ROOF STRUCTURE DESIGN FOR SOLAR PANEL INSTALLATION

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Solar energy is a form of renewable energy that is increasingly becoming popular due to its many benefits. It is a clean source of energy that does not produce harmful emissions and does not contribute to climate change. Solar panels are the main component used to capture solar energy and convert it into electricity. These panels are made up of photovoltaic cells that convert sunlight into direct current (DC) electricity. An inverter is then used to convert the DC electricity into alternating current (AC) electricity that can be used to power homes, businesses, and other electrical devices. As technology continues to advance, new and more efficient types of solar panels are being developed, making solar energy even more accessible and cost-effective for both residential and commercial use.

Solar panels can be installed on a wide variety of structures, including residential, commercial, and industrial structures, regardless of the type of roofs adopted in each application. In residential structures, pitched roofs are often preferred for their classic and aesthetically pleasing appearance. These sloping roofs efficiently shed rainwater, preventing water buildup. Conversely, flat roofs find favor in commercial buildings due to their cost-effectiveness and suitability for rooftop installations like HVAC units. However, flat roofs require slight slopes toward the middle or edges for proper drainage, necessitating more maintenance to ensure watertight seals. In factory buildings, both flat and pitched roofs have their merits. Flat roofs allow expansive rooftop workspaces and equipment installations, while pitched roofs provide efficient ventilation and insulation.

Pitched roofs and flat roofs are exposed to distinct loadings, and it's crucial to take these differences into account when considering the installation of solar panels. The design load is the amount of weight that the roof can support without being structurally compromised. For example, sloping roofs are subjected to gravity loads and wind loads, while flat roofs must bear additional live loads, such as HVAC equipment or people. The design load for a particular roof can be determined by consulting with a structural engineer.

The load of a solar panel can vary depending on several factors, such as its size, type, and brand. However, on average, a standard 60 solar cells panel, measuring 1.7 square meters, typically weighs around 18 kg (equivalent to 0.10 kN/m^2), while a 72 solar cells module with a size of 2.3 square meters weighs approximately 23.5 kg (equivalent to 0.10 kN/m^2). After adding the weights of the mounting structure, DC cabling, cable trunking, and other components, the average load typically becomes 16 kg per square meter (equivalent to 0.16 kN/m^2). 60 solar cells panels are commonly used in residential units due to their smaller size, allowing for more efficient placement on a house's roof. In contrast, 72 solar cells panels are around 35% larger than 60 solar cells panels, making them challenging to arrange efficiently on residential roofs. They are also heavier, and their increased height can complicate handling and maneuvering, resulting in higher installation costs. Therefore, 72 solar cells panels are more commonly adopted for commercial solar arrays or solar farms [1].

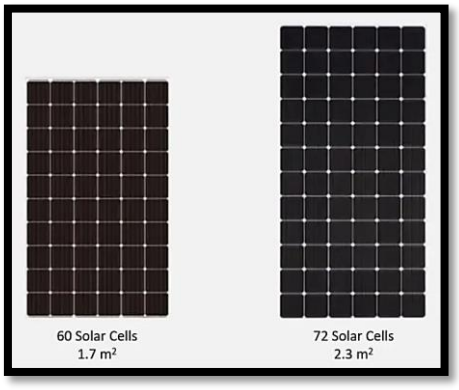

Figure 1：60 solar cells and 72 solar cells panels [1]

As the installation of solar panels on a roof can cause additional load, it will lead to structural issues if not considered properly. These structural issues can manifest in the form of sagging, bowing, cracking of the roof, or even collapse. Thus, it is crucial to verify the roof's structural capacity before installing solar panels to ensure that it can support the added weight of the panels.

For an industrial building, the roof has already designed to take up the dead load and live load without accounting for the wind load and additional weight due to the solar panels. The dead load on the roof is approximately 25 kg per square meter (equivalent to 0.25 kN/m^2), which includes the weight of the steel plate, metal zinc, purlins, insulation materials, and other components. The live load, as per the Uniform Building By-Law (UBBL), is also about 25 kg per square meter for both flat roofs and sloping roofs up to 10º, where no access is provided to the roof except for maintenance. The additional loading from the solar panels, amounting to 0.16 kN/m^2, even if not leading to structural failure of the roof, will certainly compromise the safety margin specified in the design based on either the BS Code or Eurocode. If the roof cannot even sustain the unfactored loading, it may become necessary to reinforce the roof structure to prevent structural failure. This can involve reinforcing the rafters or trusses, adding additional supports, or even replacing the entire roof structure.

Attempting to install solar panels on a roof that cannot support the additional weight without any reinforcement can have severe consequences. The roof may fail, leading to property damage, injury, or even loss of life. Therefore, it is crucial to consult with a qualified structural engineer to assess the roof's design load and ensure that it can support the additional weight of solar panels without compromising the structural integrity of the building.

In conclusion, solar panels are a cost-effective and sustainable way to generate electricity for buildings. However, before installing solar panels, it's important to consider the type of roof on the building and the weight of the panels. It's also important to consult with a structural engineer to ensure that the roof can support the additional weight of solar panels. By taking these steps, you can ensure a safe and successful installation of solar panels for your building, whether it be a residential, commercial, or industrial building.

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References:
[1] Solar Choice (2023). Solar panel sizes and dimensions?. Retrieved on 28th October 2023 from https://www.solarchoice.net.au/solar-panels/sizes/