Detailed Calculation of Posi-Joist (Metal-Web Timber Joist)

Variable depth PS8–PS12 | Standard web thickness 1.0 mm | Eurocodes EN 1990 / EN 1991 / EN 1995-1-1 / EN 1993

Centres 600 mm | Load 1.5 kN/m² | Chords 45×70 mm C24

1. Input Data

Structure: Open-web Posi-Joist with timber chords and steel webs of variable depth (PS8 → PS9 → PS10 → PS12). Drawing designation: “Kaldferm” (sloping member).

Parameter	Value	Source / Justification
Span L (variable)	4.2 … 5.5 m	Determined by deflection
Joist centres s	600 mm	Default maximum
Characteristic load q_k	1.5 kN/m²	Specified by client
Load per joist q	0.9 kN/m	1.5 × 0.6
Chords	45 × 70 mm, C24	EN 338
Webs (Posi-Strut)	Steel 1.0 mm thick	Standard MiTek / ETA value
Service class	2	Roof structure (EN 1995-1-1)
k_{mod}	0.80	Medium-term (snow)
k_{def}	0.80	Service class 2, solid timber
γ_M (timber)	1.30	EN 1995-1-1, Table 2.3
Support conditions	Simply supported	Pinned–pinned

Note on web thickness: The original drawing indicated 0.7 mm. According to MiTek technical data, ETA 07/0161 / ETA 20/1169 and ICC-ES ESR-4722, the standard thickness of Posi-Strut metal webs (PS8–PS16) is 1.00 ± 0.09 mm (Europe) or 20 gauge ≈ 0.91 mm (North America). This calculation uses the European standard value of 1.0 mm.

2. Geometric and Stiffness Properties of Sections

2.1 Chord cross-sectional area

$$A = b \times h = 45 \times 70 = 3150 \text{ mm}^2$$

2.2 Effective depth (distance between centroids of chords)

Type	Internal height	h_{eff} = int. + 70	$I_{eff} = A \cdot h_{eff}^2/2$	EI_{eff} (N·mm²)
PS8	108 mm	178 mm	4.99×10^{7} mm⁴	5.49×10^{11}
PS9	131 mm	201 mm	6.36×10^{7} mm⁴	7.00×10^{11}
PS10	159 mm	229 mm	8.26×10^{7} mm⁴	9.09×10^{11}
PS12	210 mm	280 mm	1.23×10^{8} mm⁴	1.36×10^{12}

$I_{eff} = 2 \cdot A \cdot (h_{eff}/2)^2 = A \cdot h_{eff}^2 / 2$
$E_{0,mean}$ = 11 000 MPa (C24). $EI_{eff} = E \cdot I_{eff}$.

3. Ultimate Limit State (ULS) Design

3.1 Design loads

Characteristic load on joist q_k = 0.9 kN/m.
Design load (snow dominant): q_d = 1.5 · 0.9 = 1.35 kN/m.

3.2 Bending moment and shear force

$$M_{Ed} = q_d \cdot L^2 / 8$$
$$V_{Ed} = q_d \cdot L / 2$$

Example for L = 5.0 m:

$M_{Ed} = 1.35 \cdot 5.0^2 / 8 = 4.22$ kNm
$V_{Ed} = 1.35 \cdot 5.0 / 2 = 3.38$ kN

3.3 Axial forces in the chords

$N_{Ed} = M_{Ed} / h_{eff}$
For the weakest section (PS8, h_{eff} = 0.178 m) at L = 5.0 m: N_{Ed} = 4.22 / 0.178 ≈ 23.7 kN

3.4 Design tensile resistance of the chord

$$f_{t,0,d} = k_{mod} \cdot f_{t,0,k} / \gamma_M = 0.8 \cdot 14 / 1.3 = 8.615 \text{ MPa}$$
$$F_{t,Rd} = f_{t,0,d} \cdot A = 8.615 \cdot 3150 / 1000 = 27.1 \text{ kN}$$

3.5 Utilisation ratio

$$\eta = N_{Ed} / F_{t,Rd} = 23.7 / 27.1 \approx 0.87 \text{ (87 \%) — satisfactory.}$$

L, m	M_{Ed}, kNm	N_{Ed} (PS8), kN	$\eta = N/F_{Rd}$	Status
4.2	2.98	16.7	0.62	OK
4.5	3.42	19.2	0.71	OK
4.8	3.89	21.9	0.81	OK
5.0	4.22	23.7	0.87	OK
5.2	4.56	25.6	0.94	OK*

* At L = 5.2 m the margin is small if a PS8 section occurs in the high-moment zone. Prefer PS10–PS12 in mid-span.

4. Serviceability Limit State (SLS) – Deflection (EN 1995-1-1)

4.1 Calculation method

Finite-element model (Euler–Bernoulli beam elements) with variable flexural stiffness EI along the length. Segment distribution approximated from the drawing: ~12 % PS8 + 33 % PS9 + 33 % PS10 + 22 % PS12.

Pure bending deflection $\delta_{bending}$ obtained from FE analysis. For standard 1.0 mm webs the shear deformation is significantly lower than for 0.7 mm webs. Amplification factor for shear + joint slip: α = 1.50 (typical for standard Posi-Strut).

$$\delta_{inst} = \alpha \cdot \delta_{bending} = 1.50 \cdot \delta_{bending}$$

4.2 Instantaneous deflection (characteristic combination)

L, m	$\delta_{bending}$, mm	$\delta_{inst} = 1.50 \cdot \delta_b$, mm	L/δ_{inst}
4.2	4.43	6.6	636
4.5	5.83	8.7	515
4.8	7.55	11.3	424
5.0	8.89	13.3	375
5.2	10.40	15.6	333

4.3 Final deflection including creep

EN 1995-1-1, clause 2.2.3:
$$\delta_{fin} = \delta_{inst,G} \cdot (1 + k_{def}) + \delta_{inst,Q} \cdot (1 + \psi_2 \cdot k_{def})$$

Assumptions: permanent load ≈ 1/3 of total, snow ≈ 2/3, ψ_2 = 0 (typical for snow in Estonia).
Creep factor relative to instantaneous deflection = 1.27.

$$\delta_{fin} \approx 1.27 \cdot \delta_{inst}$$

L, m	δ_{inst}, mm	δ_{fin}, mm	L/δ_{fin}	Assessment
4.2	6.6	8.4	500	Excellent
4.5	8.7	11.1	406	Excellent
4.8	11.3	14.4	334	Very good
5.0	13.3	16.9	296	Good (≈ L/300)
5.2	15.6	19.8	263	Good (L/250)

5. Comparison with Deflection Limits

Typical limiting values for roofs (EN 1995 recommendations and National Annexes):
• L/300 — strict (floors, sensitive finishes)

• L/250 — good compromise
• L/200 — acceptable for most low-pitch roofs

6. Conclusions and Recommendations (1.0 mm webs)

Recommended maximum span at 600 mm centres and 1.5 kN/m² load with standard 1.0 mm Posi-Strut webs:

• 5.0 m — optimal (final deflection ≈ L/296 ≈ L/300, strength utilisation 87 %)
• 5.2 m — acceptable (final deflection ≈ L/263 ≈ L/250)
• Up to ≈ 5.5 m possible if mid-span consists predominantly of PS10–PS12 sections and L/200 is accepted.

Comparison with previous 0.7 mm calculation:
Increasing web thickness from 0.7 mm to the standard 1.0 mm reduces the shear amplification factor from 1.85 to 1.50. This improves instantaneous and final deflections by approximately 15–20 %, allowing a longer recommended span.

Limitations:
1. The model is a beam with variable EI (not a full truss model). Precise design should use manufacturer software or a detailed truss analysis with ETA slip moduli.
2. Local buckling and connection capacity of the 1.0 mm webs are covered by the manufacturer's ETA / design tables.
3. Segment length distribution of PS8–PS12 was approximated from the drawing.

Document prepared: 25.07.2026 | Full calculation according to Eurocode | FE model with variable stiffness + shear/connection factor α = 1.50 (standard 1.0 mm webs)