Advanced Framing & Structural Topics

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The American Dream... ?

Twice as Big
As they were in 1960

Account for 40%
Of all wood consumed in U.S.
What you don’t see...

- 20 trees of 20” dia. (1.5 acres of forest) needed to build one 2100 sq.ft home - NAHB
- 85% of California’s old growth redwood forests have been logged
Is worth respecting & protecting.
Delivery or Disposal?
Resource Use

- **Framing Factor**: percentage of surface area taken up with only wood
- What is the wall ‘framing factor’ for 16” framing?
  - Per 16” section and 8’-1” tall wall,
    \[ \frac{(3 \times 16 \times 1.5 + 92.5 \times 1.5)}{(16 \times 97)} \]
    \[ = 13.6\% \]
- … right?
What is the actual average “framing factor” for wood-framed homes nationwide?

- **25-27% (!)**
- Wasted resources
- Added cost: materials, labor & waste management
Energy Loss

- More wood = less insulation
- More cavities =
  - Harder to insulate
  - Harder to air seal
Advanced Framing:

- Systems approach to design, engineering, and construction of wood-framed structures that:
  - Minimizes wood use
  - Maximizes durability
  - Maximizes thermal efficiency…

- While maintaining structural integrity and meeting building codes
The purpose of structure:

- Provide shelter from the elements
- Carry gravity loads to foundation & ground
- Transfer lateral loads to foundation & ground
What’s related to structure?

- Site & foundation drainage
- Exterior finish assembly
- HVAC, plumbing & electrical
- Air tightness
- Insulation
- Fire safety
- Interior finishes
- Architectural design*
  *which comes first?
“Extreme” Advanced Framing:

- Every piece of wood is essential for:
  - Structural performance
  - Long-term durability
  - Energy efficiency
  - Serviceability
Applying Advanced Framing

1. Integrate energy efficiency in structural system design
2. Ensure durability in structural system
3. Optimize layout for efficient material use
4. Use structural-rated wood materials to their full approved capacities; eliminate structural materials where non-structural materials are adequate
Why Not Advanced Framing?

- Level of potential cost savings not realized.
- Connection between structure & energy performance not understood.
- Misunderstanding of what it is and how to apply it.
Advanced Framing Measures

1. Design & layout
2. Systems & materials
3. Framing techniques
Yep, size does matter.

- Since 1949, the square footage of housing per person has jumped how much in the U.S.?
  - **3.6 times** (214ft² to 769ft²)

- Sarah Susanka,
  - Not So Big House
  - [www.notsobighouse.com](http://www.notsobighouse.com)
  - Typically calls for building 1/3 less in square footage than homeowners think they need
Compactness

Building A
- 2 stories, 1600 sq.ft (20’x40’)
- Roof = 800 sq.ft
- Slab = 800 sq.ft
- Wall perimeter = 120 ft
- Wall area = 2400 sq.ft (wall ht = 20’)
- TOTAL ENVELOPE AREA = 4000 sq.ft

Building B
- 1 story, 1600 sq.ft (15’x40’ + 20’x20’ + 15’x40’)
- Roof = 1600 sq.ft
- Slab = 1600 sq.ft
- Wall perimeter = 280 ft
- Wall area = 2800 sq.ft (wall ht = 10’)
- TOTAL ENVELOPE AREA = 6000 sq.ft

50% More surface area
Simplicity = efficiency

- Excerpt from NRDC’s Efficient Wood Use in Residential Construction handbook:
  - “Design simply and elegantly. A great deal of wood and money is wasted on excess, such as unnecessarily complex roofs and applique decoration, instead of being invested in the design of timeless structures whose appeal relies on beautiful proportions and fine craftsmanship.”
Simplicity = durability

- Where does the water go?
- Are you confident with flashing details & installation quality?
Framing Greater than 16” o.c.

- 19.2” or 24”
## Size, Height & Spacing of Studs

### CBC Table 2308.9.1

<table>
<thead>
<tr>
<th>Stud Size</th>
<th>Supporting roof &amp; ceiling only</th>
<th>Supporting one floor, roof &amp; ceiling</th>
<th>Supporting two floors, roof &amp; ceiling</th>
</tr>
</thead>
<tbody>
<tr>
<td>2x4</td>
<td>24</td>
<td>16</td>
<td>Not permitted</td>
</tr>
<tr>
<td>3x4</td>
<td>24</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td>2x5</td>
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<tr>
<td>2x6</td>
<td>24</td>
<td>24</td>
<td>16</td>
</tr>
</tbody>
</table>

*Adapted from CBC Table 2308.9.1*
Modular Layout

- Lay out building on two foot module:
  - Maximize efficiency of 24 inch framing and 4x8 sheet goods
  - Reduce materials, labor & waste
  - Increase energy performance

- Keep plans simple
- Place openings on module
- Provide detailed framing elevs.
Openings Within Stud Module

HH6 @ TWO-STUD-BAY WINDOW OPENINGS TYP.

INSULATED HDR <= 4’ SPAN TYP. (3” RIGID EPS BETW 1 1/4 LVL)

2x2 BLOCKING @ WINDOW OPENING PERIMETER FOR STUCCO LATH NAILING TYP. (NOT DISPLAYED)

46 1/2 in TYP.

22 1/2 in TYP.

2x4 FLAT BLOCKING @ SINGLE STUDS @ EDGE OF 46 1/2" WINDOW OPENINGS (SEE DETAIL W/CALCS)

2'-0" TYP.

DOUBLE STUDS @ OPENINGS AND WALL ENDS AS RQD. FOR SHEAR WALL HD’s OR STRAPS TYP.

TYP. (ADVANCED) EXT. WALL FRAMING

One Sky Homes – Cottle Zero Energy Home
Goal: Passive House certification
“Extreme” Advanced Framing principles applied
CLAM Plan elements

34'-0" F.O. FRAMING

INSTALL HD ON WINDOW SIDE OF CONT POST. DO NOT INSTALL JACK STUDS.

INSTALL HD ON OUTSIDE OF INSET POST.

NO HDR REQ'D

(2) 2x6 HDR W/ HHG HANGERS

CLAM 2 House – Pt. Reyes Station
In-Line Framing

- Space studs, floor joists, & roof framing equally
- Allows for single top plate
- Provide *better* overall structural integrity
  - Holdowns closer to wall ends
  - Connectors req. less blk
  - Gravity loads align
Single Top Plate

- CBC 2308.9.2.1
  - “A single top plate is permitted, provided the top plate is adequately tied at joints, corners and intersecting walls... provided the rafters, joists or trusses are centered over the studs with a tolerance of no more than 1 inch”
Headers Sized for Load

- Rather than just one for worst-case scenario
- None where there’s no load!

Framing Techniques
Insulated Headers

- **Single Top PL**
- **Cripple Studs Aligned w/ Roof Rafters**
- **Insulated Header w/ Single Jack Stud or Header Hanger EA END**
- **XPS or High-Density Polyurethane Insulation**
- **Single 2x Sill OK for Spans up to 8', Toenail to King Studs (Jack Studs Not Req'd)**
- **Cripple Studs @ 24" O.C.**

**HEADER SECTION**

\[ 3/4" = 1'-0" \]
Header Hangers

- Jack/trimmer studs typically used to carry header loads
- Replace with framing anchors when appropriate
- Example products: Simpson HH4, HH6, LUC26Z
- PH considerations?
Open Wall Corners

- 3 or 4 studs typically used!
- Use 2-stud detail with non-structural backing to support drywall per CBC 2308.9.2.
  - Backing can be wood, specified sheathing or panel materials, and “other approved devices”
Drywall Clips

- The Nailer
  - www.thenailer.com

- Prest-on Corner-backs
  - www.prest-on.com

- Simpson DS (Drywall Stop)
  - www.strongtie.com
Ladder Framing

- Allows for insulation
- Provides nailing surface
YOU have the power!

- Designate goals at the start
- Clearly outline requirements of engineer & builder
  - Educate/bring in consultant
  - Put it in the contract!
- Communicate & collaborate
  - Subs too!
- Build in adequate construction administration
Engineer’s Role:

- **Design**
  - Work w/ architect (& builder) to optimize design
  - “Green” standard wood specs/notes
  - Size all headers, design insulated headers etc…

- **Drawings**
  - Show each stud (seriously)
  - Indicate where headers are *not* req’d
  - Provide standard Adv. Framing typ details etc…

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21. USE ADVANCED FRAMING TECHNIQUES WHERE APPROPRIATE, SUCH AS:

a. Design opening widths with regard to standard stud spacing module, and align rough openings with standard stud placement.
b. At typical wall corners, install only two studs with ladder blocking, wood spacers, drywall clips, or other approved backer materials for attachment of drywall or other finishes.
c. At non-bearing locations, do not install structural headers.
d. Install headers with framing anchors and no jack studs.
e. Install single-member headers or use rim members as headers.
f. Install insulated headers (site-built or manufactured by Ray-core Inc or equal).
g. Install single top plates, splice over studs within one inch of center and tie with LTF5 plate, coordinate longer studs as req’d.
Advanced Framing Resources

Using Wood Efficiently: From Optimizing Design to Minimizing the Dumpster

Research Report - 0201
2002 August by Steven Baczek, Peter Yost and Stephanie Finegan, Building Science Corporation

Abstract:
Americans have been building homes with wood—shaping logs, joining timbers, nailing studs—for almost 400 years. Our current approach, stick framing, grew popular in the mid-1800’s (particularly in the rapidly growing “West”) because it took less skill, required simpler tools, and took fewer people than timber framing. We apparently really like waste haulers, too. The NAHB Research Center reports that the “typical” home generates about 3,500 pounds of wood waste during its construction, about half of which is solid sawn lumber.

www.buildingscience.com/documents/reports

Efficient Wood Use in Residential Construction handbook:
www.nrdc.org/cities/building/rwoodus.asp
Advanced Framing Philosophy

- Do more with less.
- Save money and be more comfortable.
- Honor every tree
Structure vs. Passive House

- Holdowns, holdowns everywhere!
- Collectors, collectors everywhere!
- Continuous joists & framing assemblies
- Monolithic slabs; slabs doweled into stem wall
In-Line Holdowns

- Install in tight spaces
- Provide more insulation
- Simpson HDC series:
  - ⅝” anchor bolt: 4870# cap.
  - ⅞” anchor bolt: 9665# cap.
  - Post: (2) 2x4 or (1) 4x4
- Use in 2x6 or wider wall= Passive House friendly!
Perforated Shear Walls

- Slightly reduced shear capacity allows for:
  - Holdowns at each end of shear wall only
  - Less blocking & straps
  - (more insulation 😊)

Figure 1: The segmented shearwall.

Figure 2: The perforated shearwall. Only two hold-downs are required.
Perforated Shear Wall Resources

- Perforated Shear Wall Design (American Forest & Paper Association guideline document, .pdf)

- Perforated shear wall research & performance (NAHB & HUD)
Thermal Boundary
Air Tightness Detailing

Top Plate with Unconditioned Space Above

Ceiling insulation
Taped joint
Air seal (caulking, adhesive or gasket)

Penetrations through top plate must also be sealed

Building Science Corp.

INTERIOR SHEAR WALL

3/4" = 1'-0"
Rim Joist

- Another weak link in thermal envelope

Intersection of Floor Joists and Exterior Wall

- Air seals (caulking, adhesive, or gasket)
- Drywall sealed to top and bottom plates
- Bottom plate sealed to subfloor
- Subfloor sealed to rim closure board
- Rim closure board sealed to top plate
Make Garage-Home Airtight

- Minimize heat loss
- Isolate pollutants
- **Best:** discontinuous joists w/ end blkg
- If continuous, non-I-joists easier to block & airseal

*No gaps at ends*
Floor Framing Separation

- A: only need to seal at top & bottom of rim
- B: need to seal every edge of blocking

A: only need to seal at top & bottom of rim
B: need to seal every edge of blocking

Nail Boise Rimboard to BCI® Joists with 8d nail into each flange.

BCI® Joist blocking.
Quiz:

Rate these in order of which causes the most monetary damage to homes in the U.S.:

- Earthquakes
- Fires
- Storms/hurricanes/tornadoes
- Termites

$5 billion
Termite Infestation Probability

- 2000 Int’l Residential Code Figure R301.2(6)
Termite Defense #1: Keep them out!

- Manage water
- Provide 12” from grade to bottom of exterior finish
- Keep landscaping 3’ away

Oregon Caves Chateau – Jesse Stryker
Termite Defense #1: Keep them out!

- Install termite shields
- Seal penetrations

Termimesh/Termistop
Termite Defense #2: Deter

- Reduce use of wood
- Use treated wood products
  - Lowest 3 feet of wood area
  - Termite-unfriendly products:
    - Bora-Care, www.nisuscorp.com
    - BOR-RAM, www.sostram.com
    - BluWood, www.conradfp.com
    - TimberSil, www.timbersilwood.com
Protective Overhangs

- Shade windows and keep water off
- 2’ overhangs typically work well throughout CA
Water Defense #1: Keep it off!

Figure 4.1 - Frequency of Moisture Problems in Walls of Selected Buildings in a Moist, Cool Climate
(Climatic Index of approximately 70 based on Figure 4.3)

Source: Morrison Hershfield Limited, Survey of Building Envelope Failures in the Coastal Climate of British Columbia, Canada Mortgage and Housing Corporation, Burnaby, BC, Canada, 1996. Figure is based on a selection of 46 buildings of up to eight years old, three to four stories, wood-frame, with various wall claddings. Fifty percent of walls with problems used direct-applied stucco cladding over building paper and oriented strand board (OSB) wood panels.
Reduce thermal bridging & save concrete
CLAM Foundation Detailing

2x6 PT SILL. INSTALL 5/8" ANCHOR BOLTS @ 48" O.C. W/ 7" EMBEDMENT.

1 3/4" MIN EDGE DISTANCE

1'-0" MIN BELOW UNDISTURBED SOIL

1'-0" MIN ABOVE FIN GRADE

6" REINF CONC SLAB - SEE NOTES

RIGID INSULATION - SEE ARCH

4" BASE OVER COMPACTED FILL - SEE NOTES

#4@ 16" HORIZ

#4@ 18" VERT

2-#4 CONT BARS BOTTOM

3/4" = 1'-0"

TYP FOUNDATION FOOTING
Successful Collaboration

- Identify project goals & incorporate into CDs.
- Assemble quality team—and educate them.
- Identify and assign “gray area” roles. WHO is accountable for WHAT?
- Who needs to be consulted when?
- How will accountability be measured or verified?
Putting it all together:

- *Keep plans simple!*
- Ensure everyone understands goals
- Collaborate with engineer, builder & subs
- Draw the thermal boundary
- Work your way around and detail potential problem areas
- Require mockups
- Enforce accountability
Questions...