Structural calculations

Weight loading calculations

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Dead load from roof covering	0.34 kN/m^2
Imposed load	0.75 kN/m^2
Total loading without solar array	**1.09 kN/m^2**

Weight of solar panels and mounting	385.6 kg
Area covered by solar array	30 m^2
Loading imposed by solar array	0.13 kN/m^2
Total loading with solar array	**1.2 kN/m^2**

Increase in loading due to solar array: 11.9%

An increase of less than 15% in the load imposed on a roof is not considered to be a significant change (The Building Regulations 2010, Approved Document A). ✓

For a traditional cut roof with rafters and purlins we recommend also using our rafter calculator to check the load-bearing capacity of the rafters. Even if the increase in loading is more than 15% the rafters may well be able to take the additional weight.

Please note that this method does not calculate the strength of the roof, and if a roof was badly constructed, does not meet existing building regulations, or is in poor condition then it may still not be appropriate to install an array.

Span tables calculations

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Total dead load of solar array, mounting and roof covering	0.47 kN/m^2
Roof pitch	30
Rafter depth	100
Rafter breadth	47
Maximum unsupported span	**1.65**
Maximum permitted span	**2.24**

For a dead load of not more than 0.50kN/m^2 and a roof pitch of 22.5 to 30 degrees, with roof timbers of 47 × 100 mm at 600 centers, the maximum permitted unsupported span according to Trada span tables is 2.24m.

The maximum unsupported length of the roof timbers is within the permitted span. ✓

Wind loading calculations

The maximum force acting on a solar array from wind loading is given by the following formula in BRE Digest 489:

$$F = q_p \times C_{p\ net} \times C_a \times C_t \times A_{ref}$$

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Q_p		603.5 Pa
From Fig 34 in Guide to the Installation of Photovoltaic Systems for a building 7.5 m high, in windzone 1, in urban terrain, at a distance of greater than 20km from the sea		
$C_{p\ net}$	Roof Centre	Roof edge
Uplift	-0.5	-0.6
Pressure	0.462	0.528
C_a		0.888
At an altitude of 44m		
C_t		1
When there is no significant topography		
A_{ref}		29.97m^2
F	Roof Centre	Roof edge
Uplift	**-10842N**	**-13010N**
Pressure	**10018N**	**11449N**

With 64 roof hooks we should allow for an uplift force per hook in the central zone of **169N**, rising to **203N** at the edges. If 2 screws are used per roof hook, this equates to **85N**per fixing in the central zone, and **102N** at the edges.

Roof hooks for slate roofs are fixed with screws that pass through the 5mm plate of the roof hook and a 20mm batten (or spacing pad of wood) before being driven home in the rafter. So there is approximately 45 mm of thread in the timber. The pull-out force in C16 timber is given by tables and formulae in BS5268 Part 2:

$$17.3 \times 1.25 \times 45 = \mathbf{973N}$$

The pullout force on the fixings is more than the expected wind loading, even when the fixings are close to the edge of the roof.

The MCS012 certificate for the selected roof hookstates that the maximum design wind uplift is **207N per roof hook**.

For modules 1.76m high, with two rails per panel, the wind loading force per meter of rail will be **318N/m** in the center of the roof (362Pa × 1.76m / 2), rising to **382N/m**(434Pa × 1.76 / 2) at the edge of the roof. In the center of the roof the design uplift should therefore not be exceeded if hooks are spaced no more than **0.65m**apart (207N / 318N/m). At the edge of the roof hooks should be spaced no more than **0.54m** apart (207N / 382N/m).

With the specified number of hooks, loading forces are expected to be less than the uplift force per hook derived from the MCS012 certificate both at the center and edge of the roof. ✓