

Technical project overview

Chapmanslade 9479133

Building project	Chapmanslade 9479133
Date	12.05.2026
In-house project no.	PA_260512_718552
Editor	unknown
Link to configurator	Open link
Number of modules	27
Rated output	12.96 kWp

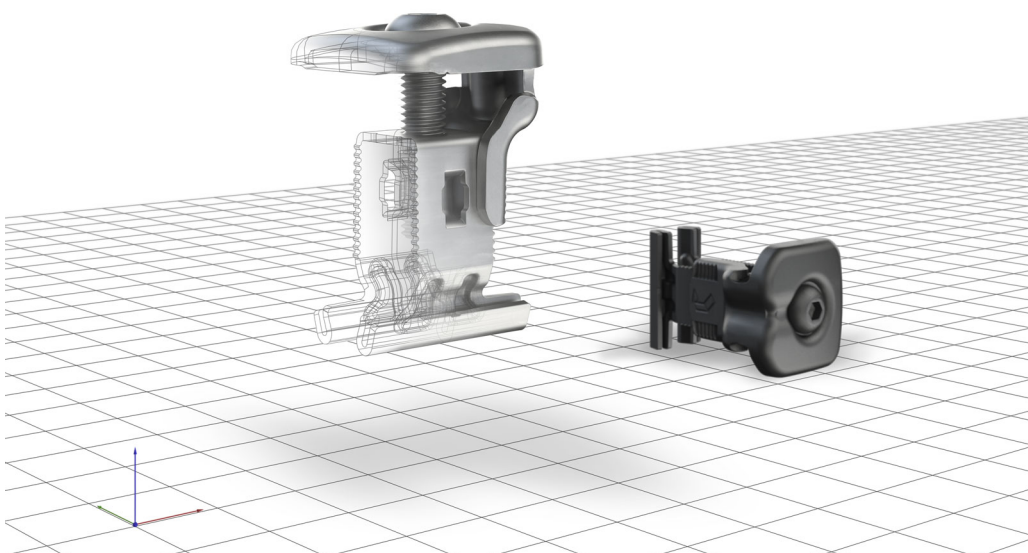


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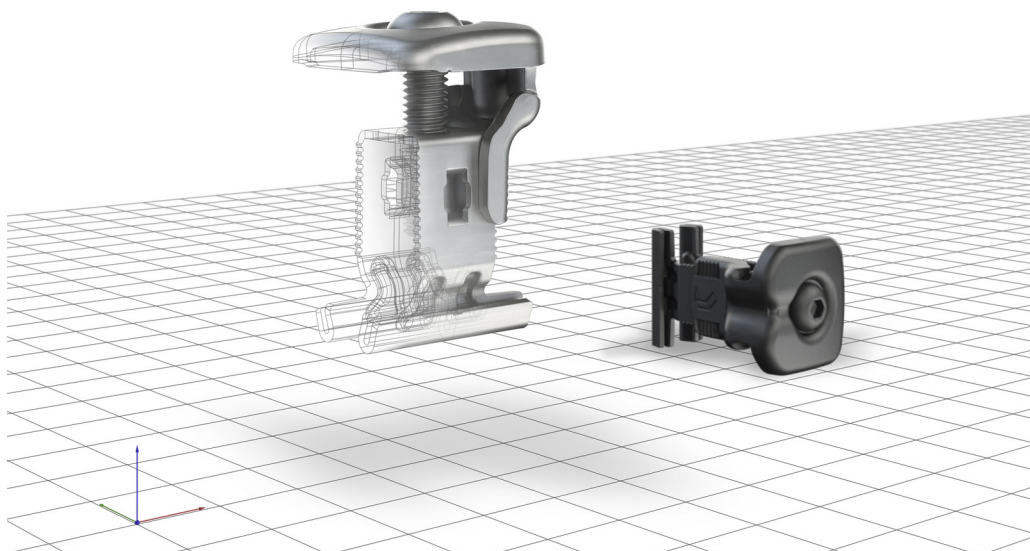
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Total bill of material	52
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Technical project overview

Chapmanslade 9479133

Building project	Chapmanslade 9479133
Address	BA13 4AS Chapmanslade
Country	United Kingdom
Module Type	Aiko Energy - AIKO-A480-MCE54Mb
Number of modules	10
Rated output	4.8 kWp
Mounting system	VarioSole+
Editor	unknown



LOCATION

Street	
City	BA13 4AS Chapmanslade
Country	United Kingdom

SURROUNDINGS

Code	Eurocode NA GB
Terrain height above sealevel	108,40 m
Snow load zone	Zone 2
Use Pressure coefficients from BRE 489 2014 roof pitch 0 -45°	yes
Terrain category	Country
Distance to coast	50,00 km
Surroundings	normal
Service life of PV system	25 years
Failure consequence class	2

LOAD CALCULATION RESULT

Peak velocity pressure	0,69 kN/m ²
Snow load	0,39 kN/m ²
Snow load on roof	0,38 kN/m ²
Base wind speed ($V_{b,0}$)	22,00 m/s

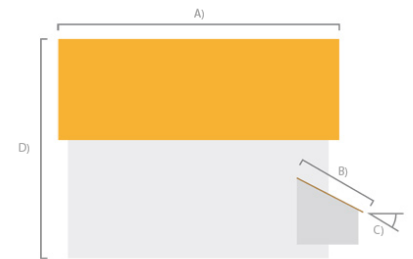
* The entered wind and snow loads are not system-verified. Please be aware that the structural analysis results are based on these unverified values.

TOPOGRAPHY

Topography	Not exposed
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ROOF PROPERTIES

Roof type	Gable roof
Coverage type	Pantile roof
Batten spacing	0,32 m
First batten at	0,10 m
Batten height	30,00 mm
Batten width	50,00 mm
A) Roof length	13,50 m
B) Roof segment width	5,00 m
C) Roof pitch	31,00 °
D) Building height	6,00 m

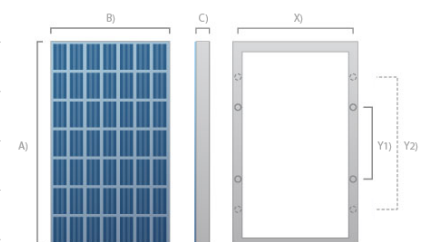


SUBSTRUCTURE

Substructure type	Rafters
Material of substructure	Wood
Spacing of substructure	600,00 mm
First substructure at	300,00 mm
Substructure thickness	50,00 mm

MODULE PARAMETERS

Manufacturer	Aiko Energy
Name	AIKO-A480-MCE54Mb
Length	1762 mm
Width	1134 mm
Height	30 mm
Weight	20.6 kg
Rated output	480 W _{peak}
Color	black



Please check the compatibility of clamping positions with module manufacturer advice.

SYSTEM

System	VarioSole+
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Please check the entered row distance for an ideal yield calculation with a correct calculation including consideration of the shading.

FASTENER DETAILS

Mounting direction of modules	Portrait
Fastener type	Roof hook RH1 Pantile (without wood screw)
Screw	Automatic

MODULE RAIL

Fastening rails	Single layer
Rail orientation	Horizontal
Mounting rail	50x37 mm
Fixations only under module surface	No
Use alternating roof hooks	No
Rail length	3600mm
Maximum cantilever length	300,00 mm
Rail colour	black
Rail count per module	2
Optimize fasteners	Roof wise

CLAMPS

Clamp type	Mid clamps+ / End clamps+
Clamp colour	black
End caps	black
Max value middle clamps	38 %
Max value end clamps	24 %

STATIC VALIDATION

Your project was validated by our statics check successfully.

Static utilization factor: 72%

Static utilization fastener: 72%

Static utilization clamp: 38%

Static utilization base rail: 72%

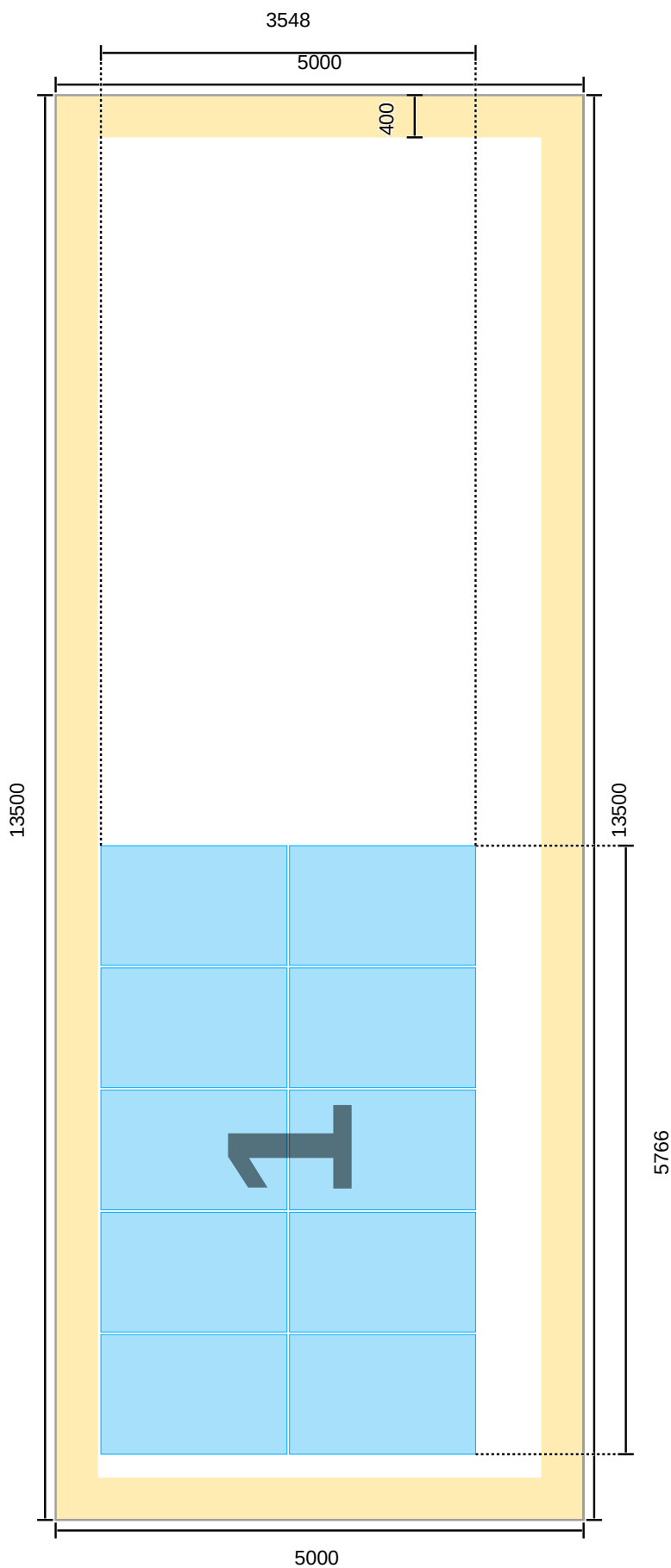
Loads on modules:

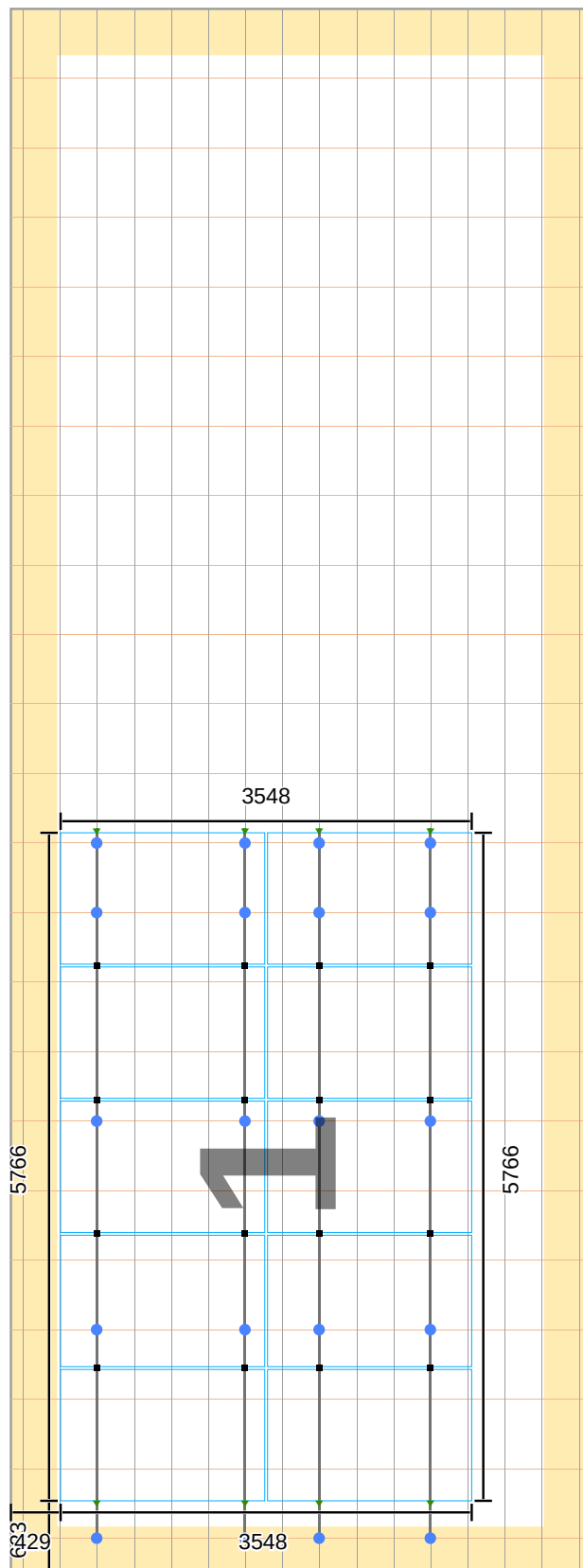
Pressure load: 820 Pa

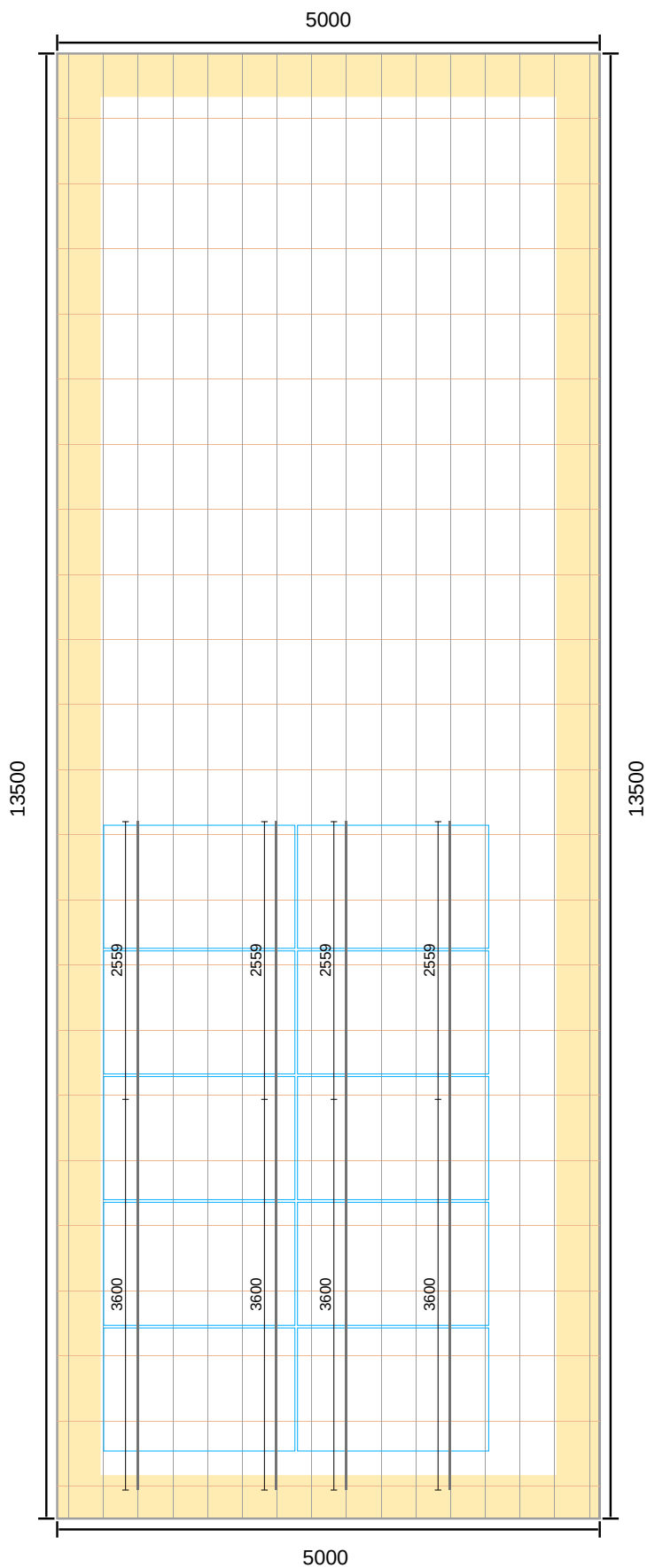
Suction load: -619 Pa

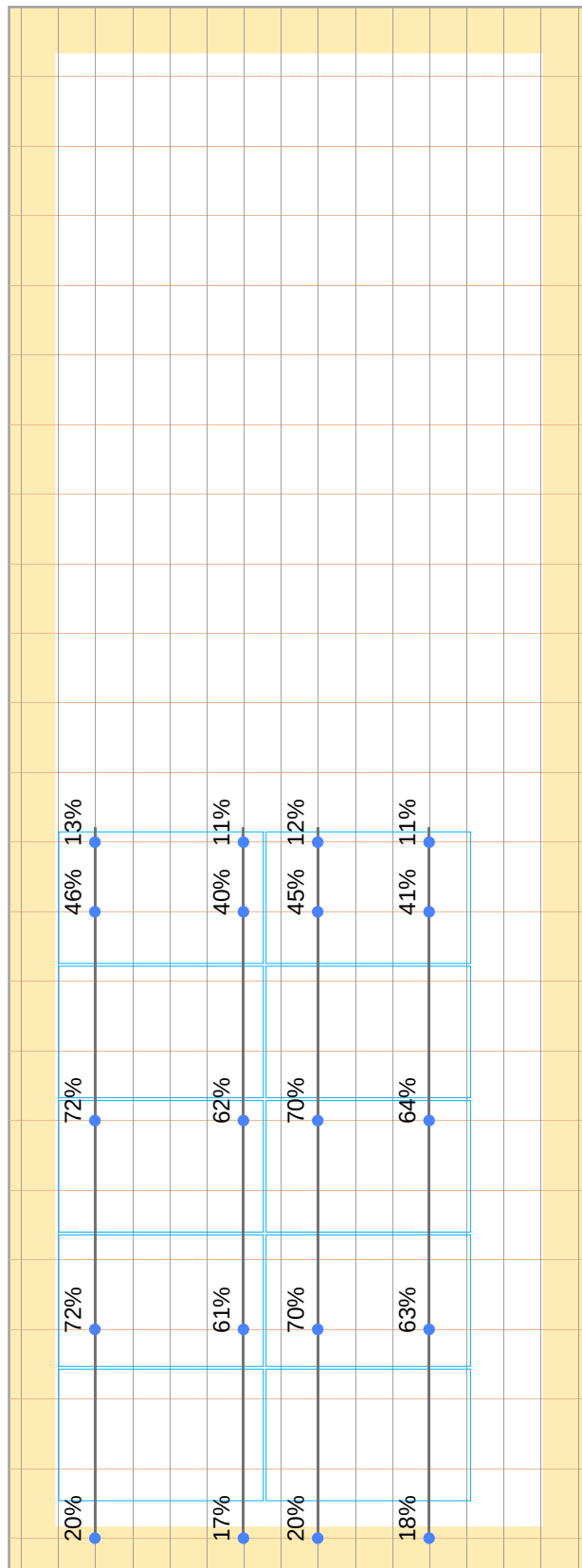
The predefined default values for input fields have to be compared with the conditions of the project. Necessary changes to adapt to local conditions must be carried out. The following relevant input fields contain their default value:

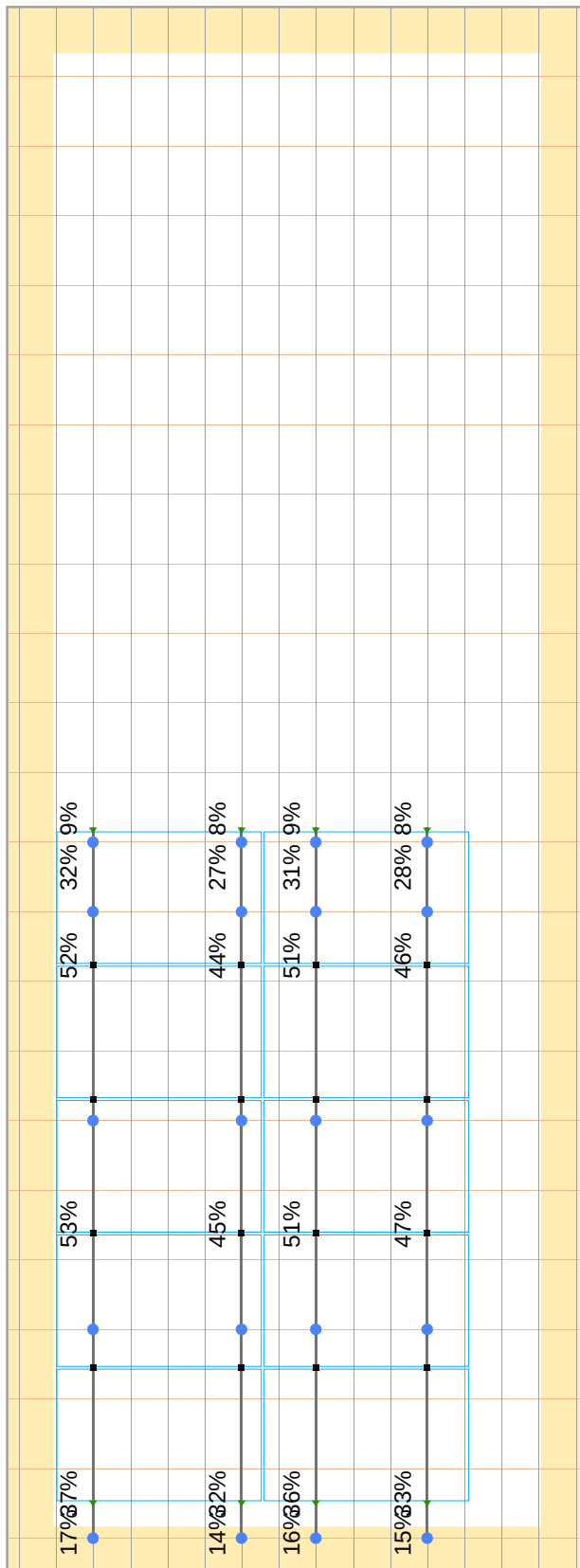
- Service life of PV system: 25 years
- Failure consequence class: 2

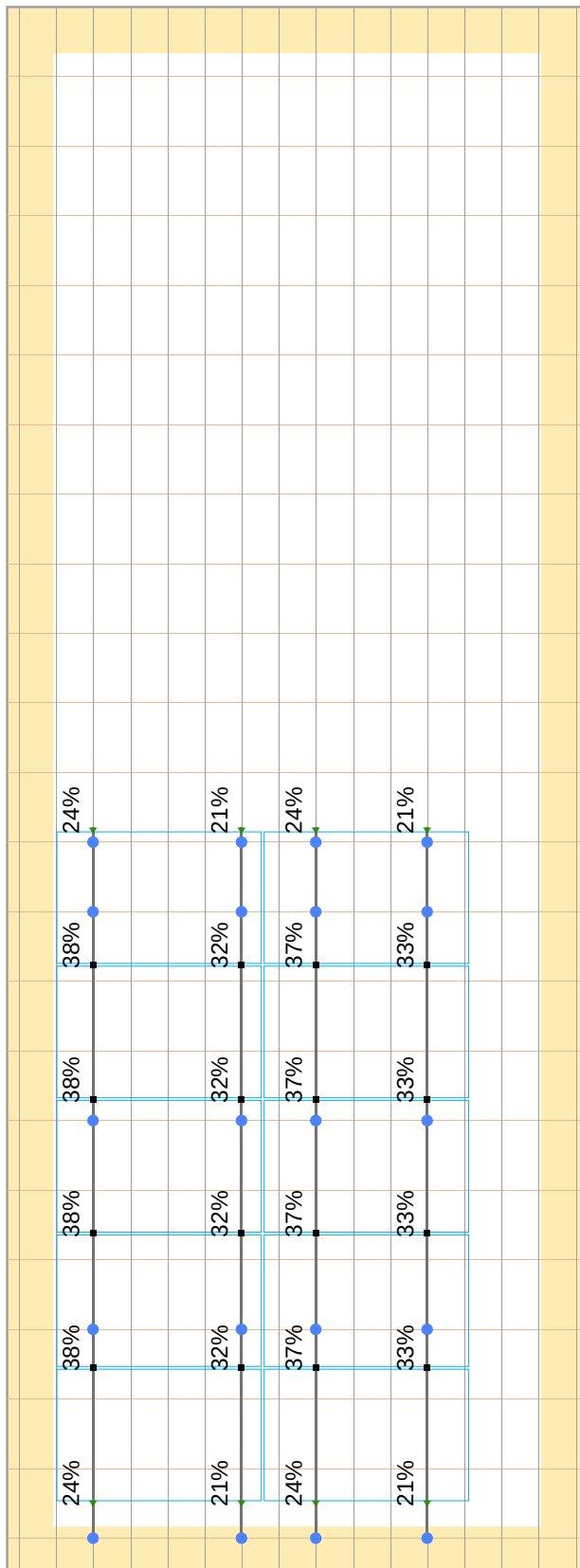


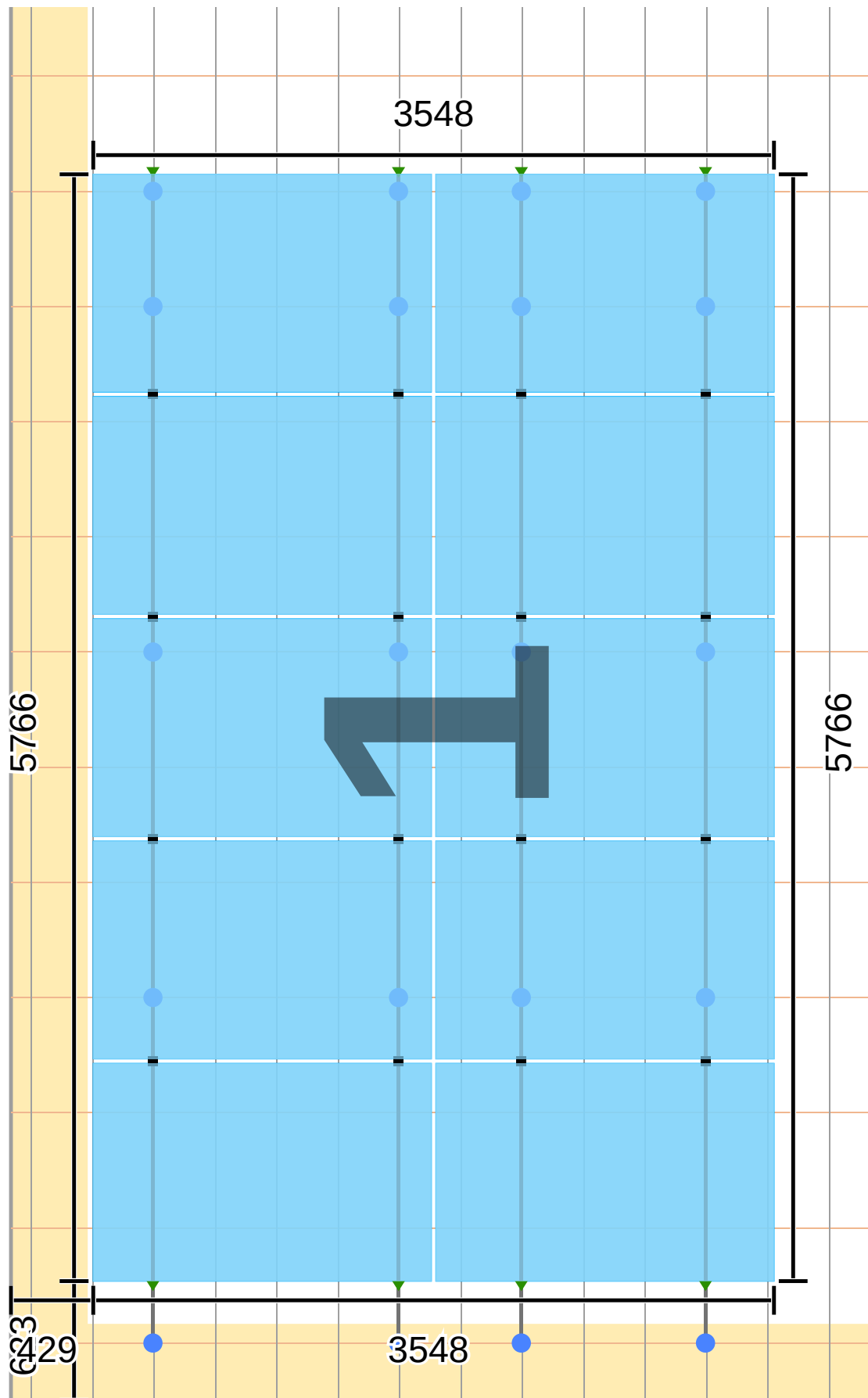












BILL OF MATERIAL

Article No.	Article	Quantity	Ordering Unit	Weight/Piece	Weight
R400532	VS+ Rail connector 50 x 37	4	1	0,193 kg	0,772 kg
R400570-B	VS+ Mounting rail 50 x 37 x 3600 mm black	8	1	2,530 kg	20,240 kg
R420081-BE	End clamp+ (black)	8	1	0,064 kg	0,512 kg
R420082-BE	Middle clamp+ (black)	16	1	0,063 kg	1,008 kg
R420171	Roof hook RH1 Pantile (without wood screw)	20	1	0,664 kg	13,280 kg
R900276	VS+ End Cap Universal black	8	1	0,008 kg	0,064 kg
R900333	Wood screw pan head 6 x 80	1	100	0,009 kg	0,900 kg
				Total Weight: 36,776 kg	

GENERAL

Technical regulations

Eurocode 0: 'Basis of structural design' EN 1990:2012
Eurocode 1: 'Action on Structures'
Part 1-3: 'General Actions, Snow Loads' EN 1991-1-3:2015
National Annex BS EN 1991-1-3:2003/NA:2010-06
Part 1-4: 'General Actions, Wind Loads' EN 1991-1-4:2010
National Annex BS EN 1991-1-4:2005/NA:2011-01
Eurocode 9: 'Design of Aluminium Structures'
Part 1-1: 'General Structural Rules' EN 1999-1-1:2007
Report BRE DG 489 (revised 2014)

Materials

Aluminium extruded sections, EN AW 6063 T6, $t \leq 10\text{mm}$
Rail connector EN AW 6063 T6
Roof hook, EN AC-42100
Screws, stainless steel A2-70
Softwood NH S10, C 24

Used documents

Schneider 'Bautabellen für Ingenieure', Werner-Verlag
SAPA 'Handbuch für Konstrukteure', Beuth Verlag

LOAD ASSUMPTIONS

Dead load

Solar modules type AIKO-A480-MCE54Mb are used.

The modules are angled vertically on the roof and are fastened on the larger module edges on the horizontal rails with modul clamps.

Dimensions:	1762 mm x 1134 mm
Weight:	$G = 20.6 \text{ kg}$
Load per longitudinal module side:	$F_G = 20.6 \text{ kg} * 9.81 \text{ m/s}^2 / 2 = 0.20 \text{ kN} / 2 = 0.101 \text{ kN}$

Mounting rails

Weight:	$0.70 \text{ kg/m} * 9.81 \text{ m/s}^2 = 0.007 \text{ kN/m}$
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Snow load

The determination of the snow load is carried out according to BS EN 1991-1-3:2003/NA:2010-06.

Snow-trap formation or snow-load accumulations are not considered in the calculation. Please contact Renusol if necessary.

Height above sea level:	108 m
Snow load zone:	2
Roof pitch:	$\alpha = 31^\circ$

Period of use:	25 Year
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Snow load:	$s_k = s_{k,50} * f_s = 0.42 \text{ kN/m}^2 * 0.93 = 0.39 \text{ kN/m}^2$ $\mu_{r1} = 1.160$ $s_{r1} = \mu_{r1} * s_k = 1.16 * 0.39 \text{ kN/m}^2 = 0.448 \text{ kN/m}^2$ $s_{1,31^\circ} = 0.448 \text{ kN/m}^2 * \cos(31.0^\circ) = 0.384 \text{ kN/m}^2$ $F_{S,k} = 0.384 \text{ kN/m}^2 * 1.76 \text{ m} * 1.13 \text{ m} / 2 = 0.383 \text{ kN}$
Load per longitudinal module side:	

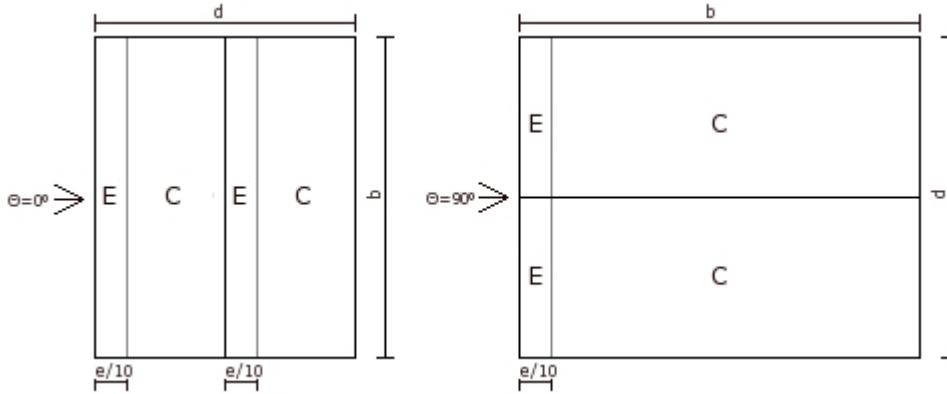
Wind load

The determination of the wind load is carried out according to BS EN 1991-1-4:2005/NA:2011-01.

Building height roof ridge:	6 m
Terrain category:	Country terrain
Basic wind velocity:	22.00 m/s
Distance to shoreline:	50.000 km
Style of roof:	Gable roof
Period of use:	25 Year
Pressure of the gusts velocity:	$q(z) = 0.688 \text{ kN/m}^2$

LOAD ASSUMPTIONS

All oncoming flow directions



Main roof

$$b = 13.50\text{m}$$

$$d = 8.57\text{m}$$

$$h = 6.00\text{m}$$

Ventilation direction 0° and 180°:

$$e = \min(b, 2h) = \min(13.50\text{m}, 12.00\text{m}) = 12.00\text{m}$$

Ventilation direction 90° and 270°:

$$e = \min(d, 2h) = \min(8.57\text{m}, 12.00\text{m}) = 8.57\text{m}$$

The coefficients of pressure and suction for the individual roof areas are interpolated for the roof pitch of 31 obtained from the report BRE Digest 489.

Wind pressure:

Edge area of roof (E)	$c_p=0.53$	$W_D = 0.53 \cdot 0.688\text{kN/m}^2 \cdot 1.76\text{m} \cdot 1.13\text{m} / 2 = 0.363\text{ kN}$
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Middle area of roof (C)	$c_p=0.28$	Area is not relevant
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Wind suction:

Edge area of roof (E)	$c_p=-0.60$	$W_s = (-0.60) \cdot 0.688\text{kN/m}^2 \cdot 1.76\text{m} \cdot 1.13\text{m} / 2 = -0.412\text{ kN}$
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Middle area of roof (C)	$c_p=-0.50$	Area is not relevant
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ANALYSIS

Load cases and load case combinations

Load cases

The respective loads are taken from the load assumptions and converted to a reference system perpendicular to the roof area.

LC 1	Dead load
LC 2	Snow load
LC 3	Wind pressure (by roof area)
LC 4	Wind suction (by roof area)

Significant load case combinations
according to: EN 1990:2012

Ultimate state of load-bearing capacity

LCC 1	Predominant action wind pressure $E_{d,LCC 1} = 1.35 \cdot E_{Gk,LC 1} + 1.50 \cdot (E_{Qk,LC 3} + 0.5 \cdot E_{Qk,LC 2})$
LCC 2	Predominant action snow $E_{d,LCC 2} = 1.35 \cdot E_{Gk,LC 1} + 1.50 \cdot (E_{Qk,LC 2} + 0.6 \cdot E_{Qk,LC 3})$
LCC 3	Predominant action wind suction (lifting) $E_{d,LCC 3} = 1.00 \cdot E_{Gk,LC 1} + 1.50 \cdot (E_{Qk,LC 4})$

Ultimate state of serviceability

LCC 4	Predominant action wind pressure $E_{d,LCC 4} = 1.00 \cdot E_{Gk,LC 1} + 1.00 \cdot (E_{Qk,LC 3} + 0.5 \cdot E_{Qk,LC 2})$
LCC 5	Predominant action snow $E_{d,LCC 5} = 1.00 \cdot E_{Gk,LC 1} + 1.00 \cdot (E_{Qk,LC 2} + 0.6 \cdot E_{Qk,LC 3})$
LCC 6	Predominant action wind suction $E_{d,LCC 6} = 1.00 \cdot E_{Gk,LC 1} + 1.00 \cdot (E_{Qk,LC 4})$

ANALYSIS

Area load on module:

Due to the building geometry and the location, the following area loads result for the module surface according to the standard calculation.

[kN/m²]		Section	Edge
LCC 1 Design	⊥	0.65	0.91
	//	0.22	0.22
LCC 2 Design	⊥	0.78	0.94
	//	0.37	0.37
LCC 3 Design	⊥	-0.43	-0.53
	//	0.05	0.05
LCC 4 Characteristic	⊥	0.44	0.61
	//	0.15	0.15
LCC 5 Characteristic	⊥	0.53	0.63
	//	0.25	0.25
LCC 6 Characteristic	⊥	-0.26	-0.33
	//	0.05	0.05

Maximum values

[kN/m²]	Characteristic	Design
Pressure	0.63	0.94
Suction	-0.33	-0.53
In parallel to the roof	0.25	0.37

ANALYSIS

Middle clamp

General

The module clamps consist of extruded aluminium sheaths material grade EN-AW 6063 T66. The lower part of the module clamps consists of a click profile made of S500 MC, EN 10149-2, which is attached to the module carrying profile and transfers the loads by form closure. On it the module end clamp or module middle clamp is fastened by a screw. When tightening the screw the module clamp presses the module to the rail.

Sketch



Static analysis

The maximum loads established in the load combinations of the tension loads perpendicular to the roof area and the respective shear loads parallel to the roof area or the maximum shear loads in combination with the corresponding tensile loads perpendicular to the roof area are significant for the analysis. Pressure loads perpendicular to the roof area are transferred by contact bearing.

Analysis

LCC 1

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 740 \text{ mm}$ $y = 8257 \text{ mm}$
 Loads: $V_{x,d} = 0.24 \text{ kN}$
 Comparison stress: $V_{x,d}/F_{R,d,y} = 0.24/1.05 = 0.23 < 1$

LCC 2

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 740 \text{ mm}$ $y = 8257 \text{ mm}$
 Loads: $V_{x,d} = 0.40 \text{ kN}$
 Comparison stress: $V_{x,d}/F_{R,d,y} = 0.40/1.05 = 0.38 < 1$

LCC 3

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 740 \text{ mm}$ $y = 8257 \text{ mm}$
 Loads: $N_d = -0.57 \text{ kN}$
 $V_{x,d} = 0.06 \text{ kN}$
 Comparison stress: $N_d/F_{R,d,x} + V_{x,d}/F_{R,d,y} = 0.57/3.22 + 0.06/0.92 = 0.24 < 1$

ANALYSIS

End clamp

General

The module clamps consist of extruded aluminium sheaths material grade EN-AW 6063 T66. The lower part of the module clamps consists of a click profile made of S500 MC, EN 10149-2, which is attached to the module carrying profile and transfers the loads by form closure. On it the module end clamp or module middle clamp is fastened by a screw. When tightening the screw the module clamp presses the module to the rail.

Sketch



Static analysis

The maximum loads established in the load combinations of the tension loads perpendicular to the roof area and the respective shear loads parallel to the roof area or the maximum shear loads in combination with the corresponding tensile loads perpendicular to the roof area are significant for the analysis. Pressure loads perpendicular to the roof area are transferred by contact bearing.

Analysis

LCC 1

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 740 \text{ mm}$ $y = 7094 \text{ mm}$
 Loads: $V_{x,d} = 0.12 \text{ kN}$
 Comparison stress: $V_{x,d}/F_{R,d,y} = 0.12/0.81 = 0.15 < 1$

LCC 2

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 740 \text{ mm}$ $y = 7094 \text{ mm}$
 Loads: $V_{x,d} = 0.20 \text{ kN}$
 Comparison stress: $V_{x,d}/F_{R,d,y} = 0.20/0.81 = 0.24 < 1$

LCC 3

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 740 \text{ mm}$ $y = 7094 \text{ mm}$
 Loads: $N_d = -0.29 \text{ kN}$
 $V_{x,d} = 0.03 \text{ kN}$
 Comparison stress: $N_d/F_{R,d,x} + V_{x,d}/F_{R,d,y} = 0.29/1.75 + 0.03/0.79 = 0.20 < 1$

ANALYSIS

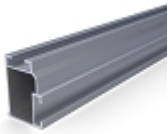
Mounting rails

General

An extruded section is used as load bearing rail.

It consists of material grade EN AW 6063 T6. At the joints, the rails are connected deflection resistant through an insertion profile (connector with rivet) with the same static parameters as the load bearing rails.

Cross section



Static analysis

The static system is a continuous beam. The single loads due to the load combinations are introduced into the supporting rails in a spacing specified by the module. The continuous beams are supported by the roof hooks or set screws.

The software analyses all rails but only the rail utilised maximally is shown (maximum stress utilisation and maximum deformation).

Analysis

LCC 1

Stress analysis

Regarding the calculation the following rail at the following position is significant.

Rail ID:	100004
Beginning of rail:	x = 740 mm y = 7076 mm
End of rail:	x = 740 mm y = 13235 mm
Position:	x = 740 mm y = 11400 mm

Loads:	$N_d = 0.00 \text{ kN}$
	$V_{y,d} = 0.25 \text{ kN}$
	$V_{z,d} = -1.04 \text{ kN}$
	$M_{y,d} = 262.33 \text{ Nm} = 26.233 \text{ kNcm}$
	$M_{z,d} = 65.12 \text{ Nm} = 6.512 \text{ kNcm}$

Stress analysis:	$\sigma_{x,d} = N_d/A + M_{y,d}/W_y + M_{z,d}/W_z =$ $(0.00/2.60 + 26.233/3.25 + 6.512/2.24) \text{ kN/cm}^2 = 10.98 \text{ kN/cm}^2$
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Utilisation:	$\sigma_{x,d}/\sigma_{R,d} = 10.98/18.18 = 0.60 < 1$
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ANALYSIS

LCC 2

Stress analysis

Regarding the calculation the following rail at the following position is significant.

Rail ID: 100004
Beginning of rail: x = 740 mm y = 7076 mm
End of rail: x = 740 mm y = 13235 mm
Position: x = 740 mm y = 11400 mm

Loads:
 $N_d = 0.00 \text{ kN}$
 $V_{y,d} = 0.42 \text{ kN}$
 $V_{z,d} = -1.07 \text{ kN}$
 $M_{y,d} = 270.57 \text{ Nm} = 27.057 \text{ kNcm}$
 $M_{z,d} = 108.21 \text{ Nm} = 10.821 \text{ kNcm}$

Stress analysis:
 $\sigma_{x,d} = N_d/A + M_{y,d}/W_y + M_{z,d}/W_z =$
 $(0.00/2.60 + 27.057/3.25 + 10.821/2.24) \text{ kN/cm}^2 = 13.16 \text{ kN/cm}^2$

Utilisation:
 $\sigma_{x,d}/\sigma_{R,d} = 13.16/18.18 = 0.72 < 1$

LCC 3

Stress analysis

Regarding the calculation the following rail at the following position is significant.

Rail ID: 100004
Beginning of rail: x = 740 mm y = 7076 mm
End of rail: x = 740 mm y = 13235 mm
Position: x = 740 mm y = 11400 mm

Loads:
 $N_d = 0.00 \text{ kN}$
 $V_{y,d} = 0.06 \text{ kN}$
 $V_{z,d} = 0.60 \text{ kN}$
 $M_{y,d} = -150.27 \text{ Nm} = -15.027 \text{ kNcm}$
 $M_{z,d} = 16.32 \text{ Nm} = 1.632 \text{ kNcm}$

Stress analysis:
 $\sigma_{x,d} = N_d/A + M_{y,d}/W_y + M_{z,d}/W_z =$
 $(0.00/2.60 + 15.027/3.25 + 1.632/2.24) \text{ kN/cm}^2 = 5.36 \text{ kN/cm}^2$

Utilisation:
 $\sigma_{x,d}/\sigma_{R,d} = 5.36/18.18 = 0.29 < 1$

LCC 4

Serviceability

Regarding the calculation the following rail at the following position is significant.

Rail ID: 100004
Beginning of rail: x = 740 mm y = 7076 mm
End of rail: x = 740 mm y = 13235 mm
Position: x = 740 mm y = 12300 mm
Deformation: u = 5.23 mm
permitted deformation: $u_{zul} = l/100 = 1800.00 \text{ mm} / 100 = 18.0 \text{ mm}$
Utilisation: $u/u_{zul} = 5.23 / 18.00 = 0.29 < 1$

LCC 5

Serviceability

Regarding the calculation the following rail at the following position is significant.

Rail ID: 100004
Beginning of rail: x = 740 mm y = 7076 mm
End of rail: x = 740 mm y = 13235 mm
Position: x = 740 mm y = 12300 mm
Deformation: u = 6.11 mm
permitted deformation: $u_{zul} = l/100 = 1800.00 \text{ mm} / 100 = 18.0 \text{ mm}$
Utilisation: $u/u_{zul} = 6.11 / 18.00 = 0.34 < 1$

ANALYSIS

LCC 6

Serviceability

Regarding the calculation the following rail at the following position is significant.

Rail ID:	100004
Beginning of rail:	x = 740 mm y = 7076 mm
End of rail:	x = 740 mm y = 13235 mm
Position:	x = 740 mm y = 12300 mm
Deformation:	u = 2.53 mm
permitted deformation:	$u_{zul} = l/100 = 1800.00 \text{ mm} / 100 = 18.0 \text{ mm}$
Utilisation:	$u/u_{zul} = 2.53 / 18.00 = 0.14 < 1$

ANALYSIS

Mounting on the existing rafter roof with gutter tile roofing

General

The mounting rail is connected with the rafter using a roof hook.

The loads are conducted from the mounting rail to the fastening element via a hammer-head bolt M8, A2. Ripples on the mounting rail and the fastening element provide for vertical load transmission despite the existing slotted hole. The roof hook is connected to the rafter with 3 wood screws Ø 6.0mm.

Sketch

Analysis

The roof hook, item number R420171 made of aluminium by Renusol GmbH is used.

With the specified design values of the roof hook, the used wood screws are not overloaded and will not be considered in the following statements.

LCC 1

Regarding the calculation the following fastener at the following position is significant.

Position: $x = 740 \text{ mm}$ $y = 9600 \text{ mm}$

Loads: $N_d = 1.60 \text{ kN}$

$V_{x,d} = 0.39 \text{ kN}$

Comparison stress: $N_d/F_{R,d,x} + V_{x,d}/F_{R,d,y} = 1.60/3.50 + 0.39/2.60 = 0.61 < 1$

LCC 2

Regarding the calculation the following fastener at the following position is significant.

Position: $x = 740 \text{ mm}$ $y = 9600 \text{ mm}$

Loads: $N_d = 1.65 \text{ kN}$

$V_{x,d} = 0.65 \text{ kN}$

Comparison stress: $N_d/F_{R,d,x} + V_{x,d}/F_{R,d,y} = 1.65/3.50 + 0.65/2.60 = 0.72 < 1$

LCC 3

Regarding the calculation the following fastener at the following position is significant.

Position: $x = 740 \text{ mm}$ $y = 9600 \text{ mm}$

Loads: $N_d = -0.92 \text{ kN}$

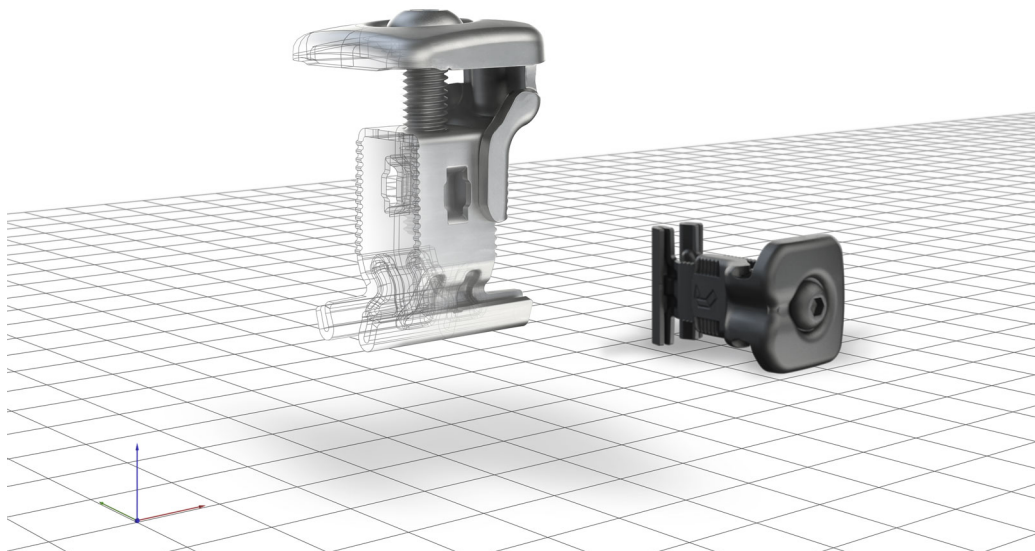
$V_{x,d} = 0.10 \text{ kN}$

Comparison stress: $N_d/F_{R,d,x} + V_{x,d}/F_{R,d,y} = 0.92/3.02 + 0.10/2.60 = 0.34 < 1$

Technical project overview

Chapmanslade 9479133

Building project	Chapmanslade 9479133
Address	BA13 4AS Chapmanslade
Country	United Kingdom
Module Type	Aiko Energy - AIKO-A480-MCE54Mb
Number of modules	17
Rated output	8.16 kWp
Mounting system	VarioSole+
Editor	unknown



LOCATION

Street	
City	BA13 4AS Chapmanslade
Country	United Kingdom

SURROUNDINGS

Code	Eurocode NA GB
Terrain height above sealevel	108,40 m
Snow load zone	Zone 2
Use Pressure coefficients from BRE 489 2014 roof pitch 0 -45°	yes
Terrain category	Country
Distance to coast	50,00 km
Surroundings	normal
Service life of PV system	25 years
Failure consequence class	2

LOAD CALCULATION RESULT

Peak velocity pressure	0,65 kN/m ²
Snow load	0,39 kN/m ²
Snow load on roof	0,16 kN/m ²
Base wind speed ($V_{b,0}$)	22,00 m/s

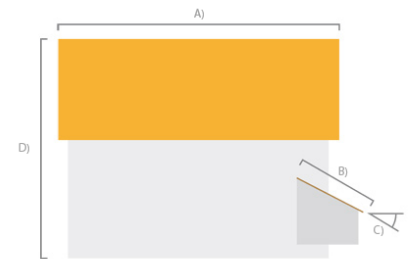
* The entered wind and snow loads are not system-verified. Please be aware that the structural analysis results are based on these unverified values.

TOPOGRAPHY

Topography	Not exposed
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ROOF PROPERTIES

Roof type	Gable roof
Coverage type	Pantile roof
Batten spacing	0,32 m
First batten at	0,10 m
Batten height	30,00 mm
Batten width	50,00 mm
A) Roof length	17,53 m
B) Roof segment width	5,14 m
C) Roof pitch	45,00 °
D) Building height	5,00 m

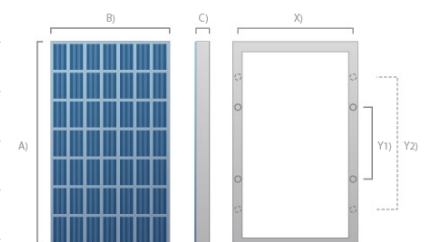


SUBSTRUCTURE

Substructure type	Rafters
Material of substructure	Wood
Spacing of substructure	600,00 mm
First substructure at	300,00 mm
Substructure thickness	50,00 mm

MODULE PARAMETERS

Manufacturer	Aiko Energy
Name	AIKO-A480-MCE54Mb
Length	1762 mm
Width	1134 mm
Height	30 mm
Weight	20.6 kg
Rated output	480 W _{peak}
Color	black



Please check the compatibility of clamping positions with module manufacturer advice.

SYSTEM

System	VarioSole+
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Please check the entered row distance for an ideal yield calculation with a correct calculation including consideration of the shading.

FASTENER DETAILS

Mounting direction of modules	Portrait
Fastener type	Roof hook RH1 Pantile (without wood screw)
Screw	Automatic

MODULE RAIL

Fastening rails	Single layer
Rail orientation	Horizontal
Mounting rail	50x37 mm
Fixations only under module surface	No
Use alternating roof hooks	No
Rail length	3600mm
Maximum cantilever length	300,00 mm
Rail colour	black
Rail count per module	2
Optimize fasteners	Roof wise

CLAMPS

Clamp type	Mid clamps+ / End clamps+
Clamp colour	black
End caps	black
Max value middle clamps	27 %
Max value end clamps	20 %

STATIC VALIDATION

Your project was validated by our statics check successfully.

Static utilization factor: 52%

Static utilization fastener: 47%

Static utilization clamp: 27%

Static utilization base rail: 52%

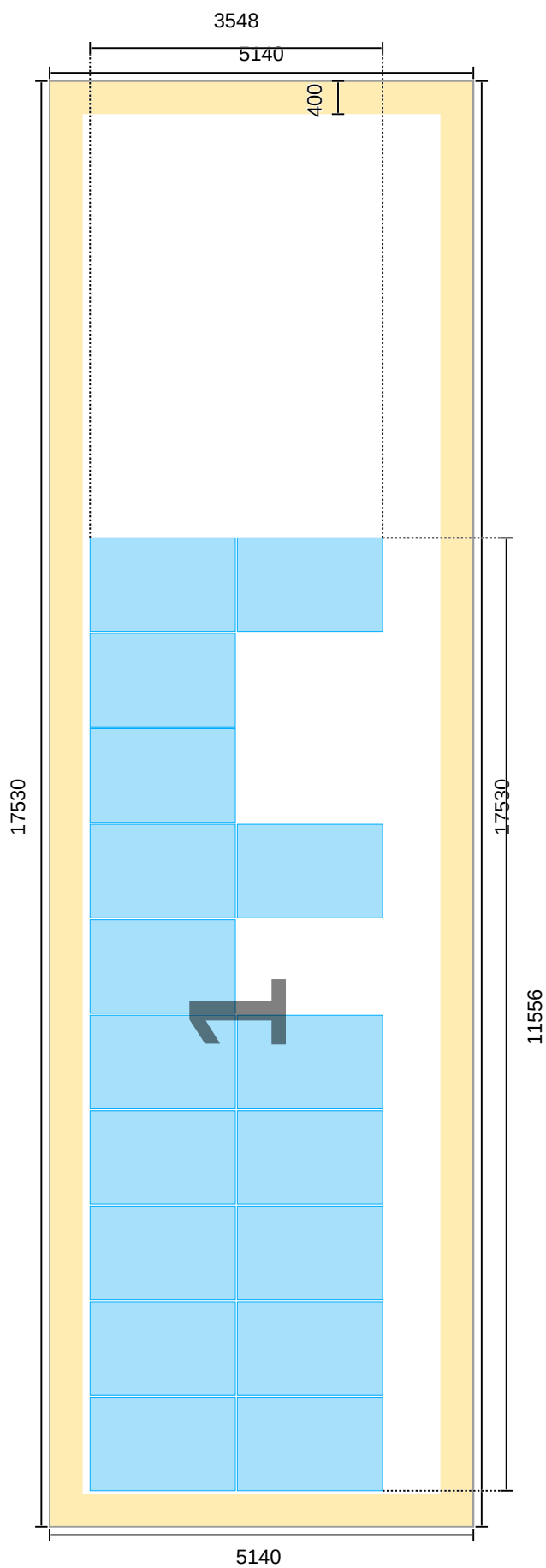
Loads on modules:

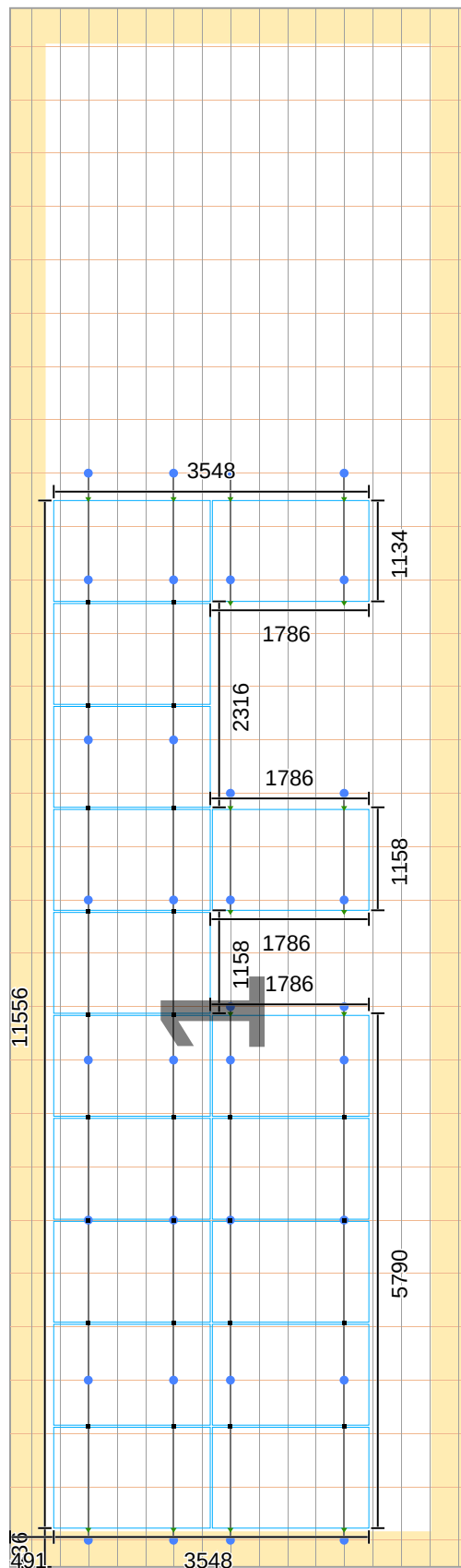
Pressure load: 602 Pa

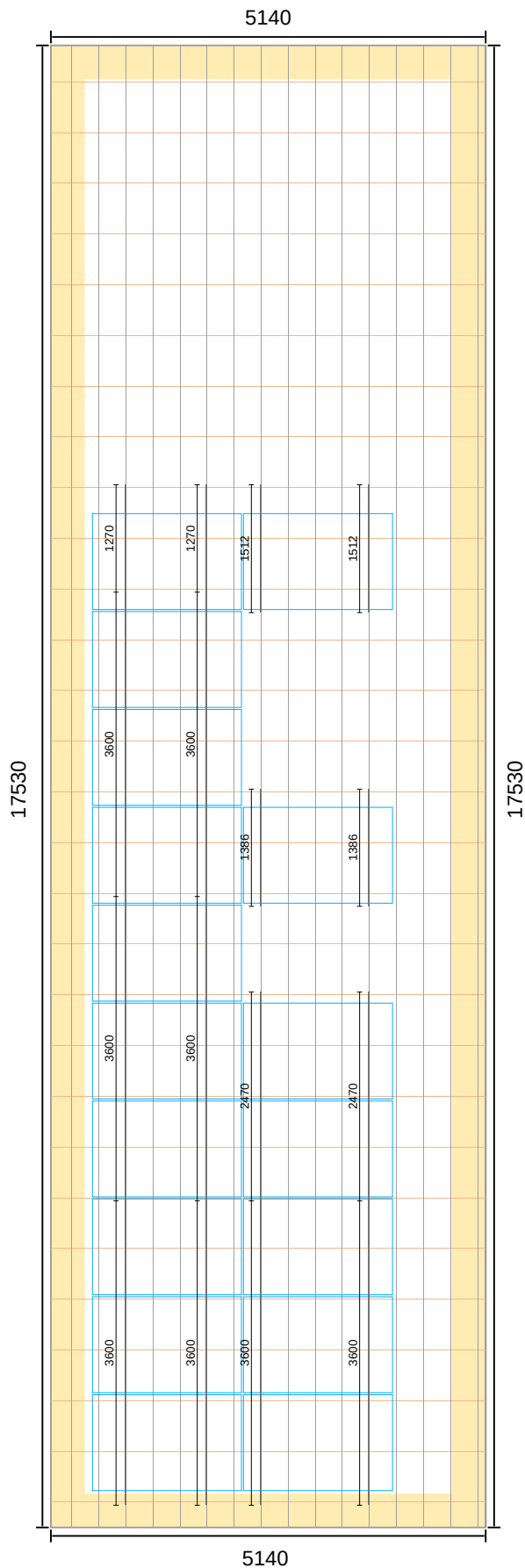
Suction load: -586 Pa

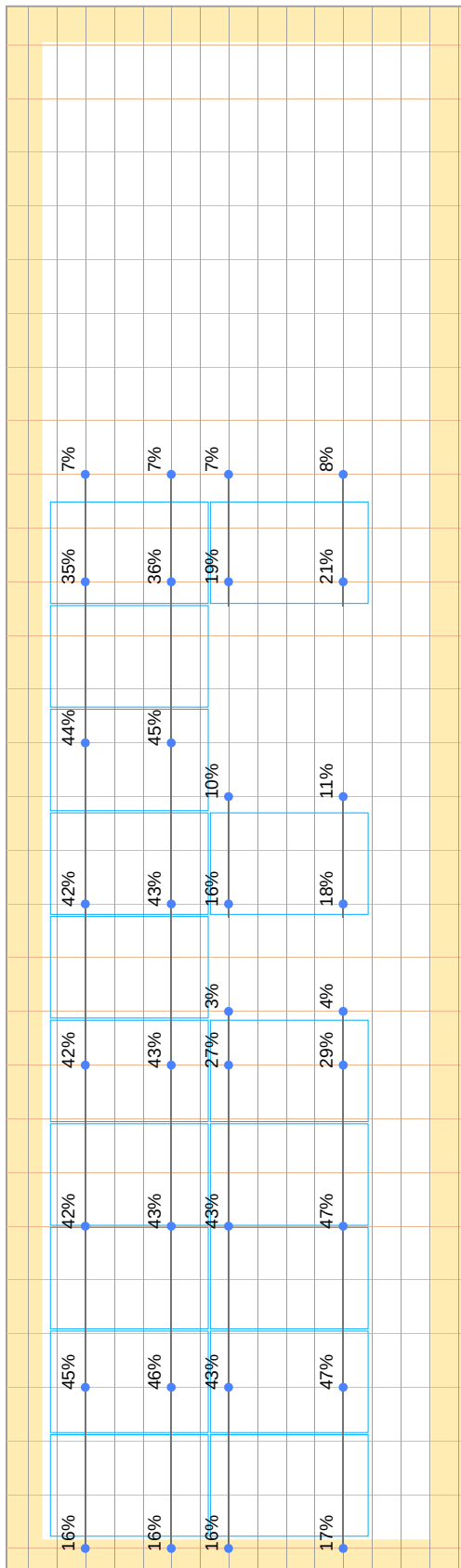
The predefined default values for input fields have to be compared with the conditions of the project. Necessary changes to adapt to local conditions must be carried out. The following relevant input fields contain their default value:

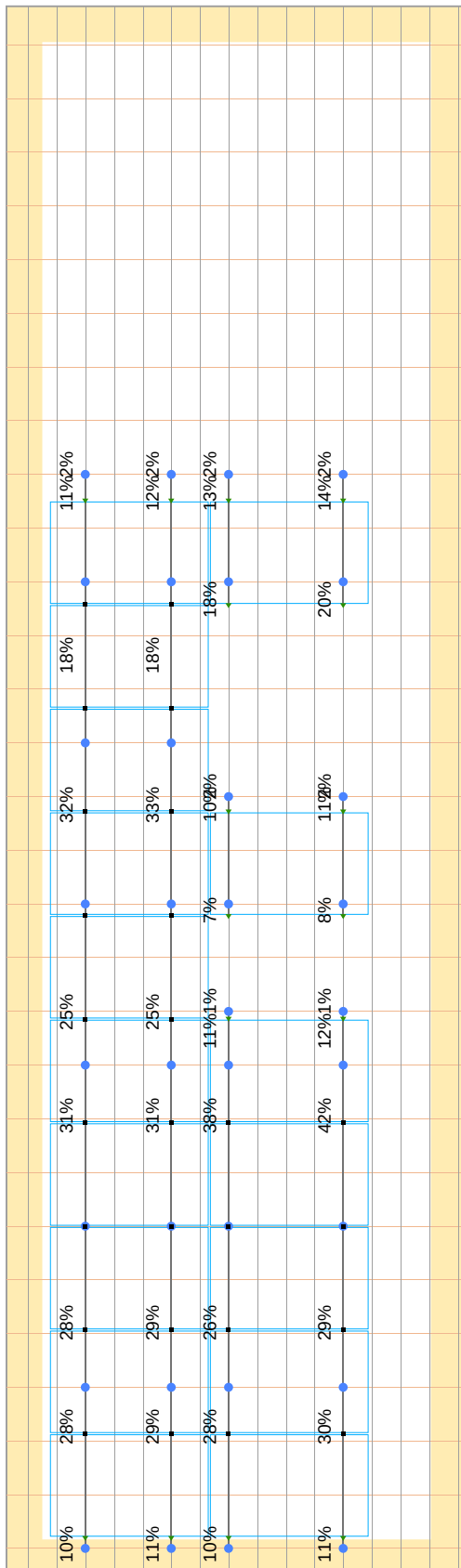
- Service life of PV system: 25 years
- Failure consequence class: 2

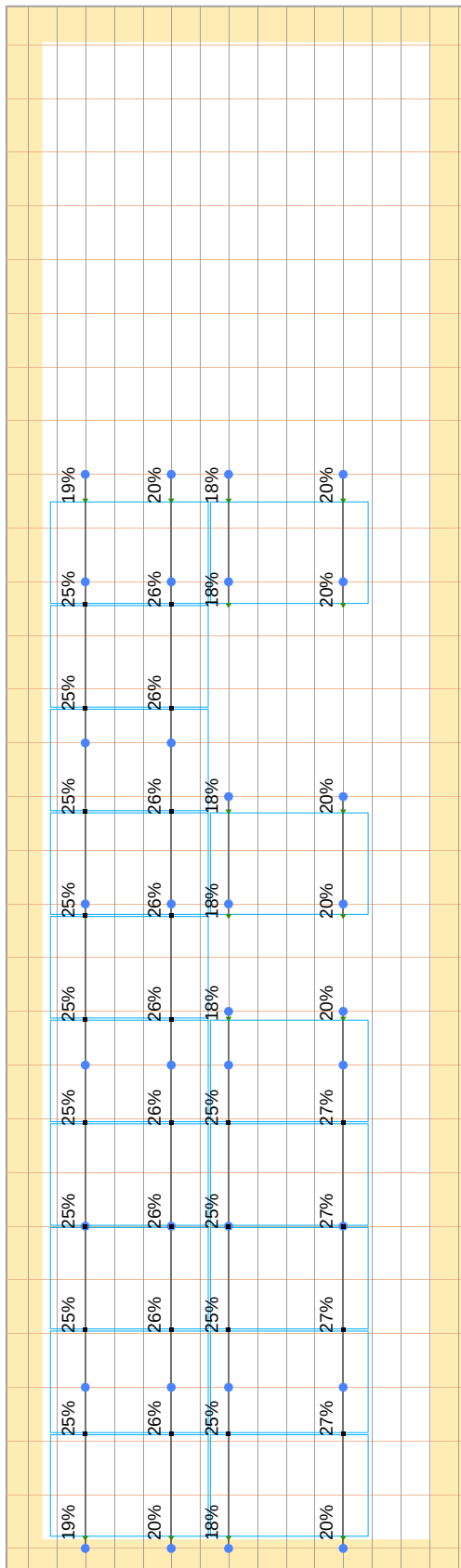


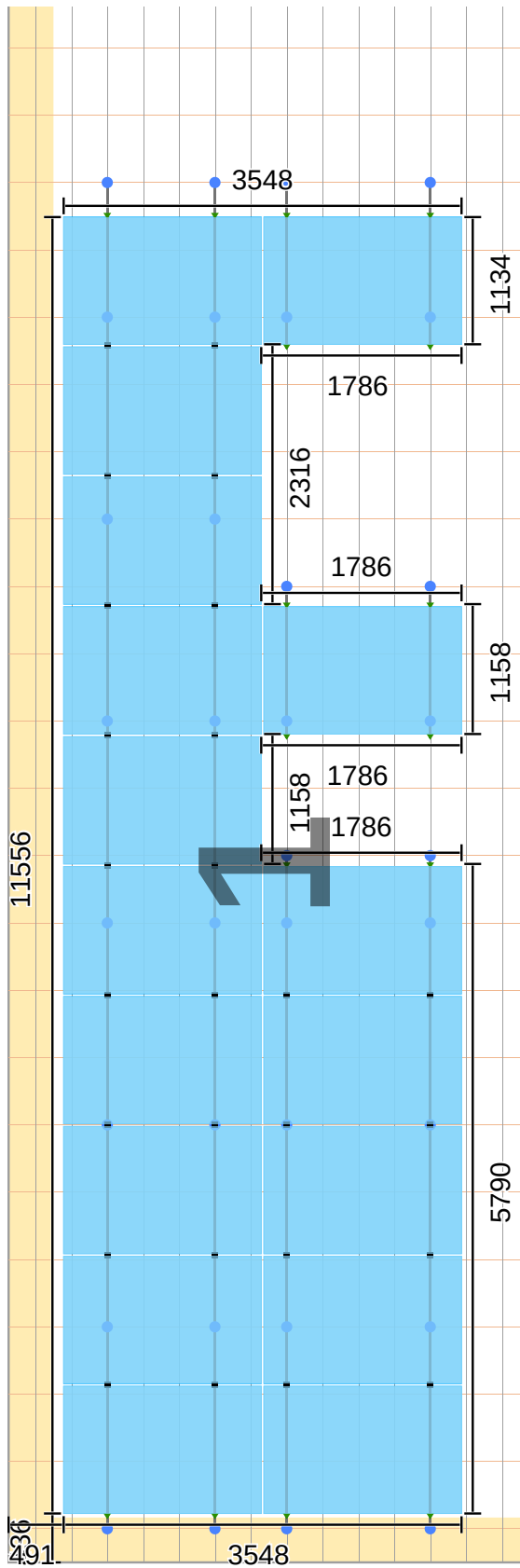












BILL OF MATERIAL

Article No.	Article	Quantity	Ordering Unit	Weight/Piece	Weight
R400532	VS+ Rail connector 50 x 37	8	1	0,193 kg	1,544 kg
R400570-B	VS+ Mounting rail 50 x 37 x 3600 mm black	13	1	2,530 kg	32,890 kg
R420081-BE	End clamp+ (black)	16	1	0,064 kg	1,024 kg
R420082-BE	Middle clamp+ (black)	26	1	0,063 kg	1,638 kg
R420171	Roof hook RH1 Pantile (without wood screw)	34	1	0,664 kg	22,576 kg
R900276	VS+ End Cap Universal black	16	1	0,008 kg	0,128 kg
R900333	Wood screw pan head 6 x 80	2	100	0,009 kg	1,800 kg
				Total Weight: 61,600 kg	

GENERAL

Technical regulations

Eurocode 0: 'Basis of structural design' EN 1990:2012
Eurocode 1: 'Action on Structures'
Part 1-3: 'General Actions, Snow Loads' EN 1991-1-3:2015
National Annex BS EN 1991-1-3:2003/NA:2010-06
Part 1-4: 'General Actions, Wind Loads' EN 1991-1-4:2010
National Annex BS EN 1991-1-4:2005/NA:2011-01
Eurocode 9: 'Design of Aluminium Structures'
Part 1-1: 'General Structural Rules' EN 1999-1-1:2007
Report BRE DG 489 (revised 2014)

Materials

Aluminium extruded sections, EN AW 6063 T6, $t \leq 10\text{mm}$
Rail connector EN AW 6063 T6
Roof hook, EN AC-42100
Screws, stainless steel A2-70
Softwood NH S10, C 24

Used documents

Schneider 'Bautabellen für Ingenieure', Werner-Verlag
SAPA 'Handbuch für Konstrukteure', Beuth Verlag

LOAD ASSUMPTIONS

Dead load

Solar modules type AIKO-A480-MCE54Mb are used.

The modules are angled vertically on the roof and are fastened on the larger module edges on the horizontal rails with modul clamps.

Dimensions:	1762 mm x 1134 mm
Weight:	$G = 20.6 \text{ kg}$
Load per longitudinal module side:	$F_G = 20.6 \text{ kg} * 9.81 \text{ m/s}^2 / 2 = 0.20 \text{ kN} / 2 = 0.101 \text{ kN}$

Mounting rails

Weight:	$0.70 \text{ kg/m} * 9.81 \text{ m/s}^2 = 0.007 \text{ kN/m}$
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Snow load

The determination of the snow load is carried out according to BS EN 1991-1-3:2003/NA:2010-06.

Snow-trap formation or snow-load accumulations are not considered in the calculation. Please contact Renusol if necessary.

Height above sea level:	108 m
Snow load zone:	2
Roof pitch:	$\alpha = 45^\circ$

Period of use:	25 Year
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Snow load:	$s_k = s_{k,50} * f_s = 0.42 \text{ kN/m}^2 * 0.93 = 0.39 \text{ kN/m}^2$ $\mu_{r1} = 0.600$ $s_{r1} = \mu_{r1} * s_k = 0.6 * 0.39 \text{ kN/m}^2 = 0.232 \text{ kN/m}^2$ $s_{r1,45^\circ} = 0.232 \text{ kN/m}^2 * \cos(45.0^\circ) = 0.164 \text{ kN/m}^2$ $F_{S,k} = 0.164 \text{ kN/m}^2 * 1.76 \text{ m} * 1.13 \text{ m} / 2 = 0.164 \text{ kN}$
Load per longitudinal module side:	

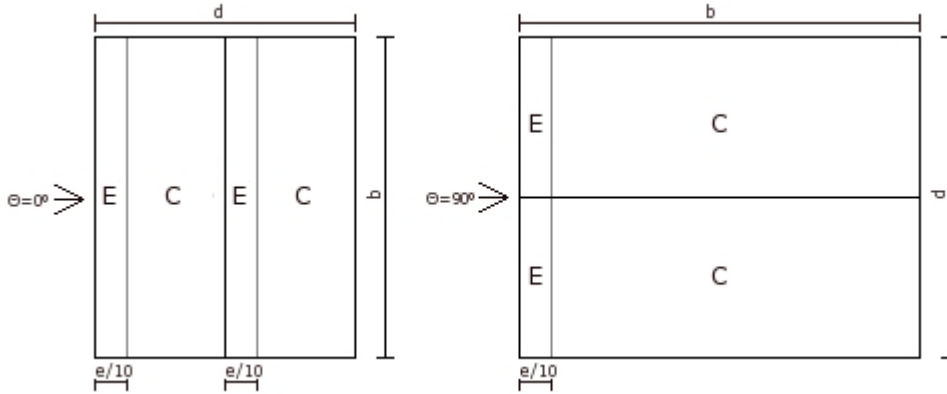
Wind load

The determination of the wind load is carried out according to BS EN 1991-1-4:2005/NA:2011-01.

Building height roof ridge:	5 m
Terrain category:	Country terrain
Basic wind velocity:	22.00 m/s
Distance to shoreline:	50.000 km
Style of roof:	Gable roof
Period of use:	25 Year
Pressure of the gusts velocity:	$q(z) = 0.651 \text{ kN/m}^2$

LOAD ASSUMPTIONS

All oncoming flow directions



Main roof

$$b = 17.53\text{m}$$

$$d = 7.27\text{m}$$

$$h = 5.00\text{m}$$

Ventilation direction 0° and 180°:

$$e = \min(b, 2h) = \min(17.53\text{m}, 10.00\text{m}) = 10.00\text{m}$$

Ventilation direction 90° and 270°:

$$e = \min(d, 2h) = \min(7.27\text{m}, 10.00\text{m}) = 7.27\text{m}$$

The coefficients of pressure and suction for the individual roof areas are interpolated for the roof pitch of 45 obtained from the report BRE Digest 489.

Wind pressure:

Edge area of roof (E)	$c_p = 0.53$	$W_D = 0.53 \cdot 0.651 \text{ kN/m}^2 \cdot 1.76 \text{ m} \cdot 1.13 \text{ m} / 2 = 0.343 \text{ kN}$
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Middle area of roof (C)	$c_p = 0.46$	Area is not relevant
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Wind suction:

Edge area of roof (E)	$c_p = -0.60$	$W_s = (-0.60) \cdot 0.651 \text{ kN/m}^2 \cdot 1.76 \text{ m} \cdot 1.13 \text{ m} / 2 = -0.390 \text{ kN}$
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Middle area of roof (C)	$c_p = -0.50$	Area is not relevant
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ANALYSIS

Load cases and load case combinations

Load cases

The respective loads are taken from the load assumptions and converted to a reference system perpendicular to the roof area.

LC 1	Dead load
LC 2	Snow load
LC 3	Wind pressure (by roof area)
LC 4	Wind suction (by roof area)

Significant load case combinations
according to: EN 1990:2012

Ultimate state of load-bearing capacity

LCC 1	Predominant action wind pressure $E_{d,LCC 1} = 1.35 * E_{GK,LC 1} + 1.50 * (E_{QK,LC 3} + 0.5 * E_{QK,LC 2})$
LCC 2	Predominant action snow $E_{d,LCC 2} = 1.35 * E_{GK,LC 1} + 1.50 * (E_{QK,LC 2} + 0.6 * E_{QK,LC 3})$
LCC 3	Predominant action wind suction (lifting) $E_{d,LCC 3} = 1.00 * E_{GK,LC 1} + 1.50 * (E_{QK,LC 4})$

Ultimate state of serviceability

LCC 4	Predominant action wind pressure $E_{d,LCC 4} = 1.00 * E_{GK,LC 1} + 1.00 * (E_{QK,LC 3} + 0.5 * E_{QK,LC 2})$
LCC 5	Predominant action snow $E_{d,LCC 5} = 1.00 * E_{GK,LC 1} + 1.00 * (E_{QK,LC 2} + 0.6 * E_{QK,LC 3})$
LCC 6	Predominant action wind suction $E_{d,LCC 6} = 1.00 * E_{GK,LC 1} + 1.00 * (E_{QK,LC 4})$

ANALYSIS

Area load on module:

Due to the building geometry and the location, the following area loads result for the module surface according to the standard calculation.

[kN/m²]		Section	Edge
LCC 1 Design	⊥	0.63	0.70
	//	0.18	0.18
LCC 2 Design	⊥	0.54	0.58
	//	0.27	0.27
LCC 3 Design	⊥	-0.42	-0.51
	//	0.07	0.07
LCC 4 Characteristic	⊥	0.43	0.47
	//	0.13	0.13
LCC 5 Characteristic	⊥	0.37	0.39
	//	0.19	0.19
LCC 6 Characteristic	⊥	-0.25	-0.32
	//	0.07	0.07

Maximum values

[kN/m²]	Characteristic	Design
Pressure	0.47	0.70
Suction	-0.32	-0.51
In parallel to the roof	0.19	0.27

ANALYSIS

Middle clamp

General

The module clamps consist of extruded aluminium sheaths material grade EN-AW 6063 T66. The lower part of the module clamps consists of a click profile made of S500 MC, EN 10149-2, which is attached to the module carrying profile and transfers the loads by form closure. On it the module end clamp or module middle clamp is fastened by a screw. When tightening the screw the module clamp presses the module to the rail.

Sketch



Static analysis

The maximum loads established in the load combinations of the tension loads perpendicular to the roof area and the respective shear loads parallel to the roof area or the maximum shear loads in combination with the corresponding tensile loads perpendicular to the roof area are significant for the analysis. Pressure loads perpendicular to the roof area are transferred by contact bearing.

Analysis

LCC 1

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 3760 \text{ mm}$ $y = 12474 \text{ mm}$
 Loads: $V_{x,d} = 0.19 \text{ kN}$
 Comparison stress: $V_{x,d}/F_{R,d,y} = 0.19/1.05 = 0.18 < 1$

LCC 2

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 3760 \text{ mm}$ $y = 12474 \text{ mm}$
 Loads: $V_{x,d} = 0.28 \text{ kN}$
 Comparison stress: $V_{x,d}/F_{R,d,y} = 0.28/1.05 = 0.27 < 1$

LCC 3

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 3760 \text{ mm}$ $y = 12474 \text{ mm}$
 Loads: $N_d = -0.54 \text{ kN}$
 $V_{x,d} = 0.07 \text{ kN}$
 Comparison stress: $N_d/F_{R,d,x} + V_{x,d}/F_{R,d,y} = 0.54/3.22 + 0.07/0.93 = 0.25 < 1$

ANALYSIS

End clamp

General

The module clamps consist of extruded aluminium sheaths material grade EN-AW 6063 T66. The lower part of the module clamps consists of a click profile made of S500 MC, EN 10149-2, which is attached to the module carrying profile and transfers the loads by form closure. On it the module end clamp or module middle clamp is fastened by a screw. When tightening the screw the module clamp presses the module to the rail.

Sketch



Static analysis

The maximum loads established in the load combinations of the tension loads perpendicular to the roof area and the respective shear loads parallel to the roof area or the maximum shear loads in combination with the corresponding tensile loads perpendicular to the roof area are significant for the analysis. Pressure loads perpendicular to the roof area are transferred by contact bearing.

Analysis

LCC 1

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 3760 \text{ mm}$ $y = 11311 \text{ mm}$
 Loads: $V_{x,d} = 0.10 \text{ kN}$
 Comparison stress: $V_{x,d}/F_{R,d,y} = 0.10/0.81 = 0.12 < 1$

LCC 2

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 3760 \text{ mm}$ $y = 11311 \text{ mm}$
 Loads: $V_{x,d} = 0.14 \text{ kN}$
 Comparison stress: $V_{x,d}/F_{R,d,y} = 0.14/0.81 = 0.17 < 1$

LCC 3

Regarding the calculation the following module clamp at the following position is significant.

Position: $x = 3760 \text{ mm}$ $y = 11311 \text{ mm}$
 Loads: $N_d = -0.27 \text{ kN}$
 $V_{x,d} = 0.04 \text{ kN}$
 Comparison stress: $N_d/F_{R,d,x} + V_{x,d}/F_{R,d,y} = 0.27/1.75 + 0.04/0.79 = 0.20 < 1$

ANALYSIS

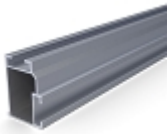
Mounting rails

General

An extruded section is used as load bearing rail.

It consists of material grade EN AW 6063 T6. At the joints, the rails are connected deflection resistant through an insertion profile (connector with rivet) with the same static parameters as the load bearing rails.

Cross section



Static analysis

The static system is a continuous beam. The single loads due to the load combinations are introduced into the supporting rails in a spacing specified by the module. The continuous beams are supported by the roof hooks or set screws.

The software analyses all rails but only the rail utilised maximally is shown (maximum stress utilisation and maximum deformation).

Analysis

LCC 1

Stress analysis

Regarding the calculation the following rail at the following position is significant.

Rail ID:	100001
Beginning of rail:	x = 3760 mm y = 11195 mm
End of rail:	x = 3760 mm y = 17265 mm
Position:	x = 3760 mm y = 15430 mm

Loads:	$N_d = 0.00 \text{ kN}$
	$V_{y,d} = 0.18 \text{ kN}$
	$V_{z,d} = -0.67 \text{ kN}$
	$M_{y,d} = 217.11 \text{ Nm} = 21.711 \text{ kNcm}$
	$M_{z,d} = 59.38 \text{ Nm} = 5.938 \text{ kNcm}$

Stress analysis:	$\sigma_{x,d} = N_d/A + M_{y,d}/W_y + M_{z,d}/W_z =$ $(0.00/2.60 + 21.711/3.25 + 5.938/2.24) \text{ kN/cm}^2 = 9.34 \text{ kN/cm}^2$
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Utilisation:	$\sigma_{x,d}/\sigma_{R,d} = 9.34/18.18 = 0.51 < 1$
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ANALYSIS

LCC 2

Stress analysis

Regarding the calculation the following rail at the following position is significant.

Rail ID: 100001
Beginning of rail: x = 3760 mm y = 11195 mm
End of rail: x = 3760 mm y = 17265 mm
Position: x = 3760 mm y = 15430 mm

Loads: $N_d = 0.00 \text{ kN}$
 $V_{y,d} = 0.26 \text{ kN}$
 $V_{z,d} = -0.56 \text{ kN}$
 $M_{y,d} = 180.39 \text{ Nm} = 18.039 \text{ kNcm}$
 $M_{z,d} = 86.47 \text{ Nm} = 8.647 \text{ kNcm}$

Stress analysis: $\sigma_{x,d} = N_d/A + M_{y,d}/W_y + M_{z,d}/W_z =$
 $(0.00/2.60 + 18.039/3.25 + 8.647/2.24) \text{ kN/cm}^2 = 9.42 \text{ kN/cm}^2$

Utilisation: $\sigma_{x,d}/\sigma_{R,d} = 9.42/18.18 = 0.52 < 1$

LCC 3

Stress analysis

Regarding the calculation the following rail at the following position is significant.

Rail ID: 100001
Beginning of rail: x = 3760 mm y = 11195 mm
End of rail: x = 3760 mm y = 17265 mm
Position: x = 3760 mm y = 15430 mm

Loads: $N_d = 0.00 \text{ kN}$
 $V_{y,d} = 0.07 \text{ kN}$
 $V_{z,d} = 0.48 \text{ kN}$
 $M_{y,d} = -156.62 \text{ Nm} = -15.662 \text{ kNcm}$
 $M_{z,d} = 23.92 \text{ Nm} = 2.392 \text{ kNcm}$

Stress analysis: $\sigma_{x,d} = N_d/A + M_{y,d}/W_y + M_{z,d}/W_z =$
 $(0.00/2.60 + 15.662/3.25 + 2.392/2.24) \text{ kN/cm}^2 = 5.89 \text{ kN/cm}^2$

Utilisation: $\sigma_{x,d}/\sigma_{R,d} = 5.89/18.18 = 0.32 < 1$

LCC 4

Serviceability

Regarding the calculation the following rail at the following position is significant.

Rail ID: 100001
Beginning of rail: x = 3760 mm y = 11195 mm
End of rail: x = 3760 mm y = 17265 mm
Position: x = 3760 mm y = 16330 mm
Deformation: u = 4.53 mm
permitted deformation: $u_{zul} = l/100 = 1800.00 \text{ mm} / 100 = 18.0 \text{ mm}$
Utilisation: $u/u_{zul} = 4.53 / 18.00 = 0.25 < 1$

LCC 5

Serviceability

Regarding the calculation the following rail at the following position is significant.

Rail ID: 100001
Beginning of rail: x = 3760 mm y = 11195 mm
End of rail: x = 3760 mm y = 17265 mm
Position: x = 3760 mm y = 16330 mm
Deformation: u = 4.55 mm
permitted deformation: $u_{zul} = l/100 = 1800.00 \text{ mm} / 100 = 18.0 \text{ mm}$
Utilisation: $u/u_{zul} = 4.55 / 18.00 = 0.25 < 1$

ANALYSIS

LCC 6

Serviceability

Regarding the calculation the following rail at the following position is significant.

Rail ID:	100001
Beginning of rail:	x = 3760 mm y = 11195 mm
End of rail:	x = 3760 mm y = 17265 mm
Position:	x = 3760 mm y = 16330 mm
Deformation:	u = 2.87 mm
permitted deformation:	$u_{zul} = l/100 = 1800.00 \text{ mm} / 100 = 18.0 \text{ mm}$
Utilisation:	$u/u_{zul} = 2.87 / 18.00 = 0.16 < 1$

ANALYSIS

Mounting on the existing rafter roof with gutter tile roofing

General

The mounting rail is connected with the rafter using a roof hook.

The loads are conducted from the mounting rail to the fastening element via a hammer-head bolt M8, A2. Ripples on the mounting rail and the fastening element provide for vertical load transmission despite the existing slotted hole. The roof hook is connected to the rafter with 3 wood screws Ø 6.0mm.

Sketch

Analysis

The roof hook, item number R420171 made of aluminium by Renusol GmbH is used.

With the specified design values of the roof hook, the used wood screws are not overloaded and will not be considered in the following statements.

LCC 1

Regarding the calculation the following fastener at the following position is significant.

Position: $x = 3760 \text{ mm}$ $y = 15430 \text{ mm}$

Loads: $N_d = 1.20 \text{ kN}$

$V_{x,d} = 0.33 \text{ kN}$

Comparison stress: $N_d/F_{R,d,x} + V_{x,d}/F_{R,d,y} = 1.20/3.50 + 0.33/2.60 = 0.47 < 1$

LCC 2

Regarding the calculation the following fastener at the following position is significant.

Position: $x = 3760 \text{ mm}$ $y = 15430 \text{ mm}$

Loads: $N_d = 1.00 \text{ kN}$

$V_{x,d} = 0.47 \text{ kN}$

Comparison stress: $N_d/F_{R,d,x} + V_{x,d}/F_{R,d,y} = 1.00/3.50 + 0.47/2.60 = 0.47 < 1$

LCC 3

Regarding the calculation the following fastener at the following position is significant.

Position: $x = 3760 \text{ mm}$ $y = 15430 \text{ mm}$

Loads: $N_d = -0.86 \text{ kN}$

$V_{x,d} = 0.13 \text{ kN}$

Comparison stress: $N_d/F_{R,d,x} + V_{x,d}/F_{R,d,y} = 0.86/3.02 + 0.13/2.60 = 0.34 < 1$

TOTAL BILL OF MATERIAL

Article No.	Article	Quantity	Ordering Unit	Weight/Piece	Weight
R400532	VS+ Rail connector 50 x 37	12	1	0,193 kg	2,316 kg
R400570-B	VS+ Mounting rail 50 x 37 x 3600 mm black	21	1	2,530 kg	53,130 kg
R420081-BE	End clamp+ (black)	24	1	0,064 kg	1,536 kg
R420082-BE	Middle clamp+ (black)	42	1	0,063 kg	2,646 kg
R420171	Roof hook RH1 Pantile (without wood screw)	54	1	0,664 kg	35,856 kg
R900276	VS+ End Cap Universal black	24	1	0,008 kg	0,192 kg
R900333	Wood screw pan head 6 x 80	2	100	0,009 kg	1,800 kg
				Total Weight: 97,476 kg	

IMPORTANT NOTES

The Project Report is a result of information provided by the Customer ("Customer" means customer of Renusol ordering this Project Report from the technical service of Renusol or user of the PV Configurator creating this Project Report himself). Renusol has neither verified the accurateness nor the completeness of the information and data provided by the Customer, which form the basis of this Project Report. It is the responsibility of the Customer to check and verify all input variables (including but not limited to those input variables which had been pre-set with proposed values) and assumptions used in the Project for their accuracy and correctness.

These verifications shall include but not be limited to the following aspects: (a) Wind and snow loads are proposed by the PV Configurator using respective wind and snow load maps. It should be verified that the local conditions do not deviate from the values used in the Configuration (e.g. location on mountain with higher snow load). (b) The Customer shall check and verify the Failure Consequence Class ("CC"). Typical residential and commercial buildings require CC 2. The Customer shall use higher CC in sensitive local environment (e.g. public building, high frequency of visitors, vicinity with potential for severe damages). (c) The service lifetime of the PV installation shall be verified by the Customer depending on the expectation of the ultimate user of the PV installation as well as the lifetime of the other components used in the installation. If the lifetime is expected beyond the service lifetime used for this Project Report, all relevant structural properties as well as input variables and assumptions shall be re-checked using the then expected service lifetime. (d) For flat roof systems: The Customer shall in any case measure and document the friction coefficient of the PV system on the location-specific roof cover it is placed on. The measurement shall be performed in various, at least three roof areas. (e) For flat roof systems: The PV Configurator proposes a ballast calculation. The ballast forms, together with the weight of the PV mounting system itself and the weight of the module, the total weight of the system. The actual ballast applied may in no case be lower than the values proposed by the PV Configurator. The ballast applied shall furthermore be documented. If the ballast applied cannot be precisely determined, a safety factor increasing the ballast is to be applied.

To the extent values of input variables measured or observed by the Customer differ from values used in this Project Report, the configuration of the PV installation shall be re-iterated using the respective correct values.

To the extent this Project Report includes a data concerning structural properties, it is the responsibility of the Customer to professionally verify (have verified) the structural data with regards to its compliance with the applicable local laws and properties of the location for which the Project Report has been prepared.

Furthermore the Terms of Use of the Renusol PV Configurator (<https://www.pv-configurator.com/pages/terms>) and the General Terms and Conditions (https://www.renusol.com/files/content/Downloads/Rechtliche%20Dokumente/Renusol_AGB_EN_110406.pdf) apply. The General Installation Guidelines of Renusol as well as the Installation Manuals and Data Sheets of the respective Renusol products, have likewise to be complied to.



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