

Perma-Column Deck Post Design Manual

DP4430, DP4440, DP4640, DP6630, DP6640, DP6430, and DP6440 models



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1. Deck Post Design Overview

The Perma-Column Deck Post is designed to support wood decks, porches or other similar structures, and is intended to be used as an alternative to embedded wood posts and cast-in-place concrete piers. This manual contains drawings, descriptions and design assumptions for seven (7) Deck Post models, tables showing axial compression, axial tension, shear and bending strengths of each model, and tables showing downward, uplift and lateral strengths of several foundation (soil) options. Each Deck Post assembly consists of a reinforced concrete column designed in accordance with The American Concrete Institute (ACI 318-14) and an epoxy powder coated steel bracket designed in accordance with The American Institute of Steel Construction (AISC 360-16). The structural design is based on the allowable stress design (ASD) and the load and resistance factor (LRFD) design methodologies with references to ESR-4237 report by ICC Evaluation Service (ICC-ES). The lateral and rotational stability of the Deck Post is provided by surrounding soils below grade and the wood framing of the structure above the ground (if applicable). The “U” shaped steel bracket at the top of the concrete post does not have any usable rotational rigidity and bending strength and should be modeled as a “hinge”.

The allowable (ASD) and design (LRFD) downward, uplift and shear loads at the top of the Deck Post may not exceed the values reported in Tables 7.1 through 8.1. The values in Table 7.1 are calculated using structural properties of the Deck Post and the steel bracket-to-wood connections as specified in ESR-4237 and exclude all considerations of surrounding soils (see Section 4: Deck Post Design). Tables 7.2 through 8.1 include the downward, uplift and lateral strengths of the soil around the Deck Posts using soil assumptions provided in Section 6. The values in Tables 7.2 through 8.1 are provided for demonstration purposes only as soil types and consistency vary. The analysis and design of the soils (foundation) is the responsibility of the project engineer or the building designer.

Wood member sizes, connections, post spacing, footing size, lateral bracing and height limitations of the structure above the Deck Post should follow the prescriptive code requirements. For construction that falls outside the prescriptive code limitations, the Deck Post shall be part of an engineered design.

2. Deck Post Description

The Perma-Column Deck Post is a 10 ksi reinforced pre-cast concrete column with a u-shaped steel bracket (saddle). The Deck Post is embedded into the ground and, except for a short segment above grade (maximum 10 inches), the post is laterally restrained along the full length by surrounding compacted soils. Having a continuous lateral restraint, the ACI 318 classifies the Deck Post as a “short column” or a “pedestal”. The steel bracket at the top of the concrete column is welded to #4 A706 (grade 60) weldable vertical reinforcing bars. A short segment of a ½” pipe size tubing (PST) is welded to the vertical rebar near the bottom of the column. The ½” PST is positioned approximately 2-1/4 inches from the base of the column and provides an opening through which to insert the uplift load resisting attachments: 2”x2”x8 ½” steel uplift angles or a DP Extender fastened with a ½” through bolt, or a #4 horizontal reinforcing bar inserted through the post can be used for wind uplift resistance.

The dimensions for the seven models are given in Table 2.1. The DP4430, DP4440 and DP4640 models are to be used with 4x4 nominal wood posts or 3-1/2” wide wood beams, the DP6630 and DP6640 models are to be used with 6x6 nominal wood posts or 5-1/2 inch wide wood beams, and the DP6430 and DP6440 models are to be used with 6x6 full size wood posts or 6” wide wood beams. The DP4430, DP4440 and DP4640 are reinforced with one #4 rebar centered and continuous through the entire column length. The DP6630, DP6640, DP6430 and DP6440 are reinforced with two #4 rebar positioned in a “V” shape with it’s vertex near the bottom of the column. Every model may not be stocked in all areas, check with your Deck Post supplier. The “*Minimum Embedment*” depth column in Table 2.1 ensures that the top of the concrete post projects above ground a maximum of ten (10) inches; see also Section 4: Deck Post Design and Section 8: DP Extender.

TABLE 2.1: DECK POST DESCRIPTION					
Model ID	Width (in)	Depth (in)	Length (in)	Minimum Embedment (in)	Reinforcement
DP4430	3-5/8	3-1/2	30	20	(1) #4 Rebar
DP4440	3-5/8	3-1/2	40	30	(1) #4 Rebar
DP4640	3-5/8	5	40	30	(1) #4 Rebar
DP6630	5-5/8	5	30	20	(2) #4 Rebar
DP6640	5-5/8	5	40	30	(2) #4 Rebar
DP6430	6-1/8	5	30	20	(2) #4 Rebar
DP6440	6-1/8	5	40	30	(2) #4 Rebar

Note: Every model may not be stocked in all areas, please check with your Deck Post supplier.

IMPORTANT NOTE: The Deck Post must not project more than ten (10) inches above grade as measured from top of adjacent ground to top of the concrete post (bottom of steel u-bracket). This limitation must not be ignored.

3. Steel Bracket Design

The forces applied from a wood deck, or similar structure, to the “U” shaped steel bracket are a vertical uplift force, a downward gravity force, and a horizontal shear force. The wood beam or column should have direct bearing on the bottom to transfer axial loads directly to the concrete deck post. The steel bracket is assumed to have no rotational rigidity and moment strength. The dimensions and physical properties for the steel brackets are given in Table 3.1. All mechanical fasteners are to be installed as per the manufacturer’s recommendations and this design manual. Each steel bracket is made of 1/8” thick ASTM A1018 SS Grade 40 steel plate. The DP4430 and DP4440 brackets have four holes for #14 x 3-inch grade 5 galvanized wood screws on each side, staggered; the DP4640, DP6630, DP6640, DP6430, and DP6440 brackets have five holes on each side, also staggered.

TABLE 3.1: STEEL BRACKET DESCRIPTION					
Model ID	Pocket Width (in)	Length (in)	Height (in)	Bracket Thickness (in)	Total Number of Holes (in)
DP4430	3-5/8	3-1/2	5	1/8	8
DP4440	3-5/8	3-1/2	5	1/8	8
DP4640	3-5/8	5	7	1/8	10
DP6630	5-5/8	5	7	1/8	10
DP6640	5-5/8	5	7	1/8	10
DP6430	6-1/8	5	7	1/8	10
DP6440	6-1/8	5	7	1/8	10

4. Deck Post Design

The Deck Post is designed to resist axial compression, bending, shear, bending and axial tension forces; the allowable strengths (ASD) and the design strengths (LRFD) are reported in Table 7.1 and ICC ESR-4237.

The **axial compression strength** is calculated using ACI 318-14 Equation 22.4.2.2: $P_o = 0.85f_c (A_g - A_{st}) + f_y A_{st}$. To address accidental eccentricity, ACI requires that P_o is multiplied by a 0.80 or 0.85 multiplier for concrete columns with transverse reinforcement consisting of ties or spirals, respectively (ACI 318 Table 22.4.2.1). Because the Deck Post does not have any transverse reinforcement, the multiplier is reduced to 0.60. With this multiplier, the axial strength of the Deck Post is equal to the strength of a column made of plain structural concrete (no vertical or transverse reinforcement):

$$P_n = 0.60[0.85f_c (A_g - A_{st}) + f_y A_{st}] \quad (\text{Eq. 4-1})$$

The **bending strength** of the Deck Post is calculated in accordance with ACI 318-14, chapters 10 and 22 (Eq. 4-2). The maximum reinforcement ratio limit, ρ_{max} , is set so that the tension strain, ϵ_t , in the tension rebar is 0.005 or greater (Eq. 4-3) and the bending strength reduction factor, ϕ , is 0.90. The analysis includes bending about the “x” and the “z” axes; however, for simplicity and to avoid confusion on site, only the smallest bending value is reported for each model in Table 7.1. For biaxial bending, the sum of the individual unities about each axis may not exceed 1 (Eq. 4-4).

$$M_n = A_s f_y (d - a/2) \quad (\text{Eq. 4-2})$$

$$\rho_{max} = 0.85\beta_1 (f_c / f_y) [0.003 / (0.003 + 0.005)] \quad (\text{Eq. 4.3})$$

$$m_x / M + m_z / M \leq 1 \quad (\text{Eq. 4-4})$$

Because of the absence of transverse reinforcement, the **shear strength** of the Deck Post is calculated using ACI provisions for *plain structural concrete* (Eq 4-5). ACI 318 allows the use of plain structural concrete for a *pedestal* which is defined as a “*member with a ratio of height-to-least lateral dimension less than or equal to 3, used primarily to support axial compressive load...*” ACI 318 commentary, Section R14.3.3.1 clarifies that the ratio limit applies only to the unsupported height - the ten (10) inch segment of the Deck Post that extends above grade. The Deck Post is intended to support primarily axial compression load and, having only a ten (10) inch segment extend above grade, the intended use and ratio limit of the pedestal, as defined, are satisfied.

$$\phi V_n = \phi (4/3) \sqrt{f_c} b h \quad (\text{Eq. 4-5})$$

$$(\phi = 0.60)$$

The **tensile strength** of the Deck Post is defined by the strength of the external and internal steel components and connections: the u-shaped steel bracket, vertical rebar, weld connection between the rebar and the steel bracket, weld connection between the rebar and the steel sleeve (pipe) at the bottom of the post, shear strength of the bolt through the sleeve, and the strength of the external steel angles at the bottom. Under pure tension load, the concrete around the steel components is considered non-structural.

Under **combined tension and bending loading**, the sum of the tension and bending unities may not exceed 1:

$$t/T + m/M \leq 1 \quad (\text{Eq. 4-6})$$

When a Deck Post is subjected to a **combined axial compression and bending loading**, the balanced failure occurs when the tension steel just begins to yield ($\epsilon_s = 0.002$) as the concrete reaches its limiting strain ϵ_u of 0.003. Because of the 0.60 multiplier used in the axial compression strength equation, a multiplier associated with the accidental eccentric loading, the design bending strength under the combined loading is never less than the design bending strength without the axial compression load. Similarly, the design axial compression strength under combined loading is never less than the design axial compression strength without the bending loading. This is visually demonstrated in Figure 4. The Deck Post, therefore, may be subjected to axial and bending

loading simultaneously up to the axial compression and bending strengths reported in Table 7.1 - no reductions are required for combined axial compression and bending loading.

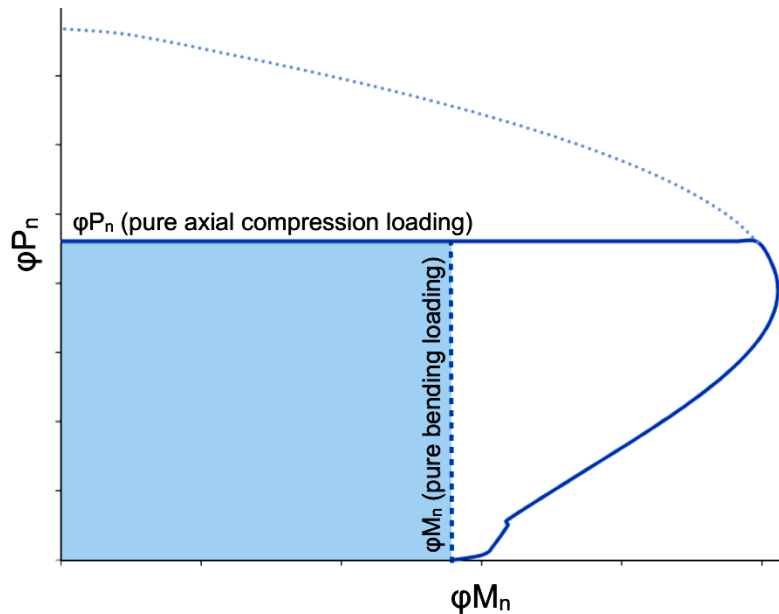


Figure 4: Design axial compression strength vs. design bending strength interaction diagram

5. Wood Connection Design

The wood beam or column is assumed to have a specific gravity of 0.36 or greater and is fastened to the steel bracket with #14 x 3" grade 5 galvanized wood screws. All metal components, including steel bracket and screw fasteners, must be suitable for treated wood applications. The wood-to-steel connection is designed per the National Design Specification for Wood Construction (NDS), 2015 edition, by the American Wood Council. The NDS adjustment factors are as follows:

Load Duration Factor	$C_D = 1.6$
Wet Service Factor	$C_M = 0.7$
(All other factors = 1.0)	

A barrier membrane between the pressure treated wood post or beam and the steel bracket is not necessary. The steel bracket is protected by the Perma-Column EpoxyZirc Coating pretreatment, a process in which Zirconium molecules chemically crystallize the steel molecules, effectively changing the surface of the steel into a compound that does not oxidize. The ASTM B-117 Salt Spray Testing results show that the Perma-Column EpoxyZirc Coating outperforms the G185 galvanized coating, which is thicker than the galvanized coating prescribed by the ASTM A653.

6. Foundation Design

The foundation design in this manual is intended only for demonstrational purposes to establish a base line of what a designer may expect from a non-constrained shallow post foundation consisting of medium to dense soils described as *silty or clayey fine to coarse sand* (United Soil Classification: SM, SC, SP-SM, SP-SC, SW-SM, SW-SC). Other soil consistencies and types have different strength characteristics and are outside of the scope of this manual. The foundation is designed in accordance with ASAE EP486.3, Shallow Post Foundation Design

by the American Society of Agricultural and Biological Engineers as referenced in International Building Code (IBC) using the following design parameters (EP486.3, Table 1):

- | | |
|---------------------------------------|------------------------------------|
| • Unified Soil Classification | SM, SC, SP-SM, SP-SC, SW-SM, SW-SC |
| • Consistency | Medium to dense |
| • Moist Unit Weight, γ | 110 lb/ft ³ |
| • Drained Soil Friction Angle, ϕ | 35 degrees |
| • Required Post Embedment, d | see Table 2.1 |
| • Concrete Collar Width, w | see Figure 6.1 & Table 7.2 |
| • Concrete Collar Thickness, t_c | see Figure 6.1 & Table 7.2 |
| • Footing Width, t_w | see Figure 6.1 & Table 7.2 |
| • Footing Thickness, t_f | see Figure 6.1 & Table 7.2 |

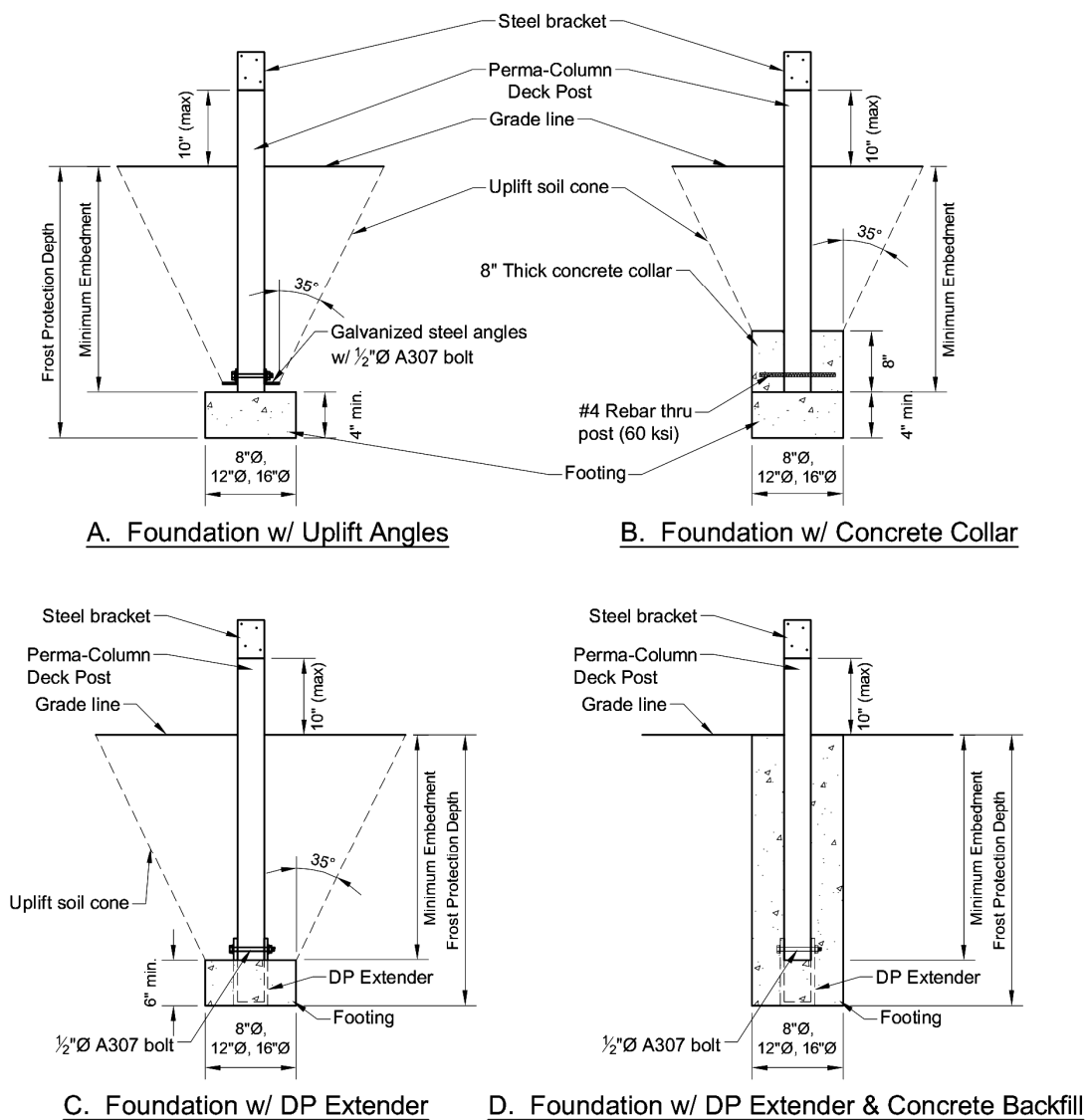


Figure 6.1: Foundation Details

NOTE: A building designer may consider any foundation option for Deck Posts supporting wood beams. Unless the Deck Post is constrained at grade (concrete slab), the foundation option D should be considered the preferred option for Deck Posts supporting wood columns.

The **shear strength** of the foundation for all options in Figure 6.1 is calculated using the Simplified Method (EP486.3, Section 11.4) formula for a non-constrained shallow post foundation without concrete collars. In option B, the concrete collar is very small and its contribution to the lateral resistance is insignificant and is conservatively ignored. In option D, the width of the concrete collar is used as the width of the "post" in the non-constrained shallow post foundation equation. In option B, the thickness (height) of a concrete collar is intentionally limited to eight (8) inches to increase the uplift resistance of the system. Increasing the thickness of the concrete collar will reduce the dimension between the top of the concrete and grade, resulting in reduced size of uplift soil cone and reduced uplift strength of the foundation. For this option, the thickness of the concrete collar may be increased only by increasing the embedment depth of the deck post such that the dimension between top of concrete collar and grade remains unchanged.

The **uplift strength** of the foundation is designed in accordance with EP486.3 Chapter 12. The uplift resistance is provided by the weight of the concrete collar, if present, and the weight of the soil cone, see Figure 6.1. The option D uplift resistance is limited only to the weight of the concrete fill below and around the deck post. The tabulated uplift strengths are only applicable to footings installed as described in this manual. Uplift resistance can be achieved by any of the following methods:

- Steel uplift angles (see Figure 6.1, option A)
- Concrete collar with rebar inserted through column (see Figure 6.1, option B)
- DP Extender (see Figure 6.1, options C and D)
- Molded Plastic FootingPad (see Figure 9.1)

The **bearing strength** of the foundation is designed in accordance with EP486.3 Chapter 10. The **minimum frost depth** and **footing thickness** requirement is determined by local authorities and is outside of the scope of this manual. The DP4430, DP6430 and DP6630 models embedded twenty (20) inches with a four (4) inch thick footing provide twenty-four (24) inches of frost protection, while DP4440, DP4640, DP6640 and DP6440 models embedded thirty (30) inches with a six (6) inch thick footing provide thirty-six (36) inches of frost protection. An optional DP Extender can be used with all models to increase the footing depth for frost protection. Table 6.1 shows several options that may be used to achieve the required frost depth specified by the local authority.

Option* #	Deck Post Length (in)	Projection Above Grade (in)	Embedment Depth (in)	Footing Thickness (in)	DP Extender Length (in)	Frost Protection Depth (in)
1	30	10	20	4	n/a	24
2	30	6	24	6	n/a	30
3	30	10	20	12	12	32
4	40	10	30	6	n/a	36
5	40	6	34	6	n/a	40
6	40	10	30	12	12	42
7	40	10	30	18	18	48

*Other frost protection option combinations may be used to achieve different frost protection depths

7. Deck Post Design Chart

Table 7.1 shows the axial compression, bending, shear, and tensile strengths of the seven (7) Deck Post models using Allowable Strength Design (ASD) and Load and Resistance Factored Design (LRFD) methods (values provided by ICC ESR-4237 report). Tables 7.2 through 8.1 show the downward (bearing), lateral and uplift strengths of the foundation system as dictated by the strength and stability requirements of the surrounding soil. Tables 7.2 through 8.1 include (7) foundation systems, six (6) shown in Figure 6.1 and one (1) in Section 9 for the seven (7) Deck Post models using the materials, design methods and design assumptions described in this manual. Consistent with provisions of ASABE EP486.3, the weight of the concrete column and steel bracket is not added to the uplift resistance of the foundation and may be considered on the load side of the equation. The downward, horizontal and uplift loads applied to the u-bracket at the top of the concrete post may not exceed the axial compression, shear, and tensile strengths of the Deck Post as reported in Table 7.1 and the bearing, lateral and uplift strengths of the soils (foundation) as reported in Tables 7.2 through 8.1. The steel u-bracket at the top of the Deck Post does not have the ability to transfer moments into the concrete post. However, the horizontal load applied to the bracket above grade and the resisting lateral soil forces below grade will generate internal bending moments in the Deck Post. The magnitude of the internal bending moments must be calculated by the designer using the established engineering standards such as ASABE EP486.3 or standard engineering mechanics. A free body diagram of the *Simplified Method* (EP 486.3) is shown in Figure 7.1. The bending moment may be calculated as $M = V(12+w)$, where w is the width of the concrete post in the direction of the loading as shown in Figure 7.1. An in-depth discussion on this topic is also available in the Post-Frame Building Design Manual by National Frame Building Association (NFBA PFBDM). The internal bending moments must not exceed the bending strength of the Deck Post as reported in Table 7.1.

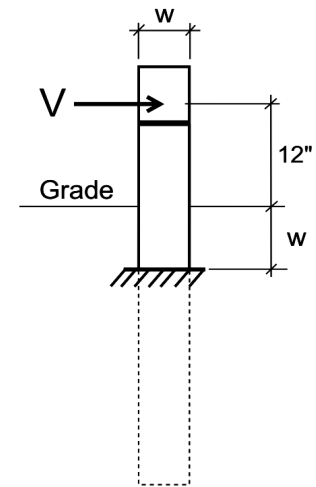


Figure 7.1: Free Body Diagram for Simplified Method per EP486.3

The bending moment may be calculated as $M = V(12+w)$, where w is the width of the concrete post in the direction of the loading as shown in Figure 7.1. An in-depth discussion on this topic is also available in the Post-Frame Building Design Manual by National Frame Building Association (NFBA PFBDM). The internal bending moments must not exceed the bending strength of the Deck Post as reported in Table 7.1.

TABLE 7.1: DECK POST STRENGTH VALUES								
Model ID	LRFD				ASD			
	P_{LRFD} (lb)	M_{LRFD} (lb-ft)	V_{LRFD} (lb)	T_{LRFD} (lb)	P_{ASD} (lb)	M_{ASD} (lb-ft)	V_{ASD} (lb)	T_{ASD} (lb)
DP4430	46,076	1,400	952	956	28,798	875	595	636
DP4440	46,076	1,400	952	956	28,798	875	595	636
DP6630	101,268	2,981	2,109	1,658	63,293	1,863	1,318	1,103
DP6640	101,268	2,981	2,109	1,658	63,293	1,863	1,318	1,103
DP6430	109,556	3,215	2,297	1,289	68,472	2,009	1,436	857
DP6440	109,556	3,215	2,297	1,289	68,472	2,009	1,436	857

Table 7.1 Footnotes:

1. P_{LRFD} = Maximum compression/gravity load strength (ϕP_n) of the Deck Post based on LRFD design
2. P_{ASD} = Maximum compression/gravity load strength (P_n/Ω) of the Deck Post based on ASD design
3. M_{LRFD} = Maximum bending strength (ϕM_n) of the Deck Post based on LRFD design (loaded about any axis)
4. M_{ASD} = Maximum bending strength (M_n/Ω) of the Deck Post based on ASD design (loaded about any axis)
5. V_{LRFD} = Maximum shear strength (ϕV_n) of the Deck Post based on LRFD design (loaded in any direction)
6. V_{ASD} = Maximum shear strength (V_n/Ω) of the Deck Post based on ASD design (loaded in any direction)
7. T_{LRFD} = Maximum tensile strength (ϕT_n) of the Deck Post based on LRFD design
8. T_{ASD} = Maximum tensile strength (T_n/Ω) of the Deck Post based on ASD design
9. See Section 4 for biaxial load and combined axial and bending load application
10. Values in Table 7.1 are provided by ICC Evaluation Services Report ESR-4237
11. Values in Table 7.1 do not include considerations of strength and stability of the surrounding soils (foundation)

TABLE 7.2: FOUNDATION (SOIL) BEARING STRENGTH						
Model ID	8" Ø Pier or Footer		12" Ø Pier or Footer		16" Ø Pier or Footer	
	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)
DP4430	1770	2480	3980	5570	7120	9960
DP4440	2500	3500	5590	7830	9950	13930
DP4640	2500	3500	5590	7830	9950	13930
DP6630	1770	2480	3980	5570	7120	9960
DP6640	2500	3500	5590	7830	9950	13930
DP6430	1770	2480	3980	5570	7120	9960
DP6440	2500	3500	5590	7830	9950	13930

Table 7.2 Footnotes:

1. Soils should be verified by construction testing; if soils are not verified by testing, all values in Table 7.2 must be adjusted (reduced) by a 0.54 multiplier.
2. The calculations are based on ASABE EP486.3, Chapter 10, Table 1 using soil properties as described in this manual. Local authorities may override EP486.3 results and may require that allowable soil bearing strength stays constant with depth and does not exceed 1500 psf or 2000 psf. In such cases, the allowable bearing strength (ASD) can be calculated by multiplying the footing area by the allowable soil bearing pressure. Allowable bearing strength (ASD) may be converted to design bearing strength (LRFD) using a 1.4 multiplier: $LRFD = ASD \times 1.4$.
3. The values in Table 7.2 are limited to foundation options A through D in Figure 6.1.
4. The values in Table 7.2 are provided for demonstrational purposes only. Perma-Column, LLC, is not responsible for the analysis and design of soils (foundation). The analysis and design of soils (foundation) is the responsibility of the project engineer or the building designer.

TABLE 7.3: FOUNDATION (SOIL) LATERAL STRENGTH								
Model ID	No Concrete Backfill		8" Ø Concrete Backfill		12" Ø Concrete Backfill		16" Ø Concrete Backfill	
	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)
DP4430	24	34	55	77	83	116	110	154
DP4440	64	90	146	204	219	307	291	407
DP4640	66	92	146	204	219	307	291	407
DP6630	34	48	55	77	83	116	110	154
DP6640	91	127	146	204	219	307	291	407
DP6430	34	48	55	77	83	116	110	154
DP6440	91	127	146	204	219	307	291	407

Table 7.3 Footnotes:

1. Soils should be verified by construction testing; if soils are not verified by testing, all values in Table 7.3 must be adjusted (reduced) by a 0.55 multiplier.
2. The calculations are based on ASABE EP486.3, Chapter 11 (Simplified Method), using soil properties as described in this manual.
3. The lateral strength of the foundation is measured at the top of the concrete pier (bottom of the steel u-bracket) maximum 10 inches above grade.
4. The values in Table 7.3 are limited to foundation options A through D in Figure 6.1.
5. The values in Table 7.3 are provided for demonstrational purposes only. Perma-Column, LLC, is not responsible for the analysis and design of soils (foundation). The analysis and design of soils (foundation) is the responsibility of the project engineer or the building designer.

TABLE 7.4: FOUNDATION (SOIL) UPLIFT STRENGTH								
Model ID	2"x2"x8.5" Steel Angles		8" Ø Concrete Collar		12" Ø Concrete Collar		16" Ø Concrete Collar	
	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)
DP4430	220	308	119	156	223	284	352	441
DP4440	529	740	315	430	528	711	774	1032
DP4640	591	828	308	422	521	703	767	1023
DP6630	241	338	103	137	207	265	336	423
DP6640	584	817	294	406	508	687	754	1007
DP6430	240	336	100	134	204	262	334	420
DP6440	582	814	291	402	504	683	750	1003

Table 7.4 Footnotes:

1. Soils should be verified by construction testing; if the soils are not verified by testing, all values in Table 7.4 must be adjusted by a 0.54 multiplier.
2. The calculations are based on ASABE EP486.3, Chapter 12, using soil properties as described in this manual.
3. The values in Table 7.4 are limited to foundation options A and B in Figure 6.1.
4. The values in Table 7.4 are provided for demonstrational purposes only. Perma-Column, LLC, is not responsible for the analysis and design of soils (foundation). The analysis and design of soils (foundation) is the responsibility of the project engineer or the building designer.

TABLE 7.5: FOUNDATION UPLIFT STRENGTH WITH SOLID-FILLED CONCRETE BACKFILL						
Model ID	8" Ø Concrete Backfill		12" Ø Concrete Backfill		16" Ø Concrete Backfill	
	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)
DP4430	44	62	116	163	217	304
DP4440	66	93	174	244	325	455
DP4640	57	79	165	231	316	442
DP6630	26	37	99	138	199	279
DP6640	39	55	148	207	298	418
DP6430	23	33	96	134	196	275
DP6440	35	49	143	200	294	412

Table 7.5 Footnotes:

1. The uplift resistance is calculated as weight of the concrete backfill divided by the factor of safety of 1.5 for the ASD design. The weight of the Deck Post is not included in the uplift resistance.
2. The relationship between the LRFD and ASD values is described using the following expression: LRFD = ASD x 1.4.
3. The values in Table 7.5 are limited to foundation option D in Figure 6.1.
4. The values in Table 7.5 are provided for demonstrational purposes only. Perma-Column, LLC, is not responsible for the analysis and design of soils (foundation). The analysis and design of soils (foundation) is the responsibility of the project engineer or the building designer.

8. DP Extender

All Deck Post models can be fitted with an optional DP Extender. DP extender is a 1/8"x3 1/2" "U" shaped steel bracket that can extend 4" to 24" past the bottom of the concrete column and is attached to the column with (1) 1/2" ASTM A307 through bolt. The DP Extender may increase the depth of footing for frost protection. The main benefit, however, is the ability to install a column prior to installing a footing pad and pour the concrete footing and collar simultaneously in one single pour to create a strong monolithic foundation. Table 8.1 shows the uplift strength of the foundation (soils) for Deck Posts with the DP Extender on 8 Ø inch, 12 Ø inch and 16 Ø inch footers. Table 8.1 assumes a six (6) inch thick concrete footer poured just to the bottom of the concrete post (no concrete collar). If the top of the concrete footer is higher than the bottom of the concrete post, values in Table 8.1 should not be used and the designer should instead reference Tables 7.4 and 7.5.

TABLE 8.1: FOUNDATION UPLIFT STRENGTH WITH DP EXTENDER						
Model ID	8" Ø Concrete Footing		12" Ø Concrete Footing		16" Ø Concrete Footing	
	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)	ASD (lb)	LRFD (lb)
DP4430	262	359	439	593	643	861
DP4440	546	756	875	1205	1239	1695
DP4640	538	747	868	1195	1231	1686
DP6630	245	338	422	573	626	840
DP6640	525	730	854	1178	1218	1669
DP6430	242	335	419	570	623	837
DP6440	525	725	851	1174	1214	1664

Table 8.1 Footnotes:

1. The values in Table 8.1 are limited to foundation option C in Figure 6.1.
2. No concrete collar; top of concrete (footer) is at the bottom of the concrete Deck Post (Figure 6.1, Option C).
3. Concrete footer below Deck Post is 6 inches or thicker.
4. Soils should be verified by construction testing; if soils are not verified by construction testing, all values in Table 8.1 must be adjusted (reduced) by a 0.54 multiplier.
5. The values in Table 8.1 are provided for demonstrational purposes only. Perma-Column, LLC, is not responsible for the analysis and design of soils (foundation). The analysis and design of soils (foundation) is the responsibility of the project engineer or the building designer.

9. AG-CO Molded Plastic FootingPad

All Perma-Column Deck Post models can be installed on AG-CO 10 inch or 16 inch molded plastic FootingPads manufactured by AG-CO Products, Inc., see Figure 9.1. **The internal steel components at the bottom of the Perma-Column Deck Post for this option are different from the standard models and may not be available in some regions.** Specifically, the 1/2" PST, described in Section 2 of this manual, is threaded on the inside and placed vertically. The vertical tube extends from the bottom face of the concrete column to vertical rebar where it is welded with 1/4" fillet weld all around. The AG-CO molded plastic FootingPad is fastened to the vertical threaded pipe of the Perma-Column Deck Post via one 1/2"x1 1/2" and 1/2"x2 1/2" grade 5 bolt for 10 inch and 16 inch FootingPad models respectively. The bolt is installed with a 2" diameter x 1/8" flat washer on the bottom face of the FootingPad. A more thorough description of this product and installation requirements are provided by ESR-2147 report by ICC-ES and GEE111711-10 report by NTA, Inc.

Governed by the bolt-head-pull-through test (GEE111711-10 report by NTA, Inc), the ultimate **uplift strength** of the 10 inch and 16 inch AG-CO Molded Plastic FootingPad is 908 lb and 1315 lb, respectively. With the safety factor of 3, the recommended allowable uplift strength (ASD) of the 10 inch and 16 inch FootingPad is 300 lb and 430 lb, respectively. The recommended design uplift strength (LRFD) is 420 lb and 600 lb, respectively (LRFD = ASD x 1.4). The uplift strength of the FootingPad controls the design: the uplift strength of the foundation (soil) is greater than the uplift strength of the AG-CO Molded Plastic FootingPad. However, soil properties vary and may be less favorable than what is assumed in this manual in Section 6. If the properties of the soil in Section 6 are not verified by construction testing, the uplift strength of the foundation (soil) will control the foundation design with 30 inch Deck Post models. The analysis and design of the foundation (soil) is the responsibility of the project engineer or the building designer.

The allowable vertical bearing strength of the FootingPad is provided in Table 1 of ESR-2147 report. The building designer may convert the ASD values provided in ESR-2147 to LRFD using the following relationship: LRFD = ASD x 1.4. The allowable lateral strength for the Deck Post and the foundation (soil) is provided in Tables 7.1 and 7.3.

Installation of a concrete collar above the FootingPad is not permitted for reasons described in the Foundation Design Section of this manual. The bottom of the molded plastic FootingPad must be located below the frost depth line as determined by the local authorities.

10. Summary and Conclusion

The Perma-Column Deck Post is designed to support wood decks, porches or other similar structures. The Deck Post can be used as an alternative to cast-in-place concrete piers and embedded wood posts that are incorporated in code-approved prescriptive specifications or an engineered design. This manual provides the axial compression, axial tension, shear and bending strengths of the (7) Deck Post models and the downward, uplift and lateral strengths of different foundation sizes and styles. The projection above grade, embedment depth, and footing thickness can be adjusted to accommodate a wide range of frost depth requirements. The Perma-Column Deck Post is a permanent foundation solution for the small structures market.



Figure 9.1: Deck Post on AG-CO Molded Plastic FootingPad