



Installed capacity

27.30 kWp

42 × LONGi Hi-MO X10 Scientist 650 W bifacial

PV structures

28 + 14

carport (6 cars) + low PV structure – panels

Cement floor

99 m²

under the PV carport only (S2)

Pebble ground

162 m²

1.50 m band all round + low-structure zone

Scope of works

#	Item	Scope	Panels	kWp
1	PV modules	42 × LONGi Hi-MO X10 Scientist 650 W bifacial (LR7-72HVD-650M) = 27.30 kWp · 3 strings of 14, all facing south	42	27.30
2	PV carport structure	28 panels · 2.30 / 2.50 m · 3 frames at 5.70 m · 6 cars · purlins 4"×2"×4.0 + aluminium mid / end clamps on M8 rivet nuts (page 4, D1)	28	18.20
3	Low PV structure	14 panels (7 + 7) · 1.50 / 1.70 m · 2 frames 4.0 m apart · purlins 4"×2"×2.3 + aluminium mid / end clamps on M8 rivet nuts (page 4, D1)	14	9.10
4	Carport floor + pebble ground	Cement floor under the carport only 99.1 m² (120 mm, 280 ksc, mesh) + pebbles 161.7 m² incl. under the low structure + edging (sheets F1–F3)	–	–
5	Rain gutter + downpipe	Carport front edge: box gutter 200 × 125 mm, 16.14 m, falls to the west · Ø100 PVC downpipe under the west edge to a post at the back (sheet G1)	–	–
6	PV roof waterproofing NEW	Thin EPDM T-seal TS-10 in every 10 mm module gap (long sides and short ends), 13 moulded crosses TX-10 and 52 clamp boots TB-10 (sheets W1–W4)	–	–
	TOTAL		42	27.30

Included

- 42 PV modules LONGi Hi-MO X10 Scientist 650 W bifacial (delivered).
- Steel carport (28 panels, 6 cars) and low PV structure (14 panels): steel, 4"×2" purlins, 60 + 32 aluminium mid / end clamps on M8 rivet nuts, footings, earthing, paint, labour.
- Site preparation, cement floor under the carport 99.1 m², pebble ground 161.7 m² (incl. under the low structure), edging, joints.
- Carport rain gutter along the front (south) edge draining to the west, Ø100 downpipe to the back (north-west) on its own post, splash block on the pebbles (sheet G1).
- Waterproof PV carport roof: TS-10 in all 10 mm module gaps, TX-10 crosses and TB-10 clamp boots, laid and water-tested (sheets W1–W4).

Not included

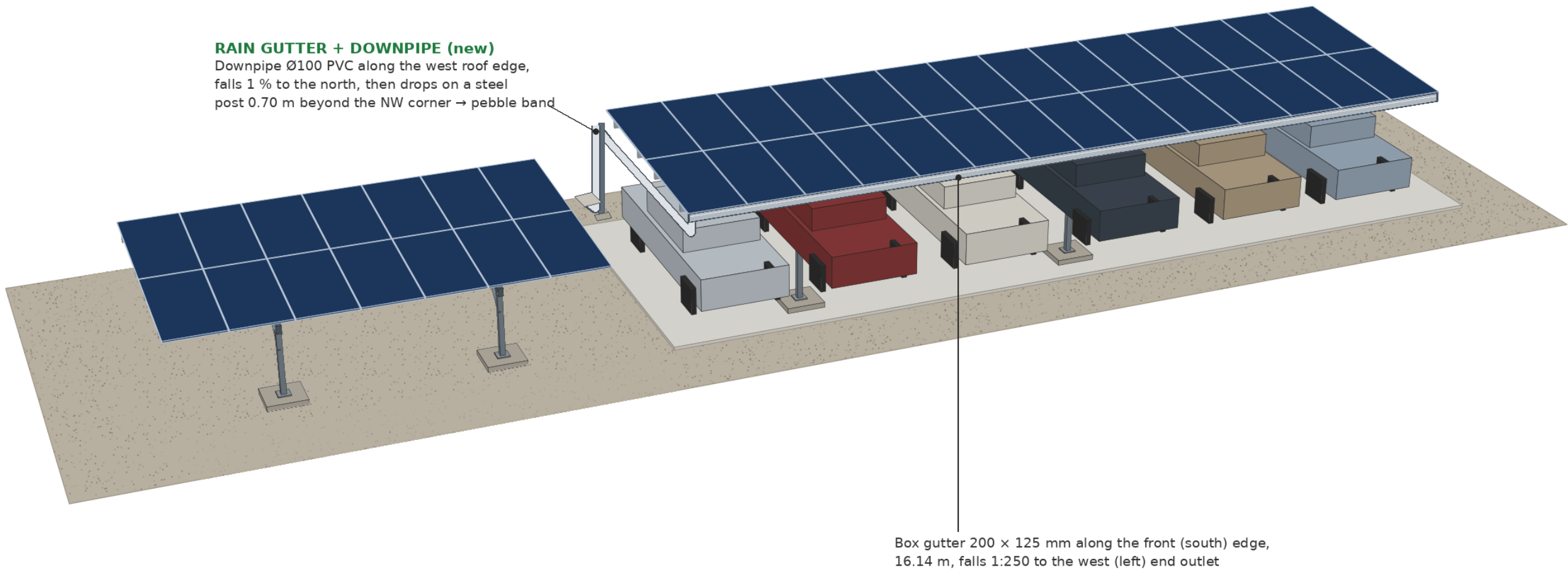
- Inverter, DC/AC cabling, protection and metering; panel installation labour.
- Inverter room (built by others), PEA grid connection and permits.
- Sealing the low PV structure (option, W2) – it stands on pebbles with no cars under it.

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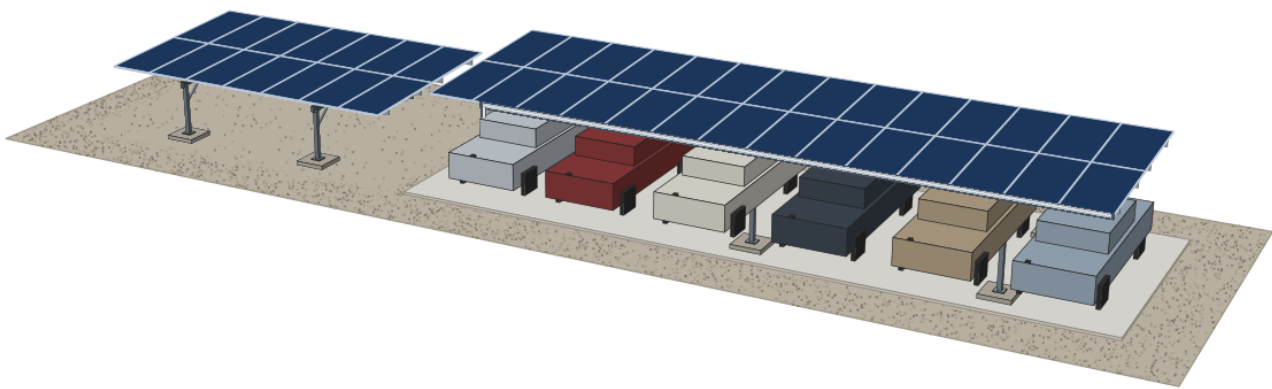
Combined design – 42 × LONGi Hi-MO X10 650 W (27.30 kWp), facing south · carport 28 panels (2.30/2.50 m, 6 cars) + low PV structure 14 panels (1.50/1.70 m) · cement floor under carport only, pebbles elsewhere

Illustrative 3D model

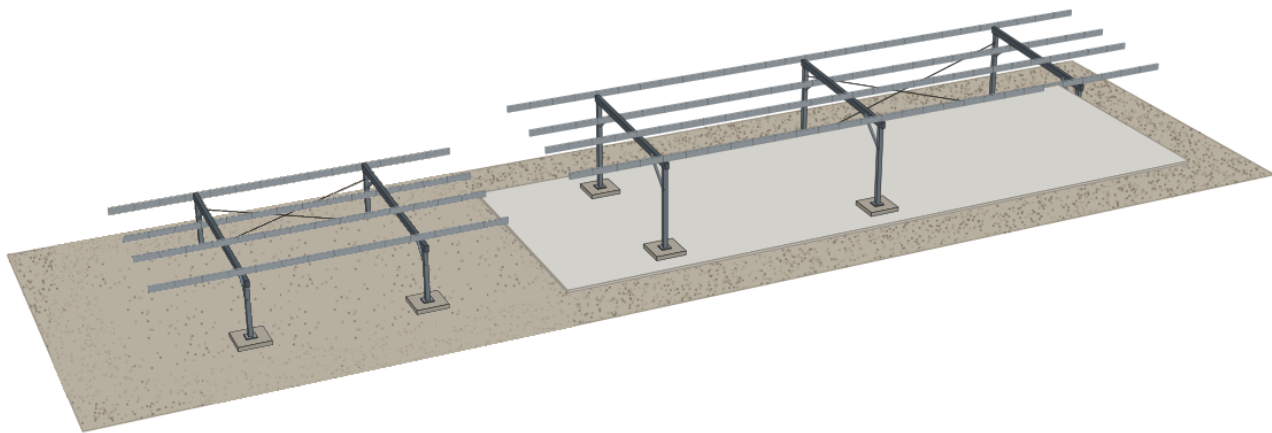
3D VIEW - from south-west: low PV structure (14) on pebbles · PV carport (28) on a cement floor · pebble ground all round



From south-east



Steel only - panels and cars hidden





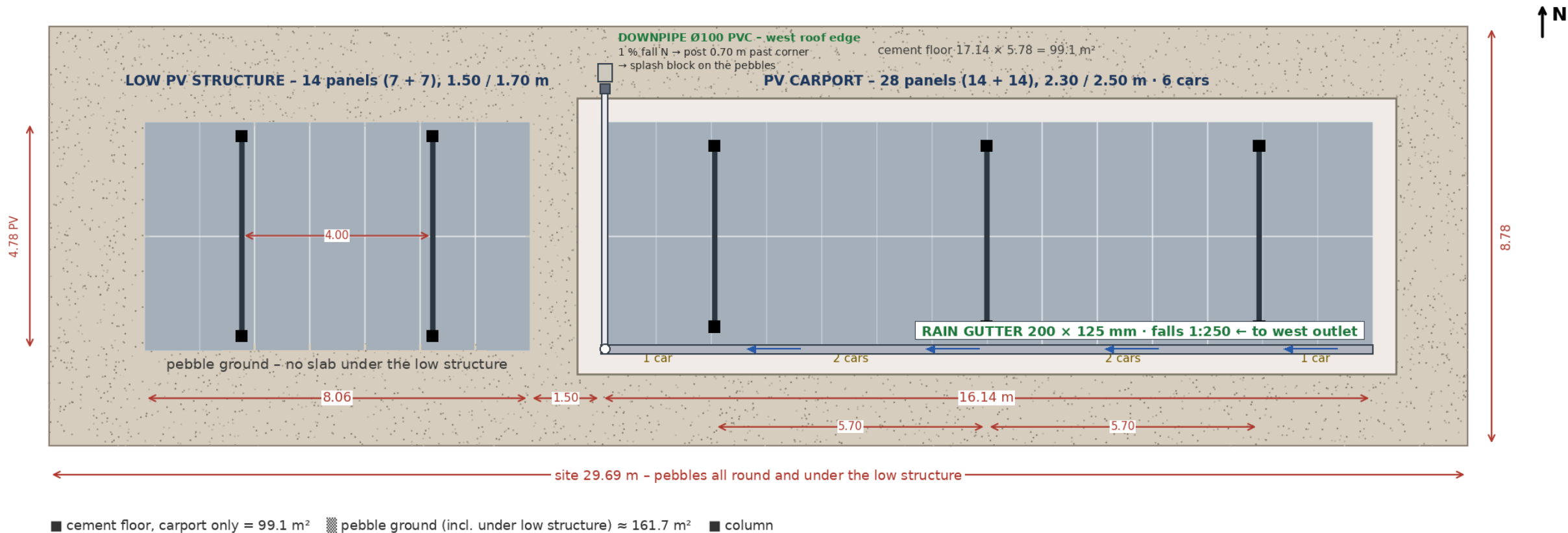
Solar Energy for Sustainable Solution

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Combined design – carport 28 panels + low PV structure 14 panels ($42 \times 650 \text{ W} = 27.30 \text{ kWp}$) – plan, elevation and floors

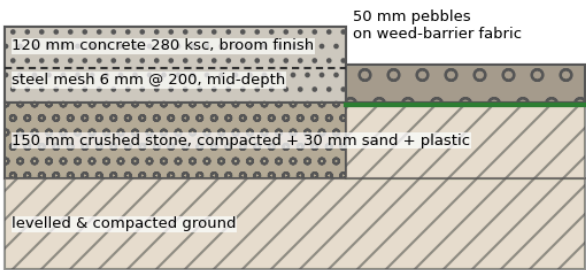
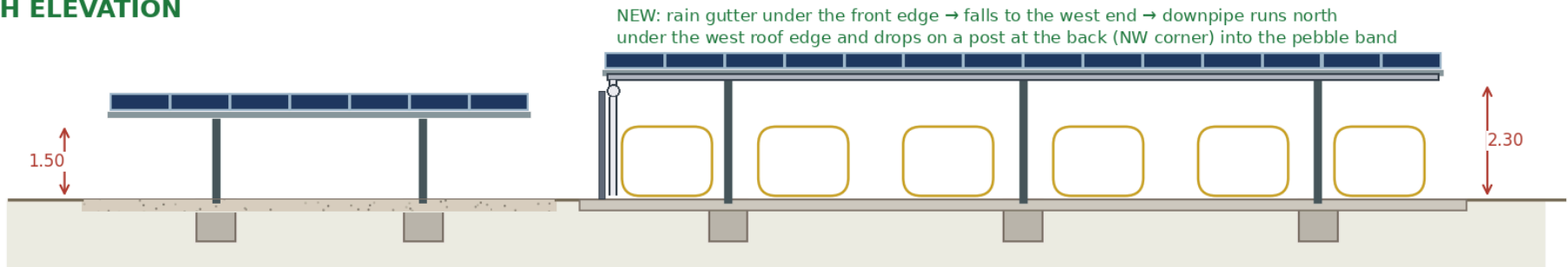
Dimensions in metres
Illustrative – confirm by licensed engineer

SITE PLAN – all panels facing south · no inverter room · cement floor under the carport only (sedans & pickups) · pebbles elsewhere



FLOOR SECTION – sedans & pickups

SOUTH ELEVATION



- Same structure type for both PV roofs: 4"×4" columns, 6"×4" beams with knee braces, 4"×2" purlins on edge (carport 4.0 mm, low 2.3 mm) + aluminium mid / end clamps on M8 rivet nuts (Rev7, D1), RB16 rod bracing, footings 0.75 × 0.75 × 0.8 m.
- Carport: 2 × 14 panels, 10 mm gaps both ways – roof 16.01 × 4.77 m (Rev9; plan above drawn with the old 20 mm gaps), 3 frames at 5.70 m, purlins cantilever $\approx 2.30 \text{ m}$ each end – 2 cars per bay + 1 under each cantilever = 6 cars.
- Low PV structure: 2 × 7 panels (no spare slot), roof 8.00 × 4.77 m (Rev6), 2 frames 4.00 m apart, columns 4.18 m front-back, purlins cantilever $\approx 2.00 \text{ m}$; 1.35 m clear under the front beam.
- Strings: 3 × 14 (carport 2, low structure 1) – all panels face south at $\approx 3^\circ$. No inverter room in this design – the inverter location is agreed separately.
- Floor for sedans & pickups – carport only: 120 mm slab 280 ksc, mesh 6 mm @ 200, on 150 mm crushed stone, 0.50 m beyond the carport roof (99.1 m^2), thickened edges; saw-cut joints on column lines ($\leq 2.9 \text{ m}$ bays); pebbles 161.7 m^2 incl. under the low structure – F1-F3.

Combined design – structures summary (42 × LONGi Hi-MO X10 650 W = 27.30 kWp)

Item	Panels	kWp
PV carport, 28 panels, 2.30 / 2.50 m, 6 cars · 4"×2" purlins + aluminium mid / end clamps	28	18.2
Low PV structure, 14 panels, 1.50 / 1.70 m (same design, 4"×2"×2.3 purlins)	14	9.1
Floor works – cement floor under the carport only 99.1 m² (120 mm, 280 ksc) + pebble ground 161.7 m²	–	–
TOTAL	42	27.3

Inverter room removed from this design (built by others). Excludes PV modules, inverter, cabling and permits.

PV carport – 28 panels, 2.30 / 2.50 m, 3 frames at 5.7 m, 6 cars · material quantities

#	Item	Specification	Qty	Unit
1	Columns	Tube 4"×4" × 2.3 mm, 6 m (front + back column per length)	3	length
2	Beams	Tube 6"×4" × 2.3 mm, 6 m (≈3.9 m beam)	3	length
3	Knee braces	Tube 2"×2" × 2.3 mm, ≈0.85 m, 2 per frame	1	length
4	Purlins / PV rails (4 lines)	Tube 4"×2" × 4.0 mm (100×50, on edge), 6 m – bolted splices	12	length
5	Purlin splice plates	2 side plates 100×8×600 mm per joint – keep clear of clamp positions	61	kg
6	Purlin splice bolts	M12 × 90 through-bolts, 8 per joint	64	set
7	Plates	Base, cap, gusset, end plates, cleats, splice plates	114	kg
8	Anchor bolts	M16 J-bolt L=400 + nuts & washers	24	set
9	Bracing	RB16 rods + turnbuckles, back plane + roof plane	1	lot
10	Purlin bolts	M12 bolts, nuts, washers	56	set
11	Welding consumables	Electrodes, grinding & cutting discs	1	lot
12	Paint	Zinc-rich primer + PU top coat	1	lot
13	Concrete	CPAC 240 ksc, footings + 50 mm lean	2.9	m³
14	DB12	DB12 SD40, 10 m (12 verticals per footing)	8	bar
15	DB10	DB10 SD40, 10 m (screens)	6	bar
16	Binding wire	Tie wire #18	1	kg
17	Earthing	2 × earth rod 5/8" × 2.4 m, bonding cable & clamps	1	lot
18	Transport	Delivery of steel & materials to site	1	lot
19	Labour	Excavation, footings, fabrication, erection	3	frame
20	PV mid clamps (Rev7)	Aluminium 6005-T5, 50 mm long, for 30 mm frames, 10 mm gap – 52 + 4 spares (D1)	56	pc
21	PV end clamps (Rev7)	Aluminium 6005-T5, 50 mm long, 30 mm frames – 8 + 2 spares (D1)	10	pc
22	Rivet nuts + bolts (Rev7)	M8 closed-end countersunk steel rivet nut + M8 × 45 A2-70 bolt (D1)	66	set

Carport checks

Purlin 4"×2"×4.0 span stress, 5.70 m span (S = 28,000 mm³)	127.1 MPa
Purlin span deflection (I = 1.40×10 ⁶ mm ⁴)	17.9 mm
Purlin cantilever stress	87.7 MPa
Purlin cantilever tip deflection	12.4 mm
Worst-frame beam 6"×4"×2.3 stress, with knee braces (S = 50,800 mm³)	79.4 MPa
Footing safety factor	1.7 –
Result	OK

Notes

- PV fixing (Rev7): aluminium mid and end clamps** on M8 closed-end rivet nuts set flush in the purlin top wall; bolts go down the 10 mm module gap, nothing is drilled in the frames. Mid clamps at every joint/purlin crossing (52 + 24), end clamps at the roof ends (8 + 8) – sheet D1. The PSI U-clamps (Rev4) are removed.
- Purlins 4"×2" (100 × 50 mm, stood on edge): carport 4.0 mm wall (5.70 m spans), low structure 2.3 mm. Stresses at or below about 130 MPa, deflection ≤ L/300 – see checks. Panel edge heights stay 2.30/2.50 and 1.50/1.70 m (columns cut 50 mm longer).
- Place purlin splices between clamp positions and keep rivet nuts ≥ 60 mm clear of the splice plates. Don't drill module frames.
- Both PV roofs: 10 mm module gaps both ways (Rev9), width 4.77 m, all 42 panels face south – 3 strings of 14. Carport roof 16.01 × 4.77 m, purlin cantilever ≈ 2.30 m each end, 6 cars; low structure roof 8.00 × 4.77 m, frames 4.0 m apart, shares the carport delivery trip and earth system.
- Preliminary – confirm with a licensed structural engineer.

Rev7 – aluminium mid / end clamps on M8 rivet nuts (D1) · thin EPDM seals, boots and crosses (W1–W4)

Carport front gutter, falls to the west outlet, Ø100 downpipe to the NW post (sheet G1)
Cement floor under the carport only; the low PV structure stands on pebbles (sheets F1–F3)

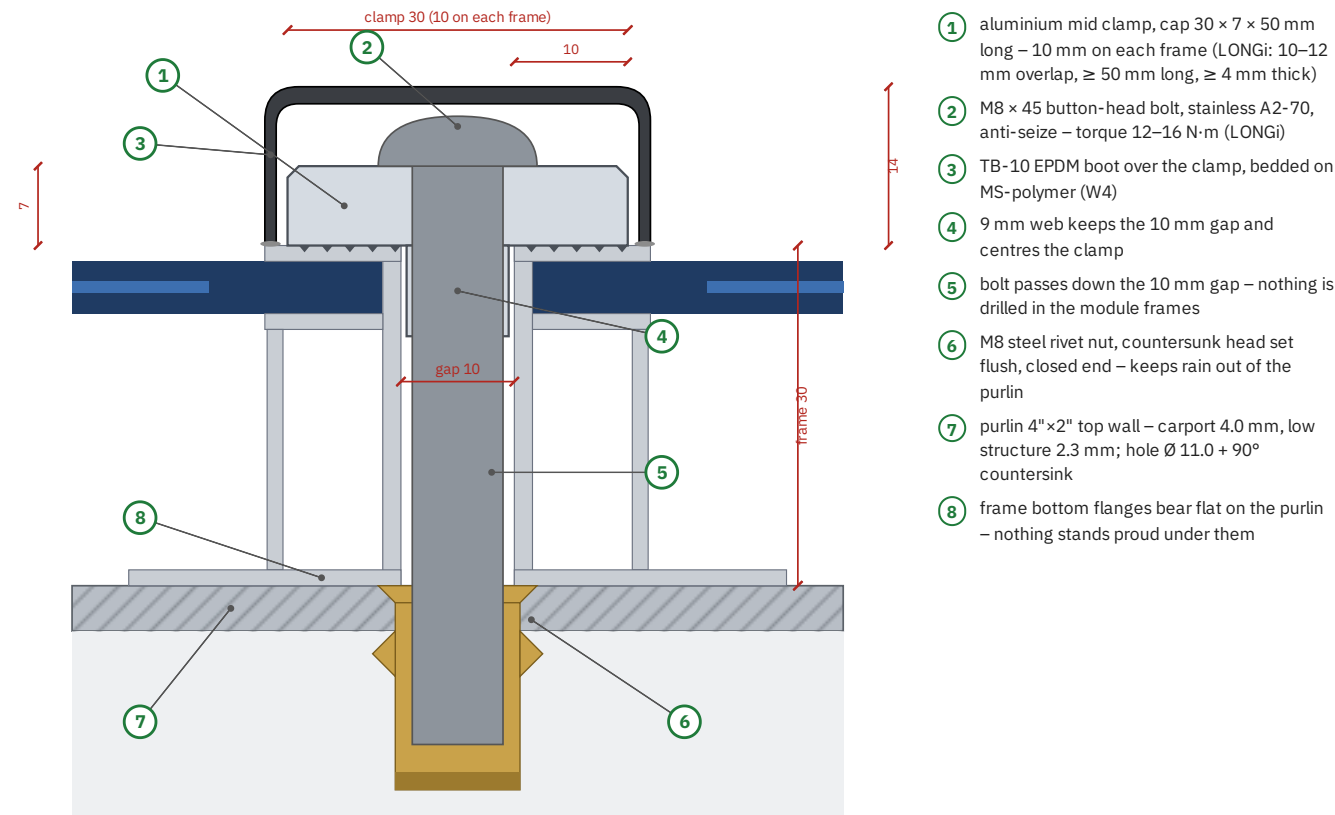
Low PV structure – 14 panels (7 + 7), 1.50 / 1.70 m, 2 frames 4.0 m apart · material quantities

#	Item	Specification	Qty	Unit
1	Columns	Tube 4"×4" × 2.3 mm, 6 m (front + back column per length)	2	length
2	Beams	Tube 6"×4" × 2.3 mm, 6 m (≈4.3 m beam)	2	length
3	Knee braces	Tube 2"×2" × 2.3 mm, ≈0.85 m, 2 per frame	1	length
4	Purlins / PV rails (4 lines)	Tube 4"×2" × 2.3 mm (100×50, on edge), 6 m – bolted splices	8	length
5	Purlin splice plates	2 side plates 100×6×600 mm per joint – keep clear of clamp positions	23	kg
6	Purlin splice bolts	M12 × 90 through-bolts, 8 per joint	32	set
7	Plates	Base, cap, gusset, end plates, cleats, splice plates	79	kg
8	Anchor bolts	M16 J-bolt L=400 + nuts & washers	16	set
9	Bracing	RB16 rods + turnbuckles, back plane + roof plane	0.5	lot
10	Purlin bolts	M12 bolts, nuts, washers	43	set
11	Welding consumables	Electrodes, grinding & cutting discs	1	lot
12	Paint	Zinc-rich primer + PU top coat	1	lot
13	Concrete	CPAC 240 ksc, footings + 50 mm lean	1.9	m³
14	DB12	DB12 SD40, 10 m (12 verticals per footing)	5	bar
15	DB10	DB10 SD40, 10 m (screens)	4	bar
16	Binding wire	Tie wire #18	1	kg
17	Earthing	Bonding to the carport earth system	1	lot
18	Transport	Same delivery trip as the carport	1	lot
19	Labour	Excavation, footings, fabrication, erection	2	frame
20	PV mid clamps (Rev7)	Aluminium 6005-T5, 50 mm long, for 30 mm frames, 10 mm gap – 24 + 2 spares (D1)	26	pc
21	PV end clamps (Rev7)	Aluminium 6005-T5, 50 mm long, 30 mm frames – 8 + 2 spares (D1)	10	pc
22	Rivet nuts + bolts (Rev7)	M8 closed-end countersunk steel rivet nut (grip 1.5–3.0) + M8 × 45 A2-70 bolt (D1)	36	set

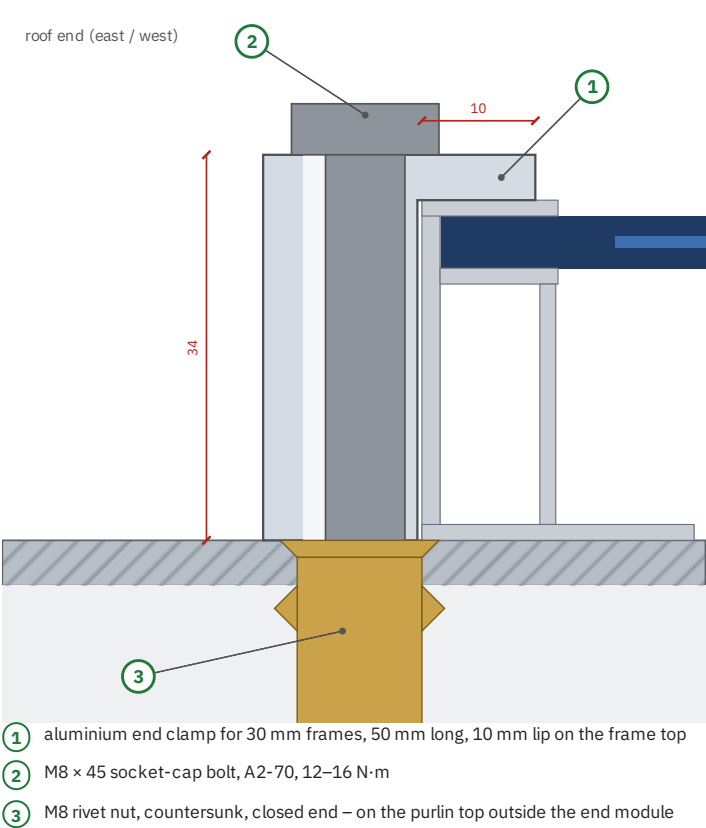
Low structure checks

Purlin 4"×2"×2.3 span stress, 4.0 m span (S = 17,400 mm³)	100.7 MPa
Purlin span deflection (I = 0.87×10 ⁶ mm ⁴)	7.0 mm
Purlin cantilever stress	103.6 MPa
Purlin cantilever tip deflection	10.6 mm
Worst-frame beam 6"×4"×2.3 stress, with knee braces (S = 50,800 mm³)	71.5 MPa
Footing safety factor	2.4 –
Result	OK

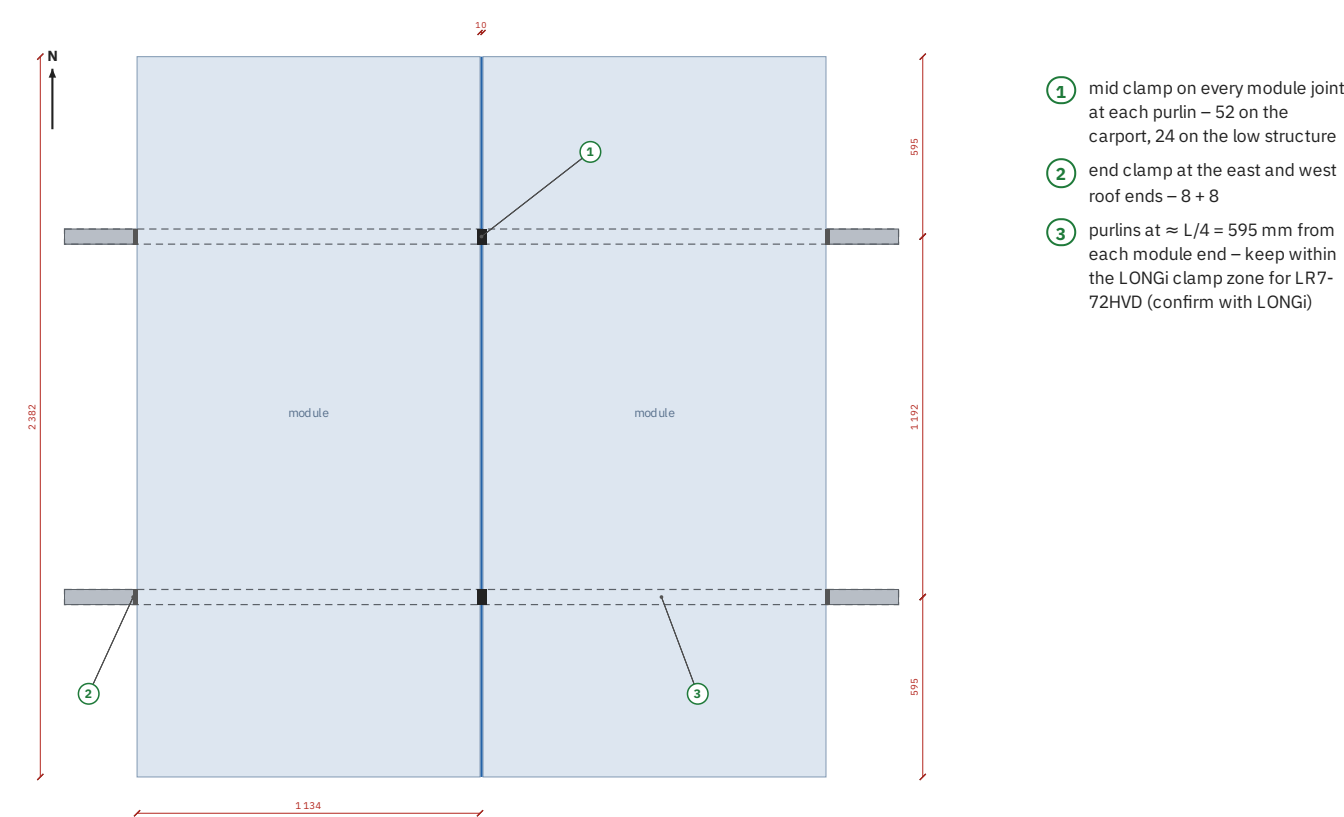
SECTION A – across a joint at a mid clamp · scale 1.5:1 on A3 · looking along the purlin



SECTION B – end clamp at the roof end · scale 1.5:1



PLAN – clamp positions · scale 1:25 · two carport modules



Clamp and fixing specification

Mid clamp	aluminium 6005-T5, anodised, 50 mm long, cap 30 × 7 mm, 9 mm gap web, serrated underside with earthing pins
End clamp	aluminium 6005-T5, for 30 mm frames, 50 mm long, 10 mm lip
Overlap	10 mm on each frame top – LONGi: 10–12 mm overlap, clamp ≥ 50 mm long, ≥ 4 mm thick, no shading of the cells
Bolts	M8 × 45 stainless A2-70 – button head (mid), socket cap (end), with anti-seize
Torque	12–16 N·m (LONGi, M8) – two passes; re-check after 1 month
Rivet nuts	M8 steel, zinc-flake, knurled, countersunk head, closed end · grip 3.0–5.0 mm (carport, 4.0 mm wall) / 1.5–3.0 mm (low structure, 2.3 mm wall) · pull-out ≥ 3 kN – confirm with the supplier
Holes	Ø 11.0 mm + 90° countersink on the joint centre line; deburr, touch up with zinc-rich primer
Positions	purlins at ≈ 595 mm (L/4) from each module end – within the LONGi clamp zone for LR7-72HVD (confirm)
Earthing	serrated clamps bite through the anodising; bond each purlin line to the carport earth (page 4)

Quantities

Item	Car port	Low (option)
Mid clamps	52 + 4	24 + 2
End clamps	8 + 2	8 + 2
M8 rivet nuts	60 + 6	32 + 4
M8 × 45 A2 bolts	60 + 6	32 + 4
Clamp boots TB-10 (W4)	52 + 4	24 + 2

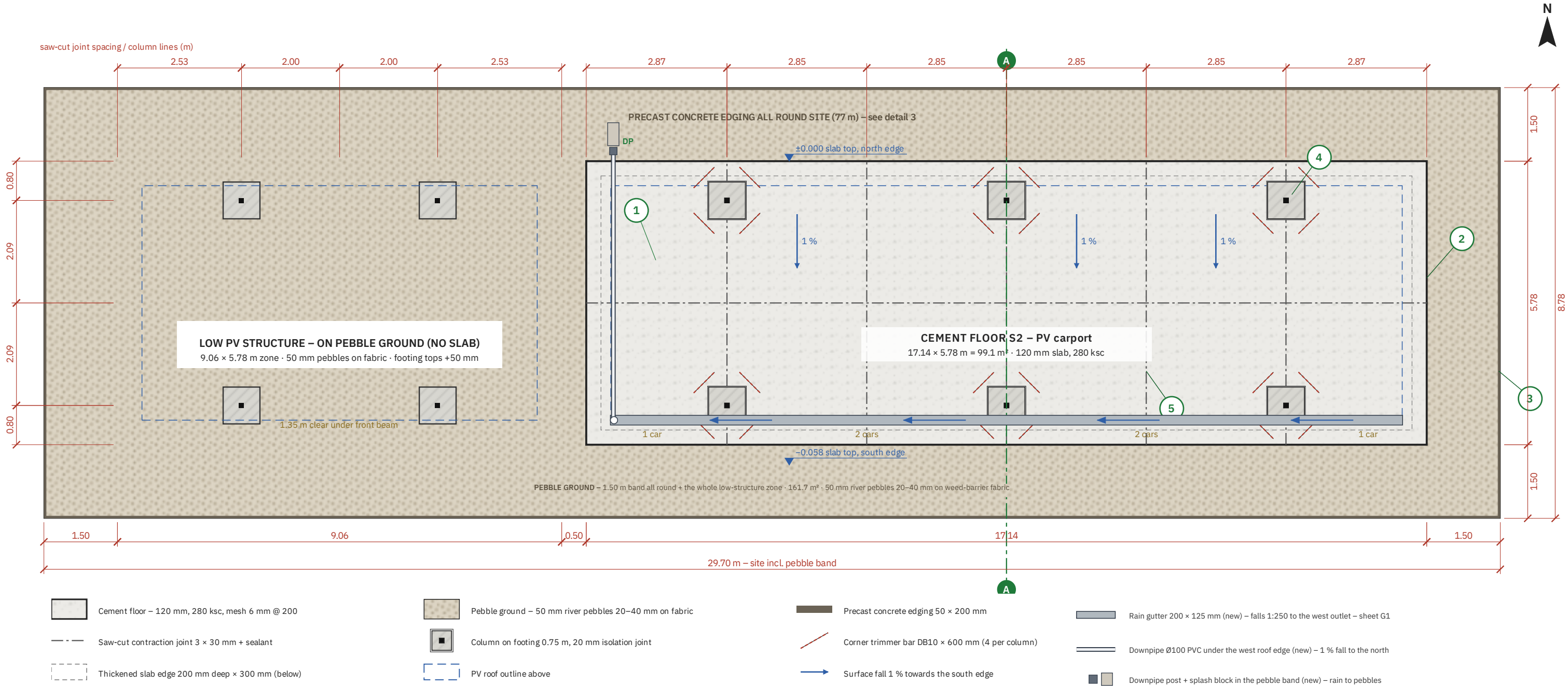
Figures are fitted + spares.

Installation

1. Mark the clamp points on the purlin tops from the module layout: joint centre lines at 1 144 mm pitch, end clamps outside the end modules.
2. Drill Ø 11.0 mm through the top wall, countersink 90°, deburr, prime the hole edge.
3. Set the rivet nuts with the setting tool; check each one is flush (straightedge) and does not spin.
4. Lay the modules in portrait; set the gaps to 10–11 mm with spacers – never under 10 mm (LONGi).
5. Fit the mid and end clamps with anti-seize on the bolts; torque 12–16 N·m in two passes.
6. Check the earthing bond, then fit the TB-10 boots and the seals (W1–W4).

Notes

- Bolts go down the 10 mm gap into the purlin – nothing is drilled in the module frames.
- Closed-end rivet nuts keep rain out of the purlin tubes; set flush so the frames bear flat.
- Keep rivet nuts ≥ 60 mm clear of purlin splice plates; place splices between clamp positions.
- Rev7: the PSI U-clamps (Rev4) are removed from the design. The 4"x2" purlins and the checks on page 4 stay as they are.



Floor schedule

Zone	Size (m)	Area
S1 low PV structure – pebbles only	9.06 × 5.78	– (no slab)
S2 cement floor – PV carport	17.14 × 5.78	99.1 m²
Cement floor total		99.1 m²
Pebble ground (band + S1 zone + strip)	29.70 × 8.78 – S2 slab	161.7 m²
Whole site	29.70 × 8.78	260.8 m²
Saw-cut joints / isolation joints		41.5 / 19.0 m
Slab edge (thickened) / site edging		45.8 / 77.0 m

Setting out and levels

- The carport cement floor (S2) extends **0.50 m beyond its PV roof** on all sides; the low PV structure (S1) stands on **pebble ground – no slab**.
- Pebble band **1.50 m wide** all round, held by precast concrete edging on the site boundary; pebbles also cover the whole S1 zone.
- Datum **±0.000** = slab top at the north edge; set it **≥ 150 mm above existing ground** / access road (confirm on site).
- Slab falls **1 % to the south** (–0.058 at the south edge); rain from the PV roofs and slab soaks into the pebbles.
- Pebble surface **20 mm below the slab edge**; edging top 30 mm above the pebbles; S1 footing tops **50 mm above the pebbles**.

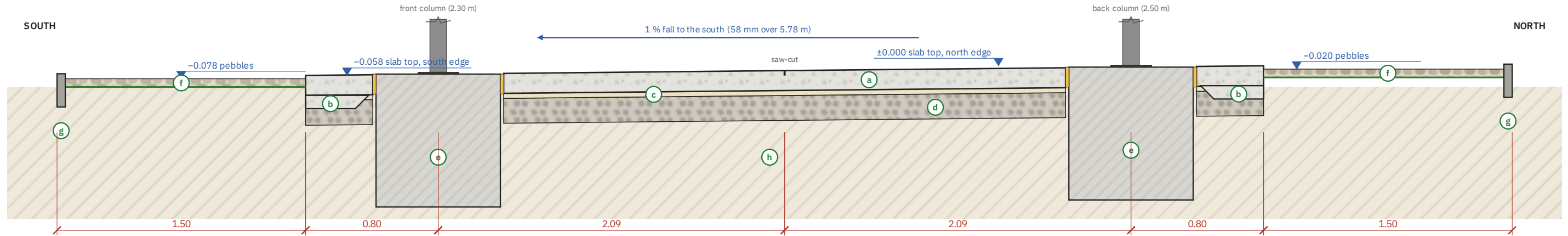
Joints

- Saw-cut joints** (carport slab only) on every column line and midway between them, plus one longitudinal joint at mid-width – bays ≤ 2.9 × 2.9 m (≤ 24 × slab thickness).
- Cut 3 mm × 30 mm deep **6–18 h after the pour**; later widen the top to 6 × 10 mm and seal with PU sealant (detail 5).
- Carport footing tops are cast flush with the slab and separated by a **20 mm isolation joint** (detail 4). Low-structure footings stand free in the pebbles – no joints.
- DB10 × 600 mm corner bars** at the 4 corners of each carport footing stop cracks at re-entrant corners.

Construction sequence

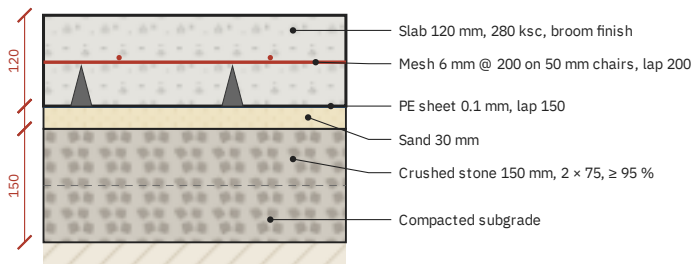
- 1 Clear, level and compact the whole site; set out columns and footings.
- 2 Cast the 10 footings – 6 carport footings up to slab level, 4 low-structure footings to +50 mm above the pebbles; anchor bolts with a template.
- 3 Carport slab only: crushed stone 150 mm in 2 layers (≥ 95 %) → sand 30 mm → PE sheet → mesh on chairs → edge forms.
- 4 Pour 280 ksc, broom finish, saw-cut, **wet-cure 7 days**; cars after 7 days, full load after 28 days.
- 5 Erect steel and PV roofs; seal joints.
- 6 Edging → fabric over the whole pebble area (incl. S1) → pebbles 50 mm; rake level.

(A-A) Section A-A – north-south through the carport middle frame scale 1:25 · levels in metres · steel above floor level not shown

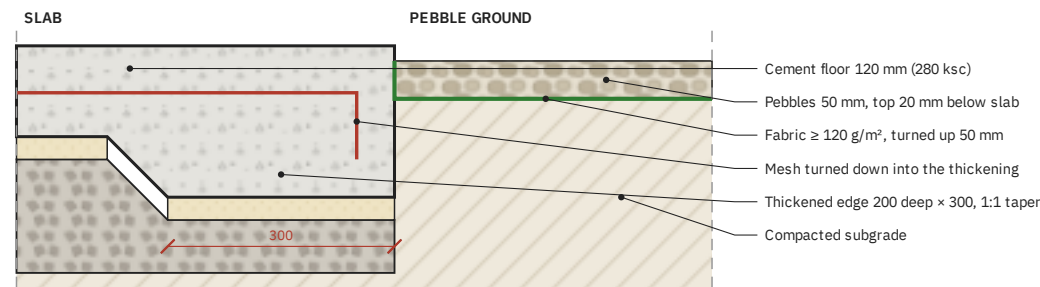


- (a)** Cement floor 120 mm, ready-mix 280 ksc, welded mesh 6 mm @ 200 at mid-depth
- (b)** Thickened slab edge 200 mm deep × 300 mm, mesh turned down (detail 2)
- (c)** Sand 30 mm + PE sheet
- (d)** Crushed stone 150 mm, 2 layers, ≥ 95 % compaction
- (e)** Footing 0.75 × 0.75 × 0.80 m, cast up to slab level; 20 mm isolation joint (detail 4)
- (f)** Pebble ground: 50 mm river pebbles 20–40 mm on weed-barrier fabric, 20 mm below slab
- (g)** Precast concrete edging 50 × 200 mm on the site boundary (detail 3)
- (h)** Levelled and compacted subgrade

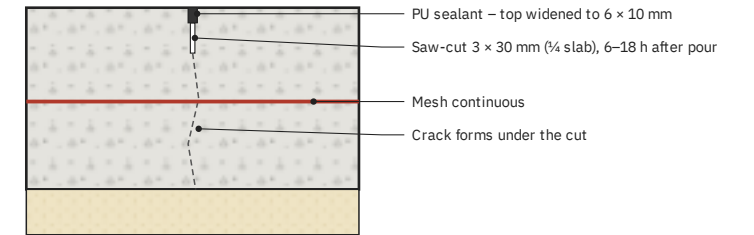
1 Typical cement floor build-up scale 1:10



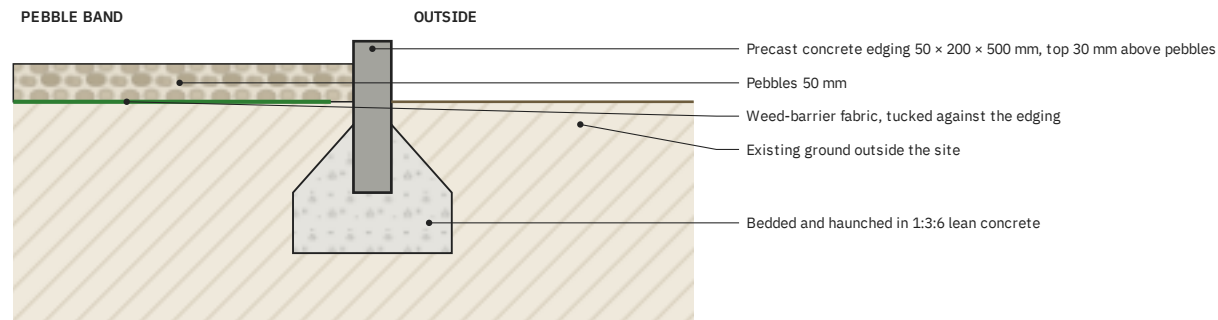
2 Slab edge to pebble ground scale 1:10



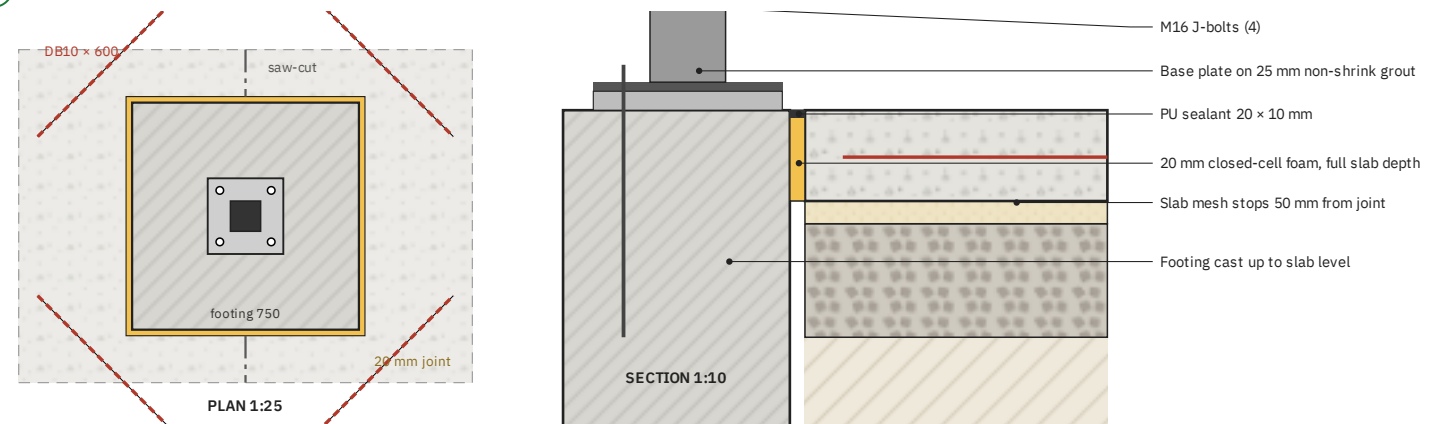
5 Saw-cut contraction joint scale 1:5



3 Site edge – precast concrete edging scale 1:10



4 Column footing – isolation joint and corner bars plan 1:25 · section 1:10



Loads and use: sedans and pickup trucks up to ≈ 3 t – not for 6-wheel trucks. Keep vehicles off for 7 days; full load after 28 days. **Curing:** keep the slab wet (hessian / water) for 7 days. **Tolerances:** slab surface ±5 mm under a 3 m straight-edge; no ponding. **Pebbles:** washed, rounded river pebbles 20–40 mm; top up yearly where thin. **Low PV structure (Rev4):** no slab under it – its 4 footings are cast to 50 mm above the pebbles, with the fabric turned up 50 mm around each footing.

Floor works – reinforced cement floor under the carport (sedans & pickups) + pebble ground

#	Item	Specification	Qty	Unit
1	Site preparation	Clear, level and compact the whole site (carport slab + pebble area)	260.8	m²
2	Crushed stone base	Crushed stone 150 mm, compacted in 2 layers (≥ 95 %), under the carport slab only	17.8	m³
3	Sand bedding	Sand 30 mm levelling layer	3	m³
4	Plastic sheet	Polyethylene sheet 0.1 mm under the slab, lap 150 mm	109	m²
5	Steel mesh	Welded steel mesh 6 mm @ 200 × 200 mm, on 50 mm chairs, lap 200 mm	109	m²
6	Concrete	Ready-mix 280 ksc (cube), 120 mm slab + thickened edges 200 mm, +5 % waste	13.5	m³
7	Edge forms	Timber edge forms incl. thickened slab edge	46	m
8	Saw-cut joints	Saw-cut 3 × 30 mm within 6–18 h, widened 6 × 10 mm + PU sealant (layout F1)	42	m
9	Isolation joints	20 mm closed-cell foam, full depth, + PU sealant around the 6 carport footings	19	m
10	Corner trimmer bars	DB10 SD40 × 600 mm, 4 per carport column (24 pcs = 14.4 m)	2	bar
11	Labour – slab	Compact base, place mesh, pour, broom finish, 7-day wet curing	99	m²
12	Weed-barrier fabric	Non-woven geotextile ≥ 120 g/m², lap 300 mm, turned up 50 mm at slab edge and footings	178	m²
13	Pebbles	River pebbles 20–40 mm, 50 mm layer (incl. +10 %)	9	m³
14	Edging	Precast concrete edging 50 × 200 × 500 mm, bedded in lean concrete, around the site	77	m
15	Labour – pebbles	Lay fabric, spread and level pebbles (incl. around the low-structure footings)	162	m²
16	Transport	Ready-mix truck access, stone and pebble delivery	1	lot

Quantities for the Rev4 design – cement floor under the carport only. Confirm quantities on site before ordering.

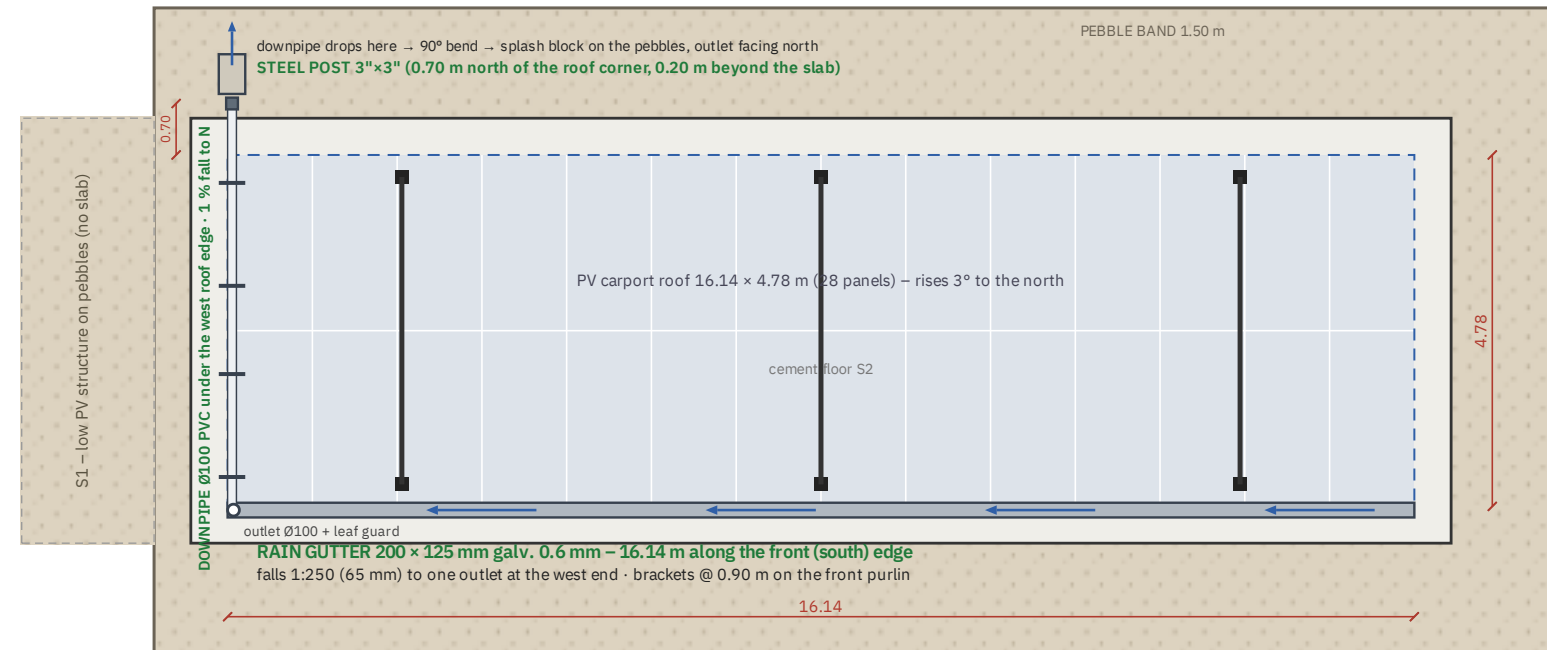
What changed and why

- **Rev4:** cement floor under the PV carport only (S2, 99.1 m²); the low PV structure (S1) stands on pebbles – its 52.4 m² slab is deleted.
- **Slab items scaled to S2:** stone, sand, PE, mesh, concrete 20.5 → 13.5 m³, edge forms 76 → 46 m, saw-cuts 65 → 42 m, slab labour 152 → 99 m².
- **Isolation joints + corner bars** only at the 6 carport footings (32 → 19 m, 40 → 24 pcs).
- **Pebble ground** 109.3 → 161.7 m² (fabric 178 m², pebbles 9 m³); site prep, edging, transport unchanged.

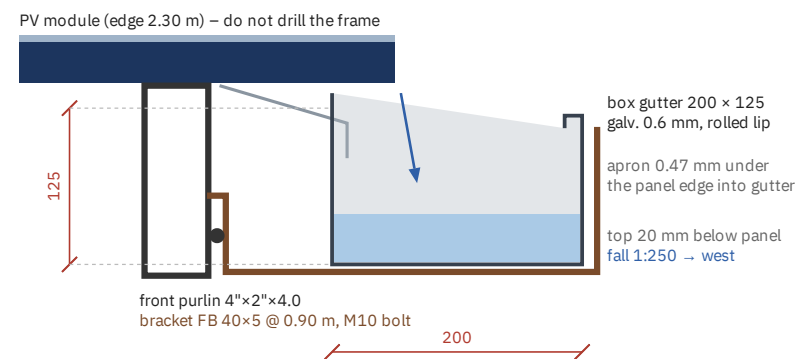
Areas and volumes

Cement floor S2 (carport only)	17.14 × 5.78 = 99.1 m²
Pebble ground	161.7 m²
Concrete, net / to order (+5 %)	12.7 / 13.5 m³
Crushed stone to order (incl. compaction)	17.8 m³
Pebbles to order (+10 %)	9.0 m³
Saw-cut / isolation joints	41.5 / 19.0 m
Slab edge / site edging	45.8 / 77.0 m

PLAN – PV carport roof with gutter and downpipe route · scale $\approx 1:100$ on A3



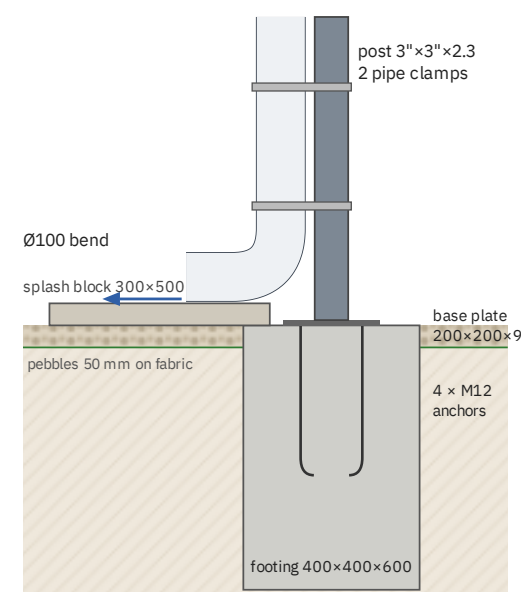
DETAIL 1 – gutter at the front edge · section, scale 1:5



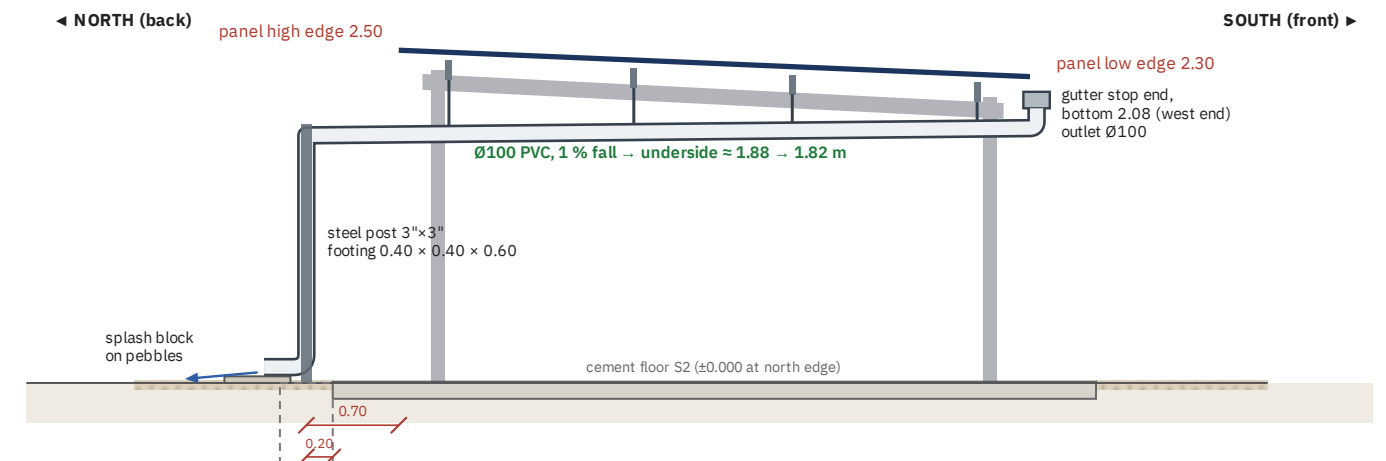
Design basis

Catchment (plan area of the carport roof)	16.14 × 4.78 = 77.2 m²
Design rainfall (short, intense storm – preliminary)	150 mm/h
Design flow Q = 77.2 × 150 / 3 600	3.2 L/s
Gutter 200 × 125, fall 1:250, flowing 100 mm deep	> 6 L/s – OK
Downpipe Ø100 PVC at 1 % (horizontal run, full bore)	≈ 7 L/s – OK
Clear height under the pipe (west roof edge)	≈ 1.88 → 1.82 m

DETAIL 2 – post foot and splash block · 1:20



WEST ELEVATION – downpipe route along the west roof edge · scale ≈ 1:50



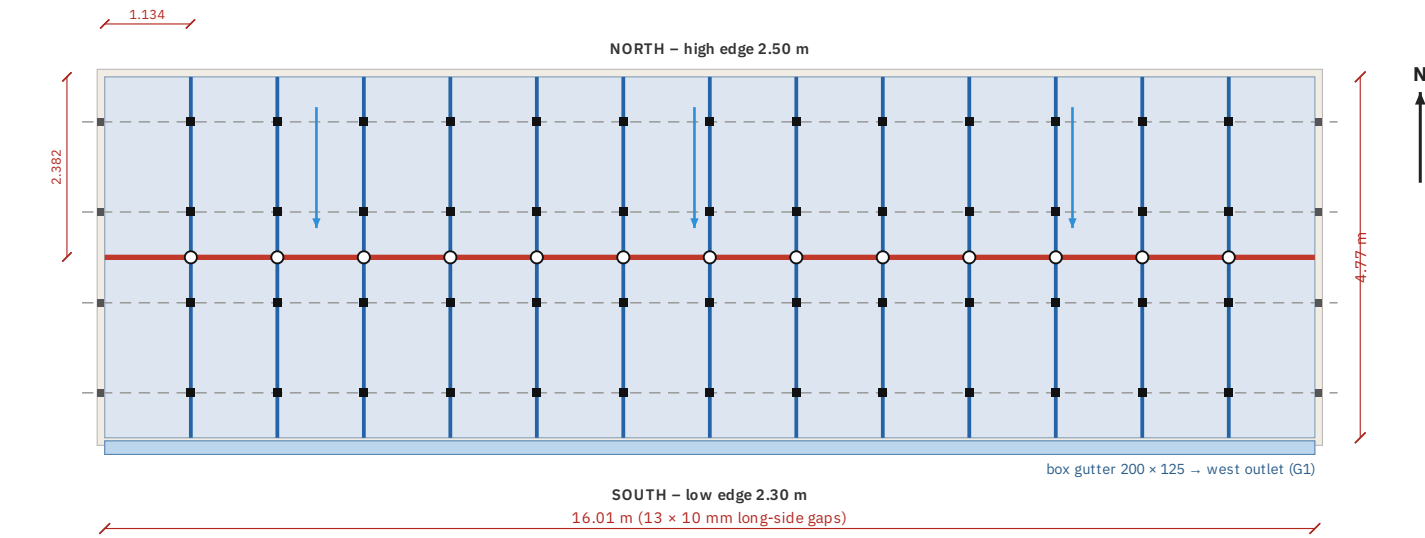
Bill of quantities – rain gutter + downpipe · quantities

#	Item	Specification	Qty	Unit
1	Box gutter	Galvanised steel 0.6 mm, 200 × 125 mm, folded to order, 16.14 m + laps	16.6	m
2	Stop ends + outlet	2 stop ends, 100 mm sump outlet with leaf guard at the west end	1	lot
3	Apron flashing	Zincalume 0.47 mm drip apron from panel edge into the gutter	16.6	m
4	Gutter brackets	Flat bar 40 × 5 mm galv. @ 0.90 m, bolted to the front purlin (M10)	19	pc
5	Downpipe	PVC Ø100 mm (4") class 8.5, 4 m lengths	3	length
6	PVC fittings	Outlet connector, 3 × 90° long bends, 2 × 45°, cleaning-eye tee, solvent cement	1	lot
7	Pipe hangers	Drop hangers from the 4 purlin tips + post clamps, stainless band clamps	6	set
8	Downpipe post	Tube 3"×3" × 2.3 mm, 6 m (2.4 m used, offcut for hangers)	1	length
9	Post plates	Base plate 200 × 200 × 9 mm, 4 × M12 anchors, pipe bracket at top	1	lot
10	Post footing	0.40 × 0.40 × 0.60 m, concrete + 4 × DB12, dug in the pebble band	1	lot
11	Splash block	Precast concrete 300 × 500 mm on the pebbles, outlet facing north	1	pc
12	Paint	Zinc-rich primer + PU top coat on post, hangers and brackets	1	lot
13	Earth bonding	Gutter bonded to the carport earth, 10 mm² cable + lugs	1	lot
14	Labour	Gutter fabrication and fixing, downpipe, post and footing	1	lot

Notes

- **Route:** gutter along the front (south, low) edge, falling to the west (left) end; the Ø100 downpipe runs north under the west roof edge on 4 hangers from the purlin tips, then drops on its own post at the back (north-west) and discharges onto a splash block in the north pebble band – no water on the slab, nothing in the parking bays.
- **PV roof sealed (Rev5-7):** TS-10 seals, TX-10 crosses and clamp boots close every module gap and the row joint (sheets W1–W4), so all rain now runs off the front edge into this gutter – sized for the full roof catchment ($\approx 76 \text{ m}^2$).
- Do not screw into the module frames; fix brackets and apron to the front purlin, clear of the mid and end clamps. Bond the gutter to the carport earth.
- Pipe underside $\approx 1.82\text{--}1.88 \text{ m}$ along the west edge – fine for cars, mark it with reflective tape for pedestrians. Clean the gutter and leaf guard before and during the rainy season.

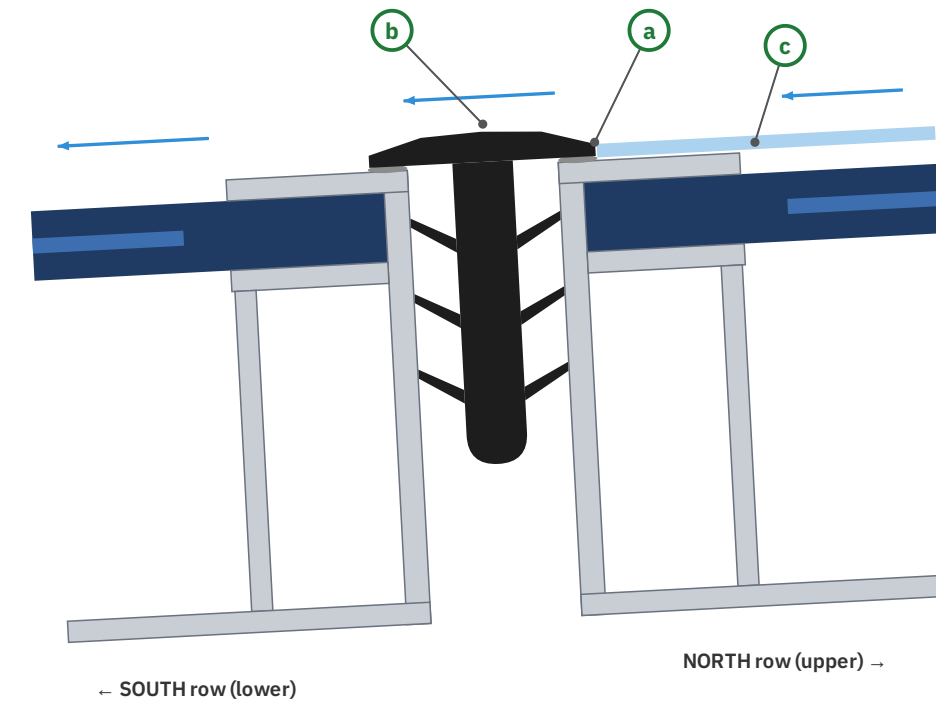
PLAN – PV carport roof, joints to seal · scale 1:100 on A3



■ J1 – long-side joints N-S · 26 × 2.38 m ■ J2 – row joint E-W · 16.01 m in 14 segments ○ 13 crossings – moulded cross TX-10 (W3)

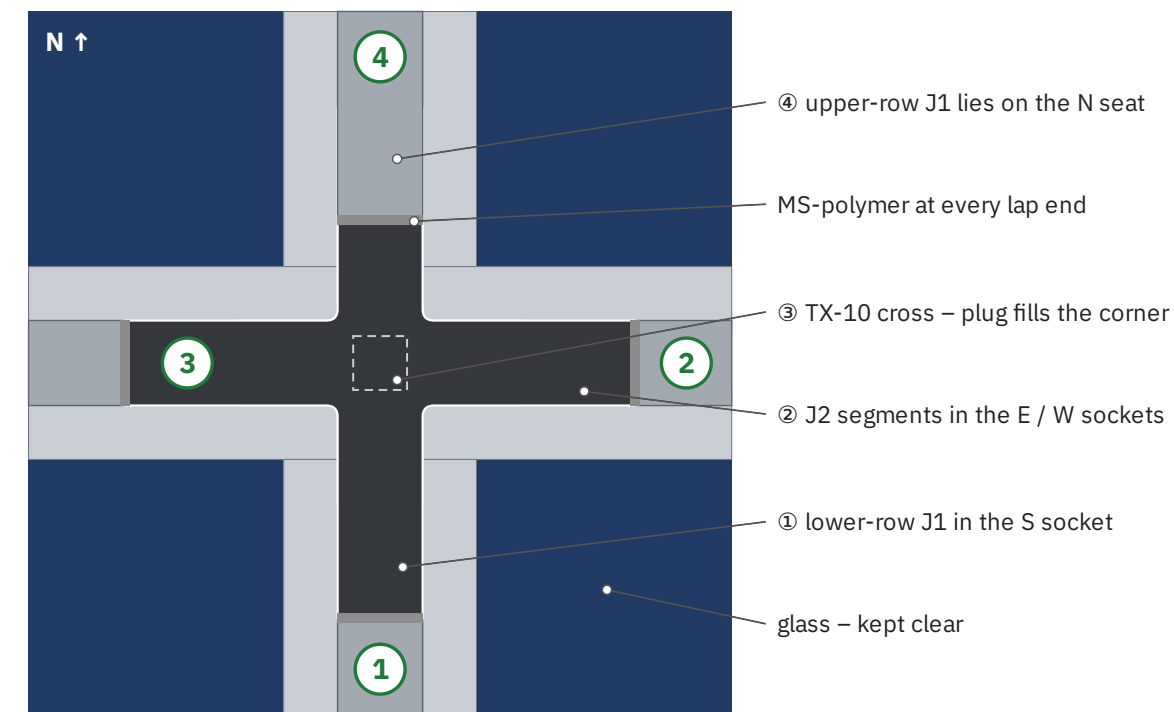
■ 52 mid clamps with boots TB-10 (D1, W4) ■ 8 end clamps — purlins (indicative) — all rain runs south to the gutter

SECTION 2 – J2 row joint, looking east · scale 2:1 · roof falls ≈ 3° to the south

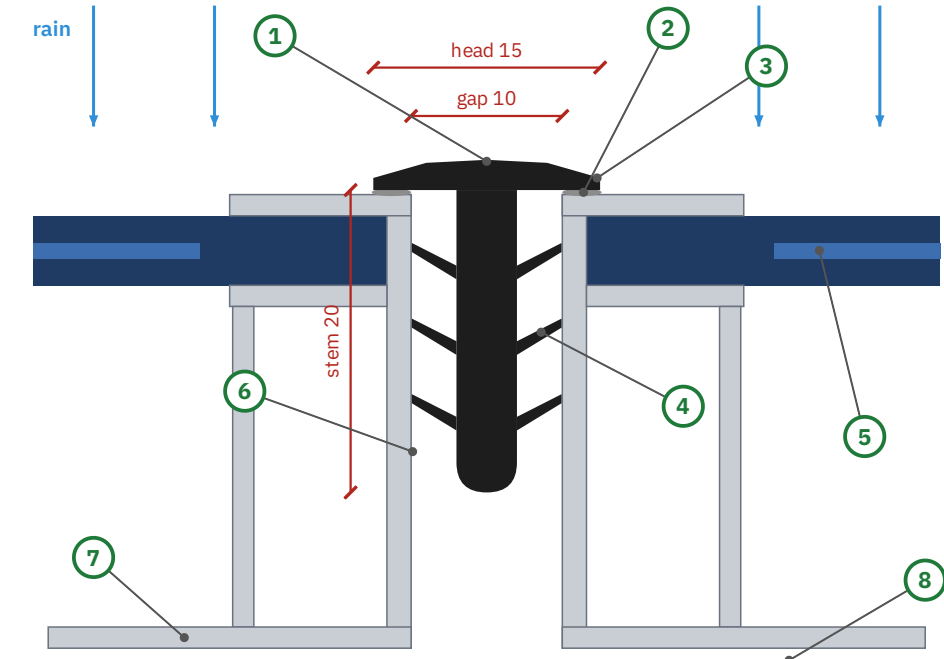


- (a) feather edge 0.8 mm – water runs on and over the thin head
- (b) J2 seal, same TS-10 profile, in 14 segments between the moulded crosses
- (c) only ≈ 1 mm of water holds upslope of the head before it spills over – self-draining at ≈ 3°

DETAIL 3 – crossing with moulded cross TX-10, plan · scale 3:4 on A3 · lay in order ① → ④ · details on W3

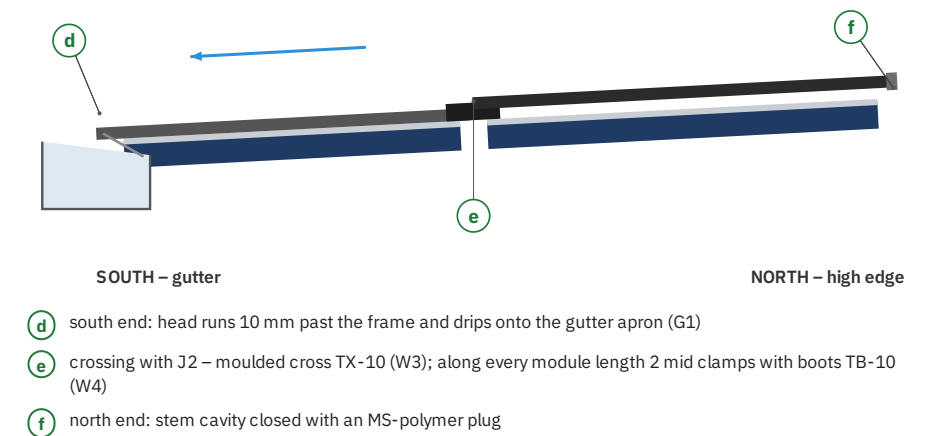


SECTION 1 – J1 long-side joint with EPDM T-seal · scale 2:1 on A3 · typical between clamps



- ① thin EPDM T-seal TS-10 (profile on W2): head 15 mm, stem 4 mm
- ② MS-polymer bead under each wing – bonds and seals the head to the frame
- ③ wing 2.5 mm – rests on the aluminium frame top only
- ④ 3 pairs of thin fins press on both frame walls – grip and a second seal line
- ⑤ glass-glass laminate; the cells are well away from the seal – no shading
- ⑥ 10 mm gap (LONGi minimum) – between clamps the gap is clear full depth
- ⑦ frame bottom flange rests on the purlin at the clamp positions
- ⑧ purlin top (at clamp positions only – mid clamps and boots: D1, W4)

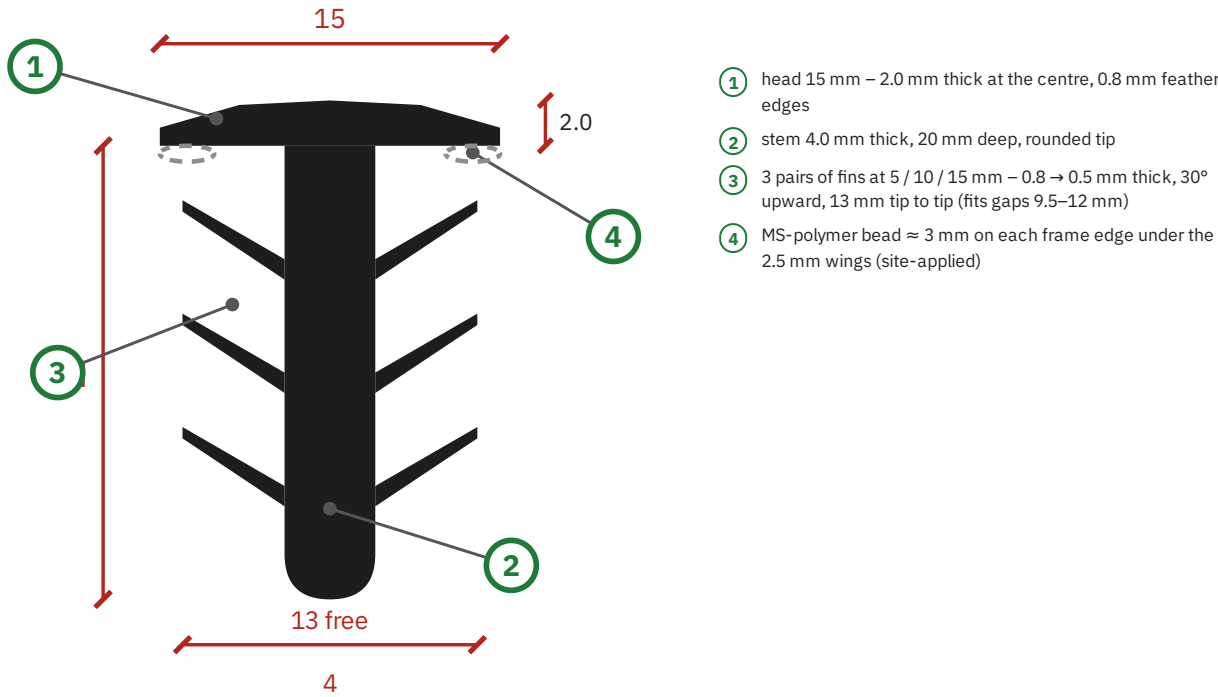
SECTION 3 – along one J1 joint · schematic, not to scale



How the seal keeps the roof dry

- Every 10 mm module gap gets a thin EPDM T-seal TS-10 (4 mm stem, 15 mm head) – 26 J1 joints along the slope and the J2 joint across it in 14 segments. At the 13 crossings a one-piece moulded cross TX-10 joins the two T-seals and plugs the corner void (W3).
- The 15 mm head rests only 2.5 mm on each frame edge – nothing touches the glass, no shading.
- Joints at the crosses are 20 mm moulded laps – a seat on the uphill arm, sockets under tongues on the others. The uphill piece is always on top and nothing is skived on site.
- Rev7 – clamps:** aluminium mid clamps sit in the gap at the 52 purlin crossings, bolted into M8 rivet nuts in the purlin tops (D1). Each gets a moulded EPDM boot TB-10 that laps into the seal the same way as the crosses (W4).
- Rev9:** 10 mm gaps on both the long sides and the short ends (LONGi minimum) – the Rev8 3 mm short-end joint is withdrawn. Roof 16.01 × 4.77 m. Frames, footings and floor unchanged; purlin cantilevers ≈ 2.30 m each end; gutter G1 can stay 16.14 m.
- Low PV structure (14 modules on pebbles): not sealed – optional (W2).

PROFILE TS-10 – thin EPDM T-seal to order · as extruded · scale 3:1 on A3 · dimensions in mm



Seal and materials specification

Profile	TS-10 thin EPDM T-seal (this sheet) – head 15 mm, stem 4 mm × 20 mm, 3 pairs of fins, 13 mm free
Fits	module gap 10–11 mm (LONGi minimum 10 mm), frame depth ≥ 30 mm, flat frame edge ≥ 3 mm
Material	dense EPDM (not sponge), black, carbon-black UV-stabilised
Hardness	60 ± 5 Shore A (soft enough for the thin fins)
Weathering	ozone- and UV-resistant – no cracks after ozone test (ISO 1431-1 / ASTM D1149)
Temperature	–40 ... +120 °C (module frame up to ≈ 85 °C in sun)
Strength	tensile ≥ 8 MPa, elongation ≥ 300 %, compression set ≤ 35 % (22 h / 70 °C)
Tolerances	ISO 3302-1 class E2 · supplied in 50 m coils, straight cut
Bedding	MS-polymer bead ≈ 3 mm on each frame edge under the 2.5 mm wings – replaces butyl tape
Cross junction	TX-10 moulded cross, same EPDM compound – drawing and spec on W3
Clamp boot	TB-10 moulded boot over each aluminium mid clamp – drawing and spec on W4
Sealant	MS-polymer (hybrid), black, neutral cure – bonds EPDM, anodised Al and glass; no acetoxysilicone
Cleaner	isopropyl alcohol (IPA) ≥ 99 %, lint-free cloths

Quantities – PV carport, 28 modules

#	Item	Basis	Qty	Unit
1	Thin EPDM T-seal TS-10	cutting list on W3: 74.0 m + 10 %	85	m
1a	Moulded cross junction TX-10	13 crossings + 2 spares (W3)	15	pc
1b	Moulded clamp boot TB-10	52 mid clamps + 4 spares (W4)	56	pc
2	MS-polymer sealant, black, 290 ml	beads under both wings (≈ 150 m) + 13 crosses + 52 boots + ends	7	cartridge
3	IPA cleaner ≥ 99 %	frame edges and gap walls	1	litre
4	Lint-free cloths	also to wipe sealant squeeze-out off the glass	2	pack
5	Gap spacer blocks 10 mm	plastic, to set the gaps before final clamping	20	pc
6	Hand roller + plastic wedge	silicone roller 20 mm; plastic wedge to push the stem in – no metal tools on glass	1	set
Option – low PV structure, 14 modules (only if the area under it must stay dry)				
O1	Thin EPDM T-seal TS-10	A–F × 6 + J2 7 segments (W3 lengths) + 10 %	39	m
O2	MS-polymer sealant, black, 290 ml	beads + 4 laps at each of 6 crosses + 14 ends	3	cartridge
O3	Moulded cross junction TX-10	6 crossings + 1 spare	7	pc
O4	Moulded clamp boot TB-10	24 mid clamps + 2 spares	26	pc

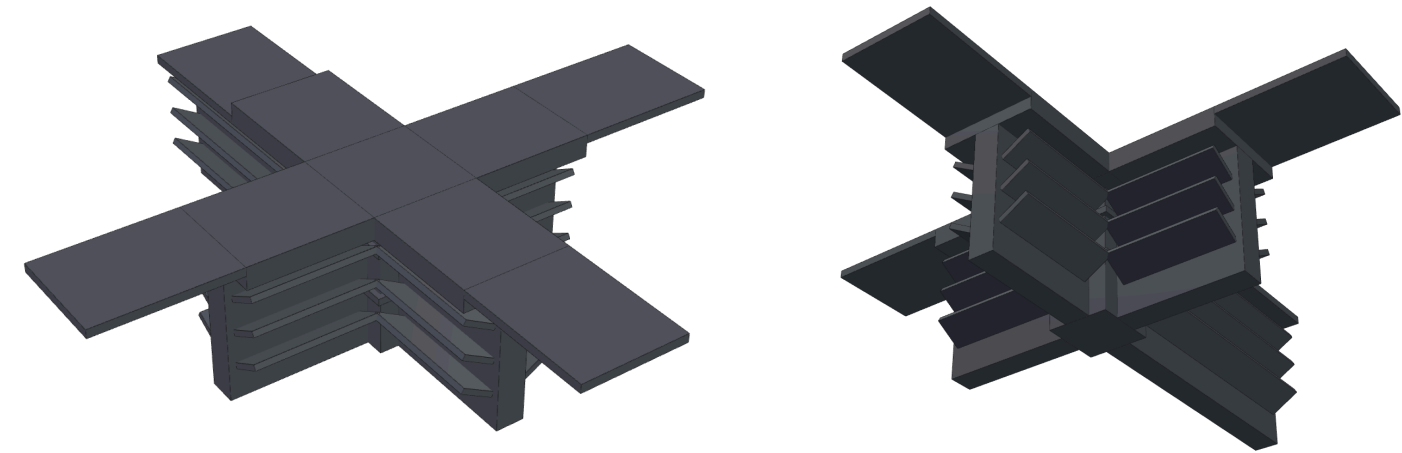
Installation sequence

- Set the gaps** to 10–11 mm with the spacer blocks before final clamping – never under 10 mm (LONGi). Keep module cables and connectors clipped under the frames, out of the gaps.
- Test-fit a 1 m sample** of TS-10 in 3 gaps: the stem must go in with a firm push, the fins must grip, and the head must lie flat on both frame edges.
- Clean** the frame edges and gap walls with IPA; let them dry. Work in dry weather, frame temperature 10–45 °C.
- Cut lengths relaxed.** Unroll the coil and let it rest flat 24 h in the shade. Cut pieces A–F and J2 to the W3 cutting list – straight cuts only; trim the stem off the last 20 mm where the list says so.
- Work uphill along every joint:** seal piece → boot (W4) or cross (W3) → next seal piece, each lapping onto the one below. MS-polymer bead on both frame tops, press the stem in with the wedge, roll the head. Start at the south edge (pieces F run 10 mm past the frame).
- Clamps first:** torque all mid and end clamps (12–16 N·m, D1) before any boot goes on. Lay the J2 segments before each cross. Plug the north and roof-end ends with MS-polymer.
- Wipe** any sealant squeeze-out off the glass before it skins (≈ 10 min).
- Water test** after 24 h: hose each joint from the north edge for 10 min and check the underside is dry; then run the full roof and check that the gutter takes all the water.

Checks and notes

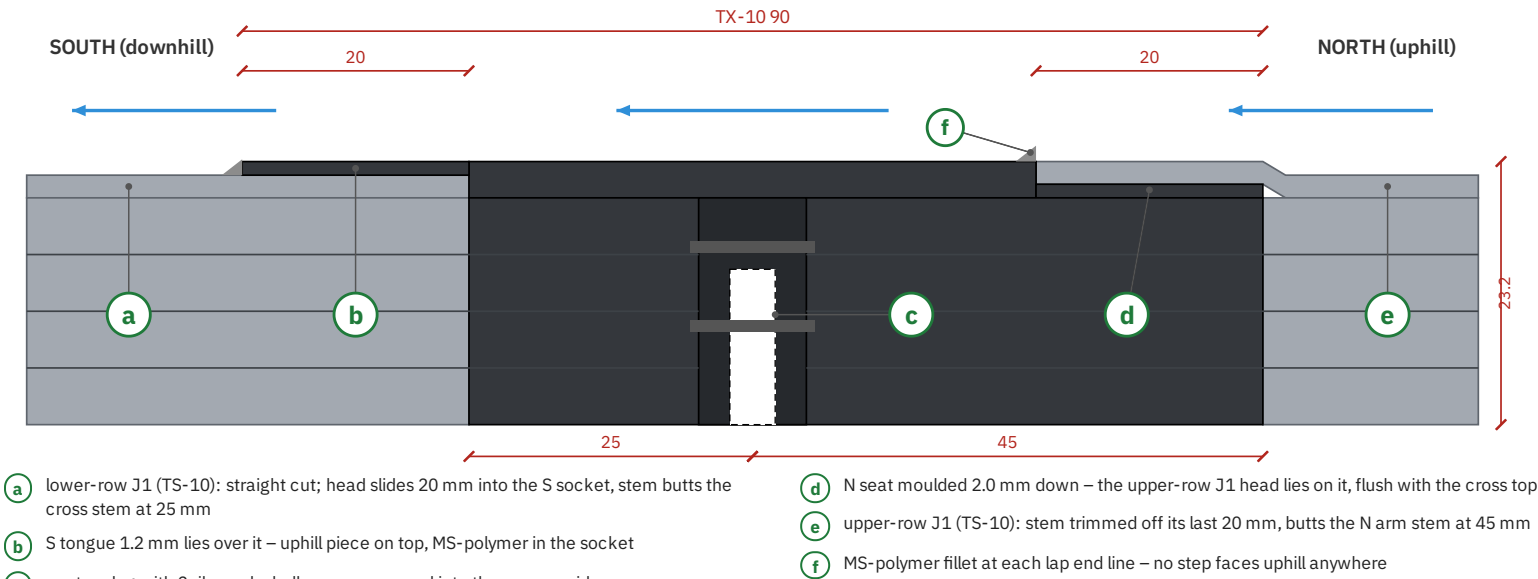
- Module gap:** the LONGi Hi-MO X10 installation manual (V19) requires at least 10 mm between adjoining modules. This design keeps 10–11 mm – do not close the gaps further.
- No shading:** the 2.5 mm wings stay on the frame edges, well clear of the cells. The bifacial rear side stays open to the floor.
- Roof size (Rev6):** 14 × 1 134 + 13 × 10 = 16.01 m long, 2 × 2 382 + 10 = 4.77 m wide (was 16.14 × 4.78 m with 20 mm gaps). Frames, footings and floor unchanged; purlin cantilevers ≈ 2.30 m each end.
- Gutter G1:** all rain now leaves at the front edge; G1 is sized for the full roof (≈ 76 m²) – OK, and can stay 16.14 m long.
- Pitch ≈ 3°:** the thin J2 head holds back only ≈ 1 mm of water before it spills over; clean it with every panel wash (every 6 months).
- Frame drainage holes** in the module frame corners must stay open – do not fill them with sealant.
- No load on glass:** the seal is not structural. Do not walk or kneel on modules – work from a mobile scaffold or ladders; modules are live in daylight.
- Warranty:** send D1 and W1–W4 to the LONGi distributor to confirm that the frame-edge seals are acceptable under the module warranty.
- Supply:** TS-10 is a small custom extrusion – ask extruders for their nearest standard T-seal die for 10 mm gaps first; TX-10 and TB-10 are moulded. Order samples of all three, and fit the TB-10 sample over the actual mid clamp.

TX-10 – moulded EPDM cross junction · 3D views, not to scale



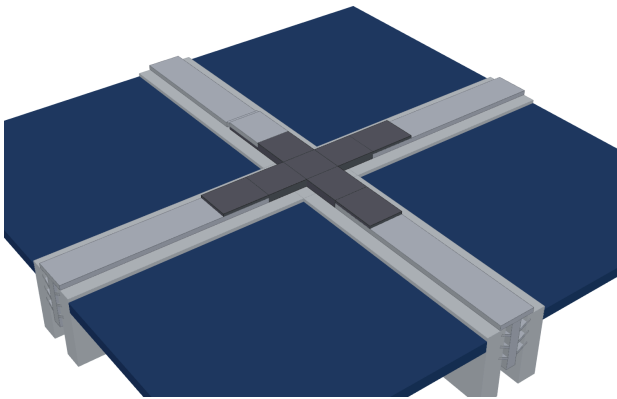
from above – the N arm (back left) has the 2 mm seat; the other three arms end in tongues over sockets
from below – centre plug with 2 ribs, 4 mm stems and thin fins under all four arms

SECTION A-A – along the J1 line through the cross · scale 1.5:1 on A3 · roof falls to the south (left) · dashed line = frame top level



- a) lower-row J1 (TS-10): straight cut; head slides 20 mm into the S socket, stem butts the cross stem at 25 mm
- b) S tongue 1.2 mm lies over it – uphill piece on top, MS-polymer in the socket
- c) centre plug with 2 ribs and a hollow core, pressed into the corner void
- d) N seat moulded 2.0 mm down – the upper-row J1 head lies on it, flush with the cross top
- e) upper-row J1 (TS-10): stem trimmed off its last 20 mm, butts the N arm stem at 45 mm
- f) MS-polymer fillet at each lap end line – no step faces uphill anywhere

Fitted at a crossing · 3D view



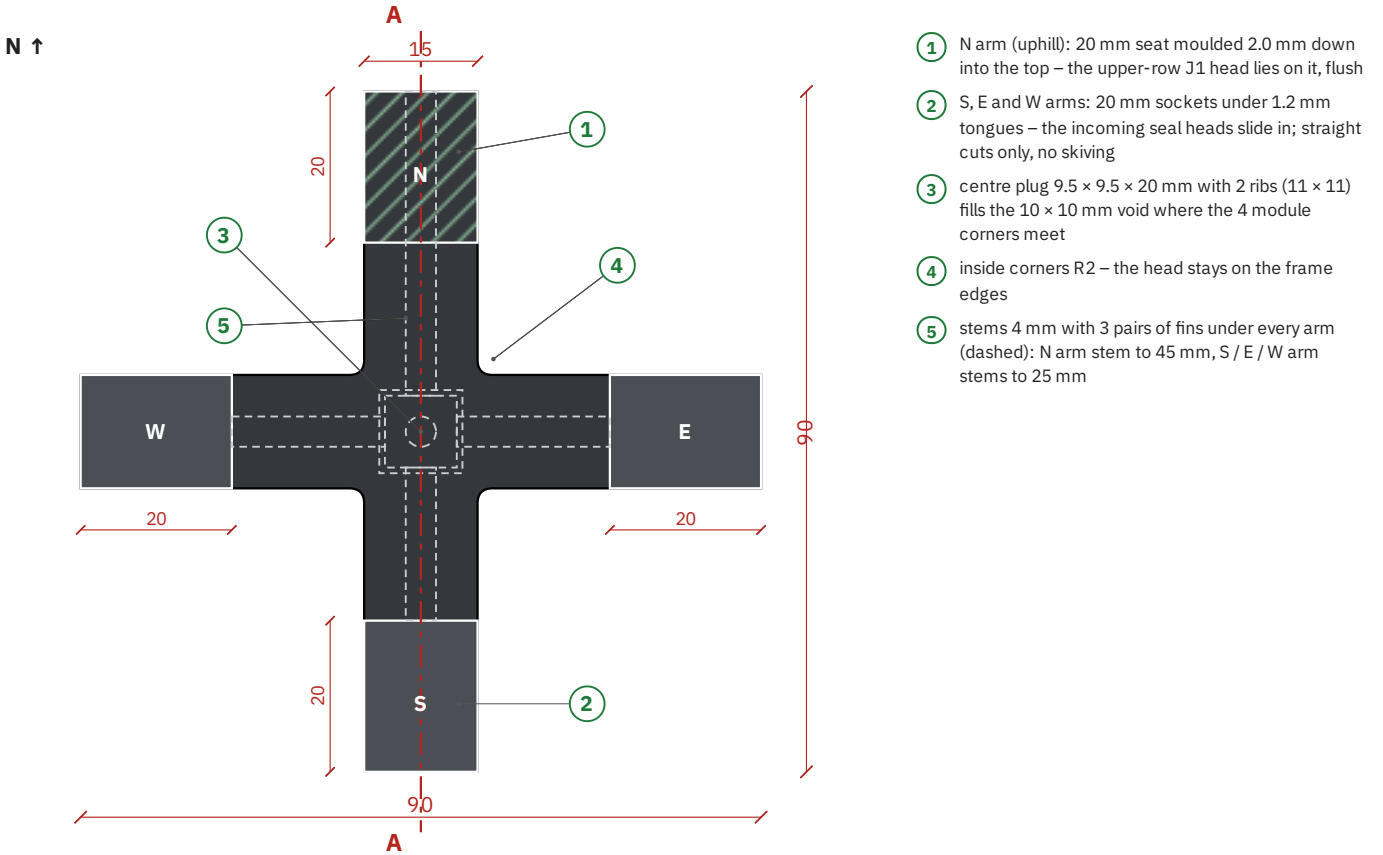
light grey = straight TS-10 seals, dark = TX-10. North is back left: the upper-row J1 lies on the cross seat; the other three seals slide into the cross sockets.

Cutting list – TS-10 pieces for the carport (Rev9)

#	Piece	Qty	Stem	Head	Ends
A	Upper row – north piece	13	547	567	N: flush + plug · S: on boot seat, stem trimmed 20
B	Upper row – middle piece	13	1 116	1 136	N: into boot socket · S: on boot seat, stem trimmed 20
C	Upper row – south piece	13	527	547	N: into boot socket · S: on TX-10 N seat, stem trimmed 20
D	Lower row – north piece	13	527	547	N: into TX-10 S socket · S: on boot seat, stem trimmed 20
E	Lower row – middle piece	13	1 116	1 136	N: into boot socket · S: on boot seat, stem trimmed 20
F	Lower row – south piece	13	567	577	N: into boot socket · S: 10 mm past the frame (drip)
J2	J2 middle segments	12	1 094	1 094	straight cuts into TX-10 E / W sockets
J2e	J2 end segments	2	1 114	1 114	cross end straight · roof end flush + plug
TX	TX-10 moulded cross	13 + 2	–	–	W3
TB	TB-10 clamp boot	52 + 4	–	–	W4

Lengths in mm, per J1 joint: A–C upper row, D–F lower row, with mid clamps (boots) at 595 mm from each module end. Total TS-10 = 74.0 m (+10 % → 85 m, W2).

PLAN – TX-10 · scale 1:1 on A3 · dimensions in mm



- 1) N arm (uphill): 20 mm seat moulded 2.0 mm down into the top – the upper-row J1 head lies on it, flush
- 2) S, E and W arms: 20 mm sockets under 1.2 mm tongues – the incoming seal heads slide in; straight cuts only, no skiving
- 3) centre plug 9.5 × 9.5 × 20 mm with 2 ribs (11 × 11) fills the 10 × 10 mm void where the 4 module corners meet
- 4) inside corners R2 – the head stays on the frame edges
- 5) stems 4 mm with 3 pairs of fins under every arm (dashed): N arm stem to 45 mm, S / E / W arm stems to 25 mm

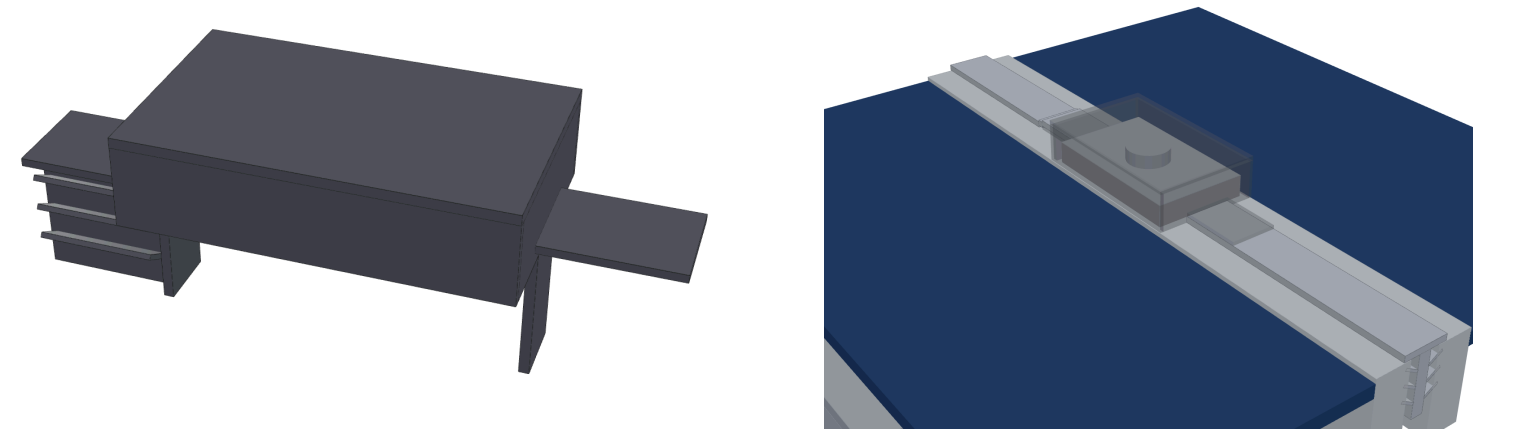
TX-10 specification

Part	TX-10 cross junction – one piece, compression-moulded EPDM
Compound	same as TS-10: dense EPDM 60 ± 5 Shore A, black, UV + ozone resistant, –40 ... +120 °C
Size	90 × 90 mm, arms 15 mm wide, head 3.2 mm (1.2 mm above the straight seals), total depth 23.2 mm
Centre plug	9.5 × 9.5 × 20 mm, 2 ribs 11 × 11 × 1.0 mm, hollow core Ø 4 × 12 mm, 1.5 mm lead-in chamfer
Stems / fins	4 mm core, 3 pairs of fins at 5 / 10 / 15 mm as TS-10 – N arm to 45 mm, S / E / W arms to 25 mm
Lap zones	20 mm at every arm end – N: seat 2.0 mm deep with an end ramp; S / E / W: sockets 2.0 × 15.5 mm under 1.2 mm tongues
Weight	≈ 20 g
Tolerances	ISO 3302-1 class M2 · steel 2-part mould with side cores – fins flex out on demoulding
Approval	5 first-off samples test-fitted on a real module crossing before the series is moulded

Fitting a crossing

- Check the 4 module corners: gaps 10–11 mm (never under 10), and the upper- and lower-row J1 gaps in line within ± 1.5 mm (string line).
- Clean the frame edges around the crossing with IPA.
- Lay the lower-row J1 and both J2 segments first – straight-cut ends stopping 25 mm from the crossing centre.
- MS-polymer beads on the frame edges under the cross wings and a thin bead inside the 3 sockets.
- Press the centre plug into the corner void first, then the 4 arm stems; the 3 sockets slide over the incoming seal heads.
- MS-polymer on the N seat; lay the upper-row J1 (stem trimmed off its last 20 mm) onto it.
- Tool small MS-polymer fillets along the 4 lap end lines; wipe the glass clean.
- Hose-test the crossing for 10 min from uphill – the underside must stay dry.

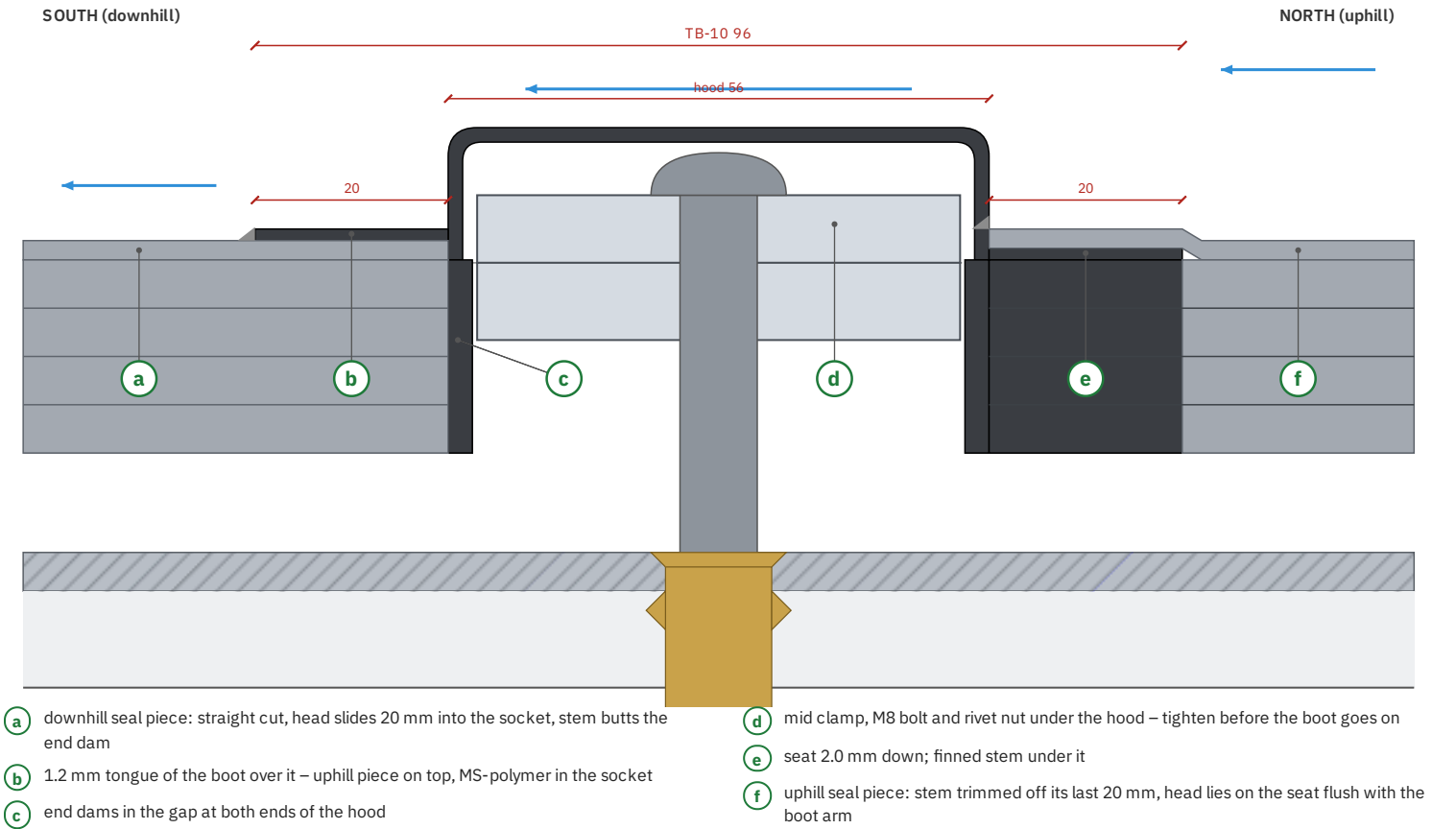
TB-10 – moulded EPDM clamp boot · 3D views, not to scale



the boot: hood over the clamp, seat on the uphill arm (left, with finned stem), tongue over the socket on the downhill arm (right)

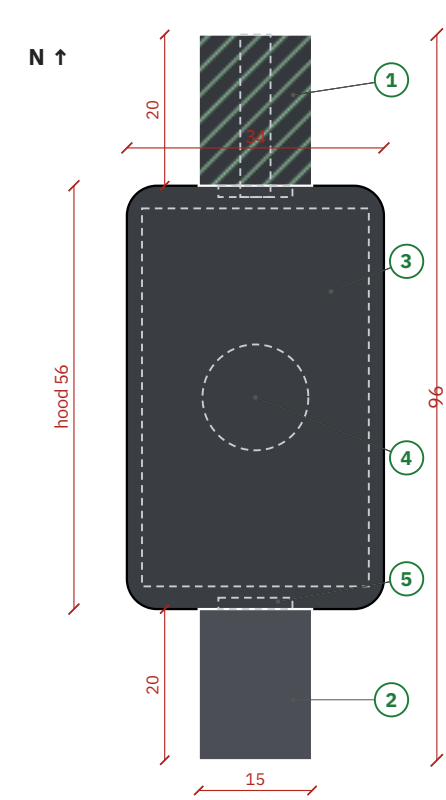
fitted: boot shown see-through over the mid clamp and M8 bolt; the uphill seal (back) lies on the seat, the downhill seal (front) runs into the socket

SECTION – along the joint through a mid clamp and its boot · scale 1.33:1 on A3 · roof falls to the south (left) · dashed line = frame top



- (a) downhill seal piece: straight cut, head slides 20 mm into the socket, stem butts the end dam
- (b) 1.2 mm tongue of the boot over it – uphill piece on top, MS-polymer in the socket
- (c) end dams in the gap at both ends of the hood
- (d) mid clamp, M8 bolt and rivet nut under the hood – tighten before the boot goes on
- (e) seat 2.0 mm down; finned stem under it
- (f) uphill seal piece: stem trimmed off its last 20 mm, head lies on the seat flush with the boot arm

PLAN – TB-10 · scale 1:1 on A3



- (1) uphill (north) arm: 20 mm seat moulded 2.0 mm down – the uphill seal lies on it, flush
- (2) downhill (south) arm: 20 mm socket under a 1.2 mm tongue – the downhill seal slides in
- (3) hood 56 × 34 × 14 mm, R4 corners – covers the 50 × 30 clamp and the bolt head; skirt stays on the 12 mm frame tops
- (4) clamp and M8 bolt inside (dashed)
- (5) end dams drop into the 10 mm gap at both ends of the hood; the uphill arm carries a 4 mm finned stem

TB-10 specification

Part	TB-10 clamp boot – one piece, compression-moulded EPDM, same compound as TS-10 (60 ± 5 Shore A, UV + ozone resistant)
Size	96 × 34 mm overall; hood 56 × 34 × 14 mm high, walls 1.0 mm sides / 1.5 mm roof and ends (inside 53 × 32 × 12.5); arms 15 mm wide
Fits	generic aluminium mid clamp 50 × 30 × 7 mm with an M8 button head ≤ 11.5 mm above the frame, frame tops ≥ 12 mm – confirm on the chosen clamp and module, adjust the hood
Laps	uphill arm: 20 mm seat 2.0 mm deep + finned 4 mm stem · downhill arm: 20 mm socket 2.0 × 15.5 mm under a 1.2 mm tongue
Gap dams	end dams 9.8 × 1.5 × 20 mm at both ends of the hood, in the 10 mm gap
Bedding	MS-polymer bead under the hood skirt on both frames and in the socket
Weight	≈ 25 g
Access	to re-torque a clamp: cut the bead, lift the boot, re-bed with fresh MS-polymer
Approval	5 first-off samples fitted over the real clamp before the series is moulded

Fitting a boot

1. Torque the mid clamp to 12–16 N·m and check the earthing first.
2. Lay the downhill seal piece; its straight-cut end stops 28 mm from the clamp centre.
3. MS-polymer bead on the frame tops along the hood skirt lines and a thin bead in the socket.
4. Press the boot over the clamp: the tongue slides over the downhill seal head, the end dams drop into the gap.
5. MS-polymer on the seat; lay the uphill seal (stem trimmed off its last 20 mm) onto it.
6. Tool fillets at both lap end lines; wipe the glass clean before the sealant skins.