Seismic and Lateral Design Considerations for Wood Framed Structures

Presented by Karyn Beebe, P.E.

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Learning Objectives

- Load Path Continuity
- California Building Code Updates
- Shear Wall Design Alternatives

Load Path

“Any system of method of construction to be used shall be based on a rational analysis in accordance with well established principles of mechanics. Such analysis shall result in a system that provides a complete load path capable of transferring loads from their point of origin to the load-resisting elements.”

(CBC 2007 1604.4)

Vertical Load Path
Vertical (Gravity) Load Path

Lateral Load Path

Lateral Loads: National Issue

Lateral Loads (Wind)

F = PA

Effort is devoted to determining:

P – wind pressure

Wind Hazards
Earthquake Hazard

Lateral Loads (Seismic)

F = ma

Effort is devoted to determining:

a – acceleration

Wind Loads (ASCE7-05)

• Pressures vary in magnitude and direction (+/-)
Wood – Light and Flexible

General Modes of Failure
- Uplift
- Base Shear
- Racking
- Overturning

3-D Connector
General Lateral Load Path

Load Path Components

Code Definitions

Diaphragm
• Horizontal or slopped system acting to transmit lateral forces to the vertical-resisting elements (CBC 2007 Sec. 1602.1)

Load Path Components

Load Path Components

Diaphragm

Load Path Components

Diaphragm Design: Load Effects

Load Path Components

Load Path Components

Load Path Components
Code Definitions

Shear Wall
- A wall designed to resist lateral forces parallel to the plane of wall (CBC 2007 Sec. 2302.1)

Shear Wall

Lateral Force (Shear)

Shear Wall Overturning

Idealizing and Simplifying Complicated Structures

- Sloped roofs
- Offset roof planes
- T-, L-shaped and other odd
- Drag struts
- Flexible v. rigid diaphragm

Sloped Roofs

Idealize sloped wood roof diaphragms as if they are flat

Curved Diaphragms

Idealize it as flat

Offset Roof Planes

Offset roof planes
- Treat as two separate diaphragms
- Each with their own chords
Code Definitions

**Collector**
- A horizontal diaphragm element parallel and in line with the applied force that collects and transfers diaphragm shear forces to the vertical elements of the lateral-force-resisting system and/or distributes forces within the diaphragm. (CBC 2007 Sec. 2302.1)

Collector
- A collector works just like a post collects load from beam and transfers it to the foundation
- A collector collects load from the diaphragm and transfers it to the shear wall

Collector

Irregular Diaphragm Shape

Shear Walls, Drag Struts

Framing Parallel to Strut Forces
Framing Perpendicular to Strut Forces

Overstrength, $\Omega$ Requirements

- Collectors and their connections in SDC C-F require design for $\Omega \times Q_e$ (ASCE 7-05 Sec. 12.10.2.1)
  - $\Omega = 3$ for wood shear wall systems (Table 12.2-1)
  - $Q_e =$ horizontal seismic loads
- Exception: structures braced with light frame shear walls are exempt

Overstrength, $\Omega$ Requirements

- Besides collectors, $\Omega$ is required for the design of elements under shear walls that occur in an upper floor but do not continue down to the foundation
- Elements supporting discontinuous walls (in-plane discontinuity) – ASCE 7-05 Sec. 12.3.3.3

2007 California Building Code (CBC)

Transition from the
1997 UBC to the
2006 IBC

Governing Codes for Engineered Wood Design

- 2006 IBC (International Building Code)
  - Chapter 16 Loads
  - Chapter 23 Wood

Governing Codes for Engineered Wood Design

- ASCE 7-05
  - Design Loads
Governing Codes for Engineered Wood Design

2005 NDS (National Design Specification for Wood Construction)

2005 SDPWS (Special Design Provisions for Wind and Seismic)
- http://www.awc.org/Standards/SDPWS.html
- Free download

2007 CBC Update Diaphragms & Shear Walls
1. 40% Increase for Wind
2. Framing Species Adjustment
3. Minimum Penetration Depth

Shear Wall and Diaphragm Design Concepts

Wood Structural Panels are by definition either Plywood or OSB (2302 & R202)

Wood Structural Panels come in two grades: Structural I, and Sheathing
Wood Shear Wall and Diaphragms Design

- Function of: fastener’s size, spacing and panel thickness
- Values in Tables all building codes
- Alternately, capacities can be calculated by principles of mechanics

Wood SW and Diaphragm Design

Design Capacity Increase - Wind

2007 CBC 2306.3.2 and 2306.4.1

- The allowable shear capacities can be increased 40% for wind load resistance

40% Increase for Wind - Justification

- Confidence in code wind load accuracy is high
- The current shear wall and diaphragm tables are based on a 2.8 min. safety factor and it was agreed that a 2.0 safety factor is adequate, thus a 40% increase in tabulated values

Adjust Shearwall and Diaphragm Values for Framing Species

UBC 97– Multiply Struct. I values by 0.82 (for SG ≥ 0.42) or 0.65 (for SG <0.42)

“New” - 2007 CBC – Multiply actual values by: (1-(0.5-SG))

Footnote a of Table 2306.3.1 and 2306.4.1

CBC Changes - Minimum Fastener Penetration for Shear

Minimum Penetration

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<thead>
<tr>
<th>Nail</th>
<th>UBC 97</th>
<th>2007 CBC</th>
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</thead>
<tbody>
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<td>6d</td>
<td>1-1/4”</td>
<td>1-1/4”</td>
</tr>
<tr>
<td>8d</td>
<td>1-1/2”</td>
<td>1-3/8”</td>
</tr>
<tr>
<td>10d</td>
<td>1-5/8”</td>
<td>1-1/2”</td>
</tr>
</tbody>
</table>

(Tables 2306.3.1 and 2306.4.1)

Fastener Penetration for Shear

- What difference does 1/8 inch make?
- Allows use of I-joist framing for diaphragms
- Allows the use of flat-wise blocking for shearwalls and diaphragms
- Allows the use of 2x nailers over metal framing
Wood Diaphragms Design

4.2.3 Unit Shear Capacities

The nominal unit shear capacities for seismic design are provided in Column A of Tables 4.2A, 4.2B, and 4.2C, and for wind design in Column B of Tables 4.2A, 4.2B, and 4.2C. The ASD allowable unit shear capacity shall be determined by dividing the nominal unit shear capacity by the ASD reduction factor of 2.0. No further increases shall be permitted. The LRFD factored unit resistance shall be determined by multiplying the nominal unit shear capacity by a resistance factor, \( f_R \), of 0.80.

Flexible, Rigid and Semi-Rigid Diaphragms

- **Flexible**
  - Diaphragm load is distributed to shear walls by tributary area
- **Rigid**
  - Diaphragm load is distributed to shear walls by wall stiffness and torsion
- **Semi-rigid**
  - Between flexible and rigid, dependent on stiffness

2007 CBC Update Diaphragms

4. Load distribution

5. High Load Diaphragm Values
Prescribed Flexible Diaphragm

In many cases wood diaphragms are permitted to be idealized as flexible

ASCE 7-05 Sec. 12.3.1.1 exempts one- and two-family dwellings from rigid diaphragm analysis.

CBC 2007 Sec 1613.6.1 adds following text to the ASCE provisions.
Prescribed Flexible Diaphragm

1. Concrete topping is non-structural and is less than 1.5 in.
2. Each line of vertical elements of LFRS complies with allowable story drift of ASCE7-05 Table 12.12-1
3. Vertical elements of LFRS are light framed walls sheathed with wood structural panels or steel sheets
4. Cantilever portions of the diaphragm designed in accordance with Sec. 2305.2.5

Calculated Flexible Diaphragm

ASCE 7-05 Sec. 12.3.1.3
Diaphragms are permitted to be idealized as flexible when:
• The diaphragm deflection is more than two times the average story drift of adjoining shear walls

\[ \Delta_{\text{DIAPHRAGM}} \geq 2 \times \Delta_{\text{SHEARWALLS}} \]

Calculated Flexible Diaphragm

The longer the diaphragm the more likely it is to calculate as flexible

Prescribed Rigid Wood Diaphragms (CBC 2305.2.5)

• Open front
• Cantilevered diaphragms

Semi-Rigid Diaphragm

• Diaphragm flexibility - ASCE 7 Sec. 12.3.1
• Unless it can be idealized as flexible or rigid, then:
  • The structural analysis shall consider the relative stiffness of diaphragms and shear walls
Semi-Rigid Diaphragm

- Semi-rigid results in force distribution somewhere between rigid and flexible
- Thus, an envelope approach can be used where both rigid and flexible models are used and the highest forces from each are selected

Calculating Shear Wall and Diaphragm Deflection

Importance
- Rigid v. flexible diaphragm
- Drift limit
- Building separation

Deflections (4-term eqn’s)

- Shear Wall (IBC §2305.3.2)
  \[ \Delta = \frac{5vL^4}{8EAb} + \frac{vL}{G_{tc}} + 0.75hc + \frac{2h}{b} \]

- Diaphragm (IBC §2305.2.2)
  \[ \Delta = \frac{5vL^4}{8EAb} + \frac{vL}{4G_{tc}} + 0.188Le + \sum \left( \frac{\Delta X}{2b} \right) \]

APA L350 (www.apawood.org) has comprehensive listing of input parameters and examples

Deflection (3-term eqn.)

- Diaphragm (SDPWS §4.2.2)
  \[ \Delta = \frac{5vL^4}{8EAW} + \frac{0.25vL}{1000G_s} + \frac{\sum (\Delta X)}{2W} \]

- \( G_s \) values for blocked and unblocked diaphragms

Diaphragms and Shear Walls

- Deflection of Unblocked Diaphragms is 2.5 times the deflection of blocked diaphragm.
- If framing members are spaced more than 24” o.c., testing indicates further deflection increase of about 20%, or 3 times the deflection of a comparable blocked diaphragm. (This is based on limited testing of the diaphragm by APA)

High load diaphragms
High Load Diaphragms

- 2007 CBC Table 2306.3.2, Tables in ICC-ES Legacy Report ER-1952, and Table B-1, p. 28 in APA Form L350
- Uses multiple rows of nails
- ASD capacity up to 1800 plf (seismic)
- ASD capacity up to 2520 plf (wind)

Typical Fastener Pattern for use with High-Load Diaphragm Table

3" nominal, two lines of fasteners

Footnotes to High-Load Diaphragm Table

Table 2306.3.2 note (g)

- High Load Diaphragms shall be subject to special inspection IAW IBC Section 1704.6.1

Footnotes to High-Load Diaphragm Table

Loads were limited by lumber splitting.

2 x 4

2007 CBC Update Shear Walls

6. Aspect Ratio Adjustment
7. Summing Shear Capacities
8. Perforated Shear Wall
Wood Shear Wall Design Concepts

Max. Shear Wall Aspect Ratios (2305.3.4)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>3.5:1</td>
<td>3.5:1</td>
<td>3.5:1</td>
</tr>
<tr>
<td>Zone 4</td>
<td>2:1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Zone 0-3</td>
<td>3.5:1</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>SDC D-F</td>
<td>--</td>
<td>2:1</td>
<td>2:1*</td>
</tr>
<tr>
<td>SDC A-C</td>
<td>--</td>
<td>3.5:1</td>
<td>2:1*</td>
</tr>
</tbody>
</table>

a. May be reduced to 3.5:1 if allowable shear is reduced by 2w/h

Height to width ratio (2305.3.5)

- For shear walls and perforated shear walls
  - h:w must not exceed 2:1 or 3.5:1 ratio

Summing Shear Capacities

CBC §2305.3.8

- Two sides sheathed = twice the strength (1740 plf max)
- For wind design:
  - Gypsum shear wall strength can be added to wood shear wall strength

Shear Walls: Wind v. Seismic

- Wind Design:
  - 40% increased capacity
  - Gypsum strength can be added
  - 3.5:1 max. aspect ratio

- Seismic Design:
  - Requires 3x framing more often (SDC D-F)
  - 2:1 max. aspect ratio without penalty
  - 3.5:1 permitted with penalty (2w/h)
**Shear Walls: Wind v. Seismic**

**Given:**
- 7/16" OSB
- 8d common
- 3"/ 6" edge/field nail spacing
- Gypsum on opposite face

**Wind Capacity:**
\[ V = (450 \text{ plf} \times 1.4) \times 2.25' = 1418 \text{ lb} \]

**Length of wall**
- From table

**Seismic Capacity:**
\[ V = 450 \text{ plf} \times 2(2.25')/8' \times 2.25' = 570 \text{ lb} \]

When less than 2:1 aspect ratio, 2w/h adjustment

---

**Shear Walls: Wind v. Seismic**

**Given:**
- 7/16" OSB
- 8d common
- 3"/ 6" edge/field nail spacing
- Gypsum on opposite face

**Wind Capacity:**
\[ V = (450 \text{ plf} \times 1.4 + 100 \text{ plf}) \times 5.33' = 3891 \text{ lb} \]

**Length of wall**
- From table

**Seismic Capacity:**
\[ V = 450 \text{ plf} \times 5.33' = 2399 \text{ lb} \]

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**Design Methods (2007 CBC)**

1. **Segmented Shear Walls**
2. **Shear Walls with Openings**
   - a. force transfer around openings
   - b. perforated shear walls

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**Shear Wall Design**

- Segmented
  1. Aspect Ratio for seismic 2:1
  2. Aspect ratio up to 3.5:1, if allowable shear is reduced by 2w/h

- Force Transfer
  1. Code does not provide guidance for this method
  2. Different approaches using rational analysis could be used

- Perforated
  1. Code provides specific requirements
  2. The capacity is determined based on empirical equations and tables

CBC 2305.3.3  CBC 2305.3.8.1  CBC 2305.3.8.2
Segmented (Traditional) Wood Shear Walls (CBC §2305.3)

- Only full height segments are considered
- Max aspect ratio
  - 2:1 – for seismic
  - 3.5:1 – for wind
- Current Code design values based on data dating back to 1950’s.

Shear Wall With Opening – Force Transfer Around Opening (CBC §2305.3.7.1)

- Openings accounted for by strapping or framing
  - “based on a rational analysis”
- H/w ratio defined by wall pier

Shear Wall With Opening – Force Transfer Around Opening

- Hold-downs only at ends
- Extra calculations and added construction details (connections & blocking)
  - Uses traditional design values

Shear Wall With Opening – Perforated Shear Wall (CBC §2305.3.7.2)

- Openings accounted for by empirical adjustment factor
- Hold-downs only at ends
- Uplift between hold downs, t, at full height segments is also required
- Limited to 490 plf

Perforated Shear Wall Design

**Definition 2302**

Perforated Shear Wall – a wood structural panel sheathed shear wall with openings that has not been specifically designed and detailed for force transfer around the openings

**Perforated Shear Wall segment** – full height segment meeting aspect ratio limits
Perforated Shear Wall Design

Code sets specific limitations on the use of this method

- Limitations

  - (2007 CBC sec.2305.3.8.2.1)

Limitations

1. Perforated Shear Wall segment required at each end of perforated shear wall

   - Required

   - Perforated Shear Wall

2. Openings are allowed beyond the ends of the perforated shear wall, but should not be included in the width of perforated shear wall

   - Permitted

   - Perforated Shear Wall

3. Allowable shear set in Table 2306.4.1 shall not exceed 490 plf

4. Out-of-plane offsets occur, walls shall be considered as separate perforated shear walls

   - Perforated Shear Wall

Limitations

2. Allowable shear set in Table 2306.4.1 shall not exceed 490 plf

3. Out-of-plane offsets occur, walls shall be considered as separate perforated shear walls

   - Full length shear collector

   - Perforated Shear Wall
Perforated Shear Wall Design

Limitations
5. A perforated wall shall have uniform top of wall and bottom of wall elevation. (otherwise use different method)

Perforated Shear Wall OK
Use other methods

Perforated Shear Wall Design

Limitations
6. Maximum Perforated Wall height is 20 ft

Perforated Shear Wall Design

Resistance (2007 CBC sec.2305.3.8.2.2)
1. Calculating percentage (%) of full-height sheathing

\[
\% = \frac{a_1 + a_2 + a_3 + a_4}{L}
\]

Perforated Shear Wall Design

Resistance
2. The maximum opening height is the maximum opening clear height

Perforated Shear Wall Design

Resistance
3. The unadjusted shear resistance shall be the allowable shear set in Table 2306.4.1 for h/w ratio of any perforated shear wall segments that do not exceed 2:1 for seismic forces and 3.5:1 for other forces.

Perforated Shear Wall Design

Maximum h/w ratio requirements for Perforated Shear Walls

<table>
<thead>
<tr>
<th>Load</th>
<th>Maximum h/w Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seismic</td>
<td>2:1</td>
</tr>
<tr>
<td>Seismic (shear values in table adjusted by 2w/h)</td>
<td>2:1 &lt; h/w &lt; 3.5:1</td>
</tr>
<tr>
<td>Other than seismic</td>
<td>3.5 : 1</td>
</tr>
</tbody>
</table>

Based on CBC 2006 Table 2305.3.4
Maximum Shear h/w Ratio
Perforated Shear Wall Design

Resistance

4. The adjusted shear resistance shall be calculated by multiplying the unadjusted shear resistance by the shear resistance adjustment factors of Table 2305.3.8.2. (interpolations are allowed)

Perforated Shear Wall Design

Table 2305.3.8.2 Shear Resistance Adjustment Factor, C_o

<table>
<thead>
<tr>
<th>WALL HEIGHT (h)</th>
<th>1/2</th>
<th>2/3</th>
<th>3/4</th>
<th>8/12</th>
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<tr>
<td>h/3</td>
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<td>0.59</td>
<td>0.49</td>
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<tr>
<td>2h/3</td>
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<td>0.71</td>
<td>0.59</td>
<td>0.49</td>
<td>0.42</td>
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<tr>
<td>3h/4</td>
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<td>0.71</td>
<td>0.59</td>
<td>0.49</td>
<td>0.42</td>
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<tr>
<td>4h/5</td>
<td>1.00</td>
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<td>0.59</td>
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<td>0.71</td>
<td>0.59</td>
<td>0.49</td>
<td>0.42</td>
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Percent Full-Height Sheathing

<table>
<thead>
<tr>
<th>Shear Capacity Adjustment Factor</th>
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<tr>
<td>10%</td>
</tr>
<tr>
<td>20%</td>
</tr>
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<td>30%</td>
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<td>80%</td>
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<tr>
<td>90%</td>
</tr>
<tr>
<td>100%</td>
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</tbody>
</table>

Perforated Shear Wall Design

Resistance

5. The perforated shear wall resistance shall be equal to the shear resistance times the sum of the width of the perforated shear wall segments.

\[ V = (V_{allowable}) \times \frac{2w}{h} \times (C_o) \times (a_1+a_2+a_3+a_4) \]

Perforated Shear Wall Design

Uplift Anchorage

- Should either comply with the additional prescriptive code requirements or calculated using principles of mechanics.

2305.3.8.2.4 Uplift anchorage at perforated shear wall ends. Anchorage for uplift forces due to overturning shall be provided at each end of the perforated shear wall. The uplift anchorage shall conform to the requirements of Section 2305.3.7, except that for each story the minimum tension chord uplift force, \( T \), shall be calculated in accordance with the following:

\[ T = \frac{Vh}{C \Sigma L} \]

Perforated Shear Wall Design

2305.3.8.2.5 Anchorages for in-plane shear. The unit shear force, \( V \), transmitted to the top of a perforated shear wall, out of the base of the perforated shear wall at full height sheathing and into collectors connecting shear wall segments shall be calculated in accordance with the following:

\[ V = \frac{C \Sigma L}{T} \]
Perforated Shear Wall Design

Summary

- Prescribed forces for shear and uplift connections ensure that the capacity of the wall is governed by the sheathing to wall connection and not bottom plate attachment for shear and/or uplift.

2007 CBC Update Connections

9. Fastener specification
   - Specify pennyweight, type, diameter and length
   - Ex: 10d common = 0.148" x 3"

10. Overdriven fasteners (APA TT-012)

11. 3x requirements

12. Sill plate anchorage

Shear Wall 3x Requirements

Shear Walls: 3x’s

- 3x’s at adjoining panels required when:
  - Allowable shear > 350 plf (UBC: Zone 3 & 4; IBC SDC D-F)
  - Double sided walls do not have panels offset (UBC and IBC)
  - Nails are spaced 2” o.c. (IBC)
  - 10d nails are spaced 3” o.c. and have penetration >1.5” (IBC)

- See footnotes to shear wall tables!

Framing at Adjoining Panel Edges

Two 2x stitch nailed per 2006 IBC Table 2306.4.1 Footnote i
Shear Walls: 3x’s

- 3x’s at sill plate required when:
  - Allowable shear > 350 plf (CBC SDC D-F) Section 2305.3.11
  - Except when allowable shear < 600 plf a 2x may be used if anchorage capacity is halved and 3” x 3” x 0.229” plate washers are used

- See footnotes to shear wall tables and Section 2305.3.11

Shear Walls: Plate Washers

Large plate washers (3” x 3” x 1/4”), like a 3x sill plate, prevent cross grain bending-splitting of sill plate

Shear Wall Design Examples

- Segmented Shear Wall Approach
- Force Transfer Around Opening Approach
- Perforated Shear Wall Approach

Design Example

V = 3,750 lbs

Segmented Approach

V = 3,750 lbs

Do not consider contribution of wall below and above openings

Code Limitation

Height/width Ratio = 8:3.5
2wh = (2)(3.5)/8 = 0.875
Segmented Approach

1. Unit Shear
   \[ V = \frac{V}{L} = \frac{3,750}{15} = 250 \text{ lbs/ft} \]

2. Allowable Shear 3'-6" walls
   \[ v \text{ allowable} = 380 (0.875) = 332 \text{ lbs/ft} > 250 \text{ lbs/ft} \]
   \[
   15/32" \text{ Rated Sheathing 8d @ 4"o.c. at 3.5'} \text{ walls}
   \]

3. Allowable Shear 4' walls (2:1 h:w)
   \[ v \text{ allowable} = 260 \text{ lbs/ft} > 250 \text{ lbs/ft} \]
   \[
   15/32" \text{ Rated Sheathing 8d @ 6"o.c. @ 4'} \text{ walls}
   \]

4. Hold-down forces
   \[ H = vh = 250 \times 8 = 2,000 \text{ lbs} \]
   8 – hold downs @ 2000+ lb capacity

Note: For simplicity Dead Load contribution and various footnote adjustments are omitted

Force Transfer Approach

1. Only sheathing provides resistance to shear forces
2. Shear forces are uniformly distributed along the length of sheathing
3. Shear Wall rigidity is linear proportional to length of wall
4. Only framing members provide bending resistance
Perforated Shear Wall Approach

1. Unit shear in the wall
\[ v = \frac{3750}{15} = 250 \text{ lb/ft} \]

2. Percent of Full-Height Sheathed
\[ \frac{15}{26} = 0.57 \ (57\%) \]

3. Maximum opening height
\[ 2H/3 = 6'-8" \]

4. Co – Shear Resistance Adjustment Factor
\[ Co = 0.612 \text{ say } 0.61 \]

5. Adjusted Shear Resistance
\[ \text{allowable } V_{\text{allowable}} = 250 \times 0.61 = 262 \text{ lbs/ft} > 250 \text{ lbs/ft} \]

6. Uplift at Perforated Shear Wall ends (hold downs)
\[ H = \frac{250}{0.61} \times 8 = 3280 \text{ lbs} \]

7. In-plane Shear Anchorage
\[ H = 250/0.61 = 410 \text{ psf} \]

8. Uplift anchorage between shear wall ends
\[ t = 250/0.61 = 410 \text{ psf (at full segments only)} \]

9. Deflection is determined based on the deflection of any segment of the wall divided by \( C_o \)
Segmented Approach

15/32" Rated sheathing 8d @ 4" o.c. (3'-6" walls),
@ 6" o.c. (4' walls)

8 – hold downs @ 2000+ lb capacity

15/32" Rated Sheathing
8d @ 4" o.c.

2 – hold downs @ 1550 lb capacity

2 Straps – 1,250 lb

15/32” Rated Sheathing
8d @ 3” o.c.

2 – hold downs @ 3280 lb capacity

extensive plate anchorage

For More Information: APA Forms

Go to www.apawood.org and enter the publications store

The following publications expand on the information given in this presentation and can be downloaded for free using subject, title, or form number

APA Forms (www.apawood.org)

L350 – Diaphragms and Shear Walls

Examples of:
Shear Wall Design
Deflection Calculations

APA Forms (www.apawood.org)

Z350 – Subdiaphragms, low slope roof connections
L350 – Diaphragms and Shear Walls
X305 – Intro to lateral load design
T325 – Roof fastening for wind uplift
Y250 – Shear transfer at engineered floors
A410 – Roof retrofit for wind uplift

APA Forms (www.apawood.org)

TT-070 – Nail pullthrough
TT-045 – Min. nail penetration
TT-012 – Overdriven fasteners
TT-056 – Power driven fasteners
TT-058 – Slant nailing
TT-061 - Nailing thin flange I-joist
TT-074 – Portal frame for engineered applications
TT-076 – Double 2x in lieu of single 3x
TT-087 – Box v. Common nails in a shear wall
TT-075 – Green-dry shear wall framing

Suggested Reference

~ 1000 pages
Textbook format
Good coverage of shear walls and diaphragms
2006 IBC
Learning Objectives

• Load Path Continuity
• California Building Code Updates
• Shear Wall Design Alternatives

Questions/ Comments?

Karyn A. Beebe, P.E.
karyn.beebe@apawood.org (858) 560-1298 www.apawood.org