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Planning documentation for the bearing system AluGrid for solar modules

Project: 05-UK-WC1 St Giles Circus - AluGrid-10° - ORMS_Zone 2

Type of module: Sunpower 1560 x 1046 mm

By order of

ORMS

UK-EC1Y London

April 2015

summary

Preliminary remarks

The following design calculations apply for multi-span mounting systems in midland areas with regular conditions. In coastal areas and exposed locations (camber and sag), additional expert examinations concerning the higher assumable wind loads are required.

Customer	ORMS
project	St Giles Circus

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construction site

ZIP-location	WC1 Holborn
Country	Großbritannien
Geographic coordinates	51.5167° North
	0.1167° West
height above sea level	39 m

solar module

height / width / thickness	1560 / 1046 / 46 mm
maximum power at STC	327 Wp

building

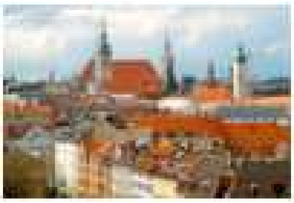
length in east-west direction	28 m
length in north-south direction	9 m
total roof height	17 m
height of parapet	25 cm

Load assumptions acc. to BS EN 1991-1

module weight g	0.15 kN/m²

Wind load

Standard	BS EN 1991-1-4:2004
wind zone	21.4 m/s
Terrain formation	Flat/Plane
terrain category	IV
	I V
peak velocity pressure $q_{(z)}$	0.47 kN/m²

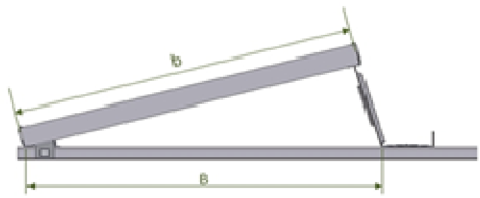


snow load

Standard	BS EN 1991-1-3:2003/NA
snow zone	3
ground snow load s_k	0.4 kN/m²
shape factor μ_1	0.8
snow load s	0.31 kN/m²

configuration

System selection	AluGrid
inclination angle	10°
roof inclination	0°
module orientation	horizontal
number of modules	30



shadowing distance

S = 1.76 m — S_0 = 1.76 m shadowing distance according to Erfurt und Bahner

Required loading kg — friction factor 0.51

	sliding verification	uplift safety
zone a	32.1	32.3
zone b	24.8	14.7
zone c	15.4	0.0
zone d	10.8	0.0

equivalent substitute loads

	q_k kN/m²	q_d kN/m²
zone a	0.21	0.29
zone b	0.18	0.25
zone c	0.15	0.20
zone d	0.13	0.18

includes the following loads:

- module weight
- weight of mounting rack
- weight of the ballast

verification of position permanence for loaded installations on flat roofs

module inclination	α	10	°
roof inclination		0	°
snow load	s	0.31	kN/m²
total roof height	z	17.00	m
module height	h	1.56	m
module width	b	1.05	m
module weight	g	0.15	kN/m²

sin = 0.174	cos = 0.985
peak velocity pressure 0.47 kN/m²	

load assembly per m² module area

dead load

$g = 0.15 \cdot 1.00 \cdot 1.00 = 0.15$ kN/m²

snow load

$s = 0.31 \cdot 1.00 \cdot 0.985 = 0.30$ kN/m²

Safetyfactors an Combinationfactors

$\gamma_g = 1.35$ $\gamma_g = 0.90$ for favourable load action

$\gamma_q = 1.50$

$\Psi_{0,w} = 0.50$

$\Psi_{0,s} = 0.50$

load combinations

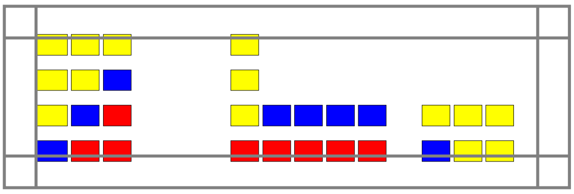
LC 1: $\gamma_g \cdot g + \gamma_q \cdot s + \Psi_{0,w} \cdot \gamma_q \cdot W_{1,j}$

LC 2: $\gamma_g \cdot g + \Psi_{0,s} \cdot \gamma_q \cdot s + \gamma_q \cdot W_{1,j}$

LC 3: $0.9 \cdot g + \gamma_q \cdot W_{2,j}$ uplifting

distribution in various roof areas

Due to the low module tilt of 10° and due to the closed structure of the aluminum tray, the ballasting is calculated following the rules for flat roofs. The ballasting depends on where it is to be located on the roof.

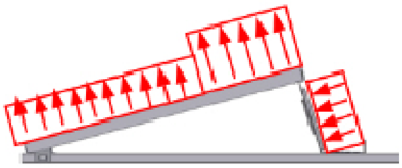


Required loading

zone a	(yellow)	32.3 kg/Module
zone b	(blue)	24.8 kg/Module
zone c	(red)	15.4 kg/Module
zone d	(grey)	10.8 kg/Module

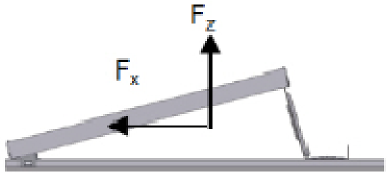
pressure coefficients

north wind



south wind

instead: uplifting and sliding



Total tensile force related to one module $F_z = \sum q_p \cdot (c_{p,res,i} \cdot A_i \cdot \cos \alpha_i)$

Total shear force related to one module $F_x = \sum q_p \cdot (c_{p,res,i} \cdot A_i \cdot \sin \alpha_i)$

pressure coefficients for the determination of the uplifting loads Module area = 1.63 m²

The self-weight of the construction is g = 25.69 kg basic width B = 1.03 m height H = 0.2 m

	uplifting load				horizontal shear force			
	$c_{p,vi}$	**$c_{p,vs}$**	**F_z kN**	**req g/Module**	**$c_{p,hi}$**	**$c_{p,hs}$**	**F_x kN**	**req g/Module**
zone a	-0.57	-0.44	-0.33	32.3 kg	1.25	0.95	0.13	32.1 kg
zone b	-0.57	-0.30	-0.23	14.7 kg	1.25	0.73	0.10	24.8 kg
zone c	-0.40	-0.17	-0.13	0.0 kg	0.91	0.45	0.06	15.4 kg
zone d	-0.30	-0.09	-0.07	0.0 kg	0.67	0.32	0.04	10.8 kg

A corner block / curbstone of the size 100 x 25 x 6 cm weighs 36 kg

shadowing distance S = 1.76 m S_0 = 1.76 m shadowing distance according to Erfurt und Bahner

equivalent substitute loads

	q_k kN/m²	q_d kN/m²
zone a north	0.21	0.29
zone b north	0.18	0.25
zone c north	0.15	0.20
zone d north	0.13	0.18
Maxima	**0.21**	**0.29**

q_k characteristic equivalent load

q_d design value of the equivalent load

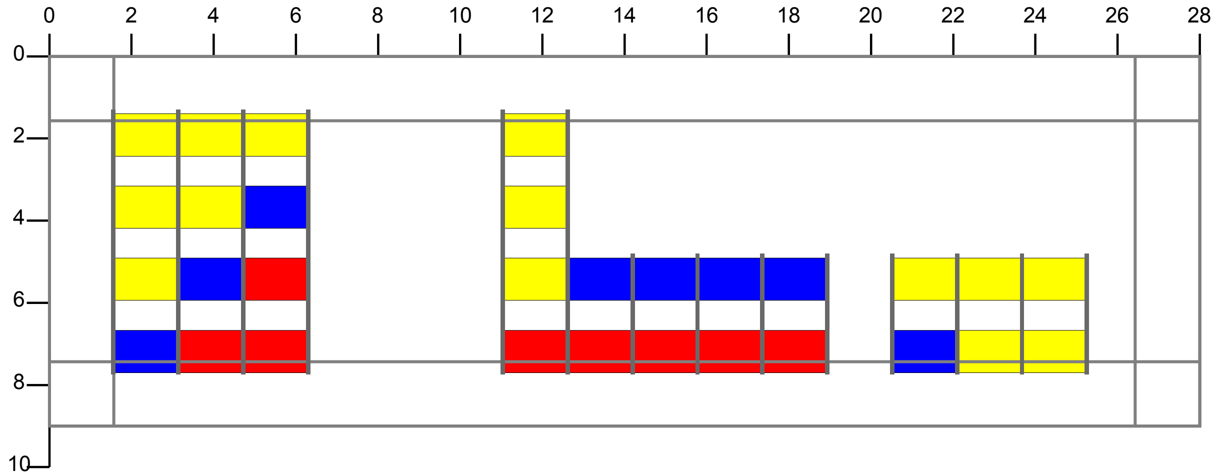
The global horizontal forces for the building are calculated with friction coefficients, multiplied by the roof area in main and transversal direction. An additional reduction may be made in case of larger building widths.

$F_x = c_{fx} \cdot A_{roof} \cdot q_b \cdot F_G = 0.024 \cdot 252 \cdot 0.47 \cdot 1.0 = 2.8$ kN

$F_y = c_{fy} \cdot A_{Dach} \cdot q_b \cdot F_G = 0.013 \cdot 252 \cdot 0.47 \cdot 1.0 = 1.5$ kN

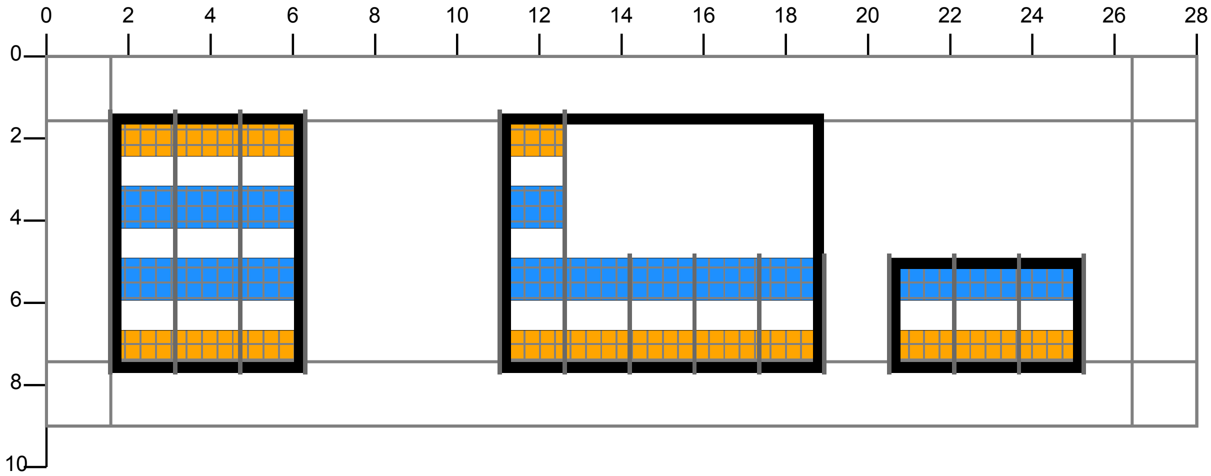
with: $c_{fx} = 0.024$ $c_{fy} = 0.013$ $F_G = 1.0$

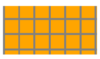
Schematic roof layout plan



border zones:	west side	a = 1.57 m	
	east side	a = 1.57 m	
	north side	a = 1.40 m	(empfohlen: 1.57 m)
	south side	a = 1.57 m	

Schematical view of thermal division





Please note:
With the marked modules, the distance to the roof edge is shorter than the required minimum distance. Thus, the superimposed load (ballast load) specified for these modules must be increased by 50%.