Structural Insulated Panel (SIP) — Validation Report

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

Engine	Kouzouki — Structural Insulated Panel (SIP)
Basis	Sandwich-panel mechanics: facing-centroid depth d=T-t_f, EI_eff=E_f b t_f d^2/2 (+facing own bending), (AG)_eff=b d^2 G_c/c, facing couple sigma_f=M/(b t_f d), core shear tau=V/(b d), wrinkling sigma_wr=0.5(E_f E_c G_c)^(1/3), and shear-reduced buckling P_cr=P_E/(1+P_E/(AG)) (Allen 1969 / ASTM C393 / Plantema).
Validation type	Method verification
Report date	2026-06-18
Result	**PASS** — 11/11 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.

SI1. 6.5 in roof SIP — section depth & stiffness

Inputs: panel_use=Roof / Floor, span=12.0, panel_thickness=6.5, skin_thickness=0.4375, w_dead=10.0, w_live=40.0, wind_pressure=25.0, P_dead=0.0, P_live=0.0, E_skin=1300000.0, Fb_skin=1400.0, E_core=350.0, G_core=280.0, Fv_core=3.5, Fc_perp_bearing=30.0, deflection_limit=240, bearing_length=3.0, buckling_FS=3.0

Checked quantity	Independent value	Tool output	Dev.	Verdict
Facing centroid depth d = T - t_f Sandwich geometry	6.062 in	6.062 in	0.00%	**PASS**
EI_eff = E_f b t_f d^2/2 + E_f b t_f^3/6 Allen 1969 Eq. 2.7	1.256e+08 lb-in^2	1.256e+08 lb-in^2	0.00%	**PASS**
(AG)_eff = b d^2 G_c / c Allen 1969 Eq. 2.13	21,954.3 lb	21,954.3 lb	0.00%	**PASS**

SI2. 6.5 in roof SIP, 12 ft, 50 psf — demand & facing stress

Inputs: panel_use=Roof / Floor, span=12.0, panel_thickness=6.5, skin_thickness=0.4375, w_dead=10.0, w_live=40.0, wind_pressure=25.0, P_dead=0.0, P_live=0.0, E_skin=1300000.0, Fb_skin=1400.0, E_core=350.0, G_core=280.0, Fv_core=3.5, Fc_perp_bearing=30.0, deflection_limit=240, bearing_length=3.0, buckling_FS=3.0

Checked quantity	Independent value	Tool output	Dev.	Verdict
Moment M = wL^2/8 Statics	900.0 lb-ft	900.0 lb-ft	0.00%	**PASS**
Shear V = wL/2 Statics	300.0 lb	300.0 lb	0.00%	**PASS**
Facing stress sigma_f = M/(b t_f d) Allen 1969 facing couple	339.3 psi	339.3 psi	0.00%	**PASS**

SI3. 6.5 in roof SIP — core shear & facing wrinkling

Inputs: panel_use=Roof / Floor, span=12.0, panel_thickness=6.5, skin_thickness=0.4375, w_dead=10.0, w_live=40.0, wind_pressure=25.0, P_dead=0.0, P_live=0.0, E_skin=1300000.0, Fb_skin=1400.0, E_core=350.0, G_core=280.0, Fv_core=3.5, Fc_perp_bearing=30.0, deflection_limit=240, bearing_length=3.0, buckling_FS=3.0

Checked quantity	Independent value	Tool output	Dev.	Verdict
Core shear tau = V/(b d) Allen 1969	4.124 psi	4.124 psi	0.00%	**PASS**
Wrinkling sigma_wr = 0.5(E_f E_c G_c)^(1/3) Plantema 1966	2,515.9 psi	2,515.9 psi	0.00%	**PASS**
Total deflection = 5wL^4/384EI + wL^2/8AG ASTM C393	0.678 in	0.678 in	0.00%	**PASS**

SI4. 8.25 in WALL SIP, 9 ft — shear-reduced buckling

Inputs: panel_use=Wall, span=9.0, panel_thickness=8.25, skin_thickness=0.4375, w_dead=10.0, w_live=40.0, wind_pressure=20.0, P_dead=400.0, P_live=600.0, E_skin=1300000.0, Fb_skin=1400.0, E_core=350.0, G_core=280.0, Fv_core=3.5, Fc_perp_bearing=30.0, deflection_limit=180, bearing_length=3.0, buckling_FS=3.0

Checked quantity	Independent value	Tool output	Dev.	Verdict
Euler load P_E = pi^2 EI/L^2 Euler buckling	1.764e+05 lb	1.764e+05 lb	0.00%	**PASS**
Shear-reduced P_cr = P_E/(1+P_E/AG) Allen 1969 sandwich column	24,021.1 lb	24,021.1 lb	0.00%	**PASS**

2. Assumptions

- Thin OSB facings act as flanges; EPS core carries shear & stabilises facings.
- 12-in design strip; simply supported; isotropic linear-elastic materials.
- Deflection = bending + shear (shear term significant for SIPs).

3. Limitations

- Facing (OSB) and core (EPS) allowable VALUES are representative — production design must use the panel's ICC-ES ESR (AC04, tested). The sandwich MECHANICS below are independently re-derived; the allowables are not.
- No single consensus SIP design code; this tool follows sandwich theory + ESR allowables, not a prescriptive standard.
- Splines/panel-joint connections and combined biaxial effects not covered.

4. Sources of the independent values

How the reference values are obtained. The values in Section 1 reproduce the documented design method and the representative tabulated inputs identified under Limitations, computed independently of the engine. They confirm the engine applies the cited method and adjustments correctly; the representative tabulated values must be verified against the governing source named below for final design.

Basis of the independent values
Sandwich-panel mechanics: facing-centroid depth d=T-t_f, EI_eff=E_f b t_f d^2/2 (+facing own bending), (AG)_eff=b d^2 G_c/c, facing couple sigma_f=M/(b t_f d), core shear tau=V/(b d), wrinkling sigma_wr=0.5(E_f E_c G_c)^(1/3), and shear-reduced buckling P_cr=P_E/(1+P_E/(AG)) (Allen 1969 / ASTM C393 / Plantema).

Governing standards & published sources

- Allen, H.G. (1969), 'Analysis and Design of Structural Sandwich Panels' (Pergamon) — SIP facing/core mechanics and buckling.
- Plantema, F.J. (1966), 'Sandwich Construction' (Wiley) — facing wrinkling stress sigma_wr = 0.5(E_f E_c G_c)^(1/3).
- ASTM C273 / C393 / E72 — sandwich core shear, flexural, and panel racking (in-plane shear) test methods.
- Classical statics & Euler-Bernoulli beam theory (equilibrium, M=wL^2/8, V=wL/2, deflection=5wL^4/384EI) — independently re-derived in the validation harness.

Per-check citations (Section 1): Sandwich geometry; Allen 1969 Eq. 2.7; Allen 1969 Eq. 2.13; Statics; Allen 1969 facing couple; Allen 1969; Plantema 1966; ASTM C393; Euler buckling; Allen 1969 sandwich column.

5. Conclusion

All 11 checks confirm the engine reproduces the stated basis and applies the documented adjustments correctly. Note the representative tabulated values identified under Limitations — verify those against the governing source for final design.

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.