Structural Assessment – BiTile Mounting System

1. Introduction

This document describes the structural assessment of the BiTile system, in which photovoltaic panels are mounted on aluminium rails that function as structural support members.

The rails are fixed to timber battens using roof hooks, which are anchored into the substructure with screws.

The assessment is based on:
- **EN 1991-1-4** – Wind actions
- **EN 1995-1-1** – Timber structures
- Aluminium material properties (EN AW 6063 T66)

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2. System Description
The load transfer is as follows:

PV panel → rail → roof hook → screws → batten → roof structure

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3. Geometry

- Centre-to-centre spacing of rails: **800 mm**
- Centre-to-centre spacing of roof hooks: **800 mm**
- Rail span: **800 mm**

Tributary area per rail:

$$0.8 \times 0.8 = 0.64\ \text{m}^2$$

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4. Material Properties

Aluminium profile:

- Alloy: EN AW 6063 T66
- Modulus of elasticity:

$$E = 70{,}000\ \text{N/mm}^2$$

- Allowable stress:

$$\sigma_{allow} = 195\ \text{N/mm}^2$$

Section properties:

- Section modulus:

$$W_x = 4508.5\ \text{mm}^3$$

- Second moment of area:

$$I_x = 95522.3\ \text{mm}^4$$

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5. Loads

5.1 Permanent load

$$q_g = 100\ \text{N/m}^2$$

5.2 Wind load (conservative – edge zone)

According to EN 1991-1-4:

- Wind region: I (Dutch reference)
- Terrain: open terrain
- Building height: 20 m

Peak velocity pressure:

$$q_p = 1.27\ \text{kN/m}^2$$

Pressure coefficient (edge zone, worst case):

$$C_{pe} = -2.9$$

5.3 Resulting load

$$q_w = 1.27 \cdot 2.9 = 3.68\ \text{kN/m}^2$$
$$q_{tot} = 3.68 + 0.10 = 3.78\ \text{kN/m}^2$$

$$q_{tot} = 3780\ \text{N/m}^2$$

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6. Conversion to line load

Tributary width = 0.8 m:

$$q_{line} = 3780 \cdot 0.8 = 3024\ \text{N/m}$$
$$= 3.02\ \text{N/mm}$$

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7. Profile calculation

7.1 Bending moment

$$M_{max} = \frac{qL^2}{8}$$
$$M = \frac{3.02 \cdot 800^2}{8} = 241600 \text{ Nmm}$$

7.2 Stress check

$$\sigma = \frac{M}{W}$$
$$\sigma = \frac{241600}{4508.5} \approx 53.6 \text{ N/mm}^2$$

Allowable:

$$195 \text{ N/mm}^2$$

Utilisation ≈ 27%

7.3 Deflection

$$w_{max} = \frac{5qL^4}{384EI}$$
$$w \approx 0.25 \text{ mm}$$

Allowable deflection

$$\frac{L}{200} = 4 \text{ mm}$$

Utilisation ≈ 6%

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8. Load on connection

Reaction force per support:

$$R = \frac{qL}{2} = \frac{3.02 \cdot 800}{2} = 1208 \text{ N}$$

≈ 1.2 kN per roof hook

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9. Screw load

Per roof hook:
  2 screws

$$F_{screw} = 1208/2 = 604\ \text{N}$$

≈ 0.6 kN per screw

Comparison with capacity

- Screw: fully threaded 5×60 mm stainless steel
- Timber class: conservative C18

Characteristic density:

$$\rho_k = 320\ \text{kg/m}^3$$

Effective embedment depth:

$$l_{ef} = 25\ \text{mm}$$

Withdrawal parameter (Eurocode 5)

$$f_{ax,k} = 0.082 \cdot \rho_k = 0.082 \cdot 320 = 26.2\ \text{N/mm}^2$$

Characteristic withdrawal resistance

$$F_{ax,Rk} = f_{ax,k} \cdot d \cdot l_{ef}$$
$$F_{ax,Rk} = 26.2 \cdot 5 \cdot 25 = 3275\ \text{N}$$

Design value

$$F_{ax,d} = 3275/1.3 \approx 2520\ \text{N}$$

Design value ≈ 2.5 kN per screw

Utilisation

$$\frac{0.6}{2.5} \approx 0.24$$

Utilisation ≈ 30%

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10. Results

Component	Capacity	Load	Utilisation
Profile (stress)	195 N/mm²	54 N/mm²	~27%
Deflection	4 mm	0.25 mm	~6%
Screw	2.5 kN	0.6 kN	~30%

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11. Conclusion

The BiTile system meets the structural requirements for strength and deflection with a significant safety margin, even under conservatively assumed wind loads in edge zones at a building height of 20 m.

- The aluminium profile has ample reserve capacity
- The screw connections are sufficiently dimensioned

The system can therefore be considered **structurally robust and reliable**.

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12. Remarks

- The calculation is based on a regular grid of 800 × 800 mm
- Edge zones are conservatively included
- Actual loads will generally be lower in practice

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13. Disclaimer

This assessment is based on **Dutch wind conditions (EN 1991-1-4, National Annex Netherlands)**.

For projects:

- outside the Netherlands
- in different wind or snow regions
- or with deviating geometries

the final structural design must always be verified and approved by a **locally certified structural engineer**, in accordance with national regulations.