Bracing Systems
Wind Bracing Systems

HOW BRACING WORKS
Wind Bracing Systems

Load Dispersal

The WIND load on Endwall panels...
Wind Bracing Systems

Load Dispersal

is dispersed through Endwall framing...
Wind Bracing Systems

Load Dispersal into the Continuous Purlin system.
Wind Bracing Systems

Load Dispersal

The Purlins transfer the load...
Wind Bracing Systems

Load Dispersal

into the roof Brace Rods.
Wind Bracing Systems

Load Dispersal

The load travels through the Roof bracing...
Wind Bracing Systems

Load Dispersal

through the Eave Purlin ...
Wind Bracing Systems

Load Dispersal

to the wall Diagonal Bracing ...
Wind Bracing Systems

Load Dispersal

...(or auxiliary bracing)...

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Wind Bracing Systems

Load Dispersal

into the Building’s foundation.
Wind Bracing Systems

Load Dispersal into the Building’s foundation.
Transverse (Perpendicular to Sidewall)

Figure 1 Transverse load resisting systems
Longitudinal (Perpendicular to Endwall)

Figure 2. Longitudinal load resisting system.
Standard EP Location
Roof Rods Break at Endpost(s)
If possible, keep endpost spacing similar at each endwall for a more efficient bracing pattern.
### Typical Rod Bracing Location

**Table 2 Location of braced bays**

<table>
<thead>
<tr>
<th>Number of bays (n)</th>
<th>Braced Bays</th>
<th>Additional (if more than min. is required)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3</td>
<td>any one</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>middle</td>
<td></td>
</tr>
<tr>
<td>4 - 7</td>
<td>middle</td>
<td>2, n-1</td>
</tr>
<tr>
<td>8 - 12</td>
<td>2, n-1</td>
<td>3, n-2</td>
</tr>
<tr>
<td>&gt; 12</td>
<td>2, n-1</td>
<td>4, n-3</td>
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</table>

**Notes:**
- = Bay not braced
- = Braced bay – primary locations. For available BBNA lateral-force resisting systems see DP 5.4.
- = Braced bay location when additional bays of bracing are needed

**Design Procedures**

- Section: DP 5.1
- BRACING General
- Page 1 of 3
- Section: 1 (10/09)
Wind Bracing Systems

Standard Bracing Methods
Diagonal Bracing

- VP standard bracing utilizes Diagonal Bracing in the Roof and Walls.
- The bracing design is determined by:
  - Building Loads & Code
  - Building Size
  - Building Location
Diagonal Rod Bracing

Notes about Diagonal Rod Bracing:

- Stiffest bracing system available
- Most economical bracing system
Diagonal Rods
Diagonal Rods

Diagonal Rods

HARDWARE INSTALLED IN THIS ORDER:
HILLSIDE WASHER
FLAT WASHER "B"
FLAT WASHER "A"
HEX NUT

ROD SLOT BACKING PLATE MAY EXIST

WALL BRACE ROD

NOTE: FIELD CUT HOLES IN INSET CFITS AT INTERFERENCE WITH RODS

ROD SLOT BACKING PLATE MAY EXIST

WASHERS

<table>
<thead>
<tr>
<th>ROD Dia</th>
<th>NUT</th>
<th>A</th>
<th>B</th>
<th>HILLSIDE</th>
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<tbody>
<tr>
<td>3/8&quot;</td>
<td>095321</td>
<td>088408</td>
<td>48040</td>
<td>04-3557</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>095230</td>
<td>086872</td>
<td>095846</td>
<td>04-3557</td>
</tr>
<tr>
<td>5/8&quot;</td>
<td>095233</td>
<td>089949</td>
<td>099646</td>
<td>04-3557</td>
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<tr>
<td>3/4&quot;</td>
<td>095235</td>
<td>089948</td>
<td>099646</td>
<td>04-3557</td>
</tr>
<tr>
<td>7/8&quot;</td>
<td>095337</td>
<td>095947</td>
<td>095948</td>
<td>04-3558</td>
</tr>
<tr>
<td>1&quot;</td>
<td>095338</td>
<td>095948</td>
<td>095949</td>
<td>04-3559</td>
</tr>
<tr>
<td>1 1/8&quot;</td>
<td>095339</td>
<td>095948</td>
<td>095949</td>
<td>04-3559</td>
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</table>

ROD BRACING THRU ROD SLOT
COLUMN SHOWN / RAFTER SIMILAR

ROD BRACING THRU ROD SLOT
COLUMN SHOWN / RAFTER SIMILAR
Diagonal Bracing Options (Rods)
Alternate Diagonal Bracing
Rod Brace Assembly

<table>
<thead>
<tr>
<th>ROD DIA.</th>
<th>CLEVIS MARK NO.</th>
<th>CLEVIS PIN DIA.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8&quot;</td>
<td>097572</td>
<td>1 1/4&quot;</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>097573</td>
<td></td>
</tr>
<tr>
<td>5/8&quot;</td>
<td>095277</td>
<td></td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>095278</td>
<td></td>
</tr>
<tr>
<td>7/8&quot;</td>
<td>095279</td>
<td></td>
</tr>
<tr>
<td>1&quot;</td>
<td>095280</td>
<td></td>
</tr>
<tr>
<td>1 1/8&quot;</td>
<td>095281</td>
<td></td>
</tr>
<tr>
<td>1 1/4&quot;</td>
<td>095282</td>
<td></td>
</tr>
<tr>
<td>1 3/8&quot;</td>
<td>095284</td>
<td></td>
</tr>
<tr>
<td>1 1/2&quot;</td>
<td>095286</td>
<td>1 1/2&quot;</td>
</tr>
</tbody>
</table>

COTTER PIN

CLEVIS

BRACE ROD

CLEVIS PIN

BR02.K1 ROD BRACING CLEVIS ASSEMBLY
Coupling Nuts
Angle Bracing

- Bracing may be single rods or angles depending upon loading/design
Angle Bracing
Angle Bracing
Angle Bracing
Wind Bracing Systems

Alternative Bracing Methods
Alternative Bracing Methods

**Torsional Bracing**

Rods are omitted from one sidewall.
Torsional Bracing
No Torsional Allowed if...

Torsion bracing Geometry/Environmental Limitations:

- Non-rectangular shape (maximum of 4 walls)
- Span exceeds 50 ft.
- Eave height exceeds 16 ft.
- Roof pitch exceeds 1:12
- Have less than 3 bays
- Portal braces
- Portal frames
- Cantilevered columns (fixed base wind posts)
- Partial height rods
- Have lean-to frames
- Has a mezzanine
- Has a crane
- Brittle finishes
- Facades
- Wind speed exceeds 110 mph
  - For Canadian jobs: Basic wind pressure exceeds 32 psf
- High Seismic Applications (IBC/ASCE: SDC D, e or F).
  - For Canadian jobs: $I_E F_a S_{a(0.2)} > 0.35$, and all post-disaster buildings
Alternative Bracing Methods

Notes About Torsional Bracing

- Inexpensive
- Maximum building width of 50’
- Maximum eave height of 18’
- 100 mph maximum wind speed
- Minimum 3 bays
- *Call your Service Center if close to these parameters*
Rod Brace to Floor

Diagram showing details of rod brace connections to the floor.
## Rod Mark Numbers

<table>
<thead>
<tr>
<th>Rod Bracing</th>
<th>03R A2510</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>FFII</td>
</tr>
<tr>
<td>Length</td>
<td></td>
</tr>
</tbody>
</table>

**MARK NUMBER KEY**

- **Common Generated Mark Numbers**
- **EN50A1V5**
- **R 11/04/2005**
Portal Bracing

Portal Brace Includes:

- Portal Beam
- Knee Braces
- Additional column support
NOTE: DO NOT ATTACH PANEL (OR PANEL CLIPS) TO PORTAL BRACE BEAM.

PORTAL BRACE BEAM

PORTAL BRACE SUPPORT LOCATION

SEE BR12H3

SEE ROOF PLAN FOR PART # (CPB_)

(4) 3/4" x 2 1/2" A325 BOLTS UNLESS NOTED OTHERWISE

3/4" x 2 1/2" A325 BOLTS TYP EACH END

KNEE BRACE KBD

PORTAL BRACING
KNEE BRACE CONNECTION
Portal Bracing

Portal Brace Beam

(2) 3/4” A325 bolts unless noted otherwise

3/4” x ___ A325 bolts typ each end

(4) 3/4” A325 bolts unless noted otherwise

3/4” x ___ A325 bolts typ each end

Knee Brace Connection (bolting knife plate)
Bracing-Wind Posts

Bracing

**New Bracing Option**

- Fixed Base Wind Post (with automated Wind Post Base Plate Design)
- Use at sidewalls or endwalls
- 35’-0” max. eave height
- Max. 24” column depth
- Connection at main frame is similar to that of portal frame
Automated diaphragm check
If fails Rods may automatically be designed
Initially at interior bay
Then at endbay
Post and Beam Stability
Alternative Bracing Methods

Notes About Portal Bracing

• More expensive than rod
• Flexible, not as stiff as diagonal bracing
• Maximum eave height of 20’
• Special clearances possible
Portal Bracing???
Portal Frames

Portal Frame Includes:

- Portal Frame Beam
- Portal Frame Columns
- Load Transfer Clips
- Bolts and Nuts
Portal Frame

FLANGE BRACE REQUIREMENTS:

<table>
<thead>
<tr>
<th>PORTAL COLUMN DEPTH</th>
<th>FLANGE BRACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 24&quot; &amp; ≤ 36&quot;</td>
<td>HF34106</td>
</tr>
<tr>
<td>&gt; 36&quot; &amp; ≤ 48&quot;</td>
<td>HF36032</td>
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</table>

NOTES:

1. FIELD DRILL 9/16" HOLES IN PRIMARY AND PORTAL FRAME WEBS FOR FLANGE BRACE CONNECTIONS.
2. DRILL 9/16" HOLE IN PORTAL FRAME COLUMN WEB APPROX. 2" FROM BOLTING PLATE @ BEAM C.
Portal Frame (1/2" offset)

PORTAL FRAME

(2, 3 OR 4) A325 BOLTS

PRIMARY FRAME

1/2" x 1 1/2" A-325 BOLT
(49080) TYP.

FLANGE BRACE REQUIREMENTS:

<table>
<thead>
<tr>
<th>PORTAL COLUMN DEPTH</th>
<th>FLANGE BRACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 24&quot; &amp; ≤ 36&quot;</td>
<td>HFB4106</td>
</tr>
<tr>
<td>&gt; 26&quot; &amp; ≤ 48&quot;</td>
<td>HFB6032</td>
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NOTES:
1. FIELD DRILL 9/16" HOLES IN PRIMARY AND PORTAL FRAME WEBS FOR FLANGE BRACE CONNECTIONS.
2. DRILL 9/16" HOLE IN PORTAL FRAME COLUMN WEB APPROX. 2" FROM BOLTING PLATE @ BEAM C.

REV. DATE 07/01/28 REV NO. 00
BR12K1 FLUSH PORTAL FRAME CONNECTION FLANGE BRACE CONNECTION AND LOCATION
Portal Frame
Portal Frame
Alternative Bracing Methods

Notes About Portal Frames

- More expensive than rods
- Relatively stiff (can hold drift on frame)
- Special clearances possible (Hold column & rafter depths)
Portal Frame
Portal Frame
(typical Anchor Rod Detail)
Alternative Bracing Methods

Combination of Rods and Portal Frame

- May be more for building heights above 20’ tall.
Partial Height Portal Frame
Bracing Comparisons
(Building Size = 200 x 300 x 19, IBC, 85 MPH Wind - Book Price Shown)
Strut Bracing at Wall

SEE ERECTION DRAWINGS FOR LOCATIONS AND PART MARKS

BRACE ROD

CLEVIS PIN W/ COTTER PIN (SEE ERECTION DWGS)

A325 BOLTS
SEE DRAWINGS FOR SIZES AND QUANTITIES

COLUMN

WHERE SLOTTED HOLES ARE PRESENT BOLTS ARE SLIP CRITICAL AND MUST BE FULLY PRE TENSIONED.
FAVING SURFACES MUST BE PAINT FREE. IF PAINT IS FOUND ON FAYING SURFACES IN SLOTTED
CONNECTIONS REMOVE WITH LIGHT GRINDING.
STANDARD HARDENED WASHERS ARE REQUIRED OVER ALL SLOTS.

REV: DATE: 07/21/08 | REV. NO: 00
BR15J1 STRUT BRACING
GAGE STRUT ON WALL
Tube Strut
Rod Bracing at Truss Frame

- TRUSS
- BAY SPACE
- ROOF SECONDARY MEMBER
- BRACE ROD (SEE ERECTION DWGS)
- CLEVIS PIN W/ COTTER PIN (SEE ERECTION DWGS)
- OPEN WEB TRUSS

REV. DATE 07/01/99  REV. NO. 00
BR14D1 OPEN WEB TRUSS INTERIOR FRAME BRACING
INTERIOR LATERAL ROD BRACING
Rod Bracing at Truss Frame
Rod Bracing at Facade

**Lower Facade Lifter (LFL-)**
- Center lifter on bottom girt & field drill 9/16" holes

**Lifter Spacing:**
- Bay space = 20\(\frac{\text{ft}}{}\) = 1/3 Points
- Bay space = 10\(\frac{\text{ft}}{}\) to 20\(\frac{\text{ft}}{}\) = Midspan
- Bay space = 10\(\frac{\text{ft}}{}\) or less = none required

**Note:** Utilize the center slot when only one rod connects to the LFL-

**Field Locate Slots Along Intermediate Girts for Rods**

**Support Rods**

**Facade Bottom Girt**

**Facade Lifter at Bottom Girt**

**Structural Framing (Bracing)**

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**Facade Brace Rod at Corner**

**Structural Framing (Bracing)**

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No Bracing?!?!?!

- As erection proceeds all Brace Rods, Flange Braces, Struts, Purlin/Girt Laps should be installed before proceeding.
- All buildings will require some temporary bracing until all erection is complete! Do NOT take any chances!
What Wind Can Do!
Bracing Tips

- Bracing most effective at 45 degree angle
- **Diagonal bracing** always most economical
- Consider **Interior Column Bracing** at wide buildings
- Consider “**shear walls**” with masonry, etc.