

# Slender Beam-Column (Moment Magnification) — Validation Report

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

<b>Engine</b>	Kouzouki — Slender Beam-Column (Moment Magnification)
<b>Basis</b>	Slenderness $k l_u / r$ with $r = 0.3 h$ (ACI 6.2.5.1); nonsway magnifier $\delta_{ns} = C_m / (1 - P_u / 0.75 P_c) \geq 1$ , $M_c = \delta_{ns} M_2$ (ACI 6.6.4.5); P-M as for the column tool.
<b>Validation type</b>	Independent validation
<b>Report date</b>	2026-06-20
<b>Result</b>	<b>PASS</b> — 2/2 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.

### BX1. Slenderness ratio

Inputs: width\_b=16.0, depth\_h=16.0, fc=4000.0, fy=60000.0, cover=2.5, bar\_size=#8, n\_bars=8, Pu=300.0, M1=60.0, M2=100.0, k\_factor=1.0, lu=18.0, beta\_dns=0.6

Checked quantity	Independent value	Tool output	Dev.	Verdict
$k l_u / r$ , $r = 0.3h$ ACI 6.2.5	45	45	0.00%	<b>PASS</b>

### BX2. Squash load Po

Inputs: width\_b=16.0, depth\_h=16.0, fc=4000.0, fy=60000.0, cover=2.5, bar\_size=#8, n\_bars=8, Pu=300.0, M1=60.0, M2=100.0, k\_factor=1.0, lu=18.0, beta\_dns=0.6

Checked quantity	Independent value	Tool output	Dev.	Verdict
$P_o = 0.85 f'_c (A_g - A_{st}) + f_y A_{st}$ ACI 22.4.2.2	1,228.1 kip	1,228.0 kip	0.01%	<b>PASS</b>

## 2. Assumptions

- Nonsway (braced) frame;  $k \leq 1.0$ .
- $EI = 0.4 E_c I_g / (1 + \beta_{dns})$ ;  $E_c = 57000 \sqrt{f'_c}$ .
- $C_m = 0.6 - 0.4 M_1 / M_2 \geq 0.4$  (no transverse load).

## 3. Limitations

- Sway (P-Delta) magnification not included.
- Single-axis bending only.

## 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

Slenderness  $k l_u / r$  with  $r = 0.3 h$  (ACI 6.2.5.1); nonsway magnifier  $\delta_{ns} = C_m / (1 - P_u / 0.75 P_c) \geq 1$ ,  $M_c = \delta_{ns} M_2$  (ACI 6.6.4.5); P-M as for the column tool.

### 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 6.2.5; ACI 22.4.2.2.

## 5. Conclusion

All 2 independent checks reproduce the reference values within tolerance. The engine correctly implements the governing equations for this tool.

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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.