3,233
	008	@FREIGHT		

(mp)² STRUCTURAL ENGINEERS, LLC

Project Name: STRANG DANE COUNTY P.V.

Project No: 1714147 WI

Designed By: JTR Page No:

Date: 11/14/2017

EXISTING JOIST DESIGNATION: 22H7 (CIRCA 1967)

TOTAL ALLOWABLE UNIFORM LOAD: 219 PLF (140 PLF LIVE)

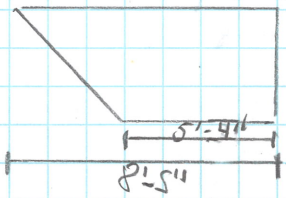
- Max allowable moment = $\frac{(219\text{PLF})(40\text{FT})^2}{8} = 43.8\text{ k-ft}$
- Max allowable shear = $\frac{(219\text{PLF})(40\text{FT})}{2} = 4.38\text{ k}$

EXISTING DEAD LOADS (4FT TRIB.)

SELF-WEIGHT OF JOIST = 10.7 PLF (2.7 PSF)

MEMBRANE, INSULATION, DECK, MEP, MISC. = 40 PLF (10 PSF) ASSUMED

MECH. UNIT + CURB = 3,255lbs (5'-4" x 15'-5" FOOTPRINT, NON-CONCRETE CURB)
(RTU-5) + ~250lbs → SEE S1 DATED 7/7/1995



NEW DEAD LOADS (4FT TRIB.)

TILTED P.V. CELLS = 16 PLF - 24 PLF (4-6 PSF)

EXISTING DL + NEW DL = 74.7 PLF (USE 75 PLF)

SNOW LOAD PER IBC 2009 & ASCE SOLAR PANEL DRIFT LOAD RECOMMENDATIONS
→ SEE ATTACHED

IBC 3403.2 ALLOWABLE OVER-STRESS THRESHOLDS:

MOMENT: 43.8 k-ft x 1.05 = 45.99 k-ft

SHEAR: 4.60 k x 1.05 = 4.60 k

RTU POINT LOADS

3,255lbs + 250lbs = 3,505lbs

$\frac{3{,}505\text{lbs}}{5.333' \times 15.417'} = 42.63\text{ PSF}$

$\left(\frac{42.63\text{ PSF}}{2}\right)(5.333') = 113.7\text{ PLF}$

$\left(\frac{(113.7\text{PLF})(15.417')}{5}\right) = 350.5\text{lbs}$ JOISTS

Code Search

Code: International Building Code 2009

Occupancy:

Occupancy Group = B Business

Occupancy Category & Importance Factors:

Occupancy Category =	II
Wind factor =	1.00
Snow factor =	1.00
Seismic factor =	1.00

Type of Construction:

Fire Rating:

Roof =	0.0 hr
Floor =	0.0 hr

Building Geometry:

Roof angle (θ)	0.25 / 12	1.2 deg	-> SLIGHLTLY SLOPES TO DRAINS
Building length (L)	400.0 ft		
Least width (B)	200.0 ft		
Mean Roof Ht (h)	18.0 ft	-> ASSUMED	
Parapet ht above grd	0.0 ft		
Minimum parapet ht	0.0 ft		

MP-Squared Structural Engineers
MP-Squared Structural Engineers
Madison, WI 53719
608-821-4770

JOB TITLE Strang Dane County P.V.
JOB NO. 1714147WI SHEET NO.
CALCULATED BY jtr DATE 10/14/17
CHECKED BY MAP DATE

Snow Loads : ASCE 7-05

Nominal Snow Forces

Roof slope		=	1.2 deg
Horiz. eave to ridge dist (W)		=	200.0 ft
Roof length parallel to ridge (L)		=	400.0 ft
Type of Roof			Monoslope
Ground Snow Load	Pg	=	30.0 psf
Occupancy Category		=	II
Importance Factor	I	=	1.0
Thermal Factor	Ct	=	1.00
Exposure Factor	Ce	=	1.0
Pf = 0.7*Ce*Ct*I*Pg		=	21.0 psf
Unobstructed Slippery Surface			no
Sloped-roof Factor	Cs	=	1.00
Balanced Snow Load	**Ps**	**=**	**21.0 psf**
Rain on Snow Surcharge Angle			4.00 deg
Code Maximum Rain Surcharge			5.0 psf
Rain on Snow Surcharge		=	0.0 psf
Ps plus rain surcharge		=	21.0 psf
Minimum Snow Load	Pfmin	=	20.0 psf
Uniform Roof Design Snow Load		=	**21.0 psf**

EXPOSURE B
URBAN AREA

ORIGINAL DESIGN SNOW LOAD
FOR GIVEN YEAR: 30 PSF

DESIGN SNOW LOAD PER
CURRENT WI BUILDING CODE
WITHOUT P.V. CELL ARRAYS

MP-Squared Structural Engineers
MP-Squared Structural Engineers
Madison, WI 53719
608-821-4770

JOB TITLE Strang Dane County P.V.
JOB NO. 1714147WI SHEET NO.
CALCULATED BY jtr DATE 10/14/17
CHECKED BY MAP DATE

Snow Loads : ASCE 7-05

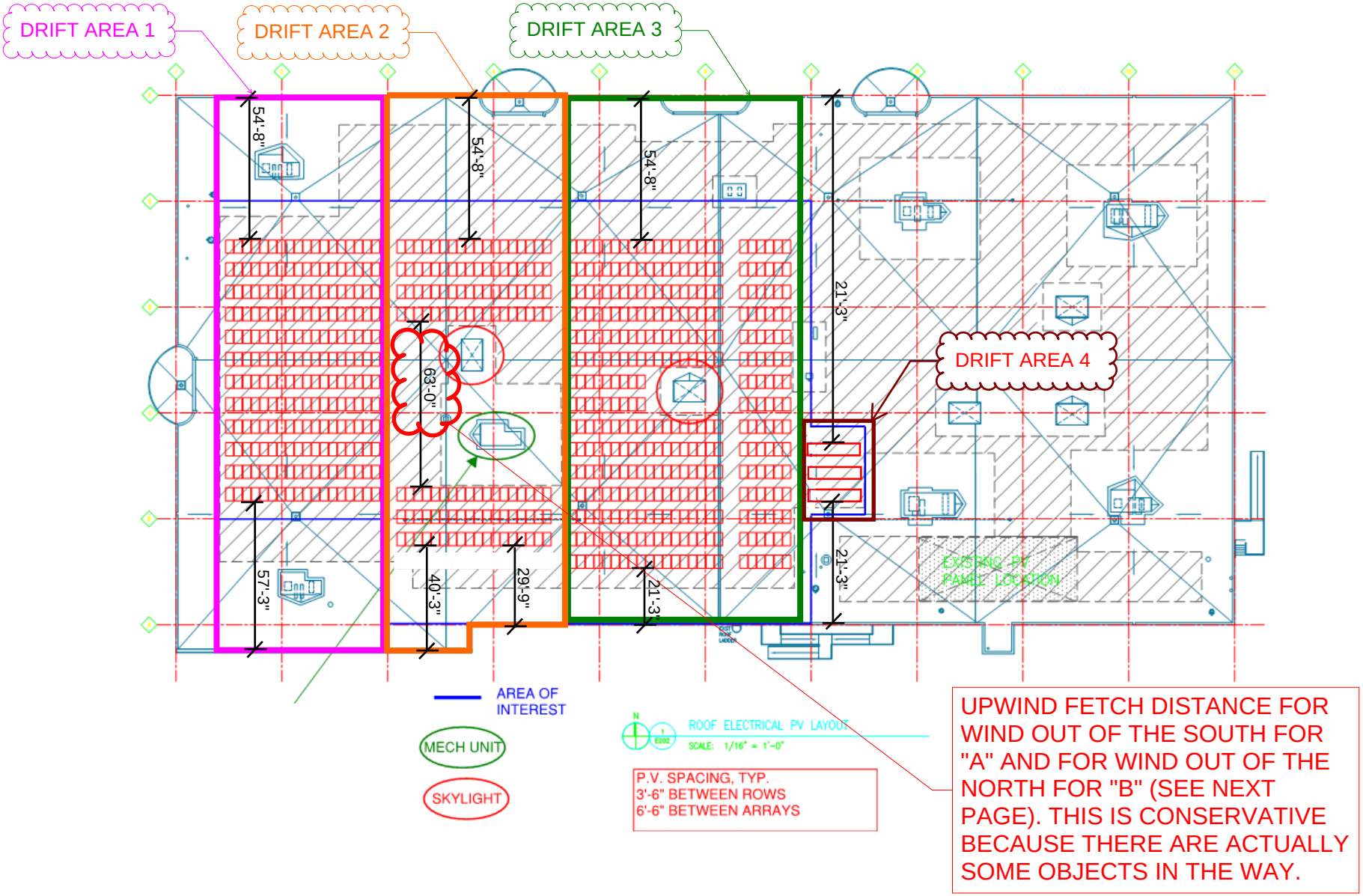
Nominal Snow Forces

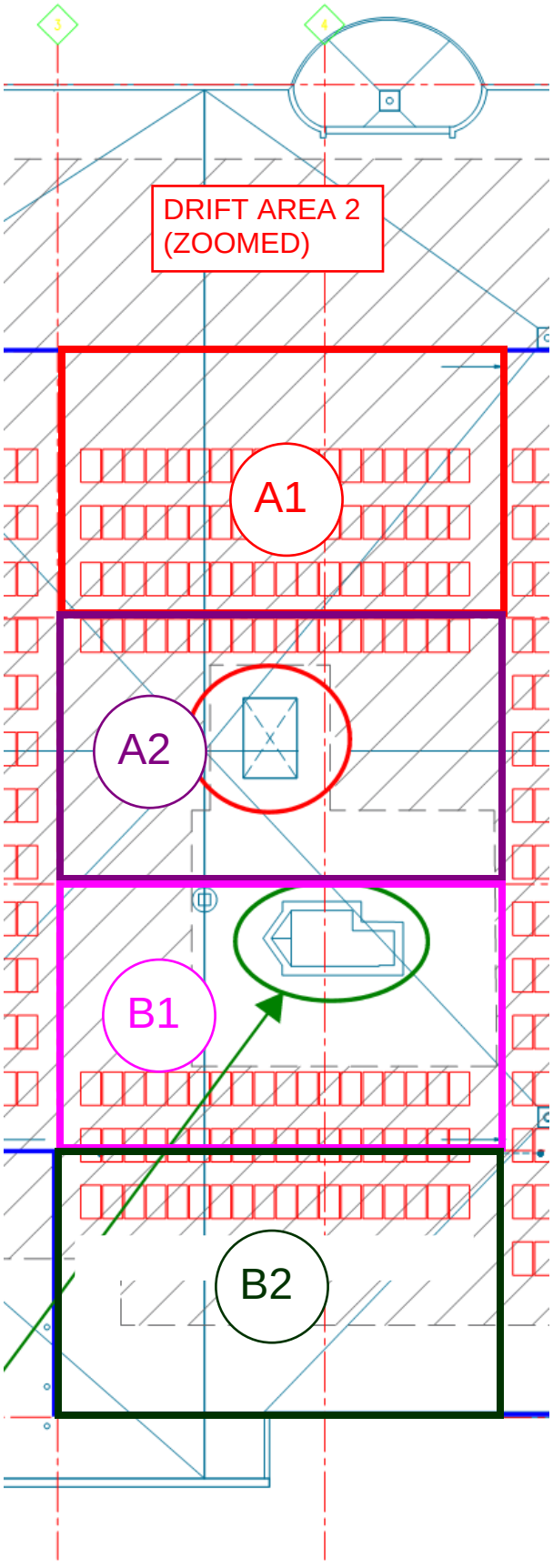
Roof slope		=	1.2 deg
Horiz. eave to ridge dist (W)		=	200.0 ft
Roof length parallel to ridge (L)		=	400.0 ft
Type of Roof			Monoslope
Ground Snow Load	Pg	=	30.0 psf
Occupancy Category		=	II
Importance Factor	I	=	1.0
Thermal Factor	Ct	=	1.00
Exposure Factor	Ce	=	1.2
Pf = 0.7*Ce*Ct*I*Pg		=	25.2 psf
Unobstructed Slippery Surface			no
Sloped-roof Factor	Cs	=	1.00
Balanced Snow Load	**Ps**	**=**	**25.2 psf**
Rain on Snow Surcharge Angle			4.00 deg
Code Maximum Rain Surcharge			5.0 psf
Rain on Snow Surcharge		=	0.0 psf
Ps plus rain surcharge		=	25.2 psf
Minimum Snow Load	Pfmin	=	20.0 psf
Uniform Roof Design Snow Load		=	**25.2 psf**

THE ASCE "SNOW LOADS ON SOLAR-PANELED ROOFS" DESIGN GUIDE SUGGESTS THAT THE PRESENCE OF P.V. CELL ARRAYS MOVES AN OTHERWISE PARTIALLY-EXPOSED SECTION OF ROOF INTO THE SHELTERED CATEGORY.

DESIGN SNOW LOAD PER CURRENT WI BUILDING CODE FOR A ROOF SECTION WITH P.V. CELL ARRAYS

AS ELUDED TO ABOVE, THE ADDITION OF A P.V. CELL ARRAY CHANGES THE SNOW LOAD PATTERN ON A ROOF. THE CALCULATIONS THAT FOLLOW EXAMINE THESE NEW PATTERNS ACCORDING TO THE ASCE "SNOW LOADS ON SOLAR-PANELED ROOFS" DESIGN GUIDE. THE PATTERNS TO BE EXAMINED ARE DRIFTED SNOW AROUND THE PERIMETER OF THE ARRAY, DRIFTED SNOW BETWEEN P.V. CELL ROWS, AND SLIDING SNOW OFF THE TILTED PANEL INTO THE AISLE.


DRIFT AREA 1
DRIFT AREA 2
DRIFT AREA 3
DRIFT AREA 4
54'-8"
54'-8"
54'-8"
21'-3"
63'-0"
57'-3"
40'-3"
29'-9"
21'-3"
21'-3"
EXISTING PV PANEL LOCATION
AREA OF INTEREST
MECH UNIT
SKYLIGHT
ROOF ELECTRICAL PV LAYOUT
SCALE: 1/16" = 1'-0"
P.V. SPACING, TYP.
3'-6" BETWEEN ROWS
6'-6" BETWEEN ARRAYS
UPWIND FETCH DISTANCE FOR WIND OUT OF THE SOUTH FOR "A" AND FOR WIND OUT OF THE NORTH FOR "B" (SEE NEXT PAGE). THIS IS CONSERVATIVE BECAUSE THERE ARE ACTUALLY SOME OBJECTS IN THE WAY.


DRIFT AREA 2
(ZOOMED)
A1
A2
B1
B2

(mp)² STRUCTURAL ENGINEERS, LLC

Project Name: STRANG DANE COUNTY R.V. PANELS

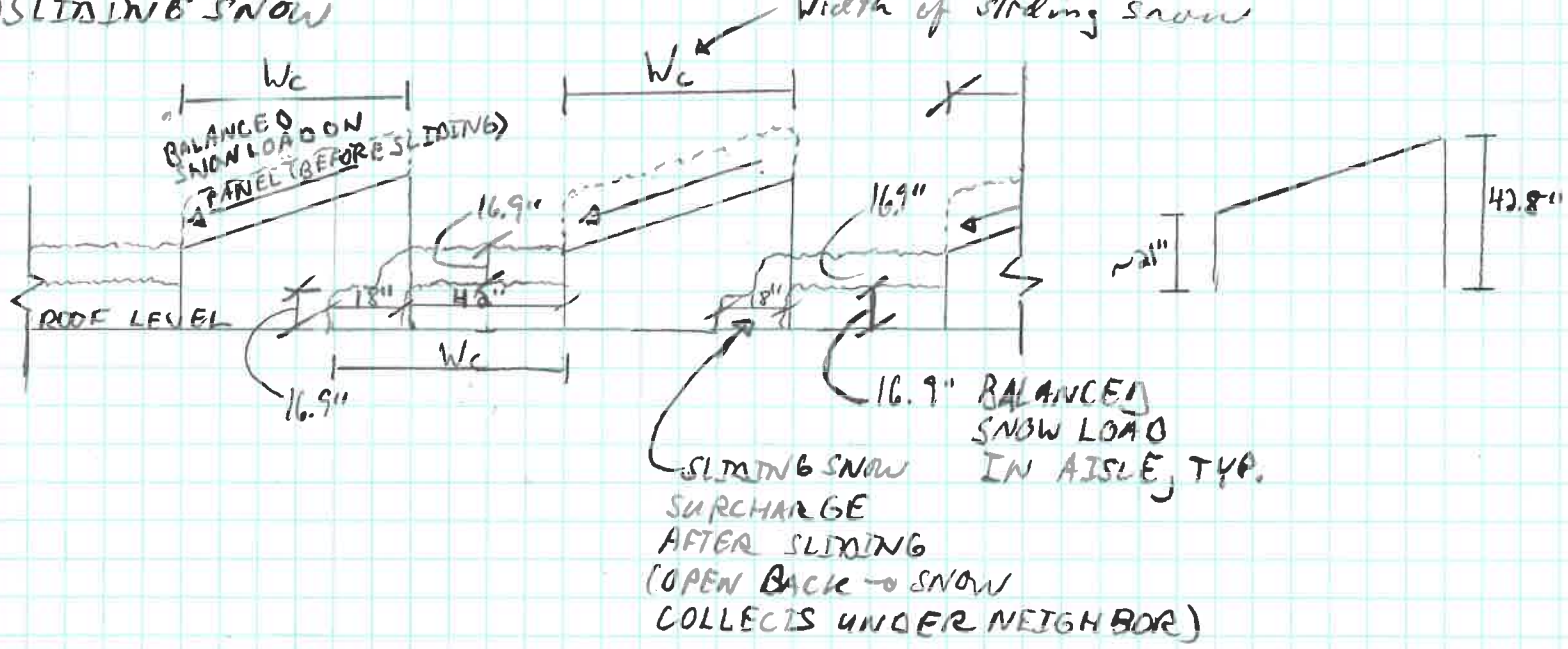
Project No: 1714147 WI

Designed By: JTR Page No:

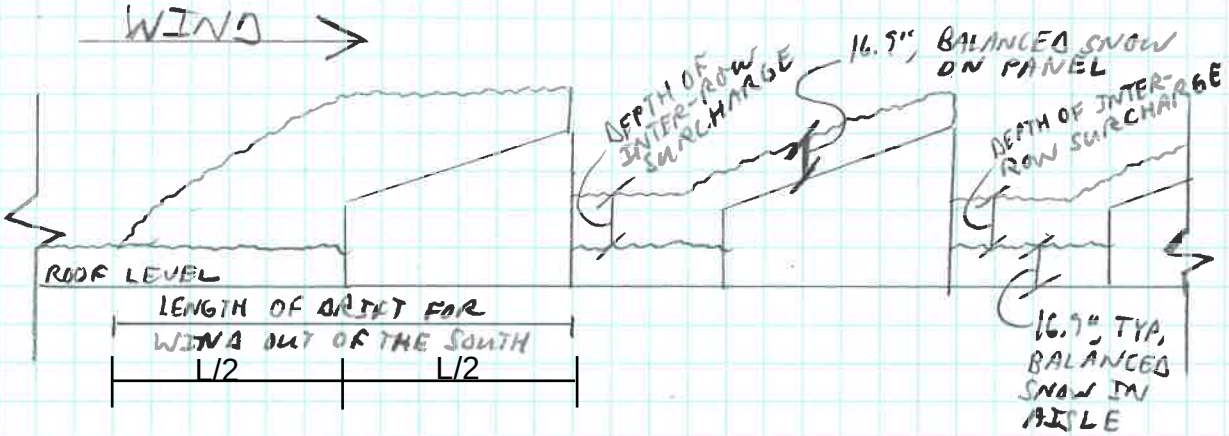
Date: 11/30/2017

R.V. PANEL SNOW LOAD PATTERNS AS-IS **WITH 21" GAP PER DETAIL 1/E401**

(1) SLIDING SNOW



(2) WIND OUT OF THE SOUTH



(mp)² STRUCTURAL ENGINEERS, LLC

Project Name: STRANG
DANE COUNTY P.V. PANELS

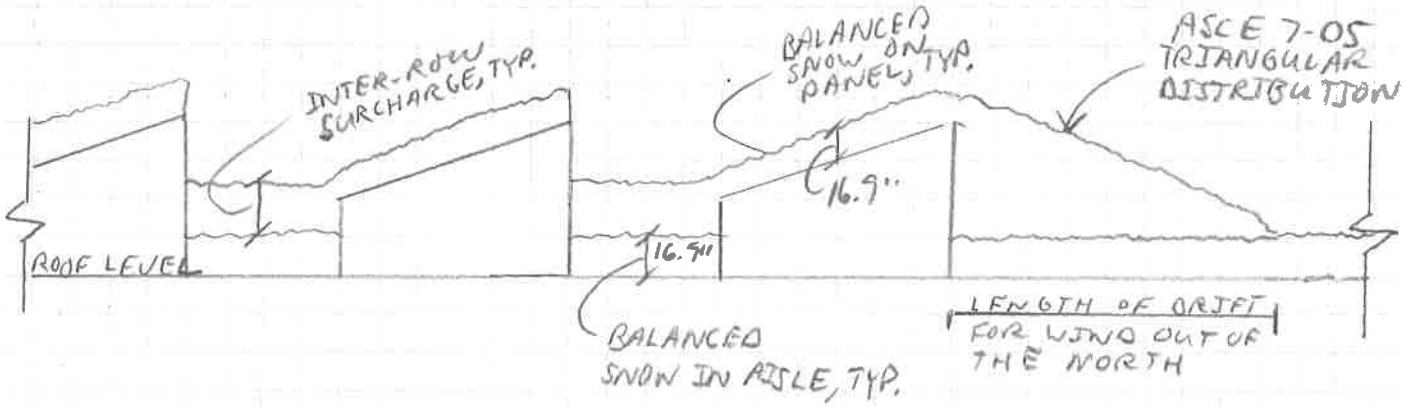
Project No: 1714147 WI

Designed By: JTR Page No:

Date: 11/20/2017

P.V. PANEL SNOW LOAD PATTERNS CONT.

③ WIND OUT OF THE NORTH
(CONVENTION IS TO ASSUME A CLOSED-BACK)



** LEEWARD DISTRIBUTIONS MUST BE CALCULATED IF THERE IS NOT ENOUGH ROOM ~~FOR~~ AVAILABLE FOR THE INTER-ROW SNOW CHARGE (I.E. ALL AVAILABLE AISLES **FILL** UP).

Snow Load Pattern for Elevated, Tilted-Open Solar Panel Array

THIS SHEET ASSUMES THE LOW SIDE OF THE PANEL(S) FACES SOUTH. SWAP DIRECTIONS IN THE HEADINGS, IF DIFFERENT.

DRIFT AREA 1

$h_{p1} := 21\,in$ Low side dimension

$l_{horiz} := 60\,in$ Length of horizontal projection

$\theta := 20\,deg$ Angle of tilt

$l_p := \left(\frac{l_{horiz}}{\cos(\theta)}\right) = 63.851\,in$ Length of panel

$h_{p2} := h_{p1} + l_p \cdot \sin(\theta) = 42.838\,in$ High side dimension

$l_{aisle} := 42\,in$ Width of aisle between rows

Drift Fetch Distances:

$l_{north} := 54.667\,ft$ Upwind fetch for wind OUT OF THE NORTH

$l_{south} := 57.25\,ft$ Upwind fetch for wind OUT OF THE SOUTH

Balanced Snow Load

Exposure Category: B

$C_e := 1.2$ $I_s := 1.0$

$C_t := 1.0$ $p_g := 30\,psf$

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\,psf$

For Ct, ignore any thermal contribution from a solar panel array. For Ce, the presence of solar panels bumps the roof exposure into a more severe state. For example, an otherwise fully exposed roof would be considered partially exposed with the addition of solar panels.

$C_s := 1.0$ Obstructed & monoslope roof

$p_s := C_s \cdot p_f = 25.2\,psf$

$\gamma := 0.13 \cdot \frac{1}{ft} \cdot p_g + 14\,\frac{lbf}{ft^3} = 17.9\,\frac{lbf}{ft^3}$

$h_b := \frac{p_s}{\gamma} = 16.894\,in$ $h_c := h_{p2} - h_b = 25.944\,in$

$h_{exposed} := h_{p2} - h_b = 25.944\,in$ Amount of panel exposed above balanced snow load depth. If positive, sliding snow surcharge from the solar panels must be considered.

Sliding Snow Load

Consider only if panels are exposed above balanced snow depth.

$w_c := l_{horiz} = 60\,in$ The depth of the balanced snow load in an aisle is shallower than the height of the low edge of the panel. The sliding snow surcharge width is the whole horizontal projection of the panel.

$w_{c\_panel} := l_{horiz} - w_c = 0\,in$ Horizontal projection of panel covered by sliding snow

$w_{aisle} := w_c - w_{c\_panel} = 60\,in$ Width of aisle covered by sliding snow

SAME 25.2 PSF SURCHARGE FOR ALL DRIFT AREAS

Note:
For a open-back tilted panel, the slding snow can slide under the panel itself. For a closed-back panel, the sliding snow stops at the panel back. 18" of the surcharge is under the adjacent panel.

$p_f + p_s = 50.4\,psf$ Balanced snow load in aisle plus sliding surcharge (use balanced snow load only for portion of aisle not covered by sliding snow)

Drift Load

Check requirements to avoid calculating drift patterns.

check_1a := if $h_{p2} < 1.2 \cdot h_b$ = "DRIFT REQ'D, CHECK LOW-SIDE"
"DRIFT NOT REQ'D, CHECK 2ND CONDITION"
else
"DRIFT REQ'D, CHECK LOW-SIDE"

check_1b := if $h_{p1} < h_b$ = "CHECK 2ND CONDITION"
"DRIFT REQ'D"
else
"CHECK 2ND CONDITION"

check_2 := if $h_{p1} < 2\,ft + 2 \cdot h_b$ = "DRIFT REQ'D"
"DRIFT REQ'D"
else
"DRIFT NOT REQ'D"

Check if closely spaced.

check_close := if $l_{aisle} > 8 \cdot h_c$ = "YES"
"NO"
else
"YES"

Wind out of the south

$l_{u\_south} := l_{south} \cdot \frac{1}{ft} = 57.25$

$h_d := \left(0.43 \cdot l_{u\_south}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 32.014\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^{\,2} = 2049.767\,in^2$

$h_{dw} := 0.75 \cdot h_d = 24.01\,in$ Windward drift depth per ASCE7

$h_s := 0.707 \cdot h_{dw} = 16.975\,in$

$h_{s_design} := $ if $h_s > h_c = 16.975\,in$ Windward drift for wind blowing at low-side of panel
h_c
else
h_s

$P_{d\_windward} := h_{s\_design} \cdot \gamma = 25.322\,psf$ Drift surcharge for wind blowing at low-side of panel

$l_{drift_windard} := $ if $4 \cdot h_{s\_design} > l_{horiz} = 5\,ft$ Horizontal extent for wind blowing at low-side of panel (multiply by 2)
l_{horiz}
else
$4 \cdot h_{s\_design}$

$A_{d\_SW} := 0.5 \cdot h_{s\_design} \cdot \left(2 \cdot l_{drift\_windard}\right) = 1018.519\,in^2$ Drift area at low-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 48.804\,in$

$h_{u\_design} := \text{if } h_u > h_c = 25.944\,in$ Depth of inter-row surcharge
$\quad h_c$
$\quad \text{else}$
$\quad h_u$

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 38.7\,psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_SW}}{h_{u\_design} \cdot l_{aisle}} = 4.709$ Extent of inter-row surcharge (round up)

Wind out of the north

ASSUME 5 ROWS ARE FILLED BY INTER-ROW SURCHARGE

$l_{u\_north} := l_{north} \cdot \frac{1}{ft} = 54.667$

$h_d := \left(0.43 \cdot l_{u\_north}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 31.25\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^2 = 1953.128\,in^2$

$h_{dw} := 0.75 \cdot h_d = 23.438\,in$ windward Windward drift depth per ASCE7

$h_{n\_design} := \text{if } h_{dw} > h_c = 23.438\,in$ Windward drift depth for wind blowing at high-side of panel
$\quad h_c$
$\quad \text{else}$
$\quad h_{dw}$

$P_{d\_windward} := h_{n\_design} \cdot \gamma = 34.961\,psf$ Drift surcharge for wind blowing at high-side of panel

$l_{drift\_windard} := \text{if } h_{dw} \le h_c = 7.813\,ft$ Horizontal extent for wind blowing at high-side of panel
$\quad 4 \cdot h_{dw}$
$\quad \text{else}$
$\quad \quad \text{if } \frac{4 \cdot h_{dw}^2}{h_c} > 8 \cdot h_c$
$\quad \quad \quad 8 \cdot h_c$
$\quad \quad \text{else}$
$\quad \quad \quad \frac{4 \cdot h_{dw}^2}{h_c}$

$A_{d\_NW} := 0.5 \cdot h_{n\_design} \cdot \left(l_{drift\_windard}\right) = 1098.635\,in^2$ Drift area at high-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 46.503\,in$

$h_{u\_design} := \text{if } h_u > h_c = 25.944\,in$ Depth of inter-row surcharge
$\quad h_c$
$\quad \text{else}$
$\quad h_u$

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 38.7\ psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_NW}}{h_{u\_design} \cdot l_{aisle}} = 4.369$ Extent of inter-row surcharge (round up)

ASSUME 5 ROWS ARE FILLED BY INTER-ROW SURCHARGE

Snow Load Pattern for Elevated, Tilted-Open Solar Panel Array

THIS SHEET ASSUMES THE LOW SIDE OF THE PANEL(S) FACES SOUTH. SWAP DIRECTIONS IN THE HEADINGS, IF DIFFERENT.

DRIFT AREA 3
(SIMILAR TO DRIFT AREA 1)

$h_{p1} := 21\,in$ Low side dimension

$l_{horiz} := 60\,in$ Length of horizontal projection

$\theta := 20\,deg$ Angle of tilt

$l_p := \left(\frac{l_{horiz}}{\cos(\theta)}\right) = 63.851\,in$ Length of panel

$h_{p2} := h_{p1} + l_p \cdot \sin(\theta) = 42.838\,in$ High side dimension

$l_{aisle} := 42\,in$ Width of aisle between rows

Drift Fetch Distances:

$l_{north} := 54.667\,ft$ Upwind fetch for wind OUT OF THE NORTH

$l_{south} := 21.25\,ft$ Upwind fetch for wind OUT OF THE SOUTH

Balanced Snow Load

Exposure Category: B

$C_e := 1.2$ $I_s := 1.0$

$C_t := 1.0$ $p_g := 30\,psf$

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\,psf$

For Ct, ignore any thermal contribution from a solar panel array. For Ce, the presence of solar panels bumps the roof exposure into a more severe state. For example, an otherwise fully exposed roof would be considered partially exposed with the addition of solar panels.

$C_s := 1.0$ Obstructed & monoslope roof

$p_s := C_s \cdot p_f = 25.2\,psf$

$\gamma := 0.13 \cdot \frac{1}{ft} \cdot p_g + 14\,\frac{lbf}{ft^3} = 17.9\,\frac{lbf}{ft^3}$

$h_b := \frac{p_s}{\gamma} = 16.894\,in$ $h_c := h_{p2} - h_b = 25.944\,in$

$h_{exposed} := h_{p2} - h_b = 25.944\,in$ Amount of panel exposed above balanced snow load depth. If positive, sliding snow surcharge from the solar panels must be considered.

Sliding Snow Load

Consider only if panels are exposed above balanced snow depth.

$w_c := l_{horiz} = 60\,in$

The depth of the balanced snow load in an aisle is shallower than the height of the low edge of the panel. The sliding snow surcharge width is the whole horizontal projection of the panel.

$w_{c\_panel} := l_{horiz} - w_c = 0\,in$ Horizontal projection of panel covered by sliding snow

$w_{aisle} := w_c - w_{c\_panel} = 60\,in$ Width of aisle covered by sliding snow

Note:
For a open-back tilted panel, the slding snow can slide under the panel itself. For a closed-back panel, the sliding snow stops at the panel back. 18" of the surcharge is under the adjacent panel.

$p_f + p_s = 50.4\,psf$ Balanced snow load in aisle plus sliding surcharge (use balanced snow load only for portion of aisle not covered by sliding snow)

Drift Load

Check requirements to avoid calculating drift patterns.

check_1a := if $h_{p2} < 1.2 \cdot h_b$ = "DRIFT REQ'D, CHECK LOW-SIDE"
"DRIFT NOT REQ'D, CHECK 2ND CONDITION"
else
"DRIFT REQ'D, CHECK LOW-SIDE"

check_1b := if $h_{p1} < h_b$ = "CHECK 2ND CONDITION"
"DRIFT REQ'D"
else
"CHECK 2ND CONDITION"

check_2 := if $h_{p1} < 2\,ft + 2 \cdot h_b$ = "DRIFT REQ'D"
"DRIFT REQ'D"
else
"DRIFT NOT REQ'D"

Check if closely spaced.

check_close := if $l_{aisle} > 8 \cdot h_c$ = "YES"
"NO"
else
"YES"

Wind out of the south

$l_{u\_south} := l_{south} \cdot \frac{1}{ft} = 21.25$

$h_d := \left(0.43 \cdot l_{u\_south}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 17.943\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^{\,2} = 643.922\,in^2$

$h_{dw} := 0.75 \cdot h_d = 13.457\,in$ Windward drift depth per ASCE7

$h_s := 0.707 \cdot h_{dw} = 9.514\,in$

$h_{s\_design} :=$ if $h_s > h_c = 9.514\,in$ Windward drift for wind blowing at low-side of panel
h_c
else
h_s

$P_{d\_windward} := h_{s\_design} \cdot \gamma = 14.192\,psf$ Drift surcharge for wind blowing at low-side of panel

$l_{drift\_windard} :=$ if $4 \cdot h_{s\_design} > l_{horiz} = 3.171\,ft$ Horizontal extent for wind blowing at low-side of panel (multiply by 2)
l_{horiz}
else
$4 \cdot h_{s\_design}$

$A_{d\_SW} := 0.5 \cdot h_{s\_design} \cdot \left(2 \cdot l_{drift\_windard}\right) = 362.097\,in^2$ Drift area at low-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 15.331\,in$

$h_{u\_design} := \text{if } h_u > h_c = 15.331\,in$ Depth of inter-row surcharge

h_c

else

h_u

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 22.869\,psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_SW}}{h_{u\_design} \cdot l_{aisle}} = 2.438$ Extent of inter-row surcharge (round up)

Wind out of the north

ASSUME 3 ROWS ARE FILLED BY INTER-ROW SURCHARGE

$l_{u\_north} := l_{north} \cdot \frac{1}{ft} = 54.667$

$h_d := \left(0.43 \cdot l_{u\_north}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 31.25\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^2 = 1953.128\,in^2$

$h_{dw} := 0.75 \cdot h_d = 23.438\,in$ windward Windward drift depth per ASCE7

$h_{n\_design} := \text{if } h_{dw} > h_c = 23.438\,in$ Windward drift depth for wind blowing at high-side of panel

h_c

else

h_{dw}

$P_{d\_windward} := h_{n\_design} \cdot \gamma = 34.961\,psf$ Drift surcharge for wind blowing at high-side of panel

$l_{drift\_windard} := \text{if } h_{dw} \le h_c = 7.813\,ft$ Horizontal extent for wind blowing at high-side of panel

$4 \cdot h_{dw}$

else

$\text{if } \frac{4 \cdot h_{dw}^2}{h_c} > 8 \cdot h_c$

$8 \cdot h_c$

else

$\frac{4 \cdot h_{dw}^2}{h_c}$

$A_{d\_NW} := 0.5 \cdot h_{n\_design} \cdot \left(l_{drift\_windard}\right) = 1098.635\,in^2$ Drift area at high-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 46.503\,in$

$h_{u\_design} := \text{if } h_u > h_c = 25.944\,in$ Depth of inter-row surcharge

h_c

else

h_u

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 38.7\ psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_NW}}{h_{u\_design} \cdot l_{aisle}} = 4.369$ Extent of inter-row surcharge (round up)

ASSUME 5 ROWS ARE FILLED BY INTER-ROW SURCHARGE

(mp)² STRUCTURAL ENGINEERS, LLC

Project Name: STRANG DANE COUNTY R.V. PANELS

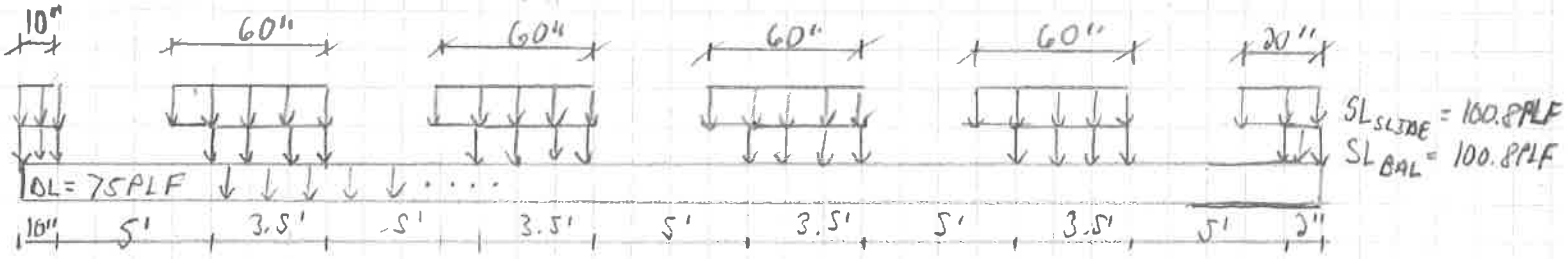
Project No: 1714147 WI

Designed By: JTR Page No:

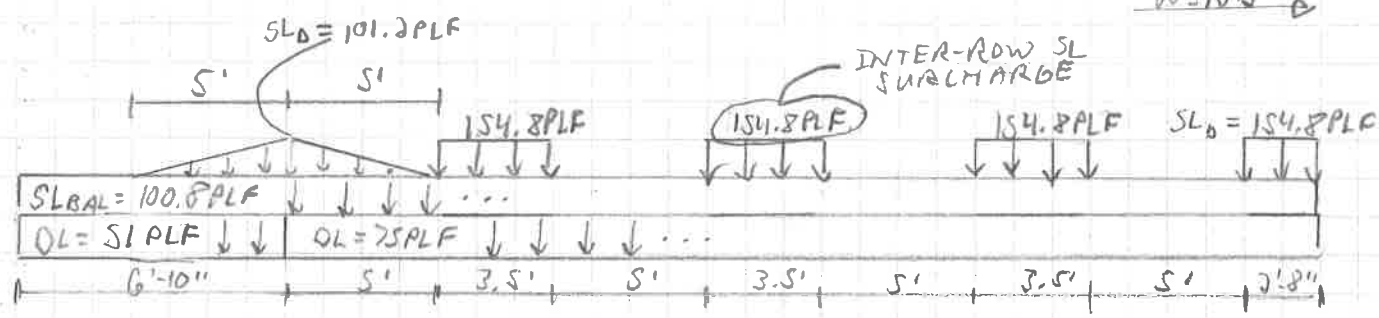
Date: 11/20/2017

DRIFT AREA 1 + 3

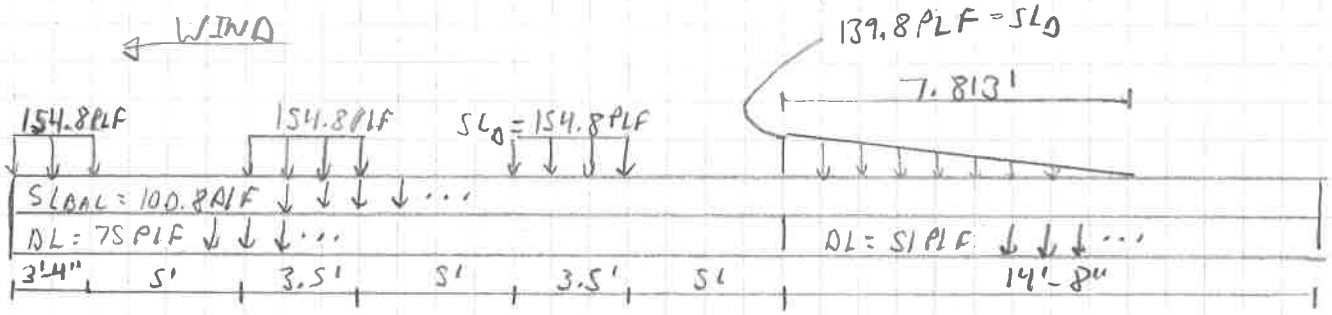
① SLIDING SNOW (WORST CASES ARE SPANS BETWEEN C & D) (OK < 5%)



② WIND OUT OF THE SOUTH (NOT OK > 5%)



③ WIND OUT OF THE NORTH (SHEAR NOT OK > 5%)



NOTE:
THE CALCULATIONS SHOW ~5 ROWS WILL BE FILLED BY INTER-ROW SURCHARGE. AT MOST, 2 ROWS BETWEEN C & D WILL BE FILLED. THIS CASE IS VERY UNLIKELY TO CONTROL.

Snow Load Pattern for Elevated, Tilted-Open Solar Panel Array

THIS SHEET ASSUMES THE LOW SIDE OF THE PANEL(S) FACES SOUTH. SWAP DIRECTIONS IN THE HEADINGS, IF DIFFERENT.

DRIFT AREA A1, A2

$h_{p1} := 21\,in$ Low side dimension

$l_{horiz} := 60\,in$ Length of horizontal projection

$\theta := 20\,deg$ Angle of tilt

$l_p := \left(\frac{l_{horiz}}{\cos(\theta)}\right) = 63.851\,in$ Length of panel

$h_{p2} := h_{p1} + l_p \cdot \sin(\theta) = 42.838\,in$ High side dimension

$l_{aisle} := 42\,in$ Width of aisle between rows

Drift Fetch Distances:

$l_{north} := 54.667\,ft$ Upwind fetch for wind OUT OF THE NORTH

$l_{south} := 63\,ft$ Upwind fetch for wind OUT OF THE SOUTH

Balanced Snow Load

Exposure Category: B

$C_e := 1.2$ $I_s := 1.0$

$C_t := 1.0$ $p_g := 30\,psf$

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\,psf$

For Ct, ignore any thermal contribution from a solar panel array. For Ce, the presence of solar panels bumps the roof exposure into a more severe state. For example, an otherwise fully exposed roof would be considered partially exposed with the addition of solar panels.

$C_s := 1.0$ Obstructed & monoslope roof

$p_s := C_s \cdot p_f = 25.2\,psf$

$\gamma := 0.13 \cdot \frac{1}{ft} \cdot p_g + 14\,\frac{lbf}{ft^3} = 17.9\,\frac{lbf}{ft^3}$

$h_b := \frac{p_s}{\gamma} = 16.894\,in$ $h_c := h_{p2} - h_b = 25.944\,in$

$h_{exposed} := h_{p2} - h_b = 25.944\,in$ Amount of panel exposed above balanced snow load depth. If positive, sliding snow surcharge from the solar panels must be considered.

Sliding Snow Load

Consider only if panels are exposed above balanced snow depth.

$w_c := l_{horiz} = 60\,in$

The depth of the balanced snow load in an aisle is shallower than the height of the low edge of the panel. The sliding snow surcharge width is the whole horizontal projection of the panel.

$w_{c\_panel} := l_{horiz} - w_c = 0\,in$ Horizontal projection of panel covered by sliding snow

$w_{aisle} := w_c - w_{c\_panel} = 60\,in$ Width of aisle covered by sliding snow

Note:
For a open-back tilted panel, the slding snow can slide under the panel itself. For a closed-back panel, the sliding snow stops at the panel back. 18" of the surcharge is under the adjacent panel.

$p_f + p_s = 50.4\,psf$ Balanced snow load in aisle plus sliding surcharge (use balanced snow load only for portion of aisle not covered by sliding snow)

Drift Load

Check requirements to avoid calculating drift patterns.

check_1a := if $h_{p2} < 1.2 \cdot h_b$ = "DRIFT REQ'D, CHECK LOW-SIDE"
"DRIFT NOT REQ'D, CHECK 2ND CONDITION"
else
"DRIFT REQ'D, CHECK LOW-SIDE"

check_1b := if $h_{p1} < h_b$ = "CHECK 2ND CONDITION"
"DRIFT REQ'D"
else
"CHECK 2ND CONDITION"

check_2 := if $h_{p1} < 2\,ft + 2 \cdot h_b$ = "DRIFT REQ'D"
"DRIFT REQ'D"
else
"DRIFT NOT REQ'D"

Check if closely spaced.

check_close := if $l_{aisle} > 8 \cdot h_c$ = "YES"
"NO"
else
"YES"

Wind out of the south

$l_{u\_south} := l_{south} \cdot \frac{1}{ft} = 63$

$h_d := \left(0.43 \cdot l_{u\_south}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 33.635\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^{\,2} = 2262.638\,in^2$

$h_{dw} := 0.75 \cdot h_d = 25.226\,in$ Windward drift depth per ASCE7

$h_s := 0.707 \cdot h_{dw} = 17.835\,in$

$h_{s\_design} :=$ if $h_s > h_c = 17.835\,in$ Windward drift for wind blowing at low-side of panel
h_c
else
h_s

$P_{d\_windward} := h_{s\_design} \cdot \gamma = 26.604\,psf$ Drift surcharge for wind blowing at low-side of panel

$l_{drift\_windard} :=$ if $4 \cdot h_{s\_design} > l_{horiz} = 5\,ft$ Horizontal extent for wind blowing at low-side of panel (multiply by 2)
l_{horiz}
else
$4 \cdot h_{s\_design}$

$A_{d\_SW} := 0.5 \cdot h_{s\_design} \cdot \left(2 \cdot l_{drift\_windard}\right) = 1070.1\,in^2$ Drift area at low-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 53.872\,in$

$h_{u\_design} := \text{if } h_u > h_c = 25.944\,in$ Depth of inter-row surcharge
$\quad h_c$
$\quad \text{else}$
$\quad h_u$

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 38.7\,psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_SW}}{h_{u\_design} \cdot l_{aisle}} = 5.247$ Extent of inter-row surcharge (round up)

Wind out of the north

ASSUME 6 ROWS ARE FILLED BY INTER-ROW SURCHARGE ONLY 3 ROWS ARE AVAILABE. THEREFORE, CALCULATE LEEWARD DRIFT.

$l_{u\_north} := l_{north} \cdot \frac{1}{ft} = 54.667$

$h_d := \left(0.43 \cdot l_{u\_north}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10 \right)^{\frac{1}{4}} - 1.5 \right) ft = 31.25\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^2 = 1953.128\,in^2$

$h_{dw} := 0.75 \cdot h_d = 23.438\,in$ windward Windward drift depth per ASCE7

$h_{n\_design} := \text{if } h_{dw} > h_c = 23.438\,in$ Windward drift depth for wind blowing at high-side of panel
$\quad h_c$
$\quad \text{else}$
$\quad h_{dw}$

$P_{d\_windward} := h_{n\_design} \cdot \gamma = 34.961\,psf$ Drift surcharge for wind blowing at high-side of panel

$l_{drift\_windard} := \text{if } h_{dw} \le h_c = 7.813\,ft$ Horizontal extent for wind blowing at high-side of panel
$\quad 4 \cdot h_{dw}$
$\quad \text{else}$
$\quad \quad \text{if } \frac{4 \cdot h_{dw}^2}{h_c} > 8 \cdot h_c$
$\quad \quad \quad 8 \cdot h_c$
$\quad \quad \text{else}$
$\quad \quad \quad \frac{4 \cdot h_{dw}^2}{h_c}$

$A_{d\_NW} := 0.5 \cdot h_{n\_design} \cdot \left(l_{drift\_windard} \right) = 1098.635\,in^2$ Drift area at high-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 46.503\,in$

$h_{u\_design} := \text{if } h_u > h_c = 25.944\,in$ Depth of inter-row surcharge
$\quad h_c$
$\quad \text{else}$
$\quad h_u$

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 38.7\ psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_NW}}{h_{u\_design} \cdot l_{aisle}} = 4.369$ Extent of inter-row surcharge (round up)

ASSUME 5 ROWS ARE FILLED BY INTER-ROW SURCHARGE ONLY 3 ROWS ARE AVAILABE. THEREFORE, CALCULATE LEEWARD DRIFT.

Drift Area 2 (A) Leeward Drifts

$h_c := 25.944\,in$ $l_{aisle} := 42\,in$ $l_{horiz} := 5\,ft$

$\gamma := 17.9\,\frac{lbf}{ft^3}$ $n_{rows\_available} := 3$

Leeward drift for wind out of the south

$h_{d\_s} := 33.635\,in$ $h_{u\_design} := h_c$ $A_{d\_SW} := 1070.1\,in^2$

$$h_{s\_design} := \begin{cases} h_c & \text{if } h_{d\_s} > h_c \\ h_{d\_s} & \text{else} \end{cases} = 25.944\,in$$

$P_{d\_leeward} := h_{s\_design} \cdot \gamma = 38.7\,psf$ <- LEEWARD DRIFT SURCHARGE

$$l_{drift\_leeward} := \begin{cases} 4 \cdot h_{d\_s} & \text{if } h_{d\_s} \le h_c \\ \begin{cases} 8 \cdot h_c & \text{if } \frac{4 \cdot h_{d\_s}^2}{h_c} > 8 \cdot h_c \\ \frac{4 \cdot h_{d\_s}^2}{h_c} & \text{else} \end{cases} & \text{else} \end{cases} = 14.535\,ft$$

<- HORIZONTAL EXTENT OF LEEWARD DRIFT SURCHARGE

$A_{d\_SL} := 0.5 \cdot h_{s\_design} \cdot (l_{drift\_leeward}) = 2262.626\,in^2$

$A_{d\_rows} := n_{rows\_available} \cdot h_{u\_design} \cdot l_{aisle} = 3268.944\,in^2$

$6 \cdot h_{d\_s}^2 - A_{d\_SL} - A_{d\_rows} - A_{d\_SW} = 186.209\,in^2$

Area of snow assumed to pass by aerodynamic shade region for lack of space available

Leeward drift for wind out of the north

$h_{d\_n} := 31.25\,in$ $h_{u\_design} := h_c$ $A_{d\_NW} := 1098.635\,in^2$

$h_n := 0.707 \cdot h_{d\_n} = 22.094\,in$

$$h_{n\_design} := \begin{cases} h_c & \text{if } h_n > h_c \\ h_n & \text{else} \end{cases} = 22.094\,in$$

$P_{d\_leeward} := h_{n\_design} \cdot \gamma = 32.957\,psf$ <- LEEWARD DRIFT SURCHARGE

$l_{drift\_leeward} := \text{if } 4 \cdot h_{n\_design} > l_{horiz} = 5\ ft$
$\quad l_{horiz}$
$\quad \text{else}$
$\quad\quad 4 \cdot h_{n\_design}$

<- HORIZONTAL EXTENT OF LEEWARD DRIFT SURCHARGE (MULTIPLY BY 2)

$A_{d\_NL} := 0.5 \cdot h_{n\_design} \cdot \left(2 \cdot l_{drift\_leeward}\right) = 1325.625\ in^2$

$A_{d\_rows} := n_{rows\_available} \cdot h_{u\_design} \cdot l_{aisle} = 3268.944\ in^2$

$6 \cdot h_{d\_n}^2 - A_{d\_NL} - A_{d\_rows} - A_{d\_NW} = 166.171\ in^2$

Area of snow assumed to pass by aerodynamic shade region for lack of space available

(mp)² STRUCTURAL ENGINEERS, LLC

Project Name: STRANG DANE COUNTY PV PANELS

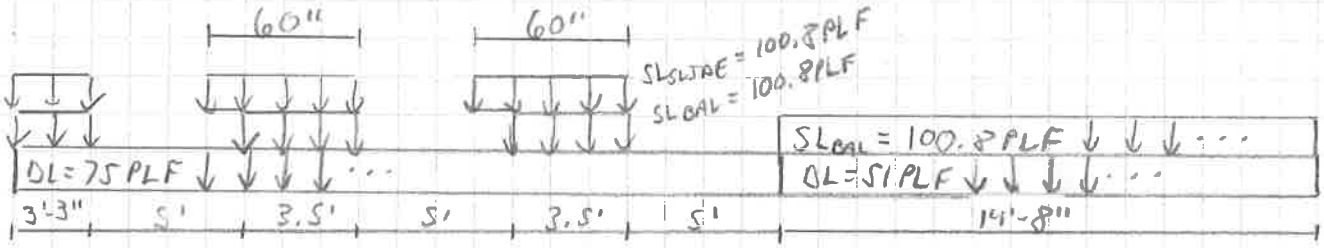
Project No: 1714147WI

Designed By: JTR Page No:

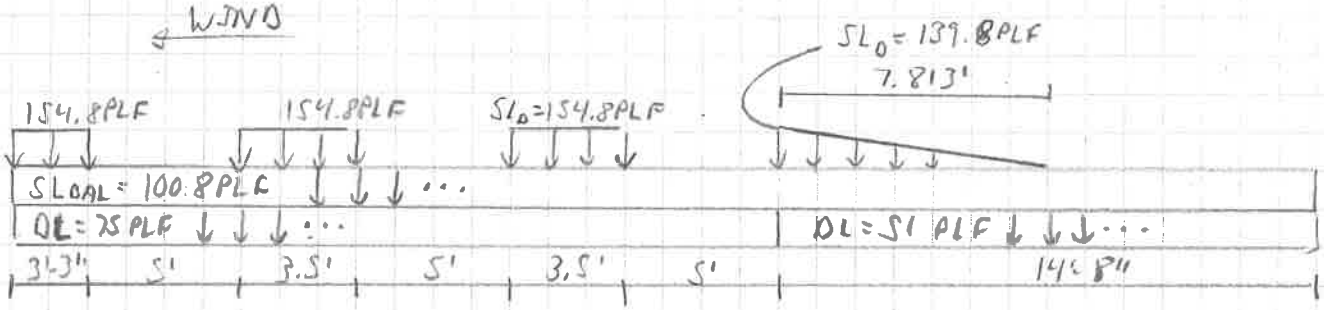
Date: 11/21/2017

DRIFT AREA 2 (A1) LOAD CASES

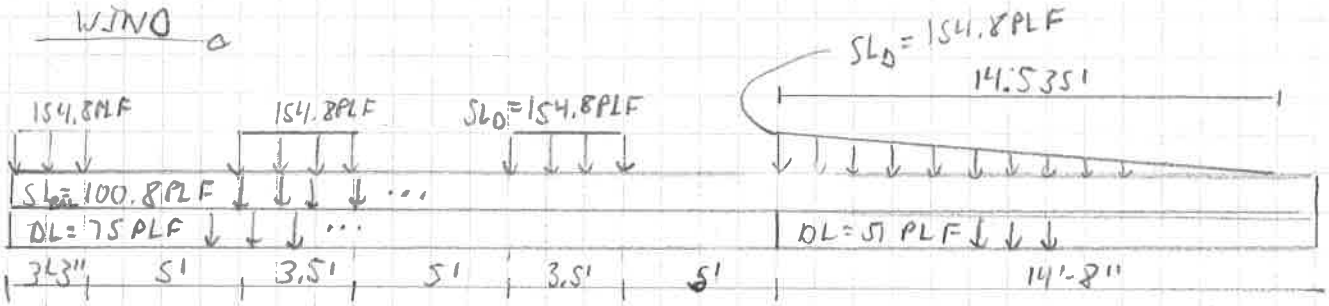
① SLIDING SNOW (OK < 5%)



② WIND OUT OF THE NORTH (SHEAR NOT OK > 5%)



③ LEEWARD DRIFT FOR WIND OUT OF THE SOUTH (NOT OK > 5%)



(mp)² STRUCTURAL ENGINEERS, LLC

Project Name: STRANG DANE COUNTY PV PANELS

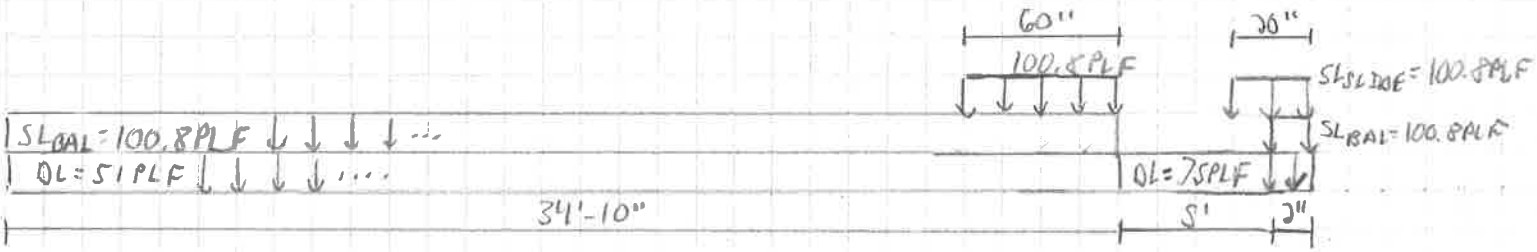
Project No: 171147WI

Designed By: JTR Page No:

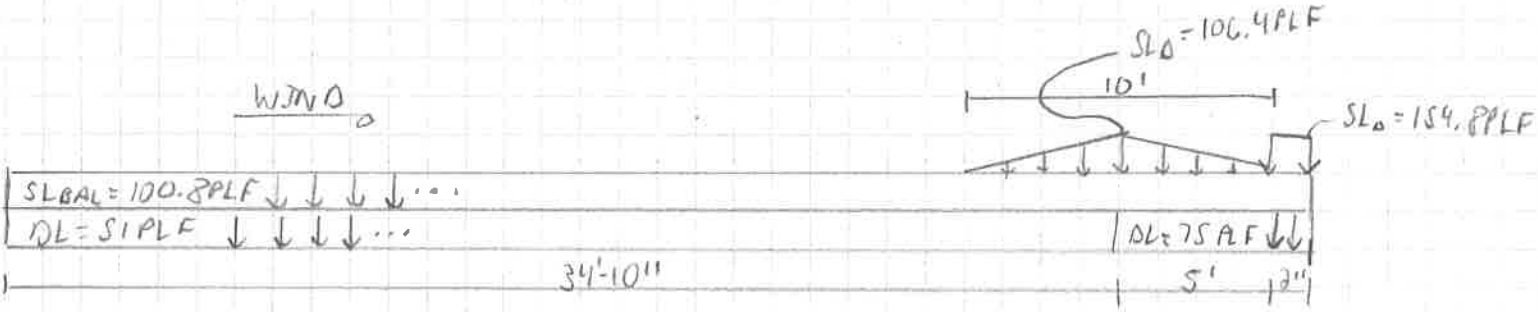
Date: 11/21/2017

DRIFT AREA 2 (A2) LOAD CASES

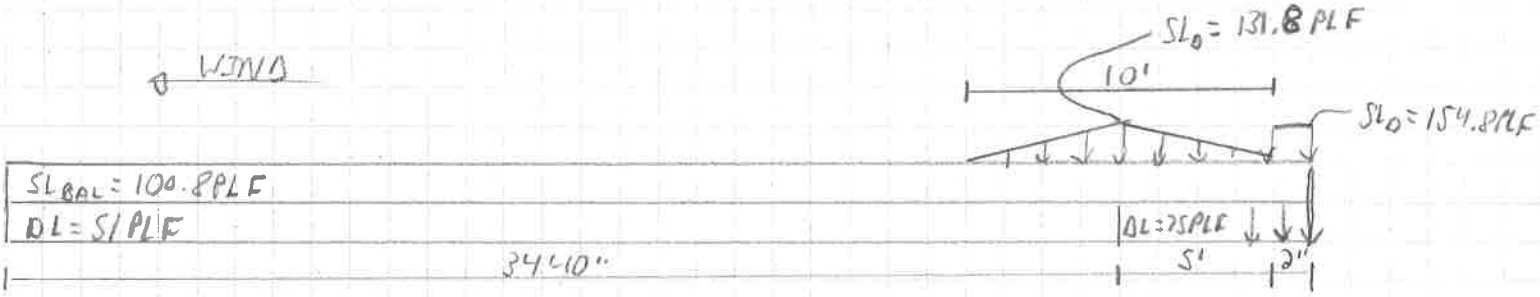
① SLIDING SNOW (OK < 5%)



② WIND OUT OF THE SOUTH (OK < 5%)



③ LEEWARD DRIFT FOR WIND OUT OF THE NORTH (OK < 5%)



Snow Load Pattern for Elevated, Tilted-Open Solar Panel Array

THIS SHEET ASSUMES THE LOW SIDE OF THE PANEL(S) FACES SOUTH. SWAP DIRECTIONS IN THE HEADINGS, IF DIFFERENT.

DRIFT AREA B1, B2

$h_{p1} := 21\,in$ Low side dimension

$l_{horiz} := 60\,in$ Length of horizontal projection

$\theta := 20\,deg$ Angle of tilt

$l_p := \left(\frac{l_{horiz}}{\cos(\theta)}\right) = 63.851\,in$ Length of panel

$h_{p2} := h_{p1} + l_p \cdot \sin(\theta) = 42.838\,in$ High side dimension

$l_{aisle} := 42\,in$ Width of aisle between rows

Drift Fetch Distances:

$l_{north} := 63\,ft$ Upwind fetch for wind OUT OF THE NORTH

$l_{south} := 40.25\,ft$ Upwind fetch for wind OUT OF THE SOUTH

Balanced Snow Load

Exposure Category: B

$C_e := 1.2$ $I_s := 1.0$

$C_t := 1.0$ $p_g := 30\,psf$

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\,psf$

For Ct, ignore any thermal contribution from a solar panel array. For Ce, the presence of solar panels bumps the roof exposure into a more severe state. For example, an otherwise fully exposed roof would be considered partially exposed with the addition of solar panels.

$C_s := 1.0$ Obstructed & monoslope roof

$p_s := C_s \cdot p_f = 25.2\,psf$

$\gamma := 0.13 \cdot \frac{1}{ft} \cdot p_g + 14\,\frac{lbf}{ft^3} = 17.9\,\frac{lbf}{ft^3}$

$h_b := \frac{p_s}{\gamma} = 16.894\,in$ $h_c := h_{p2} - h_b = 25.944\,in$

$h_{exposed} := h_{p2} - h_b = 25.944\,in$ Amount of panel exposed above balanced snow load depth. If positive, sliding snow surcharge from the solar panels must be considered.

Sliding Snow Load

Consider only if panels are exposed above balanced snow depth.

$w_c := l_{horiz} = 60\,in$ The depth of the balanced snow load in an aisle is shallower than the height of the low edge of the panel. The sliding snow surcharge width is the whole horizontal projection of the panel.

$w_{c\_panel} := l_{horiz} - w_c = 0\,in$ Horizontal projection of panel covered by sliding snow

$w_{aisle} := w_c - w_{c\_panel} = 60\,in$ Width of aisle covered by sliding snow

Note:
For a open-back tilted panel, the slding snow can slide under the panel itself. For a closed-back panel, the sliding snow stops at the panel back. 18" of the surcharge is under the adjacent panel.

$p_f + p_s = 50.4\,psf$ Balanced snow load in aisle plus sliding surcharge (use balanced snow load only for portion of aisle not covered by sliding snow)

Drift Load

Check requirements to avoid calculating drift patterns.

check_1a := if $h_{p2} < 1.2 \cdot h_b$ = "DRIFT REQ'D, CHECK LOW-SIDE"
"DRIFT NOT REQ'D, CHECK 2ND CONDITION"
else
"DRIFT REQ'D, CHECK LOW-SIDE"

check_1b := if $h_{p1} < h_b$ = "CHECK 2ND CONDITION"
"DRIFT REQ'D"
else
"CHECK 2ND CONDITION"

check_2 := if $h_{p1} < 2\,ft + 2 \cdot h_b$ = "DRIFT REQ'D"
"DRIFT REQ'D"
else
"DRIFT NOT REQ'D"

Check if closely spaced.

check_close := if $l_{aisle} > 8 \cdot h_c$ = "YES"
"NO"
else
"YES"

Wind out of the south

$l_{u\_south} := l_{south} \cdot \frac{1}{ft} = 40.25$

$h_d := \left(0.43 \cdot l_{u\_south}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 26.472\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^2 = 1401.534\,in^2$

$h_{dw} := 0.75 \cdot h_d = 19.854\,in$ Windward drift depth per ASCE7

$h_s := 0.707 \cdot h_{dw} = 14.037\,in$

$h_{s_design} := $ if $h_s > h_c = 14.037\,in$ Windward drift for wind blowing at low-side of panel
h_c
else
h_s

$P_{d\_windward} := h_{s\_design} \cdot \gamma = 20.938\,psf$ Drift surcharge for wind blowing at low-side of panel

$l_{drift_windard} := $ if $4 \cdot h_{s\_design} > l_{horiz} = 4.679\,ft$ Horizontal extent for wind blowing at low-side of panel (multiply by 2)
l_{horiz}
else
$4 \cdot h_{s\_design}$

$A_{d\_SW} := 0.5 \cdot h_{s\_design} \cdot \left(2 \cdot l_{drift\_windard}\right) = 788.125\,in^2$ Drift area at low-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 33.37\,in$

$h_{u\_design} := \text{if } h_u > h_c = 25.944\,in$ Depth of inter-row surcharge
$\quad h_c$
$\quad \text{else}$
$\quad h_u$

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 38.7\,psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_SW}}{h_{u\_design} \cdot l_{aisle}} = 3.135$ Extent of inter-row surcharge (round up)

ASSUME 4 ROWS ARE FILLED BY INTER-ROW SURCHARGE. ONLY 2 ROWS ARE AVAILABLE. CALCULATE LEEWARD DRIFT.

Wind out of the north

$l_{u\_north} := l_{north} \cdot \frac{1}{ft} = 63$

$h_d := \left(0.43 \cdot l_{u\_north}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 33.635\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^2 = 2262.638\,in^2$

$h_{dw} := 0.75 \cdot h_d = 25.226\,in$ windward Windward drift depth per ASCE7

$h_{n\_design} := \text{if } h_{dw} > h_c = 25.226\,in$ Windward drift depth for wind blowing at high-side of panel
$\quad h_c$
$\quad \text{else}$
$\quad h_{dw}$

$P_{d\_windward} := h_{n\_design} \cdot \gamma = 37.629\,psf$ Drift surcharge for wind blowing at high-side of panel

$l_{drift\_windard} := \text{if } h_{dw} \le h_c = 8.409\,ft$ Horizontal extent for wind blowing at high-side of panel
$\quad 4 \cdot h_{dw}$
$\quad \text{else}$
$\quad \text{if } \frac{4 \cdot h_{dw}^2}{h_c} > 8 \cdot h_c$
$\quad\quad 8 \cdot h_c$
$\quad\quad \text{else}$
$\quad\quad \frac{4 \cdot h_{dw}^2}{h_c}$

$A_{d\_NW} := 0.5 \cdot h_{n\_design} \cdot \left(l_{drift\_windard}\right) = 1272.734\,in^2$ Drift area at high-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 53.872\,in$

$h_{u\_design} := \text{if } h_u > h_c = 25.944\,in$ Depth of inter-row surcharge
$\quad h_c$
$\quad \text{else}$
$\quad h_u$

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 38.7\ psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_NW}}{h_{u\_design} \cdot l_{aisle}} = 5.061$ Extent of inter-row surcharge (round up)

ASSUME 6 ROWS ARE FILLED BY INTER-ROW SURCHARGE. ONLY 2 ROWS ARE AVAILABLE. CALCULATE LEEWARD DRIFT.

Drift Area 2 (B1, B2) Leeward Drifts

$h_c := 25.944\,in$ $l_{aisle} := 42\,in$ $l_{horiz} := 5\,ft$

$\gamma := 17.9\,\frac{lbf}{ft^3}$ $n_{rows\_available} := 2$

Leeward drift for wind out of the south

$h_{d\_s} := 26.472\,in$ $h_{u\_design} := h_c$ $A_{d\_SW} := 788.125\,in^2$

$$h_{s\_design} := \begin{cases} h_c & \text{if } h_{d\_s} > h_c \\ h_{d\_s} & \text{else} \end{cases} = 25.944\,in$$

$P_{d\_leeward} := h_{s\_design} \cdot \gamma = 38.7\,psf$ <- LEEWARD DRIFT SURCHARGE

$$l_{drift\_leeward} := \begin{cases} 4 \cdot h_{d\_s} & \text{if } h_{d\_s} \le h_c \\ \begin{cases} 8 \cdot h_c & \text{if } \frac{4 \cdot h_{d\_s}^2}{h_c} > 8 \cdot h_c \\ \frac{4 \cdot h_{d\_s}^2}{h_c} & \text{else} \end{cases} & \text{else} \end{cases} = 9.004\,ft$$

<- HORIZONTAL EXTENT OF LEEWARD DRIFT SURCHARGE

$A_{d\_SL} := 0.5 \cdot h_{s\_design} \cdot \left(l_{drift\_leeward}\right) = 1401.534\,in^2$

$A_{d\_rows} := n_{rows\_available} \cdot h_{u\_design} \cdot l_{aisle} = 2179.296\,in^2$

$6 \cdot h_{d\_s}^2 - A_{d\_SL} - A_{d\_rows} - A_{d\_SW} = -164.354\,in^2$ Area of snow assumed to pass by aerodynamic shade region for lack of space available

Leeward drift for wind out of the north

$h_{d\_n} := 33.635\,in$ $h_{u\_design} := h_c$ $A_{d\_NW} := 1272.734\,in^2$

$h_n := 0.707 \cdot h_{d\_n} = 23.78\,in$

$$h_{n\_design} := \begin{cases} h_c & \text{if } h_n > h_c \\ h_n & \text{else} \end{cases} = 23.78\,in$$

$P_{d\_leeward} := h_{n\_design} \cdot \gamma = 35.472\,psf$ <- LEEWARD DRIFT SURCHARGE

$l_{drift\_leeward} := \text{if } 4 \cdot h_{n\_design} > l_{horiz} = 5\ ft$
$\quad l_{horiz}$
$\quad \text{else}$
$\quad\quad 4 \cdot h_{n\_design}$

<- HORIZONTAL EXTENT OF LEEWARD DRIFT SURCHARGE (MULTIPLY BY 2)

$A_{d\_NL} := 0.5 \cdot h_{n\_design} \cdot \left(2 \cdot l_{drift\_leeward}\right) = 1426.797\ in^2$

$A_{d\_rows} := n_{rows\_available} \cdot h_{u\_design} \cdot l_{aisle} = 2179.296\ in^2$

$6 \cdot h_{d\_n}^2 - A_{d\_NL} - A_{d\_rows} - A_{d\_NW} = 1909.053\ in^2$

Area of snow assumed to pass by aerodynamic shade region for lack of space available

(mp)² STRUCTURAL ENGINEERS, LLC

Project Name: STRANG DANE COUNTY PV PANELS

Project No: 171147WI

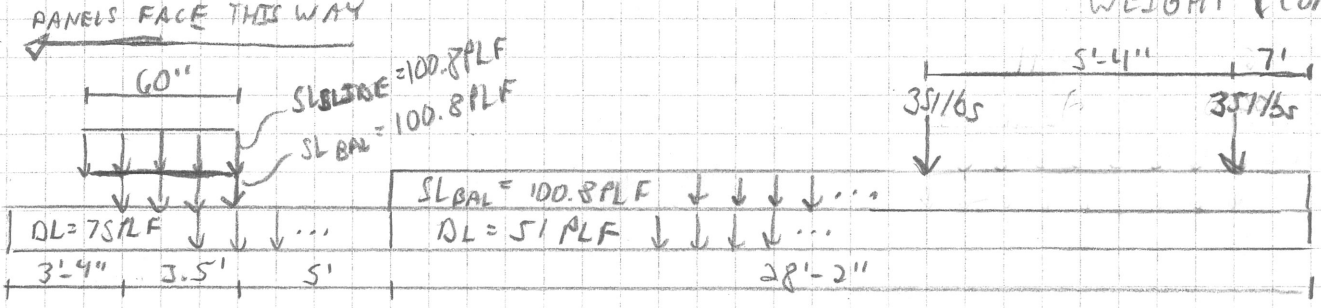
Designed By: JTR Page No:

Date: 11/21/2017

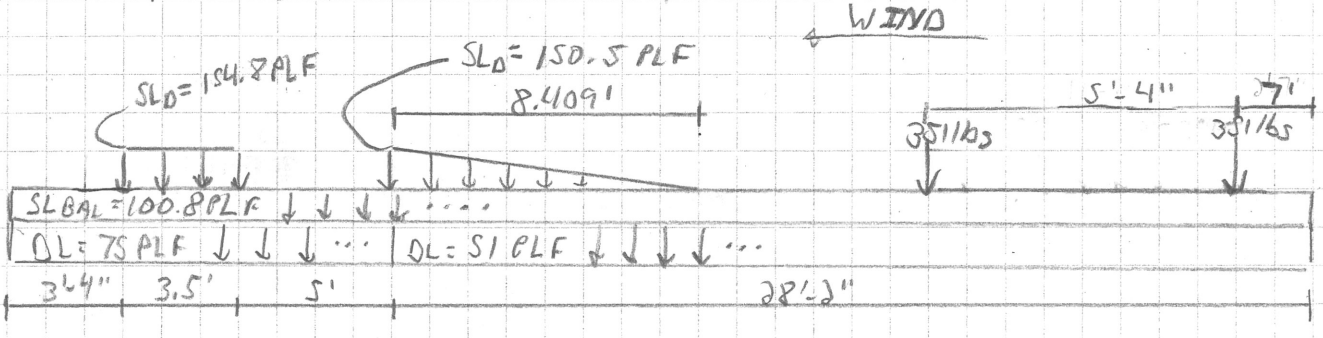
DRIFT AREA 2 (B1 & B2) LOAD CASES

① B1: SLIDING SNOW (OK < 5%)

** FOR B1 ADD IN RTU WEIGHT (CONSERVATIVE)

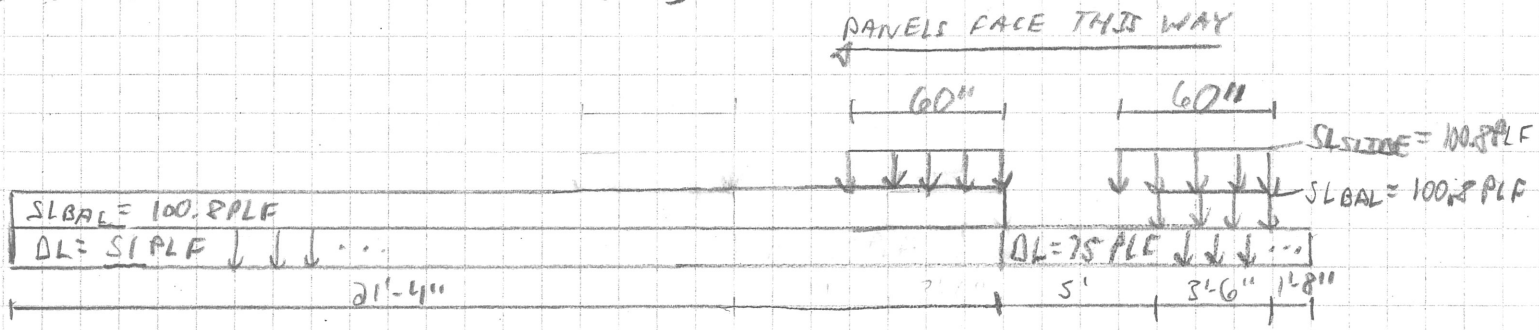


② B1: WIND OUT OF THE NORTH (OK < 5%)



~~③ B1: LEEWARD DRIFT FROM WIND OUT OF THE SOUTH → NONE, ROOFS NOT FULL~~

④ B2: SLIDING SNOW (OK < 5%)



(mp)² STRUCTURAL ENGINEERS, LLC

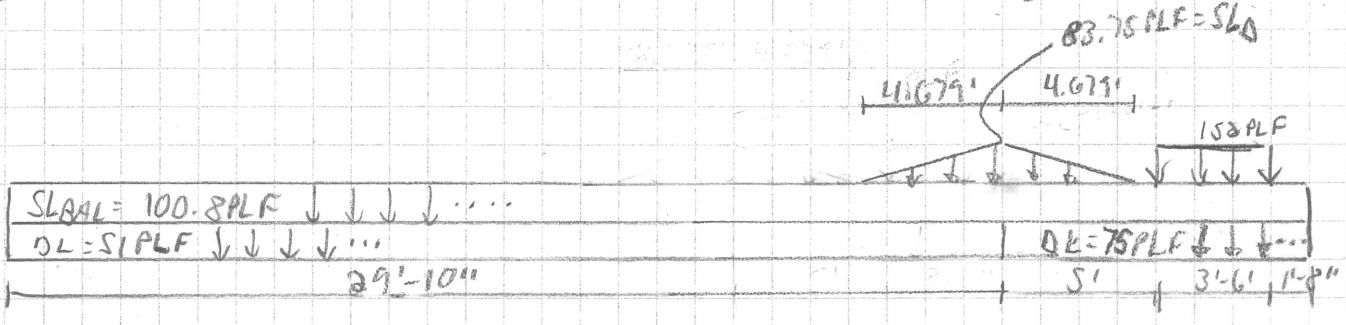
Project Name: STRANG DANE COUNTY PV PANELS

Project No: 171147WI

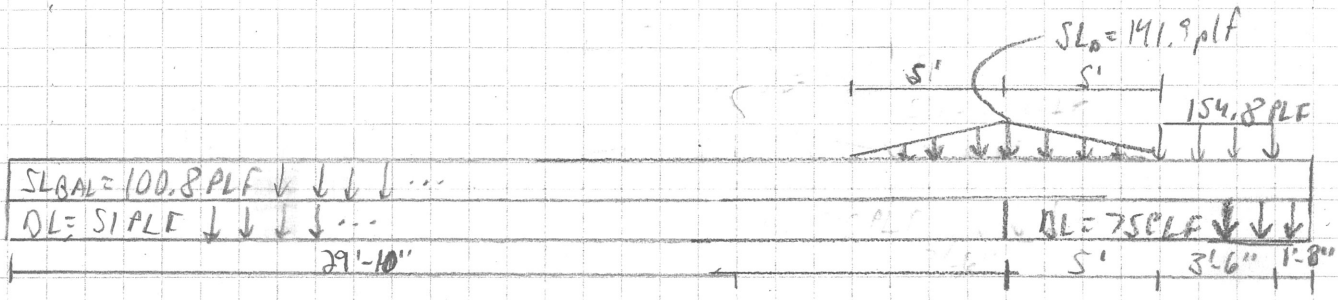
Designed By: JTR Page No:

Date: 11/21/2017

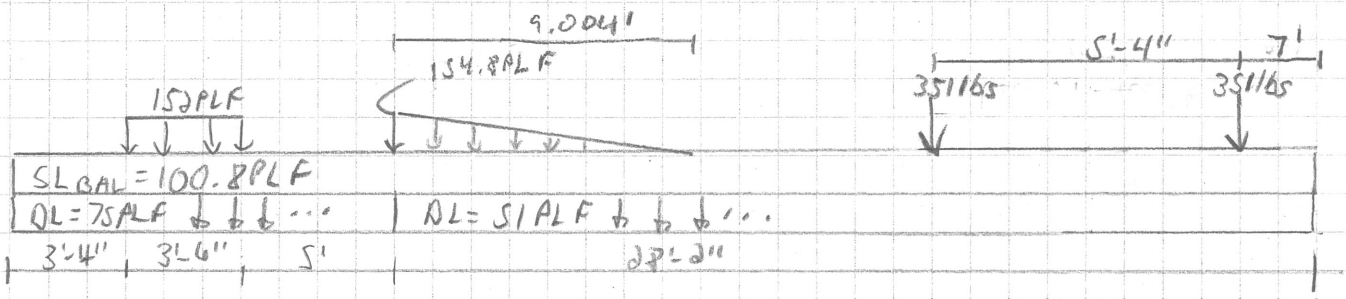
⑤ B2: WIND OUT OF THE SOUTH (OK < 5%)



⑥ B2: LEEWARD DRIFT FOR WIND OUT OF THE NORTH (OK < 5%)



① B1: LEEWARD DRIFT FOR WIND OUT OF THE SOUTH (OK < 5%)



Snow Load Pattern for Elevated, Tilted-Open Solar Panel Array

THIS SHEET ASSUMES THE LOW SIDE OF THE PANEL(S) FACES SOUTH. SWAP DIRECTIONS IN THE HEADINGS, IF DIFFERENT.

$h_{p1} := 21\,in$ Low side dimension

$l_{horiz} := 60\,in$ Length of horizontal projection

$\theta := 20\,deg$ Angle of tilt

$l_p := \left(\frac{l_{horiz}}{\cos(\theta)}\right) = 63.851\,in$ Length of panel

$h_{p2} := h_{p1} + l_p \cdot \sin(\theta) = 42.838\,in$ High side dimension

$l_{aisle} := 42\,in$ Width of aisle between rows

Drift Fetch Distances:

$l_{north} := 131.25\,ft$ Upwind fetch for wind OUT OF THE NORTH

$l_{south} := 21.25\,ft$ Upwind fetch for wind OUT OF THE SOUTH

Balanced Snow Load

Exposure Category: B

$C_e := 1.2$ $I_s := 1.0$

$C_t := 1.0$ $p_g := 30\,psf$

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\,psf$

For Ct, ignore any thermal contribution from a solar panel array. For Ce, the presence of solar panels bumps the roof exposure into a more severe state. For example, an otherwise fully exposed roof would be considered partially exposed with the addition of solar panels.

$C_s := 1.0$ Obstructed & monoslope roof

$p_s := C_s \cdot p_f = 25.2\,psf$

$\gamma := 0.13 \cdot \frac{1}{ft} \cdot p_g + 14\,\frac{lbf}{ft^3} = 17.9\,\frac{lbf}{ft^3}$

$h_b := \frac{p_s}{\gamma} = 16.894\,in$ $h_c := h_{p2} - h_b = 25.944\,in$

$h_{exposed} := h_{p2} - h_b = 25.944\,in$ Amount of panel exposed above balanced snow load depth. If positive, sliding snow surcharge from the solar panels must be considered.

Sliding Snow Load

Consider only if panels are exposed above balanced snow depth.

$w_c := l_{horiz} = 60\,in$

The depth of the balanced snow load in an aisle is shallower than the height of the low edge of the panel. The sliding snow surcharge width is the whole horizontal projection of the panel.

$w_{c\_panel} := l_{horiz} - w_c = 0\,in$ Horizontal projection of panel covered by sliding snow

$w_{aisle} := w_c - w_{c\_panel} = 60\,in$ Width of aisle covered by sliding snow

Note:
For a open-back tilted panel, the slding snow can slide under the panel itself. For a closed-back panel, the sliding snow stops at the panel back. 18" of the surcharge is under the adjacent panel.

$p_f + p_s = 50.4\,psf$ Balanced snow load in aisle plus sliding surcharge (use balanced snow load only for portion of aisle not covered by sliding snow)

Drift Load

Check requirements to avoid calculating drift patterns.

check_1a := if $h_{p2} < 1.2 \cdot h_b$ = "DRIFT REQ'D, CHECK LOW-SIDE"
"DRIFT NOT REQ'D, CHECK 2ND CONDITION"
else
"DRIFT REQ'D, CHECK LOW-SIDE"

check_1b := if $h_{p1} < h_b$ = "CHECK 2ND CONDITION"
"DRIFT REQ'D"
else
"CHECK 2ND CONDITION"

check_2 := if $h_{p1} < 2\,ft + 2 \cdot h_b$ = "DRIFT REQ'D"
"DRIFT REQ'D"
else
"DRIFT NOT REQ'D"

Check if closely spaced.

check_close := if $l_{aisle} > 8 \cdot h_c$ = "YES"
"NO"
else
"YES"

Wind out of the south

$l_{u\_south} := l_{south} \cdot \frac{1}{ft} = 21.25$

$h_d := \left(0.43 \cdot l_{u\_south}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 17.943\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^{\,2} = 643.922\,in^2$

$h_{dw} := 0.75 \cdot h_d = 13.457\,in$ Windward drift depth per ASCE7

$h_s := 0.707 \cdot h_{dw} = 9.514\,in$

$h_{s\_design} :=$ if $h_s > h_c = 9.514\,in$ Windward drift for wind blowing at low-side of panel
h_c
else
h_s

$P_{d\_windward} := h_{s\_design} \cdot \gamma = 14.192\,psf$ Drift surcharge for wind blowing at low-side of panel

$l_{drift\_windard} :=$ if $4 \cdot h_{s\_design} > l_{horiz} = 3.171\,ft$ Horizontal extent for wind blowing at low-side of panel (multiply by 2)
l_{horiz}
else
$4 \cdot h_{s\_design}$

$A_{d\_SW} := 0.5 \cdot h_{s\_design} \cdot \left(2 \cdot l_{drift\_windard}\right) = 362.097\,in^2$ Drift area at low-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 15.331\,in$

$h_{u\_design} := \text{if } h_u > h_c = 15.331\,in$ Depth of inter-row surcharge

h_c

else

h_u

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 22.869\,psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_SW}}{h_{u\_design} \cdot l_{aisle}} = 2.438$ Extent of inter-row surcharge (round up)

ASSUME 3 ROWS ARE FILLED BY INTER-ROW SURCHARGE. ONLY 2 ROWS ARE AVAILABLE. CALCULATE LEEWARD DRIFT.

Wind out of the north

$l_{u\_north} := l_{north} \cdot \frac{1}{ft} = 131.25$

$h_d := \left(0.43 \cdot l_{u\_north}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 47.947\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^2 = 4597.91\,in^2$

$h_{dw} := 0.75 \cdot h_d = 35.961\,in$ windward Windward drift depth per ASCE7

$h_{n\_design} := \text{if } h_{dw} > h_c = 25.944\,in$ Windward drift depth for wind blowing at high-side of panel

h_c

else

h_{dw}

$P_{d\_windward} := h_{n\_design} \cdot \gamma = 38.7\,psf$ Drift surcharge for wind blowing at high-side of panel

$l_{drift\_windard} := \text{if } h_{dw} \le h_c = 16.615\,ft$ Horizontal extent for wind blowing at high-side of panel

$4 \cdot h_{dw}$

else

$\text{if } \frac{4 \cdot h_{dw}^2}{h_c} > 8 \cdot h_c$

$8 \cdot h_c$

else

$\frac{4 \cdot h_{dw}^2}{h_c}$

$A_{d\_NW} := 0.5 \cdot h_{n\_design} \cdot \left(l_{drift\_windard}\right) = 2586.324\,in^2$ Drift area at high-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 109.474\,in$

$h_{u\_design} := \text{if } h_u > h_c = 25.944\,in$ Depth of inter-row surcharge

h_c

else

h_u

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 38.7\ psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_NW}}{h_{u\_design} \cdot l_{aisle}} = 10.285$ Extent of inter-row surcharge (round up)

ASSUME 11 ROWS ARE FILLED BY INTER-ROW SURCHARGE. ONLY 2 ROWS ARE AVAILABLE. CALCULATE LEEWARD DRIFT.

Drift Area 4 Leeward Drifts

$h_c := 25.944\,in$ $l_{aisle} := 42\,in$ $l_{horiz} := 5\,ft$

$\gamma := 17.9\,\frac{lbf}{ft^3}$ $n_{rows\_available} := 2$

Leeward drift for wind out of the south

$h_{d\_s} := 17.943\,in$ $h_{u\_design} := 15.331\,in$ $A_{d\_SW} := 362.097\,in^2$

$$h_{s\_design} := \begin{cases} h_c & \text{if } h_{d\_s} > h_c \\ h_{d\_s} & \text{else} \end{cases} = 17.943\,in$$

$P_{d\_leeward} := h_{s\_design} \cdot \gamma = 26.765\,psf$ <- LEEWARD DRIFT SURCHARGE

$$l_{drift\_leeward} := \begin{cases} 4 \cdot h_{d\_s} & \text{if } h_{d\_s} \le h_c \\ \begin{cases} 8 \cdot h_c & \text{if } \frac{4 \cdot h_{d\_s}^2}{h_c} > 8 \cdot h_c \\ \frac{4 \cdot h_{d\_s}^2}{h_c} & \text{else} \end{cases} & \text{else} \end{cases} = 5.981\,ft$$

<- HORIZONTAL EXTENT OF LEEWARD DRIFT SURCHARGE

$A_{d\_SL} := 0.5 \cdot h_{s\_design} \cdot \left(l_{drift\_leeward}\right) = 643.902\,in^2$

$A_{d\_rows} := n_{rows\_available} \cdot h_{u\_design} \cdot l_{aisle} = 1287.804\,in^2$

$6 \cdot h_{d\_s}^2 - A_{d\_SL} - A_{d\_rows} - A_{d\_SW} = -362.096\,in^2$ Area of snow assumed to pass by aerodynamic shade region for lack of space available

Leeward drift for wind out of the north

$h_{d\_n} := 47.947\,in$ $h_{u\_design} := h_c$ $A_{d\_NW} := 2586.324\,in^2$

$h_n := 0.707 \cdot h_{d\_n} = 33.899\,in$

$$h_{n\_design} := \begin{cases} h_c & \text{if } h_n > h_c \\ h_n & \text{else} \end{cases} = 25.944\,in$$

$P_{d\_leeward} := h_{n\_design} \cdot \gamma = 38.7\,psf$ <- LEEWARD DRIFT SURCHARGE

$l_{drift\_leeward} := \text{if } 4 \cdot h_{n\_design} > l_{horiz} = 5\ ft$
$\quad l_{horiz}$
$\quad \text{else}$
$\quad\quad 4 \cdot h_{n\_design}$

<- HORIZONTAL EXTENT OF LEEWARD DRIFT SURCHARGE (MULTIPLY BY 2)

$A_{d\_NL} := 0.5 \cdot h_{n\_design} \cdot \left(2 \cdot l_{drift\_leeward}\right) = 1556.64\ in^2$

$A_{d\_rows} := n_{rows\_available} \cdot h_{u\_design} \cdot l_{aisle} = 2179.296\ in^2$

$6 \cdot h_{d\_n}^2 - A_{d\_NL} - A_{d\_rows} - A_{d\_NW} = 7471.229\ in^2$

Area of snow assumed to pass by aerodynamic shade region for lack of space available

(mp)² STRUCTURAL ENGINEERS, LLC

Project Name: STRANG DANE COUNTY PV PANELS

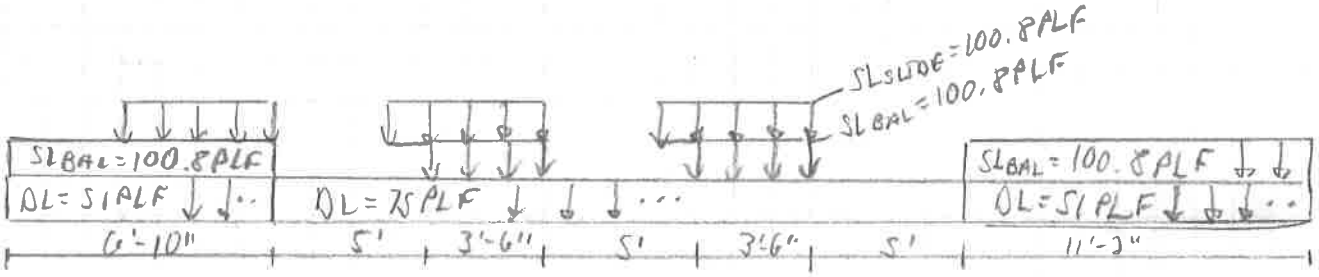
Project No: 171147WI

Designed By: JTR Page No:

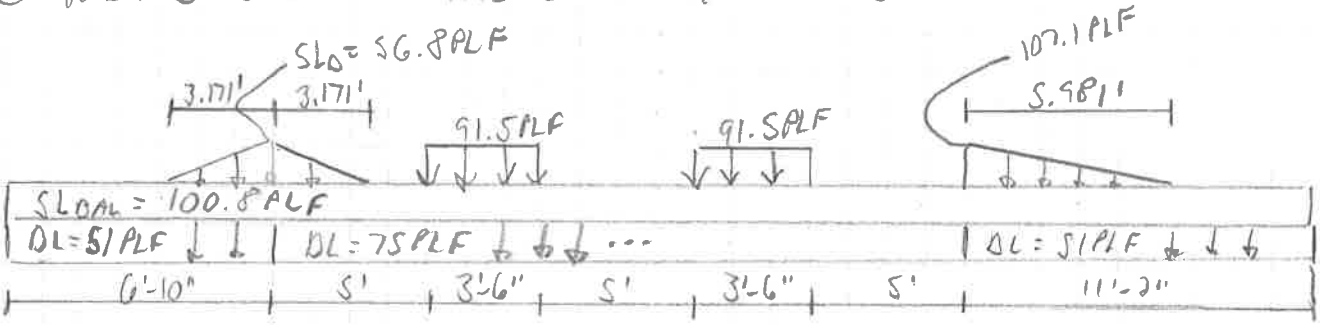
Date: 11/21/2017

DRIFT AREA 4 LOAD CASES

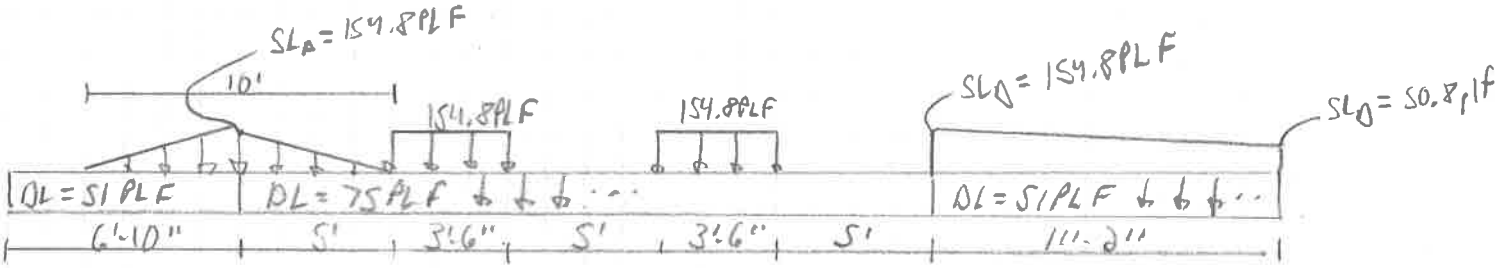
① SLIDING SNOW (OK < 5%)



② WIND OUT OF THE SOUTH (OK < 5%)



③ WIND OUT OF THE NORTH (NOT OK > 5%)



ANALYSIS OF P.V. PANEL ARRAY
(14” GAP)

The easiest, and perhaps the best, way to alleviate the issues encountered with the new snow drift load patterns is to lower the standoff height between the low-side of the photovoltaic cells and the roof. The following calculations will illustrate that reinforcing of existing framing can be avoided by simply lowering the low-side of the panel to a maximum height of 14” above the roof.

(mp)² STRUCTURAL ENGINEERS, LLC

DRIFT AREA 1 & 3

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

Lic. # : KW-06006621 — Licensee : MP-Squared Structural Engineers, LLC

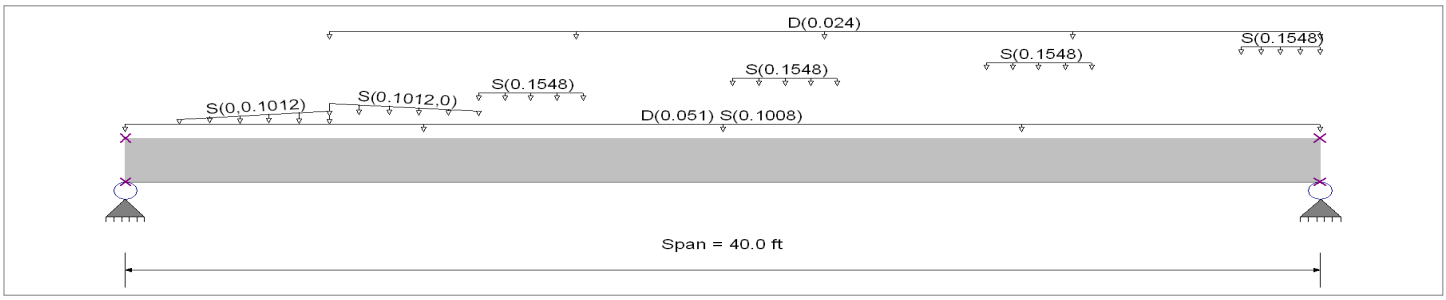
Description : S Drift+Inter-Row+SL+DL

CONTROLLING LOAD CASE FOR DRIFT AREA 1

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Varying Uniform Load : S(S,E) = 0.0->0.1012 k/ft, Extent = 1.833 -->> 6.833 ft, Trib Width = 1.0 ft, (S-Drift)
Varying Uniform Load : S(S,E) = 0.1012->0.0 k/ft, Extent = 6.833 -->> 11.833 ft, Trib Width = 1.0 ft, (S-Drift)
Uniform Load : S = 0.1548 k/ft, Extent = 11.833 -->> 15.333 ft, Tributary Width = 1.0 ft, (Inter-Row)
Uniform Load : S = 0.1548 k/ft, Extent = 20.333 -->> 23.833 ft, Tributary Width = 1.0 ft, (Inter-Row)
Uniform Load : S = 0.1548 k/ft, Extent = 28.833 -->> 32.333 ft, Tributary Width = 1.0 ft, (Inter-Row)
Uniform Load : S = 0.1548 k/ft, Extent = 37.333 -->> 40.0 ft, Tributary Width = 1.0 ft, (Inter-Row)
Uniform Load : D = 0.0240 k/ft, Extent = 6.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (PV Panel)

DESIGN SUMMARY

Maximum Bending =	48.008 k-ft	Maximum Shear =	4.885 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	20.600 ft	Location of maximum on span	40.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	3.330 in	144
Max Upward Transient Deflection	0.053 in	9074
Max Downward Total Deflection	4.799 in	100
Max Upward Total Deflection	0.014 in	34647

BOTH SHEAR AND MOMENT ARE OVER THE 5% THRESHOLD.

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			48.01		48.01					4.88		
D Only													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+L+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+S+H													
Dsgn. L = 40.00 ft	1			48.01		48.01					4.88		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			39.68		39.68					4.04		
+D+W+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			39.68		39.68					4.04		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			39.68		39.68					4.04		
+0.60D+W+H													

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

Lic. # : KW-06006621
Licensee : MP-Squared Structural Engineers, LLC

Description : S Drift+Inter-Row+SL+DL

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Dsgn. L = 40.00 ft	1			8.83		8.83					0.89		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.83		8.83					0.89		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.7985	20.200		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	4.527	4.885
Overall MINimum	0.810	0.892
D Only	1.350	1.486
+D+L+H	1.350	1.486
+D+Lr+H	1.350	1.486
+D+S+H	4.527	4.885
+D+0.750Lr+0.750L+H	1.350	1.486
+D+0.750L+0.750S+H	3.733	4.035
+D+W+H	1.350	1.486
+D+0.70E+H	1.350	1.486
+D+0.750Lr+0.750L+0.750W+H	1.350	1.486
+D+0.750L+0.750S+0.750W+H	3.733	4.035
+D+0.750Lr+0.750L+0.5250E+H	1.350	1.486
+D+0.750L+0.750S+0.5250E+H	3.733	4.035
+0.60D+W+H	0.810	0.892
+0.60D+0.70E+H	0.810	0.892
D Only	1.350	1.486
Lr Only		
L Only		
S Only	3.177	3.399
W Only		
E Only		
H Only		

Title Block Line 1
You can change this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID:

Printed: 22 NOV 2017, 9:32AM

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

Lic. # : KW-06006621 — Licensee : MP-Squared Structural Engineers, LLC

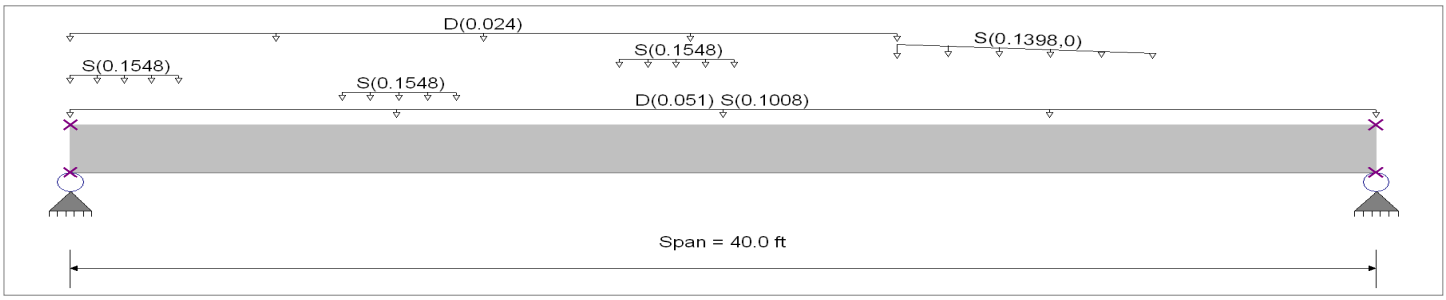
Description : N Drift+Inter-Row+SL+DL

CONTROLLING LOAD CASE FOR DRIFT AREA 3

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : S = 0.1548 k/ft, Extent = 8.333 -->> 11.833 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1548 k/ft, Extent = 0.0 -->> 3.333 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1548 k/ft, Extent = 16.833 -->> 20.333 ft, Tributary Width = 1.0 ft, (Inter-row)
Varying Uniform Load : S(S,E) = 0.1398->0.0 k/ft, Extent = 25.333 -->> 33.143 ft, Trib Width = 1.0 ft, (N-Drift)
Uniform Load : D = 0.0240 k/ft, Extent = 0.0 -->> 25.333 ft, Tributary Width = 1.0 ft, (PV Panel)

DESIGN SUMMARY

Maximum Bending =	45.450 k-ft	Maximum Shear =	4.806 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	19.200 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	3.143 in	152
Max Upward Transient Deflection	0.050 in	9608
Max Downward Total Deflection	4.504 in	106
Max Upward Total Deflection	0.013 in	36996

SHEAR IS OVER THE 5% THRESHOLD.

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			45.45		45.45					4.81		
D Only													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+L+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+S+H													
Dsgn. L = 40.00 ft	1			45.45		45.45					4.81		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			37.52		37.52					3.96		
+D+W+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			37.52		37.52					3.96		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			37.52		37.52					3.96		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			8.24		8.24					0.86		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.24		8.24					0.86		

General Beam Analysis

Description : N Drift+Inter-Row+SL+DL

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.5037	20.000		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	4.806	4.020
Overall MINimum	0.861	0.728
D Only	1.435	1.213
+D+L+H	1.435	1.213
+D+Lr+H	1.435	1.213
+D+S+H	4.806	4.020
+D+0.750Lr+0.750L+H	1.435	1.213
+D+0.750L+0.750S+H	3.963	3.318
+D+W+H	1.435	1.213
+D+0.70E+H	1.435	1.213
+D+0.750Lr+0.750L+0.750W+H	1.435	1.213
+D+0.750L+0.750S+0.750W+H	3.963	3.318
+D+0.750Lr+0.750L+0.5250E+H	1.435	1.213
+D+0.750L+0.750S+0.5250E+H	3.963	3.318
+0.60D+W+H	0.861	0.728
+0.60D+0.70E+H	0.861	0.728
D Only	1.435	1.213
Lr Only		
L Only		
S Only	3.370	2.807
W Only		
E Only		
H Only		

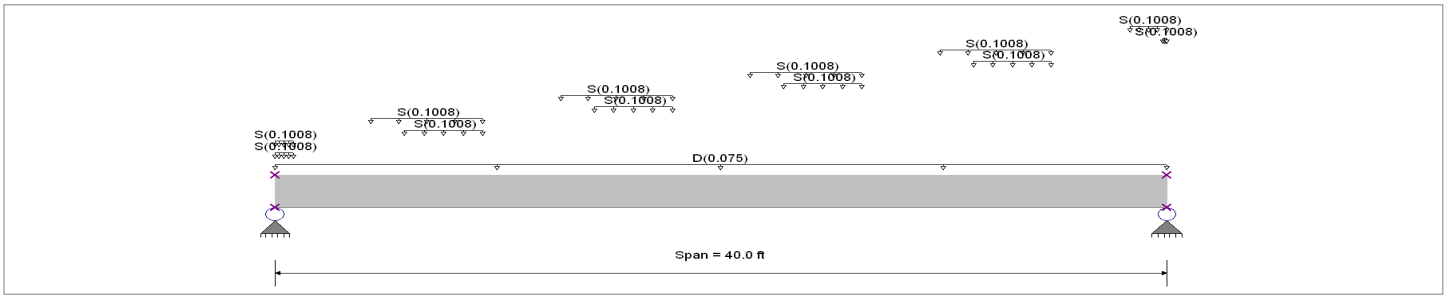
General Beam Analysis

Description : Sliding Snow+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 Span Length = 40.0 ft Area = 10.0 in^2 Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0750 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : S = 0.1008 k/ft, Extent = 0.0 -->> 0.8333 ft, Tributary Width = 1.0 ft, (Balanced Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 0.0 -->> 0.8333 ft, Tributary Width = 1.0 ft, (Sliding Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 5.833 -->> 9.333 ft, Tributary Width = 1.0 ft, (Balanced Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 4.333 -->> 9.333 ft, Tributary Width = 1.0 ft, (Sliding Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 14.333 -->> 17.833 ft, Tributary Width = 1.0 ft, (Balanced Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 12.833 -->> 17.833 ft, Tributary Width = 1.0 ft, (Sliding Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 22.833 -->> 26.333 ft, Tributary Width = 1.0 ft, (Balanced Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 21.333 -->> 26.333 ft, Tributary Width = 1.0 ft, (Sliding Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 31.333 -->> 34.833 ft, Tributary Width = 1.0 ft, (Balanced Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 29.833 -->> 34.833 ft, Tributary Width = 1.0 ft, (Sliding Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 39.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (Balanced Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 38.333 -->> 40.0 ft, Tributary Width = 1.0 ft, (Sliding Snow)

DESIGN SUMMARY

Maximum Bending =	34.813 k-ft	Maximum Shear =	3.393 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	20.200 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	2.001 in	239
Max Upward Transient Deflection	0.032 in	15150
Max Downward Total Deflection	3.503 in	137
Max Upward Total Deflection	0.014 in	33564

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			34.81		34.81					3.39		
D Only													
Dsgn. L = 40.00 ft	1			15.00		15.00					1.50		
+D+L+H													
Dsgn. L = 40.00 ft	1			15.00		15.00					1.50		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			15.00		15.00					1.50		
+D+S+H													
Dsgn. L = 40.00 ft	1			34.81		34.81					3.39		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			15.00		15.00					1.50		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			29.86		29.86					2.92		
+D+W+H													
Dsgn. L = 40.00 ft	1			15.00		15.00					1.50		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			15.00		15.00					1.50		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			15.00		15.00					1.50		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			29.86		29.86					2.92		

General Beam Analysis

Description : Sliding Snow+SL+DL

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			15.00		15.00					1.50		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			29.86		29.86					2.92		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			9.00		9.00					0.90		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			9.00		9.00					0.90		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	3.5031	20.200		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.393	3.387
Overall MINimum	0.900	0.900
D Only	1.500	1.500
+D+L+H	1.500	1.500
+D+Lr+H	1.500	1.500
+D+S+H	3.393	3.387
+D+0.750Lr+0.750L+H	1.500	1.500
+D+0.750L+0.750S+H	2.919	2.916
+D+W+H	1.500	1.500
+D+0.70E+H	1.500	1.500
+D+0.750Lr+0.750L+0.750W+H	1.500	1.500
+D+0.750L+0.750S+0.750W+H	2.919	2.916
+D+0.750Lr+0.750L+0.5250E+H	1.500	1.500
+D+0.750L+0.750S+0.5250E+H	2.919	2.916
+0.60D+W+H	0.900	0.900
+0.60D+0.70E+H	0.900	0.900
D Only	1.500	1.500
Lr Only		
L Only		
S Only	1.893	1.887
W Only		
E Only		
H Only		

DRIFT AREA 2 (A1)

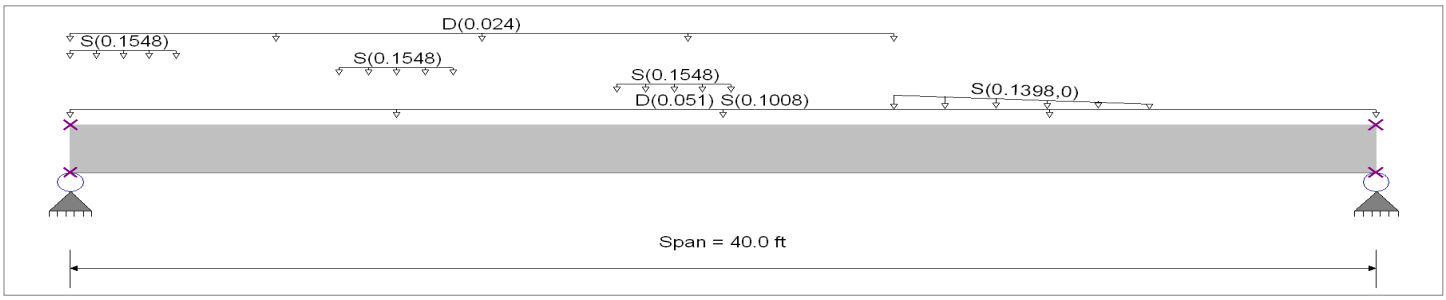
General Beam Analysis

Description : N-drift+Inter-row+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 Span Length = 40.0 ft Area = 10.0 in^2 Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Varying Uniform Load : S(S,E) = 0.1398->0.0 k/ft, Extent = 25.250 -->> 33.063 ft, Trib Width = 1.0 ft, (N-Drift)
Uniform Load : S = 0.1548 k/ft, Extent = 16.750 -->> 20.250 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1548 k/ft, Extent = 8.250 -->> 11.750 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1548 k/ft, Extent = 0.0 -->> 3.250 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : D = 0.0240 k/ft, Extent = 0.0 -->> 25.250 ft, Tributary Width = 1.0 ft, (Uniform DL & SL)

DESIGN SUMMARY

Maximum Bending =	45.404 k-ft	**Maximum Shear =**	4.797 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	19.200 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	3.140 in	152	
Max Upward Transient Deflection	0.050 in	9619	
Max Downward Total Deflection	4.499 in	106	
Max Upward Total Deflection	0.013 in	37034	

SHEAR IS OVER THE 5% THRESHOLD.

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			45.40		45.40					4.80		
D Only													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+L+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+S+H													
Dsgn. L = 40.00 ft	1			45.40		45.40					4.80		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			37.48		37.48					3.96		
+D+W+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			37.48		37.48					3.96		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			37.48		37.48					3.96		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			8.23		8.23					0.86		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.23		8.23					0.86		

General Beam Analysis

Description : N-drift+Inter-row+SL+DL

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.4991	20.000		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	4.797	4.014
Overall MINimum	0.861	0.727
D Only	1.435	1.211
+D+L+H	1.435	1.211
+D+Lr+H	1.435	1.211
+D+S+H	4.797	4.014
+D+0.750Lr+0.750L+H	1.435	1.211
+D+0.750L+0.750S+H	3.956	3.313
+D+W+H	1.435	1.211
+D+0.70E+H	1.435	1.211
+D+0.750Lr+0.750L+0.750W+H	1.435	1.211
+D+0.750L+0.750S+0.750W+H	3.956	3.313
+D+0.750Lr+0.750L+0.5250E+H	1.435	1.211
+D+0.750L+0.750S+0.5250E+H	3.956	3.313
+0.60D+W+H	0.861	0.727
+0.60D+0.70E+H	0.861	0.727
D Only	1.435	1.211
Lr Only		
L Only		
S Only	3.362	2.803
W Only		
E Only		
H Only		

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

Lic. # : KW-06006621 — Licensee : MP-Squared Structural Engineers, LLC

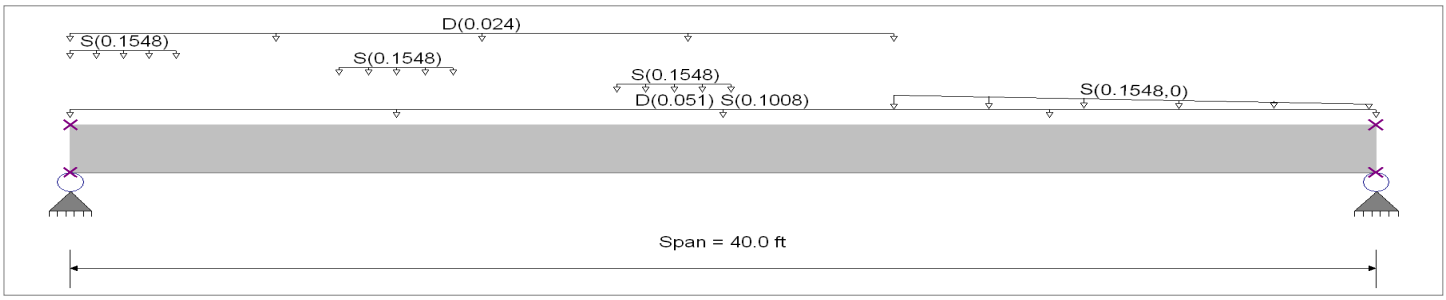
Description : Leeward S-drift+Inter-row+SL+DL

CONTROLLING LOAD CASE FOR DRIFT AREA 2 (A1)

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Varying Uniform Load : S(S,E) = 0.1548->0.0 k/ft, Extent = 25.250 -->> 39.785 ft, Trib Width = 1.0 ft, (Leeward S-drift)
Uniform Load : S = 0.1548 k/ft, Extent = 16.750 -->> 20.250 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1548 k/ft, Extent = 8.250 -->> 11.750 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1548 k/ft, Extent = 0.0 -->> 3.250 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : D = 0.0240 k/ft, Extent = 0.0 -->> 25.250 ft, Tributary Width = 1.0 ft, (Solar Panels)

DESIGN SUMMARY

Maximum Bending =	47.586 k-ft	Maximum Shear =	4.910 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	19.600 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	3.389 in	141	
Max Upward Transient Deflection	0.054 in	8964	
Max Downward Total Deflection	4.749 in	101	
Max Upward Total Deflection	0.013 in	37034	

BOTH SHEAR AND MOMENT ARE OVER THE 5% THRESHOLD.

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			47.59		47.59					4.91		
D Only													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+L+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+S+H													
Dsgn. L = 40.00 ft	1			47.59		47.59					4.91		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			39.12		39.12					4.04		
+D+W+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			39.12		39.12					4.04		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			39.12		39.12					4.04		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			8.23		8.23					0.86		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.23		8.23					0.86		

General Beam Analysis

Description : Leeward S-drift+Inter-row+SL+DL

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.7486	20.000		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	4.910	4.480
Overall MINimum	0.861	0.727
D Only	1.435	1.211
+D+L+H	1.435	1.211
+D+Lr+H	1.435	1.211
+D+S+H	4.910	4.480
+D+0.750Lr+0.750L+H	1.435	1.211
+D+0.750L+0.750S+H	4.041	3.663
+D+W+H	1.435	1.211
+D+0.70E+H	1.435	1.211
+D+0.750Lr+0.750L+0.750W+H	1.435	1.211
+D+0.750L+0.750S+0.750W+H	4.041	3.663
+D+0.750Lr+0.750L+0.5250E+H	1.435	1.211
+D+0.750L+0.750S+0.5250E+H	4.041	3.663
+0.60D+W+H	0.861	0.727
+0.60D+0.70E+H	0.861	0.727
D Only	1.435	1.211
Lr Only		
L Only		
S Only	3.475	3.269
W Only		
E Only		
H Only		

Title Block Line 1
You can change this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID:

Printed: 22 NOV 2017, 9:41AM

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

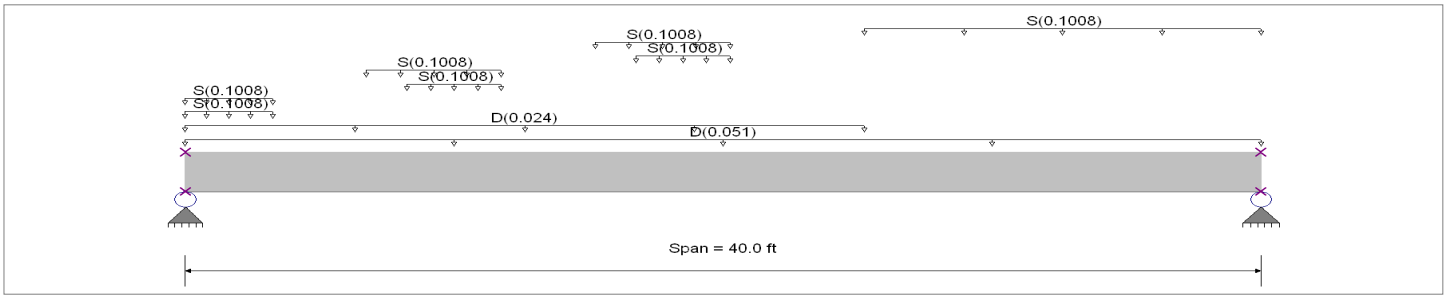
Lic. # : KW-06006621 — **Licensee : MP-Squared Structural Engineers, LLC**

Description : Sliding Snow+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : D = 0.0240 k/ft, Extent = 0.0 -->> 25.250 ft, Tributary Width = 1.0 ft, (P.V. Panels)
Uniform Load : S = 0.1008 k/ft, Extent = 0.0 -->> 3.250 ft, Tributary Width = 1.0 ft, (Balanced Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 0.0 -->> 3.250 ft, Tributary Width = 1.0 ft, (Sliding Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 8.250 -->> 11.750 ft, Tributary Width = 1.0 ft, (Balanced Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 6.750 -->> 11.750 ft, Tributary Width = 1.0 ft, (Sliding Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 16.750 -->> 20.250 ft, Tributary Width = 1.0 ft, (Balanced Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 15.250 -->> 20.250 ft, Tributary Width = 1.0 ft, (Sliding Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 25.250 -->> 40.0 ft, Tributary Width = 1.0 ft, (Balanced Snow)

DESIGN SUMMARY

Maximum Bending =	31.766 k-ft	Maximum Shear =	3.459 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	18.800 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	1.788 in	268
Max Upward Transient Deflection	0.029 in	16744
Max Downward Total Deflection	3.147 in	152
Max Upward Total Deflection	0.013 in	37034

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			31.77		31.77					3.46		
D Only													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+L+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+S+H													
Dsgn. L = 40.00 ft	1			31.77		31.77					3.46		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			27.25		27.25					2.95		
+D+W+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			27.25		27.25					2.95		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			27.25		27.25					2.95		

General Beam Analysis

Description : Sliding Snow+SL+DL

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			8.23		8.23					0.86		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.23		8.23					0.86		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	3.1472	19.800		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.459	3.042
Overall MINimum	0.861	0.727
D Only	1.435	1.211
+D+L+H	1.435	1.211
+D+Lr+H	1.435	1.211
+D+S+H	3.459	3.042
+D+0.750Lr+0.750L+H	1.435	1.211
+D+0.750L+0.750S+H	2.953	2.584
+D+W+H	1.435	1.211
+D+0.70E+H	1.435	1.211
+D+0.750Lr+0.750L+0.750W+H	1.435	1.211
+D+0.750L+0.750S+0.750W+H	2.953	2.584
+D+0.750Lr+0.750L+0.5250E+H	1.435	1.211
+D+0.750L+0.750S+0.5250E+H	2.953	2.584
+0.60D+W+H	0.861	0.727
+0.60D+0.70E+H	0.861	0.727
D Only	1.435	1.211
Lr Only		
L Only		
S Only	2.025	1.831
W Only		
E Only		
H Only		

DRIFT AREA 2 (A2)

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

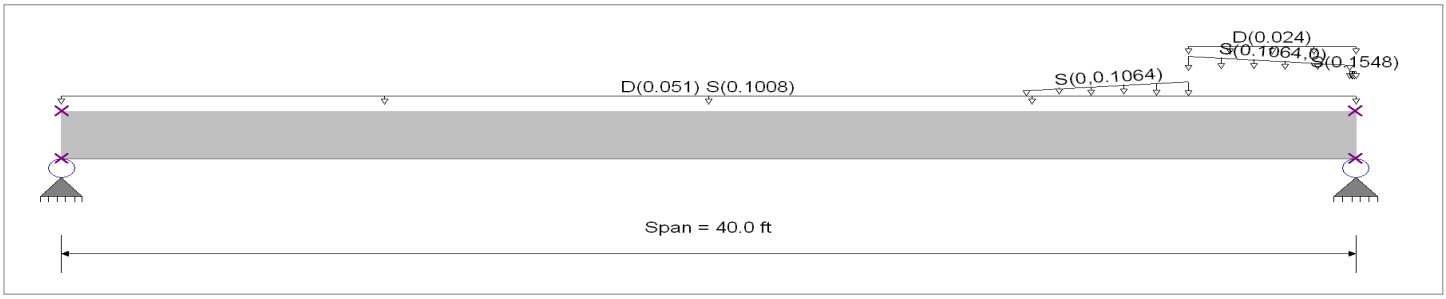
Lic. # : KW-06006621 — Licensee : MP-Squared Structural Engineers, LLC

Description : S-drift+Inter-row+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Varying Uniform Load : S(S,E) = 0.0->0.1064 k/ft, Extent = 29.833 -->> 34.833 ft, Trib Width = 1.0 ft, (S-Drift)
Uniform Load : S = 0.1548 k/ft, Extent = 39.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (Inter-row)
Varying Uniform Load : S(S,E) = 0.1064->0.0 k/ft, Extent = 34.833 -->> 39.833 ft, Trib Width = 1.0 ft, (N-Drift)
Uniform Load : D = 0.0240 k/ft, Extent = 34.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (PV Panel)

DESIGN SUMMARY

Maximum Bending =	31.914 k-ft	Maximum Shear =	3.641 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	20.600 ft	Location of maximum on span	40.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	2.178 in	220
Max Upward Transient Deflection	0.034 in	14049
Max Downward Total Deflection	3.218 in	149
Max Upward Total Deflection	0.010 in	48603

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			31.91		31.91					3.64		
D Only													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+L+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+S+H													
Dsgn. L = 40.00 ft	1			31.91		31.91					3.64		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			26.53		26.53					3.01		
+D+W+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			26.53		26.53					3.01		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			26.53		26.53					3.01		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			6.22		6.22					0.68		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			6.22		6.22					0.68		

General Beam Analysis

Description : S-drift+Inter-row+SL+DL

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	3.2181	20.200		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.113	3.641
Overall MINimum	0.617	0.682
D Only	1.028	1.136
+D+L+H	1.028	1.136
+D+Lr+H	1.028	1.136
+D+S+H	3.113	3.641
+D+0.750Lr+0.750L+H	1.028	1.136
+D+0.750L+0.750S+H	2.592	3.015
+D+W+H	1.028	1.136
+D+0.70E+H	1.028	1.136
+D+0.750Lr+0.750L+0.750W+H	1.028	1.136
+D+0.750L+0.750S+0.750W+H	2.592	3.015
+D+0.750Lr+0.750L+0.5250E+H	1.028	1.136
+D+0.750L+0.750S+0.5250E+H	2.592	3.015
+0.60D+W+H	0.617	0.682
+0.60D+0.70E+H	0.617	0.682
D Only	1.028	1.136
Lr Only		
L Only		
S Only	2.085	2.505
W Only		
E Only		
H Only		

Title Block Line 1
You can change this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID:

Printed: 22 NOV 2017, 9:50AM

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

Lic. # : KW-06006621 — **Licensee : MP-Squared Structural Engineers, LLC**

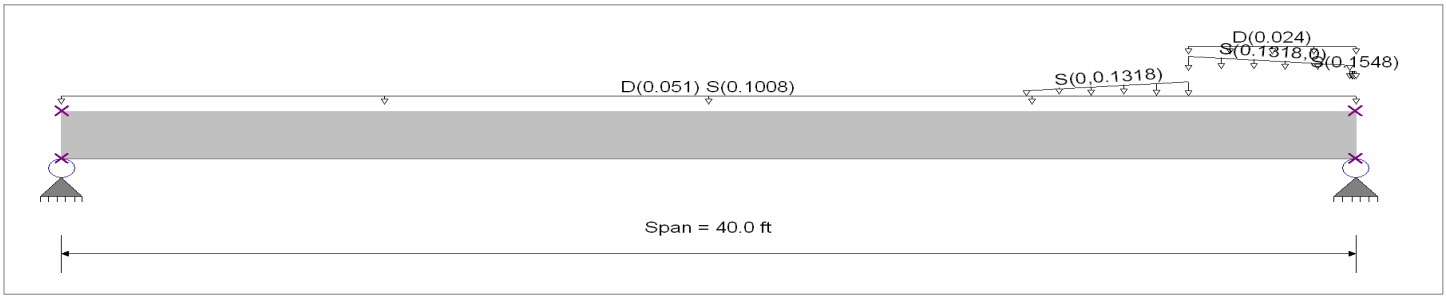
Description : Leeward N-drift+Inter-row+SL+DL

CONTROLLING LOAD CASE FOR DRIFT AREA 2 (A2)

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Varying Uniform Load : S(S,E) = 0.0->0.1318 k/ft, Extent = 29.833 -->> 34.833 ft, Trib Width = 1.0 ft, (leeward N-Drift)
Uniform Load : S = 0.1548 k/ft, Extent = 39.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (Inter-row)
Varying Uniform Load : S(S,E) = 0.1318->0.0 k/ft, Extent = 34.833 -->> 39.833 ft, Trib Width = 1.0 ft, (leeward N-Drift)
Uniform Load : D = 0.0240 k/ft, Extent = 34.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (PV Panel)

DESIGN SUMMARY

Maximum Bending =	32.252 k-ft	**Maximum Shear =**	3.752 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	20.600 ft	Location of maximum on span	40.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	2.216 in	216	
Max Upward Transient Deflection	0.035 in	13843	
Max Downward Total Deflection	3.256 in	147	
Max Upward Total Deflection	0.010 in	48603	

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			32.25		32.25					3.75		
D Only													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+L+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+S+H													
Dsgn. L = 40.00 ft	1			32.25		32.25					3.75		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			26.78		26.78					3.10		
+D+W+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			26.78		26.78					3.10		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			26.78		26.78					3.10		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			6.22		6.22					0.68		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			6.22		6.22					0.68		

General Beam Analysis

Description : Leeward N-drift+Inter-row+SL+DL

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	3.2562	20.200		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.129	3.752
Overall MINimum	0.617	0.682
D Only	1.028	1.136
+D+L+H	1.028	1.136
+D+Lr+H	1.028	1.136
+D+S+H	3.129	3.752
+D+0.750Lr+0.750L+H	1.028	1.136
+D+0.750L+0.750S+H	2.604	3.098
+D+W+H	1.028	1.136
+D+0.70E+H	1.028	1.136
+D+0.750Lr+0.750L+0.750W+H	1.028	1.136
+D+0.750L+0.750S+0.750W+H	2.604	3.098
+D+0.750Lr+0.750L+0.5250E+H	1.028	1.136
+D+0.750L+0.750S+0.5250E+H	2.604	3.098
+0.60D+W+H	0.617	0.682
+0.60D+0.70E+H	0.617	0.682
D Only	1.028	1.136
Lr Only		
L Only		
S Only	2.101	2.616
W Only		
E Only		
H Only		

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

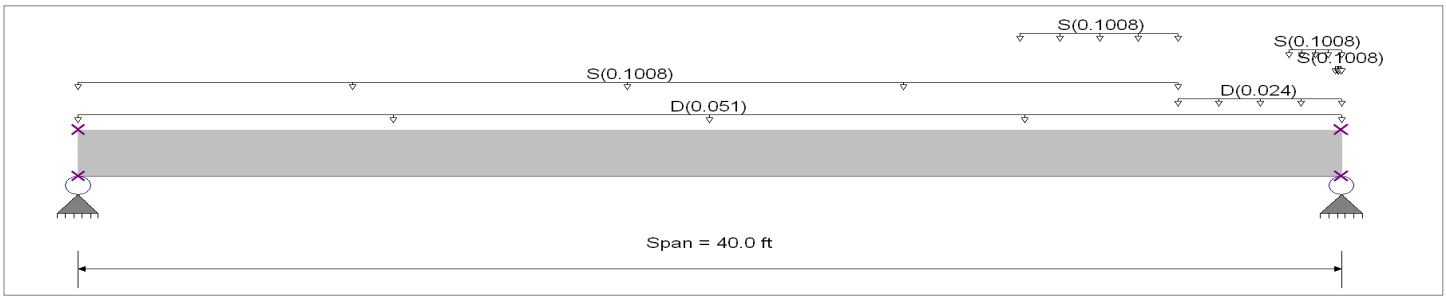
Lic. # : KW-06006621 — Licensee : MP-Squared Structural Engineers, LLC

Description : Sliding Snow+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : D = 0.0240 k/ft, Extent = 34.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (P.V. Panels)
Uniform Load : S = 0.1008 k/ft, Extent = 0.0 -->> 34.833 ft, Tributary Width = 1.0 ft, (Balanced Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 39.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (Balanced Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 38.333 -->> 40.0 ft, Tributary Width = 1.0 ft, (Sliding Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 29.833 -->> 34.833 ft, Tributary Width = 1.0 ft, (Sliding Snow)

DESIGN SUMMARY

Maximum Bending =	31.868 k-ft	Maximum Shear =	3.254 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	20.400 ft	Location of maximum on span	40.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	2.166 in	221
Max Upward Transient Deflection	0.034 in	14104
Max Downward Total Deflection	3.206 in	149
Max Upward Total Deflection	0.010 in	48603

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			31.87		31.87					3.25		
D Only													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+L+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+S+H													
Dsgn. L = 40.00 ft	1			31.87		31.87					3.25		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			26.49		26.49					2.72		
+D+W+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			26.49		26.49					2.72		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			10.36		10.36					1.14		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			26.49		26.49					2.72		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			6.22		6.22					0.68		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			6.22		6.22					0.68		

General Beam Analysis

Description : Sliding Snow+SL+DL

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	3.2063	20.200		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.111	3.254
Overall MINimum	0.617	0.682
D Only	1.028	1.136
+D+L+H	1.028	1.136
+D+Lr+H	1.028	1.136
+D+S+H	3.111	3.254
+D+0.750Lr+0.750L+H	1.028	1.136
+D+0.750L+0.750S+H	2.590	2.724
+D+W+H	1.028	1.136
+D+0.70E+H	1.028	1.136
+D+0.750Lr+0.750L+0.750W+H	1.028	1.136
+D+0.750L+0.750S+0.750W+H	2.590	2.724
+D+0.750Lr+0.750L+0.5250E+H	1.028	1.136
+D+0.750L+0.750S+0.5250E+H	2.590	2.724
+0.60D+W+H	0.617	0.682
+0.60D+0.70E+H	0.617	0.682
D Only	1.028	1.136
Lr Only		
L Only		
S Only	2.083	2.118
W Only		
E Only		
H Only		

DRIFT AREA 2 (B1)

Title Block Line 1
You can change this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID:

Printed: 29 NOV 2017, 5:05PM

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

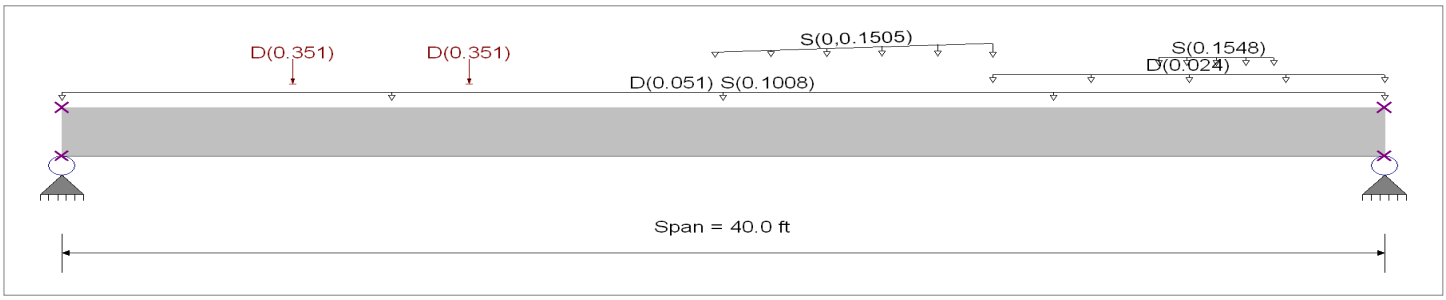
Lic. # : KW-06006621 — **Licensee : MP-Squared Structural Engineers, LLC**

Description : B1: N Drift+Inter-row+SL+DL+RTU

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : D = 0.0240 k/ft, Extent = 28.167 -->> 40.0 ft, Tributary Width = 1.0 ft, (P.V. Panels)
Point Load : D = 0.3510 k @ 7.0 ft, (RTU DL)
Uniform Load : S = 0.1548 k/ft, Extent = 33.167 -->> 36.667 ft, Tributary Width = 1.0 ft, (Inter-Row)
Varying Uniform Load : S(S,E) = 0.0->0.1505 k/ft, Extent = 19.757 -->> 28.167 ft, Trib Width = 1.0 ft, (N-Drift)
Point Load : D = 0.3510 k @ 12.330 ft, (RTU DL)

DESIGN SUMMARY

Maximum Bending =	40.692 k-ft	**Maximum Shear =**	4.322 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	21.000 ft	Location of maximum on span	40.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	2.632 in	182	
Max Upward Transient Deflection	0.041 in	11851	
Max Downward Total Deflection	4.116 in	116	
Max Upward Total Deflection	0.014 in	33460	

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			40.69		40.69					4.32		
D Only													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+L+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+S+H													
Dsgn. L = 40.00 ft	1			40.69		40.69					4.32		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			34.09		34.09					3.60		
+D+W+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			34.09		34.09					3.60		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			34.09		34.09					3.60		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			8.76		8.76					0.96		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.76		8.76					0.96		

General Beam Analysis

Description : B1: N Drift+Inter-row+SL+DL+RTU

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.1157	20.200		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.911	4.322
Overall MINimum	0.957	0.859
D Only	1.594	1.432
+D+L+H	1.594	1.432
+D+Lr+H	1.594	1.432
+D+S+H	3.911	4.322
+D+0.750Lr+0.750L+H	1.594	1.432
+D+0.750L+0.750S+H	3.332	3.599
+D+W+H	1.594	1.432
+D+0.70E+H	1.594	1.432
+D+0.750Lr+0.750L+0.750W+H	1.594	1.432
+D+0.750L+0.750S+0.750W+H	3.332	3.599
+D+0.750Lr+0.750L+0.5250E+H	1.594	1.432
+D+0.750L+0.750S+0.5250E+H	3.332	3.599
+0.60D+W+H	0.957	0.859
+0.60D+0.70E+H	0.957	0.859
D Only	1.594	1.432
Lr Only		
L Only		
S Only	2.316	2.890
W Only		
E Only		
H Only		

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

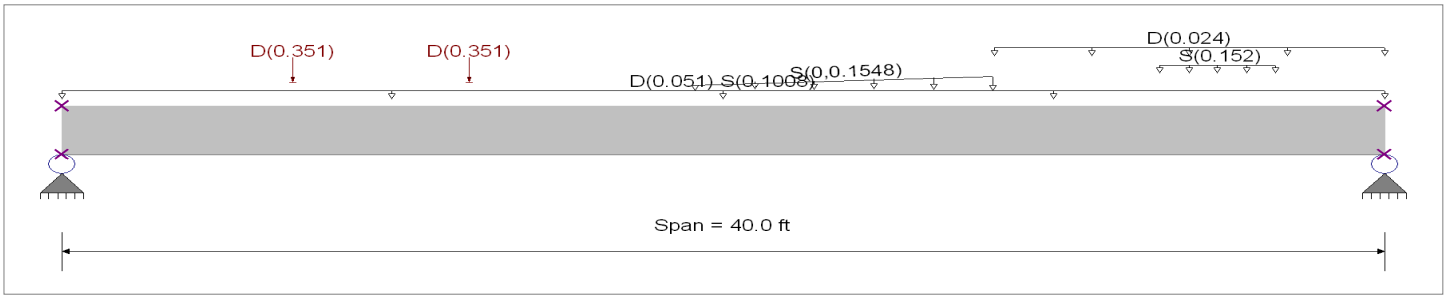
Lic. # : KW-06006621
Licensee : MP-Squared Structural Engineers, LLC

Description : B1: Leeward S-Drft+Inter-row+SL+DL+RTU

CONTROLLING LOAD CASE FOR DRIFT AREA 2 (B1)

General Beam Properties

Elastic Modulus 29,000.0 ksi
Span #1 Span Length = 40.0 ft Area = 10.0 in^2 Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Varying Uniform Load : S(S,E) = 0.0->0.1548 k/ft, Extent = 19.163 -->> 28.167 ft, Trib Width = 1.0 ft, (Leeward S Drift)
Uniform Load : S = 0.1520 k/ft, Extent = 33.208 -->> 36.708 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : D = 0.0240 k/ft, Extent = 28.208 -->> 40.0 ft, Tributary Width = 1.0 ft, (PV Panel)
Point Load : D = 0.3510 k @ 7.0 ft, (RTU)
Point Load : D = 0.3510 k @ 12.333 ft, (RTU)

DESIGN SUMMARY

Maximum Bending =	41.201 k-ft	Maximum Shear =	4.350 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	21.000 ft	Location of maximum on span	40.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	2.676 in	179
Max Upward Transient Deflection	0.041 in	11667
Max Downward Total Deflection	4.159 in	115
Max Upward Total Deflection	0.014 in	33474

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			41.20		41.20					4.35		
D Only													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+L+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+S+H													
Dsgn. L = 40.00 ft	1			41.20		41.20					4.35		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			34.47		34.47					3.62		
+D+W+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			34.47		34.47					3.62		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			34.47		34.47					3.62		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			8.75		8.75					0.96		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.75		8.75					0.96		

General Beam Analysis

Description : B1: Leeward S-Drft+Inter-row+SL+DL+RTU

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.1595	20.200		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.936	4.350
Overall MINimum	0.956	0.859
D Only	1.594	1.431
+D+L+H	1.594	1.431
+D+Lr+H	1.594	1.431
+D+S+H	3.936	4.350
+D+0.750Lr+0.750L+H	1.594	1.431
+D+0.750L+0.750S+H	3.350	3.620
+D+W+H	1.594	1.431
+D+0.70E+H	1.594	1.431
+D+0.750Lr+0.750L+0.750W+H	1.594	1.431
+D+0.750L+0.750S+0.750W+H	3.350	3.620
+D+0.750Lr+0.750L+0.5250E+H	1.594	1.431
+D+0.750L+0.750S+0.5250E+H	3.350	3.620
+0.60D+W+H	0.956	0.859
+0.60D+0.70E+H	0.956	0.859
D Only	1.594	1.431
Lr Only		
L Only		
S Only	2.342	2.919
W Only		
E Only		
H Only		

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

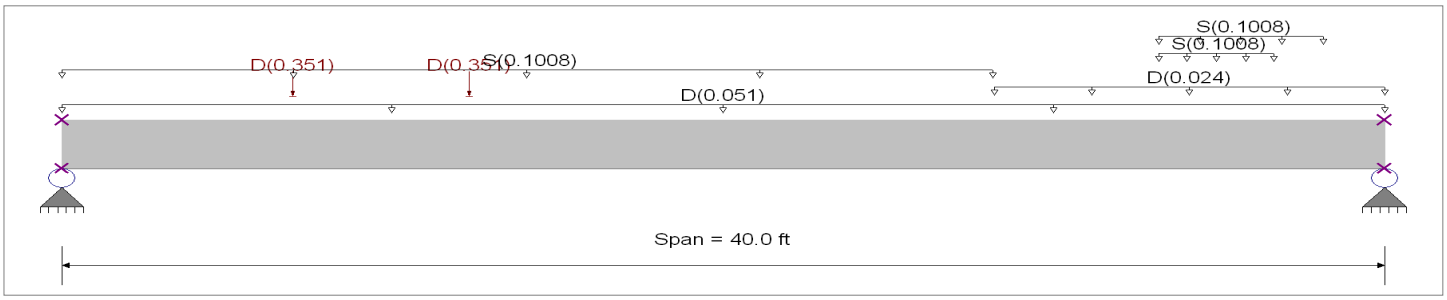
Lic. # : KW-06006621 — Licensee : MP-Squared Structural Engineers, LLC

Description : B1: Sliding Snow+SL+DL+RTU

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Load for Span Number 1

- Uniform Load : D = 0.0510 k/ft, Extent = 0.0 -->> 40.0 ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
- Uniform Load : D = 0.0240 k/ft, Extent = 28.208 -->> 40.0 ft, Tributary Width = 1.0 ft, (PV Panel)
- Point Load : D = 0.3510 k @ 7.0 ft, (RTU)
- Uniform Load : S = 0.1008 k/ft, Extent = 0.0 -->> 28.167 ft, Tributary Width = 1.0 ft, (SL Balanced)
- Uniform Load : S = 0.1008 k/ft, Extent = 33.167 -->> 36.667 ft, Tributary Width = 1.0 ft, (Balanced snow)
- Uniform Load : S = 0.1008 k/ft, Extent = 33.167 -->> 38.167 ft, Tributary Width = 1.0 ft, (Sliding snow)
- Point Load : D = 0.3510 k @ 12.333 ft, (RTU)

DESIGN SUMMARY

Maximum Bending =	33.185 k-ft	Maximum Shear =	3.533 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	18.600 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	1.853 in	259
Max Upward Transient Deflection	0.030 in	16227
Max Downward Total Deflection	3.338 in	143
Max Upward Total Deflection	0.014 in	33474

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			33.19		33.19					3.53		
D Only													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+L+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+S+H													
Dsgn. L = 40.00 ft	1			33.19		33.19					3.53		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			28.53		28.53					3.05		
+D+W+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			28.53		28.53					3.05		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			14.59		14.59					1.59		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			28.53		28.53					3.05		
+0.60D+W+H													

General Beam Analysis

Description : B1: Sliding Snow+SL+DL+RTU

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Dsgn. L = 40.00 ft	1			8.75		8.75					0.96		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.75		8.75					0.96		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	3.3381	19.800		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.533	3.188
Overall MINimum	0.956	0.859
D Only	1.594	1.431
+D+L+H	1.594	1.431
+D+Lr+H	1.594	1.431
+D+S+H	3.533	3.188
+D+0.750Lr+0.750L+H	1.594	1.431
+D+0.750L+0.750S+H	3.048	2.749
+D+W+H	1.594	1.431
+D+0.70E+H	1.594	1.431
+D+0.750Lr+0.750L+0.750W+H	1.594	1.431
+D+0.750L+0.750S+0.750W+H	3.048	2.749
+D+0.750Lr+0.750L+0.5250E+H	1.594	1.431
+D+0.750L+0.750S+0.5250E+H	3.048	2.749
+0.60D+W+H	0.956	0.859
+0.60D+0.70E+H	0.956	0.859
D Only	1.594	1.431
Lr Only		
L Only		
S Only	1.939	1.757
W Only		
E Only		
H Only		

DRIFT AREA 2 (B2)

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

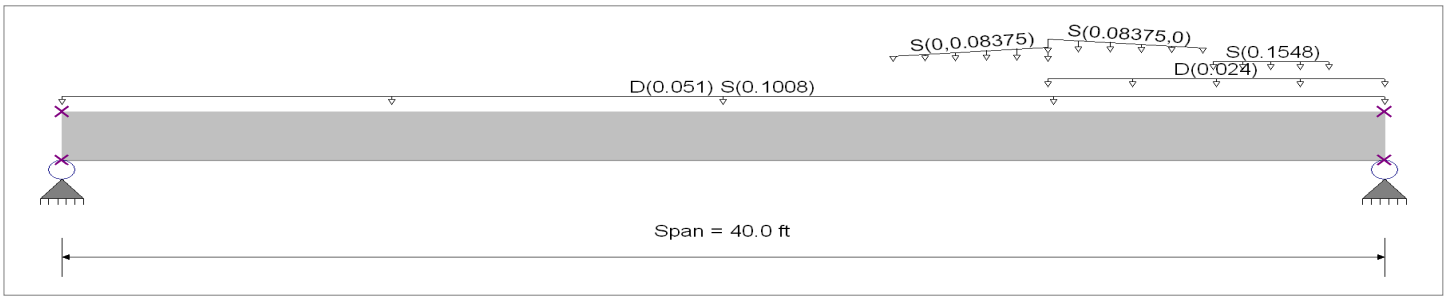
Lic. # : KW-06006621
Licensee : MP-Squared Structural Engineers, LLC

Description : B2: S Drift+Inter-Row+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 Span Length = 40.0 ft Area = 10.0 in^2 Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : D = 0.0240 k/ft, Extent = 29.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (P.V. Panel)
Uniform Load : S = 0.1548 k/ft, Extent = 34.833 -->> 38.330 ft, Tributary Width = 1.0 ft, (Inter-row)
Varying Uniform Load : S(S,E) = 0.0->0.08375 k/ft, Extent = 25.154 -->> 29.833 ft, Trib Width = 1.0 ft, (S-Drift)
Varying Uniform Load : S(S,E) = 0.08375->0.0 k/ft, Extent = 29.833 -->> 34.512 ft, Trib Width = 1.0 ft, (S-Drift)

DESIGN SUMMARY

Maximum Bending =	34.000 k-ft	**Maximum Shear =**	4.036 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	21.200 ft	Location of maximum on span	40.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	2.345 in	204	
Max Upward Transient Deflection	0.036 in	13176	
Max Downward Total Deflection	3.437 in	139	
Max Upward Total Deflection	0.010 in	46617	

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			34.00		34.00					4.04		
D Only													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+L+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+S+H													
Dsgn. L = 40.00 ft	1			34.00		34.00					4.04		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			28.21		28.21					3.34		
+D+W+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			28.21		28.21					3.34		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			28.21		28.21					3.34		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			6.50		6.50					0.74		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			6.50		6.50					0.74		

General Beam Analysis

Description : B2: S Drift+Inter-Row+SL+DL

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	3.4372	20.400		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.213	4.036
Overall MINimum	0.631	0.740
D Only	1.051	1.233
+D+L+H	1.051	1.233
+D+Lr+H	1.051	1.233
+D+S+H	3.213	4.036
+D+0.750Lr+0.750L+H	1.051	1.233
+D+0.750L+0.750S+H	2.672	3.335
+D+W+H	1.051	1.233
+D+0.70E+H	1.051	1.233
+D+0.750Lr+0.750L+0.750W+H	1.051	1.233
+D+0.750L+0.750S+0.750W+H	2.672	3.335
+D+0.750Lr+0.750L+0.5250E+H	1.051	1.233
+D+0.750L+0.750S+0.5250E+H	2.672	3.335
+0.60D+W+H	0.631	0.740
+0.60D+0.70E+H	0.631	0.740
D Only	1.051	1.233
Lr Only		
L Only		
S Only	2.162	2.803
W Only		
E Only		
H Only		

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

Lic. # : KW-06006621 — Licensee : MP-Squared Structural Engineers, LLC

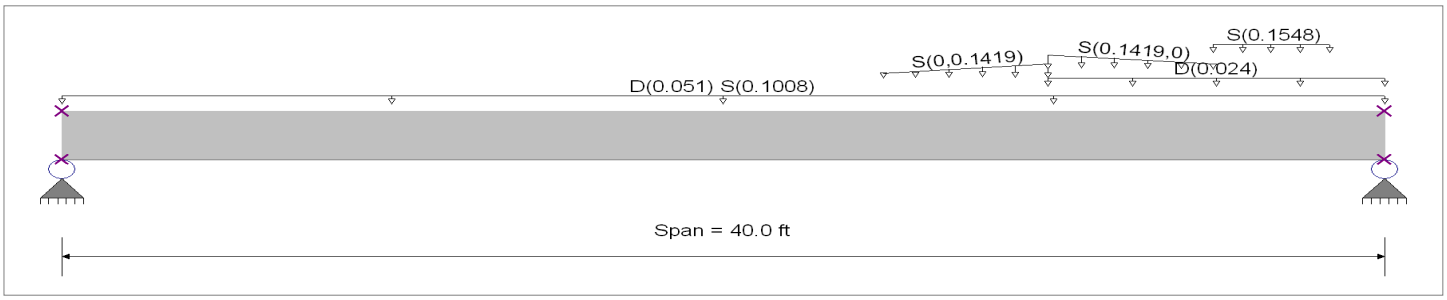
Description : B2: Leeward N Drift+Inter-Row+SL+DL

CONTROLLING LOAD CASE FOR DRIFT AREA 2 (B2)

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : D = 0.0240 k/ft, Extent = 29.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (PV Panel)
Varying Uniform Load : S(S,E) = 0.0->0.1419 k/ft, Extent = 24.833 -->> 29.833 ft, Trib Width = 1.0 ft, (Leeward N-Drift)
Varying Uniform Load : S(S,E) = 0.1419->0.0 k/ft, Extent = 29.833 -->> 34.833 ft, Trib Width = 1.0 ft, (Leeward N-Drift)
Uniform Load : S = 0.1548 k/ft, Extent = 34.833 -->> 38.333 ft, Tributary Width = 1.0 ft, (Inter-row)

DESIGN SUMMARY

Maximum Bending =	35.731 k-ft	Maximum Shear =	4.274 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	21.600 ft	Location of maximum on span	40.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	2.520 in	190
Max Upward Transient Deflection	0.039 in	12368
Max Downward Total Deflection	3.613 in	132
Max Upward Total Deflection	0.010 in	46617

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			35.73		35.73					4.27		
D Only													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+L+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+S+H													
Dsgn. L = 40.00 ft	1			35.73		35.73					4.27		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			29.50		29.50					3.51		
+D+W+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			29.50		29.50					3.51		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			29.50		29.50					3.51		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			6.50		6.50					0.74		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			6.50		6.50					0.74		

General Beam Analysis

Description : B2: Leeward N Drift+Inter-Row+SL+DL

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	3.6126	20.400		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.294	4.274
Overall MINimum	0.631	0.740
D Only	1.051	1.233
+D+L+H	1.051	1.233
+D+Lr+H	1.051	1.233
+D+S+H	3.294	4.274
+D+0.750Lr+0.750L+H	1.051	1.233
+D+0.750L+0.750S+H	2.733	3.514
+D+W+H	1.051	1.233
+D+0.70E+H	1.051	1.233
+D+0.750Lr+0.750L+0.750W+H	1.051	1.233
+D+0.750L+0.750S+0.750W+H	2.733	3.514
+D+0.750Lr+0.750L+0.5250E+H	1.051	1.233
+D+0.750L+0.750S+0.5250E+H	2.733	3.514
+0.60D+W+H	0.631	0.740
+0.60D+0.70E+H	0.631	0.740
D Only	1.051	1.233
Lr Only		
L Only		
S Only	2.243	3.041
W Only		
E Only		
H Only		

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

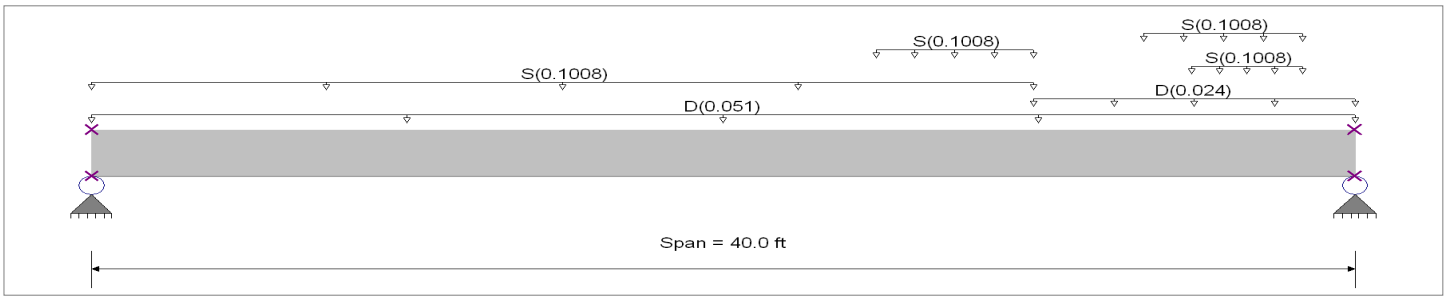
Lic. # : KW-06006621
Licensee : MP-Squared Structural Engineers, LLC

Description : B2: Sliding Snow+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 Span Length = 40.0 ft Area = 10.0 in^2 Moment of Inertia = 100.0 in^4



Applied Loads

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

Load for Span Number 1

Uniform Load : D = 0.0510 k/ft, Extent = 0.0 -->> 40.0 ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : D = 0.0240 k/ft, Extent = 29.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (PV Panel)
Uniform Load : S = 0.1008 k/ft, Extent = 0.0 -->> 29.833 ft, Tributary Width = 1.0 ft, (Balanced SL)
Uniform Load : S = 0.1008 k/ft, Extent = 34.833 -->> 38.333 ft, Tributary Width = 1.0 ft, (Balanced SL)
Uniform Load : S = 0.1008 k/ft, Extent = 24.833 -->> 29.833 ft, Tributary Width = 1.0 ft, (Sliding Snow)
Uniform Load : S = 0.1008 k/ft, Extent = 33.333 -->> 38.333 ft, Tributary Width = 1.0 ft, (Sliding Snow)

DESIGN SUMMARY

Maximum Bending =	33.287 k-ft	Maximum Shear =	3.473 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	21.000 ft	Location of maximum on span	40.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	2.244 in	213
Max Upward Transient Deflection	0.035 in	13650
Max Downward Total Deflection	3.336 in	143
Max Upward Total Deflection	0.010 in	46617

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			33.29		33.29					3.47		
D Only													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+L+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+S+H													
Dsgn. L = 40.00 ft	1			33.29		33.29					3.47		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			27.67		27.67					2.91		
+D+W+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			27.67		27.67					2.91		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			10.83		10.83					1.23		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			27.67		27.67					2.91		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			6.50		6.50					0.74		

General Beam Analysis

Description : B2: Sliding Snow+SL+DL

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			6.50		6.50					0.74		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	3.3364	20.200		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.179	3.473
Overall MINimum	0.631	0.740
D Only	1.051	1.233
+D+L+H	1.051	1.233
+D+Lr+H	1.051	1.233
+D+S+H	3.179	3.473
+D+0.750Lr+0.750L+H	1.051	1.233
+D+0.750L+0.750S+H	2.647	2.913
+D+W+H	1.051	1.233
+D+0.70E+H	1.051	1.233
+D+0.750Lr+0.750L+0.750W+H	1.051	1.233
+D+0.750L+0.750S+0.750W+H	2.647	2.913
+D+0.750Lr+0.750L+0.5250E+H	1.051	1.233
+D+0.750L+0.750S+0.5250E+H	2.647	2.913
+0.60D+W+H	0.631	0.740
+0.60D+0.70E+H	0.631	0.740
D Only	1.051	1.233
Lr Only		
L Only		
S Only	2.128	2.240
W Only		
E Only		
H Only		

DRIFT AREA 4

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

Lic. # : KW-06006621 — Licensee : MP-Squared Structural Engineers, LLC

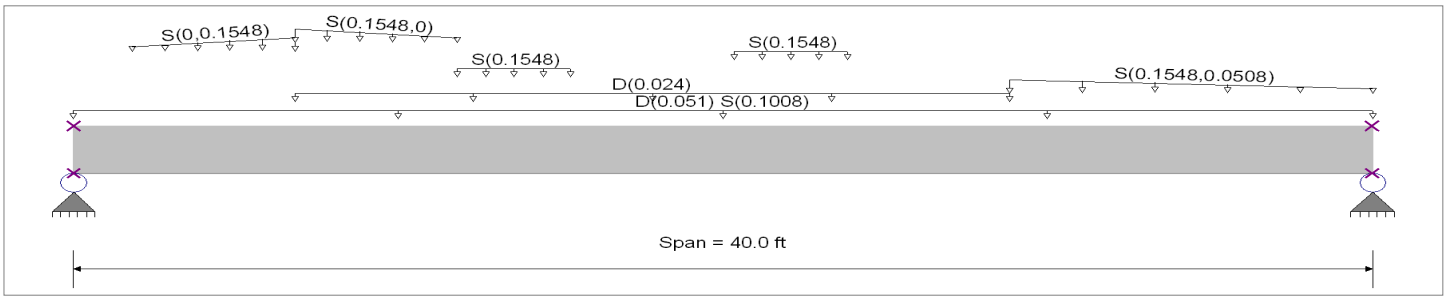
Description : N Drift+Inter-Row+SL+DL

CONTROLLING LOAD CASE FOR DRIFT AREA 4

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : D = 0.0240 k/ft, Extent = 6.833 -->> 28.833 ft, Tributary Width = 1.0 ft, (P.V. Panels)
Varying Uniform Load : S(S,E) = 0.1548->0.05080 k/ft, Extent = 28.833 -->> 40.0 ft, Trib Width = 1.0 ft, (N-drift)
Uniform Load : S = 0.1548 k/ft, Extent = 11.833 -->> 15.333 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1548 k/ft, Extent = 20.333 -->> 23.833 ft, Tributary Width = 1.0 ft, (Inter-row)
Varying Uniform Load : S(S,E) = 0.0->0.1548 k/ft, Extent = 1.833 -->> 6.833 ft, Trib Width = 1.0 ft, (LEEWARD N-DRIFT)
Varying Uniform Load : S(S,E) = 0.1548->0.0 k/ft, Extent = 6.833 -->> 11.833 ft, Trib Width = 1.0 ft, (LEEWARD N-drift)

DESIGN SUMMARY

Maximum Bending =	49.076 k-ft	Maximum Shear =	4.847 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	20.400 ft	Location of maximum on span	40.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	3.543 in	135	
Max Upward Transient Deflection	0.056 in	8498	
Max Downward Total Deflection	4.926 in	97	
Max Upward Total Deflection	0.013 in	36537	

BOTH SHEAR AND MOMENT ARE OVER THE 5% THRESHOLD.

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			49.08		49.08					4.85		
D Only													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+L+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+S+H													
Dsgn. L = 40.00 ft	1			49.08		49.08					4.85		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			40.30		40.30					3.95		
+D+W+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			40.30		40.30					3.95		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			40.30		40.30					3.95		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			8.39		8.39					0.79		

General Beam Analysis

Description : N Drift+Inter-Row+SL+DL

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.39		8.39					0.79		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.9260	20.000		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	4.758	4.847
Overall MINimum	0.788	0.753
D Only	1.313	1.255
+D+L+H	1.313	1.255
+D+Lr+H	1.313	1.255
+D+S+H	4.758	4.847
+D+0.750Lr+0.750L+H	1.313	1.255
+D+0.750L+0.750S+H	3.897	3.949
+D+W+H	1.313	1.255
+D+0.70E+H	1.313	1.255
+D+0.750Lr+0.750L+0.750W+H	1.313	1.255
+D+0.750L+0.750S+0.750W+H	3.897	3.949
+D+0.750Lr+0.750L+0.5250E+H	1.313	1.255
+D+0.750L+0.750S+0.5250E+H	3.897	3.949
+0.60D+W+H	0.788	0.753
+0.60D+0.70E+H	0.788	0.753
D Only	1.313	1.255
Lr Only		
L Only		
S Only	3.446	3.592
W Only		
E Only		
H Only		

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

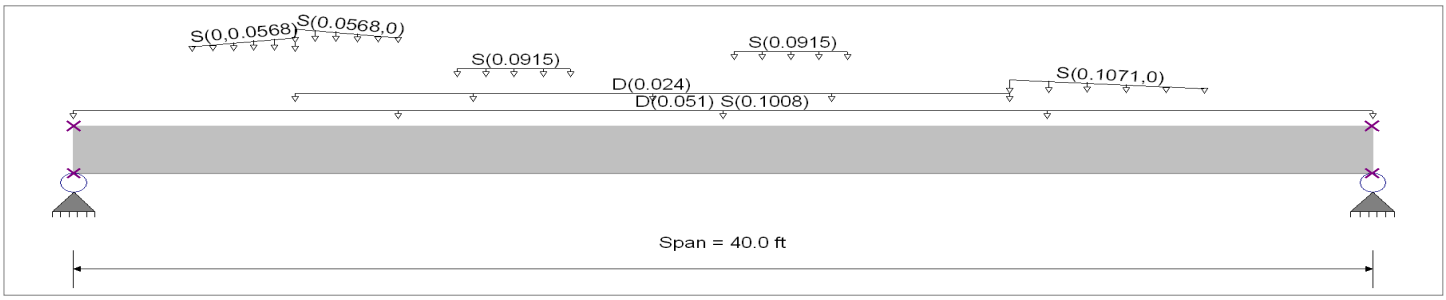
Lic. # : KW-06006621 — Licensee : MP-Squared Structural Engineers, LLC

Description : S Drift+Inter-Row+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : D = 0.0240 k/ft, Extent = 6.833 -->> 28.833 ft, Tributary Width = 1.0 ft, (P.V. Panels)
Varying Uniform Load : S(S,E) = 0.1071->0.0 k/ft, Extent = 28.833 -->> 34.814 ft, Trib Width = 1.0 ft, (LEEWARD S-drift)
Uniform Load : S = 0.09150 k/ft, Extent = 11.833 -->> 15.333 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.09150 k/ft, Extent = 20.333 -->> 23.833 ft, Tributary Width = 1.0 ft, (Inter-row)
Varying Uniform Load : S(S,E) = 0.0->0.05680 k/ft, Extent = 3.662 -->> 6.833 ft, Trib Width = 1.0 ft, (S-drift)
Varying Uniform Load : S(S,E) = 0.05680->0.0 k/ft, Extent = 6.833 -->> 10.004 ft, Trib Width = 1.0 ft, (S-drift)

DESIGN SUMMARY

Maximum Bending =	41.267 k-ft	Maximum Shear =	3.906 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	20.400 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	2.724 in	176	
Max Upward Transient Deflection	0.043 in	11132	
Max Downward Total Deflection	4.107 in	116	
Max Upward Total Deflection	0.013 in	36537	

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			41.27		41.27					3.91		
D Only													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+L+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+S+H													
Dsgn. L = 40.00 ft	1			41.27		41.27					3.91		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			34.44		34.44					3.26		
+D+W+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			34.44		34.44					3.26		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			34.44		34.44					3.26		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			8.39		8.39					0.79		

General Beam Analysis

Description : S Drift+Inter-Row+SL+DL

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.39		8.39					0.79		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.1074	20.000		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.906	3.835
Overall MINimum	0.788	0.753
D Only	1.313	1.255
+D+L+H	1.313	1.255
+D+Lr+H	1.313	1.255
+D+S+H	3.906	3.835
+D+0.750Lr+0.750L+H	1.313	1.255
+D+0.750L+0.750S+H	3.258	3.190
+D+W+H	1.313	1.255
+D+0.70E+H	1.313	1.255
+D+0.750Lr+0.750L+0.750W+H	1.313	1.255
+D+0.750L+0.750S+0.750W+H	3.258	3.190
+D+0.750Lr+0.750L+0.5250E+H	1.313	1.255
+D+0.750L+0.750S+0.5250E+H	3.258	3.190
+0.60D+W+H	0.788	0.753
+0.60D+0.70E+H	0.788	0.753
D Only	1.313	1.255
Lr Only		
L Only		
S Only	2.594	2.579
W Only		
E Only		
H Only		

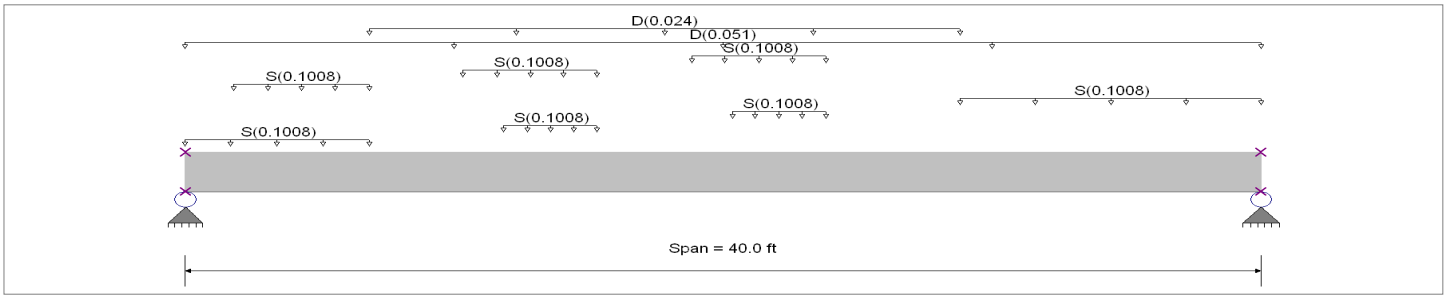
General Beam Analysis

Description : Sliding Snow+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 Span Length = 40.0 ft Area = 10.0 in^2 Moment of Inertia = 100.0 in^4



Applied Loads

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

Load for Span Number 1

- Uniform Load : S = 0.1008 k/ft, Extent = 0.0 -->> 6.833 ft, Tributary Width = 1.0 ft, (Balanced SL)
- Uniform Load : S = 0.1008 k/ft, Extent = 11.833 -->> 15.333 ft, Tributary Width = 1.0 ft, (Balanced SL)
- Uniform Load : S = 0.1008 k/ft, Extent = 20.330 -->> 23.833 ft, Tributary Width = 1.0 ft, (Balanced SL)
- Uniform Load : S = 0.1008 k/ft, Extent = 28.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (Balanced SL)
- Uniform Load : S = 0.1008 k/ft, Extent = 1.833 -->> 6.833 ft, Tributary Width = 1.0 ft, (Sliding SL)
- Uniform Load : S = 0.1008 k/ft, Extent = 10.333 -->> 15.333 ft, Tributary Width = 1.0 ft, (Sliding SL)
- Uniform Load : S = 0.1008 k/ft, Extent = 18.833 -->> 23.833 ft, Tributary Width = 1.0 ft, (Sliding SL)
- Uniform Load : D = 0.0510 k/ft, Tributary Width = 1.0 ft, (Uniform DL)
- Uniform Load : D = 0.0240 k/ft, Extent = 6.833 -->> 28.833 ft, Tributary Width = 1.0 ft, (P.V. Panels)

DESIGN SUMMARY

Maximum Bending =	32.812 k-ft	Maximum Shear =	3.518 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	20.000 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	1.877 in	255
Max Upward Transient Deflection	0.030 in	15941
Max Downward Total Deflection	3.260 in	147
Max Upward Total Deflection	0.013 in	36537

BOTH SHEAR AND MOMENT ARE OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			32.81		32.81					3.52		
D Only													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+L+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+S+H													
Dsgn. L = 40.00 ft	1			32.81		32.81					3.52		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			28.10		28.10					2.97		
+D+W+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			28.10		28.10					2.97		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+0.5250E+H													

General Beam Analysis

Description : Sliding Snow+SL+DL

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Dsgn. L = 40.00 ft +0.60D+W+H	1			28.10		28.10					2.97		
Dsgn. L = 40.00 ft +0.60D+0.70E+H	1			8.39		8.39					0.79		
Dsgn. L = 40.00 ft	1			8.39		8.39					0.79		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	3.2604	20.000		0.0000	0.000

Vertical Reactions

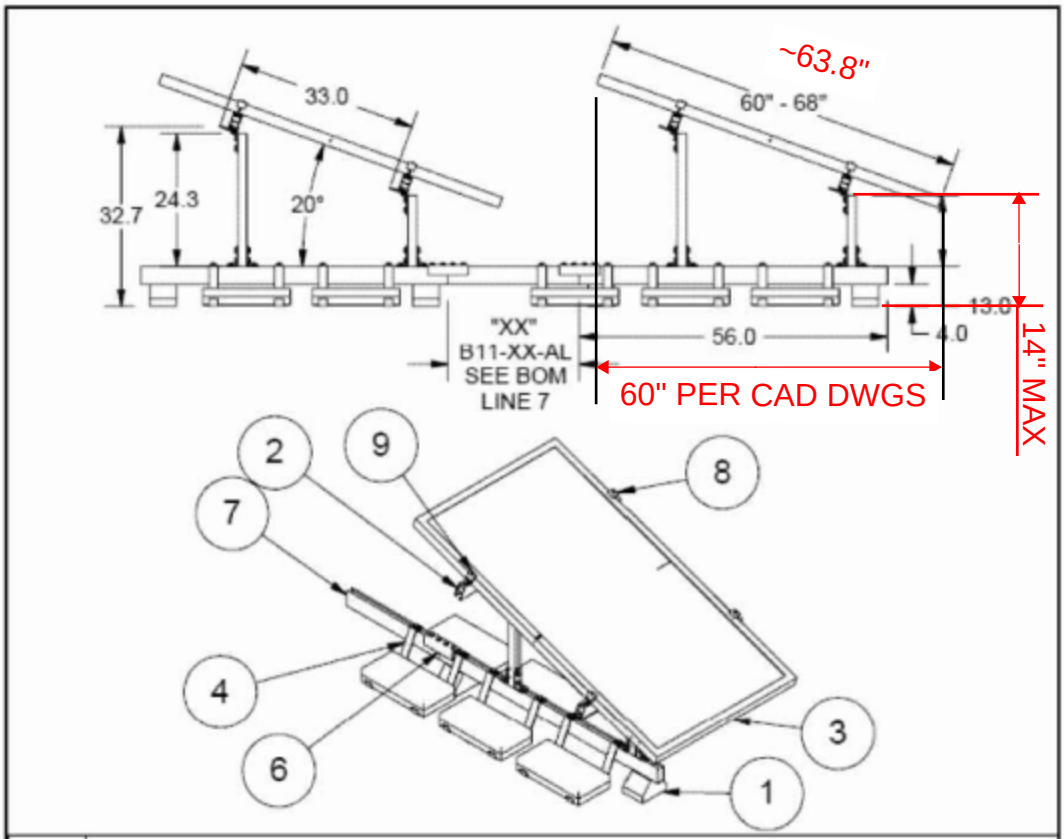
Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	3.518	3.083
Overall MINimum	0.788	0.753
D Only	1.313	1.255
+D+L+H	1.313	1.255
+D+Lr+H	1.313	1.255
+D+S+H	3.518	3.083
+D+0.750Lr+0.750L+H	1.313	1.255
+D+0.750L+0.750S+H	2.966	2.626
+D+W+H	1.313	1.255
+D+0.70E+H	1.313	1.255
+D+0.750Lr+0.750L+0.750W+H	1.313	1.255
+D+0.750L+0.750S+0.750W+H	2.966	2.626
+D+0.750Lr+0.750L+0.5250E+H	1.313	1.255
+D+0.750L+0.750S+0.5250E+H	2.966	2.626
+0.60D+W+H	0.788	0.753
+0.60D+0.70E+H	0.788	0.753
D Only	1.313	1.255
Lr Only		
L Only		
S Only	2.205	1.827
W Only		
E Only		
H Only		

SECONDARY ANALYSIS OF PROBLEM AREAS

The easiest, and perhaps the best, way to alleviate the issues encountered with the new snow drift load patterns is to lower the standoff height between the low-side of the photovoltaic cells and the roof. The following calculations will illustrate that reinforcing of existing framing can be avoided by simply lowering the low-side of the panel to a maximum height of 14” above the roof.

PROPOSED P.V. CELL SCHEMATIC



ITEM NO.	DESCRIPTION
9	SHDENDXX PA AL W/SS
8	SHDMIDXX PA AL W SS
7	B11-XX AL - LENGTH TO SET ROW SPACING
6	B172PA FOUR HOLE SPLICE, PREASSEMBLED
4	SRTBS-1PA BALLAST STRIP - PRE ASSEMBLED
3	SOLAR MODULE, CUSTOMER SUPPLIED
2	B22A-AL
1	SRTM20PXXXX, ROOFTOP SOLAR SUPPORT 20 DEGREE MONOLITHIC PORTRAIT

BILL OF MATERIAL

COOPER B-Line
509 W. Monroe Street
Highland, IL 62249
Phone (618) 654-2184
FAX (618) 654-5499
www.cooperbline.com

SUBMITTAL DRAWING

TITLE:
ARISTA MONOLITHIC ROOFTOP
SOLAR RACKING SYSTEM
20 DEGREE PORTRAIT
60"-68" SOLAR MODULES

EQUIPMENT FURNISHED HAS BEEN FABRICATED IN ACCORDANCE WITH THIS DRAWING.

REFERENCE DWG(S): 00018181, 00017106, 00018216, 00003117, 00017240, 00000018

MODEL SOURCE FILE: 00018175 REV: 00

SUBMITTAL NO: S00018182

DRAWN BY: ERN REV: A

DATE: 01/27/2011

SHEET: 1 OF 1

Snow Load Pattern for Elevated, Tilted-Open Solar Panel Array

$h_{p1} := 14\,in$ Low side dimension

THIS SHEET ASSUMES THE LOW SIDE OF THE PANEL(S) FACES SOUTH. SWAP DIRECTIONS IN THE HEADINGS, IF DIFFERENT.

$l_{horiz} := 60\,in$ Length of horizontal projection

$\theta := 20\,deg$ Angle of tilt

$l_p := \left(\frac{l_{horiz}}{\cos(\theta)}\right) = 63.851\,in$ Length of panel

$h_{p2} := h_{p1} + l_p \cdot \sin(\theta) = 35.838\,in$ High side dimension

$l_{aisle} := 42\,in$ Width of aisle between rows

Drift Fetch Distances:

$l_{north} := 54.667\,ft$ Upwind fetch for wind OUT OF THE NORTH

$l_{south} := 57.25\,ft$ Upwind fetch for wind OUT OF THE SOUTH

Balanced Snow Load

Exposure Category: B

$C_e := 1.2$ $I_s := 1.0$

$C_t := 1.0$ $p_g := 30\,psf$

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\,psf$

For Ct, ignore any thermal contribution from a solar panel array. For Ce, the presence of solar panels bumps the roof exposure into a more severe state. For example, an otherwise fully exposed roof would be considered partially exposed with the addition of solar panels.

$C_s := 1.0$ Obstructed & monoslope roof

$p_s := C_s \cdot p_f = 25.2\,psf$

$\gamma := 0.13 \cdot \frac{1}{ft} \cdot p_g + 14\,\frac{lbf}{ft^3} = 17.9\,\frac{lbf}{ft^3}$

$h_b := \frac{p_s}{\gamma} = 16.894\,in$ $h_c := h_{p2} - h_b = 18.944\,in$

$h_{exposed} := h_{p2} - h_b = 18.944\,in$ Amount of panel exposed above balanced snow load depth. If positive, sliding snow surcharge from the solar panels must be considered.

Sliding Snow Load

THE SLIDING SNOW LOAD PATTERN CHANGES BUT AS BEFORE, IT WILL NOT CONTROL. (TYPICAL)

Consider only if panels are exposed above balanced snow depth.

$w_c := \frac{(-l_{horiz}) \cdot (h_b - h_{p1})}{(h_{p2} - h_{p1})} + l_{horiz} = 52.049\,in$ Width of sliding snow surcharge

$w_{c\_panel} := l_{horiz} - w_c = 7.951\,in$ Horizontal projection of panel covered by sliding snow

$w_{aisle} := w_c - w_{c\_panel} = 44.098\,in$ Width of aisle covered by sliding snow

Note:
For a open-back tilted panel, the slding snow can slide under the panel itself. For a closed-back panel, the sliding snow stops at the panel back. 18" of the surcharge is under the adjacent panel.

$p_f + p_s = 50.4\,psf$ Balanced snow load in aisle plus sliding surcharge (use balanced snow load only for portion of aisle not covered by sliding snow)

Drift Load

Check requirements to avoid calculating drift patterns.

check_1a := if $h_{p2} < 1.2 \cdot h_b$ = "DRIFT REQ'D, CHECK LOW-SIDE"
"DRIFT NOT REQ'D, CHECK 2ND CONDITION"
else
"DRIFT REQ'D, CHECK LOW-SIDE"

check_1b := if $h_{p1} < h_b$ = "DRIFT REQ'D"
"DRIFT REQ'D"
else
"CHECK 2ND CONDITION"

check_2 := if $h_{p1} < 2\,ft + 2 \cdot h_b$ = "DRIFT REQ'D"
"DRIFT REQ'D"
else
"DRIFT NOT REQ'D"

Check if closely spaced.

check_close := if $l_{aisle} > 8 \cdot h_c$ = "YES"
"NO"
else
"YES"

Wind out of the south

NEW SNOW DRIFT PATTERN FOR DRIFT AREA 1 CONTROLLING LOAD CASE

$l_{u\_south} := l_{south} \cdot \frac{1}{ft} = 57.25$

$h_d := \left(0.43 \cdot l_{u\_south}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 32.014\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^{\,2} = 2049.767\,in^2$

$h_{dw} := 0.75 \cdot h_d = 24.01\,in$ Windward drift depth per ASCE7

$h_s := 0.707 \cdot h_{dw} = 16.975\,in$

h_{s_design} := if $h_s > h_c$ = 16.975 in Windward drift for wind blowing at low-side of panel
h_c
else
h_s

$P_{d\_windward} := h_{s\_design} \cdot \gamma = 25.322\,psf$ Drift surcharge for wind blowing at low-side of panel

$l_{drift\_windard}$:= if $4 \cdot h_{s\_design} > l_{horiz}$ = 5 ft Horizontal extent for wind blowing at low-side of panel (multiply by 2)
l_{horiz}
else
$4 \cdot h_{s\_design}$

$A_{d\_SW} := 0.5 \cdot h_{s\_design} \cdot \left(2 \cdot l_{drift\_windard}\right) = 1018.519\,in^2$ Drift area at low-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 48.804\,in$

$h_{u\_design} := \text{if } h_u > h_c = 18.944\,in$ Depth of inter-row surcharge

h_c

else

h_u

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 28.259\,psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_SW}}{h_{u\_design} \cdot l_{aisle}} = 6.448$ Extent of inter-row surcharge (round up)

ASSUME 7 ROWS ARE FILLED BY INTER-ROW SURCHARGE.

Wind out of the north

NEW SNOW DRIFT PATTERN FOR DRIFT AREA 3 CONTROLLING LOAD CASE

$l_{u\_north} := l_{north} \cdot \frac{1}{ft} = 54.667$

$h_d := \left(0.43 \cdot l_{u\_north}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10 \right)^{\frac{1}{4}} - 1.5 \right) ft = 31.25\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^2 = 1953.128\,in^2$

$h_{dw} := 0.75 \cdot h_d = 23.438\,in$ windward Windward drift depth per ASCE7

$h_{n\_design} := \text{if } h_{dw} > h_c = 18.944\,in$ Windward drift depth for wind blowing at high-side of panel

h_c

else

h_{dw}

$P_{d\_windward} := h_{n\_design} \cdot \gamma = 28.259\,psf$ Drift surcharge for wind blowing at high-side of panel

$l_{drift\_windard} := \text{if } h_{dw} \le h_c = 9.665\,ft$ Horizontal extent for wind blowing at high-side of panel

$4 \cdot h_{dw}$

else

$\text{if } \frac{4 \cdot h_{dw}^2}{h_c} > 8 \cdot h_c$

$8 \cdot h_c$

else

$\frac{4 \cdot h_{dw}^2}{h_c}$

$A_{d\_NW} := 0.5 \cdot h_{n\_design} \cdot \left(l_{drift\_windard} \right) = 1098.635\,in^2$ Drift area at high-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 46.503\,in$

$h_{u\_design} := \text{if } h_u > h_c = 18.944\,in$ Depth of inter-row surcharge

h_c

else

h_u

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 28.259\,psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_NW}}{h_{u\_design} \cdot l_{aisle}} = 5.983$ Extent of inter-row surcharge (round up)

ASSUME 6 ROWS ARE FILLED BY INTER-ROW SURCHARGE.

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

Lic. # : KW-06006621 — Licensee : MP-Squared Structural Engineers, LLC

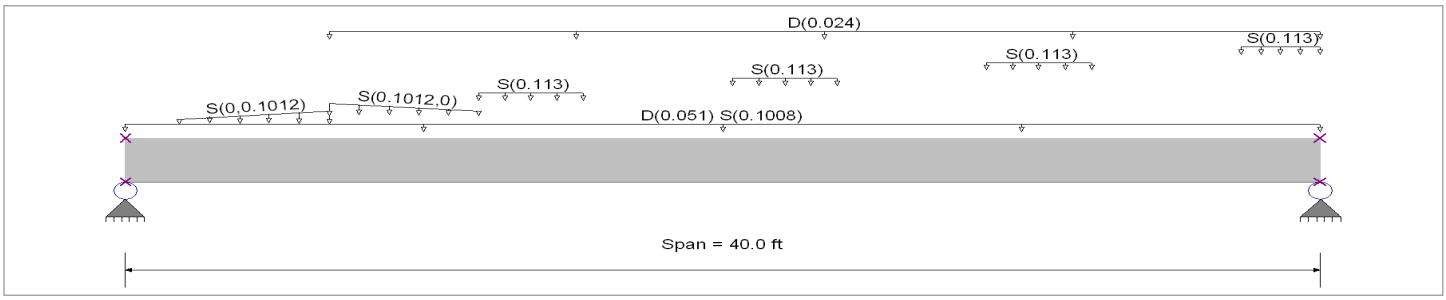
Description : Area 1 (south side)
Trying 14" low-side

DRIFT AREA 1 CONTROLLING LOAD CASE
S Drift+Inter-row+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Varying Uniform Load : S(S,E) = 0.0->0.1012 k/ft, Extent = 1.833 -->> 6.833 ft, Trib Width = 1.0 ft, (S-Drift)
Varying Uniform Load : S(S,E) = 0.1012->0.0 k/ft, Extent = 6.833 -->> 11.833 ft, Trib Width = 1.0 ft, (S-Drift)
Uniform Load : S = 0.1130 k/ft, Extent = 11.833 -->> 15.333 ft, Tributary Width = 1.0 ft, (Inter-Row)
Uniform Load : S = 0.1130 k/ft, Extent = 20.333 -->> 23.833 ft, Tributary Width = 1.0 ft, (Inter-Row)
Uniform Load : S = 0.1130 k/ft, Extent = 28.833 -->> 32.333 ft, Tributary Width = 1.0 ft, (Inter-Row)
Uniform Load : S = 0.1130 k/ft, Extent = 37.333 -->> 40.0 ft, Tributary Width = 1.0 ft, (Inter-Row)
Uniform Load : D = 0.0240 k/ft, Extent = 6.833 -->> 40.0 ft, Tributary Width = 1.0 ft, (PV Panel)

DESIGN SUMMARY

Maximum Bending =	44.916 k-ft	Maximum Shear =	4.535 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	20.400 ft	Location of maximum on span	40.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	3.029 in	158
Max Upward Transient Deflection	0.048 in	9932
Max Downward Total Deflection	4.498 in	106
Max Upward Total Deflection	0.014 in	34647

BOTH SHEAR AND MOMENT ARE
WITHIN THE 5% THRESHOLD. OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			44.92		44.92					4.53		
D Only													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+L+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+S+H													
Dsgn. L = 40.00 ft	1			44.92		44.92					4.53		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			37.37		37.37					3.77		
+D+W+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			37.37		37.37					3.77		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			14.72		14.72					1.49		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			37.37		37.37					3.77		
+0.60D+W+H													

General Beam Analysis

Description : Area 1 (south side)
Trying 14" low-side

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Dsgn. L = 40.00 ft	1			8.83		8.83					0.89		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.83		8.83					0.89		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.4978	20.000		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	4.327	4.535
Overall MINimum	0.810	0.892
D Only	1.350	1.486
+D+L+H	1.350	1.486
+D+Lr+H	1.350	1.486
+D+S+H	4.327	4.535
+D+0.750Lr+0.750L+H	1.350	1.486
+D+0.750L+0.750S+H	3.583	3.773
+D+W+H	1.350	1.486
+D+0.70E+H	1.350	1.486
+D+0.750Lr+0.750L+0.750W+H	1.350	1.486
+D+0.750L+0.750S+0.750W+H	3.583	3.773
+D+0.750Lr+0.750L+0.5250E+H	1.350	1.486
+D+0.750L+0.750S+0.5250E+H	3.583	3.773
+0.60D+W+H	0.810	0.892
+0.60D+0.70E+H	0.810	0.892
D Only	1.350	1.486
Lr Only		
L Only		
S Only	2.977	3.049
W Only		
E Only		
H Only		

Title Block Line 1
You can change this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID:

Printed: 22 NOV 2017, 11:48AM

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

Lic. # : KW-06006621 — **Licensee : MP-Squared Structural Engineers, LLC**

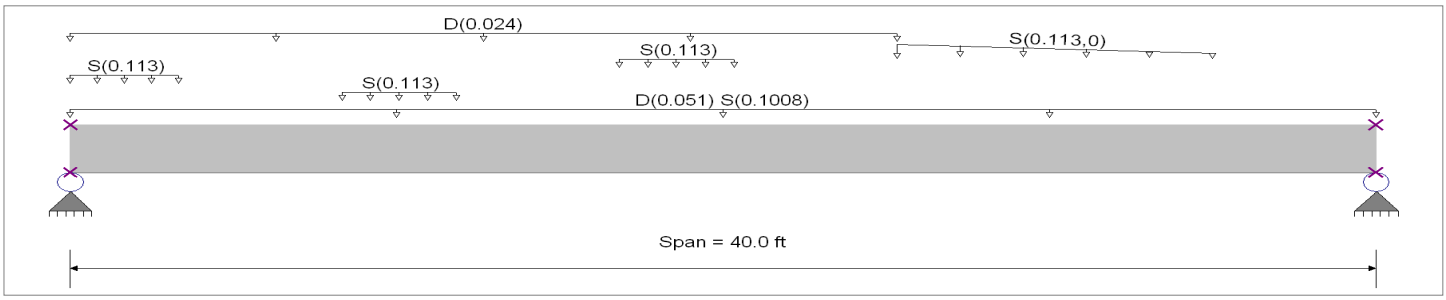
Description : Area 1&3 (north-side)
Trying 14" low-side depth

DRIFT AREA 3 CONTROLLING LOAD CASE
N Drift+Inter-row+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : S = 0.1130 k/ft, Extent = 8.333 -->> 11.833 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1130 k/ft, Extent = 0.0 -->> 3.333 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1130 k/ft, Extent = 16.833 -->> 20.333 ft, Tributary Width = 1.0 ft, (Inter-row)
Varying Uniform Load : S(S,E) = 0.1130->0.0 k/ft, Extent = 25.333 -->> 34.995 ft, Trib Width = 1.0 ft, (N-Drift)
Uniform Load : D = 0.0240 k/ft, Extent = 0.0 -->> 25.333 ft, Tributary Width = 1.0 ft, (PV Panel)

DESIGN SUMMARY

Maximum Bending =	43.020 k-ft	Maximum Shear =	4.476 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	19.400 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	2.917 in	164	
Max Upward Transient Deflection	0.046 in	10351	
Max Downward Total Deflection	4.278 in	112	
Max Upward Total Deflection	0.013 in	36996	

BOTH SHEAR AND MOMENT ARE WITHIN THE 5% THRESHOLD. OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			43.02		43.02					4.48		
D Only													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+L+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+S+H													
Dsgn. L = 40.00 ft	1			43.02		43.02					4.48		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			35.70		35.70					3.72		
+D+W+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			35.70		35.70					3.72		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			13.74		13.74					1.44		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			35.70		35.70					3.72		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			8.24		8.24					0.86		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.24		8.24					0.86		

General Beam Analysis

Description : Area 1&3 (north-side)
Trying 14" low-side depth

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.2780	20.000		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	4.476	3.917
Overall MINimum	0.861	0.728
D Only	1.435	1.213
+D+L+H	1.435	1.213
+D+Lr+H	1.435	1.213
+D+S+H	4.476	3.917
+D+0.750Lr+0.750L+H	1.435	1.213
+D+0.750L+0.750S+H	3.716	3.241
+D+W+H	1.435	1.213
+D+0.70E+H	1.435	1.213
+D+0.750Lr+0.750L+0.750W+H	1.435	1.213
+D+0.750L+0.750S+0.750W+H	3.716	3.241
+D+0.750Lr+0.750L+0.5250E+H	1.435	1.213
+D+0.750L+0.750S+0.5250E+H	3.716	3.241
+0.60D+W+H	0.861	0.728
+0.60D+0.70E+H	0.861	0.728
D Only	1.435	1.213
Lr Only		
L Only		
S Only	3.041	2.705
W Only		
E Only		
H Only		

Snow Load Pattern for Elevated, Tilted-Open Solar Panel Array

$h_{p1} := 14\,in$ Low side dimension

THIS SHEET ASSUMES THE LOW SIDE OF THE PANEL(S) FACES SOUTH. SWAP DIRECTIONS IN THE HEADINGS, IF DIFFERENT.

$l_{horiz} := 60\,in$ Length of horizontal projection

$\theta := 20\,deg$ Angle of tilt

$l_p := \left(\frac{l_{horiz}}{\cos(\theta)}\right) = 63.851\,in$ Length of panel

$h_{p2} := h_{p1} + l_p \cdot \sin(\theta) = 35.838\,in$ High side dimension

$l_{aisle} := 42\,in$ Width of aisle between rows

Drift Fetch Distances:

$l_{north} := 54.667\,ft$ Upwind fetch for wind OUT OF THE NORTH

$l_{south} := 63\,ft$ Upwind fetch for wind OUT OF THE SOUTH

Balanced Snow Load

Exposure Category: B

$C_e := 1.2$ $I_s := 1.0$

$C_t := 1.0$ $p_g := 30\,psf$

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\,psf$

For Ct, ignore any thermal contribution from a solar panel array. For Ce, the presence of solar panels bumps the roof exposure into a more severe state. For example, an otherwise fully exposed roof would be considered partially exposed with the addition of solar panels.

$C_s := 1.0$ Obstructed & monoslope roof

$p_s := C_s \cdot p_f = 25.2\,psf$

$\gamma := 0.13 \cdot \frac{1}{ft} \cdot p_g + 14\,\frac{lbf}{ft^3} = 17.9\,\frac{lbf}{ft^3}$

$h_b := \frac{p_s}{\gamma} = 16.894\,in$ $h_c := h_{p2} - h_b = 18.944\,in$

$h_{exposed} := h_{p2} - h_b = 18.944\,in$ Amount of panel exposed above balanced snow load depth. If positive, sliding snow surcharge from the solar panels must be considered.

Sliding Snow Load

Consider only if panels are exposed above balanced snow depth.

$w_c := \frac{\left(-l_{horiz}\right) \cdot \left(h_b - h_{p1}\right)}{\left(h_{p2} - h_{p1}\right)} + l_{horiz} = 52.049\,in$ Width of sliding snow surcharge

$w_{c\_panel} := l_{horiz} - w_c = 7.951\,in$ Horizontal projection of panel covered by sliding snow

$w_{aisle} := w_c - w_{c\_panel} = 44.098\,in$ Width of aisle covered by sliding snow

Note:
For a open-back tilted panel, the slding snow can slide under the panel itself. For a closed-back panel, the sliding snow stops at the panel back. 18" of the surcharge is under the adjacent panel.

$p_f + p_s = 50.4\,psf$ Balanced snow load in aisle plus sliding surcharge (use balanced snow load only for portion of aisle not covered by sliding snow)

Drift Load

Check requirements to avoid calculating drift patterns.

check_1a := if $h_{p2} < 1.2 \cdot h_b$ = "DRIFT REQ'D, CHECK LOW-SIDE"
"DRIFT NOT REQ'D, CHECK 2ND CONDITION"
else
"DRIFT REQ'D, CHECK LOW-SIDE"

check_1b := if $h_{p1} < h_b$ = "DRIFT REQ'D"
"DRIFT REQ'D"
else
"CHECK 2ND CONDITION"

check_2 := if $h_{p1} < 2\,ft + 2 \cdot h_b$ = "DRIFT REQ'D"
"DRIFT REQ'D"
else
"DRIFT NOT REQ'D"

Check if closely spaced.

check_close := if $l_{aisle} > 8 \cdot h_c$ = "YES"
"NO"
else
"YES"

Wind out of the south

$l_{u\_south} := l_{south} \cdot \frac{1}{ft} = 63$

$h_d := \left(0.43 \cdot l_{u\_south}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 33.635\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^{\,2} = 2262.638\,in^2$

$h_{dw} := 0.75 \cdot h_d = 25.226\,in$ Windward drift depth per ASCE7

$h_s := 0.707 \cdot h_{dw} = 17.835\,in$

$h_{s\_design} :=$ if $h_s > h_c = 17.835\,in$ Windward drift for wind blowing at low-side of panel
h_c
else
h_s

$P_{d\_windward} := h_{s\_design} \cdot \gamma = 26.604\,psf$ Drift surcharge for wind blowing at low-side of panel

$l_{drift\_windard} :=$ if $4 \cdot h_{s\_design} > l_{horiz} = 5\,ft$ Horizontal extent for wind blowing at low-side of panel (multiply by 2)
l_{horiz}
else
$4 \cdot h_{s\_design}$

$A_{d\_SW} := 0.5 \cdot h_{s\_design} \cdot \left(2 \cdot l_{drift\_windard}\right) = 1070.1\,in^2$ Drift area at low-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 53.872\,in$

$h_{u\_design} := \text{if } h_u > h_c = 18.944\,in$ Depth of inter-row surcharge
$\quad h_c$
$\quad \text{else}$
$\quad h_u$

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 28.259\,psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_SW}}{h_{u\_design} \cdot l_{aisle}} = 7.186$ Extent of inter-row surcharge (round up)

Wind out of the north

ASSUME 8 ROWS ARE FILLED BY INTER-ROW SURCHARGE ONLY 3 ROWS ARE AVAILABE. THEREFORE, CALCULATE LEEWARD DRIFT.

$l_{u\_north} := l_{north} \cdot \frac{1}{ft} = 54.667$

$h_d := \left(0.43 \cdot l_{u\_north}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 31.25\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^2 = 1953.128\,in^2$

$h_{dw} := 0.75 \cdot h_d = 23.438\,in$ windward Windward drift depth per ASCE7

$h_{n\_design} := \text{if } h_{dw} > h_c = 18.944\,in$ Windward drift depth for wind blowing at high-side of panel
$\quad h_c$
$\quad \text{else}$
$\quad h_{dw}$

$P_{d\_windward} := h_{n\_design} \cdot \gamma = 28.259\,psf$ Drift surcharge for wind blowing at high-side of panel

$l_{drift\_windard} := \text{if } h_{dw} \le h_c = 9.665\,ft$ Horizontal extent for wind blowing at high-side of panel
$\quad 4 \cdot h_{dw}$
$\quad \text{else}$
$\quad \quad \text{if } \frac{4 \cdot h_{dw}^2}{h_c} > 8 \cdot h_c$
$\quad \quad 8 \cdot h_c$
$\quad \quad \text{else}$
$\quad \quad \frac{4 \cdot h_{dw}^2}{h_c}$

$A_{d\_NW} := 0.5 \cdot h_{n\_design} \cdot \left(l_{drift\_windard}\right) = 1098.635\,in^2$ Drift area at high-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 46.503\,in$

$h_{u\_design} := \text{if } h_u > h_c = 18.944\,in$ Depth of inter-row surcharge
$\quad h_c$
$\quad \text{else}$
$\quad h_u$

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 28.259\,psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_NW}}{h_{u\_design} \cdot l_{aisle}} = 5.983$ Extent of inter-row surcharge (round up)

ASSUME 6 ROWS ARE FILLED BY INTER-ROW SURCHARGE ONLY 3 ROWS ARE AVAILABE. THEREFORE, CALCULATE LEEWARD DRIFT.

Drift Area 2 (A) Leeward Drifts

$h_c := 18.944\,in$ $l_{aisle} := 42\,in$ $l_{horiz} := 5\,ft$

$\gamma := 17.9\,\frac{lbf}{ft^3}$ $n_{rows\_available} := 3$

Leeward drift for wind out of the south

$h_{d\_s} := 33.635\,in$ $h_{u\_design} := h_c$ $A_{d\_SW} := 1070.1\,in^2$

$$h_{s\_design} := \begin{cases} h_c & \text{if } h_{d\_s} > h_c \\ h_{d\_s} & \text{else} \end{cases} = 18.944\,in$$

NEW SNOW DRIFT PATTERN FOR DRIFT AREA 2 (A1) CONTROLLNG LOAD CASE

$P_{d\_leeward} := h_{s\_design} \cdot \gamma = 28.258\,psf$ <- LEEWARD DRIFT SURCHARGE

$$l_{drift\_leeward} := \begin{cases} 4 \cdot h_{d\_s} & \text{if } h_{d\_s} \le h_c \\ \begin{cases} \frac{4 \cdot h_{d\_s}^2}{h_c} & \text{if } \frac{4 \cdot h_{d\_s}^2}{h_c} > 8 \cdot h_c \\ 8 \cdot h_c & \text{else} \end{cases} & \text{else} \end{cases} = 12.629\,ft$$

<- HORIZONTAL EXTENT OF LEEWARD DRIFT SURCHARGE

$A_{d\_SL} := 0.5 \cdot h_{s\_design} \cdot (l_{drift\_leeward}) = 1435.501\,in^2$

$A_{d\_rows} := n_{rows\_available} \cdot h_{u\_design} \cdot l_{aisle} = 2386.944\,in^2$

$6 \cdot h_{d\_s}^2 - A_{d\_SL} - A_{d\_rows} - A_{d\_SW} = 1895.335\,in^2$ Area of snow assumed to pass by aerodynamic shade region for lack of space available

Leeward drift for wind out of the north

$h_{d\_n} := 31.25\,in$ $h_{u\_design} := h_c$ $A_{d\_NW} := 1098.635\,in^2$

$h_n := 0.707 \cdot h_{d\_n} = 22.094\,in$

$$h_{n\_design} := \begin{cases} h_c & \text{if } h_n > h_c \\ h_n & \text{else} \end{cases} = 18.944\,in$$

$P_{d\_leeward} := h_{n\_design} \cdot \gamma = 28.258\,psf$ <- LEEWARD DRIFT SURCHARGE

$l_{drift\_leeward} := \text{if } 4 \cdot h_{n\_design} > l_{horiz} = 5\ ft$
$\quad l_{horiz}$
$\quad \text{else}$
$\quad\quad 4 \cdot h_{n\_design}$

<- HORIZONTAL EXTENT OF LEEWARD DRIFT SURCHARGE (MULTIPLY BY 2)

$A_{d\_NL} := 0.5 \cdot h_{n\_design} \cdot \left(2 \cdot l_{drift\_leeward}\right) = 1136.64\ in^2$

$A_{d\_rows} := n_{rows\_available} \cdot h_{u\_design} \cdot l_{aisle} = 2386.944\ in^2$

$6 \cdot h_{d\_n}^2 - A_{d\_NL} - A_{d\_rows} - A_{d\_NW} = 1237.156\ in^2$

Area of snow assumed to pass by aerodynamic shade region for lack of space available

Title Block Line 1
You can change this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID:

Printed: 22 NOV 2017, 12:09PM

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

Lic. # : KW-06006621 — **Licensee : MP-Squared Structural Engineers, LLC**

Description : Drift Area 2 (A1)
Trying 14" low-side

DRIFT AREA 2 (A1) CONTROLLING LOAD CASE
Leeward S Drift+Inter-row+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4

Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Varying Uniform Load : S(S,E) = 0.1130->0.0 k/ft, Extent = 25.250 -->> 37.879 ft, Trib Width = 1.0 ft, (Leeward S-drift)
Uniform Load : S = 0.1130 k/ft, Extent = 16.750 -->> 20.250 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1130 k/ft, Extent = 8.250 -->> 11.750 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1130 k/ft, Extent = 0.0 -->> 3.250 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : D = 0.0240 k/ft, Extent = 0.0 -->> 25.250 ft, Tributary Width = 1.0 ft, (Solar Panels)

DESIGN SUMMARY

Maximum Bending =	43.581 k-ft	**Maximum Shear =**	4.50 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	19.400 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	2.984 in	160	
Max Upward Transient Deflection	0.047 in	10154	
Max Downward Total Deflection	4.344 in	110	
Max Upward Total Deflection	0.013 in	37034	

BOTH SHEAR AND MOMENT ARE WITHIN THE 5% THRESHOLD. OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			43.58		43.58					4.50		
D Only													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+L+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+S+H													
Dsgn. L = 40.00 ft	1			43.58		43.58					4.50		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			36.12		36.12					3.73		
+D+W+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			36.12		36.12					3.73		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			13.72		13.72					1.43		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			36.12		36.12					3.73		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			8.23		8.23					0.86		
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.23		8.23					0.86		

General Beam Analysis

Description : Drift Area 2 (A1)
Trying 14" low-side

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.3436	20.000		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	4.500	4.049
Overall MINimum	0.861	0.727
D Only	1.435	1.211
+D+L+H	1.435	1.211
+D+Lr+H	1.435	1.211
+D+S+H	4.500	4.049
+D+0.750Lr+0.750L+H	1.435	1.211
+D+0.750L+0.750S+H	3.734	3.340
+D+W+H	1.435	1.211
+D+0.70E+H	1.435	1.211
+D+0.750Lr+0.750L+0.750W+H	1.435	1.211
+D+0.750L+0.750S+0.750W+H	3.734	3.340
+D+0.750Lr+0.750L+0.5250E+H	1.435	1.211
+D+0.750L+0.750S+0.5250E+H	3.734	3.340
+0.60D+W+H	0.861	0.727
+0.60D+0.70E+H	0.861	0.727
D Only	1.435	1.211
Lr Only		
L Only		
S Only	3.066	2.838
W Only		
E Only		
H Only		

Snow Load Pattern for Elevated, Tilted-Open Solar Panel Array

$h_{p1} := 14\,in$ Low side dimension

THIS SHEET ASSUMES THE LOW SIDE OF THE PANEL(S) FACES SOUTH. SWAP DIRECTIONS IN THE HEADINGS, IF DIFFERENT.

$l_{horiz} := 60\,in$ Length of horizontal projection

$\theta := 20\,deg$ Angle of tilt

$l_p := \left(\frac{l_{horiz}}{\cos(\theta)}\right) = 63.851\,in$ Length of panel

$h_{p2} := h_{p1} + l_p \cdot \sin(\theta) = 35.838\,in$ High side dimension

$l_{aisle} := 42\,in$ Width of aisle between rows

Drift Fetch Distances:

$l_{north} := 131.25\,ft$ Upwind fetch for wind OUT OF THE NORTH

$l_{south} := 21.25\,ft$ Upwind fetch for wind OUT OF THE SOUTH

Balanced Snow Load

Exposure Category: B

$C_e := 1.2$ $I_s := 1.0$

$C_t := 1.0$ $p_g := 30\,psf$

$p_f := 0.7 \cdot C_e \cdot C_t \cdot I_s \cdot p_g = 25.2\,psf$

For Ct, ignore any thermal contribution from a solar panel array. For Ce, the presence of solar panels bumps the roof exposure into a more severe state. For example, an otherwise fully exposed roof would be considered partially exposed with the addition of solar panels.

$C_s := 1.0$ Obstructed & monoslope roof

$p_s := C_s \cdot p_f = 25.2\,psf$

$\gamma := 0.13 \cdot \frac{1}{ft} \cdot p_g + 14\,\frac{lbf}{ft^3} = 17.9\,\frac{lbf}{ft^3}$

$h_b := \frac{p_s}{\gamma} = 16.894\,in$ $h_c := h_{p2} - h_b = 18.944\,in$

$h_{exposed} := h_{p2} - h_b = 18.944\,in$ Amount of panel exposed above balanced snow load depth. If positive, sliding snow surcharge from the solar panels must be considered.

Sliding Snow Load

Consider only if panels are exposed above balanced snow depth.

$w_c := \frac{\left(-l_{horiz}\right) \cdot \left(h_b - h_{p1}\right)}{\left(h_{p2} - h_{p1}\right)} + l_{horiz} = 52.049\,in$ Width of sliding snow surcharge

$w_{c\_panel} := l_{horiz} - w_c = 7.951\,in$ Horizontal projection of panel covered by sliding snow

$w_{aisle} := w_c - w_{c\_panel} = 44.098\,in$ Width of aisle covered by sliding snow

Note:
For a open-back tilted panel, the slding snow can slide under the panel itself. For a closed-back panel, the sliding snow stops at the panel back. 18" of the surcharge is under the adjacent panel.

$p_f + p_s = 50.4\,psf$ Balanced snow load in aisle plus sliding surcharge (use balanced snow load only for portion of aisle not covered by sliding snow)

Drift Load

Check requirements to avoid calculating drift patterns.

check_1a := if $h_{p2} < 1.2 \cdot h_b$ = "DRIFT REQ'D, CHECK LOW-SIDE"
"DRIFT NOT REQ'D, CHECK 2ND CONDITION"
else
"DRIFT REQ'D, CHECK LOW-SIDE"

check_1b := if $h_{p1} < h_b$ = "DRIFT REQ'D"
"DRIFT REQ'D"
else
"CHECK 2ND CONDITION"

check_2 := if $h_{p1} < 2\,ft + 2 \cdot h_b$ = "DRIFT REQ'D"
"DRIFT REQ'D"
else
"DRIFT NOT REQ'D"

Check if closely spaced.

check_close := if $l_{aisle} > 8 \cdot h_c$ = "YES"
"NO"
else
"YES"

Wind out of the south

$l_{u\_south} := l_{south} \cdot \frac{1}{ft} = 21.25$

$h_d := \left(0.43 \cdot l_{u\_south}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10\right)^{\frac{1}{4}} - 1.5\right) ft = 17.943\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^{\,2} = 643.922\,in^2$

$h_{dw} := 0.75 \cdot h_d = 13.457\,in$ Windward drift depth per ASCE7

$h_s := 0.707 \cdot h_{dw} = 9.514\,in$

h_{s_design} := if $h_s > h_c$ = 9.514 in Windward drift for wind blowing at low-side of panel
h_c
else
h_s

$P_{d\_windward} := h_{s\_design} \cdot \gamma = 14.192\,psf$ Drift surcharge for wind blowing at low-side of panel

$l_{drift\_windard}$:= if $4 \cdot h_{s\_design} > l_{horiz}$ = 3.171 ft Horizontal extent for wind blowing at low-side of panel (multiply by 2)
l_{horiz}
else
$4 \cdot h_{s\_design}$

$A_{d\_SW} := 0.5 \cdot h_{s\_design} \cdot \left(2 \cdot l_{drift\_windard}\right) = 362.097\,in^2$ Drift area at low-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 15.331\,in$

$h_{u\_design} := \text{if } h_u > h_c = 15.331\,in$ Depth of inter-row surcharge

h_c

else

h_u

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 22.869\,psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_SW}}{h_{u\_design} \cdot l_{aisle}} = 2.438$ Extent of inter-row surcharge (round up)

ASSUME 3 ROWS ARE FILLED BY INTER-ROW SURCHARGE.
ONLY 2 ROWS ARE AVAILABLE. CALCULATE LEEWARD DRIFT.

Wind out of the north

$l_{u\_north} := l_{north} \cdot \frac{1}{ft} = 131.25$

NEW SNOW DRIFT PATTERN FOR
DRIFT AREA 4 CONTROLLING LOAD CASE

$h_d := \left(0.43 \cdot l_{u\_north}^{\frac{1}{3}} \cdot \left(p_g \cdot \frac{1}{psf} + 10 \right)^{\frac{1}{4}} - 1.5 \right) ft = 47.947\,in$ Leeward drift depth

$A_{d\_expected} := 2 \cdot h_d^2 = 4597.91\,in^2$

$h_{dw} := 0.75 \cdot h_d = 35.961\,in$ windward Windward drift depth per ASCE7

$h_{n\_design} := \text{if } h_{dw} > h_c = 18.944\,in$ Windward drift depth for wind blowing at high-side of panel

h_c

else

h_{dw}

$P_{d\_windward} := h_{n\_design} \cdot \gamma = 28.259\,psf$ Drift surcharge for wind blowing at high-side of panel

$l_{drift\_windard} := \text{if } h_{dw} \le h_c = 12.63\,ft$ Horizontal extent for wind blowing at high-side of panel

$4 \cdot h_{dw}$

else

$\text{if } \frac{4 \cdot h_{dw}^2}{h_c} > 8 \cdot h_c$

$8 \cdot h_c$

else

$\frac{4 \cdot h_{dw}^2}{h_c}$

$A_{d\_NW} := 0.5 \cdot h_{n\_design} \cdot \left(l_{drift\_windard} \right) = 1435.555\,in^2$ Drift area at high-side of panel

$h_u := \frac{A_{d\_expected}}{l_{aisle}} = 109.474\,in$

$h_{u\_design} := \text{if } h_u > h_c = 18.944\,in$ Depth of inter-row surcharge

h_c

else

h_u

$P_{d\_leeward} := h_{u\_design} \cdot \gamma = 28.259\,psf$ Inter-row surcharge

$n_{rows} := \frac{6 \cdot h_d^2 - A_{d\_NW}}{h_{u\_design} \cdot l_{aisle}} = 15.532$ Extent of inter-row surcharge (round up)

ASSUME 16 ROWS ARE FILLED BY INTER-ROW SURCHARGE. ONLY 2 ROWS ARE AVAILABLE. CALCULATE LEEWARD DRIFT.

Drift Area 4 Leeward Drifts

$h_c := 18.944\,in$ $l_{aisle} := 42\,in$ $l_{horiz} := 5\,ft$

$\gamma := 17.9\,\frac{lbf}{ft^3}$ $n_{rows\_available} := 2$

Leeward drift for wind out of the south

$h_{d\_s} := 17.943\,in$ $h_{u\_design} := 15.331\,in$ $A_{d\_SW} := 362.097\,in^2$

$$h_{s\_design} := \begin{cases} h_c & \text{if } h_{d\_s} > h_c \\ h_{d\_s} & \text{else} \end{cases} = 17.943\,in$$

$P_{d\_leeward} := h_{s\_design} \cdot \gamma = 26.765\,psf$ <- LEEWARD DRIFT SURCHARGE

$$l_{drift\_leeward} := \begin{cases} 4 \cdot h_{d\_s} & \text{if } h_{d\_s} \le h_c \\ 8 \cdot h_c & \text{if } \frac{4 \cdot h_{d\_s}^2}{h_c} > 8 \cdot h_c \\ \frac{4 \cdot h_{d\_s}^2}{h_c} & \text{else} \end{cases} = 5.981\,ft$$

<- HORIZONTAL EXTENT OF LEEWARD DRIFT SURCHARGE

$A_{d\_SL} := 0.5 \cdot h_{s\_design} \cdot \left(l_{drift\_leeward}\right) = 643.902\,in^2$

$A_{d\_rows} := n_{rows\_available} \cdot h_{u\_design} \cdot l_{aisle} = 1287.804\,in^2$

$6 \cdot h_{d\_s}^2 - A_{d\_SL} - A_{d\_rows} - A_{d\_SW} = -362.096\,in^2$ Area of snow assumed to pass by aerodynamic shade region for lack of space available

Leeward drift for wind out of the north

$h_{d\_n} := 47.947\,in$ $h_{u\_design} := h_c$ $A_{d\_NW} := 1435.555\,in^2$

$h_n := 0.707 \cdot h_{d\_n} = 33.899\,in$

NEW SNOW DRIFT PATTERN FOR DRIFT AREA 4 CONTROLLING LOAD CASE

$$h_{n\_design} := \begin{cases} h_c & \text{if } h_n > h_c \\ h_n & \text{else} \end{cases} = 18.944\,in$$

$P_{d\_leeward} := h_{n\_design} \cdot \gamma = 28.258\,psf$ <- LEEWARD DRIFT SURCHARGE

$$l_{drift\_leeward} := \text{if } 4 \cdot h_{n\_design} > l_{horiz} = 5\ ft \quad l_{horiz} \quad \text{else} \quad 4 \cdot h_{n\_design}$$

<- HORIZONTAL EXTENT OF LEEWARD DRIFT SURCHARGE (MULTIPLY BY 2)

$$A_{d\_NL} := 0.5 \cdot h_{n\_design} \cdot \left(2 \cdot l_{drift\_leeward}\right) = 1136.64\ in^2$$

$$A_{d\_rows} := n_{rows\_available} \cdot h_{u\_design} \cdot l_{aisle} = 1591.296\ in^2$$

$$6 \cdot h_{d\_n}^2 - A_{d\_NL} - A_{d\_rows} - A_{d\_NW} = 9629.998\ in^2$$

Area of snow assumed to pass by aerodynamic shade region for lack of space available

Title Block Line 1
You can change this area
using the "Settings" menu item
and then using the "Printing &
Title Block" selection.
Title Block Line 6

Project Title:
Engineer:
Project Descr:

Project ID:

Printed: 22 NOV 2017, 12:44PM

General Beam Analysis

File = S:\Projects\2017PR~1\179604~1\01_CAL~1\88_ENE~1\JOISTC~1.EC6
ENERCALC, INC. 1983-2017, Build:10.17.9.25, Ver:10.17.9.25

Lic. # : KW-06006621 — **Licensee : MP-Squared Structural Engineers, LLC**

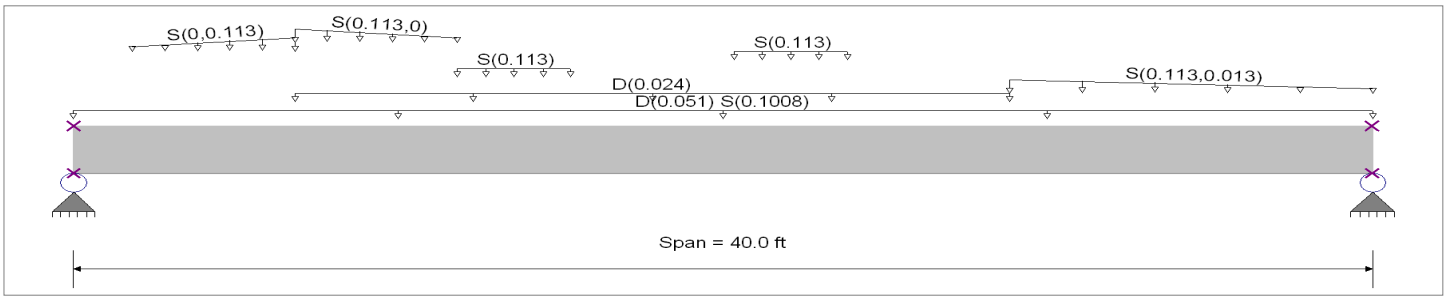
Description : Trying 14" low-side
N Drift+Inter-Row+SL+DL

DRIFT AREA 4 CONTROLLING LOAD CASE
N DRIFT+INTER-ROW+SL+DL

General Beam Properties

Elastic Modulus 29,000.0 ksi

Span #1 — Span Length = 40.0 ft — Area = 10.0 in^2 — Moment of Inertia = 100.0 in^4



Applied Loads

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

Uniform Load : D = 0.0510, S = 0.1008 k/ft, Tributary Width = 1.0 ft, (Uniform DL & SL)
Uniform Load : D = 0.0240 k/ft, Extent = 6.833 -->> 28.833 ft, Tributary Width = 1.0 ft, (P.V. Panels)
Varying Uniform Load : S(S,E) = 0.1130->0.0130 k/ft, Extent = 28.833 -->> 40.0 ft, Trib Width = 1.0 ft, (N-drift)
Uniform Load : S = 0.1130 k/ft, Extent = 11.833 -->> 15.333 ft, Tributary Width = 1.0 ft, (Inter-row)
Uniform Load : S = 0.1130 k/ft, Extent = 20.333 -->> 23.833 ft, Tributary Width = 1.0 ft, (Inter-row)
Varying Uniform Load : S(S,E) = 0.0->0.1130 k/ft, Extent = 1.833 -->> 6.833 ft, Trib Width = 1.0 ft, (LEEWARD N-DRIFT)
Varying Uniform Load : S(S,E) = 0.1130->0.0 k/ft, Extent = 6.833 -->> 11.833 ft, Trib Width = 1.0 ft, (LEEWARD N-drift)

DESIGN SUMMARY

Maximum Bending =	44.781 k-ft	Maximum Shear =	4.360 k
Load Combination	+D+S+H	Load Combination	+D+S+H
Location of maximum on span	20.200 ft	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1

Maximum Deflection

Max Downward Transient Deflection	3.102 in	154
Max Upward Transient Deflection	0.049 in	9698
Max Downward Total Deflection	4.485 in	107
Max Upward Total Deflection	0.013 in	36537

BOTH SHEAR AND MOMENT ARE
WITHIN THE 5% THRESHOLD. OK!

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 40.00 ft	1			44.78		44.78					4.36		
D Only													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+L+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+Lr+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+S+H													
Dsgn. L = 40.00 ft	1			44.78		44.78					4.36		
+D+0.750Lr+0.750L+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+H													
Dsgn. L = 40.00 ft	1			37.08		37.08					3.60		
+D+W+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.70E+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750Lr+0.750L+0.750W+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+0.750W+H													
Dsgn. L = 40.00 ft	1			37.08		37.08					3.60		
+D+0.750Lr+0.750L+0.5250E+H													
Dsgn. L = 40.00 ft	1			13.98		13.98					1.31		
+D+0.750L+0.750S+0.5250E+H													
Dsgn. L = 40.00 ft	1			37.08		37.08					3.60		
+0.60D+W+H													
Dsgn. L = 40.00 ft	1			8.39		8.39					0.79		

General Beam Analysis

Description : Trying 14" low-side
N Drift+Inter-Row+SL+DL

Load Combination / Segment Length	Span #	Max Stress Ratios M	Max Stress Ratios V	Summary of Moment Values Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Summary of Shear Values Va Max	Vnx	Vnx/Omega
+0.60D+0.70E+H													
Dsgn. L = 40.00 ft	1			8.39		8.39					0.79		

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S+H	1	4.4853	20.000		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	4.360	4.300
Overall MINimum	0.788	0.753
D Only	1.313	1.255
+D+L+H	1.313	1.255
+D+Lr+H	1.313	1.255
+D+S+H	4.360	4.300
+D+0.750Lr+0.750L+H	1.313	1.255
+D+0.750L+0.750S+H	3.598	3.539
+D+W+H	1.313	1.255
+D+0.70E+H	1.313	1.255
+D+0.750Lr+0.750L+0.750W+H	1.313	1.255
+D+0.750L+0.750S+0.750W+H	3.598	3.539
+D+0.750Lr+0.750L+0.5250E+H	1.313	1.255
+D+0.750L+0.750S+0.5250E+H	3.598	3.539
+0.60D+W+H	0.788	0.753
+0.60D+0.70E+H	0.788	0.753
D Only	1.313	1.255
Lr Only		
L Only		
S Only	3.047	3.045
W Only		
E Only		
H Only		

GIRDER CHECK

The existing roof was originally designed to support a 30 psf uniform snow load. As a preliminary check to determine whether or not a full stress analysis is warranted, the total uniform load on a fully-loaded girder using the as-designed 30 psf snow load will be compared to that of the now solar-paneled roof using the modern 25.2 psf snow load and the drift effects produced by lowering the low-side of each row to 14" maximum. This method is considered a "rational analysis of loads."

Existing Girder Check

Dead Loads

$DL_{joist} := \frac{10.7\ \frac{lbf}{ft}}{4\ ft} = 2.675\ psf$ $DL_{SI} := 10\ psf$ $DL_{PV} := 6\ psf$

$DL_{total1} := DL_{joist} + DL_{SI} = 12.675\ psf$ w/o P.V. panels

$DL_{total2} := DL_{joist} + DL_{SI} + DL_{PV} = 18.675\ psf$ w/ P.V. panels

Snow Loads

$SL1 := 30\ psf$ w/o P.V. panels (original design load)

$SL2 := 25.2\ psf$ w/ P.V. panels (sheltered)

$SL_{d\_aisle} := 28.259\ psf$

$SL_{sliding} := 25.2\ psf$

Load Ratios for Snow/Drift in P.V. Panel Aisles & Sliding Snow

$L := 40\ ft$ $L_{trib} := 40\ ft$

Aisle Snow/Drift:		Sliding Snow:	
$l_{1A} := 6\ ft$	$R_{1A} := \frac{l_{1A}}{L} = 0.15$	$l_{1B} := 5.75\ ft$	$R_{1B} := \frac{l_{1B}}{L} = 0.144$
$l_{2A} := 14.5\ ft$	$R_{2A} := \frac{l_{2A}}{L} = 0.362$	$l_{2B} := 14.25\ ft$	$R_{2B} := \frac{l_{2B}}{L} = 0.356$
$l_{3A} := 23\ ft$	$R_{3A} := \frac{l_{3A}}{L} = 0.575$	$l_{3B} := 22.75\ ft$	$R_{3B} := \frac{l_{3B}}{L} = 0.569$
$l_{4A} := 31.5\ ft$	$R_{4A} := \frac{l_{4A}}{L} = 0.788$	$l_{4B} := 31.25\ ft$	$R_{4B} := \frac{l_{4B}}{L} = 0.781$
$l_{5A} := 40\ ft$	$R_{5A} := \frac{l_{5A}}{L} = 1$	$l_{5B} := 39.75\ ft$	$R_{5B} := \frac{l_{5B}}{L} = 0.994$
$l_{6A} := 31.5\ ft$	$R_{6A} := \frac{l_{6A}}{L} = 0.788$	$l_{6B} := 31.75\ ft$	$R_{6B} := \frac{l_{6B}}{L} = 0.794$
$l_{7A} := 23\ ft$	$R_{7A} := \frac{l_{7A}}{L} = 0.575$	$l_{7B} := 23.25\ ft$	$R_{7B} := \frac{l_{7B}}{L} = 0.581$
$l_{8A} := 14.5\ ft$	$R_{8A} := \frac{l_{8A}}{L} = 0.362$	$l_{8B} := 14.75\ ft$	$R_{8B} := \frac{l_{8B}}{L} = 0.369$
$l_{9A} := 6\ ft$	$R_{9A} := \frac{l_{9A}}{L} = 0.15$	$l_{9B} := 6.25\ ft$	$R_{9B} := \frac{l_{9B}}{L} = 0.156$

$R_{A\_total} := R_{1A} + R_{2A} + R_{3A} + R_{4A} + R_{5A} + R_{6A} + R_{7A} + R_{8A} + R_{9A} = 4.8$

$R_{B\_total} := R_{1B} + R_{2B} + R_{3B} + R_{4B} + R_{5B} + R_{6B} + R_{7B} + R_{8B} + R_{9B} = 4.7$

$SL_{aisle} := SL2 + SL_{d\_aisle} = 53.459\,psf$

$Line\_Load1 := \left(DL_{total1} + SL1\right) \cdot L_{trib} = 1707\,\frac{lbf}{ft}$

TOTAL UNIFORM LOAD ON A FULLY-LOADED GIRDER THAT IS SUPPORTING THE AS-DESIGNED 30 PSF SNOW LOAD, BUT NOT P.V. PANELS (BARE ROOF).

$LIne\_Load2 := DL_{total2} \cdot L_{trib} + R_{A\_total} \cdot SL_{aisle} \cdot 3.5\,ft = 1635.8\,\frac{lbf}{ft}$

$Line\_Load3 := DL_{total2} \cdot L_{trib} + R_{A\_total} \cdot SL2 \cdot 3.5\,ft + R_{B\_total} \cdot SL_{sliding} \cdot 52.049\,in = 1684.456\,\frac{lbf}{ft}$

TOTAL UNIFORM LOAD ON A FULLY-LOADED GIRDER THAT IS SUPPORTING THE MODERN 25.2 PSF SNOW LOAD, DRIFT EFFECTS PRODUCED BY ROWS OF P.V. PANELS (14" LOW-SIDE), AND P.V. PANEL DEAD WEIGHT.

TOTAL UNIFORM LOAD ON A FULLY-LOADED GIRDER THAT IS SUPPORTING THE MODERN 25.2 PSF SNOW LOAD, SLIDING SNOW EFFECTS PRODUCED BY ROWS OF P.V. PANELS (14" LOW-SIDE), AND P.V. PANEL DEAD WEIGHT.

SINCE THE TOTAL UNIFORM LOAD ON A FULLY-LOADED GIRDER SUPPORTING JUST THE DEAD WEIGHT OF THE ROOF AND THE AS-DESIGNED 30 PSF SNOW LOAD IS GREATER THAN THAT OF THE SAME GIRDER SUPPORTING THE MODERN 25.2 PSF SNOW LOAD, THE DRIFT/SLIDING SNOW EFFECTS PRODUCED BY ROWS OF P.V. PANELS, AND THE DEAD WEIGHT OF A SOLAR-PANELED ROOF, THE GIRDERS ARE OK BY RATIONAL ANALYSIS. NO IN-DEPTH STRESS ANALYSIS IS WARRANTED.

Dane County Solar Array

PROJECT NAME: Dane County Job Center PV Solar Array
PROJECT LOCATION: Madison, Wisconsin
PROJECT NUMBER: 2017010

STRANG

Question & Response Log

#	RFB Questions	Responder	Reply
1	In Page 173, it is mentioned assembled within USA required for modules. Does this mean modules assembled in any other countries cannot be used? In Page 175, it is mentioned cell materials as monocrystalline. Is there an exemption to use higher wattage polycrystalline instead of lower wattage monocrystalline?	STRANG	Provide "Made in USA" per Specifications. Provide monocrystalline per specifications.
2	Does the design have to be exactly 170 kW AC or is it permissible to get to the expected production of 226,049 kWh with a lower system size ?	STRANG	Provide per specifications. Energy production is an estimate based upon modeled software.
3	Regarding the inverters, are only micro inverters allowed? Is it allowed to use a string inverter which is more efficient than the Enphase, both NEC 2014/2017 compliant and CA Rule 21 compliant instead of the mentioned Enphase IQ7Plus?	STRANG	Provide microinverters per Specification.
4	Is it possible to share the structural report?	Dane County	Included with Addendum.
5	Regarding the mounting structures, does it specifically have to be at 20 degrees tilt angle? Is 5 and 10 degrees permissible for mounting structures that will still meet all the characteristics mentioned?	STRANG	Provide 20 degree tilt angle.
6	With respect to the monitoring system, can we use a third party monitoring system instead of using Enphase IQ Envoy System?	STRANG	Provide per specifictions.
7	Is there mandatory requirement of using union labor for this project?	Dane County	No
8	Is there prevailing wages for this project?	Dane County	No
9	In page 177 of the document, (Photovoltaic Collectors, 26 31 00 - 9, 2.8 Mounting Structures) it mentions the required manufacturer of mounting structures as Cooper B-Line ARISTA monolithic solar mounting system. We reached out to the manufacturer, Cooper B-Line and they informed us that the ARISTA monolithic solar mounting system is no longer in production and it was discontinued couple of years ago. Kindly let us know how to proceed as the representatives from Strang instructed us to use 20 degree ARISTA mounting system during the site walk last week.	Strang	Approved equivalent flat roof, ballasted system as manufacutred by: Schletter, Inc. (Windsafe); Krannich/K2 System Triangle/Multiangle 20 degree.

DANE COUNTY
RFB 317031

Department of Public Works,
Highway & Transportation

JOB CENTER PV ARRAY
FEB 8 / 2018
PRE-BID SITE TOUR

Clark Solowicz	Strang Inc	csolowicz@strang-inc.com
Scott Wheaton	Strang, Inc.	swheaton@strang-inc.com
Ryan Bartel	H+H Solar	rbartel@hhelectric.com
Gautam Panikkar	H+H SOLAR	gpanikkar@hhsolarenergy.com
Leigh Weaver MIKE JOYCE	Full Spectrum Solar "	mikej@fullspectrumsolar.com