

# Residential solar PV: are mounting systems being structurally verified?

**Words:** Jason McCabe, Technical Director UK & Ireland

Are residential solar installations being built on assumptions rather than engineering evidence? A closer look at mounting systems, design software and fixing layouts raises serious questions about how structural adequacy is being verified, and whether current industry practice is putting installations at risk.

For nearly two decades, I have questioned how residential solar photovoltaic (PV) mounting systems are structurally verified across the UK and Europe.

Discussions with leading mounting system manufacturers have highlighted a significant disparity between the number of residential products sold and the number of projects designed using manufacturers' own design platforms. This raises an important question: are residential pitched-roof PV systems being installed without project-specific structural calculations?

A common installation practice appears to involve positioning roof fixings on every second rafter, typically at 1,200 mm centres, then doubling up at the ends to achieve 600 mm spacing.

Where did this approach originate and, more importantly, is it structurally adequate for every installation?

## The purpose of manufacturer design software

Mounting system manufacturers invest heavily in design software developed around wind tunnel testing, mechanical load testing

and the structural performance of individual components and complete systems.

These tools assess project-specific requirements, accounting for factors such as wind and snow loads, location and system configuration, whether the installation is 2 kW or 2 MW.

If these tools are not being used for many residential installations, how are those systems being structurally verified?

## Understanding the guidance and testing

Relevant UK guidance and standards include:

- BRE Digest 489 (2014 revision).
- MIS 3002, Issue 6.0.
- The IET Code of Practice for Grid-connected Solar Photovoltaic Systems, second edition.

BRE Digest 489 provides a simplified methodology for calculating wind loads on roof-mounted PV systems, drawing on BS EN 1991-1-4 and previous testing. Both MIS 3002 and the IET Code of Practice reference this guidance.

MCS 012 addresses mechanical load testing of PV mounting systems, including resistance

to wind uplift under prescribed test conditions. However, wind uplift testing alone does not establish a system's complete structural performance under all relevant loading conditions, including snow, compression and shear.

Such testing is valuable, but it should not be treated as a substitute for project-specific structural verification.

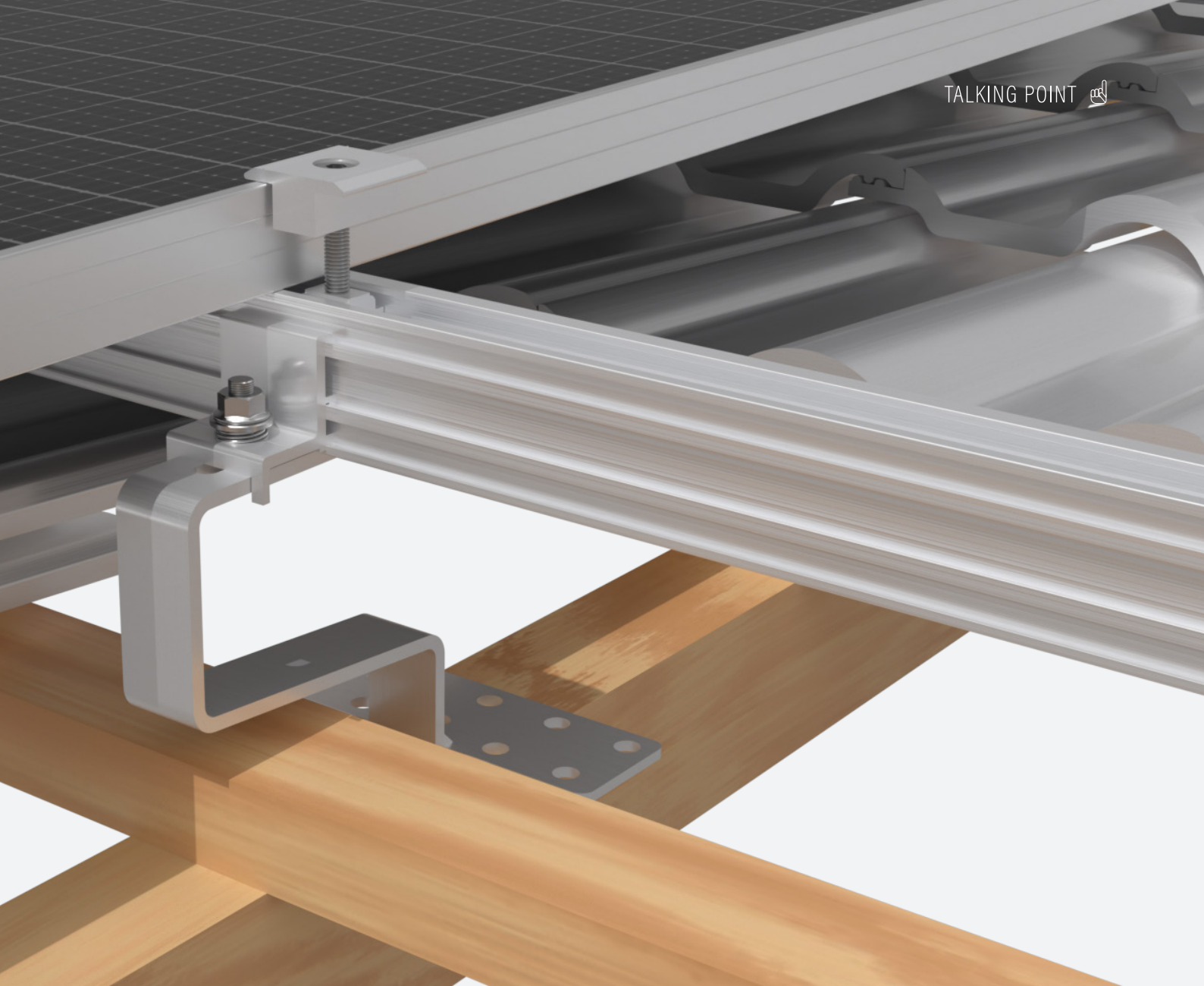
## The problem with generic fixing layouts

In practice, there appear to be three approaches to residential system design:

- Fixings are positioned according to the installer's judgement, without a project-specific structural calculation.
- An alternative calculator or kit-building platform is used instead of the manufacturer's design software.
- Wind loads are calculated using BRE Digest 489 and compared with published MCS 012 test results to determine fixing numbers and spacing.

The first approach is clearly inadequate without appropriate engineering assessment. The second and third warrant closer scrutiny.





From my experience of testing alternative kit-building platforms, some appear to calculate site-specific wind uplift and divide the resulting force by a resistance value taken from MCS 012 test documentation.

However, BRE Digest 489's author, Dr Paul Blackmore, explicitly cautions against this approach, stating:

'The uplift resistance of each hook therefore cannot be determined by simply dividing the uplift force, by the number of hooks. The mounting system manufacturer or structural engineer should be consulted.'

This is a critical point. Structural performance depends on much more than the number of fixings. Rail strength, bending resistance, clamp performance, connection capacities, roof construction and load distribution must also be considered.

#### **Different systems, identical results?**

To investigate further, I compared two mounting systems from manufacturers active in the UK market.

One fixing had a reported tested design load of 1.24 kN, compared with 340 N for the other. The systems also differed considerably in rail strength, bending resistance and module clamp tensile performance.

Using calculations for an array comprising two rows of four modules, my assessment indicated that one system did not meet the requirements of the load cases considered, even under relatively moderate loading. The other performed more favourably, although some locations, including parts of northern Scotland and coastal areas, required reduced fixing spacings. In certain cases, the maximum spacing was 600 mm.

Yet, when both systems were assessed using a particular alternative kit-building platform, the results were identical: 1,200 mm fixing centres, reduced to 600 mm at the ends, regardless of the wind load entered.

When I assessed the stronger system using its manufacturer's own design software, the results aligned with my independent calculations.

If mounting systems have materially different structural capacities, how can a design platform reliably produce identical fixing layouts without adequately accounting for those differences?

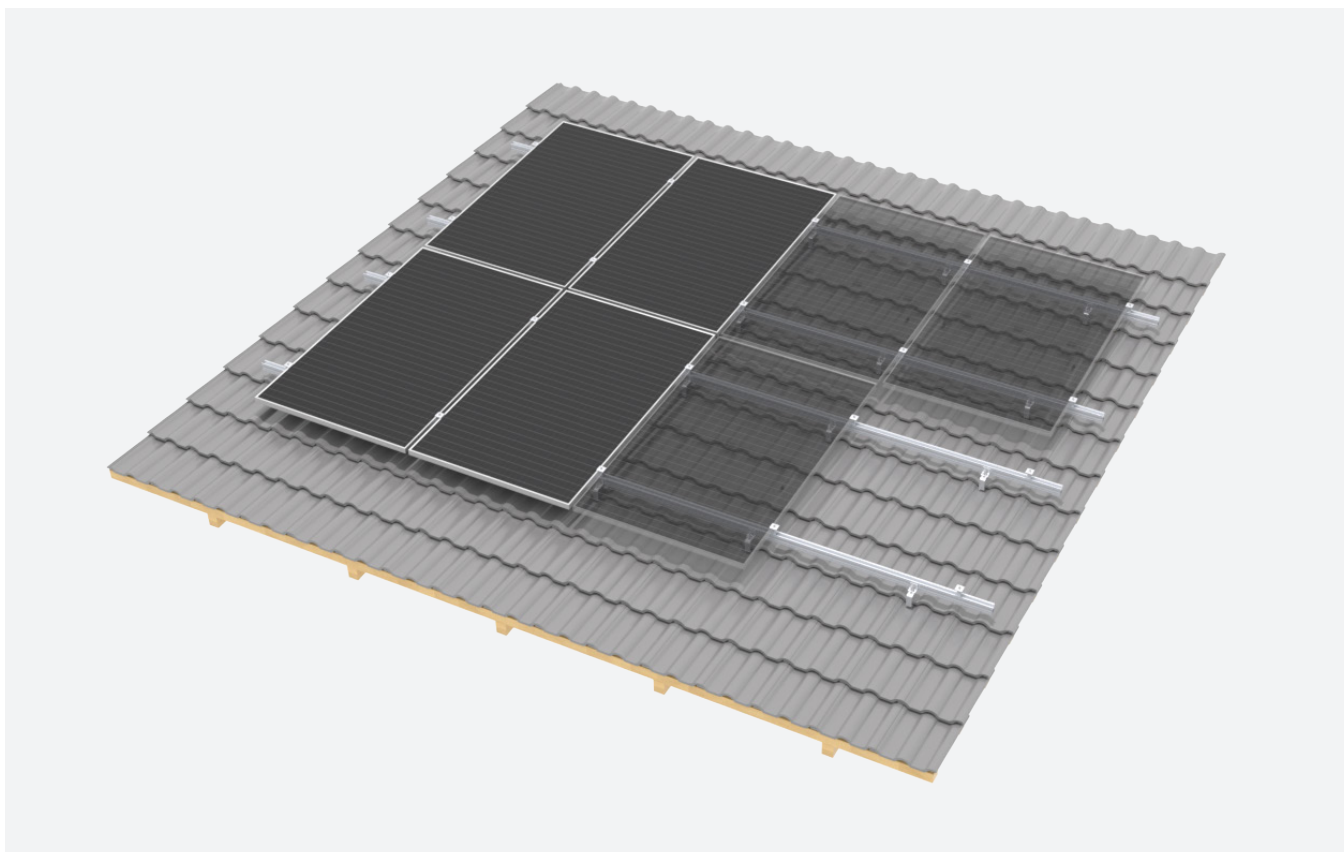
#### **Why are more systems not failing?**

Industry contacts have reasonably asked why, if these concerns are valid, more failures are not being reported.

First, PV system failures do occur, but reporting is fragmented. Companies responsible for installations may have ceased trading or re-emerged under different names. Businesses specialising in rectifying failed or poorly installed PV systems operate across the UK, serving both residential and commercial markets.



Jason McCabe



In my own experience working with these businesses, nearly every failed system I encountered lacked a project report demonstrating structural verification. While this is not statistical evidence of industry-wide failure rates, it is a concerning observation.

Second, systems must be designed for the environmental loads they may experience over their intended service life. Depending on the design parameter, wind and snow actions may be based on 25- or 50-year return periods under the applicable standards and National Annexes. These are statistical design concepts, not predictions of when an event will occur.

A system that performs adequately in everyday weather may still be vulnerable under more severe conditions. The absence of failure to date does not demonstrate that a system has been adequately designed.

#### Structural verification must be standard practice

Project-specific structural calculations should be an integral part of every residential PV installation.

Manufacturers' design platforms are widely available, often free of charge, and are developed to account for the characteristics of their products and the requirements of individual projects. Installers and designers should ensure that the selected components, fixing arrangements and supporting roof structure have been assessed for the relevant loads and failure modes.

Where alternative design tools are used, their methodology, assumptions and validation must be understood, and the resulting calculations must demonstrate that the proposed system is structurally appropriate. Relevant manufacturer warranty requirements should also be checked, as some may specify particular design and verification procedures.

The objective is not simply to produce a fixing layout. It is to demonstrate that the complete installation, including modules, clamps, rails, roof fixings and supporting structure, has been assessed appropriately.

#### A shared responsibility

The message to the industry is straightforward: ensure that every installation is properly assessed.

As an industry, we must not allow convenience, assumptions or generic fixing layouts to replace sound engineering practice.

The consequences of inadequate structural design extend beyond damaged equipment and costly remedial work. In the worst-case scenario, a poorly secured PV array could detach from a roof and endanger the public.

Every residential solar PV installation deserves the same fundamental consideration: structural adequacy must be demonstrated, not assumed.

[clenergy.com](https://www.clenergy.com)

### Three references, different roles

#### BRE Digest 489

The 2014 revision provides guidance on wind loads for roof-mounted solar systems. It helps establish the forces an installation must resist; it does not certify a mounting product.

#### MIS 3002

This is an installation standard for MCS contractors. Issue 6.0 covers the design, installation, commissioning and handover of solar PV systems with a maximum DC output of 50 kWp.

#### MCS 012

This is a product standard for solar mounting systems and components. Issue 3.0 addresses wind uplift resistance, fire performance and weathertightness. It also includes a downward-load test for certain roof hooks or brackets that transfer load onto fragile roof coverings.

Product test results must be considered alongside the installation conditions and the manufacturer's stated limits.

Sources: BRE Digest 489, revised 2014; MIS 3002, Issue 6.0; MCS 012, Issue 3.0.