Timber Tech Engineering, Inc.
206 S. Main St.
Kouts, IN 46347
Phone: 219-766-2499
Fax: 219-766-2394

June 18, 2012

Mr. Bob Meyer
Perma-Column Inc.
400 Carol Ann Lane
Ossian, IN 46777

RE: Comparative Analysis of #1 SYP Nail Laminated Columns and Glulam Columns by Rigidply Rafters, Both Installed on Perma-Column, Sturdi-Wall or Sturdi-Wall Plus Brackets (Timber Tech Engineering Number S022-12).

Dear Mr. Meyer,

Per your request we completed a comparative analysis of select sizes of #1 SYP nail laminated columns and glulam columns by Rigidply Rafters, Inc., both attached to a Perma-Column base, Sturdi-Wall bracket, or Sturdi-Wall Plus bracket. The details and results of this analysis are described in the three page enclosed summary sheet. Though only 12 ft and 16 ft high columns were analyzed, the glulam column by Rigidply Rafters, Inc., outperformed the #1 SYP nail laminated column by a margin large enough to conclude that glulam columns are better than the equivalent #1 SYP nail laminated columns throughout all heights. **Therefore, a Ridigply glulam column of equivalent size may substitute for <u>any</u> #1 SYP nail laminated column.**

Appropriately sized wood shims need to be added on both sides of the pocket to provide a snug fit, ⅛" total tolerance is acceptable. The shim should be APA B-C Exterior plywood (or equivalent), no more than ¼" thick, and have the same dimensions as the vertical leg of the bracket. The shim should be fastened to the column with 2 beads of Builders Choice 490 construction adhesive by Liquid Nails (or equal) and (6) 0.113"x2.375" nails. Please refer to the enclosed Figures 1, 2 and 3 for details.

Table 1 provides the allowable bending and axial compression forces for both the #1 SYP nail laminated columns and Rigidply glulam columns, describes the difference in terms of percent, and lists the employed assumptions. The $M_{max}$ is the maximum bending moment located within a column as the result of the assumed maximum constant lateral wind load of 120 lb/ft. The $P_{max}$ is the maximum allowable axial compression force applied to top of column and is controlled by a combined bending and axial loading design check where $M_{max}$ and $P_{max}$ are applied simultaneously. In absence of bending moments, the $P_{max}$ would have been 8% to 18% greater than shown in Table 1; the purely axial loading, however, is unrealistic and inapplicable for main structural columns used in post-frame construction. The bending moments and axial compression forces in a column shall not exceed the $M_{max}$ and $P_{max}$ capacities defined in Table 1. The "Δ%*" column in Table 1 quantifies the advantage of a glulam column over an equivalent #1 SYP nail laminated column in terms of percent, $\Delta\% = P_{max}$ Glulam / $P_{max}$ Nail-lam x 100 - 100. For example, the $P_{max}$ of a 3-ply 2x8 glulam and 3-ply 2x8 nail laminated column is 15,000 lbs and 12,450 lbs, respectively. Therefore, the 3-ply 2x8 glulam column is 20.5% better than the 3-ply 2x8 #1 nail laminated column: 15,000 / 12,450 x 100 - 100 = 20.5%.

Please feel free to contact me with any questions regarding this letter or the enclosed documents.

Sincerely,
*Brent Leatherman*

Brent Leatherman, P.E.
Timber Tech Engineering, Inc.
BL:dar
Enclosures

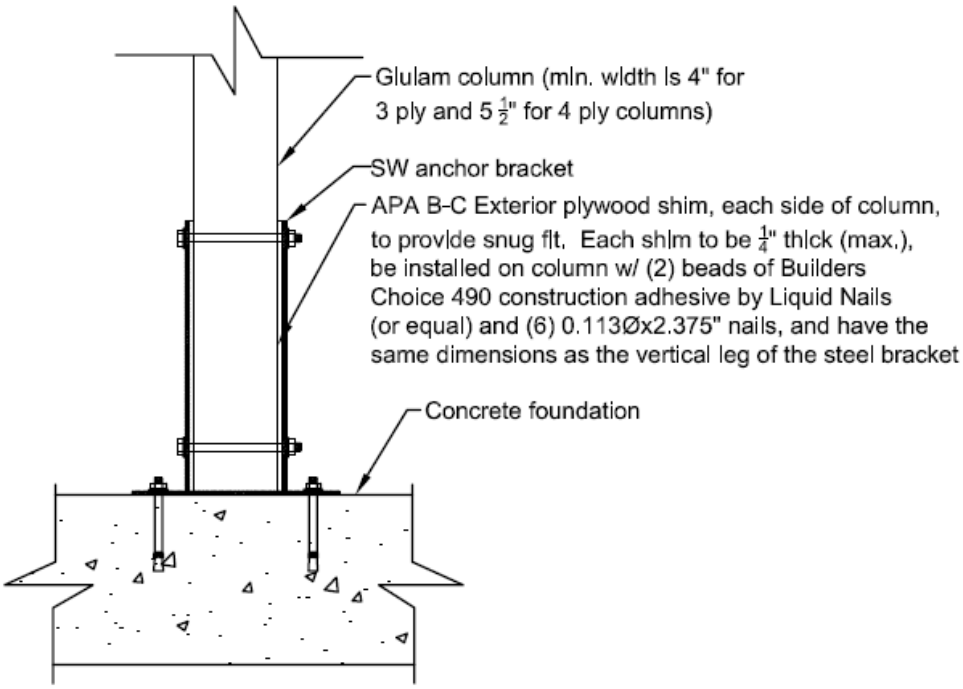


**Figure 1: Sturdi-Wall Shim Detail**

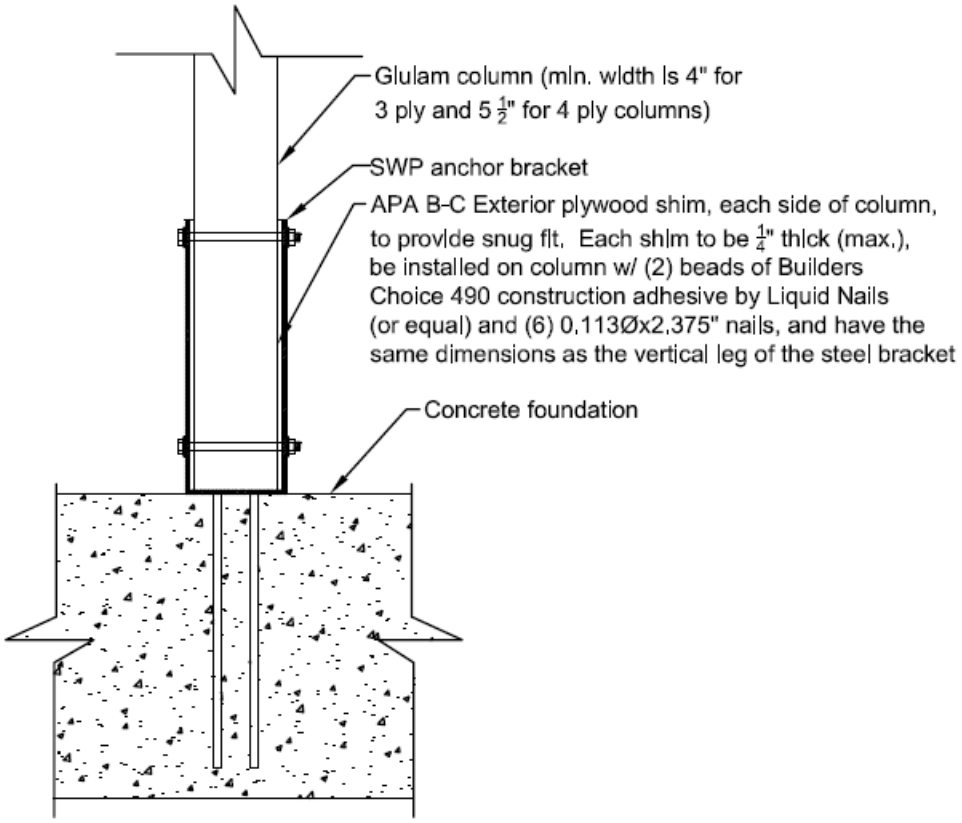


**Figure 2: Sturdi-Wall Plus Shim Detail**

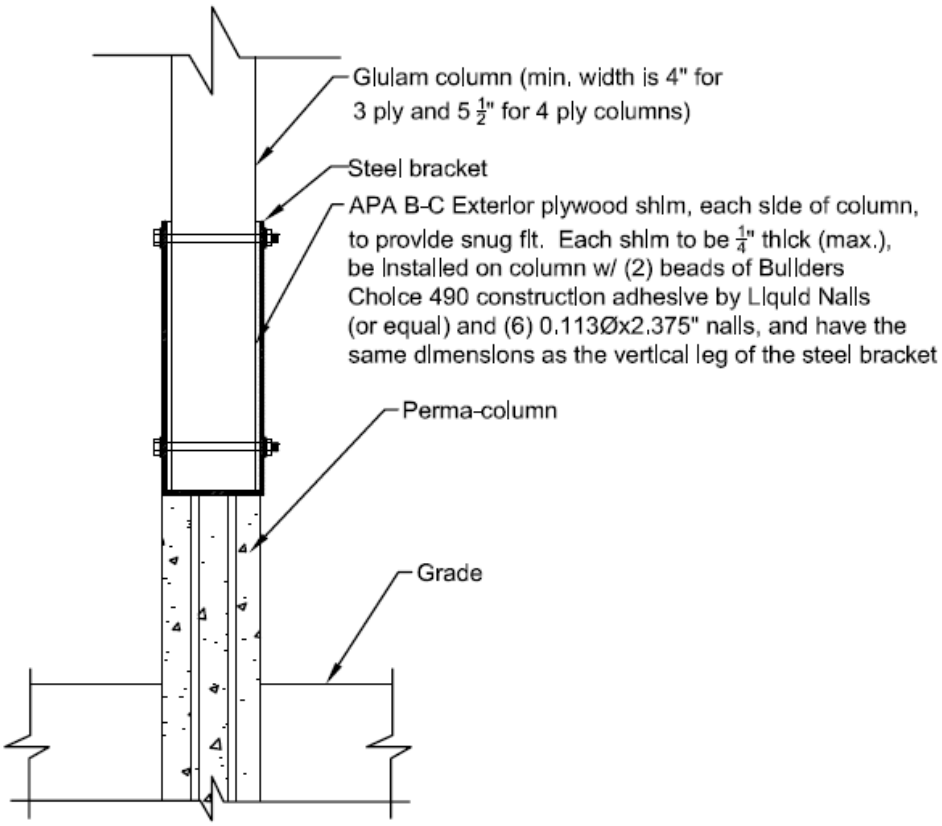


**Figure 3: Perma-Column Shim Detail**

## TABLE 1: #1 SYP NAIL LAMINATED COLUMN VS RIGID PLY GLULAM COLUMN COMPARISON

INSTALLED ON PERMA-COLUMN BASE, STURDI WALL OR STURDI WALL PLUS BRACKETS

| Size | Girt Spacing (in) | Column Height (ft) | $M_{max}$ Nail-Lam (ft-lb) | $M_{max}$ Glulam (ft-lb) | $P_{max}$ Nail-lam (lbs) | $P_{max}$ Glulam (lbs) | Δ%* |
|---|---|---|---|---|---|---|---|
| 3-ply 2x6 | 24 | 12 | 1315 | 1315 | **8750** | **10700** | 22.3 |
| 4-ply 2x6 | 24 | 12 | 1265 | 1265 | **12650** | **16750** | 32.4 |
| 3-ply 2x8 | 24 | 16 | 2238 | 2238 | **12450** | **15000** | 20.5 |
| 4-ply 2x8 | 24 | 16 | 2289 | 2289 | **17700** | **22300** | 26.0 |

**Rigidply glulam column of equivalent size may substitute #1 SYP nail laminated column of ANY height, not limited to 12 ft and 16ft heights provided in this chart**

***Rigidply glulam columns are better than #1 SYP nail laminated columns by the specified percent values**

Chart Assumptions:

- Columns are used as the main structural columns in a post-frame building application and are designed using Allowable Stress Design (ASD) as per 2005 NDS
- The Maximum Moment, $M_{max}$, and Maximum Axial Compression Force, $P_{max}$, for nail laminated and glulam columns are applicable only for specified column heights. Interpolating techniques to determine allowable values for other heights and sizes may not be employed.
- The Maximum Moment, $M_{max}$, and Maximum Axial Compression force, $P_{max}$, are unfactored values
- The Maximum Moment, $M_{max}$, is the result of a constant wind load of 120 lb/ft on each post based on 90 mph wind speed
- Columns are supported at top to simulate diaphragm resistance with maximum movement at eave of L/120
- The effective length factor, $K_e$, is 1.2
- The design values of Rigidply columns are based upon proprietary product testing
- Glulam columns require an appropriately sized wood shim to be added on both sides of the steel bracket pocket to provide a snug fit (⅛" total tolerance is acceptable). The shim should be APA B-C Exterior plywood (or equivalent), no more than ¼" thick, and have the same dimensions as the vertical leg of the bracket. The shim should be fastened to the column with 2 beads of Builders Choice 490 construction adhesive by Liquid Nails (or equal) and (6) 0.113"x2.375" nails.
- Foundation is a non-constrained post foundation with 4'-0" embedment depth or a continuous concrete wall designed for shear, uplift, gravity and moment where applicable
- Columns have full lateral bracing and major axis bending only, no loads acting on weak axis
- Columns are intended for dry use for laminated wood portion in Perma-Column assembly or with Sturdi-Wall or Sturdi-Wall Plus brackets
- Columns have no splices in laminated wood portion
- Columns are used in exterior sidewall with lateral loading from wind only
- Laminated wood portion transfers axial loads through direct bearing on steel seat plate
- See also "Perma-Column Design and Use Guide" and "Sturdi-Wall Design Manual" by Brent Leatherman, P.E.
- Geometrical and strength properties of each column are provided in two charts on this page
- Intermediate calculations are provided on page 5 and 6
- **Final column design should include a complete building analysis by a Design Professional**

| | PROPERTIES OF #1 SYP NAIL LAM COLUMN | | | | | | | | PROPERTIES OF RIGIDPLY GLULAM COLUMN | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Size | b (in) | d (in) | A ($in^2$) | $S_x$ ($in^3$) | E (psi) | $E'_{min}$ | $F_b$ (psi) | $F_c$ (psi) | b (in) | d (in) | A ($in^2$) | $S_x$ ($in^3$) | E (psi) | $E'_{min}$ | $F_b$ (psi) | $F_c$ (psi) |
| 3-ply 2x6 | 4.31 | 5.31 | 22.9 | 20.3 | 1700000 | 620000 | 1650 | 1750 | 4.0625 | 5.25 | 21.3 | 18.7 | 1700000 | 830000 | 2050 | 2000 |
| 4-ply 2x6 | 5.75 | 5.31 | 30.5 | 27.0 | 1700000 | 620000 | 1650 | 1750 | 5.3750 | 5.25 | 28.2 | 24.7 | 1700000 | 880000 | 2350 | 2150 |
| 3-ply 2x8 | 4.31 | 7.19 | 31.0 | 37.1 | 1700000 | 620000 | 1500 | 1650 | 4.0625 | 7.00 | 28.4 | 33.2 | 1700000 | 880000 | 1900 | 2150 |
| 4-ply 2x8 | 5.75 | 7.19 | 41.3 | 49.5 | 1700000 | 620000 | 1500 | 1650 | 5.3750 | 7.00 | 37.6 | 43.9 | 1700000 | 880000 | 2350 | 2150 |

## INTERMEDIATE CALCULATIONS FOR #1 SYP NAIL LAMINATED COLUMNS

### 3-PLY 2x6 #1 SYP NAIL LAM COLUMN

| Load Comb. | $C_D$ | $C_r$ | $C_F$ | $F'_b$ (psi) | $C_p$ | c | $K_e$ | l (in) | $l_e$ (in) | $F_{cE}$ (psi) | $F^*_c$ (psi) | $F'_c$ (psi) | $M_a$ (ft-lb) | $P_a$ (lbs) | $R_B$ | $F_{bE}$ (psi) | $f_c$ | $f_b$ | Unity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D+S | 1.15 | n/a | n/a | n/a | 0.226 | 0.8 | 1.2 | 144 | 173 | 481 | 2013 | 455 | n/a | **10406** | n/a | n/a | n/a | n/a | **0.84** |
| D+W | 1.6 | 1.15 | 1.0 | 3036 | 0.165 | 0.8 | 1.2 | 144 | 173 | 481 | 2800 | 463 | **5124** | n/a | n/a | n/a | n/a | n/a | **0.26** |
| D+0.75S+0.75W | 1.6 | 1.15 | 1.0 | 3036 | 0.165 | 0.8 | 1.2 | 144 | 173 | 481 | 2800 | 463 | n/a | n/a | 3.76 | 52645 | 311 | 584 | **0.99** |

### 4-PLY 2x6 #1 SYP NAIL LAM COLUMN

| Load Comb. | $C_D$ | $C_r$ | $C_F$ | $F'_b$ (psi) | $C_p$ | c | $K_e$ | l (in) | $l_e$ (in) | $F_{cE}$ (psi) | $F^*_c$ (psi) | $F'_c$ (psi) | $M_a$ (ft-lb) | $P_a$ (lbs) | $R_B$ | $F_{bE}$ (psi) | $f_c$ | $f_b$ | Unity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D+S | 1.15 | n/a | n/a | n/a | 0.226 | 0.8 | 1.2 | 144 | 173 | 481 | 2013 | 455 | n/a | **13883** | n/a | n/a | n/a | n/a | **0.91** |
| D+W | 1.6 | 1.15 | 1.0 | 3036 | 0.165 | 0.8 | 1.2 | 144 | 173 | 481 | 2800 | 463 | **6836** | n/a | n/a | n/a | n/a | n/a | **0.19** |
| D+0.75S+0.75W | 1.6 | 1.15 | 1.0 | 3036 | 0.165 | 0.8 | 1.2 | 144 | 173 | 481 | 2800 | 463 | n/a | n/a | 2.82 | 93699 | 337 | 421 | **0.99** |

### 3-PLY 2x8 #1 SYP NAIL LAM COLUMN

| Load Comb. | $C_D$ | $C_r$ | $C_F$ | $F'_b$ (psi) | $C_p$ | c | $K_e$ | l (in) | $l_e$ (in) | $F_{cE}$ (psi) | $F^*_c$ (psi) | $F'_c$ (psi) | $M_a$ (ft-lb) | $P_a$ (lbs) | $R_B$ | $F_{bE}$ (psi) | $f_c$ | $f_b$ | Unity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D+S | 1.15 | n/a | n/a | n/a | 0.246 | 0.8 | 1.2 | 192 | 230 | 496 | 1898 | 466 | n/a | **14440** | n/a | n/a | n/a | n/a | **0.86** |
| D+W | 1.6 | 1.15 | 1.1 | 3036 | 0.180 | 0.8 | 1.2 | 192 | 230 | 496 | 2640 | 475 | **9395** | n/a | n/a | n/a | n/a | n/a | **0.24** |
| D+0.75S+0.75W | 1.6 | 1.15 | 1.1 | 3036 | 0.180 | 0.8 | 1.2 | 192 | 230 | 496 | 2640 | 475 | n/a | n/a | 4.37 | 38879 | 326 | 542 | **0.99** |



### 4-PLY 2x8 #1 SYP NAIL LAM COLUMN

| Load Comb. | $C_D$ | $C_r$ | $C_F$ | $F'_b$ (psi) | $C_p$ | c | $K_e$ | l (in) | $l_e$ (in) | $F_{cE}$ (psi) | $F^*_c$ (psi) | $F'_c$ (psi) | $M_a$ (ft-lb) | $P_a$ (lbs) | $R_B$ | $F_{bE}$ (psi) | $f_c$ | $f_b$ | Unity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D+S | 1.15 | n/a | n/a | n/a | 0.246 | 0.8 | 1.2 | 192 | 230 | 496 | 1898 | 466 | n/a | **19265** | n/a | n/a | n/a | n/a | **0.92** |
| D+W | 1.6 | 1.15 | 1.1 | 3036 | 0.180 | 0.8 | 1.2 | 192 | 230 | 496 | 2640 | 475 | **12534** | n/a | n/a | n/a | n/a | n/a | **0.18** |
| D+0.75S+0.75W | 1.6 | 1.15 | 1.1 | 3036 | 0.180 | 0.8 | 1.2 | 192 | 230 | 496 | 2640 | 475 | n/a | n/a | 3.28 | 69199 | 348 | 416 | **0.99** |

Notes: D+S row is a design check for column subjected to axial compression forces, no bending moments, Unity = $P_{max} / P_a$

D+W row is a design check for column subjected to bending moments, no axial forces, Unity = $M_{max} / M_a$

D+0.75S+0.75W row is a design check for column subjected to a combined bending and axial compression, Unity = $(f_c / F_c')^2 + f_b / (F_b' - F_b' f_c / F_{cE})$, NDS 2005 Eq. (3.9-3)

$P_{max}$ = applied maximum axial compression force, see Table 1

$P_a$ = allowable axial compression force in absence of bending moments

$M_{max}$ = applied bending moment, calculated based on a constant wind load of 120 lb/ft on column

$M_a$ = allowable bending moment in absence of axial forces

l = unbraced column height, $l_e = K_e l$, all other letters and characters are as defined in NDS 2005 National Design Specifications for Wood Construction

## INTERMEDIATE CALCULATIONS FOR RIGIDPLY GLULAM COLUMNS

### 3-PLY 2x6 GLULAM COLUMN

| Load Comb. | $C_D$ | $C_r$ | $C_F$ | $F'_b$ (psi) | $C_p$ | c | $K_e$ | l (in) | $l_e$ (in) | $F_{cE}$ (psi) | $F^*_c$ (psi) | $F'_c$ (psi) | $M_a$ (ft-lb) | $P_a$ (lbs) | $R_B$ | $F_{bE}$ (psi) | $f_c$ | $f_b$ | Unity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D+S | 1.15 | n/a | n/a | n/a | 0.264 | 0.9 | 1.2 | 144 | 173 | 630 | 2300 | 608 | n/a | **12966** | n/a | n/a | n/a | n/a | **0.83** |
| D+W | 1.6 | 1 | n/a | 3280 | 0.192 | 0.9 | 1.2 | 144 | 173 | 630 | 3200 | 615 | **5101** | n/a | n/a | n/a | n/a | n/a | **0.26** |
| D+0.75S+0.75W | 1.6 | 1 | n/a | 3280 | 0.192 | 0.9 | 1.2 | 144 | 173 | 630 | 3200 | 615 | n/a | n/a | 3.97 | 63330 | 408 | 634 | **0.99** |

### 4-PLY 2x6 GLULAM COLUMN

| Load Comb. | $C_D$ | $C_r$ | $C_F$ | $F'_b$ (psi) | $C_p$ | c | $K_e$ | l (in) | $l_e$ (in) | $F_{cE}$ (psi) | $F^*_c$ (psi) | $F'_c$ (psi) | $M_a$ (ft-lb) | $P_a$ (lbs) | $R_B$ | $F_{bE}$ (psi) | $f_c$ | $f_b$ | Unity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D+S | 1.15 | n/a | n/a | n/a | 0.261 | 0.9 | 1.2 | 144 | 173 | 668 | 2473 | 645 | n/a | **18200** | n/a | n/a | n/a | n/a | **0.92** |
| D+W | 1.6 | 1 | n/a | 3760 | 0.190 | 0.9 | 1.2 | 144 | 173 | 668 | 3440 | 652 | **7737** | n/a | n/a | n/a | n/a | n/a | **0.16** |
| D+0.75S+0.75W | 1.6 | 1 | n/a | 3760 | 0.190 | 0.9 | 1.2 | 144 | 173 | 668 | 3440 | 652 | n/a | n/a | 3.00 | 117539 | 482 | 461 | **0.99** |

### 3-PLY 2x8 GLULAM COLUMN

| Load Comb. | $C_D$ | $C_r$ | $C_F$ | $F'_b$ (psi) | $C_p$ | c | $K_e$ | l (in) | $l_e$ (in) | $F_{cE}$ (psi) | $F^*_c$ (psi) | $F'_c$ (psi) | $M_a$ (ft-lb) | $P_a$ (lbs) | $R_B$ | $F_{bE}$ (psi) | $f_c$ | $f_b$ | Unity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D+S | 1.15 | n/a | n/a | n/a | 0.261 | 0.9 | 1.2 | 192 | 230 | 668 | 2473 | 645 | n/a | **18341** | n/a | n/a | n/a | n/a | **0.82** |
| D+W | 1.6 | 1 | n/a | 3040 | 0.190 | 0.9 | 1.2 | 192 | 230 | 668 | 3440 | 652 | **8405** | n/a | n/a | n/a | n/a | n/a | **0.27** |
| D+0.75S+0.75W | 1.6 | 1 | n/a | 3040 | 0.190 | 0.9 | 1.2 | 192 | 230 | 668 | 3440 | 652 | n/a | n/a | 4.58 | 50359 | 429 | 607 | **0.99** |

### 4-PLY 2x8 GLULAM COLUMN

| Load Comb. | $C_D$ | $C_r$ | $C_F$ | $F'_b$ (psi) | $C_p$ | c | $K_e$ | l (in) | $l_e$ (in) | $F_{cE}$ (psi) | $F^*_c$ (psi) | $F'_c$ (psi) | $M_a$ (ft-lb) | $P_a$ (lbs) | $R_B$ | $F_{bE}$ (psi) | $f_c$ | $f_b$ | Unity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D+S | 1.15 | n/a | n/a | n/a | 0.261 | 0.9 | 1.2 | 192 | 230 | 668 | 2473 | 645 | n/a | **24266** | n/a | n/a | n/a | n/a | **0.92** |
| D+W | 1.6 | 1 | n/a | 3760 | 0.190 | 0.9 | 1.2 | 192 | 230 | 668 | 3440 | 652 | **13754** | n/a | n/a | n/a | n/a | n/a | **0.17** |
| D+0.75S+0.75W | 1.6 | 1 | n/a | 3760 | 0.190 | 0.9 | 1.2 | 192 | 230 | 668 | 3440 | 652 | n/a | n/a | 3.46 | 88154 | 482 | 469 | **0.99** |

Notes: D+S row is a design check for column subjected to axial compression forces, no bending moments, Unity = $P_{max} / P_a$

D+W row is a design check for column subjected to bending moments, no axial forces, Unity = $M_{max} / M_a$

D+0.75S+0.75W row is a design check for column subjected to a combined bending and axial compression, Unity = $(f_c / F_c')^2 + f_b / (F_b' - F_b' f_c / F_{cE})$, NDS 2005 Eq. (3.9-3)

$P_{max}$ = applied maximum axial compression force, see Table 1

$P_a$ = allowable axial compression force in absence of bending moments

$M_{max}$ = applied bending moment, calculated based on a constant wind load of 120 lb/ft on column

$M_a$ = allowable bending moment in absence of axial forces

l = unbraced column height, $l_e = K_e l$, all other letters and characters are as defined in NDS 2005 National Design Specifications for Wood Construction