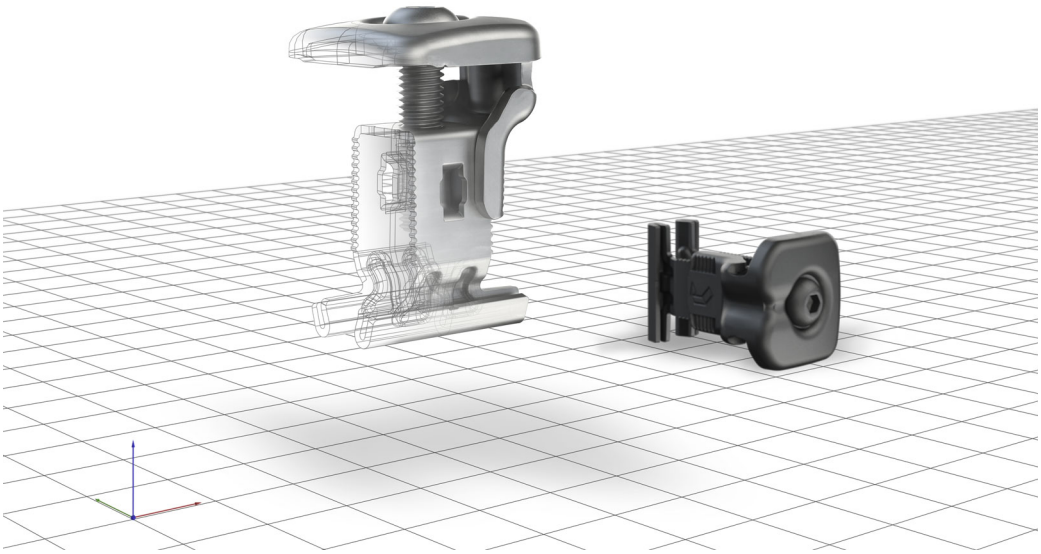
Technical project overview

Kew Gardens - Tractor & Log Store Building

Building project	Kew Gardens - Tractor & Log Store Building
Address	Treetop Walkway , TW9 2AA
Country	United Kingdom
Module Type	Shanghai JA Solar Technology Co. Ltd. - JAM54S31-420/LR (1500V)
Number of modules	75
Rated output	31.5 kWp
Mounting system	MetaSole+
Editor	Renusol Europe GmbH



LOCATION

Street	Treetop Walkway
City	TW9 2AA
Country	United Kingdom

SURROUNDINGS

Code	Eurocode NA GB
Terrain height above sealevel	8,00 m
Snow load zone	Zone 3
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

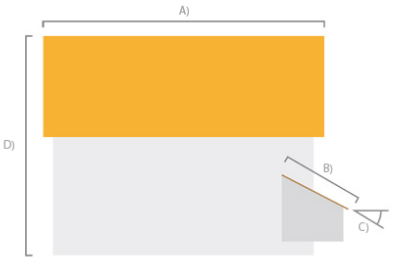
Peak velocity pressure	0,52 kN/m^2
Snow load	0,46 kN/m^2
Snow load on roof	0,36 kN/m^2
Base wind speed ($V_{b,0}$)	22,00 m/s

TOPOGRAPHY

Topography	Not exposed

ROOF PROPERTIES

Roof type	Gable roof
Coverage type	Trapezoidal profile
A) Raised bead spacing	333,00 mm
First raised bead at	100,00 mm
B) Raised bead width	20,00 mm
C) Raised bead height	40,00 mm
Sheet quality	Steel ≥ S320GD
Sheet thickness	0.50mm
C) Roof pitch	11,00 º
D) Building height	4,46 m

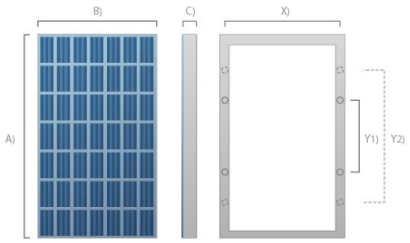


SUBSTRUCTURE

Substructure type	Purlins
Material of substructure	Wood
Spacing of substructure	1200,00 mm
First substructure at	300,00 mm
Substructure thickness	200,00 mm

MODULE PARAMETERS

Manufacturer	Shanghai JA Solar Technology Co. Ltd.
Name	JAM54S31-420/LR (1500V)
Length	1762 mm
Width	1134 mm
Height	30 mm
Weight	20 kg
Rated output	420 W_{peak}
Color	black
Datasheet	Open datasheet



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

The module data was taken from a database. Please check whether this data corresponds to your actual module order. If necessary, please correct the data using the editing function.

SYSTEM

System	MetaSole+

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	Landscape
Fastener type	MS+: steel 0.40-1.25mm

MODULE RAIL

Optimize fasteners	Mounting optimized

CLAMPS

Clamp type	Mid clamps+ / End clamps+
Clamp colour	black
Max value middle clamps	32 %
Max value end clamps	41 %

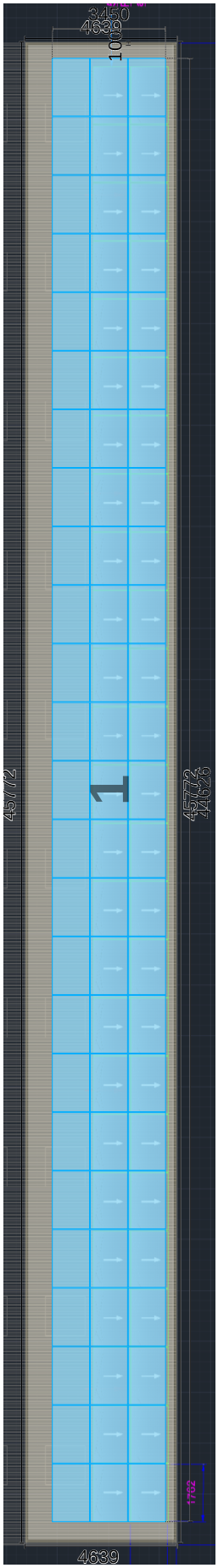
STATIC VALIDATION

Your project was validated by our statics check successfully.

Static utilization factor: 79%

Static utilization fastener: 79%
Static utilization clamp: 41%

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
• Sheet quality: Steel ≥ S320GD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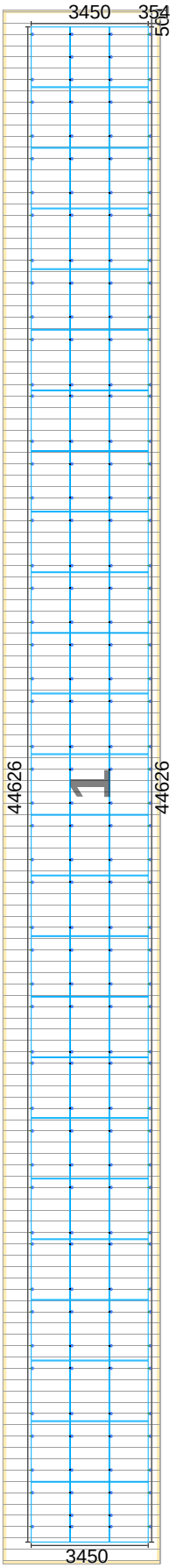
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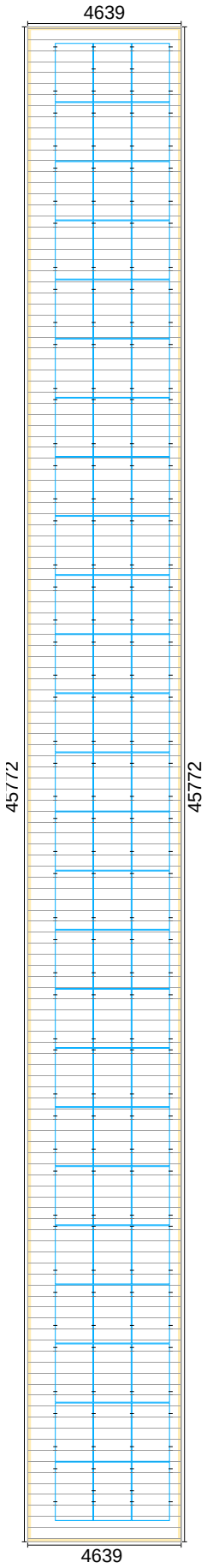
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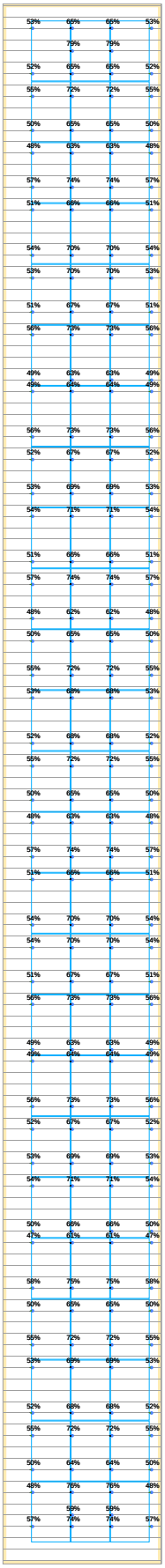

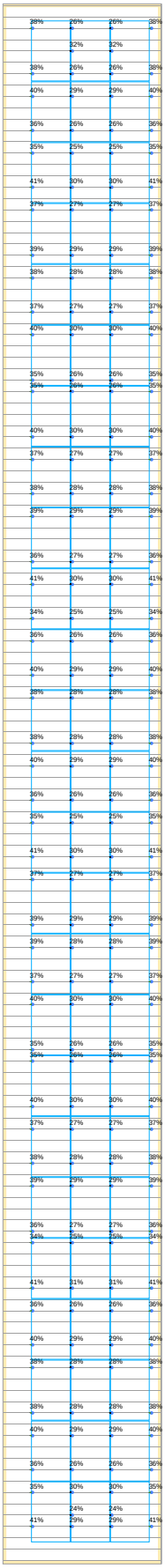

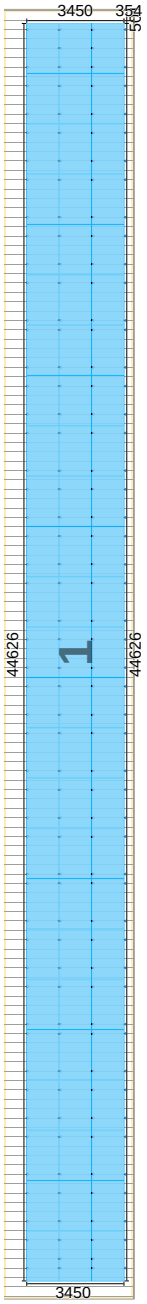
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BILL OF MATERIAL

Article No.	Article	Quantity	Ordering Unit	Weight/Piece	Weight
R420081-BE	End clamp+ (black)	100	1	0,064 kg	6,400 kg
R420082-BE	Middle clamp+ (black)	104	1	0,063 kg	6,552 kg
R420402	MetaSole+ metal sheet thickness: steel 0.40-1.25mm; alu 0.50-2.00 mm	204	1	0,084 kg	17,136 kg
				Total Weight:	30,088 kg

LOAD ASSUMPTIONS

Dead load

Solar modules type JAM54S31-420/LR (1500V) are used.
The modules are angled horizontally on the roof and are fastened on the larger module edges on the vertical rails with module clamps.

Dimensions:	1762 mm x 1134 mm
Weight:	G = 20.0 kg
Load per longitudinal module side:	F_G = 20.0 kg * 9.81 m/s² / 2 = 0.20 kN / 2 = 0.098 kN

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:	8 m
Snow load zone:	3
Roof pitch:	α = 11°
Period of use:	25 Year
Snow load:	$s_k = s_{k,50} * f_s$ = 0.50 kN/m² * 0.93 = 0.46 kN/m² μ_1 = 0.800 $s_1 = \mu_1 * s_k$ = 0.8 * 0.46 kN/m² = 0.371 kN/m² $s_{1,11°}$ = 0.371 kN/m² * cos(11.0°) = 0.364 kN/m²
Load per longitudinal module side:	$F_{S,k}$ = 0.364 kN/m² * 1.76m * 1.13m / 2 = 0.364 kN

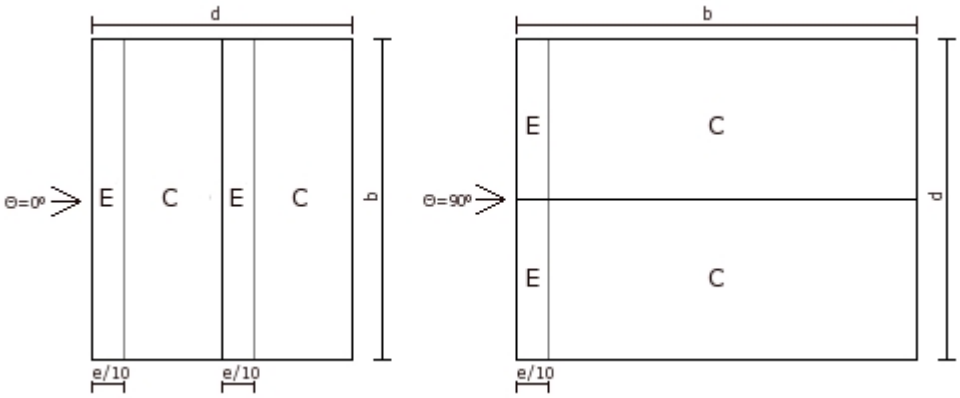
Wind load

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

Building height roof ridge:	4 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) = 0.520 kN/m²

LOAD ASSUMPTIONS

All oncoming flow directions



Main roof	b = 45.77m
	d = 9.11m
	h = 4.46m
Ventilation direction 0° and 180°:	e = min(b,2h) = min(45.77m, 8.91m) = 8.91m
Ventilation direction 90° and 270°:	e = min(d,2h) = min(9.11m, 8.91m) = 8.91m

The coefficients of pressure and suction for the individual roof areas are interpolated for the roof pitch of 11 obtained from the report BRE Digest 489.

Wind pressure:

Edge area of roof (E)	c_p=0.12	W_D = 0.12*0.520kN/m²*1.76m*1.13m/2 = 0.062 kN
Middle area of roof (C)	c_p=0.12	W_D = 0.12*0.520kN/m²*1.76m*1.13m/2 = 0.062 kN

Wind suction:

Edge area of roof (E)	c_p=-1.76	W_s = (-1.76)*0.520kN/m²*1.76m*1.13m/2 = -0.914 kN
Middle area of roof (C)	c_p=-0.60	W_s = (-0.60)*0.520kN/m²*1.76m*1.13m/2 = -0.311 kN

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	⊥	0.49	0.49
	//	0.08	0.08
LCC 2 Design	⊥	0.72	0.72
	//	0.13	0.13
LCC 3 Design	⊥	-0.37	-1.28
	//	0.02	0.02
LCC 4 Characteristic	⊥	0.34	0.34
	//	0.05	0.05
LCC 5 Characteristic	⊥	0.49	0.49
	//	0.09	0.09
LCC 6 Characteristic	⊥	-0.22	-0.82
	//	0.02	0.02

Maximum values

[kN/m²]	Characteristic	Design
Pressure	0.49	0.72
Suction	-0.82	-1.28
In parallel to the roo	0.09	0.13

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

Plate thickness:	0,5 mm

LCC 1

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

Position:	x = 3139 mm y = 37680 mm
Loads:	$V_{x,d}$ = 0.09 kN
Comparison stress:	$V_{x,d}/F_{R,d,y}$ = 0.09/1.05 = 0.08 < 1

LCC 2

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

Position:	x = 3139 mm y = 37680 mm
Loads:	$V_{x,d}$ = 0.14 kN
Comparison stress:	$V_{x,d}/F_{R,d,y}$ = 0.14/1.05 = 0.14 < 1

LCC 3

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

Position:	x = 3139 mm y = 1383 mm
Loads:	N_d = -0.96 kN
	$V_{x,d}$ = 0.01 kN
Comparison stress:	$N_d/F_{R,d,x}$ + $V_{x,d}/F_{R,d,y}$ = 0.96/3.22 + 0.01/0.84 = 0.32 < 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 = 4303 mm y = 37680 mm
Loads:	$V_{x,d}$ = 0.04 kN
Comparison stress:	$V_{x,d}/F_{R,d,y}$ = 0.04/0.81 = 0.05 < 1

LCC 2

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

Position:	x = 4303 mm y = 37680 mm
Loads:	$V_{x,d}$ = 0.07 kN
Comparison stress:	$V_{x,d}/F_{R,d,y}$ = 0.07/0.81 = 0.09 < 1

LCC 3

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

Position:	x = 4303 mm y = 37680 mm
Loads:	N_d = -0.70 kN $V_{x,d}$ = 0.01 kN
Comparison stress:	$N_d/F_{R,d,x}$ + $V_{x,d}/F_{R,d,y}$ = 0.70/1.75 + 0.01/0.75 = 0.41 < 1

ANALYSIS

MetaSole

General

To calculate the maximum load capacity per MetaSole, the support forces per longitudinal module side are used for the decisive combinations of loading cases. For this purpose, the exact position of the module clamp and with this, of the MetaSole is considered using a bar chart. The resulting support forces are checked against the permitted forces (for MetaSole and the module clamps).

Sketch

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.

Plate thickness:	0,5 mm

LCC 1
Regarding the calculation the following fastener at the following position is significant.

Position:	x = 3139 mm y = 37680 mm
Loads:	N_d = 0.54 kN
	$V_{x,d}$ = 0.09 kN
Comparison stress:	$V_{x,d}/F_{R,d,y}$ = 0.09/1.19 = 0.07 < 1

LCC 2
Regarding the calculation the following fastener at the following position is significant.

Position:	x = 3139 mm y = 37680 mm
Loads:	N_d = 0.79 kN
	$V_{x,d}$ = 0.14 kN
Comparison stress:	$V_{x,d}/F_{R,d,y}$ = 0.14/1.19 = 0.12 < 1

LCC 3
Regarding the calculation the following fastener at the following position is significant.

Position:	x = 3139 mm y = 1383 mm
Loads:	N_d = -0.96 kN
	$V_{x,d}$ = 0.01 kN
Comparison stress:	$N_d/F_{R,d,-x} + V_{x,d}/F_{R,d,y}$ = 0.96/1.23 + 0.01/1.19 = 0.79 < 1