How to Mount PV Modules: the Effect of Different Clamping Configuration on Mechanical Stresses in PV Modules

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- Installation manuals of photovoltaic (PV) modules frequently outlines various mounting configurations
- As per IEC 61215 [1], each mounting configuration must withstand a mechanical load of at least 2400 Pa
- To save cost and time often only most critical configuration is tested
- **Question: which configuration is most critical, and which is most effective in minimizing mechanical stress in PV modules?**
- **To answer: using FEM (finite element method) to examine impact of various mounting configurations and clamp length on stresses in PV modules**

Method

- 3D FEM model of framed 1.8 x 1.1 m² glass-backsheet PV module, containing 144 M6 half-cells
- Simulation of a homogeneous mechanical load of 5400 Pa acting on the frontglass
- Variation of
  1. Clamp length: 50 mm → 100 mm
  2. Clamp position at the long side of the PV module
  3. Clamp position at the short side of the PV module
- Evaluation of the first principal stress in both the solar cells and the front glass
- **Identification of the clamping configuration that results in the lowest stress** in either solar cells or front glass

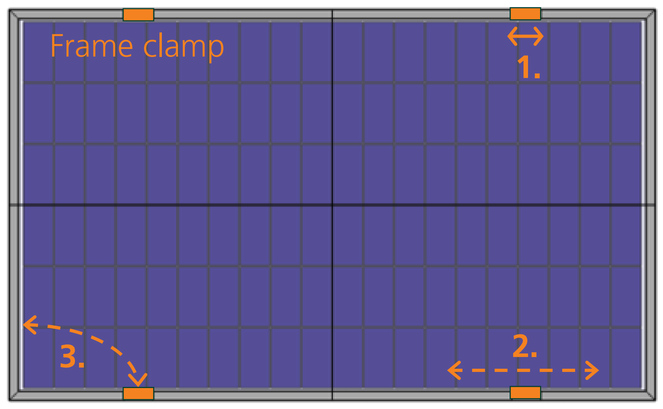

Fig. 1: Module geometry alongside the simulated parameter variations of the module clamping.

Results

1. Clamp length

- Reduction of clamp size: 100 mm → 50 mm
  - Deflection increases: 44.1 mm → 47.2 mm
  - First principal stress in glass increases: 106 MPa → 122 MPa
  - First principal stress in solar cells increases: 78 MPa → 84 MPa
- **Larger clamp size results in lower stresses**

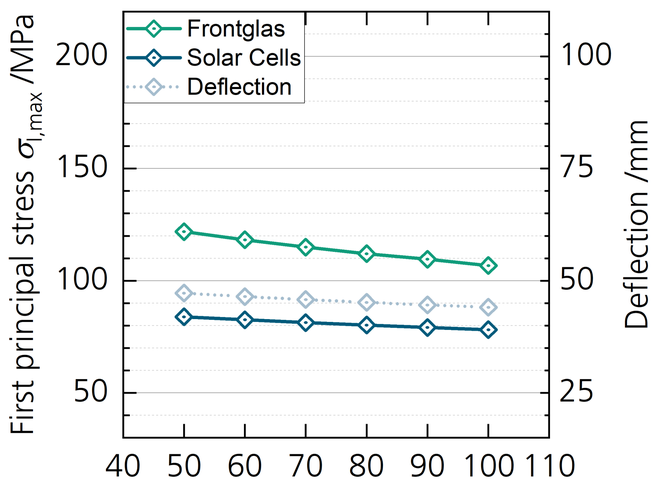

Fig. 2: First principal stress in the frontglass (green), solar cells (blue) alongside the modules deflection (grey) for clamp length between 50 mm and 100 mm.

2. Clamp position at long side

- Variation of clamp position
  - Minimal deflection using a clamping position of 15 % module length
  - Minimal first principal stress in frontglass at a clamping position of 15 % module length
  - Minimal first principal stress in solar cells clamping at modules corner
- **Clamping at modules corner results in lower stress in solar cells**
- **Optimal clamping position for glass: 15 % of module length**

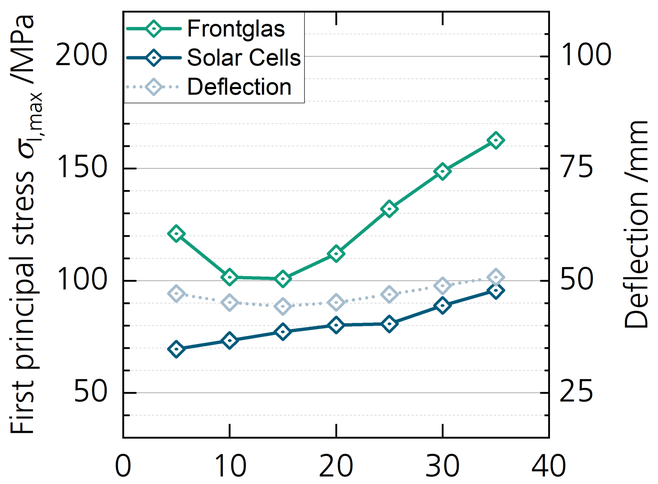

Fig. 3: First principal stress in the frontglass (green), solar cells (blue) alongside the modules deflection (grey) for different clamping positions at the modules long side.

3. Clamp position at short side

- Variation of clamp position
  - Minimal deflection clamping at modules corner
  - Minimal first principal stress in frontglass clamping at modules corner
  - Minimal first principal stress in solar cells clamping at modules corner
- **Clamping at modules middle results in lower stress in the solar cells**
- **Clamping at modules corner result in lower stress in the frontglass**

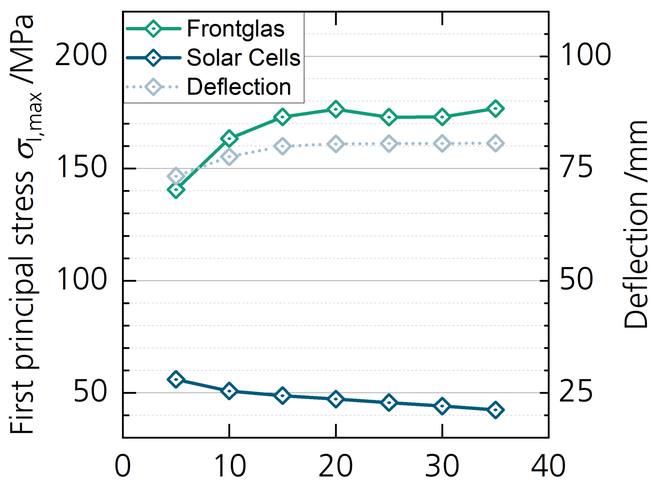

Fig. 4: First principal stress in the frontglass (green), solar cells (blue) alongside the modules deflection (grey) for different clamping positions at the modules short side

Summary

- Effect of **different clamping configurations** on **mechanical stress** in PV modules is investigated using FEM
- **Longer clamp** reduces both modules deflection as well as stresses in frontglass and solar cells
- **Clamping position on long side at 15 % of module length** minimizes first principal **stress in frontglass**
- **Clamping position on short side** reduces first principal **stress in solar cells**

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1 International Electrotechnical Commission (IEC), IEC 61215-2:2021 Terrestrial photovoltaic (PV) modules – Design qualification and type approval: Part 2: Test Procedures 2, accessed 21 April 2021.

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