SimulATe — Validation Dossier

Worked examples verifying the calculation engine against the published standards · software version 4.24.11 · generated 2026-07-13

Methodology: each example states its inputs, walks through the calculation BY HAND using only the formulas and table values of the referenced standard, and compares the result with the value computed by the SimulATe engine (the same functions the application calls — the engine values in this document are produced live at generation time, not copied). Deviations stem only from display rounding. The engine is additionally covered by an automated regression suite of 2,400+ tests, and every exported report carries a SHA-256 content fingerprint recorded in a hash-linked audit trail.

WE-1 — Ampacity derating chain — grouping (air) and ambient temperature

IEC 60364-5-52:2009 Ed. 3.0 — Table B.52.20 (perforated tray, multi-core, touching) and Table B.52.14 (ambient air temperature, XLPE)

Inputs

Installation	Perforated cable tray, method E, 1 tray
Circuits on tray	6 multi-core cables, touching
Insulation	XLPE (90 °C)
Ambient air temperature	40 °C

Manual calculation

1. Table B.52.20, row 'Perforated cable tray systems (touching)', 1 tray, 6 cables → grouping factor Cg = 0.76 (read directly from the published table).
2. Table B.52.14, XLPE column, 40 °C → temperature factor Ct = 0.91 ($\sqrt{(90–40)/(90–30)}$ = √0.833 = 0.913 → tabulated 0.91).
3. Combined derating: Cg × Ct = 0.76 × 0.91 = 0.6916.

Comparison — manual vs SimulATe engine

Quantity	Manual	SimulATe	Δ %
Grouping factor Cg (B.52.20)	0.76	0.76	0.000
Temperature factor Ct (B.52.14)	0.91	0.91	0.000
Combined derating Cg·Ct	0.6916	0.6916	0.000

Verdict: agreement within 0.000 % — MATCH.

WE-2 — Buried circuits — direct buried (D2) vs in conduit (D1)

IEC 60364-5-52:2009 Ed. 3.0 — Table B.52.18 (D2, direct in ground, touching) and Table B.52.19 (D1, in conduit in ground, touching)

Inputs

Circuits	8, cables touching
Arrangement D2	Direct buried
Arrangement D1	Single-way ducts (conduit) in ground

Manual calculation

1. Table B.52.18 (D2 touching), 8 circuits → 0.43. Direct-buried cables have no duct air cushion, so mutual heating is the most restrictive of all grouping tables.
2. Table B.52.19 (D1 touching), 8 circuits → 0.54.
3. Note: Edition 2.0:2001 numbered these two tables the other way around; SimulATe follows Edition 3.0:2009 numbering and values (verified against the published tables page by page).

Comparison — manual vs SimulATe engine

Quantity	Manual	SimulATe	Δ %
D2 direct buried, 8 circuits (B.52.18)	0.43	0.43	0.000
D1 in conduit, 8 circuits (B.52.19)	0.54	0.54	0.000

Verdict: agreement within 0.000 % — MATCH.

WE-3 — Cable pulling tension — sequential capstan, 3 × 90° bends

IEEE Std 1185 — straight-section friction $T = \mu \cdot W \cdot L$ per segment; bend amplification $T_{out} = T_{in} \cdot e^{(\mu\theta)}$ applied sequentially

Inputs

Cable weight	2.0 kg/m ($W = 2.0 \times 9.81 = 19.62$ N/m)
Route length	120 m — 4 equal 30 m segments
Bends	3 × 90° ($\theta = \pi/2$)
Coefficient of friction μ	0.35
Weight correction wc	1.0 (single cable)

Manual calculation

1. Per-segment friction: $\Delta T = \mu \cdot W \cdot L = 0.35 \times 19.62 \times 30 = 206.0$ N.
2. Bend multiplier: $e^{(\mu\theta)} = e^{(0.35 \times \pi/2)} = e^{0.5498} = 1.7330$.
3. Seg 1 → T = 206.0 N; bend 1 → 206.0 × 1.7330 = 357.0 N.
4. Seg 2 → 357.0 + 206.0 = 563.0 N; bend 2 → 975.6 N.
5. Seg 3 → 975.6 + 206.0 = 1181.6 N; bend 3 → 2047.6 N.
6. Seg 4 → final pulling tension T = 2047.6 + 206.0 = 2253.6 N.

Comparison — manual vs SimulATe engine

Quantity	Manual	SimulATe	Δ %
Tension after bend 1 (N)	357	357	0.000
Tension after bend 2 (N)	975.6	975.6	0.000
Tension after bend 3 (N)	2047.6	2047.6	0.000
Final pulling tension (N)	2253.6	2253.6	0.000

Verdict: agreement within 0.000 % — MATCH.

WE-4 — Sidewall pressure at the governing bend

IEEE Std 1185 — P = T/R evaluated at each bend EXIT; limit 7300 N/m (500 lb/ft) for LV cables

Inputs

Governing bend	Bend 3 of WE-3 (highest exit tension)
Tension at bend exit T	2047.7 N (manual, WE-3)
Bend radius R	0.6 m
Limit (LV XLPE)	7300 N/m

Manual calculation

1. Sidewall pressure uses the tension AT the governing bend, not the final pull tension — the last straight segment adds friction after the bend and would overstate P.
2. P = T/R = 2047.7 / 0.6 = 3412.8 N/m.
3. 3412.8 N/m < 7300 N/m → PASS.

Comparison — manual vs SimulATe engine

Quantity	Manual	SimulATe	Δ %
Sidewall pressure P (N/m)	3412.8	3412.7	0.003
Limit LV XLPE (N/m)	7300	7300	0.000

Verdict: agreement within 0.003 % — MATCH.

WE-5 — Support span check — simply supported beam under UDL

EN 1993-1-1 (member internal forces, closed-form) with the EN 61537 serviceability limit $\delta \le L/200$ applied to the span

Inputs

Span L	1500 mm, simply supported
Line load q	0.5 N/mm (≈ 51 kg/m tray + cable load)
Young's modulus E	210 000 MPa (structural steel)
Second moment I	50 000 mm■

Manual calculation

1. $M_{max} = q \cdot L^2/8 = 0.5 \times 1500^2 / 8 = 140\,625$ N·mm.
2. $V_{max} = q \cdot L/2 = 0.5 \times 1500 / 2 = 375$ N.
3. δ_{max} = 5·q·L■ / (384·E·I) = 5 × 0.5 × 1500■ / (384 × 210 000 × 50 000) = 3.139 mm.
4. Limit: L/200 = 1500/200 = 7.5 mm → 3.139 mm ≤ 7.5 mm → PASS.

Comparison — manual vs SimulATe engine

Quantity	Manual	SimulATe	Δ %
M_{max} (N·mm)	140625	140625	0.000
V_{max} (N)	375	375	0.000
δ_{max} (mm)	3.139	3.139	0.000

Verdict: agreement within 0.000 % — MATCH.

WE-6 — Concrete anchor group — EN 1992-4 cone breakout

EN 1992-4:2018 §7.2.1.4 Eq. 7.1–7.5 (concrete cone), §7.2.1.3 (steel), ISO 898-1 property class 8.8

Inputs

Anchors	2 × M12, class 8.8, post-installed
Effective embedment hef	80 mm
Edge distance c1	150 mm
Concrete	C25/30 (fck = 25 MPa), cracked
Demand	N_Ed = 5.0 kN, V_Ed = 3.0 kN (group)

Manual calculation

1. $N°_{Rk,c} = k_1 \cdot \sqrt{f_{ck}} \cdot h_{ef}^{1.5}$ with $k_1 = 7.7$ (cracked, post-installed, Table 7.1) $= 7.7 \times \sqrt{25} \times 80^{1.5} = 7.7 \times 5 \times 715.5 = 27\,548$ N = 27.55 kN.
2. Edge factor $\psi_{s,N}$: $c_{cr,N} = 1.5 \cdot h_{ef} = 120$ mm; $c_1 = 150$ mm $\geq c_{cr,N} \rightarrow \psi_{s,N} = 1.0$ (Eq. 7.4).
3. Group of 2 anchors (spacing not declared) → simplified conservative area ratio 0.90; $\psi_{re,N} = 1.0$ (no dense reinforcement).
4. $N_{Rd,c} = 27.55 \times 0.90 \times 1.0 \times 1.0 / \gamma_{Mc}(1.5) = 16.53$ kN.
5. Steel: $N_{Rd,s} = n \cdot A_s \cdot f_{uk}/\gamma_{Ms} = 2 \times 84.3 \times 800 / 1.5 = 89\,920$ N = 89.92 kN → concrete cone governs.
6. Utilisation N: 5.0 / 16.53 = 0.302 → PASS.

Comparison — manual vs SimulATe engine

Quantity	Manual	SimulATe	Δ %
N°_Rk,c single anchor (kN)	27.55	27.55	0.000
N_Rd,c group (kN)	16.53	16.53	0.000
N_Rd,s steel (kN)	89.92	89.92	0.000
Utilisation N (–)	0.302	0.302	0.000

Verdict: agreement within 0.000 % — MATCH.