GUIDELINES
FOR
SPECIAL INSPECTION OF WOOD CONSTRUCTION

Prepared by
SEAONC Construction Quality Assurance Committee
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Guidelines for Special Inspection of Wood Construction

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# GUIDELINES FOR SPECIAL INSPECTION OF WOOD-FRAMED CONSTRUCTION

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GUIDELINES FOR SPECIAL INSPECTION OF WOOD-FRAMED CONSTRUCTION

Preface

This document was developed by the Structural Engineers Association of Northern California (SEAONC) Construction Quality Assurance Committee. The purpose of this document is to provide guidance to structural engineers, special inspectors, building officials, and others in the construction industry in the use and interpretation of the special inspection provisions for wood-framed construction specified in the 2013 California Building Code, published by the State of California, Department of General Services, Building Standards Commission.

Local building jurisdictions and State agencies may have additional special inspection and testing requirements for wood-framed construction that are not discussed in this document. The reader is urged to confirm the applicable special inspection and testing requirements with the building official with jurisdiction over the specific project.

It should be noted that the suggestions, recommendations, and commentary discussed in this document are offered in an advisory capacity only and reflect the opinion solely of the authors. This document is not intended to define a standard of practice or to serve as a building code.
GUIDELINES FOR SPECIAL INSPECTION OF WOOD-FRAMED CONSTRUCTION

I. INTRODUCTION

Up until the 2006 International Building Code (IBC) the code requirements for special inspection of wood light-framed construction were limited solely to high-load diaphragms and fabricated members. Review of the wood light-framed construction outside of this work was typically done through structural observation and inspections by building officials, where the scope was limited and to a degree undefined. The scope of structural observation was not extensive and thorough enough to be considered special inspection as defined by the Code. The 2006 IBC, which was adopted into the 2007 California Building Code (CBC), introduced special inspection requirements for all the elements of the seismic and wind force-resisting system in wood-framed structures where the fastener spacing in the horizontal diaphragms and/or the vertical shear walls is 4 inches and less. In these cases, special inspection is now required for all wood framing that resists seismic forces, including diaphragms, drag members, chord members, and shear walls. This code also expanded the special inspection provisions for manufactured items to include selected wood elements and assemblies and brought the special inspection requirements for high-load diaphragms from the manufacturer’s evaluation report into the code.

There are recognized certification programs for special inspectors performing steel welding inspection, concrete sampling and testing, and masonry inspection among others. There is, however, no comparable certification that can provide a basis for qualification of inspectors for wood framing. This lack of an inspector certification program makes it difficult for building officials and the testing and inspection agencies to determine the qualifications of the inspectors for wood-framed construction. However, the CBC requirements for special inspection of wood framing requires special inspectors to learn how to inspect wood framing, building officials to determine the qualifications of wood special inspectors, and structural engineers to learn how to specify special inspections.

Special inspection of wood-framed construction could entail inspecting a large number of elements, which could pose a daunting challenge to the special inspector and result in a significant increase in the inspector’s scope of work. To help focus the special inspection towards the elements that are critical to the performance of the building and are the intended focus of the code requirements, the engineer should specify on the construction documents the elements that require special inspection and the criteria for inspection of those elements. The more specific the engineer’s specification is, the easier it will be for the special inspector to do his or her work. Please see Appendix B for further discussion on specifying special inspection of wood-framed construction.

These Guidelines are intended to help engineers and inspectors perform detailed inspection of wood framing and to help inspectors understand the intent of the engineer’s design and detailing. Contractors and framers with an interest in quality control will benefit by knowing what the inspector will be looking for. The Guidelines are applicable to both new and retrofit construction.
There are a significant number of commercial, residential, industrial, and office buildings and education facilities in California that are constructed with wood framing. Thus the potential for loss of use of these buildings in an earthquake is a major public policy concern. These Guidelines hope to lessen that potential loss by improving quality assurance and quality control under which wood-framed buildings are constructed. As the primary focus of the special inspection requirements for wood construction is on lateral forces (earthquake and wind), this document includes a discussion of how a wood shear wall building transfers and resists lateral forces through the connections and fastening of the various parts of the building from the roof down to the foundation.

II. WOOD SPECIAL INSPECTIONS – GENERAL DISCUSSION

Requirements for non-seismic/wind special inspections for wood-framed construction are in CBC Section 1705.5, which is reproduced below:

1705.5 Wood Construction. Special inspection of the fabrication process of prefabricated wood structural elements and assemblies shall be in accordance with Section 1704.2.5. Special inspections of site-built assemblies shall be in accordance with this section.

1705.5.1 High-load diaphragms. High-load diaphragms designed in accordance with Section 2306.2 shall be installed with special inspections as indicated in Section 1704.2. The special inspector shall inspect the wood structural panel sheathing to ascertain whether it is of the grade and thickness shown on the approved building plans. Additionally, the special inspector must verify the nominal size of framing members at adjoining panel edge, the nail or staple diameter and length, the number of fastener lines and that the spacing between fasteners in each line and at edge margins agrees with the approved building plans.

1705.5.2 Metal-plate-connected wood trusses spanning 60 feet or greater. Where a truss clear span is 60 feet (18288 mm) or greater, the special inspector shall verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

The reference to Section 1704.2.5 in Section 1705.5 points to the typical requirements for special inspection of fabricated items. The “site-built assemblies” alluded to include only the high-load diaphragms and the truss bracing referenced. See Section III for a more detailed discussion.

In Seismic Design Categories C, D, E, or F, additional special inspections are required in accordance with CBC Section 1705.11.2, which is reproduced below:

1705.11.2 Structural wood. Continuous special inspection is required during field gluing operation of elements of the seismic force-resisting system. Periodic special inspection is required for nailing, bolting, anchoring and other fastening of components within the seismic force-resisting system, including wood shear walls, wood diaphragms, drag struts, braces, shear panels and hold-downs.
Exception: Special inspection is not required for wood shear walls, shear panels and diaphragms, including nailing, bolting, anchoring and other fastening to other components of the seismic force-resisting system, where the fastener spacing of the sheathing is more than 4 inches (102 mm) on center (o.c).

For wind Exposure Category B where the nominal design wind speed $V_{asd}$ exceeds 120 miles per hour; and in wind Exposures C and D where the nominal design wind speed $V_{asd}$ exceeds 110 miles per hour, CBC Section 1705.10.1 uses nearly the same language to describe the required additional special inspections (note that “shear panels” are only mentioned in the exception):

1705.10.1 Structural wood. Continuous special inspection is required during field gluing operation of elements of the main windforce-resisting system. Periodic special inspection is required for nailing, bolting, anchoring and other fastening of components within the main windforce-resisting system, including wood shear walls, wood diaphragms, drag struts, braces, and hold-downs.

Exception: Special inspection is not required for wood shear walls, shear panels and diaphragms, including nailing, bolting, anchoring and other fastening to other components of the main windforce-resisting system, where the fastener spacing of the sheathing is more than 4 inches (102 mm) on center (o.c).

Although these provisions, triggered by wind or seismic, focus on the fastening of the elements of the lateral force-resisting system, the inspections should include verification of the type, size, grade, and moisture condition of the wood elements themselves.

The CBC allows for an exemption from special inspection for wood shear walls, shear panels, and diaphragms where the diaphragm fastener spacing is greater than 4 inches. This exception is intended to exempt less highly-stressed lateral force-resisting elements from special inspection. The exception eliminates the special inspections for the shear wall or diaphragm itself and its connections to other components of the main lateral force-resisting system, including hold-downs that are in an exempt shear wall and collectors that are part of an exempt horizontal diaphragm.

Often the building structure will include walls or diaphragms with nail spacing both less than and greater than 4 inches. In these cases the specific elements with nailing spacing greater than 4 inches would not require special inspection but the other elements with tighter spacing would require special inspection, since the exemption is only for specific elements and not for the entire structure. Thus, engineers should use judgment and caution in invoking this exception. It is recommended that the construction documents clearly distinguish which lateral force-resisting elements require special inspection and which are exempt. For example, identifying marks can be added to the plans and select details that note the elements that require special inspection.

The CBC specifies all wood special inspection other than field gluing of elements of the lateral system to be “periodic” as opposed to “continuous”. Thus the structural engineer should determine the specific extent and frequency of inspections and include that information in the Statement of Special Inspections and/or in the drawings and specifications. In detailing the
inspections for specific wood elements the engineer should consider the complexity of the details, the amount of repetition in the details, and other general factors such as the location of the building site, the size of the building, and so on. For complex wood structures the engineer may want to consider requiring more frequent in-progress inspections. The description of the periodic special inspection requirements should include initial inspections at the start of each element of the work (such as sole plate nailing, double top plate splicing, framing clip installation, for example), periodic in-progress inspections during the work, and final inspection of each element at completion.

The CBC does not explicitly state that the wood special inspection provisions apply to buildings constructed of wood and other materials, for example buildings with wood diaphragms and concrete or masonry walls. However, the provisions specify special inspections for wood construction, not for wood-framed buildings. Thus the provisions should apply to any building type where wood framing members described in the provisions exist, even if the lateral force-resisting system includes members made of different materials.

Note that in some cases the elements requiring special inspection may be covered up by subsequent construction (for example hold-downs and diaphragm nailing). Thus the inspection should occur before the subsequent construction is installed. CBC Section 1702.2 makes it explicit that construction must remain accessible and exposed for special inspection. Please see the SEAONC Construction Quality Assurance Committee document Guidelines for Special Inspection and Structural Observation for further discussion on this section.

III. NON-SEISMIC/WIND SPECIAL INSPECTIONS

1. Prefabricated Wood Elements and Assemblies

CBC Section 1705.5 refers back to Section 1704.2.5 for the special inspection of prefabricated wood structural elements and assemblies. Section 1704.2.5 uses the term “fabricated items” that is defined in CBC Section 202. It is important to understand this definition since it determines whether or not the manufacture of assembled items such as trusses, laminated beams, and I-joists require special inspection.

The definition of fabricated items in Section 202 notes that any item that is manufactured in accordance with one or more of the standard specifications referenced by the Code or in accordance with a referenced standard that includes “requirements for quality control done under the supervision of a third-party quality control agency” is not to be considered a “fabricated item.” Since Section 1704.2.5 only requires special inspection of the manufacture of “fabricated items”, any item that is not considered a “fabricated item” by the Code is not required to have its manufacture special inspected. Most metal plate wood trusses, laminated beams, and I-joists are manufactured to a reference standard (e.g. AITC-A190.1 for glulam beams, TPI-1 for metal plate connected wood trusses, and ASTM D5055 for wood I-joists) and thus are not “fabricated items” as defined by the Code. Therefore, unless it is special case where a reference standard is not being used special inspection of the manufacture of these items is not required by the CBC. The structural engineer or the building official can still require special inspection of the fabrication to
be performed. However, the structural engineer should be judicious when specifying these inspections since they are not typically performed and thus could increase the building owner’s construction and inspection costs.

For wood trusses, CBC Section 2303.4.7 requires that trusses that are not made as part of a manufacturing process or a referenced standard must comply with the inspection requirements of Section 1704.2.5.1 or the requirements Section 1705.5, as applicable. Special inspection of the manufacturing of such trusses would thus be required.

When shop fabrication inspection is required it would be per the provisions of CBC Section 1704.2.5. The duties required for the special inspector during fabrication include reviewing the plant’s quality control procedures and confirming that these procedures are being followed correctly.

CBC Section 1704.2.5.2 includes an additional exemption from special inspection for those items fabricated by an “approved fabricator”. Note that in this case the approval must be by the building official who has jurisdiction over a particular project. Approvals or certifications by other agencies or organizations do not justify an exemption unless the building official accepts them as a basis for fabricator approval.

The California Division of the State Architect (DSA) and the Office of Statewide Health Planning and Development (OSHPD) require a more detailed inspection of fabricated elements by the special inspector and also include inspection requirements for some elements generally considered to be manufactured items. These provisions are outlined in CBC Chapter 17A. In addition to verifying the quality control procedures the special inspector must make a visual inspection of the final product. The special inspector is then required to issue a verified report to the design professional in general responsible charge, the structural engineer, and the building official. The verified report is required to identify all of the inspected members and indicate whether the inspected members conform to the contract documents and applicable standards.

2. Site-Built Assemblies

Site-built assemblies covered by Section 1705.5 include bracing of trusses spanning 60 feet or more and high-load diaphragms. It does not include stud walls or floor framing systems, so the construction of these elements are not required to be special inspected unless that are part of the lateral force-resisting system. Inspection of elements of the lateral force-resisting systems is covered in other sections.

High-load diaphragms are sheathed diaphragms with multiple rows of fasteners and are most commonly used in wood diaphragms that support concrete or masonry walls for out-of-plane lateral loads. This requirement applies to all seismic design and wind exposure categories, whereas the inspection of other wood diaphragms is only required for high wind and seismic categories. This is why these provisions are in Section 1705.5 rather than Sections 1705.10.1 and 1705.11.2. However, it is uncommon to have diaphragms in Seismic Design Categories A and B.
or in low wind areas that have shear demands that would require high-load diaphragms. Please see Section IV for a more detailed discussion on special inspection of high-load diaphragms.

Special inspection of bracing for long span trusses has to do with the installation of truss bracing and not the fabrication or installation of the truss members themselves. Temporary bracing is usually not addressed in the CBC since it is traditionally considered to be contractor means and methods and it is not critical for the performance of the completed structure. Because this requirement is relatively unique it could potentially be missed by engineers and/or inspectors so special attention should be paid to this requirement whenever long span trusses are used.

The special inspection consists of checking that the constructed brace’s member size and connections match the approved truss submittal. The “approved truss submittal” that the Code specifies the inspector to use for inspection of truss bracing refers to the deferred submittal approved by the building official. This does not refer to any approval of the submittal package by the design professionals during construction, for example shop fabrication drawings.

IV. SEISMIC & WIND SPECIAL INSPECTIONS

1. General Discussion

The primary focus of the special inspections of wood lateral force-resisting elements should be on verification of the type, size, grade, and moisture condition of the wood members and verification of the type, size, and location of the fasteners on the connections. This includes the diaphragm and shear wall nailing, the nailed straps and bolted connections at the drag struts and chord members, top plate splices, nails and clips connecting the diaphragms to the walls, hold-down attachments, and wall anchor bolts.

2. Sheathing Fastening

A key portion of special inspection for both horizontal diaphragms and shear walls is the inspection of the sheathing fastening. Nails are typically used for sheathing fastening but occasionally specialty screws or staples can be used. These fasteners do not have equivalent capacities so the inspector should take note if a fastener different from the specifications are used, for example if staples are used where nails are specified.

The attachment spacing can vary not only within the diaphragm or shear wall but also within a single sheet. Diaphragm nail spacing is often less at diaphragm edges and boundaries and greater near the middle of diaphragm spans. The fastener spacing is typically indicated in a nailing schedule and/or diagram. Typically the attachment spacing is specified for edge fastening (around the edges of each sheet) and for field fastening (at the interior of each sheet). Sometimes the drawings will also specify boundary fastening at the diaphragm boundaries, collector lines, continuous panel joints in blocked diaphragms, hold-down and tie-down posts in shear walls, and/or in horizontal diaphragms where they connect to vertical shear walls.
The lateral capacity of a diaphragm or shear wall is determined in part by the shear at the edges of the panels and at the edges of the diaphragm or wall, so the edge and boundary fastening should be verified by the special inspector. The inspector typically does not need to inspect the field fastening. The inspector should verify that the size and spacing of the edge and boundary fastening matches the construction documents and that the fastening fully penetrates the framing below (i.e. no “shiners”). This requires inspecting the nailing on both sides of the sheathing since nails with heads in the correct location can be driven at an angle and exit the face of the framing member. The American Forest and Paper Association’s *Special Design Provisions for Wind and Seismic* (SDPWS-2008) specifies that the nails should be at least 3/8 of an inch from the sheet edge. Except for high-load diaphragms (see the discussion below) there are no specified guidelines for the distance from the nails to the member edge. However, the inspector should verify that the nails have not split the framing members. The nail heads should be flush with the surface of the sheathing without being overdriven. Nails that break the face ply of the plywood are less effective than properly installed nails.

There is no guidance in either the CBC or SDPWS on the amount of tolerance in the fastener spacing that should be permitted. The best advice would be to take a common sense approach. Small variations in spacing may be acceptable depending on the specified spacing. For example, a 1” difference may be acceptable if the nailing is at 4 inches on center, but may not be acceptable if the nailing is at 2 inches on center. Comparing the average spacing to the specified spacing may be acceptable in some cases but not in others. For example, it would not be acceptable if the specified spacing for the shear wall nailing is 4 inches on center and the contractor installed the nails at 2 inches on center on just half the wall height.

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**Figure 1: Example of a diaphragm fastening schedule. Note that the diaphragm zone that requires special inspection is specifically identified.**

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The American Plywood Association (APA) recommendation on tolerances is that the exact spacing is not as important as the number of fasteners. What is critical to them is that the total number of fasteners on a panel matches what is specified and that the fasteners are approximately evenly spaced. For example, if the construction documents call for 4 inches on center spacing then there should be 13 fasteners on a 48 inch long panel edge. If fewer fasteners are installed then this could be considered a construction error. If the fastener spacing varied between 3 inches and 5 inches then APA would not consider this to be a problem as long as the correct number of fasteners was installed. APA recognizes that there must be a reasonable limit to the variance in fastener spacing and that the engineer’s specification should be closely followed.

In the end, acceptable tolerances for fastener spacing may be a judgment call by the engineer. It is recommended that the engineer specify the tolerances on the construction documents, particularly if the specified nail spacing is less than 3 inches on center.

If the contractor provides fasteners at a smaller spacing than what is specified, the inspector should avoid assuming that this is acceptable because of the higher capacity that such spacing could provide. Instead the inspector should consider this a potential non-compliance issue and notify the engineer. The concern is that close nail spacing can lead to splitting of members. There are also specific framing width requirements in SDPWS for nails with small spacing that would be violated if the nail spacing is smaller than what the engineer specified when he/she designed the framing.

Typically sheathing nails are installed with a nail gun. The power settings on most nail guns are variable and must be adjusted by the installer to ensure that the nails are not overdriven into the sheathing or splitting the wood support member. The inspector does not need to check the gun settings, but if he or she sees a consistent pattern of overdriven nails or split framing, it is likely a sign that the nail gun settings are off and the inspector should notify the contractor immediately. Where nails are overdriven, the engineer is advised to consult APA guidelines, Form TT-012. The contractor may also want to use nails with smaller heads so that more nails can be placed inside a single clip. Research has shown that nails with clipped heads may have the same shear capacity as full round head nails (Leichti & Kurtz, 2009). However, clipped head nails have not yet been accepted by the model codes for use as sheathing nailing and thus should not be used for diaphragms unless they are specified in the approved construction documents.

A common source of confusion for both engineers and inspectors is the difference between common nails and box nails. Common nails and box nails have the same length for a given pennyweight, but box nails have slightly smaller shank diameters as shown in the table below.
<table>
<thead>
<tr>
<th>Pennyweight</th>
<th>Length (in.)</th>
<th>Common Nail Shank Diameter (in.)</th>
<th>Box Nail Shank Diameter (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6d</td>
<td>2</td>
<td>.113</td>
<td>.099</td>
</tr>
<tr>
<td>8d</td>
<td>2 ½</td>
<td>.131</td>
<td>.113</td>
</tr>
<tr>
<td>10d</td>
<td>3</td>
<td>.148</td>
<td>.128</td>
</tr>
<tr>
<td>12d</td>
<td>3 ¼</td>
<td>.148</td>
<td>.128</td>
</tr>
<tr>
<td>16d</td>
<td>3 ½</td>
<td>.162</td>
<td>.135</td>
</tr>
</tbody>
</table>

Common nails are more typically specified by engineers because of their higher allowable shear values and history of better performance than box nails. However, some contractors may prefer using box nails because they are easier to install and typically cost less than common nails. The Code allowable shear tables for horizontal diaphragms and shear walls are based on common nails, so if box nails are used instead the engineer would have to account for the lower capacity in his or her design. Thus the engineer should explicitly specify box or common nails on the construction documents. If this is not done the inspector may need to request clarification from the engineer.

During inspection of the diaphragms and shear walls, as well as other seismic-force-resisting elements connected with nails, the special inspector should verify that the specified types of nails are being used. At a minimum, the special inspector should check the label on the box the nails came in, but that alone may not be sufficient verification, especially if both common and box nails are being used on the same project, or if there is no label on the box, or the label reads “common box nail” or something similar. Since the lengths of common and box nails are the same and the difference in shank diameter is slight, the special inspector may have difficulty verifying that common nails are being used with only a visual inspection. In those instances it is recommended that the inspector spot measure the nail shank diameters with a fine measuring device such as a micrometer.

If the shear wall sill plate or other wood members attached to the building foundation are preservative treated, then the fasteners that are driven into these members may need to be hot dipped galvanized or made of stainless steel to prevent corrosion. The appropriate type of corrosion protection on the fasteners depends on the type of wood treatment. For example, all fasteners driven into lumber treated with CA, CCA, or ACQ must be either hot-dipped galvanized or made of stainless steel, depending on the actual level of chemical content retained in the wood. Stainless steel fasteners are required if the member is treated with ACZA. Stainless steel fasteners are also recommended if data on the chemical retention level is unavailable from the treated wood supplier. Borate-treated lumber does not require special fasteners. Both the corrosion protection and the wood treatment should be addressed in the construction documents. The inspector should verify that the specified wood treatment and fastener protection has been provided.
Sheathing Fastening Inspections

The special inspector should verify the following:

1. The fastener type (common nail, box nail, staple, screw) matches the specification for the project.
2. That nails with clipped heads are not used unless they are specified on the construction documents.
3. That fasteners that are driven into preservative treated lumber are protected from corrosion as specified on the construction documents.
4. The size and spacing of the edge and boundary fastening matches what is specified in the construction documents.
   a. If the nails are spaced at less than the required spacing, notify the engineer and check that the framing members have not been split.
5. That there is a minimum 3/8 inch from the edge of the sheathing to the center of the fastener, as specified in SDPWS.
6. That 8d nails are staggered along the sheathing edges of adjoining sheets of structural panels where the nail spacing is 2 inches.
7. That 10d nails are staggered along the sheathing edges of adjoining sheets of structural panels where the spacing is 3 inches or less.
8. The fastening fully penetrates the framing below without being overdriven (no “shiners”).
   a. Where possible check the opposite side of the sheathing to verify no nails missed the framing members.
9. The framing members are not split.
10. That staples if used are placed with the crown parallel to the supporting framing below.

3. Horizontal Diaphragms

Horizontal diaphragms are the primary mechanism of lateral load transfer from the roof and floors to the shear walls and thus should be inspected as part of the special inspection program. Plywood has typically been the material of choice for horizontal diaphragms, though in recent years oriented strand board (OSB) and composite panels have come into common use.

The special inspection begins with verification that the sheathing material conforms to the material specified on the construction documents. A typical horizontal sheathing specification specifies the thickness, grade, material type (usually either plywood or OSB), exposure, glue, span rating, and number of plies. All of these parameters except for the span rating, exposure, and glue relate to the performance of the sheathing during lateral loading so they should be verified by the special inspector. This information is usually noted on a stamp on the sheathing panels, allowing for easy verification. Because the stamp can be covered up by framing or finishes it is important to do this inspection early in the construction. Typically the sheathing is specified to meet the Department of Commerce (DOC) Voluntary Product Standard, either PS-1 for plywood or PS-2 for OSB and composite panels. This specification is also usually noted on the stamp.
Figure 2: Typical sheathing stamp with annotations

Once the sheathing is in the roof or floor the inspector should verify that the layout of the panels matches what is specified on the drawings, as the diaphragm shear capacities listed in the SDPWS and CBC tables are based on the panel layout. If the diaphragm is specified to be blocked then the panel edges should bear on joists, beams, or wood blocking between the joists. The inspector should also verify that diaphragms with 10d nails spaced at 3 inches or less on center have 3x or wider framing at the panel edges as required by SDPWS Section 4.2.7.1.1.

The engineer may design the diaphragm for force transfer around openings. This force transfer is often accomplished by light gage metal straps and blocking near the opening corners and edges. These elements are part of the horizontal diaphragm system and thus should be part of the special inspection of the diaphragm. Since there may be straps and blocking in the diaphragm that are not part of the shear wall system and thus would not require special inspection, the construction documents should clearly specify the straps and blocking that require special inspection.

Once the panels are attached to the framing the special inspector should inspect the fastening as discussed in the previous section.
**Horizontal Diaphragm Framing Inspections**

The special inspector should verify the following:

1. The wood framing lumber size, species, and grade conforms to the construction documents.
2. The sheathing thickness, grade, material type, exposure, the number of plies, and if specified the product standard. This data is usually stamped somewhere on the panel.
3. The layout of the panels on the floor or roof.
4. The holes in shear panels are cut neatly, without overcuts. Slots (such as to slide shear panels over existing obstructions) are not typically specified on the construction documents.
5. That the edges of the plywood bear on framing members or blocking if a blocked diaphragm is specified.
6. There are gaps provided at abutting panel joints to allow for expansion, as recommended by the panel manufacturer. Typically this gap is 1/8”.
7. That 3x or wider framing is used at panel edges with 10d nailing spaced at 3 inches on center or less.
8. That straps and blocking around openings that the construction documents specify as requiring special inspection have been installed correctly, including verifying the strap sizes, the nails in the straps, the number of blocks, and the connection of the blocks to the framing members.

4. **High-Load Diaphragms**

High-load diaphragms consist of sheathing that is attached to the framing below with multiple rows of fastening on the adjoining edges of the sheathing. Though high-load diaphragms are not commonly used in buildings with low seismic or wind design categories, the inspection requirement is listed as a separate inspection rather than in the wind and seismic inspection provisions since its applicability is independent of the wind and seismic force demands. The inspection of high-load diaphragms is similar to that required for other wood diaphragms in high seismic and wind zones, with some particular requirements pertaining to the multiple rows of fastening.

**High-Load Diaphragm Inspections**

In addition to the verifications associated with horizontal diaphragms the special inspector should verify the following construction that is specific to high-load diaphragms:

1. The nominal width of the supporting member at adjoining sheathing panel edges. Note that SDPWS Section 4.2.7.1.2 requires a minimum 3x and in some cases 4x nominal member be used for high-load diaphragms to permit multiple rows of fasteners. Single and double 2x members do not qualify for use in high-load diaphragms.
2. The fastener size (diameter and length), spacing, edge distances, and the number of fastener rows match what is specified on the drawings.
Collector members, sometimes referred to as drag struts, collect the lateral forces from the horizontal diaphragms and deliver them to the vertical lateral resisting elements such as shear walls. These elements are among the most critical elements of the lateral load resisting system since the shear walls and the other lateral resisting elements cannot work as designed if the collectors fail. Because wood diaphragms are likely to bend when loaded laterally, similar to a vertically loaded beam, a continuous element is needed around the diaphragm perimeter to keep the bending from warping the diaphragm. This element, known as a chord, is a continuous member that runs around the perimeter of the diaphragm. Both collectors and chords are designed to support axial compression and tension loads.

Around the perimeter of the wood diaphragm the collector and chord member are often the same member or members. In wood buildings this member is usually either the double plate at the top of the wall or the rim beam or joist on top of the plates. When the walls are built to run past the floor or roof framing, a technique known as “balloon” framing, the collector or chord element is usually the ledger that runs inside the studs and supports the floor or roof joists. Regardless of what wall element is used as the collector, the requirement that the element be continuous remains the same. This is usually done by either using a continuous element (with no joints) across the entire length of the building or by adding straps or (for higher loads) hold-downs at the joints in the chord, or in the case of the double top plates by overlapping the two plates and installing additional nails or bolts.
If a glu-laminated beam is used as a chord or collector element the engineer may choose to splice these beams with a special hinge bracket. Where so used the inspector should inspect the installation of these hinges. Note that hinges for glulam beams that the engineer does not specify as a chord or collector do not require special inspection.

Sometimes steel elements such as plates, thin straps, and hold-downs, are used as collectors or chords. In addition to verifying that the sizes and fastening matches the drawings, the inspector should pay particular attention to the tautness of the strap and the sag in the hold-down rods. If the straps or rods are installed too loose then the building could experience unexpected additional drift in a seismic event as the steel tightens. If the straps or rods are installed too tight, however, then the steel or the wood that it attaches to could be subjected to additional stresses as the wood swells and shrinks. If the steel plates are spliced together by welding, then these welds should be special inspected per the applicable provisions in the CBC.

Unless noted otherwise in the construction documents, the moisture content of sawn lumber that is used for chords and collectors should be less than or equal to 19 percent. Note that a lower maximum moisture content can be specified on the construction documents. The lumber should be stamped “S-Dry” (surfaced dry). Laminated members are typically manufactured with a low moisture content, so their moisture content need not be checked provided that the members are protected from moisture during transport & at the construction site. Wood members that have been exposed to moisture should be checked with a hand-held moisture meter. Lumber that measures greater than the maximum amount should be allowed to dry before the sheathing is nailed down and before any straps or ties are attached.

The inspection requirements apply to chord and collectors elements that are on top of the shear wall and those that frame into the ends of the wall. This would include the connection between...
these elements and the shear wall. The engineer should make it clear on the construction documents that these elements are subject to special inspection.

**Chord and Collector Inspections**

The special inspector should verify the following:

1. The material species and grade of the members match the construction documents. The member species and grade should be identified by a mark stamped on the member. Unidentified pieces should not be used for chords and collectors.
2. The moisture content of the framing should not exceed 19-percent, unless the construction documents state that a higher percentage is to be allowed or a lower percentage cannot be exceeded.
3. The member dimensions are as specified.
4. The members are straight and not warped.
5. Notches or holes in the members are within the limits specified on the construction documents.
6. All straps, ties, and hold-downs used to tie chords and collectors together are the correct size, are in the correct locations, are properly fastened to the framing with all specified fasteners present and no splits in the wood, and are taut without sagging or kinks.
7. The bolt holes for bolted straps, ties, and hold-downs are not oversized.

**6. Shear Wall Framing**

There are several individual components within a wood shear wall that require special inspection in high seismic and wind zones. Each of these components plays a critical role in the overall performance of each shear wall and in turn the overall seismic and wind performance of the building.

The primary element of a wood shear wall is the sheathing attached to the wall studs as this is the primary load path for both the lateral shears and the vertical overturning forces in the wall. See Section IV.3, “Horizontal Diaphragms” for a discussion of sheathing materials. The sheathing must be properly attached to the top and bottom plates, to the vertical boundary elements at each end of the shear wall, and to the wall studs and the sheathing panel edges.

2x nominal or wider framing should be at all sheathing panel edges. If they are specified on the construction drawings, the inspector should verify there are 3x studs or double 2x studs at abutting panel joints. Often such studs are specified when the fastener spacing is 2 or 3 inches on center or when there is plywood on both sides of the wall. Thicker studs are also typically required where hold-downs and tie-downs are installed. For doubled 2x studs, the studs should be securely fastened together, typically with 16d common nails at the same spacing as the panel edge nailing. Since many notches and holes are placed in the studs after the sheathing is installed (for example, plumbing lines and electrical conduits) the inspector may need to re-inspect the studs after initial sheathing inspection and before the wall finish is installed.
Unless noted otherwise in the construction documents, the moisture content of the studs should be less than or equal to 19 percent. Note that a lower maximum moisture content can be specified on the construction documents. The lumber should be stamped “S-Dry” (surfaced dry). Wood that has been exposed to moisture should be checked with a hand-held moisture meter. Sawn lumber that measures greater than the maximum amount should be allowed to dry before the sheathing is nailed down and before any straps or hold-downs are attached.

The engineer may design the shear wall for force transfer around openings. This force transfer is often accomplished by light gage metal straps and blocking near the opening corners and edges. These elements are part of the shear wall system and thus should be part of the special inspection of the shear wall. Since there may be straps and blocking in the walls that are not part of the shear wall system and thus would not require special inspection, the construction documents should clearly specify the straps and blocking that require special inspection.

The special inspector should pay particular attention to the interface between the shear walls and the horizontal diaphragms since this is a key part of the wind and seismic load path. This interface can be framed in several different ways depending on the type and configuration of the floor and roof framing. The wall sheathing should extend up to and be fastened to the continuous collecting element to which the horizontal diaphragm sheathing is attached. This is typically the wall double top plate but it can also be a rim joist or blocking on top of the wall, or blocking within the wall that is connected to a ledger that runs on the side of the wall. For deep trusses perpendicular to the wall, “blocking frames” or similar between the trusses may be specified instead of solid blocks. Gable-end walls may be sheathed all the way up and onto the end rafter or truss top chord or may stop at the truss bottom chord if the truss has been specifically engineered to transfer the lateral load through the truss from the top chord to the bottom chord. The figures below show a number of configurations of what this interface may look like.
Figure 5: Wall sheathing and edge nailing where the framing is parallel to the wall. Elements that typically require seismic special inspection are noted with boxes.

Figure 6: Wall sheathing and edge nailing where the framing is perpendicular to the wall. Elements that typically require seismic special inspection are noted with boxes.
Figure 7: Wall sheathing and edge nailing where a ledger is used. Elements that typically require seismic special inspection are noted with boxes.

Figure 8: Wall sheathing and edge nailing where the wall frames up tight to the floor. Elements that typically require seismic special inspection are noted with boxes.
The engineer should specify where the wall sheathing should stop and where the edge nailing should be. The inspector should verify that the sheathing and edge nailing has been installed per these specifications.

Typically when blocking or rim joists are used on top of shear walls the blocking will be connected to the wall top plate either with nails or steel clips in order to transfer lateral loads from the horizontal diaphragm to the shear wall. The engineer should specify the method of attachment. The inspector should verify that the specified attachment has been correctly installed.

Straps, ties, and/or blocking are often installed in horizontal diaphragms at wall locations in order to support the walls for out-of-plane wind and seismic loading, as well as vertical tension due to wind uplift. The Code is not clear as to whether or not these elements require special inspection. These elements are not part of the building’s primary lateral force-resisting system for which the Code specifically requires special inspection. However, failure of these elements in an earthquake or high wind event could create a significant life safety hazard if the walls support floor or roof framing. Thus it is recommended that the engineer consider specifying special inspection of the installation of these elements, especially if the walls are concrete or masonry.

Studs, sill plates, sole plates, top plates, and blocking all make up the framing for a wood shear wall, and all should be inspected to ensure that they have been installed properly. These elements are often subject to penetrations by the mechanical, electrical, and plumbing systems, which must be taken into account both in design and in construction. Plate alignment is also a critical factor in the performance of the walls, especially at the foundation level where the sill plates have been fastened to the foundation with anchor bolts that are usually placed in the concrete or masonry long before the wall is constructed. As discussed earlier in the diaphragm fastening section, sill plates are often pressure treated so anchor bolts that come in contact with this wood may need to be coated or made of stainless steel to protect them from corrosion. Please see the earlier discussion regarding the special inspection requirements associated with wood treatment.

Thor Matteson, SE, in his book *Wood-Framed Shear Wall Construction - an Illustrated Guide*, recommends the following procedure for inspecting wood shear walls: “Develop a routine for inspecting wood shear walls: “Develop a routine for inspecting wood shear walls. A possible sequence is as follows: Check all the sheathing nailing, around one piece of sheathing at a time. Next, verify that the top of the shear wall is connected adequately to the framing above; then check to see that the end posts are properly anchored. Finally, check to see that the bottom of the shear wall is secured to the framing or footing below to form a continuous load path to the foundation.”

**Shear Wall Framing Inspections**

The special inspector should verify the following:
1. The lengths of all shear walls conform to the framing or floor plans. The length of a shear wall is measured as the sheathed dimension.
2. The wood framing lumber size, species, and grade conforms to the construction documents.
3. Thicker or multiple studs are installed where specified.
4. The moisture content of the studs and posts does not exceed 19-percent, unless the construction documents state that a higher percentage is to be allowed or a lower percentage cannot be exceeded.
5. Notches or holes in the studs are within the limits specified on the construction documents.
6. There is full bearing of the end post on the foundation sill plate, metal post-base or sole plate.
7. At framed floors, that there is full blocking or other bearing members under the end posts.
8. That straps and blocking around openings that the construction documents specify as requiring special inspection have been installed correctly, including verifying the strap sizes, the nails in the straps, the number of blocks, and the connection of the blocks to the studs.
9. That the framing and connectors at the shear wall to horizontal diaphragm interface has been installed as specified on the construction documents.

Shear Wall Sheathing Inspections

The special inspector should verify the following:
1. The sheathing type (plywood, OSB or composite panels).
2. The sheathing grade (for example: Sheathing, Plywood Siding, Structural I, APA Rated Panel). This should be stamped on the sheets.
3. The panel thickness. For grooved siding, the thickness considered is the thickness that the fasteners are driven through.
4. There are gaps provided at abutting panel joints in exterior walls to allow for expansion, as recommended by the panel manufacturer. Typically this gap is 1/8”.
5. The shear panels are attached directly to the studs, unless the construction documents specify or allow for the sheathing to be placed on top of gypsum wallboard.
6. The holes in shear panels are cut neatly, without overcuts. Slots (such as to slide shear panels over existing obstructions) are not typically specified on the construction documents.
7. That the sheathing at the shear wall to horizontal diaphragm interfaces extends up to the locations specified on the construction documents and is fastened as specified to the framing.
8. Where specified, the location, type and spacing of framing anchors (such as clip angles) from the top plate to the roof or floor framing or blocking has been correctly installed with all nail holes filled (unless otherwise noted on approved plans).
9. The out-of-plane wall ties and blocking have been installed per the construction documents.
Top Plate Inspections (Plates at the top of the wall)

The special inspector should verify the following:

1. The top plate thicknesses match what is specified in the contract documents. While typically 2x members are used for top plates, there are some instances when thicker members may be specified.
2. The top plate grade matches what is specified in the contract documents.
3. The types of top plate splices installed matches what is specified in the construction documents.
4. At bolted and nailed splices, the size, spacing, and edge distance of the fasteners are installed as specified on the construction documents.
5. At splices with straps, the strap size, number of rows of nails, and the total number of nails are in accordance with the manufacturer’s specifications and the construction documents.
6. The straps are centered on the splice joint and that all the nail holes are filled unless otherwise specified on the construction documents.
7. No splices occur where the construction documents specify no splices are allowed.
8. Plate interruptions and notches such as pipe and conduit penetrations are treated in accordance with in the contract documents.
9. The top plates are spliced around penetrations as specified in the contract documents.

This list would also be applicable to inspect rim joists and ledgers that are used as collecting elements.

Figure 9: Example of a top plate splice detail
Sole Plate Inspections *(Plates at the bottom of an upper story wall that connects to a stud wall below)*

The special inspector should verify the following:

1. The plate thickness and grade matches what is specified in the contract documents.
2. Plate interruptions and notches such as pipe and conduit penetrations are treated in accordance with the contract documents.
3. The type of fastener used to connect the plates to the blocking or rim joist below matches what is specified in the contract documents. Note that different fastener types can be specified for different walls in the same building (i.e., some walls may have nails while others may have lag screws or bolts).
4. The spacing of the fasteners between the plate and the blocking or rim joist below matches what is specified in the contract documents.
5. The plate fasteners fully penetrate into the blocking or rim joist below and are not sticking out of the blocking, rim joist, or plate.
6. The blocking or rim joists below the plates have not been split by the plate fasteners.

*Figure 10: Example of a sole plate detail. Elements that typically require seismic special inspection are noted with boxes.*
Sill Plate Inspections (Plates at the bottom of the wall that connect to concrete or masonry)

The special inspector should verify the following:
1. The plate thickness matches what is specified in the contract documents.
2. The sill plate grade matches what is specified in the contract documents, typically either pressure treated Douglas Fir, Redwood, or Hem Fir.
3. The preservative treatment matches the treatment specified on the construction documents.
4. Plate interruptions and notches such as pipe and conduit penetrations are treated in accordance with the contract documents.
5. The sill plate joints in shear walls match what is specified in the contract documents.
6. The installed anchor bolt diameter, maximum spacing, and number of bolts (where specified) is in accordance to what is specified on the construction documents. Note that this inspection must be done prior to the concrete footing pour and thus should be inspected along with the footing reinforcement.
7. That anchor bolts that are installed into preservative treated sill plates are protected from corrosion as specified on the construction documents.
8. The anchor bolt holes in the sill plates are not more than 1/16 inch larger than actual bolt diameter.
9. The anchor bolt nuts are fully engaged with the bolts.
10. The anchor bolt washers have been installed per the contract documents. The edge of the plate washer should extend to within ½-inch from the shear panel per SDPWS Section 4.3.6.4.3.
11. The sill plate splices in shear walls match what is specified in the contract documents.
12. The anchor bolts are at or near the center of the sill plate, and that the installed edge and end distances conform to the construction documents and are within CBC and SDPWS requirements:
   a. Foundation anchor bolts should not be less than 7 bolt diameters or more than 12 inches from end of a sill plate piece.
   b. Foundation anchor bolts should not be less than 1.5 bolt diameters from centerline of bolt to the edge of the sill plate.
13. The distance from the anchor bolts to the edge and end of concrete foundation conforms to the plans.

7. Hold-downs and Tie-downs

Hold-down and tie-down devices are used to prevent overturning of a wood shear wall by restricting the vertical uplift movement at ends of the wall. They form a couple with the posts at the opposite end of the wall to counteract the moment due to the lateral force acting at the top of the wall. Hold-downs and tie-downs also restrict the lateral deflection of the wall due to rocking and reduce the lateral drift of the building. For this reason the internal deflection of the hold-downs and tie-downs is accounted for in their design along with their uplift capacity. Since both the hold-down deflection and uplift capacity are dependent on the proper installation of the hold-down components the installation of these components requires special inspection.
There are two different types of hold-downs typically used in wood construction: prefabricated light gage metal brackets and metal straps. Prefabricated light gage metal brackets are bolted or screwed into the wood framing and anchored to the foundation system with embedded anchor bolts. Hold-down brackets can also be used at upper framing levels to anchor shear walls between floors. These brackets are typically available from light-gage connector manufacturers, though brackets specially designed by the structural engineer can be used.

For lower uplift forces metal straps are often used as hold-downs instead of brackets. At the upper floors the straps are nailed or screwed into the boundary elements. At the foundation the straps are embedded into the footing.

Tie-down systems are sometimes used in multi-story buildings to vertically tie together shear walls at multiple floors. Some systems can also be used for single story walls. Tie-downs typically consist of steel rods that are bolted to each floor with special brackets or bearing plates and shrinkage compensator devices. These brackets are designed to resist uplift and also accommodate creep due to shrinkage of the wood. While tie-downs generally have greater capacities than hold-downs the shear walls must align vertically in order for them to be used. Special inspection of tie-downs includes review of the attachment of the tie-down components to the wall framing as well as review of the installation of the framing and sheathing attachments at the tie-down locations.

The list of recommended hold-down inspections was developed from the recommendations discussed in *Wood-Framed Shear Wall Construction - an Illustrated Guide*. The list of recommended tie-down inspections was also developed from this same publication and from the article “Rod Tie-Down Systems, Part 5 – Inspection” by Alfred Cummins, published in the August 2008 edition of *Structure* magazine.

**Hold-down Inspections**

The special inspector should verify the following:

1. Prior to pouring the concrete foundation:
   a. That the embedment lengths of hold-down anchor rods or straps into the concrete foundation conform to the plans.
   b. That the type of embedded end of anchor rods (L-hook, J-hook, nut and square plate, hex headed bolt) conforms to the plans.

2. End posts:
   a. That the grade and minimum size that the hold-down connects to is in accordance with plans.
   b. Where multiple studs are used as end posts, verify that the fastening of the multiple studs is in accordance with plans.
   c. That there are no notches or large holes in the end posts unless specifically shown on the plans.

3. That the hold-down connects directly to the post without spacers or shims.
4. That the hold-down is installed above the sill plate when specified by the hold-down manufacturer or on the construction documents.
5. That all required fasteners are installed from the hold-down to the post and that they are of the size specified by the manufacturer or as specified on the plans. Note that some hold-downs use nails, self-drilling screws or other types of fasteners instead of bolts.

6. At bolted hold-downs:
   a. That the diameters of the hold-down bolt holes through shear wall end post are not more than 1/16 inch larger than actual bolt diameter.
   b. That the hold-down bolt heads or nuts are not countersunk into the post unless specifically indicated on the plans.
   c. That the bolt nuts are on the side of the post away from the tie-down (unless otherwise specified by the manufacturer), that the nuts are finger tight, and that a washer is installed under the nuts.

7. That the nuts are tight on all foundation anchor rods and on all threaded rods that span from a lower floor to an upper floor.

8. That the anchor rods and threaded rods are straight and not bent or bowed.

9. At hold-down straps used at upper floors:
   a. That an equal number of nails are used in upper and lower wall framing for strap-typeunless shown otherwise on the plans.
   b. That the straps are straight, not bent to follow jogs in the framing.

**Tie-down Inspections**

The special inspector should verify the following:

1. **Tie-down rods:**
   a. Prior to pouring the concrete foundation, that the tie-down rods embedded into the foundation have embedment lengths that confirm to the construction documents.
   b. All rod sizes meet the tie-down manufacturer’s requirements or conform to the plans.
   c. The tie-down rod offset or alignment is within the tolerable limits specified by the tie-down manufacturer, usually between 1-1/2 to 4 inches horizontal to 10 feet vertical. Different tie-down systems have different plumbness tolerances.
   d. The coupler nuts are properly installed. The rods have to be fully installed into the coupler in order to fully engage the nut. Some couplers come with sight holes that allow for easy visual verification. This verification should be done prior to activation of the tie-down connector or shrinkage compensator.

2. **Tie-down posts/collector studs:**
   a. The minimum post size at the tie-down is in accordance with plans.
   b. The fastening of the multiple studs, where used as collector studs, is in accordance with plans.
   c. The nailing between the bridge support studs and the collector studs match what is specified on the drawings and is properly installed.

3. The compression bridge is installed level and tight to the collector studs. The tie-down connector and shrinkage compensator may not behave properly if the bridge is not level.

4. The tie-down connector or shrinkage compensator is properly installed and activated. The device should be free of dust and dirt and be installed level or else it may bind up.
Shrinkage compensators should be properly activated per the manufacturer’s recommendations.

Figure 11: Example of a tie-down system
8. Bracing

CBC Sections 1705.10.1 and 1705.11.2 list bracing as an element that requires wind and seismic special inspections. However, most bracing used in wood-framed buildings is not part of the lateral force-resisting system and thus does not require special inspection. This would include lateral bracing of beams and trusses (with spans less than 60 feet) and temporary bracing/shoring of walls during construction. This would also include bracing that is part of “braced wall lines” that are in structures designed per the conventional construction provisions of CBC Section 2308. Such structures are exempt from the special inspections listed in Section 1705 including the wind and seismic inspections, so bracing within these structures would fall under that exemption. These provisions may apply to wood braces used in braced frames, though these types of systems are rare in California. Steel braced frames are sometimes used in predominately wood-framed buildings and these braces may require special inspection. Inspection of these elements would not be per Sections 1705.10.1 or 1705.11.2 but instead would be per other sections of the CBC and its referenced standards.

9. Pre-Manufactured Shear Panels

Shear panels are pre-manufactured wall systems. These systems are similar to framed shear walls but with some notable differences. Rather than being assembled on site, these panels are manufactured in a factory and then shipped to the construction site for installation. These systems also come in specific sizes and are load tested as an assembly to determine their allowable shear values. Their most common use is in walls where there are several openings that will not allow for longer shear walls. They are often used in single family and multi-family residential construction, though they have been used in commercial wood construction as well.

As noted in CBC Section 1705.11.2, special inspection is required for manufactured shear panels except where they are used in buildings that are otherwise exempt from special inspections. The use of manufactured shear panels does not trigger special inspections in otherwise exempt structures. When special inspection is required, the inspector should verify the connection of the panels to the structure and the hold-downs within the panels. It is important to note that the fabrication of the shear panels does not require special inspection.

Shear Panel Inspections

The special inspector should verify the following:

1. The panels are connected to the framing above per the construction documents and the manufacturer’s specifications. Please see the list for top plate special inspections above for additional details.

2. The panels are connected to the framing or foundation system (as applicable) below per the construction documents and the manufacturer’s specifications. Please see the lists for sill and sole plate special inspections above for additional details.
3. The panel hold-downs are properly installed per the construction documents and the manufacturer’s specifications. Please see the list for hold-down inspections above for additional details.

The evaluation reports for shear panel products contain additional information on shear panels, including details and installation requirements, for reference by the building design engineer.

10. Field Gluing

The special inspection of field gluing operations appears to be applicable to only a limited number of conditions. The American Forest and Paper Association’s *Special Design Provisions for Wind and Seismic* (SDPWS) specifically limits the use of adhesives in shear walls to areas with a low seismic hazard, of which only Seismic Design Category C would apply since wood construction in buildings with SDCs A and B is not required to be special inspected under the provisions of 1705.11.2. SDPWS further restricts the use of adhesives in shear walls by requiring a low R-factor be used to calculate the seismic forces unless alternate values are reviewed and approved by the building official. While unlikely, it is possible to have shear walls that are fastened with adhesive and thus both engineers and inspectors should be aware of the special inspection requirement that pertains specifically to this type of construction. Note that this is the only wood special inspection that the CBC requires to be continuous.

SDPWS Section 4.2.6.3 permits the use of adhesives in horizontal diaphragms in combination with nails or other approved fasteners. However, these adhesives are not considered to be part of the lateral force-resisting system and are assumed to not contribute to the lateral force strength of the diaphragm. This is evident by the language of this section that permits adhesives only in combination with mechanical fasteners and the fact that the allowable diaphragm values do not mention any values for adhesives. Thus field gluing of horizontal diaphragms for non-structural applications such as to mitigate floor squeaking would not require special inspection.
APPENDIX A

SAMPLE CHECKLIST

The following sample checklist presents one method that the special inspector can use to record the inspections performed. Engineers may consider using a checklist similar to this one as part of the specification of special inspections.
# WOOD CONSTRUCTION SPECIAL INSPECTION CHECKLIST

**Project:** ________________________________

**Architect:** ______________________________

**Structural Engineer:** ______________________

**General Contractor:** _______________________

**Framing Contractor:** _______________________

**Special Inspector:** _________________________

## 1. NON-WIND AND SEISMIC INSPECTIONS

- **Fabricated Items**
  - Bracing of trusses greater than 60 feet long

## 2. FRAMING (including studs, joists, collectors, chords, and other supporting members that are identified on the construction documents as part of the lateral force resisting system)

- **Size, grade, and orientation of framing members**
- **Splits or damage caused by fasteners**
- **Improper fit or jointing**
- **Location of chords and collectors in diaphragms**
- **Location of hold-down and tie-down posts in shear walls**
- **Location of wider studs and joists at diaphragm and shear wall panel joints**
- **Stud and joist spacing**
- **Chord and collector members straight/not warped**
- **Moisture content of chords, collectors, and shear wall studs**
- **Length and location of shear walls**
- **Full bearing of shear wall end studs on framing, blocking or plates**
- **Straps and blocking around diaphragm and shear wall openings**
- **Notches or holes in studs and joists**
- **Diaphragm to shear wall connections**
- **Connection of fabricated shear panels to framing**

## 3. FRAMING CONNECTIONS (including nails, screws, bolts, etc.)

- **Check specified connections against construction documents**
- **Check size, type, material, quantity, spacing, edge distance, and washers**
- **Check additional fasteners specified at sills, top plates, double studs, etc.**
- **Holes in framing are not oversized**
- **Pre-drilling holes as specified**

## 4. DIAPHRAGM AND SHEAR WALL BLOCKING

- **Snug fit**
- **Nailing (size, amount, location)**
- **Splits or damage caused by fasteners**
- **Size and grade**
- **Location and orientation**
WOOD CONSTRUCTION SPECIAL INSPECTION CHECKLIST

Project: _______________________________________________

Special Inspector: _______________________________________

5 WALL SILLS AND PLATES

- Size and grade of lumber
- Preservative treatment or decay resistant species as specified
- Fastener size, spacing, layout, penetration, type
- Splicing and nailing of double top plates at interruptions
- No splices where not allowed
- Anchor bolt size, spacing, layout, type, embedment

6 HARDWARE (including metal straps, panel clips, glulam hinges, and other supporting members that are identified on the construction documents as part of the lateral force resisting system)

- Type (brand name, part number, etc.)
- Size, thickness, and shape
- Finish (galvanized, etc.)
- Location and orientation
- Connector size, type, and edge distance
- Tightness of connectors
- Holes in framing are not oversized
- Pre-drilling holes as specified
- Splitting of wood or other damage
- Washers

7 WOOD TO CONCRETE/MASONRY CONNECTIONS (including hold-downs, tie-downs, embedded metal straps, etc.)

- Size, type, and spacing of hold-downs and tie-downs
- Location and number specified for each wall
- Embedment into concrete/masonry
- Edge distance of anchor rods for proper concrete cover
- Adequate extension for proper nut grip and connection to framing
- No oversized holes in wood
- Hold-down fasteners to shear wall posts
- Anchor rods straight, not bent
- Bolt nuts are tight
- Size and type of tie-down rods
- Tie-down rod offset within specified tolerance
- Coupler nut type, location, and rod embedment
- Tie-down compression bridge
- Tie-down shrinkage compensators activated
WOOD CONSTRUCTION SPECIAL INSPECTION CHECKLIST

Project: _______________________________________________
Special Inspector: _______________________________________

<table>
<thead>
<tr>
<th></th>
<th>SHEATHING (material, panel layout, fasteners, installations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Type and grade of sheathing material</td>
</tr>
<tr>
<td></td>
<td>Thickness and panel size</td>
</tr>
<tr>
<td></td>
<td>Direction of face grain</td>
</tr>
<tr>
<td></td>
<td>Staggered panel layout for diaphragms</td>
</tr>
<tr>
<td></td>
<td>Offset panel joints where applied to both faces of shear walls</td>
</tr>
<tr>
<td></td>
<td>Gaps between adjacent panels</td>
</tr>
<tr>
<td></td>
<td>Holes in panels are neatly cut</td>
</tr>
<tr>
<td></td>
<td>Fastener size, type, and material</td>
</tr>
<tr>
<td></td>
<td>Fastener finish coatings at treated framing</td>
</tr>
<tr>
<td></td>
<td>Panel edges supported by framing or blocking</td>
</tr>
<tr>
<td></td>
<td>Center to center fastener spacing</td>
</tr>
<tr>
<td></td>
<td>Distance of fasteners to panel edges</td>
</tr>
<tr>
<td></td>
<td>Multiple rows of nailing at high load diaphragms</td>
</tr>
<tr>
<td></td>
<td>Penetration into framing or blocking</td>
</tr>
<tr>
<td></td>
<td>Staggered nailing at panel edges where specified</td>
</tr>
<tr>
<td></td>
<td>Pre-drilling holes as specified</td>
</tr>
<tr>
<td></td>
<td>Nail heads driven flush but do not fracture surface of sheathing</td>
</tr>
<tr>
<td></td>
<td>Field gluing</td>
</tr>
</tbody>
</table>

Comments : ____________________________________________

____________________________________________________________________
____________________________________________________________________

Inspector Signature: ________________________________
APPENDIX B

DISCUSSION OF SPECIFYING SPECIAL INSPECTIONS FOR WOOD CONSTRUCTION

The special inspection of structural steel, reinforced concrete, and reinforced masonry is specified in detail in the CBC and the referenced material standards such as AISC 360, ACI 318, and TMS 402. This is not the case for wood special inspections however. The CBC sections where the special inspection requirements for wood construction are found do not go into detail on what specific aspects of the identified elements are to be special inspected. Most special inspection forms from building departments do not go to this level of detail either. This lack of specificity in the code language, combined with the relative newness of the code requirements, has resulted in confusion among many engineers, special inspectors, and building officials as to how the special inspections should be prescribed.

The engineer may be tempted to specify the wood inspection in a broad manner, such as quoting verbatim the language in the relevant CBC sections. However, this could pose significant difficulties for the special inspector. He or she would then need to know which walls are shear walls, which beams are collectors, what differentiates high-load diaphragms from other diaphragms, and so on. In addition this approach could result in confusion since some information such as tolerances may not be obvious or may not exist in the standards.

Thus the structural engineer needs to document the wood elements subject to special inspection and specify the inspection criteria. One way to do this would be to identify the specific elements on the drawings with a symbol or set of symbols. For example, the designation “LFRS” (for Lateral Force-Resisting System) can be added to the section callouts for collector beams or to the grid lines where diaphragm boundary nailing is specified. Typical and unique details can be used to designate what needs to be inspected. For example a note on the shear wall typical details could state that all nailing on the detail is subject to special inspection. Another approach could be to list somewhere on the construction drawings the specific beams, grid lines, walls, etc., that are to be inspected.

In specifying the special inspections for specific wood elements the engineer should consider the complexity of the details, the amount of repetition in the details, and other general factors such as the location of the building site, the size of the building, and so on. The description of the special inspection requirements should include the following:

1. The initial inspections at the start of each element of the work (such as verification of member layout and material grades, for example);
2. The periodic in-progress inspections during the work;
   a. For complex wood structures the engineer may want to consider requiring more frequent in-progress inspections;
3. The final inspection of each element before it is closed in or covered.

B-1
APPENDIX C

DISCUSSION OF THE LATERAL LOAD PATH IN WOOD-FRAMED BUILDINGS

In order to effectively specify which elements in wood-framed buildings require special inspection, the structural engineer should have an understanding of the lateral load path. Since the special inspector may not have the engineering knowledge to identify the lateral load path it could be difficult for him or her to identify which elements to inspect, and without that identification the likelihood increases that either items will be missed or unneeded inspections will be performed.

The lateral load path is defined as the route that lateral forces take from where they are assumed to originate in the structure to the building base or foundation. This path not only includes the primary lateral load-resisting elements such as shear walls but also the elements that transfer the loads to the walls such as diaphragms and collectors. It also includes the connections between these elements. The goal of seismic design is to identify the forces (and their point of application) and to provide the connections (such as nails, clips, and hold-downs) and the resisting elements (such as roof, floor, and wall sheathing) to carry the forces down to the foundation. If the load path is not continuous, or if just one element of the path is undersized, missing, or constructed poorly, the building could fail during an earthquake or other lateral loading event.

Seismic forces are a function of the mass or weight of the building’s roof, floors, and walls as well as the mass of any other permanent elements such as mechanical systems and ceilings. At each story, the forces are assumed to be applied at the floor (or roof) line. The floor or roof sheathing acts as a horizontal diaphragm, gathering the lateral forces and transferring them to the vertical lateral resisting elements in the structure. Typically in a wood framing building the vertical lateral resisting system consists of wood-framed stud walls with sheathing (e.g., plywood), referred to as shear walls. The shear walls then take these forces and transfer them down to the foundation system, which in turn transfers them to the supporting soil below. Thus the lateral load path for wood-framed building flows from the floor and roof diaphragms to the shear walls to the foundation, and the connections between all of these elements are also part of this load path.
Figure 12: Example illustration of the load path at an exterior shear wall. The load path from the roof is annotated sequentially with numbers. The load path from the floor is annotated sequentially with letters.
Figure 13: Example illustration of the load path at an interior shear wall. The load path from the roof is annotated sequentially with numbers. The load path from the floor is annotated sequentially with letters.
# APPENDIX D

## DEFINITIONS AND TERMINOLOGY

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchor Bolts</td>
<td>Special bolts used to anchor down a wall to the foundation. These bolts are different from those used to connect framing members to each other.</td>
</tr>
<tr>
<td>Approved Fabricator</td>
<td>A fabricator registered and approved by the building official to perform detailed fabrication and quality control procedures without detailed special inspection.</td>
</tr>
<tr>
<td>Blocking</td>
<td>Short framing elements that are placed between joists and studs to stabilize these framing members and strengthen the ability of the diaphragm in resisting lateral loads. It is also often used on top of stud walls. It can also be used as collector or chord elements if properly tied together.</td>
</tr>
<tr>
<td>Building Official</td>
<td>The individual or entity having official jurisdiction over the work. The Building Official reviews and approves the documents submitted for the building construction.</td>
</tr>
<tr>
<td>Collector</td>
<td>A diaphragm or shear wall element parallel to the applied load that collects and transfers shear loads to the vertical elements of the seismic load resisting system or distributes forces within a diaphragm or shear wall. It is sometimes also referred to as a drag member. It may take axial tension or compression forces. The collector can be a single member or several members tied together.</td>
</tr>
<tr>
<td>Diaphragm</td>
<td>The typically horizontal element that transfers lateral forces to the vertical resisting elements. Typically it consists of sheathing supported by framing. Usually, it is also used to support floor or roof loads.</td>
</tr>
<tr>
<td>Diaphragm Chord</td>
<td>The framing element that resists the axial forces generated by bending of the diaphragm perpendicular to its axis. It is typically at the boundary of the diaphragm and acts similarly to flanges of a wide flange steel beam. It may take axial tension or compression forces. The chord can be a single member or several members tied together.</td>
</tr>
<tr>
<td>Fasteners</td>
<td>Bolts, nails, screws, staples, and other pieces used to connect pieces together.</td>
</tr>
<tr>
<td>Glulams</td>
<td>Shop fabricated members that are assembled from several flat wood boards that are glued together with their grain directions parallel to each other and to the length of the member.</td>
</tr>
<tr>
<td>Grain</td>
<td>The direction, size, arrangement, or quality of fibers in wood, normally visible on the surface of sawn wood. Typically sawn members are cut such that the grain runs parallel to the length of the member.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Hangers</td>
<td>Metal hardware used to support framing and connect framing members to their supporting elements.</td>
</tr>
<tr>
<td>Header</td>
<td>A framing member placed perpendicular to wall studs above openings to carry the weight of these studs around the opening. Also a framing member placed across joists to carry the joist weight around a diaphragm opening.</td>
</tr>
<tr>
<td>Hold-downs</td>
<td>Special hardware at the ends of shear walls designed to resist uplift forces due to wall overturning. They transfer the uplift force into the wall or foundation below.</td>
</tr>
<tr>
<td>I-Joists</td>
<td>Shop fabricated members that are assembled with glued together flanges and webs similar in shape to steel wide flange members. They are typically used in repetitive applications similar to joists.</td>
</tr>
<tr>
<td>Joists</td>
<td>Repetitive, parallel framing members used to support floor and roof loads, normally spanning between either walls or larger beams.</td>
</tr>
<tr>
<td>Lateral Force-Resisting System</td>
<td>The elements of the structure that resist lateral forces and transfer them to the foundation. The entire system typically includes horizontal elements (diaphragms, collectors, etc.), vertical elements (shear walls, bracing, etc.) and their associated connections.</td>
</tr>
<tr>
<td>Lumber Grade</td>
<td>The designation of sawn wood members based on a visual evaluation of the wood to a specific set of rules set forth by a recognized grading rules agency such as the Western Wood Products Association. The wood grade quantifies the quality of the wood member and determines the material properties to be used to design of the member.</td>
</tr>
<tr>
<td>Manufactured Lumber</td>
<td>Shop fabricated members (similar to Glulams) that are assembled from several wood elements that are glued together. Examples include parallams and microlams.</td>
</tr>
<tr>
<td>Moisture Content (M.C.)</td>
<td>The weight of water in the wood as a percentage of the weight of oven dried wood.</td>
</tr>
<tr>
<td>Nailers</td>
<td>Wood members that are bolted to steel framing that allow sheathing to be attached to the steel member.</td>
</tr>
<tr>
<td>Oriented Strand Board (OSB)</td>
<td>Sheathing panels assembled by pressing and gluing together mats comprised of wood strands with alternating orientations.</td>
</tr>
<tr>
<td>Plywood</td>
<td>Sheathing panels assembled by pressing and gluing together sheets of thin wood veneer. Typically 3 or 5 sheets are used. It is the most common form of sheathing.</td>
</tr>
<tr>
<td>Shear Walls</td>
<td>Walls designed to resist lateral forces parallel to the plane of the wall with specifically designed elements. Shear walls may or may not also resist vertical forces. Not all building walls are shear walls.</td>
</tr>
<tr>
<td>Sheathing</td>
<td>The plate element that is attached to roof, floor, or wall framing.</td>
</tr>
</tbody>
</table>
and carries lateral loads through shear. Typically it is either plywood or oriented strand board, though for older buildings flat wood boards were used.

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sill Plate</td>
<td>The bottom plate of a bottom level stud wall that is anchored to the foundation.</td>
</tr>
<tr>
<td>Sole Plate</td>
<td>The bottom plate of an upper level stud wall that is fastened to the floor framing and/or the wall below.</td>
</tr>
<tr>
<td>Special Inspection, Continuous</td>
<td>Special inspection by the special inspector who is present when and where the work to be inspected is being performed.</td>
</tr>
<tr>
<td>Special Inspection, Periodic</td>
<td>Special inspection by the special inspector who is intermittently present where the work to be inspected has been or is being performed.</td>
</tr>
<tr>
<td>Splice</td>
<td>The connection between two structural elements joined at their ends to form a single, longer element.</td>
</tr>
<tr>
<td>Studs</td>
<td>The vertical framing that makes up a wood wall, typically 2x or 3x members at a regular spacing.</td>
</tr>
<tr>
<td>Top Plate</td>
<td>The wood members that form the top of a wood stud wall. Typically this consists of two flat 2x members, though other member sizes can be used.</td>
</tr>
</tbody>
</table>
APPENDIX E

REFERENCE DOCUMENTS


SEAONC Construction Quality Assurance Committee, *Guidelines for Special Inspection and Structural Observation, in Accordance with the 2013 CBC*, Structural Engineering Association of Northern California, publication pending