

Laterally Loaded Pier / Pole Embedment — Validation Report

Independent verification of the Kouzouki calculation engine against closed-form statics, published design-standard values and worked examples

Engine	Kouzouki — Laterally Loaded Pier / Pole Embedment
Basis	IBC 1807.3.2 embedment of a laterally loaded post/pole. Non-constrained: $A=2.34P/(S1 \cdot b)$, $d=0.5A[1+\sqrt{1+4.36h/A}]$ with S1 the lateral bearing at $d/3$ (iterated). Constrained: $d=(4.25 \cdot P \cdot h / (S3 \cdot b))^{1/3}$ with S3 the bearing at depth d .
Validation type	Independent validation
Report date	2026-06-18
Result	PASS — 8/8 checks within tolerance

1. Validation cases

Each case feeds the tool a defined input set and compares its output against a value derived independently of the engine (cited per row). Tolerance is 1% unless noted.

LP1. Non-constrained — factored lateral bearing

Inputs: lateral_load=2000.0, load_height=4.0, diameter=18.0, lateral_bearing=150.0, constrained=False, allow_increase=1.0, provided_depth=0.0

Checked quantity	Independent value	Tool output	Dev.	Verdict
S/ft = table value × increase Table 1806.2, k=1.0	150.0 psf/ft	150.0 psf/ft	0.00%	PASS
Required embedment d IBC 1807.3.2.1 iter	9.536 ft	9.54 ft	0.04%	PASS

LP2. Non-constrained — coefficient & depth

Inputs: lateral_load=2000.0, load_height=4.0, diameter=18.0, lateral_bearing=150.0, constrained=False, allow_increase=1.0, provided_depth=0.0

Checked quantity	Independent value	Tool output	Dev.	Verdict
$A = 2.34 P / (S1 \cdot b)$ IBC 1807.3.2.1	6.544 ft	6.544 ft	0.00%	PASS
$d = 0.5A[1+\sqrt{1+4.36h/A}]$ IBC 1807.3.2.1	9.536 ft	9.536 ft	0.00%	PASS

LP3. Constrained — closed-form embedment

Inputs: lateral_load=3000.0, load_height=5.0, diameter=24.0, lateral_bearing=200.0, constrained=True, allow_increase=2.0, provided_depth=6.0

Checked quantity	Independent value	Tool output	Dev.	Verdict
$d = (4.25 P h / (S3 \cdot b))^{1/3}$ IBC 1807.3.2.2	4.303 ft	4.3 ft	0.08%	PASS
$S_3 = S \cdot d$ at depth d IBC 1807.3.2.2	1,721.3 psf	1,721.3 psf	0.00%	PASS

LP4. Constrained — isolated-pole increase (×2)

Inputs: lateral_load=3000.0, load_height=5.0, diameter=24.0, lateral_bearing=200.0, constrained=True, allow_increase=2.0, provided_depth=6.0

Checked quantity	Independent value	Tool output	Dev.	Verdict
S/ft = table value × 2.0 IBC 1806.3.4	400.0 psf/ft	400.0 psf/ft	0.00%	PASS
Reported lateral bearing Report	400.0 psf/ft	400.0 psf/ft	0.00%	PASS

2. Assumptions

- Lateral soil bearing increases linearly with depth (S per ft of depth).

- Non-constrained = free at grade; constrained = restrained at grade.
- Allowable lateral bearing may be doubled for isolated poles (1806.3.4).

3. Limitations

- Lateral-bearing value is from IBC Table 1806.2 — a geotechnical INPUT.
- Rigid-pier (not p-y) method; deflection at grade is not computed.
- No surcharge, slope or layered-soil effects.

4. Sources of the independent values

How the independent values are obtained. Every value in the Independent-value column of Section 1 is computed in a validation harness (validation/cases.py) written and run separately from the calculation engine. Each is an independent re-derivation of the governing closed-form equation, or a value read from a cited published worked example or design-standard table - never copied from the engine's own output. The match therefore confirms the engine reproduces the cited source within tolerance. The source beside each value (Section 1) and the references below identify the governing standard section, equation, or publication.

Basis of the independent values

IBC 1807.3.2 embedment of a laterally loaded post/pole. Non-constrained: $A=2.34P/(S1 \cdot b)$, $d=0.5A[1+\sqrt{1+4.36h/A}]$ with S1 the lateral bearing at d/3 (iterated). Constrained: $d=(4.25 \cdot P \cdot h / (S3 \cdot b))^{1/3}$ with S3 the bearing at depth d.

Governing standards & published sources

- International Building Code (2018 / 2021 / 2024), ICC — Ch. 18 (soils & foundations, Table 1806.2, Sec. 1807) and Sec. 1604.3 (deflection).

Per-check citations (Section 1): Table 1806.2, k=1.0; IBC 1807.3.2.1 iter; IBC 1807.3.2.1; IBC 1807.3.2.2; IBC 1806.3.4; Report.

5. Conclusion

All 8 independent checks reproduce the reference values within tolerance. The engine correctly implements the governing equations for this tool.

Reproduce: `python scripts/run_tool_validation.py` → `python scripts/make_tool_validation_pdfs.py`. This report is for verification/demonstration; results are for preliminary design and must be confirmed by a licensed engineer against the current adopted code and project-specific conditions.