Best Practice note on application of Building Regulations

Retrofitting Solar Panels

Introduction

Photovoltaic panels are being increasingly added to many existing roofs, often in order to benefit from the government's 'Feed-in-Tariff' scheme. Solar thermal collector panels are also gaining in popularity, although not presently part of the Feed-in-Tariff.

This best practice note is intended to provide guidance as to the effect of retro-fit installation of panels on existing domestic-scale roof structures and how this affects compliance with the functional requirement A1 of Schedule 1 to the Building Regulations 2010.

Considerations

Competent Persons Scheme

Schedule 3 of the Building Regulations 2010 makes allowance for installers to gain membership of a Competent Persons Scheme (CPS) and thereby perform self-certification of certain defined-scope building works including solar-thermal and PV installation.

For Photovoltaic (PV) panels only, the Microgeneration Certification Scheme (MCS) exists to register installers for membership of the Feed-in-Tariff scheme, but the MCS is NOT a CPS.

Guidance published by certain CPS administrators indicates that membership of a CPS will allow self-certification of Part A requirements and installers will be deemed competent to carry out structural assessments of existing roof structures, if credits have been gained in City and Guilds 2372 - PV.

Building Regulations

Regulation 3 defines Building Work which needs to secure compliance with the regulations. The installation of solar panels primarily falls within the category of 'Installation of a Controlled Service or Fitting'; additionally it will also involve a 'Material Alteration', for the structural alterations element with regard to an existing building. Approved Document A gives guidance on achieving compliance with this aspect and suggests that additional loading to a roof structure would constitute a material alteration if the loading to the roof is increased by 15% or more.

CPS membership allows installers to assess whether compliance with Part A will be achieved, and reference to the 15% increase in loading threshold may be a suitable benchmark, i.e. an increase of load that is less than 15% can be assumed to fall outside the remit of Part A. *However, it is very important to bear in mind that not all CPS scheme operators encompass Part A issues.*

Panel loads and their effect on the roof

Panels currently in production have a fitted mass of around 20 kg/m2 (both PV and Solar Thermal). Considering an average total rafter load of around 140 kg/m2, the addition of 20 kg/m^2 would represent an increase in loading of some 15%. It is the duty of an installer to assess the effect of this increase in loading in order to maintain an adequate factor of safety against failure.

Individual roof structures will vary by construction/type, workmanship, materials, maintenance/decay, exposure etc. Some roofs may already be overstressed, if carrying heavy roof coverings or in exposed locations.

Typical roof constructions

a. Trussed rafters:

Modern trussed rafters have been in common use since the 1970s. Assessment by leading structural consultants and the BRE has established that

small dead load increases to standard configuration fink trusses (of up to 9m span) will not overstress truss members or their connector plates to any significant degree. Hence, an "allowed" installation of a single row of solar thermal or PV panels is considered acceptable, without further structural investigation.

An installer should always carry out a basic assessment to establish a minimum level of robustness in the construction, which includes truss fixings to wall plate; ensuring bracings to internal members are in place; centrality of connector plates at node points; general timber degradation or metal fastener corrosion.

b. Traditional cut roofs – purlins, binders, principal trusses:

Historic roof structures, which are generally defined as pre-Victorian, will often comprise an arrangement of principal trusses, with supporting beams spanning between them (purlins and binders). The secondary members supporting the building fabric (rafters and ceiling joists) are in turn supported by the primary members. These roofs are usually constructed of locally sourced hardwood and section sizes tend to be conservative. Connections may be traditional (e.g. mortice and tenon, dove-tailed etc) with timber dowels, bolted with iron straps or fixed with large iron nails. Kept dry, the timber will tend to gain in shear strength over time, as seasoning continues. Valley and hip members are sized accordingly, depending on their degree of support and restraint.

Victorian and 20th century roofs saw the widespread use of softwood construction. In the 1950s the Timber Development Association (TDA) produced standard pattern roof arrangements, comprising softwood principal trusses, purlins, binders etc.

Studies of these roofs have shown them to be near capacity at present, with the principal variable being the standard of timber used (quality, stress-grading, seasoning etc). Bungalow roofs, on estates constructed in the 1960s and 1970s, tend to push these roof types to their limit, as spans increase.

Connections are critical in principal trusses, many of which have been found to comprise heavily corroded bolts, varying sizes of washer and inadequate projection of bolt threads. Internal members are often only connected by 2 no. nails!

Structural modelling of the addition of solar panels has indicated that bending stresses would approach 100% capacity and more. This erodes any factor of safety and presents the possibility of an ultimate failure condition (collapse). Member deflections in TDA roofs currently run at around 150% of that recommended for brittle finishes, i.e. plasterboard and plaster skim. Imposition of further dead load only exacerbates this.

Any proposed loading increase in both historic and more recent cut roofs should therefore be investigated by a Structural Engineer.

Wind uplift

The addition of solar panels should not affect the positive wind pressure acting on roofs, as they are aligned to the profile of the roof.

The unit size of the panel may be sufficient to act as a wind-suction collector and thereby generate concentrated uplift forces at certain locations on the existing roof. An average wind load to apply to all but the most exposed areas of England and Wales would assume a Dynamic Pressure, $q = 1.2\ kN/m^2$. Further specific guidance is given in BRE Digest 489.

It is unlikely that such forces would have any net effect on the overall negative wind load on the roof, as the roof dead load will remain the dominant effect. However, a localised concentration of uplift force will be expected at fixing points. The critical element is the connection of the clamp brackets to the rafters; fixing to tiling battens is not considered a suitably robust solution. On trussed rafter roofs, individual truss fixings may need strengthening, in exposed locations.

Rafters may be as little as 35mm wide in pre-fabricated roof trusses, thus careful consideration must be given to the specification of fixings into this timber in order to achieve the necessary edge distances required by the design codes. The absolute minimum acceptable edge distance is 4 x screw diameter and the minimum screw spacing is 7 x screw diameter. The installer of the clamps must ensure that these minimum distances are achieved. Brackets and fixings should also be suitably durable for their exposure (e.g. galvanised).

Snow load

It is suggested that snow will be less likely to build up on PV panels, due to their thermal property as a "black body", flat profile and low coefficient of friction. Solar thermal collectors are different in profile, however, and may encourage a localised accumulation of drifting snow. Current research data suggests that this effect is not significant, but installers should make an assessment of any risk of snow accumulation.

Conclusion

- The snow loading on roofs is not thought at this time to be significantly affected by the installation of PV or solar-thermal panels. Installers will have specialist knowledge of solar-thermal panel profiles and any likelihood of localised drifting, caused by evacuated tubes which have a raised profile, compared to flat PV panels.
- Wind effects on the overall roof structure will not be changed significantly. However, adequate fixing of panels to rafters is necessary to prevent panel uplift.
- The predominant effect of installing panels is an increase in dead load of around 15%, therefore all roof structures should be assessed for their strength and robustness to accommodate additional dead load.
- Modern trussed rafters (of up to 9m span) are generally considered suitably robust for limited additional loads, comprising a single row of panels only. Proposed loadings beyond this scale would require a survey by a Structural Engineer.
- Older roofs, of traditional cut-roof construction (including principal trusses, purlins, binders etc) are often operating at near maximum capacity. Where there are concerns about the structure of these roofs, they should be assessed by a Structural Engineer, in order to ascertain suitability to receive additional loading.
- The installer remains responsible for the commissioning of all surveys and any remedial design work.

Competent Person Scheme members may self-certify all aspects of installation, and would be expected to address all the issues discussed above. BUT not all CPS administrators require, or expect their members to carry out a structural assessment of roof structures; in some instances they merely deal with the electrical aspects of installation. So it may sometimes be necessary for a Building Regulation application to be made for the structural aspects of solar installations.

Non-members of a CPS should always obtain Building Regulations consent.