Beam & Post Calculation Check

Simple, detailed derivations matching the implementation (loads → actions → stresses → deflection → column). Units shown at each step for verification.

Assumptions (Model)

- Beam is **simply supported**, subject to **uniform line load** only (no point loads, no cantilevers).
- Cross-section is rectangular; bending about strong axis; material properties are allowable (ASD) values.
- Reactions are symmetric for the span considered; `R = w·L/2` per support.
- Shear stress uses rectangular peak factor `1.5`. Deflection uses classic closed-form for UDL.
- Column (post) check uses a simplified ASD-style cap: `min(Fc'·A, 0.3·P_crit)` with Euler buckling based on unsupported height.

Symbols & Units

Loads

`DL, SL, LL`	Dead/Snow/Live (psf)
`q`	Total area load (psf) = DL+SL+LL
`w`	Line load (plf) = q × tributary width (ft)

Geometry

`L`	Span (ft), L_{in}=12L (in)
`b,d`	Width, depth (in)
`S`	Section modulus (in^3) = $b \cdot d^2/6$
`I`	Moment of inertia (in^4) = $b \cdot d^3/12$

Actions/Responses

V_{max}	Max shear (lb) = $w \cdot L/2$
M_{max}	Max moment (lb·in) = $(w_{lb/in} \cdot L_{in}^2)/8$
`R`	Reaction per support/post (lb) = V_{max}

Stresses

f_b	Bending (psi) = M_{max}/S
f_v	Shear (psi) = $1.5 \cdot V_{max}/(b \cdot d)$
$f_{bearing}$	Bearing (psi) = $R/A_{bearing}$

Allowables

`Fb'`	Allowable bending (psi)
`Fv'`	Allowable shear (psi)
`Fc⊥'`	Allowable comp. ⊥ grain (psi)

Deflection

`Δ`	Midspan deflection (in)
`E`	Modulus of elasticity (psi)
`Limit`	L/ratio (in) = L_{in} / (limit ratio)

Step 1 — Area Load → Line Load

```
q = DL + SL + LL [psf]
w = q × (tributary width) [plf]
w_lb/in = w / 12 [lb/in]
```

Quantity	Value	Units
DL		psf
SL		psf
LL		psf
q		psf
Tributary width		ft
w		plf
$w_{lb/in}$		lb/in

Step 2 — Shear & Moment

```
V_max = (w × L) / 2 [lb]
M_max = (w_lb/in × L_in²) / 8 [lb·in]
```

Quantity	Value	Units
L		ft
L_{in}		in
V_{max}		lb
M_{max}		lb·in
R		lb

Step 3 — Section Properties

$$S = (b \times d^2)/6 \ [in^3] \qquad I = (b \times d^3)/12 \ [in^4]$$

Quantity	Value	Units
b		in
d		in
S		in^3
I		in^4

Step 4 — Stresses & Allowables

Bending

$$f_b = M_{max} / S \ [psi]$$

Item	Value	Units
f_b		psi
Fb′		psi
Status	PASS if $f_b \leq Fb'$	

Shear

$$f_v = 1.5 \times V_{max} / (b \times d) \text{ [psi]}$$

Item	Value	Units
f_v		psi
Fv′		psi
Status	PASS if $f_v \le$ Fv′	

Bearing at Beam Seat

$$f_{bearing} = R / A_{bearing} \text{ [psi]}$$

Item	Value	Units
$A_{bearing}$		in^2
$f_{bearing}$		psi
Fc⊥′		psi
Status	PASS if $f_{bearing} \le$ Fc⊥′	

Step 5 — Deflection

$$\Delta = [5 \times w_{lb/in} \times L_{in}^4] / [384 \times E \times I] \text{ [in]}$$
$$\text{Limit} = L_{in} / (\text{deflection limit ratio}) \text{ [in]}$$

Item	Value	Units
E		psi
Δ		in
Limit		in
Status	PASS if Δ ≤ Limit	

Step 6 — Post (Column) Axial Capacity

Simplified ASD-style: Euler buckling with slenderness, capped at 30% of Euler vs. axial stress capacity.

$$A = b \times d \ [in^2], \quad I_{col} = b \times d^3 / 12 \ [in^4], \quad r = \sqrt{(I_{col}/A)} \ [in]$$

$$\text{slenderness} = Le / r \ [-]$$

$$P_{crit} \approx (\pi^2 \times E \times A) / (\text{slenderness}^2) \ [lb]$$

$$P_{allow} = \min(Fc' \times A, \ 0.3 \times P_{crit}) \ [lb]$$

Item	Value	Units
Fc'		psi
A		in^2
Le		in
P_{allow}		lb
R (demand)		lb
Status	PASS if $R \le P_{allow}$	

Quick Verification Checklist

1. **Units:** psf → plf via tributary width; convert plf → lb/in where used.
2. **Statics:** For UDL: $V_{max} = wL/2$, $M_{max} = wL^2/8$ (with unit-consistent forms).
3. **Section:** Rectangular formulas: $S = b \cdot d^2/6$, $I = b \cdot d^3/12$.
4. **Stress:** $f_b = M/S \le Fb'$, $f_v = 1.5V/(bd) \le Fv'$, $f_{bearing} = R/A \le Fc\perp'$.
5. **Deflection:** $\Delta = 5wL^4/(384EI) \le L/\text{ratio}$.
6. **Column:** $P_{allow} = \min(Fc' \cdot A, \ 0.3 \cdot P_{crit})$ with $P_{crit} \approx \pi^2 EA/\text{slender}^2$.

Beam & Post Calculation Check • matches the implemented formulas in your tool • Replace placeholders with your actual results.