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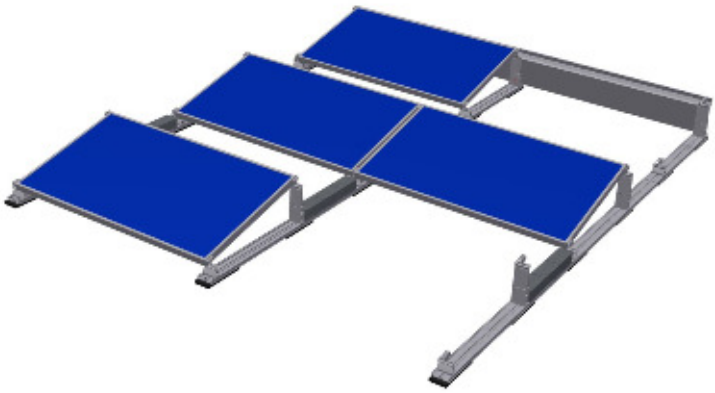
Planning documentation for the bearing system FixGrid18 13° for solar modules

Project: Sandycombe Road South Block

Module type: N Peak 1675 x 997 mm



By order

SKCG

February 2021

System dimensioning

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	SKCG
Project	Sandycombe Road South Block

Construction site

Postal code - Town/City	TW9 Richmond
Country	United Kingdom
Geographic coordinates	51.4500° North
	0.2833° West
Height above sea level	10 m

Solar module

Height / Width / Thickness	1,675 / 997 / 30 mm
Module peak power	330 Wp
Weight	18.0 kg

Building

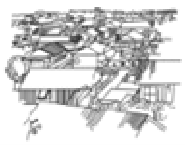
Length in east-west direction	5 m
Length in north-south direction	21 m
Height above ground	12 m
Roof parapet height	30 cm
Roof pitch	0°

Load assumptions acc. to BS EN 1991-1

Module weight	0.108 kN/m²

Wind load

Standard	BS EN 1991-1-4:2004
Wind zone	21,4 m/s
Terrain formation	Flat/plane
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)
Peak velocity pressure $q_{(z)}$	0.47 kN/m²



Snow load

Standard	BS EN 1991-1-3:2003/NA
Snow load zone	3
Ground snow load s_k	0.30 kN/m²
Shape factor μ_1	0.8
Snow load s	0.24 kN/m²

Load return period 25 years (Snow: 0.928 | Wind: 0.939)

Customer SKCG
Project Sandycombe Road South Block

Bill of Materials FixGrid18 13°

Pos	Item number	Item	Total amount	Length mm	Unit	Total weight kg
1	131101-001	End clamp Rapid16 V 30 - 40	50 (24)		ST	1.272
2	131121-001	Middle clamp Rapid16 30 - 40	100 (10)		ST	0.500
3	128039-214	Base rail for FlatGrid 4200mm	7		ST	27.986
4	129078-000	Interior connector FlatGrid kit	25 (5)		ST	1.240
5	169004-003	Surface protect.mat 300x110x20mm SK cut	50 (34)		ST	14.960
6	163900-002	FixZ-15 lower system rail 18-96mm w.conn	25 (17)		ST	2.193
7	163900-001	FixZ -15 upp. syst.rail18 - 96mm w.conn.	25 (17)		ST	6.103
8	169020-170	FixGrid ballast tray18 up to 1700 mm Mod	5		ST	8.090
9	I400105GB	ID plate Solar Mounting Systems	1		st	0.100
10	169019-170	FixZ-15 Windsafe 18 up to 1700mm Modul	11		ST	16.863
11	943000-360	Drill screw 6.0x25 self-tapping seal A2	100 (34)		ST	0.238
		Total				79.545

Verification of position permanence for ballast installations on flat roofs

Module tilt	α	13.61	°
Roof pitch		0	°
Height above ground	z	12	m
Module length	h	1,675	m
Module width	b	997	m
Module weight	g	0.108	kN/m²

Peak velocity pressure	0.47 kN/m²
Snow load	0.24 kN/m²
sin	0.235
cos	0.972

Load chart per m² of module area

Dead load

g = 0.11 · 1.00 · 1.00 = 0.11 kN/m²

Snow load

s = 0.24 · 1.00 · 0.972 = 0.24 kN/m²

Partial safety factors and combination coefficients

Importance/reliability factor

Wind: K_{FI} = 1.00

Snow: K_{FI} = 1.00

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

Load combinations

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

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

LC 3: $0.9 \cdot g + \gamma_q \cdot w$ (uplifting)

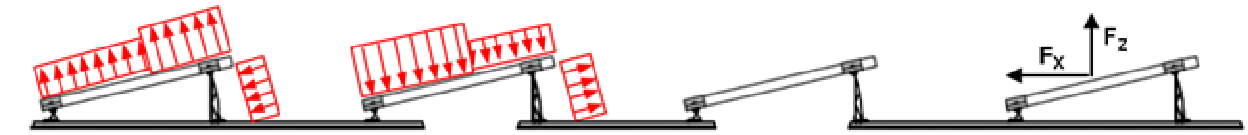
Distribution in various roof areas

Due to the low module tilt of 13.61° and due to the closed structure of the aluminium tray, the ballasting is calculated following the rules for flat roofs. The ballasting depends on where it is to be located on the roof.

The subdivision of the roof area is based on the expert statement by Prof. Ruscheweyh: The required ballasting at the south front corresponds to zone d. The colours display the different intensities of the wind loads.

Pressure coefficients

North wind | South wind | Alternative: Uplifting and sliding



Front side | Center | Rear side (uplift)

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

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

The self-weight of the construction is G = 24.47 kg

Base width B = 0.97 m

Height H = 0.36 m

	Uplifting loads				Horizontal thrust				Downhill-slope force	Σ
	$c_{p,vi}$	$c_{p,vs}$	F_z	req g	$c_{p,hi}$	$c_{p,hs}$	F_x	req g	req g	req g
Zone a	-0.32	-0.23	-0.231 kN	8.8 kg	0.25	0.27	0.209 kN	43.3 kg	0.0 kg	43.3 kg
Zone b	-0.30	-0.20	-0.212 kN	6.1 kg	0.23	0.20	0.157 kN	29.8 kg	0.0 kg	29.8 kg
Zone c	-0.25	-0.17	-0.182 kN	1.8 kg	0.20	0.19	0.146 kN	27.0 kg	0.0 kg	27.0 kg
Zone d	-0.22	-0.13	-0.152 kN	0.0 kg	0.17	0.13	0.104 kN	16.1 kg	0.0 kg	16.1 kg

Loading with paving stones (20 x 10 x 8 cm, 3.5 kg)

Row distance S = 1.84 m

		Weight	
Mounting rack		79.5 kg	
Modules	(11)	198.0 kg	Total module area: 18.4 m²
Ballast stones	(162)	567.0 kg	20 x 10 x 8 cm, 3.5 kg
		844.5 kg	

Equivalent substitute loads, Pressure on insulation

Zone		q_k	q_d	σ
a		0.22 kN/m²	0.30 kN/m²	16.26 kN/m²
b		0.18 kN/m²	0.24 kN/m²	14.22 kN/m²
c		0.17 kN/m²	0.23 kN/m²	13.80 kN/m²
d		0.13 kN/m²	0.18 kN/m²	12.14 kN/m²
Maximum		0.22 kN/m²	0.30 kN/m²	

q_k Characteristic equivalent load

q_d Load chart per m² of roof area

σ Pressure on insulation (Dead weight + snow)

Protection of the building surface: Under each support

Building

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.

$F_x = c_{fx} \cdot A_{PV} \cdot q_p \cdot F_G = 0.026 \cdot 34 \cdot 0.47 \cdot 1.0 = 0.41$ kN -> $f_{H,x,k} = 0.08$ kN/m

$F_y = c_{fy} \cdot A_{PV} \cdot q_p \cdot F_G = 0.014 \cdot 34 \cdot 0.47 \cdot 1.0 = 0.22$ kN -> $f_{H,y,k} = 0.01$ kN/m

$F_{i,k} = c_{f,i} \cdot A_{Dach} \cdot q_{b,k} \cdot F_G$

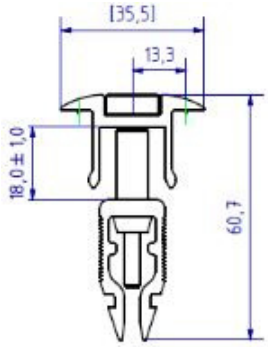
With: $c_{fx} = 0.026$

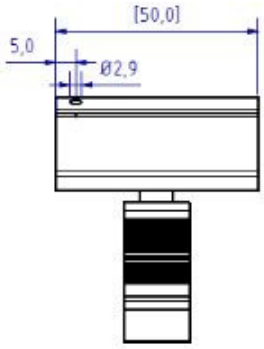
$c_{fy} = 0.014$

$F_G = 1.0$

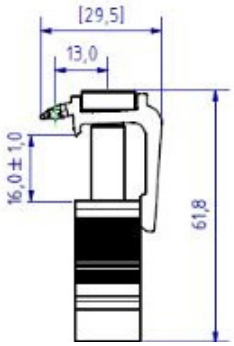
The verification of the module clamps to support profile

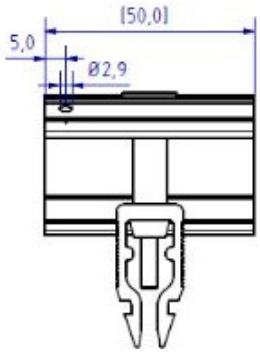
Middle clamp	$\|F_{z,Ed}\|$	$= 0.50 \cdot (0.9 \cdot 0.10 + 1.5 \cdot 0.47 \cdot -0.32) \cdot 1.67 =$	0.11 kN	< 3.88 kN
End clamp	$\|F_{z,Ed}\|$	$= 0.25 \cdot (0.9 \cdot 0.10 + 1.5 \cdot 0.47 \cdot -0.32) \cdot 1.67 =$	0.05 kN	< 1.63 kN





Detail: middle clamp (example)





Detail: end clamp (example)

$c_{p,i} = 1.3$ Wind loads downward w = 0.59 kN/m² perpendicular to the module surface

w_v = 0.58 kN/m² vertical

w_h = 0.14 kN/m² horizontal

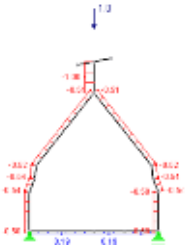
Design forces at the profile top

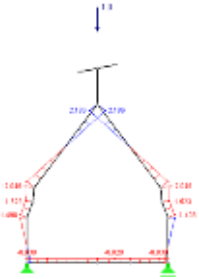
Load combination 1	$F_{z,Ed}$	$= (1.35 \cdot 0.11 + 1.50 \cdot 0.24 + 0.60 \cdot 1.50 \cdot 0.58) \cdot 1.67 / 2$	= 0.85 kN
	$F_{y,Ed}$	$= (0.6 \cdot 1.50 \cdot 0.14) \cdot 1.67$	= 0.21 kN
Load combination 2	$F_{z,Ed}$	$= (1.35 \cdot 0.11 + 0.50 \cdot 1.50 + 0.24 \cdot 1.50 \cdot 0.58) \cdot 1.67 / 2$	= 0.99 kN
	$F_{y,Ed}$	$= (1.5 \cdot 0.14) \cdot 1.67$	= 0.35 kN

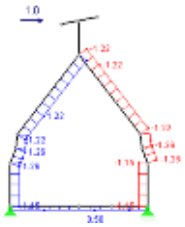
(Complete at the lower rail)

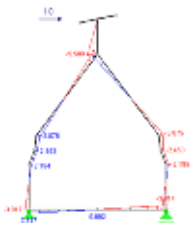
Section forces under uniform load conditions at front profile Wall thickness t = 1.40 mm Length l = 100

Profile/rail	Axial (normal) force	Bending moment	Axial (normal) force	Bending moment



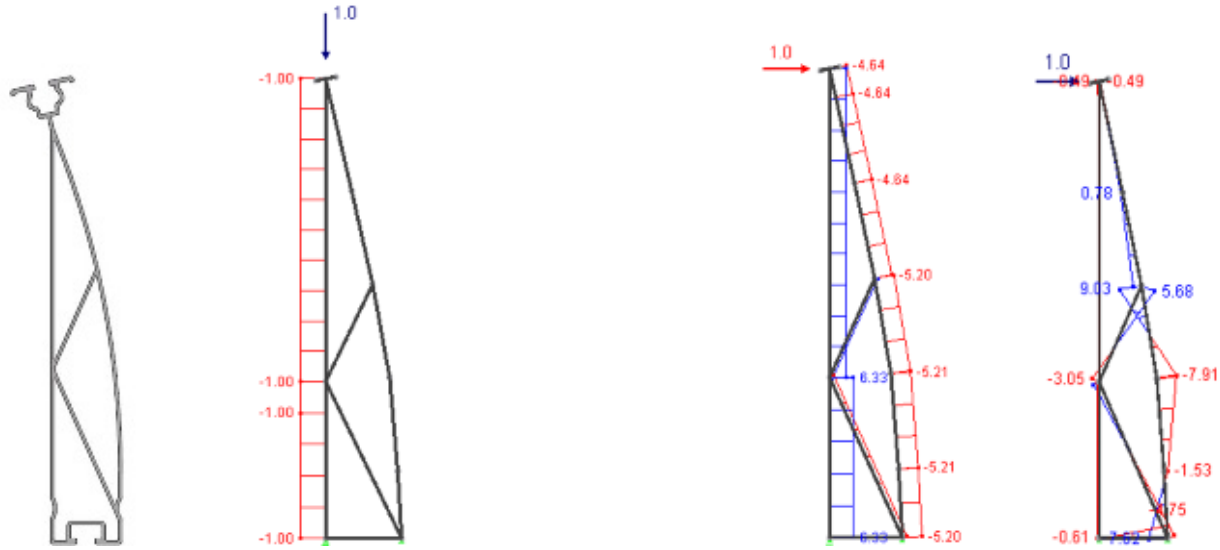






Design forces of the build-type of exterior profile - base beam:
Section forces under uniform load conditions at rear profile Wall thickness t = 1.80 mm Length l = 100

Profile/rail Axial (normal) force Axial (normal) force Bending moment



Summary of section forces from uniform load conditions

	$N_{v,1}$	$M_{v,1}$	$N_{h,1}$	$M_{h,1}$
Profile front	-0.52	-1.15	-1.22	-3.88
Profile rear	-1.00	-2.10	6.33	0.00

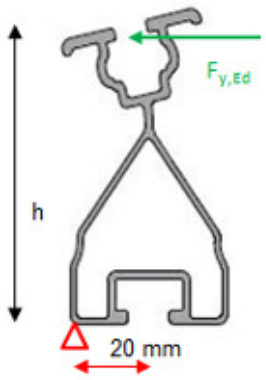
Verification format

$$\frac{N}{A} \pm \frac{M}{W} \leq f_{yd}$$

A cm²	W mm³
1.4	32.7
1.8	54.0

Section forces

	Load combination 1				Load combination 2			
	N_v	M_v	N_h	M_h	N_v	M_v	N_h	M_h
Profile front	0.44	0.98	0.26	0.81	0.52	1.14	0.43	1.35
Profile rear	0.85	1.79	1.33	0.00	0.99	2.08	2.21	0.00



Verification

	LK 1		LK 2	
Profile front	5.97	33 %	8.30	46 %
Profile rear	4.52	25 %	5.64	31 %

$f_{y,k}$ = 20.0 kN/cm² $f_{0,d}$ = 18.2 kN/cm²

Bending resistance

$Z_{R,d}$ = 3.90 kN
$M_{R,d} = Z_{R,d} \cdot 2.0$ = 7.80 kN
$V_{R,d} = M_{R,d} / h$ = 1.10 kN
With h = 71.2 mm
Verification: $F_{y,Ed} < V_{R,d}$ (32 %)
Material: EN AW-6063 T66

N

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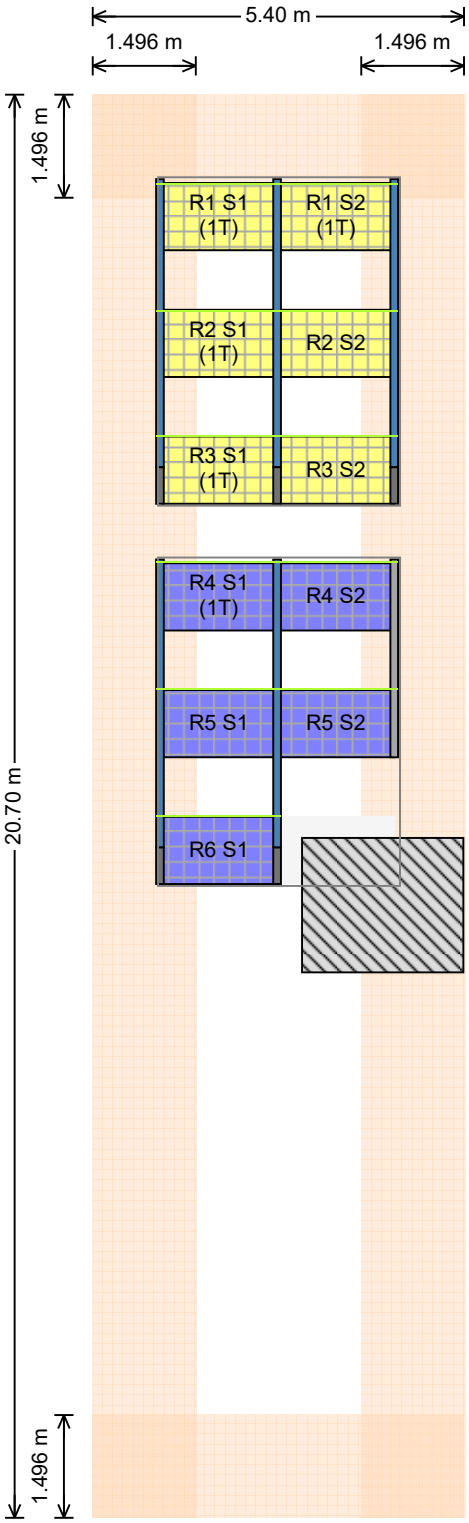
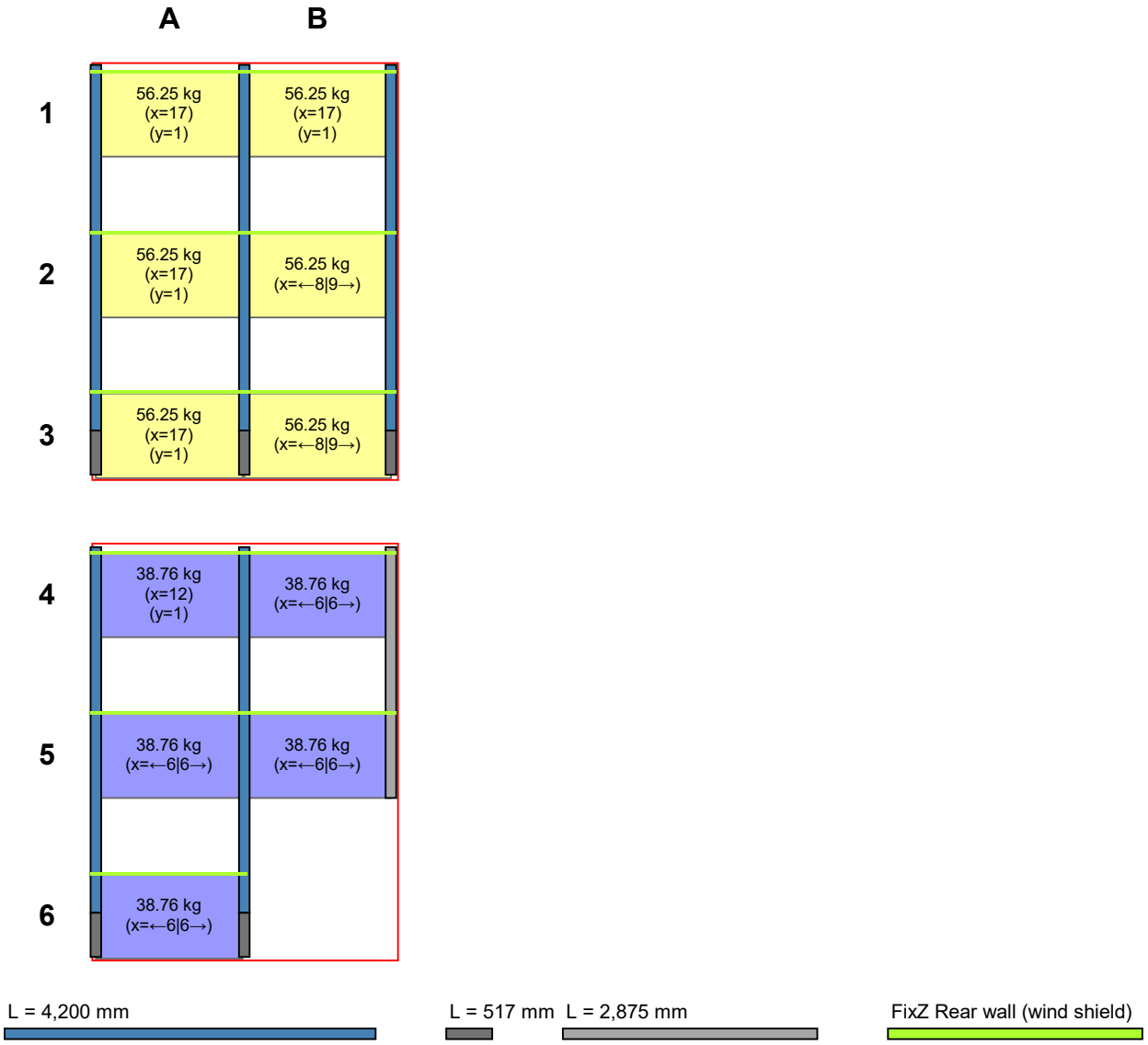
Schematic roof layout plan



Border zones:	West side	a =	1.50 m
	East side	a =	1.50 m
	North side	a =	1.50 m
	South side	a =	1.50 m

Please note:

If the indicated border area is not a[illegible]ndercut), the ballasting for the modules in that area has to be increased by 30 %.



L = 4,200 mm L = 517 mm L = 2,875 mm FixZ Rear wall (wind shield)

Values in brackets (x|y) (x) Number of ballast stones required (20 x 10 x 8 cm, 3.5 kg)
(y) Number of ballast trays required