

INTRODUCTION TO POST FRAME CONSTRUCTION, BUILDINGS & DESIGN

Presentation prepared by
Harvey B. Manbeck, P.E., PhD

Professor Emeritus
Penn State University

Research & Technical Advisor
National Frame Building Association (NFBA)

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LEARNING OBJECTIVES

At the end of this program, participants will be able to:

1. Identify the versatility of and range of applications for post frame (PF) building systems
2. Identify the structural features that make PF building systems unique
3. Identify the available resources for design of PF building systems
4. Identify key performance characteristics of PF building systems
5. Identify the two primary post frame construction systems

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WHAT IS PF BUILDING USED FOR?



RESTAURANT AND RETAIL



CHURCHES



COMMUNITY BUILDINGS



MUNICIPAL BUILDINGS



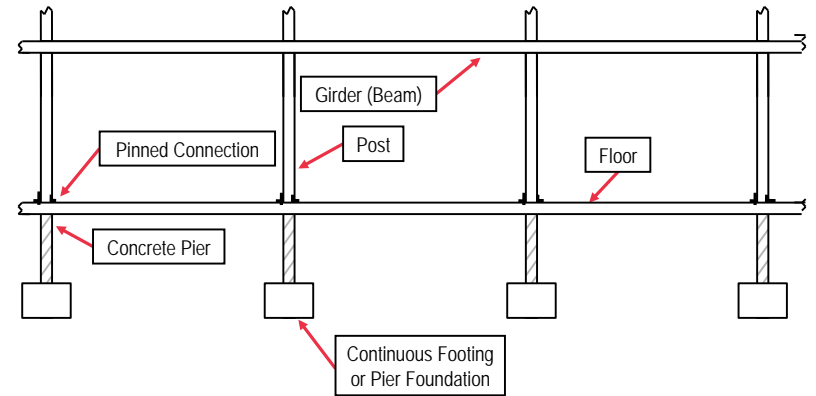
RESIDENTIAL



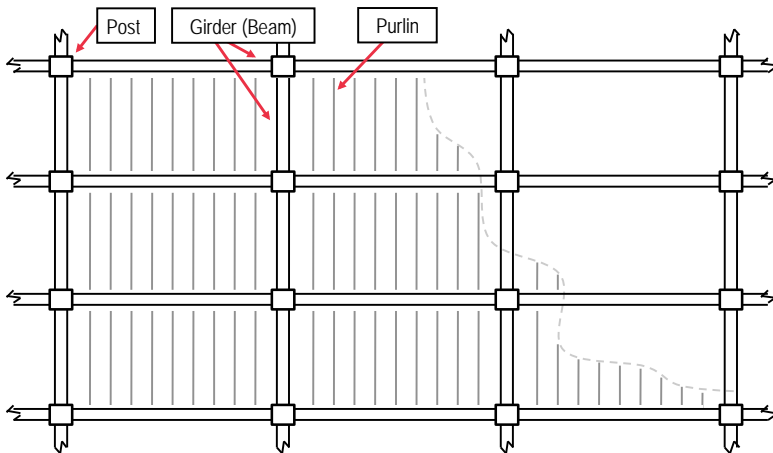
AGRICULTURAL AND HORSE FACILITIES



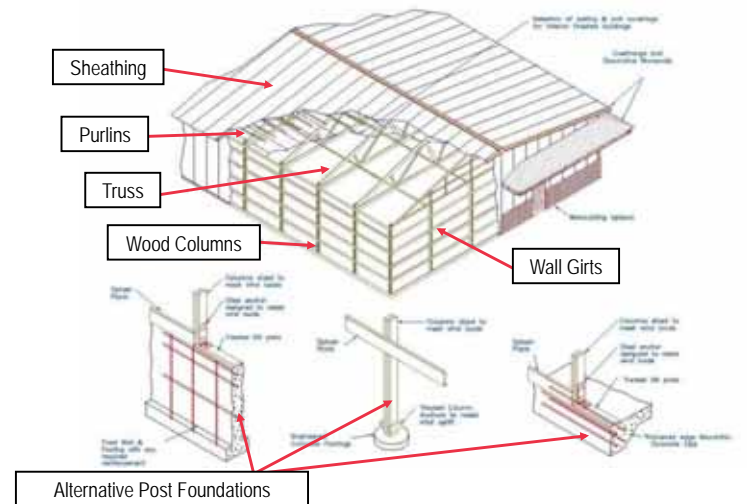
POST-AND-BEAM CONSTRUCTION ELEVATION



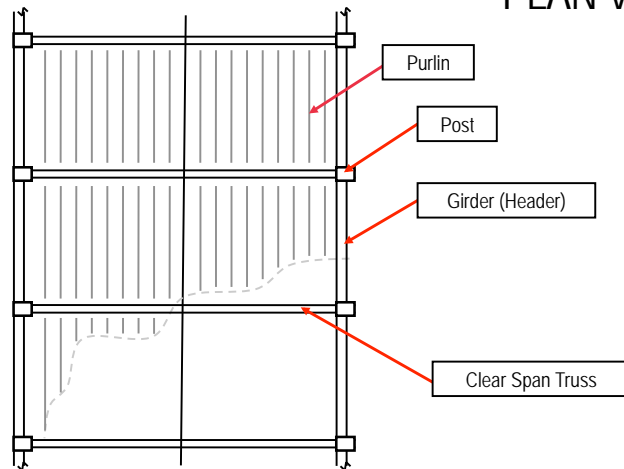
POST-AND-BEAM CONSTRUCTION PLAN VIEW



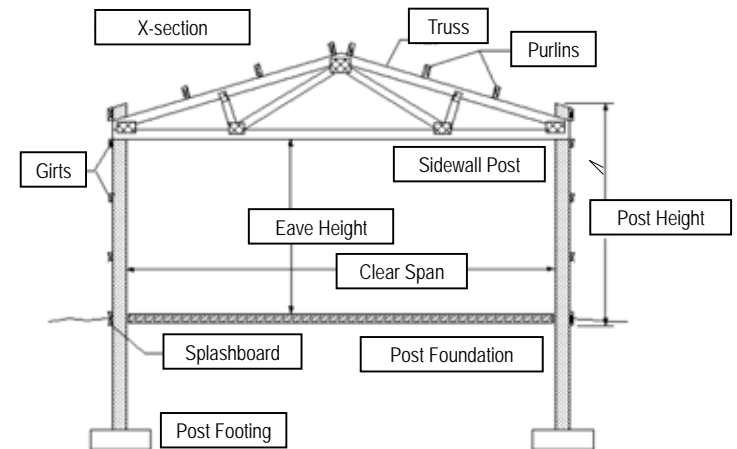
PF BUILDING SYSTEM PICTORIAL VIEW



PF BUILDING SYSTEM PLAN VIEW



PF BUILDING SYSTEM CROSS SECTION



PF BUILDING SYSTEM FEATURES

- Wood sidewall posts
- Wide bay (post) spacing—8 ft and greater
- Large clear spans—More than 100 ft
- Embedded wood post or concrete piers serve as building foundation
- Attached wall and roof sheathing/cladding form structural shear wall/structural diaphragm system for lateral loads

WOOD SIDEWALL POSTS

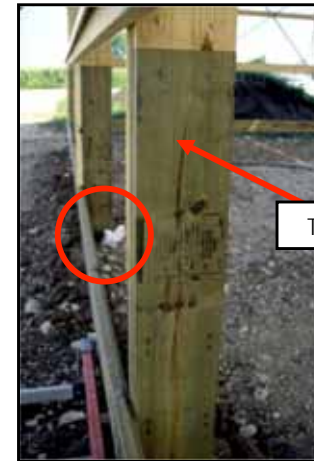
- Usually wood posts
- Either solid-sawn, glue-laminated (glulam) or mechanically (nail) laminated
- Typically nominal 6-x-6, 6-x-8, 8-x-8, or 8-x-10 cross section
- Usually spaced 4, 6, 8, 12 or 16 ft on center along sidewall
- Portion of post embedded into ground (plus 6–12 in. above ground) is preservative treated

GLUE-LAMINATED (GLULAM) WOOD POST

- Spliced glulam post
 - 3 or 4 ply, fabricated with 2x lumber
 - lower portion preservative treated; upper portion untreated



NAIL-LAMINATED POSTS



Preservative-treated section spliced to untreated portion



NAIL-LAMINATED POSTS



Nail-laminated posts with treated bottom spliced to untreated top

Preservative-treated splash board

HYBRID POST OPTIONS

Nail-laminated posts attached to precast concrete pier foundation above ground line



PRESSURE-PRESERVATIVE TREATMENTS

For posts embedded in ground, specify use category UC4B or better per AWP-1-XX (e.g., CCA@0.60 pcf)



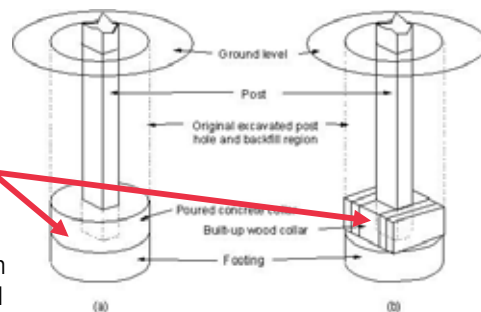
POST FOUNDATION OPTIONS

Pressure Preservative Post Embedded Directly into Ground

- 3.5 to 5 ft embedments typical
- A shallow post foundation

POST FOUNDATION OPTIONS EMBEDDED TREATED POST

- Embedment provides lateral and vertical support for bldg
- Typically embedded 3.5–5 ft depth
- Bottom concrete collar or wood cleat improves uplift resistance of post
- Post hole is typically 24–30 in diameter; back-filled with well graded gravel, sand, or excavated soil



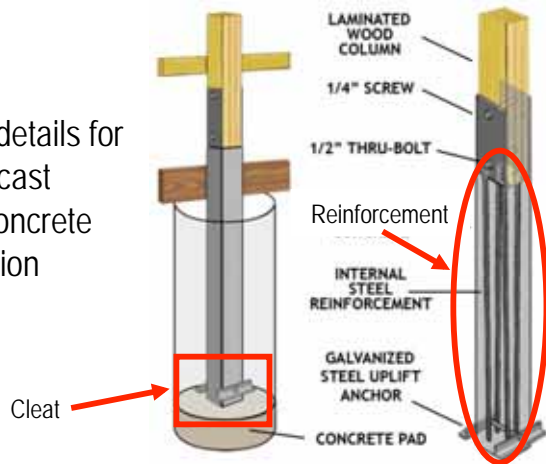
PRECAST REINFORCED CONCRETE PIER

- Precast reinforced concrete pier with post attached above grade
- Entire assembly pre-engineered
- Assembly usually fabricated in factory and shipped to site as a single unit



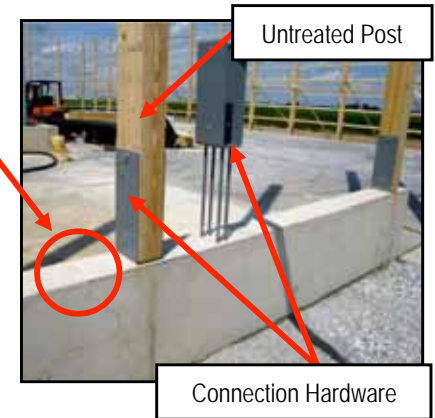
PRECAST REINFORCED CONCRETE PIER

Connection details for a typical precast reinforced-concrete post foundation



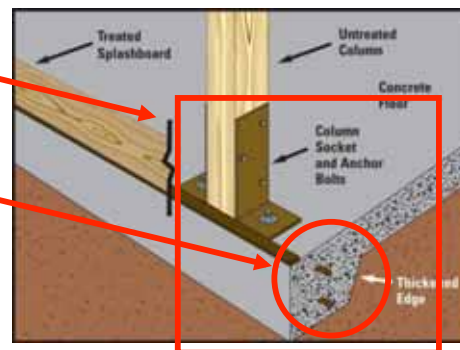
CAST-IN-PLACE CONCRETE FOUNDATION WALL

- Post attached to 6 in. or wider cast-in-place concrete foundation wall
- Solid-sawn, nail-laminated, or glulam posts attached to top of foundation wall 18–24 in. above grade and are usually untreated



THICKENED CONCRETE SLAB

- Post set on thickened edge of a concrete floor slab
- Thickened portion of slab reinforced
- Post typically untreated

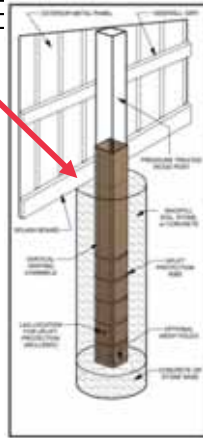


THICKENED CONCRETE SLAB



PROTECTIVE POST COVERS

- Blow-molded plastic barriers, HDPE barriers, asphalt based wraps
- Provides moisture and insect protection
- “Enhances protection of copper-based, chemical-treated wood posts or laminated columns”

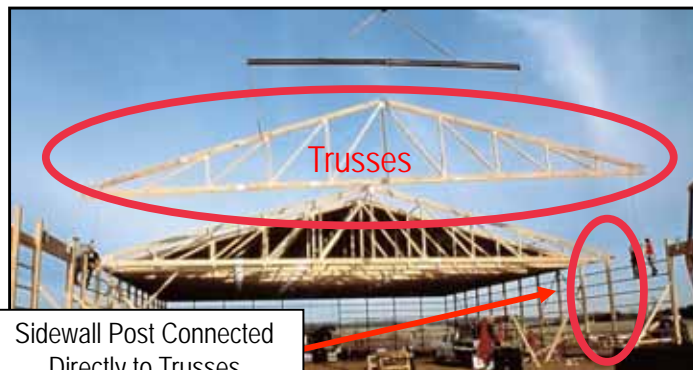


ROOF FRAMING

- Pre-engineered metal plate connected 2x lumber trusses typically spaced 4–8 ft on center
 - sometimes double trusses used on wider clear spans
- Heavier timber (solid-sawn wood or glulam) trusses for larger post and truss spacings
- Solid-sawn wood rafters spaced 2–4 ft on center for shorter clear spans
- Glulam or structural composite lumber (SCL) rafters for larger rafter spacings or clear spans

ROOF FRAMING

Setting pre-engineered wood trusses for a typical PF building



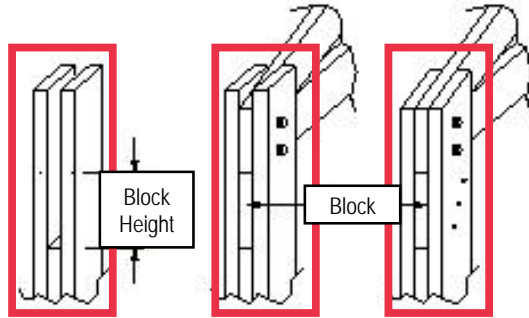
Sidewall Post Connected Directly to Trusses

POST-TO-ROOF FRAMING CONNECTIONS

- Posts are connected directly to the roof framing if post and roof-framing spacing are the same
- Posts and roof framing are often connected to header beams if post and roof-framing spacing are not the same

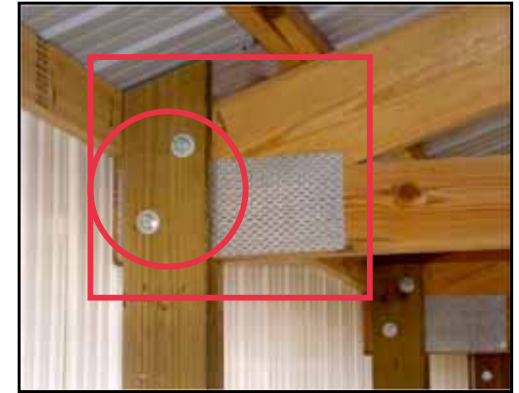
NAIL-LAMINATED POST CONNECTIONS

- Typical for a nail-laminated post-to-truss connection
- Connection is usually a pinned connection



NAIL-LAMINATED POST CONNECTIONS

Post-to-truss connection for a nail-laminated post application



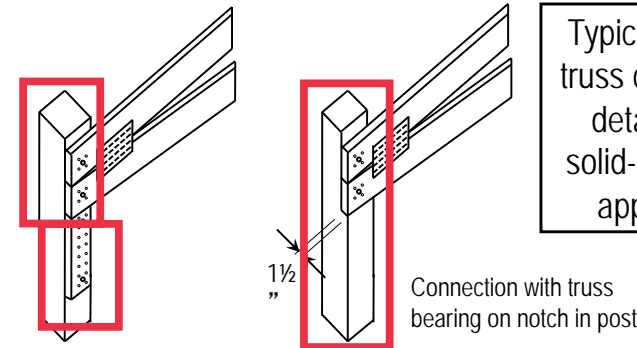
NAIL-LAMINATED POST CONNECTIONS

Post-to-truss connection for a nail-laminated post application



SOLID-SAWN POST CONNECTIONS

Typical post-to-truss connection details for a solid-sawn post application



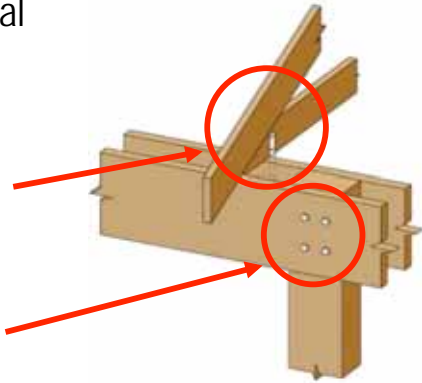
Connection with truss fastened to side of post and with bearing block

Connection with truss bearing on notch in post

POST-TO-ROOF FRAMING CONNECTION

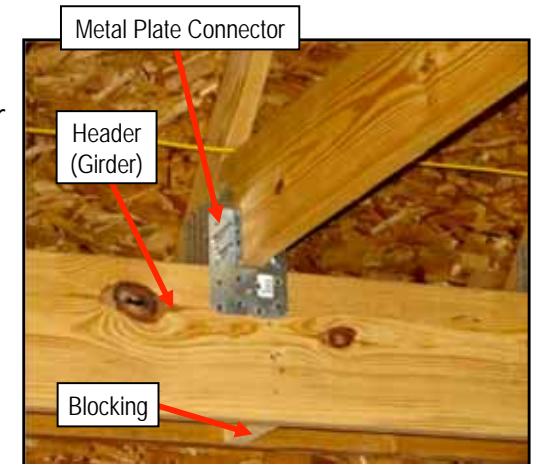
Schematic of typical connection details

- Truss to header (girder)
- Header (girder) to roof truss



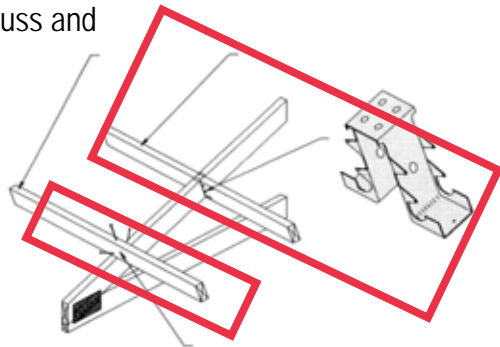
HEADER CONNECTIONS

Typical roof framing to header connection detail with blocking placed between parallel header beams (girder)



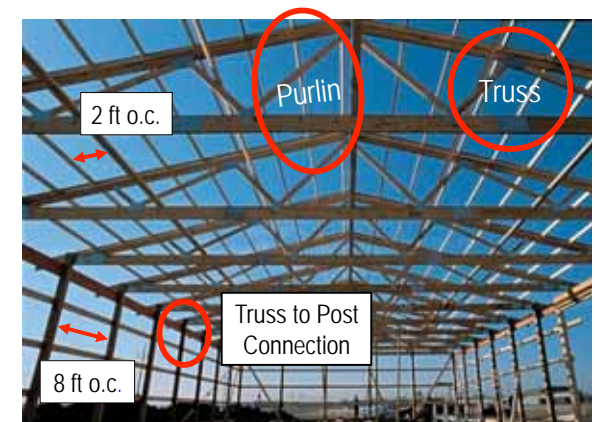
ROOF PURLIN PLACEMENT

- Purlins placed either on top or inset between truss top chords or inset between roof rafters
- Purlins oriented flat or "on-edge" depending upon truss and purlin spacing



ROOF FRAMING AND PURLINS

Typical PF system showing pre-engineered roof trusses attached to post and roof purlins attached to top of the truss chords



WALL GIRTS

- Typically 2-x-4 to 2-x-8 solid-sawn lumber spaced 24–32 in. apart
 - Placement and orientation
 - Oriented flat on outside face of wall post (for smaller post and girt spacings and loads)
- OR
- Oriented “on-edge” between adjacent posts (for larger loads and/or post or girt spacings)

WALL GIRTS AND SHEATHING

Typical wall girt and metal sheathing application to PF building system



WALL GIRTS AND SHEATHING

PF system with wall girts and wood structural panel sheathing attached



ROOF TRUSS AND LATERAL WIND BRACING

- Corner bracing in upper chords of trusses
- Diagonal bracing for lower chords of trusses
- Lower chord stiffeners for trusses
- X-bracing of selected compression webs
- Continuous longitudinal bracing of long-compression webs and chords of trusses or T-bracing for long compression webs

TRUSS BRACING

- Guide to Good Practices for Handling, Installing, Restraining and Bracing of Metal-Plate Connected Wood Trusses (WTCA & TPI)
 - B1 and B3, summary sheets on handling and bracing wood trusses, spacing ≤ 24 in.
 - B10, summary sheet on “Post-Frame Truss Installation and Temporary Restraint/Bracing”, **truss spacing ≥ 48 in.**

ENERGY EFFICIENCY

- PF buildings are exceptionally easy to insulate to higher levels ($R = 20$ to 35) required by energy codes with wide range of typical batt, blown-in, or board insulation materials
 - Large on center post spacing (>4 ft. o.c.)
 - Large wall cavity thickness (6–10 in. typical) are inherently built into PF without special features

ENERGY EFFICIENCY

- Wall and roof framing members typically spaced 4 to 16 ft o.c.
- Fewer breaks in thermal insulation barrier



ENERGY EFFICIENCY

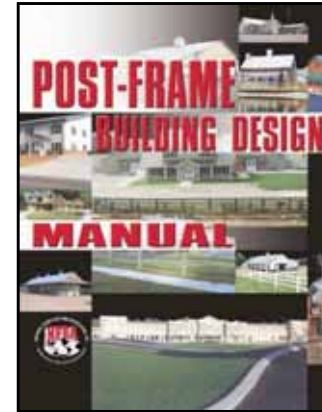
Thicker wall cavities inherently available due to use of nominal 6x to 10x posts in sidewalls



CODE COMPLIANCE

- PF foundations included in Chapter 1800 of IBC 2006 & 2009 (lateral soil resistance and wood preservative treatment requirements)
- Key PF diaphragm design and other practices from the American Society of Agricultural and Biological Engineers (ASABE) cited in Sections 2306.1 of IBC 2006 & 2009

PF BUILDING DESIGN MANUAL



- Structural design procedures for PF building systems
 - PF designer's primary reference
 - www.NFBA.org

ENGINEERING DESIGN PRACTICES

- ASAE/ANSI EP 484, Diaphragm design of metal-clad, post-frame rectangular buildings
- ASAE/ANSI EP 486, Shallow post foundation design
- ASAE/ANSI EP 559, Design requirements and bending properties for mechanically laminated columns

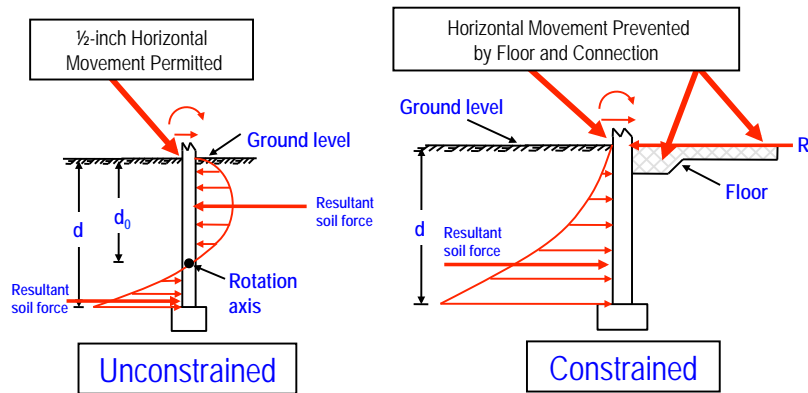
All referenced in 2006 & 2009 IBC

NFBA TECHNICAL RESOURCES

- Accepted Practices for Post-Frame Building Construction: Framing Tolerances
- Accepted Practices for Post-Frame Building Construction: Metal Panel and Trim Installation Tolerances
- Post-Frame Construction Guide
- www.NFBA.org

POST/PIER EMBEDMENT DESIGN LATERAL LOADS

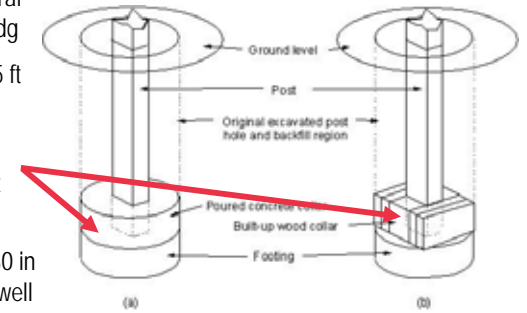
Two primary post/pier embedment types:



Procedures for calculating depth documented in PFBDM & ASAE EP 486

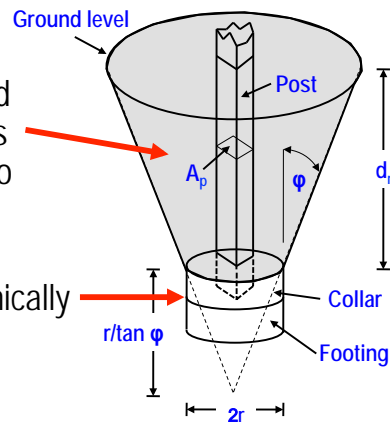
POST FOUNDATION OPTIONS EMBEDDED TREATED POST

- Embedment provides lateral and vertical support for bldg
- Typically embedded 3.5–5 ft depth
- Bottom concrete collar or wood cleat improves uplift resistance of post
- Post hole is typically 24–30 in diameter; back-filled with well graded gravel, sand, or excavated soil



POST EMBEDMENT DESIGN FOR POST UPLIFT FORCES

- Mass of soil in shaded truncated cone resists post withdrawal due to uplift forces
- Post must be mechanically attached to the collar or the footing



SPECIAL CONSIDERATIONS FOR POST FOUNDATIONS

- Place footer below frost line *or*
- Install post foundation as frost-protected foundation to eliminate frost heaving (proper insulation, below footer backfill, and drainage) (See Bohnhoff article in Jan/Feb, 2010 issue of *Frame Building News*)
- Do not use partial concrete collars immediately below ground line (top collars)
- Provide good drainage away from post holes
- Use only preservative treated wood for all wood elements in contact with the ground

SPECIAL CONSIDERATIONS FOR POST FRAME DESIGN/CONSTRUCTION

- Use hot dipped galvanized or stainless hardware for all below ground applications
- Use hot dipped galvanized or stainless hardware when in contact with preservative treated wood. (Per preservative treatment suppliers recommendations)

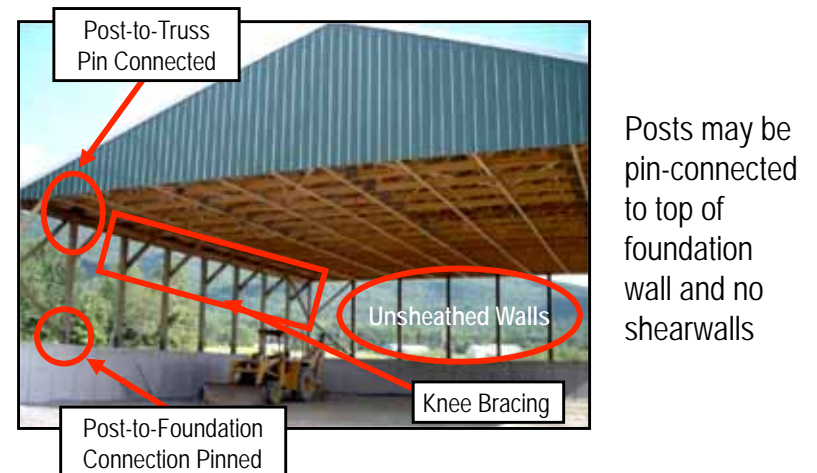
PRIMARY PF BUILDING SYSTEM TYPES

- PF Building Systems Without Diaphragm Action (2-dimensional [2-D] structural behavior)
- PF Building Systems with Diaphragm Action (3-dimensional [3-D] structural behavior)

PF SYSTEM **WITHOUT** DIAPHRAGM ACTION



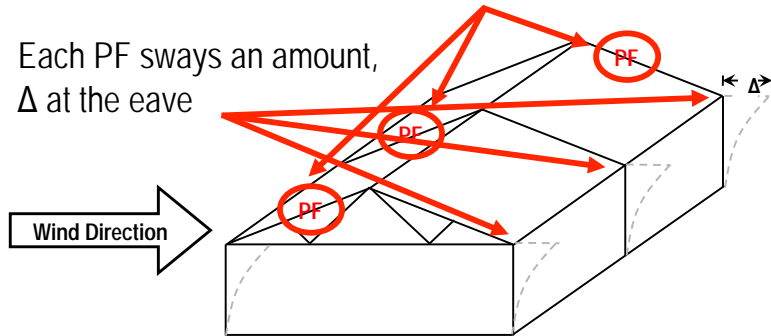
PF SYSTEM **WITHOUT** DIAPHRAGM ACTION



PF RESPONSE TO LATERAL LOADS WITHOUT DIAPHRAGM ACTION

- Without diaphragm action each PF carries the full lateral wind load applied to tributary area of the frame

- Each PF sways an amount, Δ at the eave



PF SYSTEM WITH DIAPHRAGM ACTION AND WITH MOMENT RESISTANCE AT POST-TO-FOUNDATION CONNECTION

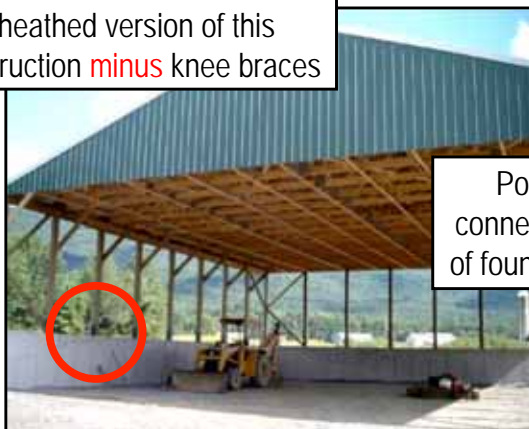
Sheathed version of
this construction
without knee braces



Posts embedded
in ground

PF SYSTEM WITH DIAPHRAGM ACTION AND WITHOUT MOMENT RESISTANCE AT POST-TO-FOUNDATION CONNECTION

Sheathed version of this
construction *minus* knee braces



Posts pin-
connected to top
of foundation wall

PF RESPONSE TO LATERAL LOADS WITH DIAPHRAGM ACTION

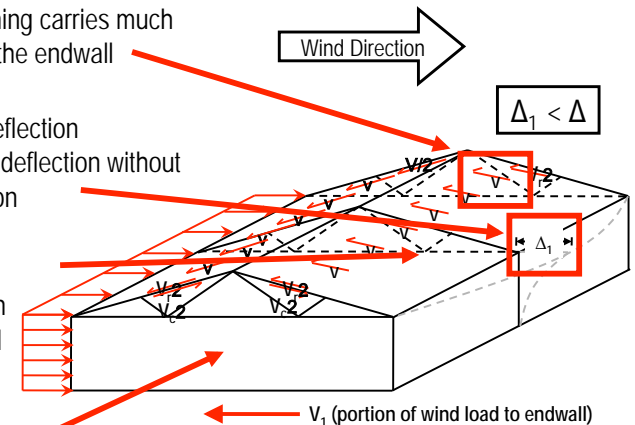
The roof sheathing carries much
of wind load to the endwall



The PF eave deflection
is less than the deflection without
diaphragm action

$$\Delta_1 < \Delta$$

The PF only
carries a portion
of the wind load
to ground



The endwall carries most
of wind load to the ground

2-D FRAME DESIGN METHOD

- 2-D frame method required for
 - PF with open sidewalls or end walls
 - PF with L:W > (2 to 2.5):1 between shearwalls
 - PF without adequate structural detailing or connection details to develop proper load paths for transfer of in-plane shear forces in and between the roof diaphragm and the shear walls

DIAPHRAGM DESIGN METHOD

- Diaphragm design is used for nearly all modern PF building systems with enclosed end walls and sidewalls
 - More economical design
 - Smaller sidewall posts
 - Shallower post or pier embedment depths
 - Greater structural integrity
 - More durable PF structures

DIAPHRAGM DESIGN RESOURCES

- Post Frame Building Design Manual
- ASABE EP 484 (www.asabe.org)
- DAFI Computer Program (On-Line and Free)
- PF Design Documents (On-Line and Free)
- 3-1/2 hour PF Firewall Report

All except EP 484 can be accessed at
www.PostFrameAdvantage.com or at
www.nfba.org

EXAMPLES OF PF BUILDING COMMERCIAL APPLICATIONS

Function and size: Church, 118 ft x 168 ft, 19,000+ sq ft
 Posts: 4 ply, 6 x 8 nail-lam posts, 7 ft 6 in. o.c.
 Post foundation: 6 in. x 4 ft cast-in-place concrete foundation wall
 Roof framing: Double 2x trusses, 7ft. 6 in o.c.; 2 x 4 purlins on edge, 24 in o.c.
 Wall girts: 2 x 6, 32 in o.c., flat
 Insulation: R-19 in walls; R-38 in ceiling
 Exterior finish: Painted steel siding; brick wainscot in selected areas
 Interior finish: Sheetrock with acoustical steel in gymnasium area



- Construction Time: 6 months
- Cost: \$84/sq ft (2002)
- Location: Salina, KS

Function and size: Childcare center, 66 ft x 138 ft, 9,100 sq ft
 Posts: 3 ply, 4.5 x 7.5 in. nail-lam, 6 ft o.c.; ACO preservative treatment
 Post foundation: Posts set on a cast-in-place foundation wall
 Roof framing: Single 2x trusses, 6 ft o.c.; heavy timber trusses; rafters; 2 x 4 purlins on edge, 22 in. o.c.
 Wall girts/sheathing: 2 x 4, 24 in. o.c., flat, 0.5 in. OSB
 Insulation: R-30 in walls; R-50 in ceiling
 Exterior finish: Hardi-Plank
 Interior finish: Sheetrock and suspended ceiling



- Construction Time: 4.5 months
- Cost: \$86/sq ft (2006)
- Location: Prescott, WI

Function and size: Volunteer Fire Company, 80 ft x 100 ft, 8,000 sq ft
 Posts: 3 ply, 4.5 x 7.5 in. nail-lam, 8 ft o.c.; 0.8 pcf CCA preservative treatment above/below ground
 Post foundation: Posts embedded in ground
 Roof framing: Single 2x, 80-ft clear span trusses, 8 ft o.c.; 2 x 4 purlins on edge, 24 in o.c.
 Wall girts/sheathing: 2 x 4, 30 in o.c., flat
 Insulation: R-30 in walls; R-38 in ceiling
 Exterior finish: 26-gauge painted ribbed steel
 Interior finish: Steel sheathing in bay; sheetrock and suspended ceilings in office areas



- Construction Time: 6 mos.
- Cost: \$70 / sq. ft (2007)
- Location: Lexington, NC

Function and size: Educational Center, 64 ft x 112 ft, 7,200 sq ft
 Posts: Solid sawn 6 x 6 posts, 8 ft o.c.; CCA at 0.6 pcf
 Post foundation: Embedded posts attached to 12 in. Φ concrete footer
 Roof framing: Single, 64-ft trusses, 2 ft o.c.; OSB sheathing attached to truss chords
 Wall girts/sheathing: 2 x 4, 24 in o.c., flat; 7/16 OSB
 Insulation: R-24 in walls; R-30 in ceiling
 Exterior finish: Log siding; ribbed steel roof
 Interior finish: Drop ceiling in parts; drywall in parts; some exposed wood



- Construction Time: 6 months
- Cost: \$72/sq ft (2007)
- Location: Medina, OH

APPLICATIONS OF PF BUILDINGS



...ARE LIMITED ONLY BY THE DESIGNER'S
IMAGINATION AND CREATIVITY



MORE ABOUT POST FRAME

- On-Line University Course
- Design Webinars
- www.PostFrameAdvantage.com
- www.NFBA.org
- NFBA
4700 W Lake Ave
Glenview, IL 60025



> Questions?

This concludes The American
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Harvey B. Manbeck
Manbeck Engineering, LLC
hmanbeck@psu.edu

QUESTIONS? COMMENTS?

- National Frame Building Association (NFBA)



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- NFBA
4700 W Lake Ave
Glenview, IL 60025

