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Planning documentation for the bearing system
Pitched roof system for solar modules

Project: Next Day Solar-Alessia

Module type: JAM54S-30-410-MR-BF 1722 x 1134 mm

By order

Next Day Solar

32 Hillsdown House
UK-NW3 Hampstead

February 2023

Project planning and auto-calculation

Version 6.1.8435.25847

Plant details

Date	07/02/2023
Customer	Next Day Solar
Order	
Plant	2 R à 3 Mod

Module selection

Manufacturer	JA Solar Holdings Co Ltd
Module	JAM54S-30-410-MR-BF
Peak power	410 W
Height	1,722 mm
Width	1,134 mm
Thickness	30 mm
Framing	Framed

Module arrangement

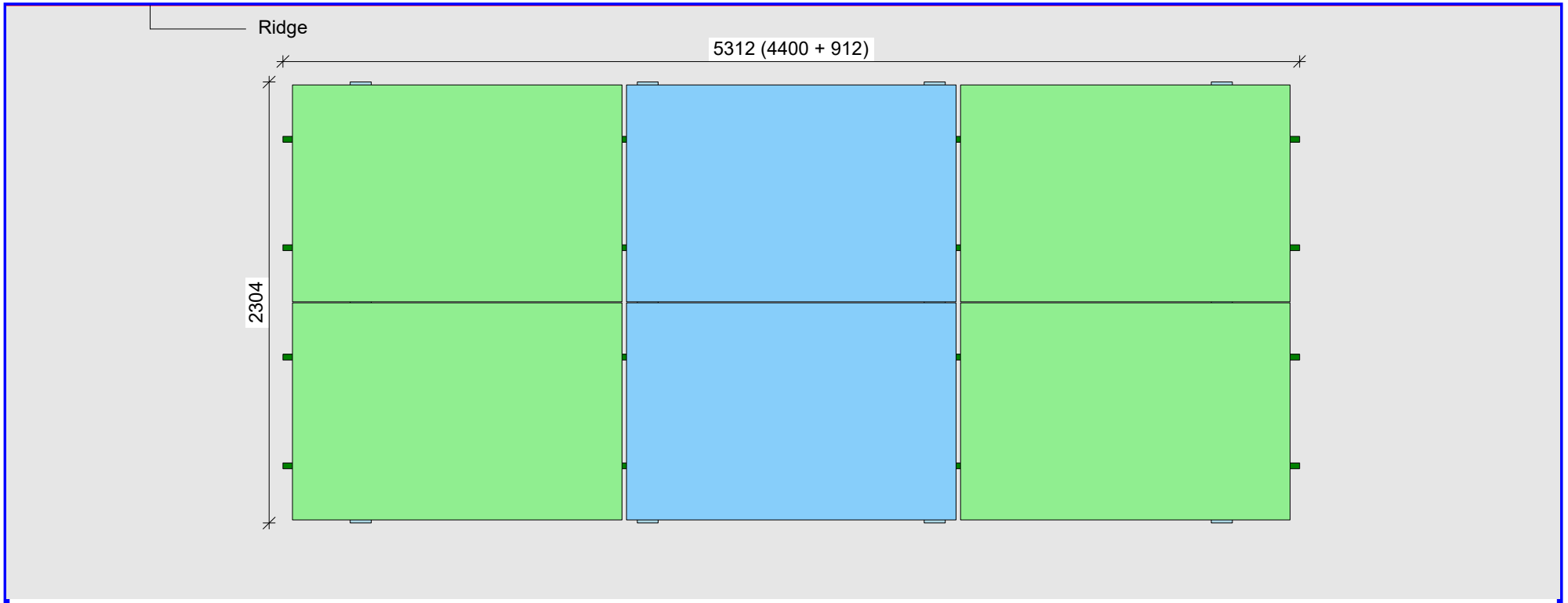
Modules per row	3		
Module rows	2		
Number of modules		Corner zone	0
		Border zone	4
		Center	2
			6
Selected support distance	1,500 mm		
Cantilever	310 mm		
Number of identical module fields	1		

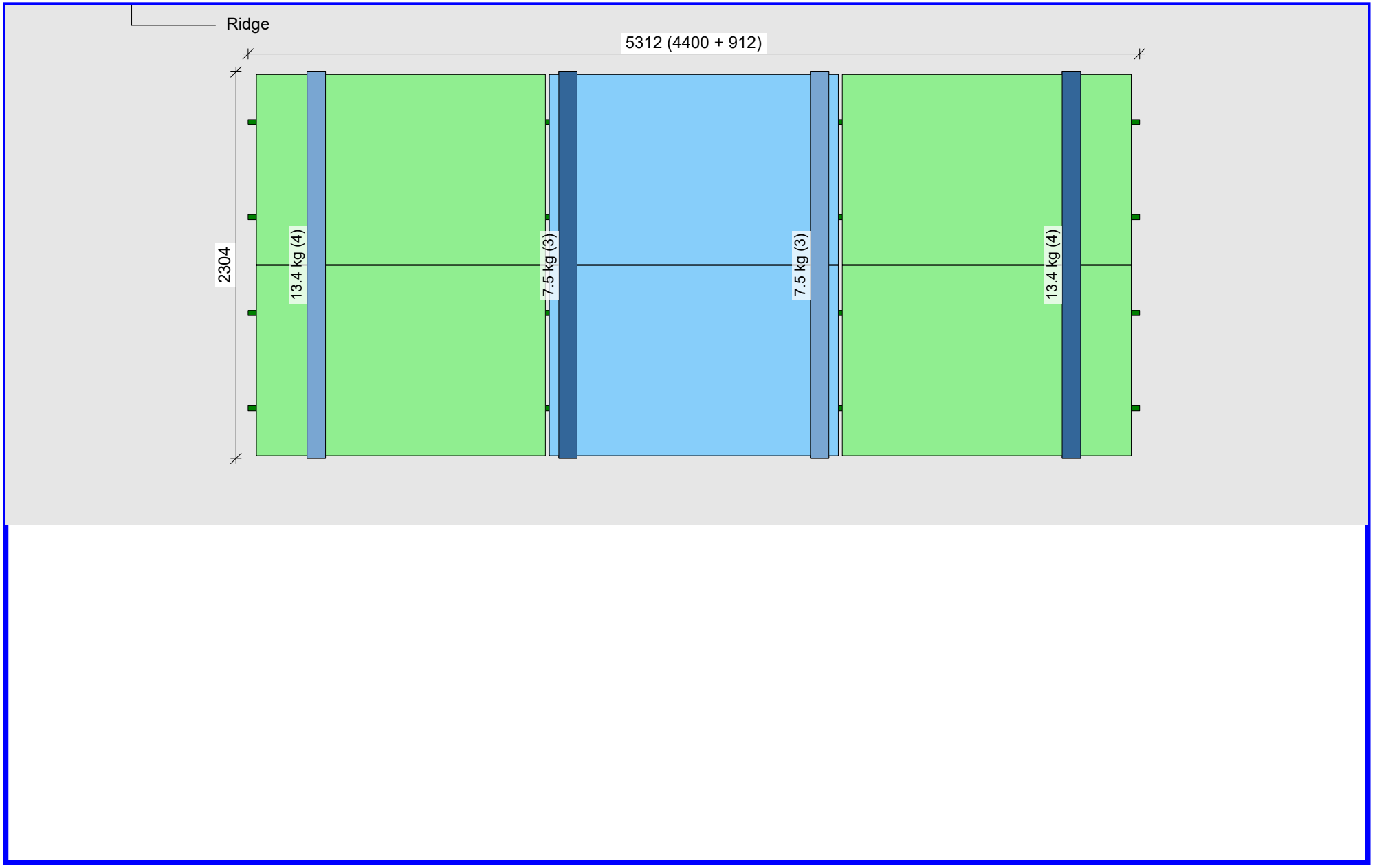
Basic configuration

System selection	
Module-bearing rail	Eco05
Clamp type	Rapid16
Fastening	Superimposed load/ballast

Results: Plant details

Peak power	2.46 kW
Required loading	41.7 kg





Customer Next Day Solar
Project Alessia

Bill of Materials: Pitched Roof System 2H

Pos	Item number	Item	Total amount	Length mm	Unit	Total weight kg
1	120001-04400	Module bearing rail Eco05 4400mm	5		ST	15.135
2	129001-003	Connector E Eco pre-assembled	100 (4)		ST	0.644
3	128039-214	Base rail for Flat Grid 4200mm	4		ST	15.992
4	119026-122	RapidPro L	100 (16)		ST	1.696
5	129010-008	KlickIn click component for nut M8	100 (16)		ST	0.016
6	169004-003	Surface protection mat 300x110x20 AK SK	25 (16)		ST	8.160
7	943308-120	BoltM8x20 hex.sock.serrat.DIN912 A2 GMB	100 (16)		ST	0.208
8	943914-008	NUT SQ DIN557 M8 WS13 A4-70	100 (16)		ST	0.096
9	943922-008	M8 Large Washer DIN9021 A2	100 (16)		ST	0.096
10	131101-001	End clamp Rapid16 V 30 - 40	50 (8)		ST	0.424
11	131121-001	Middle clamp Rapid16 30 - 40	100 (8)		ST	0.400
		Total				42.867

System configurator **Status** 6.1.8435.25847

Preliminary remarks

The following design calculations apply for multi-span mounting systems in midland areas with regular conditions. In coastal areas and exposed locations (with special terrain formation), the consideration of higher wind loads is required.

Customer	Next Day Solar		
Order			
Postal code construction site	**UB7 West Drayton** 51.5000 ° northern latitude 0.4667 ° western longitude		
Tilt angle	α	**1.0**	°
Module length	h	**1.72**	m
Height above sea level	H	**25**	m
Height above ground	z	**8.00**	m
Height of roof parapet	h_p	**0.00**	m
Cantilever module beam	a_{kr}	**0.31**	m
Span of module beam	a	**1.50**	m

Module-bearing rail

Structural system **Cross rail system**

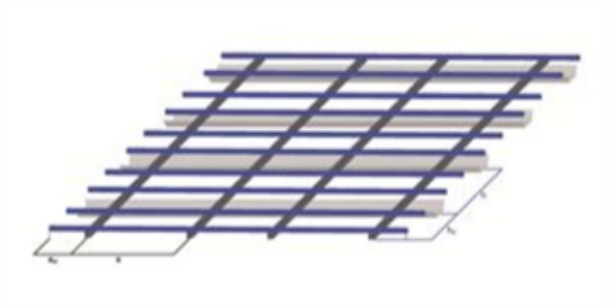
Gable roof (double pitch roof)

Module-bearing rail Eco05

Load assumptions acc. to BS EN 1991-1

Module weight	g	**0.11**	kN/m²
Peak velocity pressure	$q_{(z)}$	**0.47**	kN/m²
Snow load	s	**0.29**	kN/m²
Terrain category		**III**	

Area with regular cover of vegetation or buildings or with isolated obstacles with separations of maximum 20 obstacle heights (villages, suburban terrain, permanent forest)



Terrain category III

Verification of module-bearing rails (allowable spans) Eco05 (120001)

Applicable for Roof mounting Central area

Tilt angle	α	1	°
Module length	h	1.72	m
Height above ground	z	8.00	m
Span	a	1.50	m
Cantilever	a_{kr}	0.31	m

sin = 0.017	cos = 1.000
c_{f1} = 0.20	c_{f2} = -0.33
Peak velocity pressure	0.47 kN/m²
Snow load	0.29 kN/m²
Module weight	0.11 kN/m²

Load overview

Dead load Modules

g_v = 0.11 · 1.00 · 1.000 = 0.11 kN/m²
g_z = 0.11 · 1.000 = 0.11 kN/m²
g_y = 0.11 · 0.017 = 0.00 kN/m²

Snow load

s_v = 0.29 · 1.00 · 1.000 = 0.29 kN/m²
s_z = 0.29 · 1.000 = 0.29 kN/m²
s_y = 0.29 · 0.017 = 0.00 kN/m²

Wind pressure

w_{dz} = 0.47 · 0.20 = 0.09 kN/m²
w_{sz} = 0.47 · -0.33 = -0.16 kN/m²

W_{dz} = 0.09 · 0.57 / 2 = 0.05 kN/m
W_{sz} = -0.16 · 0.57 / 2 = -0.09 kN/m

Profile/rail characteristics

Overall system area A = 2.560 cm²
Section modulus W_y = 1.503 cm³
Section modulus W_z = 1.743 cm³

Partial safety factors and combination coefficients

γ_g = 1.35 γ_g = 0.90 for favourable action
γ_q = 1.50 · 1.00 = 1.50
$\Psi_{0,w}$ = 0.60
$\Psi_{0,s}$ = 0.50

Section forces factors for single and multi-span girders

n	$M_{1,total}$	$M_{1,partial}$	$M_{2,total}$	$M_{2,partial}$	$M_{B,total}$	$M_{B,partial}$	A_{total}	$A_{partial}$	B_{total}	$B_{partial}$	Q_{total}	$Q_{partial}$
1	0.125	0.125	0.000	0.000	0.000	0.000	0.500	0.500	0.000	0.000	0.500	0.500
2	0.070	0.096	0.000	0.000	-0.125	-0.125	0.375	0.438	1.250	1.250	0.625	0.625
3	0.080	0.101	0.025	0.075	-0.100	-0.117	0.400	0.450	1.100	1.200	0.600	0.617
4	0.077	0.100	0.036	0.080	-0.107	-0.121	0.393	0.446	1.143	1.223	0.607	0.621

Internal forces vertical

	Load combination 1				Load combination 2				Load combination 3			
n	$M_{z,span}$	$M_{z,supp}$	$M_{z,cant}$	A	$M_{z,span}$	$M_{z,supp}$	$M_{z,cant}$	A	$M_{z,span}$	$M_{z,supp}$	$M_{z,cant}$	A
1	0.106	0.000	-0.018	0.396	0.080	0.000	-0.013	0.302	-0.021	0.000	0.000	-0.080
2	0.076	-0.106	-0.018	0.704	0.057	-0.080	-0.013	0.536	-0.020	0.021	0.000	-0.143
3	0.081	-0.096	-0.018	0.663	0.061	-0.072	-0.013	0.502	-0.020	0.022	0.000	-0.145
4	0.080	-0.100	-0.018	0.678	0.060	-0.075	-0.013	0.514	-0.020	0.022	0.000	-0.146

Internal forces horizontal

	Load combination 1				Load combination 2				Load combination 3			
n	$M_{y,span}$	$M_{y,supp}$	$M_{y,cant}$	A	$M_{y,span}$	$M_{y,supp}$	$M_{y,cant}$	A	$M_{y,span}$	$M_{y,supp}$	$M_{y,cant}$	A
1	0.002	0.000	0.000	0.006	0.001	0.000	0.000	0.004	0.000	0.000	0.000	0.001
2	0.001	-0.002	0.000	0.011	0.001	-0.001	0.000	0.007	0.000	0.000	0.000	0.002
3	0.001	-0.001	0.000	0.010	0.001	-0.001	0.000	0.006	0.000	0.000	0.000	0.002
4	0.001	-0.002	0.000	0.010	0.001	-0.001	0.000	0.006	0.000	0.000	0.000	0.002

Summary

	Midspan stresses				Stresses moments at support			
n	LC1	LC2	LC3	**Max**	LC1	LC2	LC3	**Max**
1	7.114	5.407	-1.407	**7.114**	0.000	0.000	0.000	**0.000**
2	5.131	3.820	-1.302	**5.131**	-7.114	-5.407	1.407	**7.114**
3	5.479	4.100	-1.316	**5.479**	-6.441	-4.843	1.462	**6.441**
4	5.397	4.031	-1.322	**5.397**	-6.707	-5.055	1.481	**6.707**
Stresses cantilever moment					1.184	0.900	0.034	**1.184**

Utilization ratio

$f_{y,d}$ = 18.2 kN/cm²

Single-span girder	η =	39.1%
Double-span girder	η =	39.1%
3-span girder	η =	35.4%
Multi-span girder	η =	36.9%
Cantilever	η =	6.5%

Verification of module-bearing rails (allowable spans) Eco05 (120001)

Applicable for Roof mounting Border zone

Tilt angle	α	1	°
Module length	h	1.72	m
Height above ground	z	8.00	m
Span	a	1.50	m
Cantilever	a_{kr}	0.31	m

sin = 0.017	cos = 1.000
c_{f1} = 0.46	c_{f2} = -0.45
Peak velocity pressure	0.47 kN/m²
Snow load	0.29 kN/m²
Module weight	0.11 kN/m²

Load overview

Dead load Modules

g_v = 0.11 · 1.00 · 1.000 = 0.11 kN/m²
g_z = 0.11 · 1.000 = 0.11 kN/m²
g_y = 0.11 · 0.017 = 0.00 kN/m²

Snow load

s_v = 0.29 · 1.00 · 1.000 = 0.29 kN/m²
s_z = 0.29 · 1.000 = 0.29 kN/m²
s_y = 0.29 · 0.017 = 0.00 kN/m²

Wind pressure

w_{dz} = 0.47 · 0.46 = 0.22 kN/m²
w_{sz} = 0.47 · -0.45 = -0.21 kN/m²

W_{dz} = 0.22 · 0.57 / 2 = 0.12 kN/m
W_{sz} = -0.21 · 0.57 / 2 = -0.12 kN/m

Profile/rail characteristics

Overall system area A = 2.560 cm²
Section modulus W_y = 1.503 cm³
Section modulus W_z = 1.743 cm³

Partial safety factors and combination coefficients

γ_g = 1.35 γ_g = 0.90 for favourable action
γ_q = 1.50 · 1.00 = 1.50
$\Psi_{0,w}$ = 0.60
$\Psi_{0,s}$ = 0.50

Section forces factors for single and multi-span girders

n	$M_{1,total}$	$M_{1,partial}$	$M_{2,total}$	$M_{2,partial}$	$M_{B,total}$	$M_{B,partial}$	A_{total}	$A_{partial}$	B_{total}	$B_{partial}$	Q_{total}	$Q_{partial}$
1	0.125	0.125	0.000	0.000	0.000	0.000	0.500	0.500	0.000	0.000	0.500	0.500
2	0.070	0.096	0.000	0.000	-0.125	-0.125	0.375	0.438	1.250	1.250	0.625	0.625
3	0.080	0.101	0.025	0.075	-0.100	-0.117	0.400	0.450	1.100	1.200	0.600	0.617
4	0.077	0.100	0.036	0.080	-0.107	-0.121	0.393	0.446	1.143	1.223	0.607	0.621

Internal forces vertical

	Load combination 1				Load combination 2				Load combination 3			
n	$M_{z,span}$	$M_{z,supp}$	$M_{z,cant}$	A	$M_{z,span}$	$M_{z,supp}$	$M_{z,cant}$	A	$M_{z,span}$	$M_{z,supp}$	$M_{z,cant}$	A
1	0.123	0.000	-0.020	0.462	0.110	0.000	-0.018	0.412	-0.035	0.000	0.002	-0.131
2	0.090	-0.123	-0.020	0.821	0.079	-0.110	-0.018	0.731	-0.030	0.035	0.002	-0.233
3	0.096	-0.112	-0.020	0.775	0.085	-0.099	-0.018	0.689	-0.031	0.035	0.002	-0.232
4	0.094	-0.117	-0.020	0.793	0.083	-0.104	-0.018	0.705	-0.031	0.036	0.002	-0.234

Internal forces horizontal

	Load combination 1				Load combination 2				Load combination 3			
n	$M_{y,span}$	$M_{y,supp}$	$M_{y,cant}$	A	$M_{y,span}$	$M_{y,supp}$	$M_{y,cant}$	A	$M_{y,span}$	$M_{y,supp}$	$M_{y,cant}$	A
1	0.002	0.000	0.000	0.006	0.001	0.000	0.000	0.004	0.000	0.000	0.000	0.001
2	0.001	-0.002	0.000	0.011	0.001	-0.001	0.000	0.007	0.000	0.000	0.000	0.002
3	0.001	-0.001	0.000	0.010	0.001	-0.001	0.000	0.006	0.000	0.000	0.000	0.002
4	0.001	-0.002	0.000	0.010	0.001	-0.001	0.000	0.006	0.000	0.000	0.000	0.002

Summary

	Midspan stresses				Stresses moments at support			
n	LC1	LC2	LC3	**Max**	LC1	LC2	LC3	**Max**
1	8.284	7.356	-2.307	**8.284**	0.000	0.000	0.000	**0.000**
2	6.029	5.317	-1.993	**6.029**	-8.284	-7.356	2.307	**8.284**
3	6.424	5.675	-2.043	**6.424**	-7.536	-6.668	2.304	**7.536**
4	6.333	5.590	-2.042	**6.333**	-7.839	-6.941	2.352	**7.839**
Stresses cantilever moment					1.379	1.225	0.108	**1.379**

Utilization ratio

$f_{y,d}$ = 18.2 kN/cm²

Single-span girder	η =	45.6%
Double-span girder	η =	45.6%
3-span girder	η =	41.4%
Multi-span girder	η =	43.1%
Cantilever	η =	7.6%

Verification of module-bearing rails (allowable spans) Eco05 (120001)

Applicable for Roof mounting Corner zone

Tilt angle	α	1	°
Module length	h	1.72	m
Height above ground	z	8.00	m
Span	a	1.50	m
Cantilever	a_{kr}	0.31	m

sin = 0.017	cos = 1.000
c_{f1} = 0.91	c_{f2} = -0.63
Peak velocity pressure	0.47 kN/m²
Snow load	0.29 kN/m²
Module weight	0.11 kN/m²

Load overview

Dead load Modules

g_v = 0.11 · 1.00 · 1.000 = 0.11 kN/m²
g_z = 0.11 · 1.000 = 0.11 kN/m²
g_y = 0.11 · 0.017 = 0.00 kN/m²

Snow load

s_v = 0.29 · 1.00 · 1.000 = 0.29 kN/m²
s_z = 0.29 · 1.000 = 0.29 kN/m²
s_y = 0.29 · 0.017 = 0.00 kN/m²

Wind pressure

w_{dz} = 0.47 · 0.91 = 0.43 kN/m²
w_{sz} = 0.47 · -0.63 = -0.30 kN/m²

W_{dz} = 0.43 · 0.57 / 2 = 0.24 kN/m
W_{sz} = -0.30 · 0.57 / 2 = -0.17 kN/m

Profile/rail characteristics

Overall system area A = 2.560 cm²
Section modulus W_y = 1.503 cm³
Section modulus W_z = 1.743 cm³

Partial safety factors and combination coefficients

γ_g = 1.35 γ_g = 0.90 for favourable action
γ_q = 1.50 · 1.00 = 1.50
$\Psi_{0,w}$ = 0.60
$\Psi_{0,s}$ = 0.50

Section forces factors for single and multi-span girders

n	$M_{1,total}$	$M_{1,partial}$	$M_{2,total}$	$M_{2,partial}$	$M_{B,total}$	$M_{B,partial}$	A_{total}	$A_{partial}$	B_{total}	$B_{partial}$	Q_{total}	$Q_{partial}$
1	0.125	0.125	0.000	0.000	0.000	0.000	0.500	0.500	0.000	0.000	0.500	0.500
2	0.070	0.096	0.000	0.000	-0.125	-0.125	0.375	0.438	1.250	1.250	0.625	0.625
3	0.080	0.101	0.025	0.075	-0.100	-0.117	0.400	0.450	1.100	1.200	0.600	0.617
4	0.077	0.100	0.036	0.080	-0.107	-0.121	0.393	0.446	1.143	1.223	0.607	0.621

Internal forces vertical

	Load combination 1				Load combination 2				Load combination 3			
n	$M_{z,span}$	$M_{z,supp}$	$M_{z,cant}$	A	$M_{z,span}$	$M_{z,supp}$	$M_{z,cant}$	A	$M_{z,span}$	$M_{z,supp}$	$M_{z,cant}$	A
1	0.154	0.000	-0.026	0.577	0.160	0.000	-0.027	0.602	-0.055	0.000	0.003	-0.207
2	0.113	-0.154	-0.026	1.024	0.118	-0.160	-0.027	1.069	-0.046	0.055	0.003	-0.368
3	0.120	-0.140	-0.026	0.970	0.126	-0.147	-0.027	1.014	-0.047	0.054	0.003	-0.362
4	0.118	-0.146	-0.026	0.991	0.124	-0.153	-0.027	1.036	-0.047	0.055	0.003	-0.367

Internal forces horizontal

	Load combination 1				Load combination 2				Load combination 3			
n	$M_{y,span}$	$M_{y,supp}$	$M_{y,cant}$	A	$M_{y,span}$	$M_{y,supp}$	$M_{y,cant}$	A	$M_{y,span}$	$M_{y,supp}$	$M_{y,cant}$	A
1	0.002	0.000	0.000	0.006	0.001	0.000	0.000	0.004	0.000	0.000	0.000	0.001
2	0.001	-0.002	0.000	0.011	0.001	-0.001	0.000	0.007	0.000	0.000	0.000	0.002
3	0.001	-0.001	0.000	0.010	0.001	-0.001	0.000	0.006	0.000	0.000	0.000	0.002
4	0.001	-0.002	0.000	0.010	0.001	-0.001	0.000	0.006	0.000	0.000	0.000	0.002

Summary

	Midspan stresses				Stresses moments at support			
n	LC1	LC2	LC3	**Max**	LC1	LC2	LC3	**Max**
1	10.308	10.730	-3.656	**10.730**	0.000	0.000	0.000	**0.000**
2	7.584	7.907	-3.030	**7.907**	-10.308	-10.730	3.656	**10.730**
3	8.060	8.401	-3.133	**8.401**	-9.431	-9.825	3.567	**9.825**
4	7.952	8.289	-3.121	**8.289**	-9.799	-10.207	3.658	**10.207**
Stresses cantilever moment					1.716	1.786	0.221	**1.786**

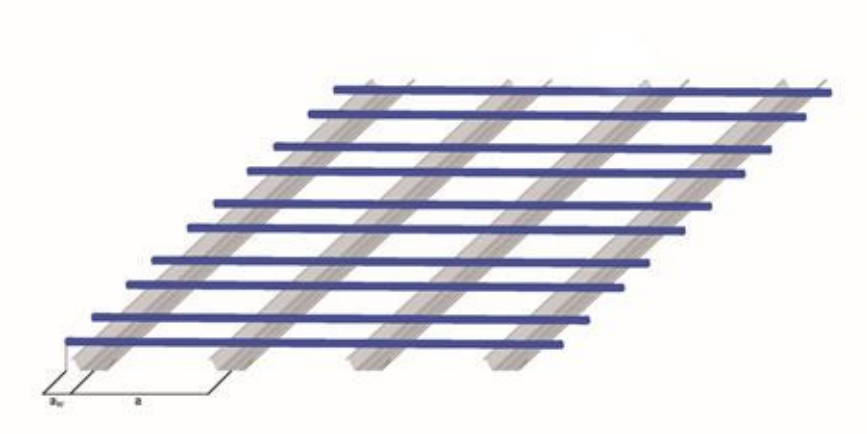
Utilization ratio

$f_{y,d}$ = 18.2 kN/cm²

Single-span girder	η =	59.0%
Double-span girder	η =	59.0%
3-span girder	η =	54.0%
Multi-span girder	η =	56.1%
Cantilever	η =	9.8%

Verification Superimposed load with FlatGrid - Standard

	kN/m	kg/m²	kg/m
Interior zone H	0.00	0.00	0.00
Border zone G	-0.07	5.48	8.21
Corner zone F	-0.19	14.11	21.17



Effective load influence zone related to the modular size of the substructure

1.50 m x 1.00 m = 1.50 m²

Equivalent substitute loads:

	m_{req} kg/m	q_k kN/m²	q_d kN/m²
Center	0	0.11	0.15
Border	8	0.16	0.22
Corner	21	0.25	0.34

Verification of connections

Tilt angle	α	1	°
Snow load	s	0.29	kN/m²
Height above ground	z	8.00	m
Module length	h	1.72	
Module weight	g	0.11	kN/m²

sin = 0.017	cos = 1.000	
Peak velocity pressure	0.47 kN/m²	
Zone F	$c_{p,1}$ = -0.63	
Zone G	$c_{p,1}$ = -0.45	Pressure coefficients $c_{pe,1}$
Zone H	$c_{p,1}$ = -0.33	

Load overview

Dead load Modules

g_v = 0.11 · 1.00 · 1.000 = 0.11 kN/m²
g_z = 0.11 · 1.000 = 0.11 kN/m²
g_y = 0.11 · 0.017 = 0.00 kN/m²

Snow load

s_v = 0.29 · 1.00 · 1.000 = 0.29 kN/m²
s_z = 0.29 · 1.000 = 0.29 kN/m²
s_y = 0.29 · 0.017 = 0.00 kN/m²

Wind suction

w_{dz} = 0.47 · 0.20 = 0.09 kN/m²
w_{sz} = 0.47 · $c_{p,1}$

Module clamps according to general technical approval Z-14.4-631

Middle clamps		End clamps	
$F_{R,d}$ kN	$V_{R,d}$ kN	$F_{R,d}$ kN	$V_{R,d}$ kN
4.65	0.67	1.63	0.45

Module surface A = 1.95 m²
Frictional connection A = 0.17 kN ($F_{S,d} \cdot \mu$))

Internal forces at module clamps

Middle clamp $|F_{S,d}| = 0.50 \cdot (0.9 \cdot g_v + 1.5 \cdot 0.47 \cdot c_p) \cdot 1.95$
End clamp $|F_{S,d}| = 0.25 \cdot (0.9 \cdot g_v + 1.5 \cdot 0.47 \cdot c_p) \cdot 1.95$

	$V_{S,d}$ kN	$F_{S,d}$ kN		
		Zone F	Zone G	Zone H
Middle clamps	-0.16	0.34	0.21	0.13
End clamps	-0.08	0.17	0.11	0.07

$V_{S,d} = V_{S,dy} - F_{S,dz} \cdot \mu$ (μ = 0.50)

Utilization ratio 4.6%
Utilization ratio 6.5%