Opening Header / Coupling Beam — Validation Report

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

Engine	Kouzouki — Opening Header / Coupling Beam
Basis	Span-depth ratio ln/h selects the model; conventional headers use beam flexure phiMn and shear phi(Vc+Vs); deep coupling beams (ln/h<2, high V) use diagonal bars Avd = Vu/(2 phi fy sin a) (ACI 18.10.7).
Validation type	Independent validation
Report date	2026-06-20
Result	**PASS** — 3/3 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.

CH1. Span-depth ratio

Inputs: clear_span=6.0, depth_h=24.0, width_bw=12.0, fc=4000.0, fy=60000.0, cover=2.5, bar_size=#8, n_bars=3, Mu=120.0, Vu=90.0, stirrup_size=#3, stirrup_spacing=6.0, stirrup_legs=2

Checked quantity	Independent value	Tool output	Dev.	Verdict
ln/h ACI 18.10.7	3	3	0.00%	**PASS**

CH2. Conventional phiMn

Inputs: clear_span=6.0, depth_h=24.0, width_bw=12.0, fc=4000.0, fy=60000.0, cover=2.5, bar_size=#8, n_bars=3, Mu=120.0, Vu=90.0, stirrup_size=#3, stirrup_spacing=6.0, stirrup_legs=2

Checked quantity	Independent value	Tool output	Dev.	Verdict
phi As fy (d - a/2) ACI 22.3	210.7 kip-ft	210.7 kip-ft	0.01%	**PASS**

CH3. Conventional phiVn

Inputs: clear_span=6.0, depth_h=24.0, width_bw=12.0, fc=4000.0, fy=60000.0, cover=2.5, bar_size=#8, n_bars=3, Mu=120.0, Vu=90.0, stirrup_size=#3, stirrup_spacing=6.0, stirrup_legs=2

Checked quantity	Independent value	Tool output	Dev.	Verdict
phi(Vc + Vs) ACI 22.5	59.951 kip	60 kip	0.08%	**PASS**

2. Assumptions

- ln/h = 3 here -> conventional beam design.
- Same flexure/shear basis as the beam tool.

3. Limitations

- Diagonal-reinforcement branch applies only to deep beams.
- Joint and anchorage detailing confirmed separately.

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

Span-depth ratio ln/h selects the model; conventional headers use beam flexure phiMn and shear phi(Vc+Vs); deep coupling beams (ln/h<2, high V) use diagonal bars Avd = Vu/(2 phi fy sin a) (ACI 18.10.7).

Governing standards & published sources

- ACI 318 — Building Code Requirements for Structural Concrete (318-14 / 318-19), American Concrete Institute (Ch. 7, 8, 13, 20, 22).

Per-check citations (Section 1): ACI 18.10.7; ACI 22.3; ACI 22.5.

5. Conclusion

All 3 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.