Structural Implications of Mounting Solar Panels on a Residential Wood Structure
Thank you Andrea Luecke, the City of Milwaukee, WE Energy, Attendees, and the US Department of Energy for the opportunity to present this material.

Regardless of how one may quantify the benefits of renewable energies it is our duty as engineers, installers, and code officials to take into account all aspects of the installation. This includes the impact on the existing structure. This material should, at the very least, make one aware of the potential to do harm and instill the need to address the building structure.

William H. Lindau, P.E.
Lindau Companies, Inc.
Hudson, Wisconsin
715-386-4444

The following information, calculations, drawings, and conclusions are part of an educational seminar intended to present a process. No claim is being made as to their accuracy or relevance as errors have been discovered since their creation. In addition no information should be taken from the drawings, tables or code excerpts due to the potential for them to be incomplete, out of date, or still under development. Consult your local building official for the current and complete information.
Objectives & Scope

To present the process by which a structural engineer might evaluate a building's ability to support solar hot water or photovoltaic equipment.

To provide examples of drawings and calculations that could be an important part of the permitting process.

William H. Lindau, P.E.
Lindau Companies, Inc.
Hudson, Wisconsin
715-386-4444

Limited to:
Residential structures as defined and governed by the Uniform Dwelling Code of Wisconsin Administrative Code (UDC)

Flush mounted flat solar panels
Photo Voltaic
Solar Hot Water
Wood Construction
Simple Trusses or Rafters

The calculations and drawings presented here have not been checked and could contain errors.
Today’s presentation is intended to provide a process from which a determination can be made as to a building’s ability to support solar equipment. This process can incorporate many complicated mathematical calculations and the designer should be aware of their own, as well as their insurance policies, limitations:
Based on my review and conversations with building officials:

• Calculations may be required by a building official but they do not need to be created by a registered professional engineer.

• UDC can be interpreted and a permit application submitted by a contractor, designer or owner

• For all new construction, the Code must be satisfied as a minimum

• Existing construction that does not meet the minimum code requirements is not required to be brought within compliance but no increased or new loads can be imparted on it.

• Structural elements that do not conform to the Code cannot be modified in such a way that decrease their strength.
Wisconsin Administration Code

- Become familiar with the entire Code – it can only help you
  www.legis.state.wi.us/rsb/code/comm/comm020.html
- Typically Chapters 20, 21 and the appendices are the most applicable
- “Work shall be done in a workmanlike manner”
- Become familiar with all structure affected by installation of solar equipment
- Follow load path through foundation
- Don’t apply additional loads to non-Code compliant, damaged, or questionable structural elements without providing adequate reinforcement
Uniform Dwelling Code of the Wisconsin Administrative Code (UDC)

- Most of the information needed is located in Chapter 21 and Appendices
Uniform Dwelling Code of the Wisconsin Administrative Code (UDC)
Uniform Dwelling Code of the Wisconsin Administrative Code (UDC)

- Snow load reduction for roof slope
- Review all of the Code, it can only help
Uniform Dwelling Code of the Wisconsin Administrative Code (UDC)
Uniform Dwelling Code of the Wisconsin Administrative Code (UDC)

- Note limitations of table
- Snow load reduction
Uniform Dwelling Code of the Wisconsin Administrative Code (UDC)

How to choose a table:
1) Rafter or Floor
2) Loads
3) Ceiling covering and deflection requirements
4) Roofing weight
   • “Light” roofing < 10 psf

<table>
<thead>
<tr>
<th>Table No.</th>
<th>Member Type</th>
<th>Live Load (psf)</th>
<th>Dead Load (psf)</th>
<th>Condition</th>
<th>Deflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-2</td>
<td>Floor Joists</td>
<td>40</td>
<td>10</td>
<td>–</td>
<td>L/360</td>
</tr>
<tr>
<td>C-1</td>
<td>Ceiling Joists</td>
<td>10</td>
<td>5</td>
<td>Drywall ceiling, no attic storage</td>
<td>L/240</td>
</tr>
<tr>
<td>C-2</td>
<td>Ceiling Joists</td>
<td>20</td>
<td>10</td>
<td>Attic storage</td>
<td>L/240</td>
</tr>
<tr>
<td>R-2</td>
<td>Roof Eaters</td>
<td>30 (Zone 2)</td>
<td>10</td>
<td>Maximum 2 layers of asphalt shingles or wood shakes/shingles</td>
<td>L/240</td>
</tr>
<tr>
<td>R-3</td>
<td>Roof Eaters</td>
<td>40 (Zone 1)</td>
<td>10</td>
<td>Maximum 2 layers of asphalt shingles or wood shakes/shingles</td>
<td>L/240</td>
</tr>
<tr>
<td>R-10</td>
<td>Roof Eaters</td>
<td>30 (Zone 2)</td>
<td>20</td>
<td>Heavy roof covering (clay tile)</td>
<td>L/240</td>
</tr>
<tr>
<td>R-11</td>
<td>Roof Eaters</td>
<td>40 (Zone 1)</td>
<td>20</td>
<td>Heavy roof covering (clay tile)</td>
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<tr>
<td>R-14</td>
<td>Roof Eaters</td>
<td>30 (Zone 2)</td>
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<td>Maximum 2 layers of asphalt shingles or wood shakes/shingles</td>
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<td>20</td>
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</tr>
<tr>
<td>R-23</td>
<td>Roof Eaters</td>
<td>40 (Zone 1)</td>
<td>20</td>
<td>Heavy roof covering (clay tile)</td>
<td>L/180</td>
</tr>
</tbody>
</table>

*Deflection criteria are optional. For roof rafters with drywall on the underside, use the stricter L/240 tables to limit deflection.

Example 1. Floor Joists. Assume a required single span of 12'–9", dead load of 10 psf and joists spaced 16" on center. Table F-2 (see following highlighted tables) shows that one solution is a grade of 2x8 having an Fb value of 1255 would allow a span of 12'–10" which satisfies the condition. (Note that the recommended E value to limit deflection would be 1,900,000.) Going to the Design Value Tables, we find that as an example, 2x8 Hem Fir grade No. 1 has an Fb value of 1310 for normal duration. (It also has an E value of 1,500,000 which does not satisfy the recommended deflection criteria.)

Example 2. Rafter. Assume a horizontal projected span of 13'–0", a live load of 40 psf, dead load of 10 psf, a roof slope of 4/12 and rafters spaced 15" on center. Since the slope is shallower than 7/12, there is no allowable reduction of the snow live load. Table R-3 shows that a 2x8 having an Fb value of 1300 would allow a span of 13'–1", which satisfies the condition. (Note that the recommended E value to limit deflection would be 1,200,000.) Going to the Design Value Tables, we find that as an example, 2x8 Douglas Fir–Larch grade No. 2 has an Fb value of 1390 for snow loading. (It also has an E value of 1,500,000 which satisfies the recommended deflection criteria.)
Uniform Dwelling Code of the Wisconsin Administrative Code (UDC)

- Use Table R-14 – 30 psf LL 10 psf DL
- 2 x 6 @ 16” o.c. 10'-0” span
- \( F_b = 1100 \text{ psi} \) \( E = 0.69 \times 1,000,000 = 690,000 \text{ psi} \)

- Locate member size, spacing and span
- Follow up to \( F_{b,\text{min}} \) and down to \( E_{\text{min}} \)
Uniform Dwelling Code of the Wisconsin Administrative Code (UDC)

- Note range in values
- Unless the lumber is stamped with grade and species, use SPF (South) and verify No. 2 grade per the following information
Methods for Evaluating a Structure

Simplified method (compare new to existing):
- Determine original design loads of an existing structure and verify conformance to the current building code
- Determine and account for changes to roof loads due to the installation of solar equipment
  - Live loads
  - Snow loads
  - Dead loads
  - Other loads per building code
- Make comparison between the structure as originally designed and the structure after the solar equipment has been installed.

More detailed method of evaluation:
- Perform complete structural analysis and review of all structural elements affected by the installation and make a determination as to their adequacy
  - Includes the analysis of members, their connections, bearing condition, and stability,
  - Follows loads through the foundations
  - Used when the simplified method cannot be performed, is not conclusive, or yields unfavorable results and reinforcing the structure is not easily accomplished.
  - Removes any doubt of adequacy and grey areas
  - Usually performed by a Structural Engineer.

Only the simplified method is included in this presentation.
Information required for evaluation

Original building construction documents or as-built drawings noting:
• Roof construction
  • Rafter size, species, grade, span, and spacing
  • Truss design literature
  • Roof sheathing thickness and type
  • Roofing material and composition
  • Ceiling location and composition
• Any other elements affected by installation
  • Typical elements include walls, headers, beams, and foundations.
• Missing or incomplete data requires the designer/reviewer to take a conservative approach and could delay permitting process

Solar equipment specifications and layout including:
• Weights of all equipment and their distribution
• Locations of all equipment and supports

Current and applicable code and standards
• Uniform Dwelling Code of the Wisconsin Administrative Code
• Additional design references as applicable
TRUSSES
Structural elements consisting of multiple members orientated in triangular patterns
Original truss design documents, created by the manufacturer, are needed to utilize the simplified method of evaluation.

RAFTERS
With room within attic space
  • Can be complicated and are outside the scope of this presentation.
Without room in attic space
  • Simple spans that can be evaluated with the use of UDC
Example 1 – Flush Mounted Solar Hot Water
Flashed Into Roofing – NO RAILS – Rafter Roof

Example 2 – Flush Mounted Solar Hot Water
Flashed Into Roof – NO RAILS – Truss Roof

Example 3 – Flush Mounted PV System
Supported by Rails – Rafter Roof

Example 4 – Flush Mounted PV System
Supported by Rails – Truss Roof
Example 1 – Flush Mounted Solar Hot Water Flashed Into Roofing – NO RAILS – Rafter Roof

1. Check adherence to current building code
   a. Tabulate dead loads
   b. DL<10 psf or 10<DL<20 psf
   c. Check UDC tables

2. Tabulate new loads
   a. Solar panel weight
   b. Removal of roofing

3. Make comparison & judgment
   (Creating moment and shear diagrams may be helpful if member capacity is borderline)
Example 1 – Flush Mounted Solar Hot Water Flashed Into Roofing – NO RAILS – Rafter Roof

- Panels consist of (3) 72”x54” 141lb SHW bearing directly on roof sheathing.

- Roofing material is removed at panel

- Panel sits directly on roof sheathing and is supported on all sides

- Flashing is installed around panels
Example 1 – Flush Mounted Solar Hot Water Flashed Into Roofing – NO RAILS – Rafter Roof
Example 1 – Flush Mounted Solar Hot Water Flashed Into Roofing – NO RAILS – Rafter Roof

- Rafter
- Zone 2 = 30 psf
- No ceiling thus L/180 deflection requirement
- “Light” roofing < 10 psf
- Table R-14
Example 1 – Flush Mounted
Solar Hot Water Flashed Into
Roofing – NO RAILS – Rafter
Roof

- Use Table R-14 – 30 psf LL 10 psf DL
- 2 x 6 @ 16” o.c. 10’-0” span
- Fb = 1100 psi  E = 0.69 x 1,000,000=690,000 psi

- Locate member size, spacing and span

- Follow up to Fb_{min} and down to E_{min}
Example 1 – Flush Mounted Solar Hot Water Flashed Into Roofing – NO RAILS – Rafter Roof

- Note range in values
- Unless the lumber is stamped with grade and species, use SPF (South) and verify No. 2 grade per “Identifying #2 Structural Framing” (attached).
Example 1 – Flush Mounted Solar Hot Water Flashed Into Roofing – NO RAILS – Rafter Roof

- Weights of building materials should be calculated for each job based on a thorough examination of the building
- Exercise in unit conversion
Example 1 – Flush Mounted Solar Hot Water Flashed Into Roofing – NO RAILS – Rafter Roof

- Always provide manufacturer’s product specification that include the product weights with the permit application

<table>
<thead>
<tr>
<th>Measurements (inches)</th>
<th>Width</th>
<th>Weight</th>
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<tr>
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<tr>
<td>Clear day</td>
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<tr>
<td>Cloudy day</td>
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<td>6</td>
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<tr>
<td>Mildly cloudy day</td>
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<td>10</td>
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<td>Thermal performance rating - cool climate (1000s Btu/day)</td>
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<tr>
<td>Clear day</td>
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<td>2</td>
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<tr>
<td>Cloudy day</td>
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<td>a2 (Btu/hr*ft2°F2)</td>
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<td>0.0020</td>
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<td>Structural performance design pressure (DP)</td>
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<td>Downward load (psf)</td>
<td>-60</td>
<td>-70</td>
<td>-875</td>
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<tr>
<td>Uplift load (psf)</td>
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<td>-70</td>
<td>-875</td>
<td>-65</td>
</tr>
</tbody>
</table>

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Example 1 – Flush Mounted Solar Hot Water Flashed Into Roofing – NO RAILS – Rafter Roof

- As the panel is tilted upward, the lbs/sq ft applied to the horizontal projection of the roof increases even though the panel weight does not change.
Example 1 – Flush Mounted Solar Hot Water Flashed Into Roofing – NO RAILS – Rafter Roof

- Determine area load of system (psf)
- Area is comprised of system dimensions

\[ \text{Distributed Load} = \frac{423 \text{#}}{70.8 \text{ ft}^2} = 5.97 \text{#/ft}^2 \]
Example 1 – Flush Mounted Solar Hot Water Flashed Into Roofing – NO RAILS – Rafter Roof

• Already determined the live load requirement is satisfied

• Verify that the dead loads (“DL”) are not in excess of 10 psf

• If DL > 10 psf, further evaluation utilizing shear & moment calculation is needed
Example 2 – Flush Mounted Solar Hot Water Flashed Into Roof – NO RAILS – Truss Roof

1. Determine original construction design loads
   a. Manufacturer supplied calculations
   b. Engineering analysis
   c. Original documents

2. Tabulate new loads
   a. Solar panel weight
   b. Removal of roofing

3. Make comparison & judgment
   Same process as Example 1
1. Check adequacy of existing rafter
2. Determine maximum allowable moment and shear ("M" and "V") of existing member based on UDC tables (using span & loads from tables)
3. Determine new load amounts & configuration on each rafter
4. Calculate new moments & shear diagrams and compare to maximum allowable moment and shear.
   
   If: \( M_{\text{new}} < M_{\text{allow}} \quad \text{OK} \)
   \( V_{\text{new}} < V_{\text{allow}} \quad \text{OK} \)

   If not: possibly add more supports or reinforce roof
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

BUILDING CODE
UNIFORM DWELLING CODE OF THE
WISCONSIN ADMINISTRATIVE CODE

DESIGN LOADS:

SNOW LOAD: ZONE 2 - 30PSF

SNOW LOAD SLOPE ADJUSTMENT:
COMM 21.27-1(c)

Cs=1-(a-30)/40

WHERE:
Cs=SNOW LOAD MULTIPLIER
a = ROOF SLOPE (PITCH OF 7-12 = 30DEG)

Cs = 1-(33.69-30)/40
Cs = 0.91

SNOW LOAD FROM MAP = 30PSF ZONE 2
REDUCED SNOW LOAD FOR SLOPE = 30x0.91=27.30psf

DEAD LOADS:

IN PLANЕ

HORIZONTAL
PROJECTION

ROOFING (ARCH) 2.7psf 3.2psf
½“ SHEATHING (OSB) 2.0 psf 2.4psf
(s/b 2x8)
2X6 RAFTER(2.1PLF/2FT O.C.) 1.05psf 1.3psf
TOTAL DEAD LOAD: 5.75psf 6.90psf

SOLAR PANEL LOADS:
4’-6” X 3’-4” = 15 SQ FT PROJECTED PANEL AREA

SL = 15X27.3 = 409 LBS OF SNOW (REDUCED FOR SLOPE)
DL PANEL = 44 LB
DL RAIL = 1PLF
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

- Many structural design manuals have beam diagrams and formulas for various static loading conditions such as $M_{\text{max}} = \frac{WL^2}{8}$
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

- The rail reactions shown here have been computed by the use of analysis software because the rail is continuous over its supports and indeterminate to solve
Example 3 – Flush Mounted PV System on Rails – Rafter Roof
Example 3 – Flush Mounted PV System on Rails – Rafter Roof
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

RAIL ELEVATIONS
RAILS SUPPORTED AT 48" O.C.

RAIL 1 ELEVATION

RAIL 2 ELEVATION

NOTE: REACTIONS INCREASE DRAMATICALLY IF RAILS ARE CANTILEVERED.
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

• Approximate methods include:

  a. Dividing the load among the tributary areas of its supports

  b. Treating all spans as simple spans and using summation of moments and the summation of forces in the vertical direction to solve for the reactions

• A conservative approach should be taken when using approximate methods
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

Simple Spans: single beam supported at each end (also works for simple cantilevers with some challenges)

- Find $R_B$ by summing moments about support $A$
- Find $R_A$ by summing vertical forces
- Chart shear
- Area under shear ("V") curve as one moves from left to right creates the moment ("M") curve
- The slope of the Moment curve at any point represents the rate of change in shear
- Moment curve changes direction where shear curve crosses axis
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

- Compare resulting maximum Moments and Shears to the design Moment and Shears.
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

Start the analysis with the rafters supporting the most load and similar members with less load and the same load configuration can be evaluated by comparison.
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

Simple Spans: single beam supported at each end (also works for simple cantilevers with some challenges)

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- Find $R_B$ by summing moments about support $A$
- Find $R_A$ by summing vertical forces
- Chart shear
- Area under shear (“V”) curve as one moves from left to right creates the moment (“M”) curve
- The slope of the Moment curve at any point represents the rate of change in shear (V)
- Moment curve changes direction where shear curve crosses axis
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

Start the analysis with the rafters supporting the most load and similar members with less load and the same load configuration can be evaluated by comparison.

- Do not assume that because the member satisfies the moment criteria that it will satisfy the shear criteria.
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

2X ROOF RAFTER @ 24"

AT CLIPS WITHIN FIELD ONE PANEL REACTION TO RAIL EQUALS:
P = (409+44)/4 SUPPORTS = 113LB
FOR BOTH PANELS:
P = 113x2=226LB

AT EDGE CLIPS PANEL REACTION TO RAIL EQUALS:
P = (409+44)/4 SUPPORTS = 113LB

1 PLF RAIL
44LB SOLAR PANEL

CENTER LINE OF RAIL

ROOF PLAN
RAILS SUPPORTED AT 24in O.C.
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

RAIL ELEVATION

RAILS SUPPORTED AT 24" O.C.

REATIONS TO ROOF ARE REDUCED TO THE MAGNITUDES PROVEN ACCEPTABLE IN THE REVIEW OF RAFTER 1 MOMENTS AND SHEARS
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

ROOF PLAN
RAILS SUPPORTED AT 48in O.C. - TRANSFER MEMBERS BETWEEN RAFTERS
Example 3 – Flush Mounted PV System on Rails – Rafter Roof

RAIL ELEVATION

RAILS SUPPORTED AT 48" O.C.
WITH TRANSFER MEMBERS INSTALLED BELOW

RESULTING LOADS TO RAFTERS IS ALMOST THE SAME AS IF THE RAILS WERE SUPPORTED AT 24in O.C.
1. Determine original construction design loads
   - Manufacturer supplied calculations
   - Engineering analysis
   - Original documents
2. Calculate rail reactions, load configuration, and tabulate dead loads
   - If rail reactions fall between nodes, determine maximum moment (M) and shear (V) of members directly supporting rails OR
   - If rail reactions fall at nodes, determine reactions at truss nodes affected
3. Make comparison & judgment
Review of Trusses:

- Capacities are determined through a lengthy process
- Usually performed by a truss supplier
Example 4 – Flush Mounted PV System on Rails – Truss Roof

Divide top chord into simple spans and use summation of moments and summation of vertical forces to determine M and V
Example 4 – Flush Mounted PV System on Rails – Truss Roof

Trusses are ideally loaded at nodes / panel points.
Example 4 – Flush Mounted PV System on Rails – Truss Roof

Courtesy of Alan Harper
Plan Review Specialist III
City of Madison
Building Inspection

Reinforcing roof system great simplifies the approval process

CRITERIA FOR SIMPLIFIED APPROVALS OF ROOFTOP SOLAR COLLECTOR INSTALLATIONS ON TRUSSES

The method shown below is approved as an acceptable method for supporting a solar installation on a trussed roof. The following criteria must be met for this system.

1) The truss spacing must not exceed 24 inches on center.
2) A minimum of 4x4 lumber is used as a brace between trusses.
3) The brace is within 12 inches of a panel point on the top chord of the truss.
4) The support legs for the solar installation are lag or thru-bolted to the brace.
5) The brace is attached to the trusses with mechanical fasteners (hangers) sized to carry the required uplift and down loads.

Notes:

1. A panel point is where the webs meet the chord. There is a truss plate at this location and it is the best location to install the brace. The mangers can be nailed through the truss plates.
2. Several manufacturers make face-mount hangers that are suitable for this installation. Hangers similar to the one shown in the diagram have a capacity of approximately 280 pounds each. If two are installed at each end, this gives a capacity of 1,120 pounds for this support.
Example 1 – Flush Mounted Solar Hot Water
   Flashed Into Roofing – NO RAILS – Rafter Roof
   ▪ Evenly distributed loads are usually within the dead load capacity of the roof system

Example 2 – Flush Mounted Solar Hot Water
   Flashed Into Roof – NO RAILS – Truss Roof
   ▪ Evenly distributed loads are usually within the dead load capacity of the roof system

Example 3 – Flush Mounted PV System
   Supported by Rails – Rafter Roof
   ▪ Depending on the rail support configuration point loads can easily be in excess of the roofs capacity.
   ▪ Distributing these loads over members at 24” will almost always be acceptable

Example 4 – Flush Mounted PV System
   Supported by Rails – Truss Roof
   ▪ Attachment or distribution to truss panel points/nodes may be necessary
Grading Existing Lumber

#2 Structural Framing


Courtesy of Alan Harper
Plan Review Specialist III
City of Madison
Building Inspection

IDENTIFYING #2 STRUCTURAL FRAMING

“Old lumber so much better than new lumber.” We hear this or a similar quote quite often. However, is this true and, whether or not it is true, can reasonable structural design values be found for old installed lumber? To answer the first part, old lumber often came from older growth trees. It is typically denser and “looks better” because it often came from the denser and more consistent center of the tree. On the other hand, these trees were not groomed the way new lumber trees are so many times large knots from large branches are found in the board and sometimes the grain curves and becomes perpendicular to the length of the board. Both of these defects can severely weaken the board.

Other problems with older wood occur from aging. As the wood ages the cells break down. Depending on atmospheric conditions and the presence of insects, mold, and fungi, this breakdown can be slow to rapid.

The question that needs to be answered is, “Just how good the wood in this building?”

Often in older homes construction lumber has no grade stamp because the lumber was installed prior to the practice of lumber grading. Reasonable structural properties may still be obtained for this lumber by comparing it to values used for commonly used current construction lumber.

The most common “typical” lumber used in Wisconsin is #2 SPF. Structural properties for this grade and species of lumber can be found in the National Design Specification For Wood Construction published by the American Wood Council.

By comparing the observations of the installed lumber in the field to the following criteria for #2 structural framing, a determination can be made whether or not the installed lumber meets these criteria. If the installed lumber meets these criteria, the design values can be taken as those for #2 SPF.

Without the observer being rigorously trained in lumber grading, a higher grade should not be assumed. If the installed lumber does not meet the criteria shown here, the pieces not meeting the criteria should be assumed to have no structural value.
Grading Existing Lumber

#2 Structural Framing


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Grading Existing Lumber

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Slope of grain:

Criteria for #2 grade: Maximum 1 in 8

Splits: A separation of the wood through the piece to the opposite surface or to an adjoining surface due to the tearing apart of the wood cells.

Criteria for #2 grade: Equal in length to 1-1/2 times the width of the piece.

Unsound wood (excluding white speck):
Criteria for #2 grade: Not permitted in thicknesses over 2”. In 2” lumber, small spots or streaks of firm honeycomb or peck are limited to 1/6 the width. Any other unsound wood is limited to a spot 1/12 the width and 2” in length or equivalent smaller areas. Honeycomb: A cellular separation that occurs in the interior of a piece of wood, usually along the wood rays. Peck: Deterioration and softening caused by fungus. White speck: A fungal organism that invades living softwoods but ceases to develop once the tree is cut. Lumber grading generally considers it a “cosmetic defect” and it may be found in framing lumber.

Wane: Bark or lack of wood from any cause, except eased edges, on the edge or corner of a piece of lumber.

Criteria for #2 grade: 1/3 the thickness and 1/3 the width full length, or equivalent on each face, provided that wane not exceed 2/3 the thickness or 1/2 the width for up to 1/4 the length.

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Questions/Discussions
Structural Implications of Mounting Solar Panels on a Residential Wood Structure

April 30, 2010